Team LiB

Java in a Nutshell, 5th Edition

By David Flanagan

Publisher: O'Reilly
Pub Date: March 2002
ISBN: 0-596-00773-6
Pages: 992

- Table of Contents
- Index
- Reviews
- Examples
- Reader Reviews
- Errata
- Academic

The 1.4 release of Java 2 Standard edition brings a load of new features - and the potential for frustration. Fret not, our new 4th edition has answers. The accelerated introduction lets you start writing code right away, and because the book's classic quick reference contains all the classes in the essential Java packages, you can find exactly what you neec to make Java's new version work for you.

Java in a Nutshell, 5th Edition

By David Flanagan

Publisher: O'Reilly
Pub Date: March 2002
ISBN: 0-596-00773-6
Pages: 992

- Table of Contents
- Index
- Reviews
- Examples
- Reader Reviews
- Errata
- Academic

- Dedication
- Copyright
- Preface
  - Changes in the Fifth Edition
  - Contents of This Book
  - Related Books
  - Examples Online
  - Conventions Used in This Book
  - Request for Comments
  - How the Quick Reference Is Generated
  - Acknowledgments
- Part I: Introducing Java
  - Chapter 1. Introduction
    - Section 1.1. What Is Java?
    - Section 1.2. Key Benefits of Java
    - Section 1.3. An Example Program
  - Chapter 2. Java Syntax from the Ground Up
    - Section 2.1. Java Programs from the Top Down
    - Section 2.2. Lexical Structure
    - Section 2.3. Primitive Data Types
    - Section 2.4. Expressions and Operators
    - Section 2.5. Statements
    - Section 2.6. Methods
    - Section 2.7. Classes and Objects Introduced
    - Section 2.8. Arrays
    - Section 2.9. Reference Types

- Section 2.10. Packages and the Java Namespace
- Section 2.11. Java File Structure
- Section 2.12. Defining and Running Java Programs
- Section 2.13. Differences Between C and Java
- Chapter 3. Object-Oriented Programming in Java
  - Section 3.1. Class Definition Syntax
  - Section 3.2. Fields and Methods
  - Section 3.3. Creating and Initializing Objects
  - Section 3.4. Destroying and Finalizing Objects
  - Section 3.5. Subclasses and Inheritance
  - Section 3.6. Data Hiding and Encapsulation
  - Section 3.7. Abstract Classes and Methods
  - Section 3.8. Important Methods of java.lang.Object
  - Section 3.9. Interfaces
  - Section 3.10. Nested Types
  - Section 3.11. Modifier Summary
  - Section 3.12. C++ Features Not Found in Java
- Chapter 4. Java 5.0 Language Features
  - Section 4.1. Generic Types
  - Section 4.2. Enumerated Types
  - Section 4.3. Annotations
- Chapter 5. The Java Platform
  - Section 5.1. Java Platform Overview
  - Section 5.2. Text
  - Section 5.3. Numbers and Math
  - Section 5.4. Dates and Times
  - Section 5.5. Arrays
  - Section 5.6. Collections
  - Section 5.7. Threads and Concurrency
  - Section 5.8. Files and Directories
  - Section 5.9. Input/Output with java.io
  - Section 5.10. Networking with java.net
  - Section 5.11. I/O and Networking with java.nio
  - Section 5.12. XML
  - Section 5.13. Types, Reflection, and Dynamic Loading
  - Section 5.14. Object Persistence
  - Section 5.15. Security
  - Section 5.16. Cryptography
  - Section 5.17. Miscellaneous Platform Features
- Chapter 6. Java Security
  - Section 6.1. Security Risks
  - Section 6.2. Java VM Security and Class File Verification
  - Section 6.3. Authentication and Cryptography
  - Section 6.4. Access Control
  - Section 6.5. Security for Everyone
  - Section 6.6. Permission Classes

- Chapter 7. Programming and Documentation Conventions
  - Section 7.1. Naming and Capitalization Conventions
  - Section 7.2. Portability Conventions and Pure Java Rules
  - Section 7.3. Java Documentation Comments
  - Section 7.4. JavaBeans Conventions
- Chapter 8. Java Development Tools
  - apt
  - extcheck
  - jarsigner
  - jar
  - java
  - javac
  - javadoc
  - javah
  - javap
  - javaws
  - jconsole
  - jdb
  - jinfo
  - jmap
  - jps
  - jsadebugd
  - jstack
  - jstat
  - jstatd
  - keytool
  - native2ascii
  - pack200
  - policytool
  - serialver
  - unpack200
- Part II: API Quick Reference
  - Chapter 9. java.io
    - Package java.io
    - BufferedInputStream
    - BufferedOutputStream
    - BufferedReader
    - BufferedWriter
    - ByteArrayInputStream
    - ByteArrayOutputStream
    - CharArrayReader
    - CharArrayWriter
    - CharConversionException
    - Closeable
    - DataInput
    - DataInputStream

- DataOutput
- DataOutputStream
- EOFException
- Externalizable
- File
- FileDescriptor
- FileFilter
- FileInputStream
- FilenameFilter
- FileNotFoundException
- FileOutputStream
- FilePermission
- FileReader
- FileWriter
- FilterInputStream
- FilterOutputStream
- FilterReader
- FilterWriter
- Flushable
- InputStream
- InputStreamReader
- InterruptedIOException
- InvalidClassException
- InvalidObjectException
- IOException
- LineNumberInputStream
- LineNumberReader
- NotActiveException
- NotSerializableException
- ObjectInput
- ObjectInputStream
- ObjectInputStream.GetField
- ObjectInputValidation
- ObjectOutput
- ObjectOutputStream
- ObjectOutputStream.PutField
- ObjectStreamClass
- ObjectStreamConstants
- ObjectStreamException
- ObjectStreamField
- OptionalDataException
- OutputStream
- OutputStreamWriter
- PipedInputStream
- PipedOutputStream
- PipedReader

- PipedWriter
- PrintStream
- PrintWriter
- PushbackInputStream
- PushbackReader
- RandomAccessFile
- Reader
- SequenceInputStream
- Serializable
- SerializablePermission
- StreamCorruptedException
- StreamTokenizer
- StringBufferInputStream
- StringReader
- StringWriter
- SyncFailedException
- UnsupportedEncodingException
- UTFDataFormatException
- WriteAbortedException
- Writer

Chapter 10. java.lang and Subpackages

- Package java.lang
- AbstractMethodError
- AbstractStringBuilder
- Appendable
- ArithmeticException
- ArrayIndexOutOfBoundsException
- ArrayStoreException
- AssertionError
- Boolean
- Byte
- Character
- Character.Subset
- Character.UnicodeBlock
- CharSequence
- Class<T>
- ClassCastException
- ClassCircularityError
- ClassFormatError
- ClassLoader
- ClassNotFoundException
- Cloneable
- CloneNotSupportedException
- Comparable<T>
- Compiler
- Deprecated

- Double
- Enum<E extends Enum<E>>
- EnumConstantNotPresentException
- Error
- Exception
- ExceptionInInitializerError
- Float
- IllegalAccessError
- IllegalAccessException
- IllegalArgumentException
- IllegalMonitorStateException
- IllegalStateException
- IllegalThreadStateException
- IncompatibleClassChangeError
- IndexOutOfBoundsException
- InheritableThreadLocal<T>
- InstantiationError
- InstantiationException
- Integer
- InternalError
- InterruptedException
- Iterable<T>
- LinkageError
- Long
- Math
- NegativeArraySizeException
- NoClassDefFoundError
- NoSuchFieldError
- NoSuchFieldException
- NoSuchMethodError
- NoSuchMethodException
- NullPointerException
- Number
- NumberFormatException
- Object
- OutOfMemoryError
- Override
- Package
- Process
- ProcessBuilder
- Readable
- Runnable
- Runtime
- RuntimeException
- RuntimePermission
- SecurityException

- SecurityManager
- Short
- StackOverflowError
- StackTraceElement
- StrictMath
- String
- StringBuffer
- StringBuilder
- StringIndexOutOfBoundsException
- SuppressWarnings
- System
- Thread
- Thread.State
- Thread.UncaughtExceptionHandler
- ThreadDeath
- ThreadGroup
- ThreadLocal<T>
- Throwable
- TypeNotPresentException
- UnknownError
- UnsatisfiedLinkError
- UnsupportedClassVersionError
- UnsupportedOperationException
- VerifyError
- VirtualMachineError
- Void
- Package java.lang.annotation
- Annotation
- AnnotationFormatError
- AnnotationTypeMismatchException
- Documented
- ElementType
- IncompleteAnnotationException
- Inherited
- Retention
- RetentionPolicy
- Target
- Package java.lang.instrument
- ClassDefinition
- ClassFileTransformer
- IllegalClassFormatException
- Instrumentation
- UnmodifiableClassException
- Package java.lang.management
- ClassLoadingMXBean
- CompilationMXBean

- GarbageCollectorMXBean
- ManagementFactory
- ManagementPermission
- MemoryManagerMXBean
- MemoryMXBean
- MemoryNotificationInfo
- MemoryPoolMXBean
- MemoryType
- MemoryUsage
- OperatingSystemMXBean
- RuntimeMXBean
- ThreadInfo
- ThreadMXBean
- Package java.lang.ref
- PhantomReference<T>
- Reference<T>
- ReferenceQueue<T>
- SoftReference<T>
- WeakReference<T>
- Package java.lang.reflect
- AccessibleObject
- AnnotatedElement
- Array
- Constructor<T>
- Field
- GenericArrayType
- GenericDeclaration
- GenericSignatureFormatError
- InvocationHandler
- InvocationTargetException
- MalformedParameterizedTypeException
- Member
- Method
- Modifier
- ParameterizedType
- Proxy
- ReflectPermission
- Type
- TypeVariable<D extends GenericDeclaration>
- UndeclaredThrowableException
- WildcardType

Chapter 11. java.math

- Package java.math
- BigDecimal
- BigInteger
- MathContext

- RoundingMode
- Chapter 12. java.net
  - Package java.net
  - Authenticator
  - Authenticator.RequestorType
  - BindException
  - CacheRequest
  - CacheResponse
  - ConnectException
  - ContentHandler
  - ContentHandlerFactory
  - CookieHandler
  - DatagramPacket
  - DatagramSocket
  - DatagramSocketImpl
  - DatagramSocketImplFactory
  - FileNameMap
  - HttpRetryException
  - HttpURLConnection
  - Inet4Address
  - Inet6Address
  - InetAddress
  - InetSocketAddress
  - JarURLConnection
  - MalformedURLException
  - MulticastSocket
  - NetPermission
  - NetworkInterface
  - NoRouteToHostException
  - PasswordAuthentication
  - PortUnreachableException
  - ProtocolException
  - Proxy
  - Proxy.Type
  - ProxySelector
  - ResponseCache
  - SecureCacheResponse
  - ServerSocket
  - Socket
  - SocketAddress
  - SocketException
  - SocketImpl
  - SocketImplFactory
  - SocketOptions
  - SocketPermission
  - SocketTimeoutException

- UnknownHostException
- UnknownServiceException
- URI
- URISyntaxException
- URL
- URLClassLoader
- URLConnection
- URLDecoder
- URLEncoder

Chapter 13. java.nio and Subpackages

- Package java.nio
- Buffer
- BufferOverflowException
- BufferUnderflowException
- ByteBuffer
- ByteOrder
- CharBuffer
- DoubleBuffer
- FloatBuffer
- IntBuffer
- InvalidMarkException
- LongBuffer
- MappedByteBuffer
- ReadOnlyBufferException
- ShortBuffer
- Package java.nio.channels
- AlreadyConnectedException
- AsynchronousCloseException
- ByteChannel
- CancelledKeyException
- Channel
- Channels
- ClosedByInterruptException
- ClosedChannelException
- ClosedSelectorException
- ConnectionPendingException
- DatagramChannel
- FileChannel
- FileChannel.MapMode
- FileLock
- FileLockInterruptionException
- GatheringByteChannel
- IllegalBlockingModeException
- IllegalSelectorException
- InterruptibleChannel
- NoConnectionPendingException

- NonReadableChannelException
- NonWritableChannelException
- NotYetBoundException
- NotYetConnectedException
- OverlappingFileLockException
- Pipe
- Pipe.SinkChannel
- Pipe.SourceChannel
- ReadableByteChannel
- ScatteringByteChannel
- SelectableChannel
- SelectionKey
- Selector
- ServerSocketChannel
- SocketChannel
- UnresolvedAddressException
- UnsupportedAddressTypeException
- WritableByteChannel
- Package java.nio.channels.spi
- AbstractInterruptibleChannel
- AbstractSelectableChannel
- AbstractSelectionKey
- AbstractSelector
- SelectorProvider
- Package java.nio.charset
- CharacterCodingException
- Charset
- CharsetDecoder
- CharsetEncoder
- CoderMalfunctionError
- CoderResult
- CodingErrorAction
- IllegalCharsetNameException
- MalformedInputException
- UnmappableCharacterException
- UnsupportedCharsetException
- Package java.nio.charset.spi
- CharsetProvider
- Chapter 14. java.security and Subpackages
  - Package java.security
  - AccessControlContext
  - AccessControlException
  - AccessController
  - AlgorithmParameterGenerator
  - AlgorithmParameterGeneratorSpi
  - AlgorithmParameters

- AlgorithmParametersSpi
- AllPermission
- AuthProvider
- BasicPermission
- Certificate
- CodeSigner
- CodeSource
- DigestException
- DigestInputStream
- DigestOutputStream
- DomainCombiner
- GeneralSecurityException
- Guard
- GuardedObject
- Identity
- IdentityScope
- InvalidAlgorithmParameterException
- InvalidKeyException
- InvalidParameterException
- Key
- KeyException
- KeyFactory
- KeyFactorySpi
- KeyManagementException
- KeyPair
- KeyPairGenerator
- KeyPairGeneratorSpi
- KeyRep
- KeyRep.Type
- KeyStore
- KeyStore.Builder
- KeyStore.CallbackHandlerProtection
- KeyStore.Entry
- KeyStore.LoadStoreParameter
- KeyStore.PasswordProtection
- KeyStore.PrivateKeyEntry
- KeyStore.ProtectionParameter
- KeyStore.SecretKeyEntry
- KeyStore.TrustedCertificateEntry
- KeyStoreException
- KeyStoreSpi
- MessageDigest
- MessageDigestSpi
- NoSuchAlgorithmException
- NoSuchProviderException
- Permission

PermissionCollection
Permissions
Policy
Principal
PrivateKey
PrivilegedAction<T>
PrivilegedActionException
PrivilegedExceptionAction<T>
ProtectionDomain
Provider
Provider.Service
ProviderException
PublicKey
SecureClassLoader
SecureRandom
SecureRandomSpi
Security
SecurityPermission
Signature
SignatureException
SignatureSpi
SignedObject
Signer
Timestamp
UnrecoverableEntryException
UnrecoverableKeyException
UnresolvedPermission
Package java.security.cert
Certificate
Certificate.CertificateRep
CertificateEncodingException
CertificateException
CertificateExpiredException
CertificateFactory
CertificateFactorySpi
CertificateNotYetValidException
CertificateParsingException
CertPath
CertPath.CertPathRep
CertPathBuilder
CertPathBuilderException
CertPathBuilderResult
CertPathBuilderSpi
CertPathParameters
CertPathValidator
CertPathValidatorException

- CertPathValidatorResult
- CertPathValidatorSpi
- CertSelector
- CertStore
- CertStoreException
- CertStoreParameters
- CertStoreSpi
- CollectionCertStoreParameters
- CRL
- CRLException
- CRLSelector
- LDAPCertStoreParameters
- PKIXBuilderParameters
- PKIXCertPathBuilderResult
- PKIXCertPathChecker
- PKIXCertPathValidatorResult
- PKIXParameters
- PolicyNode
- PolicyQualifierInfo
- TrustAnchor
- X509Certificate
- X509CertSelector
- X509CRL
- X509CRLEntry
- X509CRLSelector
- X509Extension
- Package java.security.interfaces
- DSAKey
- DSAKeyPairGenerator
- DSAParams
- DSAPrivateKey
- DSAPublicKey
- ECKey
- ECPrivateKey
- ECPublicKey
- RSAKey
- RSAMultiPrimePrivateCrtKey
- RSAPrivateCrtKey
- RSAPrivateKey
- RSAPublicKey
- Package java.security.spec
- AlgorithmParameterSpec
- DSAParameterSpec
- DSAPrivateKeySpec
- DSAPublicKeySpec
- ECField

- ECFieldF2m
- ECFieldFp
- ECGenParameterSpec
- ECParameterSpec
- ECPoint
- ECPrivateKeySpec
- ECPublicKeySpec
- EllipticCurve
- EncodedKeySpec
- InvalidKeySpecException
- InvalidParameterSpecException
- KeySpec
- MGF1ParameterSpec
- PKCS8EncodedKeySpec
- PSSParameterSpec
- RSAKeyGenParameterSpec
- RSAMultiPrimePrivateCrtKeySpec
- RSAOtherPrimeInfo
- RSAPrivateCrtKeySpec
- RSAPrivateKeySpec
- RSAPublicKeySpec
- X509EncodedKeySpec

Chapter 15. java.text
- Package java.text
- Annotation
- AttributedCharacterIterator
- AttributedCharacterIterator.Attribute
- AttributedString
- Bidi
- BreakIterator
- CharacterIterator
- ChoiceFormat
- CollationElementIterator
- CollationKey
- Collator
- DateFormat
- DateFormat.Field
- DateFormatSymbols
- DecimalFormat
- DecimalFormatSymbols
- FieldPosition
- Format
- Format.Field
- MessageFormat
- MessageFormat.Field
- NumberFormat

- NumberFormat.Field
- ParseException
- ParsePosition
- RuleBasedCollator
- SimpleDateFormat
- StringCharacterIterator

Chapter 16. java.util and Subpackages

- Package java.util
- AbstractCollection<E>
- AbstractList<E>
- AbstractMap<K,V>
- AbstractQueue<E>
- AbstractSequentialList<E>
- AbstractSet<E>
- ArrayList<E>
- Arrays
- BitSet
- Calendar
- Collection<E>
- Collections
- Comparator<T>
- ConcurrentModificationException
- Currency
- Date
- Dictionary<K,V>
- DuplicateFormatFlagsException
- EmptyStackException
- Enumeration<E>
- EnumMap<K extends Enum<K>,V>
- EnumSet<E extends Enum<E>>
- EventListener
- EventListenerProxy
- EventObject
- FormatFlagsConversionMismatchException
- Formattable
- FormattableFlags
- Formatter
- Formatter.BigDecimalLayoutForm
- FormatterClosedException
- GregorianCalendar
- HashMap<K,V>
- HashSet<E>
- Hashtable<K,V>
- IdentityHashMap<K,V>
- IllegalFormatCodePointException
- IllegalFormatConversionException

- IllegalFormatException
- IllegalFormatFlagsException
- IllegalFormatPrecisionException
- IllegalFormatWidthException
- InputMismatchException
- InvalidPropertiesFormatException
- Iterator<E>
- LinkedHashMap<K,V>
- LinkedHashSet<E>
- LinkedList<E>
- List<E>
- ListIterator<E>
- ListResourceBundle
- Locale
- Map<K,V>
- Map.Entry<K,V>
- MissingFormatArgumentException
- MissingFormatWidthException
- MissingResourceException
- NoSuchElementException
- Observable
- Observer
- PriorityQueue<E>
- Properties
- PropertyPermission
- PropertyResourceBundle
- Queue<E>
- Random
- RandomAccess
- ResourceBundle
- Scanner
- Set<E>
- SimpleTimeZone
- SortedMap<K,V>
- SortedSet<E>
- Stack<E>
- StringTokenizer
- Timer
- TimerTask
- TimeZone
- TooManyListenersException
- TreeMap<K,V>
- TreeSet<E>
- UnknownFormatConversionException
- UnknownFormatFlagsException
- UUID

- Vector<E>
- WeakHashMap<K,V>
- Package java.util.concurrent
- AbstractExecutorService
- ArrayBlockingQueue<E>
- BlockingQueue<E>
- BrokenBarrierException
- Callable<V>
- CancellationException
- CompletionService<V>
- ConcurrentHashMap<K,V>
- ConcurrentLinkedQueue<E>
- ConcurrentMap<K,V>
- CopyOnWriteArrayList<E>
- CopyOnWriteArraySet<E>
- CountDownLatch
- CyclicBarrier
- Delayed
- DelayQueue<E extends Delayed>
- Exchanger<V>
- ExecutionException
- Executor
- ExecutorCompletionService<V>
- Executors
- ExecutorService
- Future<V>
- FutureTask<V>
- LinkedBlockingQueue<E>
- PriorityBlockingQueue<E>
- RejectedExecutionException
- RejectedExecutionHandler
- ScheduledExecutorService
- ScheduledFuture<V>
- ScheduledThreadPoolExecutor
- Semaphore
- SynchronousQueue<E>
- ThreadFactory
- ThreadPoolExecutor
- ThreadPoolExecutor.AbortPolicy
- ThreadPoolExecutor.CallerRunsPolicy
- ThreadPoolExecutor.DiscardOldestPolicy
- ThreadPoolExecutor.DiscardPolicy
- TimeoutException
- TimeUnit
- Package java.util.concurrent.atomic
- AtomicBoolean

- AtomicInteger
- AtomicIntegerArray
- AtomicIntegerFieldUpdater<T>
- AtomicLong
- AtomicLongArray
- AtomicLongFieldUpdater<T>
- AtomicMarkableReference<V>
- AtomicReference<V>
- AtomicReferenceArray<E>
- AtomicReferenceFieldUpdater<T,V>
- AtomicStampedReference<V>
- Package java.util.concurrent.locks
- AbstractQueuedSynchronizer
- AbstractQueuedSynchronizer.ConditionObject
- Condition
- Lock
- LockSupport
- ReadWriteLock
- ReentrantLock
- ReentrantReadWriteLock
- ReentrantReadWriteLock.ReadLock
- ReentrantReadWriteLock.WriteLock
- Package java.util.jar
- Attributes
- Attributes.Name
- JarEntry
- JarException
- JarFile
- JarInputStream
- JarOutputStream
- Manifest
- Pack200
- Pack200.Packer
- Pack200.Unpacker
- Package java.util.logging
- ConsoleHandler
- ErrorManager
- FileHandler
- Filter
- Formatter
- Handler
- Level
- Logger
- LoggingMXBean
- LoggingPermission
- LogManager

- LogRecord
- MemoryHandler
- SimpleFormatter
- SocketHandler
- StreamHandler
- XMLFormatter
- Package java.util.prefs
- AbstractPreferences
- BackingStoreException
- InvalidPreferencesFormatException
- NodeChangeEvent
- NodeChangeListener
- PreferenceChangeEvent
- PreferenceChangeListener
- Preferences
- PreferencesFactory
- Package java.util.regex
- Matcher
- MatchResult
- Pattern
- PatternSyntaxException
- Package java.util.zip
- Adler32
- CheckedInputStream
- CheckedOutputStream
- Checksum
- CRC32
- DataFormatException
- Deflater
- DeflaterOutputStream
- GZIPInputStream
- GZIPOutputStream
- Inflater
- InflaterInputStream
- ZipEntry
- ZipException
- ZipFile
- ZipInputStream
- ZipOutputStream

Chapter 17. javax.crypto and Subpackages
- Package javax.crypto
- BadPaddingException
- Cipher
- CipherInputStream
- CipherOutputStream
- CipherSpi

- EncryptedPrivateKeyInfo
- ExemptionMechanism
- ExemptionMechanismException
- ExemptionMechanismSpi
- IllegalBlockSizeException
- KeyAgreement
- KeyAgreementSpi
- KeyGenerator
- KeyGeneratorSpi
- Mac
- MacSpi
- NoSuchPaddingException
- NullCipher
- SealedObject
- SecretKey
- SecretKeyFactory
- SecretKeyFactorySpi
- ShortBufferException
- Package javax.crypto.interfaces
- DHKey
- DHPrivateKey
- DHPublicKey
- PBEKey
- Package javax.crypto.spec
- DESedeKeySpec
- DESKeySpec
- DHGenParameterSpec
- DHParameterSpec
- DHPrivateKeySpec
- DHPublicKeySpec
- IvParameterSpec
- OAEPParameterSpec
- PBEKeySpec
- PBEParameterSpec
- PSource
- PSource.PSpecified
- RC2ParameterSpec
- RC5ParameterSpec
- SecretKeySpec

Chapter 18. javax.net and javax.net.ssl
- Package javax.net
- ServerSocketFactory
- SocketFactory
- Package javax.net.ssl
- CertPathTrustManagerParameters
- HandshakeCompletedEvent

- HandshakeCompletedListener
- HostnameVerifier
- HttpsURLConnection
- KeyManager
- KeyManagerFactory
- KeyManagerFactorySpi
- KeyStoreBuilderParameters
- ManagerFactoryParameters
- SSLContext
- SSLContextSpi
- SSLEngine
- SSLEngineResult
- SSLEngineResult.HandshakeStatus
- SSLEngineResult.Status
- SSLException
- SSLHandshakeException
- SSLKeyException
- SSLPeerUnverifiedException
- SSLPermission
- SSLProtocolException
- SSLServerSocket
- SSLServerSocketFactory
- SSLSession
- SSLSessionBindingEvent
- SSLSessionBindingListener
- SSLSessionContext
- SSLSocket
- SSLSocketFactory
- TrustManager
- TrustManagerFactory
- TrustManagerFactorySpi
- X509ExtendedKeyManager
- X509KeyManager
- X509TrustManager

Chapter 19. javax.security.auth and Subpackages
- Package javax.security.auth
- AuthPermission
- Destroyable
- DestroyFailedException
- Policy
- PrivateCredentialPermission
- Refreshable
- RefreshFailedException
- Subject
- SubjectDomainCombiner
- Package javax.security.auth.callback

- Callback
- CallbackHandler
- ChoiceCallback
- ConfirmationCallback
- LanguageCallback
- NameCallback
- PasswordCallback
- TextInputCallback
- TextOutputCallback
- UnsupportedCallbackException
- Package javax.security.auth.kerberos
- DelegationPermission
- KerberosKey
- KerberosPrincipal
- KerberosTicket
- ServicePermission
- Package javax.security.auth.login
- AccountException
- AccountExpiredException
- AccountLockedException
- AccountNotFoundException
- AppConfigurationEntry
- AppConfigurationEntry.LoginModuleControlFlag
- Configuration
- CredentialException
- CredentialExpiredException
- CredentialNotFoundException
- FailedLoginException
- LoginContext
- LoginException
- Package javax.security.auth.spi
- LoginModule
- Package javax.security.auth.x500
- X500Principal
- X500PrivateCredential

Chapter 20. javax.xml and Subpackages
- Package javax.xml
- XMLConstants
- Package javax.xml.datatype
- DatatypeConfigurationException
- DatatypeConstants
- DatatypeConstants.Field
- DatatypeFactory
- Duration
- XMLGregorianCalendar
- Package javax.xml.namespace

- NamespaceContext
- QName
- Package javax.xml.parsers
- DocumentBuilder
- DocumentBuilderFactory
- FactoryConfigurationError
- ParserConfigurationException
- SAXParser
- SAXParserFactory
- Package javax.xml.transform
- ErrorListener
- OutputKeys
- Result
- Source
- SourceLocator
- Templates
- Transformer
- TransformerConfigurationException
- TransformerException
- TransformerFactory
- TransformerFactoryConfigurationError
- URIResolver
- Package javax.xml.transform.dom
- DOMLocator
- DOMResult
- DOMSource
- Package javax.xml.transform.sax
- SAXResult
- SAXSource
- SAXTransformerFactory
- TemplatesHandler
- TransformerHandler
- Package javax.xml.transform.stream
- StreamResult
- StreamSource
- Package javax.xml.validation
- Schema
- SchemaFactory
- SchemaFactoryLoader
- TypeInfoProvider
- Validator
- ValidatorHandler
- Package javax.xml.xpath
- XPath
- XPathConstants
- XPathException

- XPathExpression
- XPathExpressionException
- XPathFactory
- XPathFactoryConfigurationException
- XPathFunction
- XPathFunctionException
- XPathFunctionResolver
- XPathVariableResolver

Chapter 21. org.w3c.dom
- Package org.w3c.dom
- Attr
- CDATASection
- CharacterData
- Comment
- Document
- DocumentFragment
- DocumentType
- DOMConfiguration
- DOMError
- DOMErrorHandler
- DOMException
- DOMImplementation
- DOMImplementationList
- DOMImplementationSource
- DOMLocator
- DOMStringList
- Element
- Entity
- EntityReference
- NamedNodeMap
- NameList
- Node
- NodeList
- Notation
- ProcessingInstruction
- Text
- TypeInfo
- UserDataHandler

Chapter 22. org.xml.sax and Subpackages
- Package org.xml.sax
- AttributeList
- Attributes
- ContentHandler
- DocumentHandler
- DTDHandler
- EntityResolver

- ErrorHandler
- HandlerBase
- InputSource
- Locator
- Parser
- SAXException
- SAXNotRecognizedException
- SAXNotSupportedException
- SAXParseException
- XMLFilter
- XMLReader
- Package org.xml.sax.ext
- Attributes2
- Attributes2Impl
- DeclHandler
- DefaultHandler2
- EntityResolver2
- LexicalHandler
- Locator2
- Locator2Impl
- Package org.xml.sax.helpers
- AttributeListImpl
- AttributesImpl
- DefaultHandler
- LocatorImpl
- NamespaceSupport
- ParserAdapter
- ParserFactory
- XMLFilterImpl
- XMLReaderAdapter
- XMLReaderFactory

Chapter 23. Class, Method, and Field Index
- Section 23.1. A
- Section 23.2. B
- Section 23.3. C
- Section 23.4. D
- Section 23.5. E
- Section 23.6. F
- Section 23.7. G
- Section 23.8. H
- Section 23.9. I
- Section 23.10. J
- Section 23.11. K
- Section 23.12. L
- Section 23.13. M
- Section 23.14. N

- Section 23.15. O
- Section 23.16. P
- Section 23.17. Q
- Section 23.18. R
- Section 23.19. S
- Section 23.20. T
- Section 23.21. U
- Section 23.22. V
- Section 23.23. W
- Section 23.24. X
- Section 23.25. Y
- Section 23.26. Z
- Colophon
- Index

Dedication

This book is dedicated to all
who teach peace and resist violence.

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

O'Reilly books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles (http://safari.oreilly.com). For more information, contact our corporate/institutional sales department: (800) 998-9938 or corporate@oreilly.com.

Preface

This book is a desktop Java™ quick reference, designed to sit faithfully by your keyboard while you program. Part I of the book is a fast-paced, "no-fluff" introduction to the Java programming language and the core APIs of the Java platform. Part II is a quick reference section that succinctly details most classes and interfaces of those core APIs. The book covers Java 1.0, 1.1, 1.2, 1.3, 1.4, and 5.0

Team LiB

Changes in the Fifth Edition

The fifth edition of this book covers Java 5.0. As its incremented version number attests, this new version of Java has a lot of new features. The three most significant new language features are generic types, enumerated types, and annotations, which are covered in a new chapter of their own. Experienced Java programmers who just want to learn about these new features can jump straight to Chapter 4.

Other new language features of Java 5.0 are:

- The `for/in` statement for easily iterating through arrays and collections (this statement is sometimes called "foreach").
- Autoboxing and autounboxing conversions to automatically convert back and forth between primitive values and their corresponding wrapper objects (such as `int` values and `Integer` objects) as needed.
- Varargs methods to define and invoke methods that accept an arbitrary number of arguments.
- Covariant returns to allow a subclass to override a superclass method and narrow the return type of the method.
- The `import static` declaration to import the `static` members of a type into the namespace.

Although each of these features is new in Java 5.0, none of them is large enough to merit a chapter of its own. Coverage of these features is integrated into Chapter 2.

In addition to these language changes, Java 5.0 also includes changes to the Java platform. Important enhancements include the following:

- The `java.util` collections classes have been converted to be generic types, providing support for typesafe collections. This is covered in Chapter 4.
- The `java.util` package also includes the new `Formatter` class. This class enables C-style formatted text output with `printf( )` and `format( )` methods. Examples are included in Chapter 5. The `java.util.Formatter` enTRy in the quick reference includes a detailed table of formatting options.
- The new package `java.util.concurrent` includes important utilities for threadsafe concurrent programming. Chapter 5 provides examples.
- `java.lang` has three new subpackages:
- `java.lang.annotation`
- `java.lang.instrument`

- `java.lang.management`

- These packages support Java 5.0 annotations and the instrumentation, management, and monitoring of a running Java interpreter. Although their position in the `java.lang` hierarchy marks these packages as very important, they are not commonly used. Annotation examples are provided in Chapter 4, and a simple instrumentation and management example is found in Chapter 5.

- New packages have been added to the `javax.xml` hierarchy. `javax.xml.validation` supports document validation with schemas. `javax.xml.xpath` supports the XPath query language. And `javax.xml.namespace` provides simple support for XML namespaces. Validation and XPath examples are in Chapter 5.

In a mostly futile attempt to make room for this new material, I've had to make some cuts. I've removed coverage of the packages `java.beans`, `java.beans.beancontext`, `java.security.acl`, and `org.ietf.jgss` from the quick reference. JavaBeans standards have not caught on in core Java APIs and now appear to be relevant only for Swing and related graphical APIs. As such, they are no longer relevant in this book. The `java.security.acl` package has been deprecated since Java 1.2 and I've taken this opportunity to remove it. And the `org.ietf.jgss` package is of interest to only a very narrow subset of readers.

Along with removing coverage of `java.beans` from the quick reference section, I've also cut the chapter on JavaBeans from Part I of this book. The material on JavaBeans naming conventions from that chapter remains useful, however, and has been moved into Chapter 7.

Contents of This Book

The first eight chapters of this book document the Java language, the Java platform, and the Java development tools that are supplied with Sun's Java Development Kit (JDK). The first five chapters are essential; the next three cover topics of interest to some, but not all, Java programmers.

Chapter 1: Introduction

This chapter is an overview of the Java language and the Java platform that explains the important features and benefits of Java. It concludes with an example Java program and walks the new Java programmer through it line by line.

Chapter 2: Java Syntax from the Ground Up

This chapter explains the details of the Java programming language, including some of the Java 5.0 language changes. It is a long and detailed chapter that does not assume substantial programming experience. Experienced Java programmers can use it as a language reference. Programmers with substantial experience with languages such as C and C++ should be able to pick up Java syntax quickly by reading this chapter; beginning programmers with only a modest amount of experience should be able to learn Java programming by studying this chapter carefully.

Chapter 3: Object-Oriented Programming in Java

This chapter describes how the basic Java syntax documented in Chapter 2 is used to write object-oriented programs in Java. The chapter assumes no prior experience with OO programming. It can be used as a tutorial by new programmers or as a reference by experienced Java programmers.

Chapter 4: Java 5.0 Language Features

This chapter documents the three biggest new features of Java 5.0: generic types, enumerated types, and annotations. If you read previous editions of this book, you might want to skip directly to this chapter.

Chapter 5: The Java Platform

This chapter is an overview of the essential Java APIs covered in this book. It contains numerous short examples that demonstrate how to perform common tasks with the classes and interfaces that comprise the Java platform. Programmers who are new to Java (and especially those who learn best by example) should find this a valuable chapter.

Chapter 6: Java Security

This chapter explains the Java security architecture that allows untrusted code to run in a secure environment from which it cannot do any malicious damage to the host system. It is important for all Java programmers to have at least a passing familiarity with Java security mechanisms.

Chapter 7: Programming and Documentation Conventions

This chapter documents important and widely adopted Java programming conventions, including JavaBeans naming conventions. It also explains how you can make your Java code self-documenting by including specially formatted documentation comments.

Chapter 8: Java Development Tools

Sun's JDK includes a number of useful Java development tools, most notably the Java interpreter and the Java compiler. This chapter documents those tools.

These first eight chapters teach you the Java language and get you up and running with the Java APIs. Part II of the book is a succinct but detailed API reference formatted for optimum ease of use. Please be sure to read Section II.1 in Part II; it explains how to get the most out of the quick reference section. Also, please note that the quick reference chapters are followed by one final chapter called "Class, Method, and Field Index." This special index allows you to look up the name of a type and find the package in which it is defined or to look up the name of a method or field and find the type in which it it is defined.

Team LiB

Related Books

O'Reilly publishes an entire series of books on Java programming, including several companion books to this one. The companion books are:

Java Examples in a Nutshell

This book contains hundreds of complete, working examples illustrating many common Java programming tasks using the core, enterprise, and desktop APIs. *Java Examples in a Nutshell* is like Chapter 4 of this book, but greatly expanded in breadth and depth, and with all the code snippets fully fleshed out into working examples. This is a particularly valuable book for readers who learn well by experimenting with existing code.

Java Enterprise in a Nutshell

This book is a succinct tutorial for the Java "Enterprise" APIs such as JDBC, RMI, JNDI, and CORBA. It also cover enterprise tools such as Hibernate, Struts, Ant, JUnit, and XDoclet.

J2ME in a Nutshell

This book is a tutorial and quick reference for the graphics, networking, and database APIs of the Java 2 Micro Edition (J2ME) platform.

You can find a complete list of Java books from O'Reilly at http://java.oreilly.com/. Books that focus on the core Java APIs, as this one does, include:

Learning Java, *by Pat Niemeyer and Jonathan Knudsen*

This book is a comprehensive tutorial introduction to Java, with an emphasis on client-side Java programming.

Java Swing*, by Marc Loy, Robert Eckstein, Dave Wood, James Elliott, and Brian Cole*

This book provides excellent coverage of the Swing APIs and is a must-read for GUI developers.

Java Threads, *by Scott Oaks and Henry Wong*

Java makes multithreaded programming easy, but doing it right can still be tricky. This book explains everything you need to know.

Java I/O, *by Elliotte Rusty Harold*

Java's stream-based input/output architecture is a thing of beauty. This book covers it in the detail it deserves.

Java Network Programming, *by Elliotte Rusty Harold*

This book documents the Java networking APIs in detail.

Java Security, *by Scott Oaks*

This book explains the Java access-control mechanisms in detail and also documents the authentication mechanisms of digital signatures and message digests.

Java Cryptography, *by Jonathan Knudsen*

This book provides thorough coverage of the Java Cryptography Extension, the `javax.crypto.*` packages, and cryptography in Java.

Examples Online

The examples in this book are available online and can be downloaded from the home page for the book at http://www.oreilly.com/catalog/javanut5. You may also want to visit this site for any important notes or errata that have been published there.

Team LiB

Conventions Used in This Book

We use the following formatting conventions in this book:

Italic

Used for emphasis and to signify the first use of a term. Italic is also used for commands, emai addresses, web sites, FTP sites, and file and directory names.

Bold

Occasionally used to refer to particular keys on a computer keyboard or to portions of a user interface, such as the **Back** button or the **Options** menu.

`Constant Width`

Used for all Java code as well as for anything that you would type literally when programming, including keywords, data types, constants, method names, variables, class names, and interface names.

`Constant Width Italic`

Used for the names of function arguments and generally as a placeholder to indicate an item that should be replaced with an actual value in your program. Sometimes used to refer to a conceptual section or line of code as in *`statement`*.

`Franklin Gothic Book Condensed`

Used for the Java class synopses in the quick reference section. This very narrow font allows us to fit a lot of information on the page without a lot of distracting line breaks. This font is also used for code entities in the descriptions in the quick reference section.

Franklin Gothic Demi Condensed

Used for highlighting class, method, field, property, and constructor names in the quick reference section, which makes it easier to scan the class synopses.

Franklin Gothic Book Condensed Italic

Used for method parameter names and comments in the quick reference section.

Request for Comments

Please address comments and questions concerning this book to the publisher:

O'Reilly Media, Inc.
1005 Gravenstein Highway North
Sebastopol, CA 95472
(800) 998-9938 (in the United States or Canada)
(707) 829-0515 (international or local)
(707) 829-1014 (fax)

There is a web page for this book, which lists errata, examples, and any additional information. You can access this page at:

http://www.oreilly.com/catalog/javanut5

To ask technical questions or comment on this book, send email to:

bookquestions@oreilly.com

For more information about books, conferences, Resource Centers, and the O'Reilly Network, see the O'Reilly web site at:

http://www.oreilly.com

Team LiB

How the Quick Reference Is Generated

For the curious reader, this section explains a bit about how the quick reference material in *Java in a Nutshell* and related books is created.

As Java has evolved, so has my system for generating Java quick reference material. The current system is part of a larger commercial documentation browser system I'm developing (visit http://www.davidflanagan.com/Jude for more information about it). The program works in two passes: the first pass collects and organizes the API information, and the second pass outputs that information in the form of quick reference chapters.

The first pass begins by reading the class files for all of the classes and interfaces to be documented. Almost all of the API information in the quick reference is available in these class files. The notable exception is the names of method arguments, which are not stored in class files. These argument names are obtained by parsing the Java source file for each class and interface. Where source files are not available, I obtain method argument names by parsing the API documentation generated by *javadoc*. The parsers I use to extract API information from the source files and *javadoc* files are created using the Antlr parser generator developed by Terence Parr. (See http://www.antlr.org for details on this very powerful programming tool.)

Once the API information has been obtained by reading class files, source files, and *javadoc* files, the program spends some time sorting and cross-referencing everything. Then it stores all the API information into a single large data file.

The second pass reads API information from that data file and outputs quick reference chapters using a custom XML doctype. Once I've generated the XML output, I hand it off to the production team at O'Reilly. In the past, these XML documents were converted to troff and formatted with GNU *groff* using a highly customized macro package. In this edition, the chapters were converted from XML to Framemaker instead, using in-house production tools.

Team LiB

Acknowledgments

Many people helped in the creation of this book, and I am grateful to them all. I am indebted to the many, many readers of the first four editions who wrote in with comments, suggestions, bug reports, and praise. Their many small contributions are scattered throughout the book. Also, my apologies to those who made many good suggestions that could not be incorporated into this edition.

Deb Cameron was the editor for the fifth edition. Deb edited not only the material that was new in this edition but also made the time to carefully read over the old material, giving it a much-needed updating. Deb was patient when my work on this book veered off in an unexpected direction and provided steady guidance to help get me back on track. The fourth edition was edited by Bob Eckstein, a careful editor with a great sense of humor. Paula Ferguson, a friend and colleague, was the editor of the first three editions of this book. Her careful reading and practical suggestions made the book stronger, clearer, and more useful.

As usual, I've had a crack team of technical reviewers for this edition of the book. Gilad Bracha of Sun reviewed the material on generic types. Josh Bloch, a former Sun employee who is now at Google, reviewed the material on enumerated types and annotations. Josh was also a reviewer for the third and fourth editions of the book, and his helpful input has been an invaluable resource for me. Josh's book *Effective Java Programming Guide* (Addison Wesley) is highly recommended. Neal Gafter, who, like Josh, left Sun for Google, answered many questions about annotations and generics. David Biesack of SAS, Changshin Lee of the Korean company Tmax Soft, and Tim Peierls were colleagues of mine on the JSR-201 expert group that was responsible for a number of language changes in Java 5.0. They reviewed the generics and enumerated type material. Joseph Bowbeer, Brian Goetz, and Bill Pugh were members of the JSR-166 or JSR-133 expert groups and helped me tc understand threading and concurrency issues behind the `java.util.concurrency` package. Iris Garcia of Sun answered my questions about the new `java.util.Formatter` class that she authored. My sincere thanks go to each of these engineers. Any mistakes that remain in the book are, of course, my own.

The fourth edition was also reviewed by a number of engineers from Sun and elsewhere. Josh Bloch reviewed material on assertions and the Preferences API. Bob Eckstein reviewed XML material. Graham Hamilton reviewed the Logging API material. Ron Hitchens reviewed the New I/O material. Jonathan Knudsen (who is also an O'Reilly author) reviewed the JSSE and Certification Path material. Charlie Lai reviewed the JAAS material. Ram Marti reviewed the JGSS material. Philip Milne, a former Sun employee, now at Dresdner Kleinwort Wasserstein, reviewed the material on the JavaBeans persistence mechanism. Mark Reinhold reviewed the `java.nio` material. Mark deserves special thanks for having been a reviewer for the second, third, and fourth editions of this book. Andreas Sterbenz and Brad Wetmore reviewed the JSSE material.

The third edition also benefited greatly from the contributions of reviewers who are intimately familia with the Java platform. Joshua Bloch, one of the primary authors of the Java collections framework, reviewed my descriptions of the collections classes and interfaces. Josh was also helpful in discussing the `Timer` and `TimerTask` classes of Java 1.3 with me. Mark Reinhold, creator of the `java.lang.ref` package, explained the package to me and reviewed my documentation of it. Scott Oaks reviewed my descriptions of the Java security and cryptography classes and interfaces. The documentation of the `javax.crypto` package and its subpackages was also reviewed by Jon Eaves. Finally, Chapter 1

was improved by the comments of reviewers who were *not* already familiar with the Java platform: Christina Byrne reviewed it from the standpoint of a novice programmer, and Judita Byrne of Virginia Power offered her comments as a professional COBOL programmer.

For the second edition, John Zukowski reviewed my Java 1.1 AWT quick reference material, and George Reese reviewed most of the remaining new material. The second edition was also blessed with a "dream team" of technical reviewers from Sun. John Rose, the author of the Java inner class specification, reviewed the chapter on inner classes. Mark Reinhold, author of the new character stream classes in `java.io`, reviewed my documentation of these classes. Nakul Saraiya, the designer of the Java Reflection API, reviewed my documentation of the `java.lang.reflect` package.

Mike Loukides provided high-level direction and guidance for the first edition of the book. Eric Raymond and Troy Downing reviewed that first editionthey helped spot my errors and omissions and offered good advice on making the book more useful to Java programmers.

The O'Reilly production team has done its usual fine work of creating a book out of the electronic files I submit. My thanks to them all.

As always, my thanks and love to Christie.

David Flanagan
http://www.davidflanagan.com
March 2005

Part I: Introducing Java

Part I is an introduction to the Java language and the Java platform. These chapters provide enough information for you to get started using Java right away.

Chapter 1
Chapter 2
Chapter 3
Chapter 4
Chapter 5
Chapter 6
Chapter 7
Chapter 8

Chapter 1. Introduction

Welcome to Java. This chapter begins by explaining what Java is and describing some of the features that distinguish it from other programming languages. Next, it outlines the structure of this book, with special emphasis on what is new in Java 5.0. Finally, as a quick tutorial introduction to the language, it walks you through a simple Java program you can type, compile, and run.

Team LiB

downloaded from: lib.ommolketab.ir

1.1. What Is Java?

In discussing Java, it is important to distinguish between the Java programming language, the Java Virtual Machine, and the Java platform. The Java programming language is the language in which Java applications, applets, servlets, and components are written. When a Java program is compiled, it is converted to byte codes that are the portable machine language of a CPU architecture known as the Java Virtual Machine (also called the Java VM or JVM). The JVM can be implemented directly in hardware, but it is usually implemented in the form of a software program that interprets and executes byte codes.

The Java platform is distinct from both the Java language and Java VM. The Java platform is the predefined set of Java classes that exist on every Java installation; these classes are available for use by all Java programs. The Java platform is also sometimes referred to as the Java runtime environment or the core Java APIs (application programming interfaces). The Java platform can be extended with optional packages (formerly called standard extensions). These APIs exist in some Java installations but are not guaranteed to exist in all installations.

1.1.1. The Java Programming Language

The Java programming language is a state-of-the-art, object-oriented language that has a syntax similar to that of C. The language designers strove to make the Java language powerful, but, at the same time, they tried to avoid the overly complex features that have bogged down other object-oriented languages like C++. By keeping the language simple, the designers also made it easier for programmers to write robust, bug-free code. As a result of its elegant design and next-generation features, the Java language has proved popular with programmers, who typically find it a pleasure to work with Java after struggling with more difficult, less powerful languages.

Java 5.0, the latest version of the Java language,[1] includes a number of new language features, most notably generic types, which increase both the complexity and the power of the language. Most experienced Java programmers have welcomed the new features, despite the added complexity they bring.

[1] Java 5.0 represents a significant change in version numbering for Sun. The previous version of Java is Java 1.4 so you may sometimes hear Java 5.0 informally referred to as Java 1.5.

1.1.2. The Java Virtual Machine

The Java Virtual Machine, or Java interpreter, is the crucial piece of every Java installation. By design, Java programs are portable, but they are only portable to platforms to which a Java interpreter has been ported. Sun ships VM implementations for its own Solaris operating system and for Microsoft Windows and Linux platforms. Many other vendors, including Apple and various commercial Unix vendors, provide Java interpreters for their platforms. The Java VM is not only for desktop systems, however. It has been ported to set-top boxes and handheld devices that run Windows CE and PalmOS.

Although interpreters are not typically considered high-performance systems, Java VM performance has improved dramatically since the first versions of the language. The latest releases of Java run remarkably fast. Of particular note is a VM technology called *just-in-time* (JIT) compilation whereby Java byte codes are converted on the fly into native platform machine language, boosting execution speed for code that is run repeatedly.

1.1.3. The Java Platform

The Java platform is just as important as the Java programming language and the Java Virtual Machine. All programs written in the Java language rely on the set of predefined classes[2] that comprise the Java platform. Java classes are organized into related groups known as *packages*. The Java platform defines packages for functionality such as input/output, networking, graphics, user-interface creation, security, and much more.

[2] A *class* is a module of Java code that defines a data structure and a set of methods (also called procedures, functions, or subroutines) that operate on that data.

It is important to understand what is meant by the term platform. To a computer programmer, a platform is defined by the APIs he can rely on when writing programs. These APIs are usually defined by the operating system of the target computer. Thus, a programmer writing a program to run under Microsoft Windows must use a different set of APIs than a programmer writing the same program for a Unix-based system. In this respect, Windows and Unix are distinct platforms.

Java is not an operating system. Nevertheless, the Java platform provides APIs with a comparable breadth and depth to those defined by an operating system. With the Java platform, you can write applications in Java without sacrificing the advanced features available to programmers writing native applications targeted at a particular underlying operating system. An application written on the Java platform runs on any operating system that supports the Java platform. This means you do not have to create distinct Windows, Macintosh, and Unix versions of your programs, for example. A single Java program runs on all these operating systems, which explains why "Write once, run anywhere" is Sun's motto for Java.

The Java platform is not an operating system, but for programmers, it is an alternative development target and a very popular one at that. The Java platform reduces programmers' reliance on the underlying operating system, and, by allowing programs to run on top of any operating system, it increases end users' freedom to choose an operating system.

1.1.4. Versions of Java

As of this writing, there have been six major versions of Java. They are:

Java 1.0

This was the first public version of Java. It contained 212 classes organized in 8 packages. It was simple and elegant but is now completely outdated.

Java 1.1

This release of Java more than doubled the size of the Java platform to 504 classes in 23 packages. It introduced nested types (or "inner classes"), an important change to the Java language itself, and included significant performance improvements in the Java VM. This version is outdated.

Java 1.2

This was a very significant release of Java; it tripled the size of the Java platform to 1,520 classes in 59 packages. Important additions included the Collections API for working with sets, lists, and maps of objects and the Swing API for creating graphical user interfaces. Because of the many new features included in the 1.2 release, the platform was rebranded as "the Java 2 Platform." The term "Java 2" was simply a trademark, however, and not an actual version number for the release.

Java 1.3

This was primarily a maintenance release, focused on bug fixes, stability, and performance improvements (including the high-performance "HotSpot" virtual machine). Additions to the platform included the Java Naming and Directory Interface (JNDI) and the Java Sound APIs, which were previously available as extensions to the platform. The most interesting classes in this release were probably `java.util.Timer` and `java.lang.reflect.Proxy`. In total, Java 1.3 contains 1,842 classes in 76 packages.

Java 1.4

This was another big release, adding important new functionality and increasing the size of the platform by 62% to 2,991 classes and interfaces in 135 packages. New features included a high-performance, low-level I/O API; support for pattern matching with regular expressions; a logging API; a user preferences API; new Collections classes; an XML-based persistence mechanism for JavaBeans; support for XML parsing using both the DOM and SAX APIs; user authentication with the Java Authentication and Authorization Service (JAAS) API; support for secure network connections using the SSL protocol; support for cryptography; a new API for reading and writing image files; an API for network printing; a handful of new GUI components in the Swing API; and a simplified drag-and-drop architecture for Swing. In addition to these platform changes, the 1.4 release introduced an `assert` statement to the Java language.

Java 5.0

The most recent release of Java introduces a number of changes to the core language itself including generic types, enumerated types, annotations, varargs methods, autoboxing, and a new `for/in` statement. Because of the major language changes, the version number was incremented. This release would logically be known as "Java 2.0" if Sun had not already used the term "Java 2" for marketing Java 1.2.

In addition to the language changes, Java 5.0 includes a number of additions to the Java platform as well. This release includes 3562 classes and interfaces in 166 packages. Notable additions include utilities for concurrent programming, a remote management framework, and classes for the remote management and instrumentation of the Java VM itself.

See the Preface for a list of changes in this edition of the book, including pointers to coverage of the new language and platform features.

To write programs in Java, you must obtain the Java Development Kit (JDK). Sun releases a new version of the JDK for each new version of Java. Don't confuse the JDK with the Java Runtime Environment (JRE). The JRE contains everything you need to run Java programs, but it does not contain the tools you need to develop Java programs (primarily the compiler).

In addition to the Standard Edition of Java used by most Java developers and documented in this book, Sun has also released the Java 2 Platform, Enterprise Edition (or J2EE) for enterprise developers and the Java 2 Platform, Micro Edition (J2ME) for consumer electronic systems, such as handheld PDAs and cellular telephones. See *Java Enterprise in a Nutshell* and *Java Micro Edition in a Nutshell* (both by O'Reilly) for more information on these other editions.

Team LiB

1.2. Key Benefits of Java

Why use Java at all? Is it worth learning a new language and a new platform? This section explores some of the key benefits of Java.

1.2.1. Write Once, Run Anywhere

Sun identifies "Write once, run anywhere" as the core value proposition of the Java platform. Translated from business jargon, this means that the most important promise of Java technology is that you have to write your application only oncefor the Java platformand then you'll be able to run it *anywhere*.

Anywhere, that is, that supports the Java platform. Fortunately, Java support is becoming ubiquitous It is integrated into practically all major operating systems. It is built into the popular web browsers, which places it on virtually every Internet-connected PC in the world. It is even being built into consumer electronic devices such as television set-top boxes, PDAs, and cell phones.

1.2.2. Security

Another key benefit of Java is its security features. Both the language and the platform were designed from the ground up with security in mind. The Java platform allows users to download untrusted code over a network and run it in a secure environment in which it cannot do any harm: untrusted code cannot infect the host system with a virus, cannot read or write files from the hard drive, and so forth. This capability alone makes the Java platform unique.

Java 1.2 took the security model a step further. It made security levels and restrictions highly configurable and extended them beyond applets. As of Java 1.2, any Java code, whether it is an applet, a servlet, a JavaBeans component, or a complete Java application, can be run with restricted permissions that prevent it from doing harm to the host system.

The security features of the Java language and platform have been subjected to intense scrutiny by security experts around the world. In the earlier days of Java, security-related bugs, some of them potentially serious, were found and promptly fixed. Because of the strong security promises Java makes, it is big news when a new security bug is found. No other mainstream platform can make security guarantees nearly as strong as those Java makes. No one can say that Java security holes will not be found in the future, but if Java's security is not yet perfect, it has been proven strong enough for practical day-to-day use and is certainly better than any of the alternatives.

1.2.3. Network-Centric Programming

Sun's corporate motto has always been "The network is the computer." The designers of the Java platform believed in the importance of networking and designed the Java platform to be network-centric. From a programmer's point of view, Java makes it easy to work with resources across a network and to create network-based applications using client/server or multitier architectures.

1.2.4. Dynamic, Extensible Programs

Java is both dynamic and extensible. Java code is organized in modular object-oriented units called *classes*. Classes are stored in separate files and are loaded into the Java interpreter only when needed. This means that an application can decide as it is running what classes it needs and can load them when it needs them. It also means that a program can dynamically extend itself by loading the classes it needs to expand its functionality.

The network-centric design of the Java platform means that a Java application can dynamically extend itself by loading new classes over a network. An application that takes advantage of these features ceases to be a monolithic block of code. Instead, it becomes an interacting collection of independent software components. Thus, Java enables a powerful new metaphor of application design and development.

1.2.5. Internationalization

The Java language and the Java platform were designed from the start with the rest of the world in mind. When it was created, Java was the only commonly used programming language that had internationalization features at its core rather than tacked on as an afterthought. While most programming languages use 8-bit characters that represent only the alphabets of English and Western European languages, Java uses 16-bit Unicode characters that represent the phonetic alphabets and ideographic character sets of the entire world. Java's internationalization features are not restricted to just low-level character representation, however. The features permeate the Java platform, making it easier to write internationalized programs with Java than it is with any other environment.

1.2.6. Performance

As described earlier, Java programs are compiled to a portable intermediate form known as byte codes, rather than to native machine-language instructions. The Java Virtual Machine runs a Java program by interpreting these portable byte-code instructions. This architecture means that Java programs are faster than programs or scripts written in purely interpreted languages, but Java programs are typically slower than C and C++ programs compiled to native machine language. Keep in mind, however, that although Java programs are compiled to byte code, not all of the Java platform is implemented with interpreted byte codes. For efficiency, computationally intensive portions of the Java platformsuch as the string-manipulation methodsare implemented using native machine code.

Although early releases of Java suffered from performance problems, the speed of the Java VM has improved dramatically with each new release. The VM has been highly tuned and optimized in many significant ways. Furthermore, most current implementations include a just-in-time (JIT) compiler, which converts Java byte codes to native machine instructions on the fly. Using sophisticated JIT compilers, Java programs can execute at speeds comparable to the speeds of native C and C++ applications.

Java is a portable, interpreted language; Java programs run almost as fast as native, nonportable C and C++ programs. Performance used to be an issue that made some programmers avoid using Java. With the improvements made in Java 1.2, 1.3, 1.4, and 5.0, performance issues should no longer keep anyone away.

1.2.7. Programmer Efficiency and Time-to-Market

The final, and perhaps most important, reason to use Java is that programmers like it. Java is an elegant language combined with a powerful and (usually) well-designed set of APIs. Programmers enjoy programming in Java and are often amazed at how quickly they can get results with it. Because Java is a simple and elegant language with a well-designed, intuitive set of APIs, programmers write better code with fewer bugs than for other platforms, thus reducing development time.

1.3. An Example Program

Example 1-1 shows a Java program to compute factorials.[3] Note that the numbers at the beginning of each line are not part of the program; they are there for ease of reference when we dissect the program line-by-line.

[3] The factorial of an integer is the product of the number and all positive integers less than the number. So, for example, the factorial of 4, which is also written 4!, is 4 times 3 times 2 times 1, or 24. By definition, 0! is 1.

Example 1-1. Factorial.java: a program to compute factorials

```
/**
 * This program computes the factorial of a number
 */
public class Factorial {                      // Define a class
  public static void main(String[] args) {   // The program starts here
    int input = Integer.parseInt(args[0]);   // Get the user's input
    double result = factorial(input);        // Compute the factorial
    System.out.println(result);              // Print out the result
  }                                          // The main() method ends here

  public static double factorial(int x) {    // This method computes x!
    if (x < 0)                               // Check for bad input
      return 0.0;                            // If bad, return 0
    double fact = 1.0;                       // Begin with an initial value
    while(x > 1) {                           // Loop until x equals 1
      fact = fact * x;                       // Multiply by x each time
      x = x - 1;                             // And then decrement x
    }                                        // Jump back to start of loop
    return fact;                             // Return the result
  }                                          // factorial() ends here
}                                            // The class ends here
```

1.3.1. Compiling and Running the Program

Before we look at how the program works, we must first discuss how to run it. In order to compile and run the program, you need a Java development kit (JDK) of some sort. Sun Microsystems created the Java language and ships a free JDK for its Solaris operating system and also for Linux and Microsoft Windows platforms.[4] At the time of this writing, the current version of Sun's JDK is available for download from http://java.sun.com. Be sure to get the JDK and not the Java Runtime Environment. The JRE enables you to run existing Java programs, but not to write and compile your own.

[4] Other companies, such as Apple, have licensed and ported the JDK to their operating systems. In Apple's case, this

arrangement leads to a delay in the latest JDK being available on that platform.

The Sun JDK is not the only Java programming environment you can use. *gcj*, for example, is a Java compiler released under the GNU general public license. A number of companies sell Java IDEs (integrated development environments), and high-quality open-source IDEs are also available. This book assumes that you are using Sun's JDK and its accompanying command-line tools. If you are using a product from some other vendor, be sure to read that vendor's documentation to learn how to compile and run a simple program, like that shown in Example 1-1.

Once you have a Java programming environment installed, the first step towards running our program is to type it in. Using your favorite text editor, enter the program as it is shown in Example 1-1.[5] Omit the line numbers, which are just for reference. Note that Java is a case-sensitive language, so you must type lowercase letters in lowercase and uppercase letters in uppercase. You'll notice that many of the lines of this program end with semicolons. It is a common mistake to forget these characters, but the program won't work without them, so be careful! You can omit everything from `//` to the end of a line: those are *comments* that are there for your benefit and are ignored by Java.

[5] I recommend that you type this example in by hand, to get a feel for the language. If you *really* don't want to, however, you can download this, and all examples in the book, from http://www.oreilly.com/catalog/javanut5/.

When writing Java programs, you should use a text editor that saves files in plain-text format, not a word processor that supports fonts and formatting and saves files in a proprietary format. My favorite text editor on Unix systems is *Emacs*. If you use a Windows system, you might use *Notepad* or *WordPad*, if you don't have a more specialized programmer's editor (versions of GNU Emacs, for example, are available for Windows). If you are using an IDE, it should include an appropriate text editor; read the documentation that came with the product. When you are done entering the program, save it in a file named *Factorial.java*. This is important; the program will not work if you save it by any other name.

After writing a program like this one, the next step is to compile it. With Sun's JDK, the Java compiler is known as *javac*. *javac* is a command-line tool, so you can only use it from a terminal window, such as an MS-DOS window on a Windows system or an *xterm* window on a Unix system. Compile the program by typing the following command:

```
C:\> javac Factorial.java
```

If this command prints any error messages, you probably got something wrong when you typed in the program. If it does not print any error messages, however, the compilation has succeeded, and *javac* creates a file called *Factorial.class*. This is the compiled version of the program.

Once you have compiled a Java program, you must still run it. Java programs are not compiled into native machine language, so they cannot be executed directly by the system. Instead, they are run by another program known as the Java interpreter. In Sun's JDK, the interpreter is a command-line program named, appropriately enough, *java*. To run the factorial program, type:

```
C:\> java Factorial 4
```

java is the command to run the Java interpreter, *Factorial* is the name of the Java program we want the interpreter to run, and *4* is the input datathe number we want the interpreter to compute the factorial of. The program prints a single line of output, telling us that the factorial of 4 is 24:

```
C:\> java Factorial 4
24.0
```

Congratulations! You've just written, compiled, and run your first Java program. Try running it again to compute the factorials of some other numbers.

1.3.2. Analyzing the Program

Now that you have run the factorial program, let's analyze it line by line to see what makes a Java program tick.

1.3.2.1 Comments

The first three lines of the program are a comment. Java ignores them, but they tell a human programmer what the program does. A comment begins with the characters `/*` and ends with the characters `*/`. Any amount of text, including multiple lines of text, may appear between these characters. Java also supports another type of comment, which you can see in lines 4 through 21. If the characters `//` appear in a Java program, Java ignores those characters and any other text that appears between those characters and the end of the line.

1.3.2.2 Defining a class

Line 4 is the first line of Java code. It says that we are defining a class named `Factorial`. This explains why the program had to be stored in a file named *Factorial.java*. That filename indicates that the file contains Java source code for a class named `Factorial`. The word `public` is a *modifier*; it says that the class is publicly available and that anyone may use it. The open curly-brace character (`{`) marks the beginning of the body of the class, which extends all the way to line 21, where we find the matching close curly-brace character (`}`). The program contains a number of pairs of curly braces; the lines are indented to show the nesting within these braces.

A class is the fundamental unit of program structure in Java, so it is not surprising that the first line of our program declares a class. All Java programs are classes, although some programs use many classes instead of just one. Java is an object-oriented programming language, and classes are a fundamental part of the object-oriented paradigm. Each class defines a unique kind of object. Example 1-1 is not really an object-oriented program, however, so I'm not going to go into detail about classes and objects here. That is the topic of Chapter 3. For now, all you need to understand is that a class defines a set of interacting *members*. Those members may be fields, methods, or other classes. The `Factorial` class contains two members, both of which are methods. They are described in upcoming sections.

1.3.2.3 Defining a method

Line 5 begins the definition of a *method* of our `Factorial` class. A method is a named chunk of Java code. A Java program can call, or *invoke*, a method to execute the code in it. If you have programmed in other languages, you have probably seen methods before, but they may have been called functions, procedures, or subroutines. The interesting thing about methods is that they have *parameters* and *return values*. When you call a method, you pass it some data you want it to operate on, and it returns a result to you. A method is like an algebraic function:

```
y = f(x)
```

Here, the mathematical function `f` performs some computation on the value represented by `x` and returns a value, which we represent by `y`.

To return to line 5, the `public` and `static` keywords are modifiers. `public` means the method is publicly accessible; anyone can use it. The meaning of the `static` modifier is not important here; it is explained in Chapter 3. The `void` keyword specifies the return value of the method. In this case, it specifies that this method does not have a return value.

The word `main` is the name of the method. `main` is a special name.[6] When you run the Java interpreter, it reads in the class you specify, then looks for a method named `main()`.[7] When the interpreter finds this method, it starts running the program at that method. When the `main()` method finishes, the program is done, and the Java interpreter exits. In other words, the `main()` method is the main entry point into a Java program. It is not actually sufficient for a method to be named `main( )`, however. The method must be declared `public static void` exactly as shown in line 5. In fact, the only part of line 5 you can change is the word `args`, which you can replace with any word you want. You'll be using this line in all of your Java programs, so go ahead and commit it to memory now!

[6] All Java programs that are run directly by the Java interpreter must have a `main()` method. Programs of this sort are often called *applications*. It is possible to write programs that are not run directly by the interpreter, but are dynamically loaded into some other already running Java program. Examples are *applets*, which are programs run by a web browser, and *servlets*, which are programs run by a web server. Applets are discussed in *Java Foundation Classes in a Nutshell* (O'Reilly) while servlets are discussed in *Java Enterprise in a Nutshell* (O'Reilly). In this book, we consider only applications.

[7] By convention, when this book refers to a method, it follows the name of the method by a pair of parentheses. As you'll see, parentheses are an important part of method syntax, and they serve here to keep method names distinct from the names of classes, fields, variables, and so on.

Following the name of the `main()` method is a list of method parameters in parentheses. This `main( )` method has only a single parameter. `String[]` specifies the type of the parameter, which is an array of strings (i.e., a numbered list of strings of text). `args` specifies the name of the parameter. In the algebraic equation `f(x)`, `x` is simply a way of referring to an unknown value. `args` serves the same purpose for the `main()` method. As we'll see, the name `args` is used in the body of the method to refer to the unknown value that is passed to the method.

As I've just explained, the `main()` method is a special one that is called by the Java interpreter when it starts running a Java class (program). When you invoke the Java interpreter like this:

```
C:\> java Factorial 4
```

the string "4" is passed to the `main( )` method as the value of the parameter named `args`. More precisely, an array of strings containing only one entry, `4`, is passed to `main()`. If we invoke the program like this:

```
C:\> java Factorial 4 3 2 1
```

then an array of four strings, 4, 3, 2, and 1, is passed to the main( ) method as the value of the parameter named args. Our program looks only at the first string in the array, so the other strings are ignored.

Finally, the last thing on line 5 is an open curly brace. This marks the beginning of the body of the main() method, which continues until the matching close curly brace on line 9. Methods are composed of *statements*, which the Java interpreter executes in sequential order. In this case, lines 6, 7, and 8 are three statements that compose the body of the main() method. Each statement ends with a semicolon to separate it from the next. This is an important part of Java syntax; beginning programmers often forget the semicolons.

1.3.2.4 Declaring a variable and parsing input

The first statement of the main() method, line 6, declares a variable and assigns a value to it. In any programming language, a *variable* is simply a symbolic name for a value. We've already seen that, in this program, the name args refers to the parameter value passed to the main() method. Method parameters are one type of variable. It is also possible for methods to declare additional "local" variables. Methods can use local variables to store and reference the intermediate values they use while performing their computations.

This is exactly what we are doing on line 6. That line begins with the words int input, which declare a variable named input and specify that the variable has the type int; that is, it is an integer. Java can work with several different types of values, including integers, real or floating-point numbers, characters (e.g., letters and digits), and strings of text. Java is a *strongly typed* language, which means that all variables must have a type specified and can refer only to values of that type. Our input variable always refers to an integer, so it cannot refer to a floating-point number or a string. Method parameters are also typed. Recall that the args parameter had a type of String[ ].

Continuing with line 6, the variable declaration int input is followed by the = character. This is the assignment operator in Java; it sets the value of a variable. When reading Java code, don't read = as "equals," but instead read it as "is assigned the value." As we'll see in Chapter 2, there is a different operator for "equals."

The value assigned to our input variable is Integer.parseInt(args[0]). This is a method invocation. This first statement of the main( ) method invokes another method whose name is Integer.parseInt( ). As you might guess, this method "parses" an integer; that is, it converts a string representation of an integer, such as 4, to the integer itself. The Integer.parseInt() method is not part of the Java language, but it is a core part of the Java API or Application Programming Interface. Every Java program can use the powerful set of classes and methods defined by this core API. The second half of this book is a quick reference that documents that core API.

When you call a method, you pass values (called *arguments*) that are assigned to the corresponding parameters defined by the method, and the method returns a value. The argument passed to Integer.parseInt() is args[0]. Recall that args is the name of the parameter for main(); it specifies an array (or list) of strings. The elements of an array are numbered sequentially, and the first one is always numbered 0. We care about only the first string in the args array, so we use the expression args[0] to refer to that string. When we invoke the program as shown earlier, line 6 takes the first string specified after the name of the class, 4, and passes it to the method named Integer.parseInt(). This method converts the string to the corresponding integer and returns the integer as its return value. Finally, this returned integer is assigned to the variable named `input`.

1.3.2.5 Computing the result

The statement on line 7 is a lot like the statement on line 6. It declares a variable and assigns a value to it. The value assigned to the variable is computed by invoking a method. The variable is named `result`, and it has a type of `double`. `double` means a double-precision floating-point number. The variable is assigned a value that is computed by the `factorial( )` method. The `factorial()` method, however, is not part of the standard Java API. Instead, it is defined as part of our program by lines 11 through 19. The argument passed to `factorial( )` is the value referred to by the `input` variable that was computed on line 6. We'll consider the body of the `factorial()` method shortly, but you can surmise from its name that this method takes an input value, computes the factorial of that value, and returns the result.

1.3.2.6 Displaying output

Line 8 simply calls a method named `System.out.println( )`. This commonly used method is part of the core Java API; it causes the Java interpreter to print out a value. In this case, the value that it prints is the value referred to by the variable named `result`. This is the result of our factorial computation. If the `input` variable holds the value `4`, the `result` variable holds the value `24`, and this line prints out that value.

The `System.out.println( )` method does not have a return value. There is no variable declaration or `=` assignment operator in this statement since there is no value to assign to anything. Another way to say this is that, like the `main( )` method of line 5, `System.out.println( )` is declared `void`.

1.3.2.7 The end of a method

Line 9 contains only a single character, `}`. This marks the end of the method. When the Java interpreter gets here, it is through executing the `main( )` method, so it stops running. The end of the `main( )` method is also the end of the *variable scope* for the `input` and `result` variables declared within `main( )` and for the `args` parameter of `main( )`. These variable and parameter names have meaning only within the `main( )` method and cannot be used elsewhere in the program unless other parts of the program declare different variables or parameters that happen to have the same name.

1.3.2.8 Blank lines

Line 10 is a blank line. You can insert blank lines and spaces anywhere in a program, and you should use them liberally to make the program readable. A blank line appears here to separate the `main( )` method from the `factorial()` method that begins on line 11. You'll notice that the program also uses whitespace to indent the various lines of code. This kind of indentation is optional; it emphasizes the structure of the program and greatly enhances the readability of the code.

1.3.2.9 Another method

Line 11 begins the definition of the `factorial()` method that was used by the `main( )` method. Compare this line to line 5 to note its similarities and differences. The `factorial( )` method has the same `public` and `static` modifiers. It takes a single integer parameter, which we call `x`. Unlike the `main( )` method, which had no return value (`void`), `factorial( )` returns a value of type `double`. The open curly brace marks the beginning of the method body, which continues past the nested braces on lines 15 and 18 to line 20, where the matching close curly brace is found. The body of the `factorial( )` method, like the body of the `main()` method, is composed of statements, which are found on lines 12 through 19.

1.3.2.10 Checking for valid input

In the `main()` method, we saw variable declarations, assignments, and method invocations. The statement on line 12 is different. It is an `if` statement, which executes another statement conditionally. We saw earlier that the Java interpreter executes the three statements of the `main()` method one after another. It always executes them in exactly that way, in exactly that order. An `if` statement is a flow-control statement; it can affect the way the interpreter runs a program.

The `if` keyword is followed by a parenthesized expression and a statement. The Java interpreter first evaluates the expression. If it is `true`, the interpreter executes the statement. If the expression is `false`, however, the interpreter skips the statement and goes to the next one. The condition for the `if` statement on line 12 is `x < 0`. It checks whether the value passed to the `factorial()` method is less than zero. If it is, this expression is `true`, and the statement on line 13 is executed. Line 12 does not end with a semicolon because the statement on line 13 is part of the `if` statement. Semicolons are required only at the end of a statement.

Line 13 is a `return` statement. It says that the return value of the `factorial( )` method is `0.0`. `return` is also a flow-control statement. When the Java interpreter sees a `return`, it stops executing the current method and returns the specified value immediately. A `return` statement can stand alone, but in this case, the `return` statement is part of the `if` statement on line 12. The indentation of line 13 helps emphasize this fact. (Java ignores this indentation, but it is very helpful for humans who read Java code!) Line 13 is executed only if the expression on line 12 is `true`.

Before we move on, we should pull back a bit and talk about why lines 12 and 13 are necessary in the first place. It is an error to try to compute a factorial for a negative number, so these lines make sure that the input value `x` is valid. If it is not valid, they cause `factorial( )` to return a consistent invalid result, `0.0`.

1.3.2.11 An important variable

Line 14 is another variable declaration; it declares a variable named `fact` of type `double` and assigns it an initial value of `1.0`. This variable holds the value of the factorial as we compute it in the statements that follow. In Java, variables can be declared anywhere; they are not restricted to the beginning of a method or block of code.

1.3.2.12 Looping and computing the factorial

Line 15 introduces another type of statement: the `while` loop. Like an `if` statement, a `while` statement consists of a parenthesized expression and a statement. When the Java interpreter sees a while statement, it evaluates the associated expression. If that expression is TRue, the interpreter executes the statement. The interpreter repeats this process, evaluating the expression and executing the statement if the expression is true, until the expression evaluates to false. The expression on line 15 is x > 1, so the while statement loops *while* the parameter x holds a value that is greater than 1. Another way to say this is that the loop continues *until* x holds a value less than or equal to 1. We can assume from this expression that if the loop is ever going to terminate, the value of x must somehow be modified by the statement that the loop executes.

The major difference between the if statement on lines 12-13 and the while loop on lines 15-18 is that the statement associated with the while loop is a *compound statement*. A compound statement is zero or more statements grouped between curly braces. The while keyword on line 15 is followed by an expression in parentheses and then by an open curly brace. This means that the body of the loop consists of all statements between that opening brace and the closing brace on line 18. Earlier in the chapter, I said that all Java statements end with semicolons. This rule does not apply to compound statements, however, as you can see by the lack of a semicolon at the end of line 18. The statements inside the compound statement (lines 16 and 17) do end with semicolons, of course.

The body of the while loop consists of the statements on line 16 and 17. Line 16 multiplies the value of fact by the value of x and stores the result back into fact. Line 17 is similar. It subtracts 1 from the value of x and stores the result back into x. The * character on line 16 is important: it is the multiplication *operator*. And, as you can probably guess, the - on line 17 is the subtraction operator. An operator is a key part of Java syntax: it performs a computation on one or two *operands* to produce a new value. Operands and operators combine to form *expressions*, such as fact * x or x - 1. We've seen other operators in the program. Line 15, for example, uses the greater-than operator (>) in the expression x > 1, which compares the value of the variable x to 1. The value of this expression is a boolean truth value either TRue or false, depending on the result of the comparison.

To understand this while loop, it is helpful to think like the Java interpreter. Suppose we are trying to compute the factorial of 4. Before the loop starts, fact is 1.0, and x is 4. After the body of the loop has been executed once after the first *iteration* fact is 4.0, and x is 3. After the second iteration, fact is 12.0, and x is 2. After the third iteration, fact is 24.0, and x is 1. When the interpreter tests the loop condition after the third iteration, it finds that x > 1 is no longer true, so it stops running the loop, and the program resumes at line 19.

1.3.2.13 Returning the result

Line 19 is another return statement, like the one we saw on line 13. This one does not return a constant value like 0.0, but instead returns the value of the fact variable. If the value of x passed into the factorial() function is 4, then, as we saw earlier, the value of fact is 24.0, so this is the value returned. Recall that the factorial() method was invoked on line 7 of the program. When this return statement is executed, control returns to line 7, where the return value is assigned to the variable named result.

1.3.3. Exceptions

If you've made it all the way through the line-by-line analysis of Example 1-1, you are well on your way to understanding the basics of the Java language.[8] It is a simple but nontrivial program that illustrates many of the features of Java. There is one more important feature of Java programming I want to introduce, but it is one that does not appear in the program listing itself.Recall that the program computes the factorial of the number you specify on the command line. What happens if you run the program without specifying a number?

[8] If you didn't understand all the details of this factorial program, don't worry. We'll cover the details of the Java language a lot more thoroughly in subsequent chapters. However, if you feel like you didn't understand any of the line-by-line analysis, you may also find that the upcoming chapters are over your head. In that case, you should probably go elsewhere to learn the basics of the Java language and return to this book to solidify your understanding, and, of course, to use as a reference. One resource you may find useful in learning the language is Sun's online Java tutorial, available at http://java.sun.com/docs/books/tutorial.

```
C:\> java Factorial
java.lang.ArrayIndexOutOfBoundsException: 0
        at Factorial.main(Factorial.java:6)
C:\>
```

And what happens if you specify a value that is not a number?

```
C:\> java Factorial ten
java.lang.NumberFormatException: ten
        at java.lang.Integer.parseInt(Integer.java)
        at java.lang.Integer.parseInt(Integer.java)
        at Factorial.main(Factorial.java:6)
C:\>
```

In both cases, an error occurs or, in Java terminology, an *exception* is thrown. When an exception is thrown, the Java interpreter prints a message that explains what type of exception it was and where it occurred (both exceptions above occurred on line 6). In the first case, the exception is thrown because there are no strings in the `args` list, meaning we asked for a nonexistent string with `args[0]`. In the second case, the exception is thrown because `Integer.parseInt( )` cannot convert the string "ten" to a number. We'll see more about exceptions in Chapter 2 and learn how to handle them gracefully as they occur.

Team LiB

Chapter 2. Java Syntax from the Ground Up

This chapter is a terse but comprehensive introduction to Java syntax. It is written primarily for readers who are new to the language but have at least some previous programming experience. Determined novices with no prior programming experience may also find it useful. If you already know Java, you should find it a useful language reference. The chapter includes comparisons of Java to C and C++ for the benefit of programmers coming from those languages.

This chapter documents the syntax of Java programs by starting at the very lowest level of Java syntax and building from there, covering increasingly higher orders of structure. It covers:

- The characters used to write Java programs and the encoding of those characters.
- Literal values, identifiers, and other tokens that comprise a Java program.
- The data types that Java can manipulate.
- The operators used in Java to group individual tokens into larger expressions.
- Statements, which group expressions and other statements to form logical chunks of Java code
- Methods (also called functions, procedures, or subroutines), which are named collections of Jav statements that can be invoked by other Java code.
- Classes, which are collections of methods and fields. Classes are the central program element i Java and form the basis for object-oriented programming. Chapter 3 is devoted entirely to a discussion of classes and objects.
- Packages, which are collections of related classes.
- Java programs, which consist of one or more interacting classes that may be drawn from one o more packages.

The syntax of most programming languages is complex, and Java is no exception. In general, it is no possible to document all elements of a language without referring to other elements that have not yet been discussed. For example, it is not really possible to explain in a meaningful way the operator and statements supported by Java without referring to objects. But it is also not possible to document objects thoroughly without referring to the operators and statements of the language. The process of learning Java, or any language, is therefore an iterative one. If you are new to Java (or a Java-style programming language), you may find that you benefit greatly from working through this chapter and the next *twice*, so that you can grasp the interrelated concepts.

2.1. Java Programs from the Top Down

Before we begin our bottom-up exploration of Java syntax, let's take a moment for a top-down overview of a Java program. Java programs consist of one or more files, or *compilation units*, of Java source code. Near the end of the chapter, we describe the structure of a Java file and explain how to compile and run a Java program. Each compilation unit begins with an optional `package` declaration followed by zero or more `import` declarations. These declarations specify the namespace within which the compilation unit will define names, and the namespaces from which the compilation unit imports names. We'll see `package` and `import` again in Section 2.10 later in this chapter.

The optional `package` and `import` declarations are followed by zero or more reference type definitions. These are typically `class` or `interface` definitions, but in Java 5.0 and later, they can also be `enum` definitions or annotation definitions. The general features of reference types are covered later in this chapter, and detailed coverage of the various kinds of reference types is in Chapters Chapter 3 and Chapter 4.

Type definitions include members such as fields, methods, and constructors.Methods are the most important type member. Methods are blocks of Java code comprised of *statements*. Most statements include *expressions*, which are built using *operators* and values known as *primitive data types*. Finally, the keywords used to write statements, the punctuation characters that represent operators, and the literals values that appear in a program are all *tokens*, which are described next. As the name of this section implies, this chapter moves from describing the smallest units, tokens, to progressively larger units. Since the concepts build upon one another, we recommend reading this chapter sequentially.

2.2. Lexical Structure

This section explains the lexical structure of a Java program. It starts with a discussion of the Unicode character set in which Java programs are written . It then covers the tokens that comprise a Java program, explaining comments, identifiers, reserved words, literals, and so on.

2.2.1. The Unicode Character Set

Java programs are written using Unicode. You can use Unicode characters anywhere in a Java program, including comments and identifiers such as variable names. Unlike the 7-bit ASCII character set, which is useful only for English, and the 8-bit ISO Latin-1 character set, which is useful only for major Western European languages, the Unicode character set can represent virtually every written language in common use on the planet. 16-bit Unicode characters are typically written to files using an encoding known as UTF-8, which converts the 16-bit characters into a stream of bytes. The format is designed so that plain ASCII text (and the 7-bit characters of Latin-1) are valid UTF-8 byte streams. Thus, you can simply write plain ASCII programs, and they will work as valid Unicode.

If you do not use a Unicode-enabled text editor, or if you do not want to force other programmers who view or edit your code to use a Unicode-enabled editor, you can embed Unicode characters into your Java programs using the special Unicode escape sequence `\u`*`xxxx`*, in other words, a backslash and a lowercase u, followed by four hexadecimal characters. For example, `\u0020` is the space character, and `\u03c0` is the character .

Unicode 3.1 and above, used in Java 5.0 and later, includes "supplementary characters" that require 21 bits to represent. 16-bit encodings of Unicode characters represent these supplementary characters using a *surrogate pair*, which is a sequence of two 16-bit characters taken from a special reserved range of the 16-bit encoding space. If you ever need to include one of these (rarely used) supplementary characters in Java source code, use two `\u` sequences to represent the surrogate pair. (Details of surrogate pair encoding are beyond the scope of this book, however.)

2.2.2. Case-Sensitivity and Whitespace

Java is a case-sensitive language. Its keywords are written in lowercase and must always be used that way. That is, `While` and `WHILE` are not the same as the `while` keyword. Similarly, if you declare a variable named `i` in your program, you may not refer to it as `I`.

Java ignores spaces, tabs, newlines, and other whitespace, except when it appears within quoted characters and string literals. Programmers typically use whitespace to format andindent their code for easy readability, and you will see common indentation conventions in the code examples of this book.

2.2.3. Comments

Comments are natural-language text intended for human readers of a program. They are ignored by the Java compiler. Java supports three types of comments. The first type is a single-line comment, which begins with the characters // and continues until the end of the current line. For example:

```
int i = 0;   // Initialize the loop variable
```

The second kind of comment is a multiline comment. It begins with the characters /* and continues, over any number of lines, until the characters */. Any text between the /* and the */ is ignored by the Java compiler. Although this style of comment is typically used for multiline comments, it can also be used for single-line comments. This type of comment cannot be nested (i.e., one /* */ comment cannot appear within another). When writing multiline comments, programmers often use extra * characters to make the comments stand out. Here is a typical multiline comment:

```
/*
 * First, establish a connection to the server.
 * If the connection attempt fails, quit right away.
 */
```

The third type of comment is a special case of the second. If a comment begins with /**, it is regarded as a special *doc comment*. Like regular multiline comments, doc comments end with */ and cannot be nested. When you write a Java class you expect other programmers to use, use doc comments to embed documentation about the class and each of its methods directly into the source code. A program named *javadoc* extracts these comments and processes them to create online documentation for your class. A doc comment can contain HTML tags and can use additional syntax understood by *javadoc*. For example:

```
/**
 * Upload a file to a web server.
 *
 * @param file The file to upload.
 * @return <tt>true</tt> on success,
 *         <tt>false</tt> on failure.
 * @author David Flanagan
 */
```

See Chapter 7 for more information on the doc comment syntax and Chapter 8 for more information on the *javadoc* program.

Comments may appear between any tokens of a Java program, but may not appear within a token. In particular, comments may not appear within double-quoted string literals. A comment within a string literal simply becomes a literal part of that string.

2.2.4. Reserved Words

The following words are reserved in Java: they are part of the syntax of the language and may not be used to name variables, classes, and so forth.

```
abstract   const      final        int         public        throw
assert     continue   finally      interface   return        throws
boolean    default    float        long        short         transient
break      do         for          native      static        true
byte       double     goto         new         strictfp      try
case       else       if           null        super         void
catch      enum       implements   package     switch        volatile
char       extends    import       private     synchronized  while
class      false      instanceof   protected   this
```

We'll meet each of these reserved words again later in this book. Some of them are the names of primitive types and others are the names of Java statements, both of which are discussed later in this chapter. Still others are used to define classes and their members (see Chapter 3).

Note that `const` and `goto` are reserved but aren't actually used in the language. `strictfp` was added in Java 1.2, `assert` was added in Java 1.4, and `enum` was added in Java 5.0.

2.2.5. Identifiers

An *identifier* is simply a name given to some part of a Java program, such as a class, a method within a class, or a variable declared within a method. Identifiers may be of any length and may contain letters and digits drawn from the entire Unicode character set. An identifier may not begin with a digit, however, because the compiler would then think it was a numeric literal rather than an identifier.

In general, identifiers may not contain punctuation characters. Exceptions include the ASCII underscore (`_`) and dollar sign (`$`) as well as other Unicode currency symbols such as £ and ¥. Currency symbols are intended for use in automatically generated source code, such as code produced by parser generators. By avoiding the use of currency symbols in your own identifiers you don't have to worry about collisions with automatically generated identifiers. Formally, the characters allowed at the beginning of and within an identifier are defined by the methods `isJavaIdentifierStart( )` and `isJavaIdentifierPart( )` of the class `java.lang.Character`.

The following are examples of legal identifiers:

```
i    x1    theCurrentTime    the_current_time
```

2.2.6. Literals

Literals are values that appear directly in Java source code. They include integer and floating-point numbers, characters within single quotes, strings of characters within double quotes, and the reserved words `true`, `false` and `null`. For example, the following are all literals:

```
1    1.0    '1'    "one"    true    false    null
```

The syntax for expressing numeric, character, and string literals is detailed in Section 2.3 later in this chapter.

2.2.7. Punctuation

Java also uses a number of punctuation characters as tokens. The Java Language Specification divides these characters (somewhat arbitrarily) into two categories,separators and operators. Separators are:

```
(   )   {   }   [   ]

<   >   :   ;

,   .   @
```

Operators are:

```
+     -     *     /     %     &    |     ^     <<    >>    >>>
+=    -=    *=    /=    %=    &=   |=    ^=    <<=   >>=   >>>=
=     =  =   !=   <     <=    >     >=
!     ~     &&   ||    ++    --    ?     :
```

We'll see separators throughout the book, and will cover each operator individually in Section 2.4 later in this chapter.

2.3. Primitive Data Types

Java supports eight basic data types known as *primitive types* as secribed in Table 2-1. The primitive types include a boolean type, a character type, four integer types, and two floating-point types. The four integer types and the two floating-point types differ in the number of bits that represent them and therefore in the range of numbers they can represent. The next section summarizes these primitive data types. In addition to these primitive types, Java supports nonprimitive data types such as classes, interfaces, and arrays. These composite types are known as reference types, which are introduced in Section 2.9 later in this chapter.

Table 2-1. Java primitive data types

Type	Contains	Default	Size	Range
`boolean`	`true` or `false`	`false`	1 bit	NA
`char`	Unicode character	`\u0000`	16 bits	`\u0000` to `\uFFFF`
`byte`	Signed integer	0	8 bits	-128 to 127
`short`	Signed integer	0	16 bits	-32768 to 32767
`int`	Signed integer	0	32 bits	-2147483648 to 2147483647
`long`	Signed integer	0	64 bits	-9223372036854775808 to 9223372036854775807
`float`	IEEE 754 floating point	0.0	32 bits	1.4E-45 to 3.4028235E+38
`double`	IEEE 754 floating point	0.0	64 bits	4.9E-324 to 1.7976931348623157E+308

2.3.1. The boolean Type

The `boolean` type represents truth values. This type has only two possible values, representing the two boolean states: on or off, yes or no, true or false. Java reserves the words `TRue` and `false` to represent these two boolean values.

C and C++ programmers should note that Java is quite strict about its `boolean` type: `boolean` values can never be converted to or from other data types. In particular, a `boolean` is not an integral type, and integer values cannot be used in place of a `boolean`. In other words, you cannot take shortcuts such as the following in Java:

```
if (o) {
    while(i) {
    }
}
```

Instead, Java forces you to write cleaner code by explicitly stating the comparisons you want:

```
if (o != null) {
    while(i != 0) {
    }
}
```

2.3.2. The char Type

The char type represents Unicode characters. It surprises many experienced programmers to learn that Java char values are 16 bits long, but in practice this fact is totally transparent. To include a character literal in a Java program, simply place it between single quotes (apostrophes):

```
char c = 'A';
```

You can, of course, use any Unicode character as a character literal, and you can use the \u Unicode escape sequence. In addition, Java supports a number of other escape sequences that make it easy both to represent commonly used nonprinting ASCII characters such as newline and to escape certain punctuation characters that have special meaning in Java. For example:

```
char tab = '\t', apostrophe = '\'', nul = '\000', aleph='\u05D0';
```

Table 2-2 lists the escape characters that can be used in char literals. These characters can also be used in string literals, which are covered in the next section.

Table 2-2. Java escape characters

Escape sequence	Character value
\b	Backspace
\t	Horizontal tab
\n	Newline
\f	Form feed
\r	Carriage return

Escape sequence	Character value
`\"`	Double quote
`\'`	Single quote
`\\`	Backslash
`\xxx`	The Latin-1 character with the encoding *xxx*, where *xxx* is an octal (base 8) number between 000 and 377. The forms `\x` and `\xx` are also legal, as in '`\0`', but are not recommended because they can cause difficulties in string constants where the escape sequence is followed by a regular digit.
`\uxxxx`	The Unicode character with encoding *xxxx*, where *xxxx* is four hexadecimal digits. Unicode escapes can appear anywhere in a Java program, not only in character and string literals.

`char` values can be converted to and from the various integral types. Unlike `byte`, `short`, `int`, and `long`, however, `char` is an unsigned type. The `Character` class defines a number of useful `static` methods for working with characters, including `isDigit( )`, `isJavaLetter( )`, `isLowerCase( )`, and `toUpperCase( )`.

The Java language and its `char` type were designed with Unicode in mind. The Unicode standard is evolving, however, and each new version of Java adopts the latest version of Unicode. Java 1.4 used Unicode 3.0 and Java 5.0 adopts Unicode 4.0. This is significant because Unicode 3.1 was the first release to include characters whose encodings, or *codepoints*, do not fit in 16 bits. These supplementary characters, which are mostly infrequently used Han (Chinese) ideographs, occupy 21 bits and cannot be represented in a single `char` value. Instead, you must use an `int` value to hold the codepoint of a supplementary character, or you must encode it into a so-called "surrogate pair" of two `char` values. Unless you commonly write programs that use Asian languages, you are unlikely to encounter any supplementary characters. If you do anticipate having to process characters that do not fit into a `char`, Java 5.0 has added methods to the `Character`, `String`, and related classes for working with text using `int` codepoints.

2.3.3. Strings

In addition to the `char` type, Java also has a data type for working with strings of text (usually simply called *strings*). The `String` type is a class, however, and is not one of the primitive types of the language. Because strings are so commonly used, though, Java does have a syntax for including string values literally in a program. A `String` literal consists of arbitrary text within double quotes. For example:

```
"Hello, world"
"'This' is a string!"
```

String literals can contain any of the escape sequences that can appear as `char` literals (see Table 2-2). Use the `\"` sequence to include a double-quote within a `String` literal. Since `String` is a reference type, string literals are described in more detail in Section 2.7.4 later in this chapter. Chapter 5 demonstrates some of the ways you can work with `String` objects in Java.

2.3.4. Integer Types

The integer types in Java are `byte`, `short`, `int`, and `long`. As shown in Table 2-1, these four types differ only in the number of bits and, therefore, in the range of numbers each type can represent. All integral types represent signed numbers; there is no `unsigned` keyword as there is in C and C++.

Literals for each of these types are written exactly as you would expect: as a string of decimal digits, optionally preceded by a minus sign.[1] Here are some legal integer literals:

> [1] Technically, the minus sign is an operator that operates on the literal, but is not part of the literal itself. Also, all integer literals are 32-bit int values unless followed by the letter L, in which case they are 64-bit long values. There is no special syntax for byte and short literals, but int literals are usually converted to these shorter types as needed. For example, in the following code

```
0
1
123
-42000
```

Integer literals can also be expressed in hexadecimal or octal notation. A literal that begins with `0x` or `0X` is taken as a hexadecimal number, using the letters `A` to `F` (or `a` to `f`) as the additional digits required for base-16 numbers. Integer literals beginning with a leading `0` are taken to be octal (base-8) numbers and cannot include the digits 8 or 9. Java does not allow integer literals to be expressed in binary (base-2) notation. Legal hexadecimal and octal literals include:

```
0xff              // Decimal 255, expressed in hexadecimal
0377              // The same number, expressed in octal (base 8)
0xCAFEBABE        // A magic number used to identify Java class files
```

Integer literals are 32-bit `int` values unless they end with the character `L` or `l`, in which case they are 64-bit `long` values:

```
1234        // An int value
1234L       // A long value
0xffL       // Another long value
```

Integer arithmetic in Java is modular, which means that it never produces an overflow or an underflow when you exceed the range of a given integer type. Instead, numbers just wrap around. For example:

```
byte b1 = 127, b2 = 1;        // Largest byte is 127
byte sum = (byte)(b1 + b2);   // Sum wraps to -128, which is the smallest byte
```

Neither the Java compiler nor the Java interpreter warns you in any way when this occurs. When doing integer arithmetic, you simply must ensure that the type you are using has a sufficient range for the purposes you intend. Integer division by zero and modulo by zero are illegal and cause an

ArithmeticException to be thrown.

Each integer type has a corresponding wrapper class: Byte, Short, Integer, and Long. Each of these classes defines MIN_VALUE and MAX_VALUE constants that describe the range of the type. The classes also define useful static methods, such as Byte.parseByte( ) and Integer.parseInt( ), for converting strings to integer values.

2.3.5. Floating-Point Types

Real numbers in Java are represented by the float and double data types. As shown in Table 2-1, float is a 32-bit, single-precision floating-point value, and double is a 64-bit, double-precision floating-point value. Both types adhere to the IEEE 754-1985 standard, which specifies both the format of the numbers and the behavior of arithmetic for the numbers.

Floating-point values can be included literally in a Java program as an optional string of digits, followed by a decimal point and another string of digits. Here are some examples:

```
123.45
0.0
.01
```

Floating-point literals can also use exponential, or scientific, notation, in which a number is followed by the letter e or E (for exponent) and another number. This second number represents the power of ten by which the first number is multiplied. For example:

```
1.2345E02       // 1.2345 x 10^2, or 123.45
1e-6            // 1 x 10^-6, or 0.000001
6.02e23         // Avogadro's Number: 6.02 x 10^23
```

Floating-point literals are double values by default. To include a float value literally in a program, follow the number with f or F:

```
double d = 6.02E23;
float f = 6.02e23f;
```

Floating-point literals cannot be expressed in hexadecimal or octal notation.

Most real numbers, by their very nature, cannot be represented exactly in any finite number of bits. Thus, it is important to remember that float and double values are only approximations of the numbers they are meant to represent. A float is a 32-bit approximation, which results in at least 6 significant decimal digits, and a double is a 64-bit approximation, which results in at least 15 significant digits. In practice, these data types are suitable for most real-number computations.

In addition to representing ordinary numbers, the float and double types can also represent four special values: positive and negative infinity, zero, and NaN. The infinity values result when a floating-point computation produces a value that overflows the representable range of a `float` or `double`. When a floating-point computation underflows the representable range of a `float` or a `double`, a zero value results. The Java floating-point types make a distinction between positive zero and negative zero, depending on the direction from which the underflow occurred. In practice, positive and negative zero behave pretty much the same. Finally, the last special floating-point value is NaN, which stands for "not-a-number." The NaN value results when an illegal floating-point operation, such as 0.0/0.0, is performed. Here are examples of statements that result in these special values:

```
double inf = 1.0/0.0;              // Infinity
double neginf = -1.0/0.0;          // -Infinity
double negzero = -1.0/inf;         // Negative zero
double NaN = 0.0/0.0;              // Not-a-Number
```

Because the Java floating-point types can handle overflow to infinity and underflow to zero and have a special NaN value, floating-point arithmetic never throws exceptions, even when performing illegal operations, like dividing zero by zero or taking the square root of a negative number.

The `float` and `double` primitive types have corresponding classes, named `Float` and `Double`. Each of these classes defines the following useful constants: `MIN_VALUE` , `MAX_VALUE`, `NEGATIVE_INFINITY`, `POSITIVE_INFINITY`, and `NaN`.

The infinite floating-point values behave as you would expect. Adding or subtracting any finite value to or from infinity, for example, yields infinity. Negative zero behaves almost identically to positive zero, and, in fact, the `= =` equality operator reports that negative zero is equal to positive zero. One way to distinguish negative zero from positive, or regular, zero is to divide by it. 1.0/0.0 yields positive infinity, but 1.0 divided by negative zero yields negative infinity. Finally, since NaN is not-a-number, the `= =` operator says that it is not equal to any other number, including itself! To check whether a `float` or `double` value is NaN, you must use the `Float.isNaN( )` and `Double.isNaN( )` methods.

2.3.6. Primitive Type Conversions

Java allows conversions between integer values and floating-point values. In addition, because every character corresponds to a number in the Unicode encoding, `char` values can be converted to and from the integer and floating-point types. In fact, `boolean` is the only primitive type that cannot be converted to or from another primitive type in Java.

There are two basic types of conversions. A *widening conversion* occurs when a value of one type is converted to a wider typeone that has a larger range of legal values. Java performs widening conversions automatically when, for example, you assign an `int` literal to a `double` variable or a `char` literal to an `int` variable.

Narrowing conversions are another matter, however. A *narrowing conversion* occurs when a value is converted to a type that is not wider than it is. Narrowing conversions are not always safe: it is reasonable to convert the integer value 13 to a `byte`, for example, but it is not reasonable to convert 13000 to a `byte` since `byte` can hold only numbers between -128 and 127. Because you can lose data in a narrowing conversion, the Java compiler complains when you attempt any narrowing conversion, even if the value being converted would in fact fit in the narrower range of the specified type:

```
int i = 13;
byte b = i;    // The compiler does not allow this
```

The one exception to this rule is that you can assign an integer literal (an `int` value) to a `byte` or `short` variable if the literal falls within the range of the variable.

If you need to perform a narrowing conversion and are confident you can do so without losing data o precision, you can force Java to perform the conversion using a language construct known as a *cast*. Perform a cast by placing the name of the desired type in parentheses before the value to be converted. For example:

```
int i = 13;
byte b = (byte) i;   // Force the int to be converted to a byte
i = (int) 13.456;    // Force this double literal to the int 13
```

Casts of primitive types are most often used to convert floating-point values to integers. When you do this, the fractional part of the floating-point value is simply truncated (i.e., the floating-point value is rounded towards zero, not towards the nearest integer). The methods `Math.round( )`, `Math.floor( )`, and `Math.ceil( )` perform other types of rounding.

The `char` type acts like an integer type in most ways, so a `char` value can be used anywhere an `int` or `long` value is required. Recall, however, that the `char` type is *unsigned*, so it behaves differently than the `short` type, even though both are 16 bits wide:

```
short s = (short) 0xffff; // These bits represent the number -1
char c = '\uffff';        // The same bits, representing a Unicode character
int i1 = s;               // Converting the short to an int yields -1
int i2 = c;               // Converting the char to an int yields 65535
```

Table 2-3 shows which primitive types can be converted to which other types and how the conversion is performed. The letter N in the table means that the conversion cannot be performed. The letter Y means that the conversion is a widening conversion and is therefore performed automatically and implicitly by Java. The letter C means that the conversion is a narrowing conversion and requires an explicit cast. Finally, the notation Y* means that the conversion is an automatic widening conversion, but that some of the least significant digits of the value may be lost in the conversion. This can happen when converting an `int` or `long` to a `float` or `double`. The floating-point types have a larger range than the integer types, so any `int` or `long` can be represented by a `float` or `double`. However, the floating-point types are approximations of numbers and cannot always hold as many significant digits as the integer types.

Table 2-3. Java primitive type conversions

Convert	Convert to:							
from:	**boolean**	**byte**	**short**	**char**	**int**	**long**	**float**	**double**
boolean	-	N	N	N	N	N	N	N
byte	N	-	Y	C	Y	Y	Y	Y
short	N	C	-	C	Y	Y	Y	Y
char	N	C	C	-	Y	Y	Y	Y
int	N	C	C	C	-	Y	Y*	Y
long	N	C	C	C	C	-	Y*	Y*
float	N	C	C	C	C	C	-	Y
double	N	C	C	C	C	C	C	-

2.4. Expressions and Operators

So far in this chapter, we've learned about the primitive types that Java programs can manipulate and seen how to include primitive values as *literals* in a Java program. We've also used *variables* as symbolic names that represent, or hold, values. These literals and variables are thetokens out of which Java programs are built.

An *expression* is the next higher level of structure in a Java program. The Java interpreter *evaluates* an expression to compute its value. The very simplest expressions are called *primary expressions* and consist of literals and variables. So, for example, the following are all expressions:

```
1.7         // A floating-point literal
true        // A boolean literal
sum         // A variable
```

When the Java interpreter evaluates a literal expression, the resulting value is the literal itself. When the interpreter evaluates a variable expression, the resulting value is the value stored in the variable

Primary expressions are not very interesting. More complex expressions are made by using *operators* to combine primary expressions. For example, the following expression uses the assignment operato to combine two primary expressionsa variable and a floating-point literalinto an assignment expression:

```
sum = 1.7
```

But operators are used not only with primary expressions; they can also be used with expressions at any level of complexity. The following are all legal expressions:

```
sum = 1 + 2 + 3*1.2 + (4 + 8)/3.0
sum/Math.sqrt(3.0 * 1.234)
(int)(sum + 33)
```

2.4.1. Operator Summary

The kinds of expressions you can write in a programming language depend entirely on the set of operators available to you. Table 2-4 summarizes the operators available in Java. The P and A columns of the table specify the precedence and associativity of each group of related operators, respectively. These conceptsand the operators themselvesare explained inmore detail in the following sections.

Table 2-4. Java operators

P	A	Operator	Operand type(s)	Operation performed
15	L	.	object, member	object member access
		[ ]	array, int	array element access
		(*args*)	method, arglist	method invocation
		++ , --	variable	post-increment, decrement
14	R	++, --	variable	pre-increment, decrement
		+ , -	number	unary plus, unary minus
		~	integer	bitwise complement
		!	boolean	boolean NOT
13	R	new	class, arglist	object creation
		(*type*)	type, any	cast (type conversion)
12	L	* , /, %	number, number	multiplication, division, remainder
11	L	+ , -	number, number	addition, subtraction
		+	string, any	string concatenation
10	L	<<	integer, integer	left shift
		>>	integer, integer	right shift with sign extension
		>>>	integer, integer	right shift with zero extension
9	L	< , <=	number, number	less than, less than or equal
		> , >=	number, number	greater than, greater than or equal
		instanceof	reference, type	type comparison
8	L	= =	primitive, primitive	equal (have identical values)
		!=	primitive, primitive	not equal (have different values)
		= =	reference, reference	equal (refer to same object)
		!=	reference, reference	not equal (refer to different objects)
7	L	&	integer, integer	bitwise AND
		&	boolean, boolean	boolean AND
6	L	^	integer, integer	bitwise XOR
		^	boolean, boolean	boolean XOR
5	L	|	integer, integer	bitwise OR
		|	boolean, boolean	boolean OR

<table>
<tr><th>P</th><th>A</th><th>Operator</th><th>Operand type(s)</th><th>Operation performed</th></tr>
<tr><td>4</td><td>L</td><td>&&</td><td>boolean, boolean</td><td>conditional AND</td></tr>
<tr><td>3</td><td>L</td><td>||</td><td>boolean, boolean</td><td>conditional OR</td></tr>
<tr><td>2</td><td>R</td><td>?:</td><td>boolean, any</td><td>conditional (ternary) operator</td></tr>
<tr><td>1</td><td>R</td><td>=</td><td>variable, any</td><td>assignment</td></tr>
<tr><td></td><td></td><td>*= , /=, %=,</td><td>variable, any</td><td>assignment with operation</td></tr>
<tr><td></td><td></td><td>+= , -=, <<=,</td><td></td><td></td></tr>
<tr><td></td><td></td><td>>>= , >>>= ,</td><td></td><td></td></tr>
<tr><td></td><td></td><td>&=, ^= , |=</td><td></td><td></td></tr>
</table>

2.4.1.1 Precedence

The P column of Table 2-4 specifies the *precedence* of each operator. Precedence specifies the order in which operations are performed. Consider this expression:

```
a + b * c
```

The multiplication operator has higher precedence than the addition operator, so a is added to the product of b and c. Operator precedence can be thought of as a measure of how tightly operators bind to their operands. The higher the number, the more tightly they bind.

Default operator precedence can be overridden through the use of parentheses that explicitly specify the order of operations. The previous expression can be rewritten as follows to specify that the addition should be performed before the multiplication:

```
(a + b) * c
```

The default operator precedence in Java was chosen for compatibility with C; the designers of C chose this precedence so that most expressions can be written naturally without parentheses. There are only a few common Java idioms for which parentheses are required. Examples include:

```
// Class cast combined with member access
((Integer) o).intValue(  );

// Assignment combined with comparison
while((line = in.readLine(  )) != null) { ... }

// Bitwise operators combined with comparison
if ((flags & (PUBLIC | PROTECTED)) != 0) { ... }
```

2.4.1.2 Associativity

When an expression involves several operators that have the same precedence, the operator associativity governs the order in which the operations are performed. Most operators are left-to-right associative, which means that the operations are performed from left to right. Theassignment and unary operators, however, have right-to-left associativity. The A column of Table 2-4 specifies the associativity of each operator or group of operators. The value L means left to right, and R means right to left.

The additive operators are all left-to-right associative, so the expression a+b-c is evaluated from left to right: (a+b)-c. Unary operators and assignment operators are evaluated from right to left. Consider this complex expression:

```
a = b += c = -~d
```

This is evaluated as follows:

```
a = (b += (c = -(~d)))
```

As with operator precedence, operator associativity establishes a default order of evaluation for an expression. This default order can be overridden through the use of parentheses. However, the default operator associativity in Java has been chosen to yield a natural expression syntax, and you rarely need to alter it.

2.4.1.3 Operand number and type

The fourth column of Table 2-4 specifies the number and type of the operands expected by each operator. Some operators operate on only one operand; these are called unary operators. For example, the unary minus operator changes the sign of a single number:

```
-n             // The unary minus operator
```

Most operators, however, are binary operators that operate on two operand values. The - operator actually comes in both forms:

```
a - b          // The subtraction operator is a binary operator
```

Java also defines one ternary operator, often called the conditional operator. It is like an if statement inside an expression. Its three operands are separated by a question mark and acolon; the second and third operands must be convertible to the same type:

```
x > y ? x : y  // Ternary expression; evaluates to the larger of x and y
```

In addition to expecting a certain number of operands, each operator also expects particulartypes of operands. Column four of the table lists the operand types. Some of the codes used in that column require further explanation:

number

An integer, floating-point value, or character (i.e., any primitive type except boolean). In Java 5.0 and later, autounboxing (see Section 2.9.7 later in this chapter) means that the wrapper classes (such as Character, Integer, and Double) for these types can be be used in this context as well.

integer

A byte, short, int, long, or char value (long values are not allowed for the array access operator [ ]). With autounboxing, Byte, Short, Integer, Long, and Character values are also allowed.

reference

An object or array.

variable

A variable or anything else, such as an array element, to which a value can be assigned

2.4.1.4 Return type

Just as every operator expects its operands to be of specific types, each operator produces a value of a specific type. The arithmetic, increment and decrement, bitwise, and shift operators return a double if at least one of the operands is a double. They return a float if at least one of the operands is a float. They return a long if at least one of the operands is a long. Otherwise, they return an int, even if both operands are byte, short, or char types that are narrower than int.

The comparison, equality, and boolean operators always return boolean values. Each assignment operator returns whatever value it assigned, which is of a type compatible with the variable on the left side of the expression. The conditional operator returns the value of its second or third argument (which must both be of the same type).

2.4.1.5 Side effects

Every operator computes a value based on one or more operand values. Some operators, however, have *side effects* in addition to their basic evaluation. If an expression contains side effects, evaluating it changes the state of a Java program in such a way that evaluating the expression again may yield a different result. For example, the ++ increment operator has the side effect of incrementing a variable. The expression ++a increments the variable a and returns the newly incremented value. If this expression is evaluated again, the value will be different. The various assignment operators also have side effects. For example, the expression `a*=2` can also be written as `a=a*2`. The value of the expression is the value of `a` multiplied by 2, but the expression also has the side effect of storing that value back into `a`. The method invocation operator `( )` has side effects if the invoked method has side effects. Some methods, such as `Math.sqrt( )`, simply compute and return a value without side effects of any kind. Typically, however, methods do have side effects. Finally, the `new` operator has the profound side effect of creating a new object.

2.4.1.6 Order of evaluation

When the Java interpreter evaluates an expression, it performs the various operations in an order specified by the parentheses in the expression, the precedence of the operators, and the associativity of the operators. Before any operation is performed, however, the interpreter first evaluates the operands of the operator. (The exceptions are the `&&`, `||`, and `?:` operators, which do not always evaluate all their operands.) The interpreter always evaluates operands in order from left to right. This matters if any of the operands are expressions that contain side effects. Consider this code, for example:

```
int a = 2;
int v = ++a + ++a * ++a;
```

Although the multiplication is performed before the addition, the operands of the `+` operator are evaluated first. Thus, the expression evaluates to 3+4*5, or 23.

2.4.2. Arithmetic Operators

Since most programs operate primarily on numbers, the most commonly used operators are often those that perform arithmetic operations. The arithmetic operators can be used with integers, floating-point numbers, and even characters (i.e., they can be used with any primitive type other than `boolean`). If either of the operands is a floating-point number, floating-point arithmetic is used; otherwise, integer arithmetic is used. This matters because integer arithmetic and floating-point arithmetic differ in the way division is performed and in the way underflows and overflows are handled, for example. The arithmetic operators are:

Addition (`+`)

The `+` operator adds two numbers. As we'll see shortly, the `+` operator can also be used to concatenate strings. If either operand of `+` is a string, the other one is converted to a string as well. Be sure to use parentheses when you want to combine addition with concatenation. For example:

```
System.out.println("Total: " + 3 + 4);    // Prints "Total: 34", not 7!
```

Subtraction (-)

When the - operator is used as a binary operator, it subtracts its second operand from its first. For example, 7-3 evaluates to 4. The - operator can also perform unary negation.

Multiplication (*)

The * operator multiplies its two operands. For example, 7*3 evaluates to 21.

Division (/)

The / operator divides its first operand by its second. If both operands are integers, the result is an integer, and any remainder is lost. If either operand is a floating-point value, however, the result is a floating-point value. When dividing two integers,division by zero throws an ArithmeticException. For floating-point calculations, however, division by zero simply yields an infinite result or NaN:

```
7/3          // Evaluates to 2
7/3.0f       // Evaluates to 2.333333f
7/0          // Throws an ArithmeticException
7/0.0        // Evaluates to positive infinity
0.0/0.0      // Evaluates to NaN
```

Modulo (%)

The % operator computes the first operand modulo the second operand (i.e., it returns the remainder when the first operand is divided by the second operand an integral number of times). For example, 7%3 is 1. The sign of the result is the same as the sign of the first operand. While the modulo operator is typically used with integer operands, it also works for floating-point values. For example, 4.3%2.1 evaluates to 0.1. When operating with integers, trying to compute a value modulo zero causes an ArithmeticException. When working with floating-point values, anything modulo 0.0 evaluates to NaN, as does infinity modulo anything.

Unary minus (-)

When the - operator is used as a unary operatorthat is, before a single operandit performs unary negation. In other words, it converts a positive value to an equivalently negative value, and vice versa.

2.4.3. String Concatenation Operator

In addition to adding numbers, the + operator (and the related += operator) also concatenates, or joins, strings. If either of the operands to + is a string, the operator converts the other operand to a string. For example:

```
System.out.println("Quotient: " + 7/3.0f);  // Prints "Quotient: 2.3333333"
```

As a result, you must be careful to put any addition expressions in parentheses when combining them with string concatenation. If you do not, the addition operator is interpreted as a concatenation operator.

The Java interpreter has built-in string conversions for all primitive types. An object is converted to a string by invoking its `toString( )` method. Some classes define custom `toString( )` methods so that objects of that class can easily be converted to strings in this way. An array is converted to a string by invoking the built-in `toString( )` method, which, unfortunately, does not return a useful string representation of the array contents.

2.4.4. Increment and Decrement Operators

The `++` operator increments its single operand, which must be a variable, an element of an array, or a field of an object, by one. The behavior of this operator depends on its position relative to the operand. When used before the operand, where it is known as the *pre-increment* operator, it increments the operand and evaluates to the incremented value of that operand. When used after the operand, where it is known as the *post-increment* operator, it increments its operand, but evaluates to the value of that operand before it was incremented.

For example, the following code sets both `i` and `j` to 2:

```
i = 1;
j = ++i;
```

But these lines set `i` to 2 and `j` to 1:

```
i = 1;
j = i++;
```

Similarly, the `--` operator decrements its single numeric operand, which must be a variable, an element of an array, or a field of an object, by one. Like the `++` operator, the behavior of `--` depends on its position relative to the operand. When used before the operand, it decrements the operand and returns the decremented value. When used after the operand, it decrements the operand, but returns the *undecremented* value.

The expressions `x++` and `x--` are equivalent to `x=x+1` and `x=x-1`, respectively, except that when using the increment and decrement operators, `x` is only evaluated once. If `x` is itself an expression with side effects, this makes a big difference. For example, these two expressions are not equivalent:

```
a[i++]++;             // Increments an element of an array
a[i++] = a[i++] + 1;  // Adds one to an array element and stores it in another
```

These operators, in both prefix and postfix forms, are most commonly used to increment or decrement the counter that controls a loop.

2.4.5. Comparison Operators

The comparison operators consist of the equality operators that test values for equality or inequality and the relational operators used with ordered types (numbers and characters) to test for greater than and less than relationships. Both types of operators yield a `boolean` result, so they are typically used with `if` statements and `while` and `for` loops to make branching and looping decisions. For example:

```
if (o != null) ...;            // The not equals operator
while(i < a.length) ...;        // The less than operator
```

Java provides the following equality operators:

Equals (`= =`)

> The `= =` operator evaluates to `TRue` if its two operands are equal and `false` otherwise. With primitive operands, it tests whether the operand values themselves are identical. For operands of reference types, however, it tests whether the operands refer to the same object or array. In other words, it does not test the equality of two distinct objects or arrays. In particular, note that you cannot test two distinct strings for equality with this operator.
>
> If `= =` is used to compare two numeric or character operands that are not of the same type, the narrower operand is converted to the type of the wider operand before the comparison is done. For example, when comparing a `short` to a `float`, the `short` is first converted to a `float` before the comparison is performed. For floating-point numbers, the special negative zero value tests equal to the regular, positive zero value. Also, the special NaN (not-a-number) value is not equal to any other number, including itself. To test whether a floating-point value is NaN, use the `Float.isNan( )` or `Double.isNan( )` method.

Not equals (`!=`)

> The `!=` operator is exactly the opposite of the `= =` operator. It evaluates to `true` if its two primitive operands have different values or if its two reference operands refer to different objects or arrays. Otherwise, it evaluates to `false`.

The relational operators can be used with numbers and characters, but not with `boolean` values, objects, or arrays because those types are not ordered. Java provides the following relational operators:

Less than (`<`)

Evaluates to `true` if the first operand is less than the second.

Less than or equal (`<=`)

Evaluates to `true` if the first operand is less than or equal to the second.

Greater than (`>`)

Evaluates to `TRue` if the first operand is greater than the second.

Greater than or equal (`>=`)

Evaluates to `true` if the first operand is greater than or equal to the second.

2.4.6. Boolean Operators

As we've just seen, the comparison operators compare their operands and yield a`boolean` result, which is often used in branching and looping statements. In order to make branching and looping decisions based on conditions more interesting than a single comparison, you can use the boolean (o logical) operators to combine multiple comparison expressions into a single, more complex expression. The boolean operators require their operands to be`boolean` values and they evaluate to `boolean` values. The operators are:

Conditional AND (`&&`)

This operator performs a boolean AND operation on its operands. It evaluates to`true` if and only if both its operands are `true`. If either or both operands are `false`, it evaluates to `false`. For example:

```
if (x < 10 && y > 3) ... // If both comparisons are true
```

This operator (and all the boolean operators except the unary `!` operator) have a lower precedence than the comparison operators. Thus, it is perfectly legal to write a line of code like the one above. However, some programmers prefer to use parentheses to make the order of evaluation explicit:

```
if ((x < 10) && (y > 3)) ...
```

You should use whichever style you find easier to read.

This operator is called a conditional AND because it conditionally evaluates its second operand. If the first operand evaluates to `false`, the value of the expression is `false`, regardless of the value of the second operand. Therefore, to increase efficiency, the Java interpreter takes a shortcut and skips the second operand. Since the second operand is not guaranteed to be evaluated, you must use caution when using this operator with expressions that have side effects. On the other hand, the conditional nature of this operator allows us to write Java expressions such as the following:

```
if (data != null && i < data.length && data[i] != -1)
    ...
```

The second and third comparisons in this expression would cause errors if the first or second comparisons evaluated to `false`. Fortunately, we don't have to worry about this because of the conditional behavior of the `&&` operator.

Conditional OR (`||`)

> This operator performs a boolean OR operation on its two `boolean` operands. It evaluates to `TRue` if either or both of its operands are `TRue`. If both operands are `false`, it evaluates to `false`. Like the `&&` operator, `||` does not always evaluate its second operand. If the first operand evaluates to `true`, the value of the expression is `true`, regardless of the value of the second operand. Thus, the operator simply skips the second operand in that case.

Boolean NOT (`!`)

> This unary operator changes the `boolean` value of its operand. If applied to a `true` value, it evaluates to `false`, and if applied to a `false` value, it evaluates to `TRue`. It is useful in expressions like these:

```
if (!found) ...          // found is a boolean variable declared somewhere
while (!c.isEmpty(  )) ... // The isEmpty(  ) method returns a boolean value
```

Because `!` is a unary operator, it has a high precedence and often must be used with parentheses:

```
if (!(x > y && y > z))
```

Boolean AND (`&`)

> When used with `boolean` operands, the `&` operator behaves like the `&&` operator, except that it always evaluates both operands, regardless of the value of the first operand. This operator is almost always used as a bitwise operator with integer operands, however, and many Java programmers would not even recognize its use with `boolean` operands as legal Java code.

Boolean OR (`|`)

> This operator performs a boolean OR operation on its two `boolean` operands. It is like the `||`

operator, except that it always evaluates both operands, even if the first one is `true`. The `|` operator is almost always used as a bitwise operator on integer operands; its use with `boolean` operands is very rare.

Boolean XOR (`^`)

When used with `boolean` operands, this operator computes the Exclusive OR (XOR) of its operands. It evaluates to `true` if exactly one of the two operands is `true`. In other words, it evaluates to `false` if both operands are `false` or if both operands are `true`. Unlike the `&&` and `||` operators, this one must always evaluate both operands. The `^` operator is much more commonly used as a bitwise operator on integer operands. With `boolean` operands, this operator is equivalent to the `!=` operator.

2.4.7. Bitwise and Shift Operators

The bitwise and shift operators are low-level operators that manipulate the individual bits that make up an integer value. The bitwise operators are most commonly used for testing and setting individual flag bits in a value. In order to understand their behavior, you must understand binary (base-2) numbers and the twos-complement format used to represent negative integers. You cannot use these operators with floating-point, `boolean`, array, or object operands. When used with `boolean` operands, the `&`, `|`, and `^` operators perform a different operation, as described in the previous section.

If either of the arguments to a bitwise operator is a `long`, the result is a `long`. Otherwise, the result is an `int`. If the left operand of a shift operator is a `long`, the result is a `long`; otherwise, the result is an `int`. The operators are:

Bitwise complement (`~`)

The unary `~` operator is known as the bitwise complement, or bitwise NOT, operator. It inverts each bit of its single operand, converting ones to zeros and zeros to ones. For example:

```
byte b = ~12;           // ~00001100 =  => 11110011 or -13 decimal
flags = flags & ~f;     // Clear flag f in a set of flags
```

Bitwise AND (`&`)

This operator combines its two integer operands by performing a boolean AND operation on their individual bits. The result has a bit set only if the corresponding bit is set in both operands. For example:

```
10 & 7                   // 00001010 & 00000111 =  => 00000010 or 2
if ((flags & f) != 0)    // Test whether flag f is set
```

When used with `boolean` operands, `&` is the infrequently used boolean AND operator described earlier.

Bitwise OR (`|`)

This operator combines its two integer operands by performing a boolean OR operation on thei individual bits. The result has a bit set if the corresponding bit is set in either or both of the operands. It has a zero bit only where both corresponding operand bits are zero. For example:

```
10 | 7                   // 00001010 | 00000111 =  => 00001111 or 15
flags = flags | f;       // Set flag f
```

When used with `boolean` operands, `|` is the infrequently used boolean OR operator described earlier.

Bitwise XOR (`^`)

This operator combines its two integer operands by performing a boolean XOR (Exclusive OR) operation on their individual bits. The result has a bit set if the corresponding bits in the two operands are different. If the corresponding operand bits are both ones or both zeros, the result bit is a zero. For example:

```
10 ^ 7               // 00001010 ^ 00000111 =  => 00001101 or 13
```

When used with `boolean` operands, `^` is the infrequently used boolean XOR operator.

Left shift (`<<`)

The `<<` operator shifts the bits of the left operand left by the number of places specified by the right operand. High-order bits of the left operand are lost, and zero bits are shifted in from the right. Shifting an integer left by *n* places is equivalent to multiplying that number by 2*n*. For example:

```
10 << 1    // 00001010 << 1 = 00010100 = 20 = 10*2
7 << 3     // 00000111 << 3 = 00111000 = 56 = 7*8
-1 << 2    // 0xFFFFFFFF << 2 = 0xFFFFFFFC = -4 = -1*4
```

If the left operand is a `long`, the right operand should be between 0 and 63. Otherwise, the left operand is taken to be an `int`, and the right operand should be between and 31.

Signed right shift (>>)

The >> operator shifts the bits of the left operand to the right by the number of places specified by the right operand. The low-order bits of the left operand are shifted away and are lost. The high-order bits shifted in are the same as the original high-order bit of the left operand. In other words, if the left operand is positive, zeros are shifted into the high-order bits. If the left operand is negative, ones are shifted in instead. This technique is known as *sign extension*; it is used to preserve the sign of the left operand. For example:

```
10 >> 1      // 00001010 >> 1 = 00000101 = 5 = 10/2
27 >> 3      // 00011011 >> 3 = 00000011 = 3 = 27/8
-50 >> 2     // 11001110 >> 2 = 11110011 = -13 != -50/4
```

If the left operand is positive and the right operand is *n*, the >> operator is the same as integer division by 2*n*.

Unsigned right shift (>>>)

This operator is like the >> operator, except that it always shifts zeros into the high-order bits of the result, regardless of the sign of the left-hand operand. This technique is called *zero extension*; it is appropriate when the left operand is being treated as an unsigned value (despite the fact that Java integer types are all signed). These are examples:

```
0xff >>> 4    // 11111111 >>> 4 = 00001111 = 15  = 255/16
-50 >>> 2     // 0xFFFFFFCE >>> 2 = 0x3FFFFFF3 = 1073741811
```

2.4.8. Assignment Operators

The assignment operators store, or assign, a value into some kind of variable. The left operand must evaluate to an appropriate local variable, array element, or object field. The right side can be any value of a type compatible with the variable. An assignment expression evaluates to the value that is assigned to the variable. More importantly, however, the expression has the side effect of actually performing the assignment. Unlike all other binary operators, the assignment operators are right-associative, which means that the assignments in a=b=c are performed right-to-left, as follows: a=(b=c).

The basic assignment operator is =. Do not confuse it with the equality operator, = =. In order to keep these two operators distinct, I recommend that you read = as "is assigned the value."

In addition to this simple assignment operator, Java also defines 11 other operators that combine assignment with the 5 arithmetic operators and the 6 bitwise and shift operators. For example, the += operator reads the value of the left variable, adds the value of the right operand to it, stores the sum back into the left variable as a side effect, and returns the sum as the value of the expression. Thus, the expression x+=2 is almost the same as x=x+2. The difference between these two expressions is that when you use the += operator, the left operand is evaluated only once. This makes a difference when that operand has a side effect. Consider the following two expressions, which are not equivalent:

```
a[i++] += 2;
a[i++] = a[i++] + 2;
```

The general form of these combination assignment operators is:

```
var op= value
```

This is equivalent (unless there are side effects in var) to:

```
var = var op value
```

The available operators are:

```
+=    -=    *=    /=    %=    // Arithmetic operators plus assignment

&=    |=    ^=                // Bitwise operators plus assignment

<<=   >>=   >>>=              // Shift operators plus assignment
```

The most commonly used operators are += and -=, although &= and |= can also be useful when working with boolean flags. For example:

```
i += 2;          // Increment a loop counter by 2
c -= 5;          // Decrement a counter by 5
flags |= f;      // Set a flag f in an integer set of flags
flags & ~f;      // Clear a flag f in an integer set of flags
```

2.4.9. The Conditional Operator

The conditional operator ?: is a somewhat obscure ternary (three-operand) operator inherited from C. It allows you to embed a conditional within an expression. You can think of it as the operator version of the if/else statement. The first and second operands of the conditional operator are separated by a question mark (?) while the second and third operands are separated by a colon (:). The first operand must evaluate to a boolean value. The second and third operands can be of any type, but they must be convertible to the same type.

The conditional operator starts by evaluating its first operand. If it is TRue, the operator evaluates its second operand and uses that as the value of the expression. On the other hand, if the first operand is false, the conditional operator evaluates and returns its third operand. The conditional operator never evaluates both its second and third operand, so be careful when using expressions with side effects with this operator. Examples of this operator are:

```
int max = (x > y) ? x : y;
String name = (name != null) ? name : "unknown";
```

Note that the `?:` operator has lower precedence than all other operators except the assignment operators, so parentheses are not usually necessary around the operands of this operator. Many programmers find conditional expressions easier to read if the first operand is placed within parentheses, however. This is especially true because the conditional `if` statement always has its conditional expression written within parentheses.

2.4.10. The instanceof Operator

The `instanceof` operator requires an object or array value as its left operand and the name of a reference type as its right operand. It evaluates to `true` if the object or array is an *instance* of the specified type; it returns `false` otherwise. If the left operand is `null`, `instanceof` always evaluates to `false`. If an `instanceof` expression evaluates to `true`, it means that you can safely cast and assign the left operand to a variable of the type of the right operand.

The `instanceof` operator can be used only with reference types and objects, not primitive types and values. Examples of `instanceof` are:

```
"string" instanceof String      // True: all strings are instances of String
"" instanceof Object            // True: strings are also instances of Object
null instanceof String          // False: null is never an instance of anything

Object o = new int[] {1,2,3};
o instanceof int[]   // True: the array value is an int array
o instanceof byte[]  // False: the array value is not a byte array
o instanceof Object  // True: all arrays are instances of Object

// Use instanceof to make sure that it is safe to cast an object
if (object instanceof Point) {
   Point p = (Point) object;
}
```

2.4.11. Special Operators

Java has five language constructs that are sometimes considered operators and sometimes considered simply part of the basic language syntax. These "operators" were included in Table 2-4 in order to show their precedence relative to the other true operators. The use of these language constructs is detailed elsewhere in this book but is described briefly here so that you can recognize them in code examples.

Object member access (.)

An *object* is a collection of data and methods that operate on that data; the data fields and

downloaded from: lib.ommolketab.ir

methods of an object are called its members. The dot (.) operator accesses these members. If `o` is an expression that evaluates to an object reference, and `f` is the name of a field of the object, `o.f` evaluates to the value contained in that field. If `m` is the name of a method, `o.m` refers to that method and allows it to be invoked using the `( )` operator shown later.

Array element access (`[]`)

An *array* is a numbered list of values. Each element of an array can be referred to by its number, or *index*. The `[ ]` operator allows you to refer to the individual elements of an array. If `a` is an array, and `i` is an expression that evaluates to an `int`, `a[i]` refers to one of the elements of `a`. Unlike other operators that work with integer values, this operator restricts array index values to be of type `int` or narrower.

Method invocation (`( )`)

A *method* is a named collection of Java code that can be run, or *invoked*, by following the name of the method with zero or more comma-separated expressions contained within parentheses. The values of these expressions are the *arguments* to the method. The method processes the arguments and optionally returns a value that becomes the value of the method invocation expression. If `o.m` is a method that expects no arguments, the method can be invoked with `o.m( )`. If the method expects three arguments, for example, it can be invoked with an expression such as `o.m(x,y,z)`. Before the Java interpreter invokes a method, it evaluates each of the arguments to be passed to the method. These expressions are guaranteed to be evaluated in order from left to right (which matters if any of the arguments have side effects).

Object creation (`new`)

In Java, objects (and arrays) are created with the `new` operator, which is followed by the type of the object to be created and a parenthesized list of arguments to be passed to the object *constructor*. A constructor is a special method that initializes a newly created object, so the object creation syntax is similar to the Java method invocation syntax. For example:

```
new ArrayList(  );
new Point(1,2)
```

Type conversion or casting (`( )`)

As we've already seen, parentheses can also be used as an operator to perform narrowing type conversions, or casts. The first operand of this operator is the type to be converted to; it is placed between the parentheses. The second operand is the value to be converted; it follows the parentheses. For example:

```
(byte) 28          // An integer literal cast to a byte type
(int) (x + 3.14f)  // A floating-point sum value cast to an integer value
```

```
(String)h.get(k)   // A generic object cast to a more specific string type
```

2.5. Statements

A *statement* is a single command executed by the Java interpreter. By default, the Java interpreter runs one statement after another, in the order they are written. Many of the statements defined by Java, however, are flow-control statements, such as conditionals and loops, that alter this default order of execution in well-defined ways. Table 2-5 summarizes the statements defined by Java.

Table 2-5. Java statements

Statement	Purpose	Syntax
expression	side effects	`var = expr; expr++; method( ); new Type( );`
compound	group statements	`{ statements }`
empty	do nothing	`;`
labeled	name a statement	`label : statement`
variable	declare a variable	`[final] type name [= value] [, name [= value]] ...;`
`if`	conditional	`if ( expr ) statement [ else statement]`
`switch`	conditional	`switch ( expr ) { [ case expr : statements ] ... [ default: statements ] }`
`while`	loop	`while ( expr ) statement`
`do`	loop	`do statement while ( expr );`
`for`	simplified loop	`for ( init ; test ; increment ) statement`
`for/in`	collection iteration	`for ( variable : iterable ) statement` Java 5.0 and later; also called "foreach"
`break`	exit block	`break [ label ] ;`
`continue`	restart loop	`continue [ label ] ;`
`return`	end method	`return [ expr ] ;`
`synchronized`	critical section	`synchronized ( expr ) { statements }`
`throw`	throw exception	`throw expr ;`

Statement	Purpose	Syntax
`try`	handle exception	`try {` *statements* `} [ catch (` *type name* `) {` *statements* `} ] ... [ finally {` *statements* `} ]`
`assert`	verify invariant	`assert` *invariant* `[ :` *error* `] ;` Java 1.4 and later.

2.5.1. Expression Statements

As we saw earlier in the chapter, certain types of Java expressions have side effects. In other words, they do not simply evaluate to some value; they also change the program state in some way. Any expression with side effects can be used as a statement simply by following it with a semicolon. The legal types of expression statements are assignments, increments and decrements, method calls, and object creation. For example:

```
a = 1;                              // Assignment
x *= 2;                             // Assignment with operation
i++;                                // Post-increment
--c;                                // Pre-decrement
System.out.println("statement");    // Method invocation
```

2.5.2. Compound Statements

A *compound statement* is any number and kind of statements grouped together within curly braces. You can use a compound statement anywhere a statement is required by Java syntax:

```
for(int i = 0; i < 10; i++) {
   a[i]++;                    // Body of this loop is a compound statement.
   b[i]--;                    // It consists of two expression statements
}                             // within curly braces.
```

2.5.3. The Empty Statement

An *empty statement* in Java is written as a single semicolon. The empty statement doesn't do anything, but the syntax is occasionally useful. For example, you can use it to indicate an empty loop body in a `for` loop:

```
for(int i = 0; i < 10; a[i++]++)  // Increment array elements
     /* empty */;                 // Loop body is empty statement
```

2.5.4. Labeled Statements

A *labeled statement* is simply a statement that has been given a name by prepending an identifier and a colon to it. Labels are used by the `break` and `continue` statements. For example:

```
rowLoop: for(int r = 0; r < rows.length; r++) {        // A labeled loop
   colLoop: for(int c = 0; c < columns.length; c++) {  // Another one
     break rowLoop;                                    // Use a label
   }
}
```

2.5.5. Local Variable Declaration Statements

A *local variable*, often simply called a variable, is a symbolic name for a location to store a value that is defined within a method or compound statement. All variables must be declared before they can be used; this is done with a variable declaration statement. Because Java is a strongly typed language, a variable declaration specifies the type of the variable, and only values of that type can be stored in the variable.

In its simplest form, a variable declaration specifies a variable's type and name:

```
int counter;
String s;
```

A variable declaration can also include an *initializer*: an expression that specifies an initial value for the variable. For example:

```
int i = 0;
String s = readLine(  );
int[] data = {x+1, x+2, x+3};  // Array initializers are documented later
```

The Java compiler does not allow you to use a local variable that has not been initialized, so it is usually convenient to combine variable declaration and initialization into a single statement. The initializer expression need not be a literal value or a constant expression that can be evaluated by the compiler; it can be an arbitrarily complex expression whose value is computed when the program is run.

A single variable declaration statement can declare and initialize more than one variable, but all variables must be of the same type. Variable names and optional initializers are separated from each other with commas:

```
int i, j, k;
float x = 1.0, y = 1.0;
String question = "Really Quit?", response;
```

In Java 1.1 and later, variable declaration statements can begin with the `final` keyword. This modifier specifies that once an initial value is specified for the variable, that value is never allowed to change:

```
final String greeting = getLocalLanguageGreeting(  );
```

C programmers should note that Java variable declaration statements can appear anywhere in Java code; they are not restricted to the beginning of a method or block of code. Local variable declarations can also be integrated with the *initialize* portion of a `for` loop, as we'll discuss shortly.

Local variables can be used only within the method or block of code in which they are defined. This is called their *scope* or *lexical scope*:

```
void method(  ) {            // A method definition
   int i = 0;              // Declare variable i
   while (i < 10) {        // i is in scope here
     int j = 0;            // Declare j; the scope of j begins here
     i++;                  // i is in scope here; increment it
   }                       // j is no longer in scope; can't use it anymore
   System.out.println(i);  // i is still in scope here
}                          // The scope of i ends here
```

2.5.6. The if/else Statement

The `if` statement is the fundamental control statement that allows Java to make decisions or, more precisely, to execute statements conditionally. The `if` statement has an associated expression and statement. If the expression evaluates to `true`, the interpreter executes the statement. If the expression evaluates to `false` the interpreter skips the statement. In Java 5.0, the expression may be of the wrapper type `Boolean` instead of the primitive type `boolean`. In this case, the wrapper object is automatically unboxed.

Here is an example `if` statement:

```
if (username == null)         // If username is null,
   username = "John Doe";     // use a default value
```

Although they look extraneous, the parentheses around the expression are a required part of the syntax for the `if` statement.

As I already mentioned, a block of statements enclosed in curly braces is itself a statement, so we can also write `if` statements that look like this:

```
if ((address == null) || (address.equals(""))) {
   address = "[undefined]";
   System.out.println("WARNING: no address specified.");
}
```

An `if` statement can include an optional `else` keyword that is followed by a second statement. In this form of the statement, the expression is evaluated, and, if it is `TRue`, the first statement is executed. Otherwise, the second statement is executed. For example:

```
if (username != null)
   System.out.println("Hello " + username);
```

```
else {
   username = askQuestion("What is your name?");
   System.out.println("Hello " + username + ". Welcome!");
}
```

When you use nested `if/else` statements, some caution is required to ensure that the `else` clause goes with the appropriate `if` statement. Consider the following lines:

```
if (i == j)
   if (j == k)
     System.out.println("i equals k");
else
   System.out.println("i doesn't equal j");    // WRONG!!
```

In this example, the inner `if` statement forms the single statement allowed by the syntax of the outer `if` statement. Unfortunately, it is not clear (except from the hint given by the indentation) which `if` the `else` goes with. And in this example, the indentation hint is wrong. The rule is that an `else` clause like this is associated with the nearest `if` statement. Properly indented, this code looks like this:

```
if (i == j)
   if (j == k)
     System.out.println("i equals k");
   else
     System.out.println("i doesn't equal j");    // WRONG!!
```

This is legal code, but it is clearly not what the programmer had in mind. When working with nested `if` statements, you should use curly braces to make your code easier to read. Here is a better way to write the code:

```
if (i == j) {
   if (j == k)
     System.out.println("i equals k");
}
else {
   System.out.println("i doesn't equal j");
}
```

2.5.6.1 The else if clause

The `if/else` statement is useful for testing a condition and choosing between two statements or blocks of code to execute. But what about when you need to choose between several blocks of code? This is typically done with an `else if` clause, which is not really new syntax, but a common idiomatic usage of the standard `if/else` statement. It looks like this:

```
if (n == 1) {
    // Execute code block #1
```

```
}
else if (n == 2) {
    // Execute code block #2
}
else if (n == 3) {
    // Execute code block #3
}
else {
    // If all else fails, execute block #4
}
```

There is nothing special about this code. It is just a series of `if` statements, where each `if` is part of the `else` clause of the previous statement. Using the `else if` idiom is preferable to, and more legible than, writing these statements out in their fully nested form:

```
if (n = = 1) {
   // Execute code block #1
}
else {
   if (n = = 2) {
     // Execute code block #2
   }
   else {
     if (n = = 3) {
       // Execute code block #3
     }
     else {
       // If all else fails, execute block #4
     }
   }
}
```

2.5.7. The switch Statement

An `if` statement causes a branch in the flow of a program's execution. You can use multiple `if` statements, as shown in the previous section, to perform a multiway branch. This is not always the best solution, however, especially when all of the branches depend on the value of a single variable. In this case, it is inefficient to repeatedly check the value of the same variable in multiple `if` statements.

A better solution is to use a `switch` statement, which is inherited from the C programming language. Although the syntax of this statement is not nearly as elegant as other parts of Java, the brute practicality of the construct makes it worthwhile. If you are not familiar with the `switch` statement itself, you may at least be familiar with the basic concept, under the name computed goto or jump table.

A `switch` statement starts with an expression whose type is an `int`, `short`, `char`, or `byte`. In Java 5.0 `Integer`, `Short`, `Character` and `Byte` wrapper types are allowed, as are enumerated types. (Enums are new in Java 5.0; see Chapter 4 for details on enumerated types and their use in `switch` statements.) This expression is followed by a block of code in curly braces that contains various entry points that correspond to possible values for the expression. For example, the following switch statement is equivalent to the repeated if and else/if statements shown in the previous section:

```
switch(n) {
   case 1:                        // Start here if n = = 1
     // Execute code block #1
     break;                       // Stop here
   case 2:                        // Start here if n = = 2
     // Execute code block #2
     break;                       // Stop here
   case 3:                        // Start here if n =  = 3
     // Execute code block #3
     break;                       // Stop here
   default:                       // If all else fails...
     // Execute code block #4
     break;                       // Stop here
}
```

As you can see from the example, the various entry points into a switch statement are labeled either with the keyword case, followed by an integer value and a colon, or with the special default keyword, followed by a colon. When a switch statement executes, the interpreter computes the value of the expression in parentheses and then looks for a case label that matches that value. If it finds one, the interpreter starts executing the block of code at the first statement following the case label. If it does not find a case label with a matching value, the interpreter starts execution at the first statement following a special-case default: label. Or, if there is no default: label, the interpreter skips the body of the switch statement altogether.

Note the use of the break keyword at the end of each case in the previous code. The break statement is described later in this chapter, but, in this case, it causes the interpreter to exit the body of the switch statement. The case clauses in a switch statement specify only the starting point of the desired code. The individual cases are not independent blocks of code, and they do not have any implicit ending point. Therefore, you must explicitly specify the end of each case with a break or related statement. In the absence of break statements, a switch statement begins executing code at the first statement after the matching case label and continues executing statements until it reaches the end of the block. On rare occasions, it is useful to write code like this that falls through from one case label to the next, but 99% of the time you should be careful to end every case and default section with a statement that causes the switch statement to stop executing. Normally you use a break statement, but return and throw also work.

A switch statement can have more than one case clause labeling the same statement. Consider the switch statement in the following method:

```
boolean parseYesOrNoResponse(char response) {
   switch(response) {
     case 'y':
     case 'Y': return true;
     case 'n':
     case 'N': return false;
     default: throw new IllegalArgumentException("Response must be Y or N");
   }
```

```
}
```

The switch statement and its case labels have some important restrictions. First, the expression associated with a switch statement must have a byte, char, short, or int value. The floating-point and boolean types are not supported, and neither is long, even though long is an integer type. Second, the value associated with each case label must be a constant value or a constant expression the compiler can evaluate. A case label cannot contain a runtime expression involving variables or method calls, for example. Third, the case label values must be within the range of the data type used for the switch expression. And finally, it is obviously not legal to have two or more case labels with the same value or more than one default label.

2.5.8. The while Statement

Just as the if statement is the basic control statement that allows Java to make decisions, the while statement is the basic statement that allows Java to perform repetitive actions. It has the following syntax:

```
while (expression)
   statement
```

The while statement works by first evaluating the *expression*, which must result in a boolean (or, in Java 5.0, a Boolean) value. If the value is false, the interpreter skips the *statement* associated with the loop and moves to the next statement in the program. If it is true, however, the *statement* that forms the body of the loop is executed, and the *expression* is reevaluated. Again, if the value of *expression* is false, the interpreter moves on to the next statement in the program; otherwise it executes the *statement* again. This cycle continues while the *expression* remains true (i.e., until it evaluates to false), at which point the while statement ends, and the interpreter moves on to the next statement. You can create an infinite loop with the syntax while(true).

Here is an example while loop that prints the numbers 0 to 9:

```
int count = 0;
while (count < 10) {
   System.out.println(count);
   count++;
}
```

As you can see, the variable count starts off at 0 in this example and is incremented each time the body of the loop runs. Once the loop has executed 10 times, the expression becomes false (i.e., count is no longer less than 10), the while statement finishes, and the Java interpreter can move to the next statement in the program. Most loops have a counter variable like count. The variable names i, j, and k are commonly used as loop counters, although you should use more descriptive names if it makes your code easier to understand.

2.5.9. The do Statement

A `do` loop is much like a `while` loop, except that the loop expression is tested at the bottom of the loop rather than at the top. This means that the body of the loop is always executed at least once. The syntax is:

```
do
   statement
while ( expression ) ;
```

Notice a couple of differences between the `do` loop and the more ordinary `while` loop. First, the `do` loop requires both the `do` keyword to mark the beginning of the loop and the `while` keyword to mark the end and introduce the loop condition. Also, unlike the `while` loop, the `do` loop is terminated with a semicolon. This is because the `do` loop ends with the loop condition rather than simply ending with a curly brace that marks the end of the loop body. The following `do` loop prints the same output as the `while` loop just discussed:

```
int count = 0;
do {
   System.out.println(count);
   count++;
} while(count < 10);
```

The `do` loop is much less commonly used than its `while` cousin because, in practice, it is unusual to encounter a situation where you are sure you always want a loop to execute at least once.

2.5.10. The for Statement

The `for` statement provides a looping construct that is often more convenient than the `while` and `do` loops. The `for` statement takes advantage of a common looping pattern. Most loops have a counter, or state variable of some kind, that is initialized before the loop starts, tested to determine whether to execute the loop body, and then incremented or updated somehow at the end of the loop body before the test expression is evaluated again. The initialization, test, and update steps are the three crucial manipulations of a loop variable, and the `for` statement makes these three steps an explicit part of the loop syntax:

```
for(initialize ; test ; update)
     statement
```

This `for` loop is basically equivalent to the following `while` loop:[2]

[2] As you'll see when we consider the `continue` statement, this `while` loop is not exactly equivalent to the `for` loop.

```
initialize;
while(test) {
   statement;
   update;
}
```

Placing the *initialize*, *test*, and *update* expressions at the top of a `for` loop makes it especially easy to understand what the loop is doing, and it prevents mistakes such as forgetting to initialize or update the loop variable. The interpreter discards the values of the *initialize* and *update* expressions, so in order to be useful, these expressions must have side effects. *initialize* is typically an assignment expression while *update* is usually an increment, decrement, or some other assignment.

The following `for` loop prints the numbers 0 to 9, just as the previous `while` and `do` loops have done:

```
int count;
for(count = 0 ; count < 10 ; count++)
   System.out.println(count);
```

Notice how this syntax places all the important information about the loop variable on a single line, making it very clear how the loop executes. Placing the update expression in the `for` statement itself also simplifies the body of the loop to a single statement; we don't even need to use curly braces to produce a statement block.

The `for` loop supports some additional syntax that makes it even more convenient to use. Because many loops use their loop variables only within the loop, the `for` loop allows the *initialize* expression to be a full variable declaration, so that the variable is scoped to the body of the loop and is not visible outside of it. For example:

```
for(int count = 0 ; count < 10 ; count++)
   System.out.println(count);
```

Furthermore, the `for` loop syntax does not restrict you to writing loops that use only a single variable. Both the *initialize* and *update* expressions of a `for` loop can use a comma to separate multiple initializations and update expressions. For example:

```
for(int i = 0, j = 10 ; i < 10 ; i++, j--)
     sum += i * j;
```

Even though all the examples so far have counted numbers, `for` loops are not restricted to loops that count numbers. For example, you might use a `for` loop to iterate through the elements of a linked list:

```
for(Node n = listHead; n != null; n = n.nextNode(  ))
   process(n);
```

The *initialize*, *test*, and *update* expressions of a `for` loop are all optional; only the semicolons that separate the expressions are required. If the *test* expression is omitted, it is assumed to be `true`. Thus, you can write an infinite loop as `for(;;)`.

2.5.11. The for/in Statement

The `for/in` statement is a powerful new loop that was added to the language in Java 5.0. It iterates through the elements of an array or collection or any object that implements `java.lang.Iterable` (we'll see more about this new interface in a moment). On each iteration it assigns an element of the array or `Iterable` object to the loop variable you declare and then executes the loop body, which typically uses the loop variable to operate on the element. No loop counter or `Iterator` object is involved; the `for/in` loop performs the iteration automatically, and you need not concern yourself with correct initialization or termination of the loop.

A `for/in` loop is written as the keyword `for` followed by an open parenthesis, a variable declaration (without initializer), a colon, an expression, a close parenthesis, and finally the statement (or block) that forms the body of the loop.

```
for( declaration : expression )
     statement
```

Despite its name, the `for/in` loop does not use the keyword `in`. It is common to read the colon as "in," however. Because this statement does not have a keyword of its own, it does not have an unambiguous name. You may also see it called "enhanced for" or "foreach."

For the `while`, `do`, and `for` loops, we've shown an example that prints ten numbers. The `for/in` loop can do this too, but not on its own. `for/in` is not a general-purpose loop like the others. It is a specialized loop that executes its body once for each element *in* an array or collection. So, in order to loop ten times (to print out ten numbers), we need an array or other collection with ten elements. Here's code we can use:

```
// These are the numbers we want to print
int[] primes = new int[] { 2, 3, 5, 7, 11, 13, 17, 19, 23, 29 };
// This is the loop that prints them
for(int n : primes)
     System.out.println(n);
```

Here are some more things you should know about the syntax of the `for/in` loop:

- As noted earlier, *`expression`* must be either an array or an object that implements the `java.lang.Iterable` interface. This type must be known at compile-time so that the compiler can generate appropriate looping code. For example, you can't use this loop with an array or `List` that you have cast to an `Object`.
- The type of the array or `Iterable` elements must be assignment-compatible with the type of the variable declared in the *`declaration`*. If you use an `Iterable` object that is not parameterized with an element type, the variable must be declared as an `Object`. (Parameterized types are also new in Java 5.0; they are covered in Chapter 4.)
- The *`declaration`* usually consists of just a type and a variable name, but it may include a `final` modifier and any appropriate annotations (see Chapter 4). Using `final` prevents the loop variable from taking on any value other than the array or collection element the loop assigns it and serves to emphasize that the array or collection cannot be altered through the loop variable.

- The loop variable of the for/in loop must be declared as part of the loop, with both a type and a variable name. You cannot use a variable declared outside the loop as you can with the for loop.

The following class further illustrates the use of the for/in statement. It relies on parameterized types, which are covered in Chapter 4, and you may want to return to this section after reading that chapter.

```
import java.util.*;

public class ForInDemo {
     public static void main(String[] args) {
         // This is a collection we'll iterate over below.
         Set<String> wordset = new HashSet<String>(  );

         // We start with a basic loop over the elements of an array.
         // The body of the loop is executed once for each element of args[].
         // Each time through one element is assigned to the variable word.
         for(String word : args) {
             System.out.print(word + " ");
             wordset.add(word);
         }
         System.out.println(  );

         // Now iterate through the elements of the Set.
         for(String word : wordset) System.out.print(word + " ");
     }
}
```

2.5.11.1 Iterable and iterator

To understand how the for/in loop works with collections, we need to consider two interfaces, java.lang.Iterable , introduced in Java 5.0, and java.util.Iterator, introduced in Java 1.2, but parameterized with the rest of the Collections Framework in Java 5.0.[3] The APIs of both interfaces are reproduced here for convenience:

[3] If you are not already familiar with parameterized types, you may want to skip this section now and return to it after reading Chapter 4.

```
public interface Iterator<E> {
     boolean hasNext(  );
     E next(  );
     void remove(  );
}
```

Iterator defines a way to iterate through the elements of a collection or other data structure. It works like this: while there are more elements in the collection (hasNext( ) returns true), call next( ) to obtain the next element of the collection. Ordered collections, such as lists, typically have iterators that guarantee that they'll return elements in order. Unordered collections like Set simply guarantee that repeated calls to next( ) return all elements of the set without omissions or duplications but do not specify an ordering.

```
public interface Iterable<E> {
     java.util.Iterator<E> iterator( );
}
```

The `Iterable` interface was introduced to make the `for/in` loop work. A class implements this interface in order to advertise that it is able to provide an `Iterator` to anyone interested. (This can be useful in its own right, even when you are not using the `for/in` loop). If an object is `Iterable<E>`, that means that that it has an `iterator( )` method that returns an `Iterator<E>`, which has a `next( )` method that returns an object of type `E`. If you implement `Iterable` and provide an `Iterator` for your own classes, you'll be able to iterate over those classes with the `for/in` loop.

Remember that if you use the `for/in` loop with an `Iterable<E>`, the loop variable must be of type `E` or a superclass or interface. For example, to iterate through the elements of a `List<String>`, the variable must be declared `String` or its superclass `Object`, or one of its interfaces `CharSequence`, `Comparable`, or `Serializable`.

If you use `for/in` to iterate through the elements of a raw `List` with no type parameter, the `Iterable` and `Iterator` also have no type parameter, and the type returned by the `next( )` method of the raw `Iterator` is `Object`. In this case, you have no choice but to declare the loop variable to be an `Object`.

2.5.11.2 What for/in cannot do

`for/in` is a specialized loop that can simplify your code and reduce the possibility of looping errors in many circumstances. It is not a general replacement for the `while`, `for`, or `do` loops, however, because it hides the loop counter or `Iterator` from you. This means that some algorithms simply cannot be expressed with a `for/in` loop.

Suppose you want to print the elements of an array as a comma-separated list. To do this, you need to print a comma after every element of the array except the last, or equivalently, before every element of the array except the first. With a traditional `for` loop, the code might look like this:

```
for(int i = 0; i < words.length; i++) {
     if (i > 0) System.out.print(", ");
     System.out.print(words[i]);
}
```

This is a very straightforward task, but you simply cannot do it with `for/in`. The problem is that the `for/in` loop doesn't give you a loop counter or any other way to tell if you're on the first iteration, the last iteration, or somewhere in between. Here are two other simple loops that can't be converted to use `for/in`, for the same basic reason:

```
String[] args;  // Initialized elsewhere
for(int i = 0; i < args.length; i++)
     System.out.println(i + ": " + args[i]);
```

```
// Map words to the position at which they occur.
List<String> words;  // Initialized elsewhere
Map<String,Integer> map = new HashMap<String,Integer>(  );
for(int i = 0, n = words.size(  ); i < n; i++) map.put(words.get(i), i);
```

A similar issue exists when using `for/in` to iterate through the elements of the collection. Just as a `for/in` loop over an array has no way to obtain the array index of the current element, a `for/in` loop over a collection has no way to obtain the `Iterator` object that is being used to itemize the elements of the collection. This means, for example, that you cannot use the `remove( )` method of the iterator (or any of the additional methods defined by `java.util.ListIterator`) as you could if you used the `Iterator` explicitly yourself.

Here are some other things you cannot do with `for/in`:

- Iterate backwards through the elements of an array or `List`.
- Use a single loop counter to access the same-numbered elements of two distinct arrays.
- Iterate through the elements of a `List` using calls to its `get( )` method rather than calls to its iterator.

2.5.12. The break Statement

A `break` statement causes the Java interpreter to skip immediately to the end of a containing statement. We have already seen the `break` statement used with the `switch` statement. The `break` statement is most often written as simply the keyword `break` followed by a semicolon:

```
break;
```

When used in this form, it causes the Java interpreter to immediately exit the innermost containing `while`, `do`, `for`, or `switch` statement. For example:

```
for(int i = 0; i < data.length; i++) { // Loop through the data array.
    if (data[i] =  = target) {          // When we find what we're looking for,
        index = i;                      // remember where we found it
        break;                          // and stop looking!
    }
}   // The Java interpreter goes here after executing break
```

The `break` statement can also be followed by the name of a containing labeled statement. When used in this form, `break` causes the Java interpreter to immediately exit the named block, which can be any kind of statement, not just a loop or `switch`. For example:

```
testfornull: if (data != null) {              // If the array is defined,
   for(int row = 0; row < numrows; row++) {   // loop through one dimension,
     for(int col = 0; col < numcols; col++) { // then loop through the other.
```

```
       if (data[row][col] =  = null)            // If the array is missing data,
         break testfornull;                   // treat the array as undefined.
     }
   }
}  // Java interpreter goes here after executing break testfornull
```

2.5.13. The continue Statement

While a `break` statement exits a loop, a `continue` statement quits the current iteration of a loop and starts the next one. `continue`, in both its unlabeled and labeled forms, can be used only within a `while`, `do`, or `for` loop. When used without a label, `continue` causes the innermost loop to start a new iteration. When used with a label that is the name of a containing loop, it causes the named loop to start a new iteration. For example:

```
for(int i = 0; i < data.length; i++) {  // Loop through data.
   if (data[i] =  = -1)                   // If a data value is missing,
     continue;                          // skip to the next iteration.
   process(data[i]);                    // Process the data value.
}
```

`while`, `do`, and `for` loops differ slightly in the way that `continue` starts a new iteration:

- With a `while` loop, the Java interpreter simply returns to the top of the loop, tests the loop condition again, and, if it evaluates to `true`, executes the body of the loop again.
- With a `do` loop, the interpreter jumps to the bottom of the loop, where it tests the loop condition to decide whether to perform another iteration of the loop.
- With a `for` loop, the interpreter jumps to the top of the loop, where it first evaluates the *`update`* expression and then evaluates the *`test`* expression to decide whether to loop again. As you can see, the behavior of a `for` loop with a `continue` statement is different from the behavior of the "basically equivalent" `while` loop presented earlier; *`update`* gets evaluated in the `for` loop but not in the equivalent `while` loop.

2.5.14. The return Statement

A `return` statement tells the Java interpreter to stop executing the current method. If the method is declared to return a value, the `return` statement is followed by an expression. The value of the expression becomes the return value of the method. For example, the following method computes and returns the square of a number:

```
double square(double x) {      // A method to compute x squared
   return x * x;               // Compute and return a value
}
```

Some methods are declared `void` to indicate that they do not return any value. The Java interpreter runs methods like this by executing their statements one by one until it reaches the end of the method. After executing the last statement, the interpreter returns implicitly. Sometimes, however, a void method has to return explicitly before reaching the last statement. In this case, it can use the return statement by itself, without any expression. For example, the following method prints, but does not return, the square root of its argument. If the argument is a negative number, it returns without printing anything:

```
void printSquareRoot(double x) {     // A method to print square root of x
   if (x < 0) return;                // If x is negative, return explicitly
   System.out.println(Math.sqrt(x)); // Print the square root of x
}                                    // End of method: return implicitly
```

2.5.15. The synchronized Statement

Java makes it easy to write multithreaded programs (see Chapter 5 for examples). When working with multiple threads, you must often take care to prevent multiple threads from modifying an object simultaneously in a way that might corrupt the object's state. Sections of code that must not be executed simultaneously are known as *critical sections*. Java provides the synchronized statement to protect these critical sections. The syntax is:

```
synchronized ( expression ) {
   statements
}
```

expression is an expression that must evaluate to an object or an array. The *statements* constitute the code of the critical section and must be enclosed in curly braces. Before executing the critical section, the Java interpreter first obtains an exclusive lock on the object or array specified by *expression*. It holds the lock until it is finished running the critical section, then releases it. While a thread holds the lock on an object, no other thread can obtain that lock. Therefore, no other thread can execute this or any other critical sections that require a lock on the same object. If a thread cannot immediately obtain the lock required to execute a critical section, it simply waits until the lock becomes available.

Note that you do not have to use the synchronized statement unless your program creates multiple threads that share data. If only one thread ever accesses a data structure, there is no need to protect it with synchronized. When you do have to use synchronized, it might be in code like the following:

```
public static void SortIntArray(int[] a) {
   // Sort the array a. This is synchronized so that some other thread
   // cannot change elements of the array while we're sorting it (at
   // least not other threads that protect their changes to the array
   // with synchronized).
   synchronized (a) {
       // Do the array sort here
   }
}
```

The synchronized keyword is also available as a modifier in Java and is more commonly used in this form than as a statement. When applied to a method, the synchronized keyword indicates that the entire method is a critical section. For a synchronized class method (a static method), Java obtains an exclusive lock on the class before executing the method. For a synchronized instance method, Java obtains an exclusive lock on the class instance. (Class and instance methods are discussed in Chapter 3.)

2.5.16. The throw Statement

An *exception* is a signal that indicates some sort of exceptional condition or error has occurred. To *throw* an exception is to signal an exceptional condition. To *catch* an exception is to handle itto take whatever actions are necessary to recover from it.

In Java, the throw statement is used to throw an exception:

```
throw expression ;
```

The *expression* must evaluate to an exception object that describes the exception or error that has occurred. We'll talk more about types of exceptions shortly; for now, all you need to know is that an exception is represented by an object. Here is some example code that throws an exception:

```
public static double factorial(int x) {
   if (x < 0)
     throw new IllegalArgumentException("x must be >= 0");
   double fact;
   for(fact=1.0; x > 1; fact *= x, x--)
     /* empty */ ;          // Note use of the empty statement
   return fact;
}
```

When the Java interpreter executes a throw statement, it immediately stops normal program execution and starts looking for an exception handler that can catch, or handle, the exception. Exception handlers are written with the try/catch/finally statement, which is described in the next section. The Java interpreter first looks at the enclosing block of code to see if it has an associated exception handler. If so, it exits that block of code and starts running the exception-handling code associated with the block. After running the exception handler, the interpreter continues execution at the statement immediately following the handler code.

If the enclosing block of code does not have an appropriate exception handler, the interpreter checks the next higher enclosing block of code in the method. This continues until a handler is found. If the method does not contain an exception handler that can handle the exception thrown by the throw statement, the interpreter stops running the current method and returns to the caller. Now the interpreter starts looking for an exception handler in the blocks of code of the calling method. In this way, exceptions propagate up through the lexical structure of Java methods, up the call stack of the Java interpreter. If the exception is never caught, it propagates all the way up to the main( ) method of the program. If it is not handled in that method, the Java interpreter prints an error message, prints a stack trace to indicate where the exception occurred, and then exits.

2.5.16.1 Exception types

An exception in Java is an object. The type of this object is java.lang.Throwable, or more commonly, some subclass[4] of Throwable that more specifically describes the type of exception that occurred. Throwable has two standard subclasses: java.lang.Error and java.lang.Exception. Exceptions that are subclasses of Error generally indicate unrecoverable problems: the virtual machine has run out of memory, or a class file is corrupted and cannot be read, for example. Exceptions of this sort can be caught and handled, but it is rare to do so.Exceptions that are subclasses of Exception, on the other hand, indicate less severe conditions. These exceptions can be reasonably caught and handled. They include such exceptions as java.io.EOFException, which signals the end of a file, and java.lang.ArrayIndexOutOfBoundsException, which indicates that a program has tried to read past the end of an array. In this book, I use the term "exception" to refer to any exception object, regardless of whether the type of that exception is Exception or Error.

[4] We haven't talked about subclasses yet; they are covered in detail in Chapter 3.

Since an exception is an object, it can contain data, and its class can define methods that operate on that data. The Throwable class and all its subclasses include a String field that stores a human-readable error message that describes the exceptional condition. It's set when the exception object is created and can be read from the exception with the getMessage( ) method. Most exceptions contain only this single message, but a few add other data. The java.io.InterruptedIOException, for example, adds a field named bytesTransferred that specifies how much input or output was completed before the exceptional condition interrupted it.

2.5.17. The try/catch/finally Statement

The try/catch/finally statement is Java's exception-handling mechanism. The TRy clause of this statement establishes a block of code for exception handling. This try block is followed by zero or more catch clauses, each of which is a block of statements designed to handle a specific type of exception. The catch clauses are followed by an optional finally block that contains cleanup code guaranteed to be executed regardless of what happens in the try block. Both the catch and finally clauses are optional, but every try block must be accompanied by at least one or the other. The TRy, catch, and finally blocks all begin and end with curly braces. These are a required part of the syntax and cannot be omitted, even if the clause contains only a single statement.

The following code illustrates the syntax and purpose of the try/catch/finally statement:

```
try {
   // Normally this code runs from the top of the block to the bottom
   // without problems. But it can sometimes throw an exception,
   // either directly with a throw statement or indirectly by calling
   // a method that throws an exception.
}
catch (SomeException e1) {
   // This block contains statements that handle an exception object
   // of type SomeException or a subclass of that type. Statements in
   // this block can refer to that exception object by the name e1.
}
catch (AnotherException e2) {
   // This block contains statements that handle an exception object
```

```
   // of type AnotherException or a subclass of that type. Statements
   // in this block can refer to that exception object by the name e2.
}
finally {
   // This block contains statements that are always executed
   // after we leave the try clause, regardless of whether we leave it:
   //   1) normally, after reaching the bottom of the block;
   //   2) because of a break, continue, or return statement;
   //   3) with an exception that is handled by a catch clause above; or
   //   4) with an uncaught exception that has not been handled.
   // If the try clause calls System.exit(  ), however, the interpreter
   // exits before the finally clause can be run.
}
```

2.5.17.1 try

The `TRy` clause simply establishes a block of code that either has its exceptions handled or needs special cleanup code to be run when it terminates for any reason. The `try` clause by itself doesn't do anything interesting; it is the `catch` and `finally` clauses that do the exception-handling and cleanup operations.

2.5.17.2 catch

A `try` block can be followed by zero or more `catch` clauses that specify code to handle various types of exceptions. Each `catch` clause is declared with a single argument that specifies the type of exceptions the clause can handle and also provides a name the clause can use to refer to the exception object it is currently handling. The type and name of an exception handled by a `catch` clause are exactly like the type and name of an argument passed to a method, except that for a `catch` clause, the argument type must be `Throwable` or one of its subclasses.

When an exception is thrown, the Java interpreter looks for a `catch` clause with an argument of the same type as the exception object or a superclass of that type. The interpreter invokes the first such `catch` clause it finds. The code within a `catch` block should take whatever action is necessary to cope with the exceptional condition. If the exception is a `java.io.FileNotFoundException` exception, for example, you might handle it by asking the user to check his spelling and try again. It is not required to have a `catch` clause for every possible exception; in some cases the correct response is to allow the exception to propagate up and be caught by the invoking method. In other cases, such as a programming error signaled by `NullPointerException`, the correct response is probably not to catch the exception at all, but allow it to propagate and have the Java interpreter exit with a stack trace and an error message.

2.5.17.3 finally

The `finally` clause is generally used to clean up after the code in the `TRy` clause (e.g., close files and shut down network connections). What is useful about the `finally` clause is that it is guaranteed to be executed if any portion of the `try` block is executed, regardless of how the code in the `try` block completes. In fact, the only way a `try` clause can exit without allowing the `finally` clause to be executed is by invoking the System.exit( ) method, which causes the Java interpreter to stop running.

In the normal case, control reaches the end of the TRy block and then proceeds to the finally block, which performs any necessary cleanup. If control leaves the try block because of a return, continue, or break statement, the finally block is executed before control transfers to its new destination.

If an exception occurs in the try block and there is an associated catch block to handle the exception, control transfers first to the catch block and then to the finally block. If there is no local catch block to handle the exception, control transfers first to the finally block, and then propagates up to the nearest containing catch clause that can handle the exception.

If a finally block itself transfers control with a return, continue, break, or throw statement or by calling a method that throws an exception, the pending control transfer is abandoned, and this new transfer is processed. For example, if a finally clause throws an exception, that exception replaces any exception that was in the process of being thrown. If a finally clause issues a return statement, the method returns normally, even if an exception has been thrown and has not yet been handled.

try and finally can be used together without exceptions or any catch clauses. In this case, the finally block is simply cleanup code that is guaranteed to be executed, regardless of any break, continue, or return statements within the try clause.

In previous discussions of the for and continue statements, we've seen that a for loop cannot be naively translated into a while loop because the continue statement behaves slightly differently when used in a for loop than it does when used in a while loop. The finally clause gives us a way to write a while loop that handles the continue statement in the same way that a for loop does. Consider the following generalized for loop:

```
for( initialize ; test ; update )
     statement
```

The following while loop behaves the same, even if the statement block contains a continue statement:

```
initialize ;
while ( test ) {
   TRy { statement }
   finally { update ; }
}
```

Note, however, that placing the update statement within a finally block causes this while loop to respond to break statements differently than the for loop does.

2.5.18. The assert Statement

An assert statement is used to document and verify design assumptions in Java code. This statement was added in Java 1.4 and cannot be used with previous versions of the language. An *assertion* consists of the assert keyword followed by a boolean expression that the programmer believes should always evaluate to TRue. By default, assertions are not enabled, and the assert statement does not actually do anything. It is possible to enable assertions as a debugging and testing tool, however; when this is done, the assert statement evaluates the expression. If it is indeed TRue, assert does nothing. On the other hand, if the expression evaluates to false, the assertion fails, and the assert statement throws a java.lang.AssertionError.

The assert statement may include an optional second expression, separated from the first by a colon. When assertions are enabled and the first expression evaluates to false, the value of the second expression is taken as an error code or error message and is passed to the AssertionError( ) constructor. The full syntax of the statement is:

```
assert assertion ;
```

or:

```
assert assertion : errorcode ;
```

It is important to remember that the *assertion* *must* be a boolean expression, which typically means that it contains a comparison operator or invokes a boolean-valued method.

2.5.18.1 Compiling assertions

Because the assert statement was added in Java 1.4, and because assert was not a reserved word prior to Java 1.4, the introduction of this new statement can cause code that uses "assert" as an identifier to break. For this reason, the *javac* compiler does not recognize the assert statement by default. To compile Java code that uses the assert statement, you must use the command-line argument -source 1.4. For example:

```
javac -source 1.4 ClassWithAssertions.java
```

In Java 1.4, the *javac* compiler allows "assert" to be used as an identifier unless -source 1.4 is specified. If it finds assert used as an identifier, it issues an incompatibility warning to encourage you to modify your code.

In Java 5.0, the *javac* compiler recognizes the assert statement (as well as all the new Java 5.0 syntax) by default, and no special compiler arguments are required to compile code that contains assertions. If you have legacy code that still uses assert as an identifier, it will no longer compile by default in Java 5.0. If you can't fix it, you can compile it in Java 5.0 using the -source 1.3 option.

2.5.18.2 Enabling assertions

assert statements encode assumptions that should always be true. For efficiency, it does not make sense to test assertions each time code is executed. Thus, by default, assertions are disabled, and assert statements have no effect. The assertion code remains compiled in the class files, however, so it can always be enabled for testing, diagnostic, and debugging purposes. You can enable assertions, either across the board or selectively, with command-line arguments to theJava interpreter. To enable assertions in all classes except for system classes, use the `-ea` argument. To enable assertions in system classes, use `-esa`. To enable assertions within a specific class, use `-ea` followed by a colon and the classname:

```
java -ea:com.example.sorters.MergeSort com.example.sorters.Test
```

To enable assertions for all classes in a package and in all of its subpackages, follow the `-ea` argument with a colon, the package name, and three dots:

```
java -ea:com.example.sorters... com.example.sorters.Test
```

You can disable assertions in the same way, using the `-da` argument. For example, to enable assertions throughout a package and then disable them in a specific class or subpackage, use:

```
java -ea:com.example.sorters... -da:com.example.sorters.QuickSort
java -ea:com.example.sorters... -da:com.example.sorters.plugins...
```

If you prefer verbose command-line arguments, you can use `-enableassertions` and `-disableassertions` instead of `-ea` and `-da` and `-enablesystemassertions` instead of `-esa`.

Java 1.4 added to `java.lang.ClassLoader` methods for enabling and disabling the assertions for classes loaded through that `ClassLoader`. If you use a custom class loader in your program and want to turn on assertions, you may be interested in these methods. See `ClassLoader` in the reference section.

2.5.18.3 Using assertions

Because assertions are disabled by default and impose no performance penalty on your code, you can use them liberally to document any assumptions you make while programming. It may take some time to get used to this, but as you do, you'll find more and more uses for the `assert` statement. Suppose, for example, that you're writing a method in such a way that you know that the variable `x` is either 0 or 1. Without assertions, you might code an `if` statement that looks like this:

```
if (x =  = 0) {
   ...
}
else {  // x is 1
   ...
}
```

The comment in this code is an informal assertion indicating that you believe that within the body of the `else` clause, `x` will always equal 1.

Now suppose your code is later modified in such a way that `x` can take on a value other than 0 and 1. The comment and the assumption that go along with it are no longer valid, and this may cause a bug that is not immediately apparent or is difficult to localize. The solution in this situation is to convert your comment into an assert statement. The code becomes:

```
if (x = = 0) {
   ...
}
else {
   assert x = = 1 : x  // x must be 0 or 1
   ...
}
```

Now, if x somehow ends up holding an unexpected value, an AssertionError is thrown, which makes the bug immediately apparent and easy to pinpoint. Furthermore, the second expression (following the colon) in the assert statement includes the unexpected value of x as the "error message" of the AssertionError. This message is not intended to mean anything to an end user, but to provide enough information so that you know not just that an assertion failed but also what caused it to fail.

A similar technique is useful with switch statements. If you write a switch statement without a default clause, you make an assumption about the set of possible values for the switch expression. If you believe that no other value is possible, you can add an assert statement to document and validate that fact. For example:

```
switch(x) {
   case -1: return LESS;
   case 0: return EQUALS;
   case 1: return GREATER;
   default: assert false:x; // Throw AssertionError if x is not -1, 0, or 1.
}
```

Note that the form assert false; always fails. It is a useful "dead-end" statement when you believe that the statement can never be reached.

Another common use of the assert statement is to test whether the arguments passed to a method all have values that are legal for that method; this is also known as enforcing method preconditions. For example:

```
private static Object[] subArray(Object[] a, int x, int y) {
   assert x <= y : "subArray: x > y";   // Precondition: x must be <= y
   // Now go on to create and return a subarray of a...
}
```

Note that this is a private method. The programmer has used an assert statement to document a precondition of the subArray( ) method and state that she believes that all methods that invoke this private method do in fact honor that precondition. She can state this because she has control over all the methods that invoke subArray( ). She can verify her belief by enabling assertions while testing the code. But once the code is tested, if assertions are left disabled, the method does not suffer the overhead of testing its arguments each time it is called. Note that the programmer did not use an assert statement to test that argument *a* is non-null and that the *x* and *y* arguments were legal indexes into that array. These implicit preconditions are always tested by Java at runtime, and a failure results in an unchecked NullPointerException or an ArrayIndexOutOfBoundsException, so an assertion is not required for them.

It is important to understand that the assert statement is not suitable for enforcing preconditions on public methods. A public method can be called from anywhere, and the programmer cannot assert in advance that it will be invoked correctly. To be robust, a public API must explicitly test its arguments and enforce its preconditions each time it is called, whether or not assertions are enabled.

A related use of the assert statement is to verify a class invariant. Suppose you are creating a class that represents a list of objects and allows objects to be inserted and deleted but always maintains the list in sorted order. You believe that your implementation is correct and that the insertion methods always leave the list in sorted order, but you want to test this to be sure. You might write a method that tests whether the list is actually sorted, then use an assert statement to invoke the method at the end of each method that modifies the list. For example:

```
public void insert(Object o) {
    ...                // Do the insertion here
   assert isSorted(  );  // Assert the class invariant here
}
```

When writing code that must be threadsafe, you must obtain locks (using a synchronized method or statement) when required. One common use of the assert statement in this situation is to verify that the current thread holds the lock it requires:

```
assert Thread.holdsLock(data);
```

The Thread.holdsLock( ) method was added in Java 1.4 primarily for use with the assert statement.

To use assertions effectively, you must be aware of a couple of fine points. First, remember that your programs will sometimes run with assertions enabled and sometimes with assertions disabled. This means that you should be careful not to write assertion expressions that contain side effects. If you do, your code will run differently when assertions are enabled than it will when they are disabled. There are a few exceptions to this rule, of course. For example, if a method contains two assert statements, the first can include a side effect that affects only the second assertion. Another use of side effects in assertions is the following idiom that determines whether assertions are enabled (which is not something that your code should ever really need to do):

```
boolean assertions = false;  // Whether assertions are enabled
assert assertions = true;    // This assert never fails but has a side effect
```

Note that the expression in the assert statement is an assignment, not a comparison. The value of an assignment expression is always the value assigned, so this expression always evaluates to TRue, and the assertion never fails. Because this assignment expression is part of an assert statement, the assertions variable is set to true only if assertions are enabled.

In addition to avoiding side effects in your assertions, another rule for working with the assert statement is that you should never try to catch an AssertionError (unless you catch it at the top level simply so that you can display the error in a more user-friendly fashion). If an AssertionError is thrown, it indicates that one of the programmer's assumptions has not held up. This means that the code is being used outside of the parameters for which it was designed, and it cannot be expected to work correctly. In short, there is no plausible way to recover from an`AssertionError`, and you should not attempt to catch it.

Team LiB

2.6. Methods

A *method* is a named sequence of Java statements that can be invoked by other Java code. When a method is invoked, it is passed zero or more values known as *arguments*. The method performs some computations and, optionally, returns a value. As described in Section 2.4 earlier in this chapter, a method invocation is an expression that is evaluated by the Java interpreter. Because method invocations can have side effects, however, they can also be used as expression statements. This section does not discuss method invocation, but instead describes how to define methods.

2.6.1. Defining Methods

You already know how to define the body of a method; it is simply an arbitrary sequence of statements enclosed within curly braces. What is more interesting about a method is its *signature*.[5] The signature specifies the following:

[5] In the Java Language Specification, the term "signature" has a technical meaning that is slightly different than that used here. This book uses a less formal definition of method signature.

- The name of the method
- The number, order, type, and name of the parameters used by the method
- The type of the value returned by the method
- The checked exceptions that the method can throw (the signature may also list unchecked exceptions, but these are not required)
- Various method modifiers that provide additional information about the method

A method signature defines everything you need to know about a method before calling it. It is the method *specification* and defines the API for the method. The reference section of this book is essentially a list of method signatures for all publicly accessible methods of all publicly accessible classes of the Java platform. In order to use the reference section of this book, you need to know how to read a method signature. And, in order to write Java programs, you need to know how to define your own methods, each of which begins with a method signature.

A method signature looks like this:

```
modifiers type  name ( paramlist ) [ throws exceptions ]
```

The signature (the method specification) is followed by the method body (the method implementation), which is simply a sequence of Java statements enclosed in curly braces. If the method is *abstract* (see Chapter 3), the implementation is omitted, and the method body is replaced with a single semicolon. In Java 5.0 and later, the signature of a *generic method* may also include type variable declarations. Generic methods and type variables are discussed in Chapter 4.

Here are some example method definitions, which begin with the signature and are followed by the method body:

```
// This method is passed an array of strings and has no return value.
// All Java programs have a main entry point with this name and signature.
public static void main(String[] args) {
     if (args.length > 0) System.out.println("Hello " + args[0]);
     else System.out.println("Hello world");
}

// This method is passed two double arguments and returns a double.
static double distanceFromOrigin(double x, double y) {
     return Math.sqrt(x*x + y*y);
}

// This method is abstract which means it has no body.
// Note that it may throw exceptions when invoked.
protected abstract String readText(File f, String encoding)
    throws FileNotFoundException, UnsupportedEncodingException;
```

modifiers is zero or more special modifier keywords, separated from each other by spaces. A method might be declared with the `public` and `static` modifiers, for example. The allowed modifiers and their meanings are described in the next section.

The *type* in a method signature specifies the return type of the method. If the method does not return a value, *type* must be `void`. If a method is declared with a non-`void` return type, it must include a `return` statement that returns a value of (or convertible to) the declared type.

A *constructor* is a special kind of method used to initialize newly created objects. As we'll see in Chapter 3, constructors are defined just like methods, except that their signatures do not include this *type* specification.

The *name* of a method follows the specification of its modifiers and type. Method names, like variable names, are Java identifiers and, like all Java identifiers, may contain letters in any language represented by the Unicode character set. It is legal, and often quite useful, to define more than one method with the same name, as long as each version of the method has a different parameter list. Defining multiple methods with the same name is called *method overloading* . The `System.out.println( )` method we've seen so much of is an overloaded method. One method by this name prints a string and other methods by the same name print the values of the various primitive types. The Java compiler decides which method to call based on the type of the argument passed to the method.

When you are defining a method, the name of the method is always followed by the method's parameter list, which must be enclosed in parentheses. The parameter list defines zero or more arguments that are passed to the method. The parameter specifications, if there are any, each consist of a type and a name and are separated from each other by commas (if there are multiple parameters). When a method is invoked, the argument values it is passed must match the number, type, and order of the parameters specified in this method signature line. The values passed need no have exactly the same type as specified in the signature, but they must be convertible to those types without casting. C and C++ programmers should note that when a Java method expects no arguments, its parameter list is simply `( )`, not `(void)`.

In Java 5.0 and later, it is possible to define and invoke methods that accept a variable number of arguments, using a syntax known colloquially as *varargs*. Varargs are covered in detail later in this chapter.

The final part of a method signature is the `tHRows` clause, which is used to list the *checked exceptions* that a method can throw. Checked exceptions are a category of exception classes that must be listed in the `tHRows` clauses of methods that can throw them. If a method uses the `throw` statement to throw a checked exception, or if it calls some other method that throws a checked exception and does not catch or handle that exception, the method must declare that it can throw that exception. If a method can throw one or more checked exceptions, it specifies this by placing the `tHRows` keyword after the argument list and following it by the name of the exception class or classes it can throw. If a method does not throw any exceptions, it does not use the `throws` keyword. If a method throws more than one type of exception, separate the names of the exception classes from each other with commas. More on this in a bit.

2.6.2. Method Modifiers

The modifiers of a method consist of zero or more modifier keywords such as `public`, `static`, or `abstract`. Here is a list of allowed modifiers and their meanings. Note that in Java 5.0 and later, annotations, such as `@Override`, `@Deprecated`, and `@SuppressWarnings`, are treated as modifiers and may be mixed in with the modifier list. Anyone can define new annotation types, so it is not possible to list all possible method annotations. See Chapter 4 for more on annotations.

`abstract`

An `abstract` method is a specification without an implementation. The curly braces and Java statements that would normally comprise the body of the method are replaced with a single semicolon. A class that includes an `abstract` method must itself be declared `abstract`. Such a class is incomplete and cannot be instantiated (see Chapter 3).

`final`

A `final` method may not be overridden or hidden by a subclass, which makes it amenable to compiler optimizations that are not possible for regular methods. All `private` methods are implicitly `final`, as are all methods of any class that is declared `final`.

`native`

The `native` modifier specifies that the method implementation is written in some "native" language such as C and is provided externally to the Java program. Like `abstract` methods, `native` methods have no body: the curly braces are replaced with a semicolon.

When Java was first released, native methods were sometimes used for efficiency reasons. That is almost never necessary today. Instead, native methods are used to interface Java code to existing libraries written in C or C++. Native methods are implicitly platform-dependent, and the procedure for linking the implementation with the Java class that declares the method is dependent on the implementation of the Java virtual machine. Native methods are not covered in this book.

`public, protected, private`

These access modifiers specify whether and where a method can be used outside of the class that defines it. These very important modifiers are explained in Chapter 3.

`static`

A method declared static is a *class method* associated with the class itself rather than with an instance of the class. This is explained in detail in Chapter 3.

`strictfp`

A method declared strictfp must perform floating-point arithmetic using 32- or 64-bit floating point formats strictly and may not take advantage of any extended exponent bits available to the platform's floating-point hardware. The "fp" in this awkwardly named, rarely used modifier stands for "floating point."

`synchronized`

The synchronized modifier makes a method threadsafe. Before a thread can invoke a synchronized method, it must obtain a lock on the method's class (for static methods) or on the relevant instance of the class (for non-static methods). This prevents two threads from executing the method at the same time.

The synchronized modifier is an implementation detail (because methods can make themselves threadsafe in other ways) and is not formally part of the method specification or API. Good documentation specifies explicitly whether a method is threadsafe; you should not rely on the presence or absence of the synchronized keyword when working with multithreaded programs.

2.6.3. Declaring Checked Exceptions

In the discussion of the throw statement, we said that exceptions are Throwable objects and that exceptions fall into two main categories, specified by the Error and Exception subclasses. In addition to making a distinction between Error and Exception classes, the Java exception-handling scheme also distinguishes between checked and unchecked exceptions. Any exception object that is an Error is unchecked. Any exception object that is an Exception is checked, unless it is a subclass of java.lang.RuntimeException , in which case it is unchecked. (RuntimeException is a subclass of Exception.)

The distinction between checked and unchecked exceptions has to do with the circumstances under which the exceptions are thrown. Practically any method can throw an unchecked exception at essentially any time. There is no way to predict an OutOfMemoryError, for example, and any method that uses objects or arrays can throw a NullPointerException if it is passed an invalid null argument. Checked exceptions, on the other hand, arise only in specific, well-defined circumstances. If you try to read data from a file, for example, you must at least consider the possibility that a FileNotFoundException will be thrown if the specified file cannot be found.

Java has different rules for working with checked and unchecked exceptions. If you write a method that throws a checked exception, you must use a tHRows clause to declare the exception in the method signature. The reason these types of exceptions are called checked exceptions is that the Java compiler checks to make sure you have declared them in method signatures and produces a compilation error if you have not.

Even if you never throw an exception yourself, sometimes you must use a throws clause to declare an exception. If your method calls a method that can throw a checked exception, you must either include exception-handling code to handle that exception or use tHRows to declare that your method can also throw that exception. For example, the following method reads the first line of text from a named file. It uses methods that can throw various types of java.io.IOException objects, so it declares this fact with a tHRows clause:

```
public static String readFirstLine(String filename) throws IOException {
     BufferedReader in = new BufferedReader(new FileReader(filename));
     String firstline = in.readLine(  );
     in.close(  );
     return firstline;
}
```

How do you know if the method you are calling can throw a checked exception? You can look at its method signature to find out. Or, failing that, the Java compiler will tell you (by reporting a compilation error) if you've called a method whose exceptions you must handle or declare.

2.6.4. Variable-Length Argument Lists

In Java 5.0 and later, methods may be declared to accept, and may be invoked with, variable numbers of arguments. Such methods are commonly known as *varargs* methods. The new System.out.printf( ) method as well as the related format( ) methods of String and java.util.Formatter use varargs. The similar, but unrelated, format( ) method of java.text.MessageFormat has been converted to use varargs as have a number of important methods from the Reflection API of java.lang.reflect.

A variable-length argument list is declared by following the type of the last argument to the method with an ellipsis (...), indicating that this last argument can be repeated zero or more times. For example:

```
public static int max(int first, int... rest) {
     int max = first;
```

```
    for(int i: rest) {
        if (i > max) max = i;
    }
    return max;
}
```

This max( ) method is declared with two arguments. The first is just a regular int value. The second, however may be repeated zero or more times. All of the following are legal invocations of max( ):

```
max(0)
max(1, 2)
max(16, 8, 4, 2, 1)
```

As you can tell from the for/in statement in the body of max( ), the second argument is treated as an array of int values. Varargs methods are handled purely by the compiler. To the Java interpreter, the max( ) method is indistinguishable from this one:

```
public static int max(int first, int[] rest) { /* body omitted */ }
```

To convert a varargs signature to the "real" signature, simply replace ... with [ ]. Remember that only one ellipsis can appear in a parameter list, and it may only appear on the last parameter in the list.

Since varargs methods are compiled into methods that expect an array of arguments, invocations of those methods are compiled to include code that creates and initializes such an array. So the call max(1,2,3) is compiled to this:

```
max(1, new int[] { 2, 3 })
```

If you already have method arguments stored in an array, it is perfectly legal for you to pass them to the method that way, instead of writing them out individually. You can treat any ... argument as if it were declared as an array. The converse is not true, however: you can only use varargs method invocation syntax when the method is actually declared as a varargs method using an ellipsis.

Varargs methods interact particularly well with the new autoboxing feature of Java 5.0 (see Section 2.9.7 later in this chapter). A method that has an Object... variable length argument list can take arguments of any reference type because all objects and arrays are subclasses of Object. Furthermore, autoboxing allows you to invoke the method using primitive values as well: the compiler boxes these up into wrapper objects as it builds the Object[ ] that is the true argument to the method. The printf( ) and format( ) methods mentioned at the beginning of this section are all declared with an Object... parameter.

One quirk arises with methods with an Object... parameter. It does not arise very often in practice, but studying the quirk will solidify your understanding of varargs. Recall that varargs methods can be invoked with an argument of array type or any number of arguments of the element type. When a method is declared with an Object... argument, you can pass an Object[ ] of arguments, or zero or more individual Object arguments. But every Object[ ] is also an Object. What do you do if you want to pass an `Object[ ]` as the single object argument to the method? Consider the following code that uses the `printf( )` method:

```
import static java.lang.System.out;  // out now refers to System.out

// Here we invoke the varargs method with individual Object arguments.
// Note the use of autoboxing to convert primitives to wrapper objects
out.printf("%d %d %d\n", 1, 2, 3);

// This line does the same thing but passes the arguments in an array
// that has already been created:
Object[] args = new Object[] { 1, 2, 3 };
out.printf("%d %d %d\n", args);

// Now consider the following Object[], which we wish to pass
// as a single argument, not as an array of two arguments.
Object[] arg =  new Object[] { "hello", "world" };
// These two lines do the same thing: print "hello".  Not what we want.
out.printf("%s\n", "hello", "world");
out.printf("%s\n", arg);

// If we want arg to be treated as a single Object argument, we need to
// pass it as an the element of an array.  Here's one way:
out.printf("%s\n", new Object[] { arg });

// An easier way is to convince the compiler to create the array itself.
// We use a cast to say that arg is a single Object argument, not an array:
out.printf("%s\n", (Object)arg);
```

2.6.5. Covariant Return Types

As part of the addition of generic types, Java 5.0 now also supports *covariant returns*. This means that an overriding method may narrow the return type of the method it overrides.[6] The following example makes this clearer:

[6] Method overriding is *not* the same as method overloading discussed earlier in this section. Method overriding involves subclassing and is covered in Chapter 3. If you are not already familiar with these concepts, you should skip this section for now and return to it later.

```
class Point2D { int x, y; }
class Point3D extends Point2D { int z; }

class Event2D {
     public Point2D getLocation(  ) { return new Point2D(  ); }
}

class Event3D extends Event2D {
      @Override public Point3D getLocation(  ) { return new Point3D(  ); }
}
```

This code defines four classes: a two-dimensional point, a three-dimensional point, and event objects that represent an event in two-dimensional space and in three-dimensional space. Each event class has a `getLocation( )` method. The `Event2D` method returns a `Point2D` object. `Event3D` subclasses `Event2D` and overrides `getLocation( )`. Its version of the method sensibly returns a `Point3D`. Because every `Point3D` object is also a `Point2D` object, this is a perfectly reasonable thing to do. It simply wasn't allowed prior to Java 5.0.

In Java 1.4 and earlier, the return type of an overriding method must be identical to the type of the method it overrides. In order to compile under Java 1.4, the `Event3D.getLocation( )` method would have to be modified to have a return type of `Point2D`. It could still return a `Point3D` object, of course, but the caller would have to cast the return value from `Point2D` to `Point3D`.

The `@Override` in the code example is an *annotation*, covered in Chapter 4. This one is a compile-time assertion that the method overrides something. The compiler would have produced a compilation error if the assertion failed.

Team LiB

2.7. Classes and Objects Introduced

Now that we have introduced operators, expressions, statements, and methods, we can finally talk about classes. A *class* is a named collection of fields that hold data values and methods that operate on those values. Classes are just one of five reference types supported by Java, but they are the most important type. Classes are thoroughly documented in a chapter of their own, Chapter 3. We introduce them here, however, because they are the next higher level of syntax after methods, and because the rest of this chapter requires a basic familiarity with the concept of class and the basic syntax for defining a class, instantiating it, and using the resulting *object*.

The most important thing about classes is that they define new data types. For example, you might define a class named `Point` to represent a data point in the two-dimensional Cartesian coordinate system. This class would define fields (each of type `double`) to hold the X and Y coordinates of a point and methods to manipulate and operate on the point. The `Point` class is a new data type.

When discussing data types, it is important to distinguish between the data type itself and the values the data type represents. `char` is a data type: it represents Unicode characters. But a `char` value represents a single specific character. A class is a data type; a class value is called an *object*. We use the name class because each class defines a type (or kind, or species, or class) of objects. The `Point` class is a data type that represents X,Y points, while a `Point` object represents a single specific X,Y point. As you might imagine, classes and their objects are closely linked. In the sections that follow, we will discuss both.

2.7.1. Defining a Class

Here is a possible definition of the `Point` class we have been discussing:

```
/** Represents a Cartesian (x,y) point */
public class Point {
     public double x, y;                       // The coordinates of the point
     public Point(double x, double y) {        // A constructor that
         this.x = x; this.y = y;               // initializes the fields
     }

     public double distanceFromOrigin(  ) {    // A method that operates on
         return Math.sqrt(x*x + y*y);          // the x and y fields
     }
}
```

This class definition is stored in a file named *Point.java* and compiled to a file named *Point.class*, where it is available for use by Java programs and other classes. This class definition is provided here for completeness and to provide context, but don't expect to understand all the details just yet; most of Chapter 3 is devoted to the topic of defining classes.

Keep in mind that you don't have to define every class you want to use in a Java program. The Java platform includes thousands of predefined classes that are guaranteed to be available on every computer that runs Java.

2.7.2. Creating an Object

Now that we have defined the Point class as a new data type, we can use the following line to declare a variable that holds a Point object:

```
Point p;
```

Declaring a variable to hold a Point object does not create the object itself, however. To actually create an object, you must use the new operator. This keyword is followed by the object's class (i.e., its type) and an optional argument list in parentheses. These arguments are passed to the constructor method for the class, which initializes internal fields in the new object:

```
// Create a Point object representing (2,-3.5).
// Declare a variable p and store a reference to the new Point object in it.
Point p = new Point(2.0, -3.5);

// Create some other objects as well
Date d = new Date(  );        // A Date object that represents the current time
Set words = new HashSet(  );  // A HashSet object to hold a set of objects
```

The new keyword is by far the most common way to create objects in Java. A few other ways are also worth mentioning. First, a couple of classes are so important that Java defines special literal syntax for creating objects of those types (as we discuss later in this section). Second, Java supports a dynamic loading mechanism that allows programs to load classes and create instances of those classes dynamically. This dynamic instantiation is done with the newInstance( ) methods of java.lang.Class and java.lang.reflect.Constructor. Finally, objects can also be created by deserializing them. In other words, an object that has had its state saved, or serialized, usually to a file, can be recreated using the java.io.ObjectInputStream class.

2.7.3. Using an Object

Now that we've seen how to define classes and instantiate them by creating objects, we need to look at the Java syntax that allows us to use those objects. Recall that a class defines a collection of fields and methods. Each object has its own copies of those fields and has access to those methods. We use the dot character (.) to access the named fields and methods of an object. For example:

```
Point p = new Point(2, 3);          // Create an object
double x = p.x;                     // Read a field of the object
p.y = p.x * p.x;                    // Set the value of a field
double d = p.distanceFromOrigin(  ); // Access a method of the object
```

This syntax is central to object-oriented programming in Java, so you'll see it a lot. Note, in particular, the expression `p.distanceFromOrigin( )`. This tells the Java compiler to look up a method named `distanceFromOrigin( )` defined by the class `Point` and use that method to perform a computation on the fields of the object `p`. We'll cover the details of this operation in Chapter 3.

2.7.4. Object Literals

In our discussion of primitive types, we saw that each primitive type has a literal syntax for including values of the type literally into the text of a program. Java also defines a literal syntax for a few special reference types, as described next.

2.7.4.1 String literals

The `String` class represents text as a string of characters. Since programs usually communicate with their users through the written word, the ability to manipulate strings of text is quite important in any programming language. In some languages, strings are a primitive type, on a par with integers and characters. In Java, however, strings are objects; the data type used to represent text is the `String` class.

Because strings are such a fundamental data type, Java allows you to include text literally in programs by placing it between double-quote (") characters. For example:

```
String name = "David";
System.out.println("Hello, " + name);
```

Don't confuse the double-quote characters that surround string literals with the single-quote (or apostrophe) characters that surround `char` literals. String literals can contain any of the escape sequences `char` literals can (see Table 2-2). Escape sequences are particularly useful for embedding double-quote characters within double-quoted string literals. For example:

```
String story = "\t\"How can you stand it?\" he asked sarcastically.\n";
```

String literals cannot contain comments and may consist of only a single line. Java does not support any kind of continuation-character syntax that allows two separate lines to be treated as a single line. If you need to represent a long string of text that does not fit on a single line, break it into independent string literals and use the `+` operator to concatenate the literals. For example:

```
String s = "This is a test of the         // This is illegal; string  literals
            emergency broadcast system";  // cannot be broken across lines.

String s = "This is a test of the " +     // Do this instead
           "emergency broadcast system";
```

This concatenation of literals is done when your program is compiled, not when it is run, so you do not need to worry about any kind of performance penalty.

2.7.4.2 Type literals

The second type that supports its own special object literal syntax is the class named `Class`. Instances of the `Class` class represent a Java data type. To include a `Class` object literally in a Java program, follow the name of any data type with `.class`. For example:

```
Class typeInt = int.class;
Class typeIntArray = int[].class;
Class typePoint = Point.class;
```

2.7.4.3 The null reference

The `null` keyword is a special literal value that is a reference to nothing, or an absence of a reference. The `null` value is unique because it is a member of every reference type. You can assign `null` to variables of any reference type. For example:

```
String s = null;
Point p = null;
```

Team LiB

2.8. Arrays

An *array* is a special kind of object that holds zero or more primitive values or references. These values are held in the *elements* of the array, which are unnamed variables referred to by their position or *index*. The type of an array is characterized by its *element type* , and all elements of the array must be of that type.

Array elements are numbered starting with zero, and valid indexes range from zero to the number of elements minus one. The array element with index 1, for example, is the *second* element in the array. The number of elements in an array is its *length*. The length of an array is specified when the array is created, and it never changes.

The element type of an array may be any valid Java type, including array types. This means that Java supports arrays of arrays, which provide a kind of multidimensional array capability. Java does not support the matrix-style multidimensional arrays found in some languages.

2.8.1. Array Types

Array types are reference types, just as classes are. Instances of arrays are objects, just as the instances of a class are.[7] Unlike classes, array types do not have to be defined. Simply place square brackets after the element type. For example, the following code declares three variables of array type:

[7] There is a terminology difficulty when discussing arrays. Unlike with classes and their instances, we use the term "array" for both the array type and the array instance. In practice, it is usually clear from context whether a type or a value is being discussed.

```
byte b;                        // byte is a primitive type
byte[] arrayOfBytes;           // byte[] is an array type: array of byte
byte[][] arrayOfArrayOfBytes;  // byte[][] is another type: array of byte[]
String[] points;               // String[] is an array of String objects
```

The length of an array is not part of the array type. It is not possible, for example, to declare a method that expects an array of exactly four `int` values, for example. If a method parameter is of type `int[ ]`, a caller can pass an array with any number (including zero) of elements.

Array types are not classes, but array instances are objects. This means that arrays inherit the methods of `java.lang.Object`. Arrays implement the `Cloneable` interface and override the `clone( )` method to guarantee that an array can always be cloned and that `clone( )` never throws a `CloneNotSupportedException`. Arrays also implement `Serializable` so that any array can be serialized if its element type can be serialized. Finally, all arrays have a `public final int` field named `length` that specifies the number of elements in the array.

2.8.1.1 Array type widening conversions

Since arrays extend `Object` and implement the `Cloneable` and `Serializable` interfaces, any array type can be widened to any of these three types. But certain array types can also be widened to other array types. If the element type of an array is a reference type `T`, and `T` is assignable to a type `S`, the array type `T[ ]` is assignable to the array type `S[ ]`. Note that there are no widening conversions of this sort for arrays of a given primitive type. As examples, the following lines of code show legal array widening conversions:

```
String[] arrayOfStrings;      // Created elsewhere
int[][] arrayOfArraysOfInt;   // Created elsewhere
// String is assignable to Object, so String[] is assignable to Object[]
Object[] oa = arrayOfStrings;
// String implements Comparable, so a String[] can be considered a Comparable[]
Comparable[] ca = arrayOfStrings;
// An int[] is an Object, so int[][] is assignable to Object[]
Object[] oa2 = arrayOfArraysOfInt;
// All arrays are cloneable, serializable Objects
Object o = arrayOfStrings;
Cloneable c = arrayOfArraysOfInt;
Serializable s = arrayOfArraysOfInt[0];
```

This ability to widen an array type to another array type means that the compile-time type of an array is not always the same as its runtime type. The compiler must usually insert runtime checks before any operation that stores a reference value into an array element to ensure that the runtime type of the value matches the runtime type of the array element. If the runtime check fails, an `ArrayStoreException` is thrown.

2.8.1.2 C compatibility syntax

As we've seen, an array type is written simply by placing brackets after the element type. For compatibility with C and C++, however, Java supports an alternative syntax in variable declarations: brackets may be placed after the name of the variable instead of, or in addition to, the element type. This applies to local variables, fields, and method parameters. For example:

```
// This line declares local variables of type int, int[] and int[][]
int justOne, arrayOfThem[], arrayOfArrays[][];

// These three lines declare fields of the same array type:
public String[][] aas1;   // Preferred Java syntax
public String aas2[][];   // C syntax
public String[] aas3[];   // Confusing hybrid syntax

// This method signature includes two parameters with the same type
public static double dotProduct(double[] x, double y[]) { ... }
```

This compatibility syntax is uncommon, and its use is strongly discouraged.

2.8.2. Creating and Initializing Arrays

To create an array value in Java, you use the `new` keyword, just as you do to create an object. Array types don't have constructors, but you are required to specify a length whenever you create an array. Specify the desired size of your array as a nonnegative integer between square brackets:

```
byte[] buffer = new byte[1024];  // Create a new array to hold 1024 bytes
String[] lines = new String[50]; // Create an array of 50 references to strings
```

When you create an array with this syntax, each of the array elements is automatically initialized to the same default value that is used for the fields of a class: `false` for `boolean` elements, '`\u0000`' for `char` elements, 0 for integer elements, 0.0 for floating-point elements, and `null` for elements of reference type.

Array creation expressions can also be used to create and initialize a multidimensional rectangular array of arrays. This syntax is somewhat more complicated and is explained later in this section.

2.8.2.1 Array initializers

To create an array and initialize its elements in a single expression, omit the array length and follow the square brackets with a comma-separated list of expressions within curly braces. The type of each expression must be assignable to the element type of the array, of course. The length of the array that is created is equal to the number of expressions. It is legal, but not necessary, to include a trailing comma following the last expression in the list. For example:

```
String[] greetings = new String[] { "Hello", "Hi", "Howdy" };
int[] smallPrimes = new int[] { 2, 3, 5, 7, 11, 13, 17, 19, };
```

Note that this syntax allows arrays to be created, initialized, and used without ever being assigned to a variable. In a sense these array creation expressions are anonymous array literals. Here are examples:

```
// Call a method, passing an anonymous array literal that contains two strings
String response = askQuestion("Do you want to quit?",
                               new String[] {"Yes", "No"});

// Call another method with an anonymous array (of anonymous objects)
double d = computeAreaOfTriangle(new Point[] { new Point(1,2),
                                               new Point(3,4),
                                               new Point(3,2) });
```

When an array initializer is part of a variable declaration, you may omit the `new` keyword and element type and list the desired array elements within curly braces:

```
String[] greetings = { "Hello", "Hi", "Howdy" };
int[] powersOfTwo = {1, 2, 4, 8, 16, 32, 64, 128};
```

The Java Virtual Machine architecture does not support any kind of efficient array initialization. In other words, array literals are created and initialized when the program is run, not when the program is compiled. Consider the following array literal:

```
int[] perfectNumbers = {6, 28};
```

This is compiled into Java byte codes that are equivalent to:

```
int[] perfectNumbers = new int[2];
perfectNumbers[0] = 6;
perfectNumbers[1] = 28;
```

If you want to initialize a large array, you should think twice before including the values literally in the program, since the Java compiler has to emit lots of Java byte codes to initialize the array. It may be more space-efficient to store your data in an external file and read it into the program at runtime.

The fact that Java does all array initialization at runtime has an important corollary, however. It means that the expressions in an array initializer may be computed at runtime and need not be compile-time constants. For example:

```
Point[] points = { circle1.getCenterPoint(  ), circle2.getCenterPoint(  ) };
```

2.8.3. Using Arrays

Once an array has been created, you are ready to start using it. The following sections explain basic access to the elements of an array and cover common idioms of array usage such as iterating through the elements of an array and copying an array or part of an array.

2.8.3.1 Accessing array elements

The elements of an array are variables. When an array element appears in an expression, it evaluates to the value held in the element. And when an array element appears on the left-hand side of an assignment operator, a new value is stored into that element. Unlike a normal variable, however, an array element has no name, only a number. Array elements are accessed using a square bracket notation. If `a` is an expression that evaluates to an array reference, you index that array and refer to a specific element with `a[i]`, where `i` is an integer literal or an expression that evaluates to an `int`. For example:

```
String[] responses = new String[2];   // Create an array of two strings
responses[0] = "Yes";                 // Set the first element of the array
responses[1] = "No";                  // Set the second element of the array

// Now read these array elements
System.out.println(question + " (" + responses[0] + "/" +
                   responses[1] + " ): ");
```

```
// Both the array reference and the array index may be more complex expressions
double datum = data.getMatrix(  )[data.row(  )*data.numColumns(  ) +
                   data.column(  )];
```

The array index expression must be of type `int`, or a type that can be widened to an `int`: `byte`, `short`, or even `char`. It is obviously not legal to index an array with a `boolean`, `float`, or `double` value. Remember that the `length` field of an array is an `int` and that arrays may not have more than `Integer.MAX_VALUE` elements. Indexing an array with an expression of type `long` generates a commpile-time error, even if the value of that expression at runtime would be within the range of an `int`.

2.8.3.2 Array bounds

Remember that the first element of an array `a` is `a[0]` , the second element is `a[1]` and the last is `a[a.length-1]`. If you are accustomed to a language in which the arrays are 1-based, 0-based arrays take some getting used to.

A common bug involving arrays is use of an index that is too small (a negative index) or too large (greater than or equal to the array `length`). In languages like C or C++, accessing elements before the beginning or after the end of an array yields unpredictable behavior that can vary from invocation to invocation and platform to platform. Such bugs may not always be caught, and if a failure occurs, it may be at some later time. While it is just as easy to write faulty array indexing code in Java, Java guarantees predictable results by checking every array access at runtime. If an array index is too small or too large, Java throws an `ArrayIndexOutOfBoundsException` immediately.

2.8.3.3 Iterating arrays

It is common to write loops that iterate through each of the elements of an array in order to perform some operation on it. This is typically done with a `for` loop. The following code, for example, computes the sum of an array of integers:

```
int[] primes = { 2, 3, 5, 7, 11, 13, 17, 19 };
int sumOfPrimes = 0;
for(int i = 0; i < primes.length; i++)
    sumOfPrimes += primes[i];
```

The structure of this `for` loop is idiomatic, and you'll see it frequently.

In Java 5.0 and later, arrays can also be iterated with the `for/in` loop. The summing code could be rewritten succinctly as follows:

```
for(int p : primes) sumOfPrimes += p;
```

2.8.3.4 Copying arrays

All array types implement the Cloneable interface, and any array can be copied by invoking its clone( ) method. Note that a cast is required to convert the return value to the appropriate array type, but that the clone( ) method of arrays is guaranteed not to throw CloneNotSupportedException:

```
int[] data = { 1, 2, 3 };
int[] copy = (int[]) data.clone(  );
```

The clone( ) method makes a shallow copy. If the element type of the array is a reference type, only the references are copied, not the referenced objects themselves. Because the copy is shallow, any array can be cloned, even if the element type is not itselfCloneable.

Sometimes you simply want to copy elements from one existing array to another existing array. The System.arraycopy( ) method is designed to do this efficiently, and you can assume that Java VM implementations performs this method using high-speed block copy operations on the underlying hardware.

arraycopy( ) is a straightforward function that is difficult to use only because it has five arguments to remember. First pass the source array from which elements are to be copied. Second, pass the index of the start element in that array. Pass the destination array and the destination index as the third and fourth arguments. Finally, as the fifth argument, specify the number of elements to be copied.

arraycopy( ) works correctly even for overlapping copies within the same array. For example, if you've "deleted" the element at index 0 from array a and want to shift the elements between indexes 1 and n down one so that they occupy indexes 0 through n-1 you could do this:

```
System.arraycopy(a, 1, a, 0, n);
```

2.8.3.5 Array utilities

The java.util.Arrays class contains a number of static utility methods for working with arrays. Most of these methods are heavily overloaded, with versions for arrays of each primitive type and another version for arrays of objects. The sort( ) and binarySearch( ) methods are particularly useful for sorting and searching arrays. The equals( ) method allows you to compare the content of two arrays. The Arrays.toString( ) method is useful when you want to convert array content to a string, such as for debugging or logging output.

As of Java 5.0, the Arrays class includes deepEquals( ) , deepHashCode( ), and deepToString( ) methods that work correctly for multidimensional arrays.

2.8.4. Multidimensional Arrays

As we've seen, an array type is written as the element type followed by a pair of squarebrackets. An array of char is char[ ], and an array of arrays of char is char[ ][ ]. When the elements of an array are themselves arrays, we say that the array is *multidimensional*. In order to work with multidimensional arrays, you need to understand a few additional details.

Imagine that you want to use a multidimensional array to represent a multiplication table:

```
int[][] products;      // A multiplication table
```

Each of the pairs of square brackets represents one dimension, so this is a two-dimensional array. To access a single `int` element of this two-dimensional array, you must specify two index values, one for each dimension. Assuming that this array was actually initialized as a multiplication table, the `int` value stored at any given element would be the product of the two indexes. That is, `products[2][4]` would be 8, and `products[3][7]` would be 21.

To create a new multidimensional array, use the `new` keyword and specify the size of both dimensions of the array. For example:

```
int[][] products = new int[10][10];
```

In some languages, an array like this would be created as a single block of 100 `int` values. Java does not work this way. This line of code does three things:

- Declares a variable named `products` to hold an array of arrays of `int`.
- Creates a 10-element array to hold 10 arrays of `int`.
- Creates 10 more arrays, each of which is a 10-element array of `int`. It assigns each of these 10 new arrays to the elements of the initial array. The default value of every `int` element of each of these 10 new arrays is 0.

To put this another way, the previous single line of code is equivalent to the following code:

```
int[][] products = new int[10][];    // An array to hold 10 int[] values
for(int i = 0; i < 10; i++)          // Loop 10 times...
    products[i] = new int[10];       // ...and create 10 arrays
```

The `new` keyword performs this additional initialization automatically for you. It works with arrays with more than two dimensions as well:

```
float[][][] globalTemperatureData = new float[360][180][100];
```

When using `new` with multidimensional arrays, you do not have to specify a size for all dimensions of the array, only the leftmost dimension or dimensions. For example, the following two lines are legal:

```
float[][][] globalTemperatureData = new float[360][][];
float[][][] globalTemperatureData = new float[360][180][];
```

The first line creates a single-dimensional array, where each element of the array can hold a `float[][ ]`. The second line creates a two-dimensional array, where each element of the array is a `float[ ]`. If you specify a size for only some of the dimensions of an array, however, those dimensions must be the leftmost ones. The following lines are not legal:

```
float[][][] globalTemperatureData = new float[360][][100];  // Error!
float[][][] globalTemperatureData = new float[][180][100];  // Error!
```

Like a one-dimensional array, a multidimensional array can be initialized using an array initializer. Simply use nested sets of curly braces to nest arrays within arrays. For example, we can declare, create, and initialize a 55 multiplication table like this:

```
int[][] products = { {0, 0, 0, 0, 0},
                     {0, 1, 2, 3, 4},
                     {0, 2, 4, 6, 8},
                     {0, 3, 6, 9, 12},
                     {0, 4, 8, 12, 16} };
```

Or, if you want to use a multidimensional array without declaring a variable, you can use the anonymous initializer syntax:

```
boolean response = bilingualQuestion(question, new String[][] {
                                                   { "Yes", "No" },
                                                   { "Oui", "Non" }});
```

When you create a multidimensional array using the `new` keyword, you always get a *rectangular* array: one in which all the array values for a given dimension have the same size. This is perfect for rectangular data structures, such as matrices. However, because multidimensional arrays are implemented as arrays of arrays in Java, instead of as a single rectangular block of elements, you are in no way constrained to use rectangular arrays. For example, since our multiplication table is symmetrical diagonally from top left to bottom right, we can represent the same information in a nonrectangular array with fewer elements:

```
int[][] products = { {0},
                     {0, 1},
                     {0, 2, 4},
                     {0, 3, 6, 9},
                     {0, 4, 8, 12, 16} };
```

When working with multidimensional arrays, you'll often find yourself using nested loops to create or initialize them. For example, you can create and initialize a large triangular multiplication table as follows:

```
int[][] products = new int[12][];          // An array of 12 arrays of int.
for(int row = 0; row < 12; row++) {        // For each element of that array,
    products[row] = new int[row+1];        // allocate an array of int.
    for(int col = 0; col < row+1; col++)   // For each element of the int[],
        products[row][col] = row * col;    // initialize it to the  product.
}
```

2.9. Reference Types

Now that we've covered arrays and introduced classes and objects, we can turn to a more general description of *reference types*. Classes and arrays are two of Java's five kinds of reference types. Classes were introduced earlier and are covered in complete detail, along with *interfaces*, in Chapter 3. Enumerated types and annotation types are reference types introduced in Java 5.0 (see Chapter 4).

This section does not cover specific syntax for any particular reference type, but instead explains the general behavior of reference types and illustrates how they differ from Java's primitive types. In this section, the term *object* refers to a value or instance of any reference type, including arrays.

2.9.1. Reference vs. Primitive Types

Reference types and objects differ substantially from primitive types and their primitive values:

- Eight primitive types are defined by the Java language. Reference types are user-defined, so there is an unlimited number of them. For example, a program might define a class named `Point` and use objects of this newly defined type to store and manipulate X,Y points in a Cartesian coordinate system. The same program might use an array of characters of type `char[ ]` to store text and might use an array of `Point` objects of type `Point[ ]` to store a sequence of points.
- Primitive types represent single values. Reference types are aggregate types that hold zero or more primitive values or objects. Our hypothetical `Point` class, for example, might hold two `double` values to represent the X and Y coordinates of the points. The `char[ ]` and `Point[ ]` array types are obviously aggregate types because they hold a sequence of primitive `char` values or `Point` objects.
- Primitive types require between one and eight bytes of memory. When a primitive value is stored in a variable or passed to a method, the computer makes a copy of the bytes that hold the value. Objects, on the other hand, may require substantially more memory. Memory to store an object is dynamically allocated on the heap when the object is created and this memory is automatically "garbage-collected" when the object is no longer needed. When an object is assigned to a variable or passed to a method, the memory that represents the object is not copied. Instead, only a reference to that memory is stored in the variable or passed to the method.

This last difference between primitive and reference types explains why reference types are so named. The sections that follow are devoted to exploring the substantial differences between types that are manipulated by value and types that are manipulated by reference.

Before moving on, however, it is worth briefly considering the nature of references. A *reference* is simply some kind of reference to an object. References are completely opaque in Java and the representation of a reference is an implementation detail of the Java interpreter. If you are a C programmer, however, you can safely imagine a reference as apointer or a memory address. Remember, though, that Java programs cannot manipulate references in any way. Unlike pointers in C and C++, references cannot be converted to or from integers, and they cannot be incremented or decremented. C and C++ programmers should also note that Java does not support the& address-of operator or the * and -> dereference operators. In Java, primitive types are always handled exclusively by value, and objects are always handled exclusively by reference: the .operator in Java is more like the -> operator in C and C++ than it is like the . operator of those languages.

2.9.2. Copying Objects

The following code manipulates a primitiveint value:

```
int x = 42;
int y = x;
```

After these lines execute, the variable y contains a copy of the value held in the variable x. Inside the Java VM, there are two independent copies of the 32-bit integer 42.

Now think about what happens if we run the same basic code but use a reference type instead of a primitive type:

```
Point p = new Point(1.0, 2.0);
Point q = p;
```

After this code runs, the variable q holds a copy of the reference held in the variable p. There is still only one copy of the Point object in the VM, but there are now two copies of the reference to that object. This has some important implications. Suppose the two previous lines of code are followed by this code:

```
System.out.println(p.x);  // Print out the X coordinate of p: 1.0
q.x = 13.0;               // Now change the X coordinate of q
System.out.println(p.x);  // Print out p.x again; this time it is 13.0
```

Since the variables p and q hold references to the same object, either variable can be used to make changes to the object, and those changes are visible through the other variable as well.

This behavior is not specific to objects; the same thing happens with arrays, as illustrated by the following code:

```
char[] greet = { 'h','e','l','l','o' };  // greet holds an array reference
char[] cuss = greet;                     // cuss holds the same reference
cuss[4] = '!';                           // Use reference to change an element
System.out.println(greet);               // Prints "hell!"
```

A similar difference in behavior between primitive types and reference types occurs when arguments are passed to methods. Consider the following method:

```
void changePrimitive(int x) {
    while(x > 0)
        System.out.println(x--);
}
```

When this method is invoked, the method is given a copy of the argument used to invoke the method in the parameter x. The code in the method uses x as a loop counter and decrements it to zero. Since x is a primitive type, the method has its own private copy of this value, so this is a perfectly reasonable thing to do.

On the other hand, consider what happens if we modify the method so that the parameter is a reference type:

```
void changeReference(Point p) {
    while(p.x > 0)
        System.out.println(p.x--);
}
```

When this method is invoked, it is passed a private copy of a reference to a Point object and can use this reference to change the Point object. Consider the following:

```
Point q = new Point(3.0, 4.5);  // A point with an X coordinate of 3
changeReference(q);             // Prints 3,2,1 and modifies the Point
System.out.println(q.x);        // The X coordinate of q is now 0!
```

When the changeReference( ) method is invoked, it is passed a copy of the reference held in variable q. Now both the variable q and the method parameter p hold references to the same object. The method can use its reference to change the contents of the object. Note, however, that it cannot change the contents of the variable q. In other words, the method can change the Point object beyond recognition, but it cannot change the fact that the variable q refers to that object.

The title of this section is "Copying Objects," but, so far, we've only seen copies of references to objects, not copies of the objects and arrays themselves. To make an actual copy of an object, you must use the special clone( ) method (inherited by all objects from java.lang.Object):

```
Point p = new Point(1,2);    // p refers to one object
Point q = (Point) p.clone(  ); // q refers to a copy of that object
q.y = 42;                    // Modify the copied object, but not the original

int[] data = {1,2,3,4,5};           // An array
int[] copy = (int[]) data.clone(  );  // A copy of the array
```

Note that a cast is necessary to coerce the return value of the clone( ) method to the correct type. There are a couple of points you should be aware of when using clone( ). First, not all objects can be cloned. Java only allows an object to be cloned if the object's class has explicitly declared itself to be cloneable by implementing the Cloneable interface. (We haven't discussed interfaces or how they are implemented yet; that is covered in Chapter 3.) The definition of Point that we showed earlier does not actually implement this interface, so our Point type, as implemented, is not cloneable.

Note, however, that arrays are always cloneable. If you call the clone( ) method for a noncloneable object, it throws a CloneNotSupportedException. When you use the clone( ) method, you may want to use it within a TRy block to catch this exception.

The second thing you need to understand about clone( ) is that, by default, it creates a shallow copy of an object. The copied object contains copies of all the primitive values and references in the original object. In other words, any references in the object are copied, not cloned; clone( ) does not recursively make copies of the objects referred to by those references. A class may need to override this shallow copy behavior by defining its own version of the clone( ) method that explicitly performs a deeper copy where needed. To understand the shallow copy behavior of clone( ), consider cloning a two-dimensional array of arrays:

```
int[][] data = {{1,2,3}, {4,5}};        // An array of 2 references
int[][] copy = (int[][]) data.clone(  ); // Copy the 2 refs to a new array
copy[0][0] = 99;                         // This changes data[0][0] too!
copy[1] = new int[] {7,8,9};            // This does not change data[1]
```

If you want to make a deep copy of this multidimensional array, you have to copy each dimension explicitly:

```
int[][] data = {{1,2,3}, {4,5}};        // An array of 2 references
int[][] copy = new int[data.length][];  // A new array to hold copied arrays
for(int i = 0; i < data.length; i++)
   copy[i] = (int[]) data[i].clone(  );
```

2.9.3. Comparing Objects

We've seen that primitive types and reference types differ significantly in the way they are assigned to variables, passed to methods, and copied. The types also differ in the way they are compared for equality. When used with primitive values, the equality operator (= =) simply tests whether two values are identical (i.e., whether they have exactly the same bits). With reference types, however, = = compares references, not actual objects. In other words, = = tests whether two references refer to the same object; it does not test whether two objects have the same content. For example:

```
String letter = "o";
String s = "hello";                      // These two String objects
String t = "hell" + letter;              // contain exactly the same text.
if (s =  = t) System.out.println("equal"); // But they are not equal!

byte[] a = { 1, 2, 3 };                  // An array.
byte[] b = (byte[]) a.clone(  );           // A copy with identical content.
if (a =  = b) System.out.println("equal"); // But they are not equal!
```

When working with reference types, there are two kinds of equality: equality of reference and equality of object. It is important to distinguish between these two kinds of equality. One way to do this is to use the word "identical" when talking about equality of references and the word "equal" when talking about two distinct objects that have the same content. To test two nonidentical objects for equality, pass one of them to the equals( ) method of the other:

```
String letter = "o";
String s = "hello";                        // These two String objects
String t = "hell" + letter;                // contain exactly the same text.
if (s.equals(t))                           // And the equals( ) method
    System.out.println("equal");           // tells us so.
```

All objects inherit an `equals( )` method (from `Object`), but the default implementation simply uses `= =` to test for identity of references, not equality of content. A class that wants to allow objects to be compared for equality can define its own version of the `equals( )` method. Our `Point` class does not do this, but the `String` class does, as indicated in the code example. You can call the `equals( )` method on an array, but it is the same as using the `= =` operator, because arrays always inherit the default `equals( )` method that compares references rather than array content. You can compare arrays for equality with the convenience method `java.util.Arrays.equals( )`.

2.9.4. Terminology: Pass by Value

I've said that Java handles objects "by reference." Don't confuse this with the phrase "pass by reference." "Pass by reference" is a term used to describe the method-calling conventions of some programming languages. In a pass-by-reference language, valueseven primitive valuesare not passed directly to methods. Instead, methods are always passed references to values. Thus, if the method modifies its parameters, those modifications are visible when the method returns, even for primitive types.

Java does *not* do this; it is a "pass by value" language. However, when a reference type is involved, the value that is passed is a reference. But this is still not the same as pass-by-reference. If Java were a pass-by-reference language, when a reference type is passed to a method, it would be passed as a reference to the reference.

2.9.5. Memory Allocation and Garbage Collection

As we've already noted, objects are composite values that can contain a number of other values and may require a substantial amount of memory. When you use the `new` keyword to create a new object or use an object literal in your program, Java automatically creates the object for you, allocating whatever amount of memory is necessary. You don't need to do anything to make this happen.

In addition, Java also automatically reclaims that memory for reuse when it is no longer needed. It does this through a process called *garbage collection*. An object is considered garbage when no references to it are stored in any variables, the fields of any objects, or the elements of any arrays. For example:

```
Point p = new Point(1,2);           // Create an object
double d = p.distanceFromOrigin( );  // Use it for something
p = new Point(2,3);                 // Create a new object
```

After the Java interpreter executes the third line, a reference to the new `Point` object has replaced the reference to the first one. No references to the first object remain, so it is garbage. At some point, the garbage collector discovers this and reclaims the memory used by the object.

C programmers, who are used to using `malloc( )` and `free( )` to manage memory, and C++ programmers, who are used to explicitly deleting their objects with `delete`, may find it a little hard to relinquish control and trust the garbage collector. Even though it seems like magic, it really works! There is a slight, but usually negligible, performance penalty due to the use of garbage collection. However, having garbage collection built into the language dramatically reduces the occurrence of memory leaks and related bugs and almost always improves programmer productivity.

2.9.6. Reference Type Conversions

Objects can be converted between different reference types. As with primitive types, reference type conversions can be widening conversions (allowed automatically by the compiler) or narrowing conversions that require a cast (and possibly a runtime check). In order to understand reference type conversions, you need to understand that reference types form a hierarchy, usually called the *class hierarchy* .

Every Java reference type *extends* some other type, known as its *superclass*. A type inherits the fields and methods of its superclass and then defines its own additional fields and methods. A special class named `Object` serves as the root of the class hierarchy in Java. All Java classes extend `Object` directly or indirectly. The `Object` class defines a number of special methods that are inherited (or overridden) by all objects.

The predefined `String` class and the `Point` class we discussed earlier in this chapter both extend `Object`. Thus, we can say that all `String` objects are also `Object` objects. We can also say that all `Point` objects are `Object` objects. The opposite is not true, however. We cannot say that every `Object` is a `String` because, as we've just seen, some `Object` objects are `Point` objects.

With this simple understanding of the class hierarchy, we can return to the rules of reference type conversion:

- An object cannot be converted to an unrelated type. The Java compiler does not allow you to convert a `String` to a `Point`, for example, even if you use a cast operator.
- An object can be converted to the type of its superclass or of any ancestor class. This is a widening conversion, so no cast is required. For example, a `String` value can be assigned to a variable of type `Object` or passed to a method where an `Object` parameter is expected. Note that no conversion is actually performed; the object is simply treated as if it were an instance of the superclass.
- An object can be converted to the type of a subclass, but this is a narrowing conversion and requires a cast. The Java compiler provisionally allows this kind of conversion, but the Java interpreter checks at runtime to make sure it is valid. Only cast an object to the type of a subclass if you are sure, based on the logic of your program, that the object is actually an instance of the subclass. If it is not, the interpreter throws a `ClassCastException`. For example, if we assign a `String` object to a variable of type `Object`, we can later cast the value of that variable back to type `String`:

```
Object o = "string";    // Widening conversion from String to Object
// Later in the program...
String s = (String) o;  // Narrowing conversion from Object to String
```

Arrays are objects and follow some conversion rules of their own. First, any array can be converted to an Object value through a widening conversion. A narrowing conversion with a cast can convert such an object value back to an array. For example:

```
Object o = new int[] {1,2,3};  // Widening conversion from array to Object
// Later in the program...
int[] a = (int[]) o;           // Narrowing conversion back to array type
```

In addition to converting an array to an object, an array can be converted to another type of array if the "base types" of the two arrays are reference types that can themselves be converted. For example:

```
// Here is an array of strings.
String[] strings = new String[] { "hi", "there" };
// A widening conversion to CharSequence[] is allowed because String
// can be widened to CharSequence
CharSequence[] sequences = strings;
// The narrowing conversion back to String[] requires a cast.
strings = (String[]) sequences;
// This is an array of arrays of strings
String[][] s = new String[][] { strings };
// It cannot be converted to CharSequence[] because String[] cannot be
// converted to CharSequence: the number of dimensions don't match
sequences = s;  // This line will not compile
// s can be converted to Object or Object[], however because all array types
// (including String[] and String[][]) can be converted to Object.
Object[] objects = s;
```

Note that these array conversion rules apply only to arrays of objects and arrays of arrays. An array of primitive type cannot be converted to any other array type, even if the primitive base types can be converted:

```
// Can't convert int[] to double[] even though int can be widened to double
double[] data = new int[] {1,2,3};  // This line causes a compilation error
// This line is legal, however, since int[] can be converted to Object
Object[] objects = new int[][] {{1,2},{3,4}};
```

2.9.7. Boxing and Unboxing Conversions

Primitive types and reference types behave quite differently. It is sometimes useful to treat primitive values as objects, and for this reason, the Java platform includes wrapper classes for each of the primitive types. Boolean, Byte, Short, Character, Integer, Long, Float, and Double are immutable classes whose instances each hold a single primitive value. These wrapper classes are usually used when you want to store primitive values incollections such as java.util.List:

```
List numbers = new ArrayList(  );              // Create a List collection
```

```
numbers.add(new Integer(-1));                  // Store a wrapped primitive
int i = ((Integer)numbers.get(0)).intValue(  ); // Extract the primitive value
```

Prior to Java 5.0, no conversions between primitive types and reference types were allowed. This code explicitly calls the `Integer( )` constructor to wrap a primitive `int` in an object and explicitly calls the `intValue( )` method to extract a primitive value from the wrapper object.

Java 5.0 introduces two new types of conversions known as boxing and unboxing conversions. Boxing conversions convert a primitive value to its corresponding wrapper object and unboxing conversions do the opposite. You may explicitly specify a boxing or unboxing conversion with a cast, but this is unnecessary since these conversions are automatically performed when you assign a value to a variable or pass a value to a method. Furthermore, unboxing conversions are also automatic if you use a wrapper object when a Java operator or statement expects a primitive value. Because Java 5.0 performs boxing and unboxing automatically, this new language feature is often known as *autoboxing*.

Here are some examples of automatic boxing and unboxing conversions:

```
Integer i = 0;    // int literal 0 is boxed into an Integer object
Number n = 0.0f;  // float literal is boxed into Float and widened to Number
Integer i = 1;    // this is a boxing conversion
int j = i;        // i is unboxed here
i++;              // i is unboxed, incremented, and then boxed up again
Integer k = i+2;  // i is unboxed and the sum is boxed up again
i = null;
j = i;            // unboxing here throws a NullPointerException
```

Automatic boxing and unboxing conversions make it much simple to use primitive values with collection classes. The list-of-numbers code earlier in this section can be translated as follows in Java 5.0. Note that the translation also uses generics, another new feature of Java 5.0 that iscovered in Chapter 4.

```
List<Integer> numbers = new ArrayList<Integer>(  ); // Create a List of Integer
numbers.add(-1);                                  // Box int to Integer
int i = numbers.get(0);                           // Unbox Integer to int
```

2.10. Packages and the Java Namespace

A *package* is a named collection of classes, interfaces, and other reference types. Packages serve to group related classes and define a namespace for the classes they contain.

The core classes of the Java platform are in packages whose names begin with `java`. For example, the most fundamental classes of the language are in the package `java.lang`. Various utility classes are in `java.util`. Classes for input and output are in `java.io`, and classes for networking are in `java.net`. Some of these packages contain subpackages, such as `java.lang.reflect` and `java.util.regex`. Extensions to the Java platform that have been standardized by Sun typically have package names that begin with `javax`. Some of these extensions, such as `javax.swing` and its myriad subpackages, were later adopted into the core platform itself. Finally, the Java platform also includes several "endorsed standards," which have packages named after the standards body that created them, such as `org.w3c` and `org.omg`.

Every class has both a simple name, which is the name given to it in its definition, and a fully qualified name, which includes the name of the package of which it is a part. The `String` class, for example, is part of the `java.lang` package, so its fully qualified name is `java.lang.String`.

This section explains how to place your own classes and interfaces into a package and how to choose a package name that won't conflict with anyone else's package name. Next, it explains how to selectively import type names into the namespace so that you don't have to type the package name of every class or interface you use. Finally, the section explains a feature that is new in Java 5.0: the ability to import static members of types into the namespace so that you don't need to prefix these with a package name *or* a class name.

2.10.1. Package Declaration

To specify the package a class is to be part of, you use a `package` declaration. The `package` keyword, if it appears, must be the first token of Java code (i.e., the first thing other than comments and space) in the Java file. The keyword should be followed by the name of the desired package and a semicolon. Consider a Java file that begins with this directive:

```
package com.davidflanagan.examples;
```

All classes defined by this file are part of the package `com.davidflanagan.examples`.

If no `package` directive appears in a Java file, all classes defined in that file are part of an unnamed default package. In this case, the qualified and unqualified names of a class are the same. The possibility of naming conflicts means that you should use this default package only for very simple code or early on in the development process of a larger project.

2.10.2. Globally Unique Package Names

One of the important functions of packages is to partition the Java namespace and prevent name collisions between classes. It is only their package names that keep the `java.util.List` and `java.awt.List` classes distinct, for example. In order for this to work, however, package names must themselves be distinct. As the developer of Java, Sun controls all package names that begin with `java` , `javax`, and `sun`.

For the rest of us, Sun proposes a package-naming scheme, which, if followed correctly, guarantees globally unique package names. The scheme is to use your Internet domain name, with its elements reversed, as the prefix for all your package names. My web site is at http://davidflanagan.com, so all my Java packages begin with `com.davidflanagan`. It is up to me to decide how to partition the namespace below `com.davidflanagan`, but since I own that domain name, no other person or organization who is playing by the rules can define a package with the same name as any of mine.

Note that these package-naming rules apply primarily to API developers. If other programmers will be using classes that you develop along with unknown other classes, it is important that your package name be globally unique. On the other hand, if you are developing a Java application and will not be releasing any of the classes for reuse by others, you know the complete set of classes tha your application will be deployed with and do not have to worry about unforeseen naming conflicts. I this case, you can choose a package naming scheme for your own convenience rather than for global uniqueness. One common approach is to use the application name as the main package name (it may have subpackages beneath it).

2.10.3. Importing Types

When referring to a class or interface in your Java code, you must, by default, use the fully qualified name of the type, including the package name. If you're writing code to manipulate a file and need t use the `File` class of the `java.io` package, you must type `java.io.File`. This rule has three exceptions:

- Types from the package `java.lang` are so important and so commonly used that they can always be referred to by their simple names.
- The code in a type `p.T` may refer to other types defined in the package `p` by their simple names.
- Types that have been *imported* into the namespace with an `import` declaration may be referred to by their simple names.

The first two exceptions are known as "automatic imports." The types from `java.lang` and the current package are "imported" into the namespace so that they can be used without their package name. Typing the package name of commonly used types that are not in `java.lang` or the current package quickly becomes tedious, and so it is also possible to explicitly import types from other packages into the namespace. This is done with the `import` declaration.

`import` declarations must appear at the start of a Java file, immediately after the `package` declaration, if there is one, and before any type definitions. You may use any number of `import` declarations in a file. An `import` declaration applies to all type definitions in the file (but not to any `import` declarations that follow it).

The `import` declaration has two forms. To import a single type into the namespace, follow the `import` keyword with the name of the type and a semicolon:

```
import java.io.File;    // Now we can type File instead of java.io.File
```

This is known as the "single type import" declaration.

The other form of `import` is the "on-demand type import." In this form, you specify the name of a package followed the characters `.*` to indicate that any type from that package may be used without its package name. Thus, if you want to use several other classes from the `java.io` package in addition to the `File` class, you can simply import the entire package:

```
import java.io.*;   // Now we can use simple names for all classes in java.io
```

This on-demand `import` syntax does not apply to subpackages. If I import the `java.util` package, I must still refer to the `java.util.zip.ZipInputStream` class by its fully qualified name.

Using an on-demand type import declaration is not the same as explicitly writing out a single type import declaration for every type in the package. It is more like an explicit single type import for every type in the package *that you actually use* in your code. This is the reason it's called "on demand"; types are imported as you use them.

2.10.3.1 Naming conflicts and shadowing

`import` declarations are invaluable to Java programming. They do expose us to the possibility of naming conflicts, however. Consider the packages `java.util` and `java.awt`. Both contain types named `List`. `java.util.List` is an important and commonly used interface. The `java.awt` package contains a number of important types that are commonly used in client-side applications, but `java.awt.List` has been superseded and is not one of these important types. It is illegal to import both `java.util.List` and `java.awt.List` in the same Java file. The following single type import declarations produce a compilation error:

```
import java.util.List;
import java.awt.List;
```

Using on-demand type imports for the two packages is legal:

```
import java.util.*;  // For collections and other utilities.
import java.awt.*;   // For fonts, colors, and graphics.
```

Difficulty arises, however, if you actually try to use the type `List`. This type can be imported "on demand" from either package, and any attempt to use `List` as an unqualified type name produces a compilation error. The workaround, in this case, is to explicitly specify the package name you want.

Because `java.util.List` is much more commonly used than `java.awt.List`, it is useful to combine the two on-demand type import declarations with a single-type import declaration that serves to disambiguate what we mean when we say `List`:

```
import java.util.*;    // For collections and other utilities.
import java.awt.*;     // For fonts, colors, and graphics.
import java.util.List; // To disambiguate from java.awt.List
```

With these `import` declarations in place, we can use `List` to mean the `java.util.List` interface. If we actually need to use the `java.awt.List` class, we can still do so as long as we include its package name. There are no other naming conflicts between `java.util` and `java.awt`, and their types will be imported "on demand" when we use them without a package name.

2.10.4. Importing Static Members

In Java 5.0 and later, you can import the static members of types as well as types themselves using the keywords `import static`. (Static members are explained in Chapter 3. If you are not already familiar with them, you may want to come back to this section later.) Like type import declarations, these static import declarations come in two forms: single static member import and on-demand static member import. Suppose, for example, that you are writing a text-based program that sends a lot of output to `System.out`. In this case, you might use this single static member import to save yourself typing:

```
import static java.lang.System.out;
```

With this import in place, you can then use `out.print( )` instead of `System.out.print( )`. Or suppose you are writing a program that uses many of the the trigonometric and other functions of the `Math` class. In a program that is clearly focused on numerical methods like this, having to repeatedly type the class name "Math" does not add clarity to your code; it just gets in the way. In this case, an on-demand static member import may be appropriate:

```
import static java.lang.Math.*
```

With this import declaration, you are free to write concise expressions like `sqrt(abs(sin(x)))` without having to prefix the name of each static method with the class name `Math`.

Another important use of `import static` declarations is to import the names of constants into your code. This works particularly well with enumerated types (see Chapter 4). Suppose, for example that you want to use the values of this enumerated type in code you are writing:

```
package climate.temperate;
enum Seasons { WINTER, SPRING, SUMMER, AUTUMN };
```

You could import the type `climate.temperate.Seasons` and then prefix the constants with the type name: `Seasons.SPRING`. For more concise code, you could import the enumerated values themselves:

```
import static climate.temperate.Seasons.*;
```

Using static member import declarations for constants is generally a better technique than implementing an interface that defines the constants.

2.10.4.1 Static member imports and overloaded methods

A static import declaration imports a *name*, not any one specific member with that name. Since Java allows method overloading and allows a type to have fields and methods with the same name, a single static member import declaration may actually import more than one member. Consider this code:

```
import static java.util.Arrays.sort;
```

This declaration imports the name "sort" into the namespace, not any one of the 19 `sort( )` methods defined by `java.util.Arrays`. If you use the imported name `sort` to invoke a method, the compiler will look at the types of the method arguments to determine which method you mean.

It is even legal to import static methods with the same name from two or more different types as long as the methods all have different signatures. Here is one natural example:

```
import static java.util.Arrays.sort;
import static java.util.Collections.sort;
```

You might expect that this code would cause a syntax error. In fact, it does not because the `sort( )` methods defined by the `Collections` class have different signatures than all of the `sort( )` methods defined by the `Arrays` class. When you use the name "sort" in your code, the compiler looks at the types of the arguments to determine which of the 21 possible imported methods you mean.

2.11. Java File Structure

This chapter has taken us from the smallest to the largest elements of Java syntax, from individual characters and tokens to operators, expressions, statements, and methods, and on up to classes and packages. From a practical standpoint, the unit of Java program structure you will be dealing with most often is the Java file. A Java file is the smallest unit of Java code that can be compiled by the Java compiler. A Java file consists of:

- An optional `package` directive
- Zero or more `import` or `import static` directives
- One or more type definitions

These elements can be interspersed with comments, of course, but they must appear in this order. This is all there is to a Java file. All Java statements (except the `package` and `import` directives, which are not true statements) must appear within methods, and all methods must appear within a type definition.

Java files have a couple of other important restrictions. First, each file can contain at most one class that is declared `public`. A `public` class is one that is designed for use by other classes in other packages. This restriction on public classes only applies to top-level classes; a class can contain any number of nested or inner classes that are declared `public`. We'll see more about the `public` modifier and nested classes in Chapter 3.

The second restriction concerns the filename of a Java file. If a Java file contains a `public` class, the name of the file must be the same as the name of the class, with the extension *.java* appended. Thus, if `Point` is defined as a `public` class, its source code must appear in a file named *Point.java*. Regardless of whether your classes are `public` or not, it is good programming practice to define only one per file and to give the file the same name as the class.

When a Java file is compiled, each of the classes it defines is compiled into a separate *class* file that contains Java byte codes to be interpreted by the Java Virtual Machine. A class file has the same name as the class it defines, with the extension *.class* appended. Thus, if the file *Point.java* defines a class named `Point`, a Java compiler compiles it to a file named *Point.class*. On most systems, class files are stored in directories that correspond to their package names. Thus, the class `com.davidflanagan.examples.Point` is defined by the class file *com/davidflanagan/examples/Point.class*.

The Java interpreter knows where the class files for the standard system classes are located and can load them as needed. When the interpreter runs a program that wants to use a class named `com.davidflanagan.examples.Point`, it knows that the code for that class is located in a directory named *com/davidflanagan/examples/* and, by default, it "looks" in the current directory for a subdirectory of that name. In order to tell the interpreter to look in locations other than the current directory, you must use the `-classpath` option when invoking the interpreter or set the `CLASSPATH` environment variable. For details, see the documentation for the Java interpreter, *java*, in Chapter 8.

2.12. Defining and Running Java Programs

A Java program consists of a set of interacting class definitions. But not every Java class or Java file defines a program. To create a program, you must define a class that has a special method with the following signature:

```
public static void main(String[] args)
```

This `main( )` method is the main entry point for your program. It is where the Java interpreter starts running. This method is passed an array of strings and returns no value. When `main( )` returns, the Java interpreter exits (unless `main( )` has created separate threads, in which case the interpreter waits for all those threads to exit).

To run a Java program, you run the Java interpreter, *java*, specifying the fully qualified name of the class that contains the `main( )` method. Note that you specify the name of the class, *not* the name of the class file that contains the class. Any additional arguments you specify on the command line are passed to the `main( )` method as its `String[ ]` parameter. You may also need to specify the `-classpath` option (or `-cp`) to tell the interpreter where to look for the classes needed by the program. Consider the following command:

```
% java -classpath /usr/local/Jude com.davidflanagan.jude.Jude datafile.jude
```

java is the command to run the Java interpreter. *-classpath /usr/local/Jude* tells the interpreter where to look for *.class* files. `com.davidflanagan.jude.Jude` is the name of the program to run (i.e., the name of the class that defines the `main( )` method). Finally, *datafile.jude* is a string that is passed to that `main( )` method as the single element of an array of `String` objects.

There is an easier way to run programs. If a program and all its auxiliary classes (except those that are part of the Java platform) have been properly bundled in a Java archive (JAR) file, you can run the program simply by specifying the name of the JAR file:

```
% java -jar /usr/local/Jude/jude.jar datafile.jude
```

Some operating systems make JAR files automatically executable. On those systems, you can simply say:

```
% /usr/local/Jude/jude.jar datafile.jude
```

See Chapter 8 for details.

2.13. Differences Between C and Java

If you are a C or C++ programmer, you should have found much of the syntax of Javaparticularly at the level of operators and statementsto be familiar. Because Java and C are so similar in some ways, it is important for C and C++ programmers to understand where the similarities end. C and Java differ in important ways, as summarized in the following list:

No preprocessor

Java does not include a preprocessor and does not define any analogs of the `#define`, `#include`, and `#ifdef` directives. Constant definitions are replaced with `static final` fields in Java. (See the `java.lang.Math.PI` field for an example.) Macro definitions are not available in Java, but advanced compiler technology and inlining has made them less useful. Java does not require an `#include` directive because Java has no header files. Java class files contain both the class API and the class implementation, and the compiler reads API information from class files as necessary. Java lacks any form of conditional compilation, but its cross-platform portability means that this feature is rarely needed.

No global variables

Java defines a very clean namespace. Packages contain classes, classes contain fields and methods, and methods contain local variables. But Java has no global variables, and thus there is no possibility of namespace collisions among those variables.

Well-defined primitive type sizes

All the primitive types in Java have well-defined sizes. In C, the size of `short`, `int`, and `long` types is platform-dependent, which hampers portability.

No pointers

Java classes and arrays are reference types, and references to objects and arrays are akin to pointers in C. Unlike C pointers, however, references in Java are entirely opaque. There is no way to convert a reference to a primitive type, and a reference cannot be incremented or decremented. There is no address-of operator like `&`, dereference operator like `*` or `->`, or `sizeof` operator. Pointers are a notorious source of bugs. Eliminating them simplifies the language and makes Java programs more robust and secure.

Garbage collection

The Java Virtual Machine performs garbage collection so that Java programmers do not have to explicitly manage the memory used by all objects and arrays. This feature eliminates another entire category of common bugs and all but eliminates memory leaks from Java programs.

No goto statement

Java doesn't support a `goto` statement. Use of `goto` except in certain well-defined circumstances is regarded as poor programming practice. Java adds exception handling and labeled `break` and `continue` statements to the flow-control statements offered by C. These are a good substitute for `goto`.

Variable declarations anywhere

C requires local variable declarations to be made at the beginning of a method or block, while Java allows them anywhere in a method or block. Many programmers prefer to keep all their variable declarations grouped together at the top of a method, however.

Forward references

The Java compiler is smarter than the C compiler in that it allows methods to be invoked before they are defined. This eliminates the need to declare functions in a header file before defining them in a program file, as is done in C.

Method overloading

Java programs can define multiple methods with the same name, as long as the methods have different parameter lists.

No struct and union types

Java doesn't support C `struct` and `union` types. A Java `class` can be thought of as an enhanced `struct`, however.

No bitfields

Java doesn't support the (infrequently used) ability of C to specify the number of individual bits occupied by fields of a `struct`.

No typedef

Java doesn't support the `typedef` keyword used in C to define aliases for type names. Java's lack of pointers makes its type-naming scheme simpler and more consistent than C's, however so many of the common uses of `typedef` are not really necessary in Java.

No method pointers

C allows you to store the address of a function in a variable and pass this function pointer to other functions. You cannot do this with Java methods, but you can often achieve similar results by passing an object that implements a particular interface. Also, a Java method can be represented and invoked through a `java.lang.reflect.Method` object.

Team LiB

Chapter 3. Object-Oriented Programming in Java

Now that we've covered fundamental Java syntax, we are ready to begin object-oriented programming in Java. All Java programs use objects, and the type of an object is defined by its *class* or *interface*. Every Java program is defined as a class, and nontrivial programs usually include a number of classes and interface definitions. This chapter explains how to define new classes and interfaces and how to do object-oriented programming with them.[1]

[1] If you do not have object-oriented (OO) programming background, don't worry; this chapter does not assume any prior experience. If you do have experience with OO programming, however, be careful. The term "object-oriented" has different meanings in different languages. Don't assume that Java works the same way as your favorite OO language. This is particularly true for C++ programmers. Although Java and C++ borrow much syntax from C, the similarities between the two languages do not go far beyond the level of syntax. Don't let your experience with C++ lull you into a false familiarity with Java.

This is a relatively long and detailed chapter, so we begin with an overview and some definitions. A *class* is a collection of fields that hold values and methods that operate on those values. Classes are the most fundamental structural element of all Java programs. You cannot write Java code without defining a class. All Java statements appear within methods, and all methods are implemented within classes.

A class defines a new reference type, such as the `Point` type defined in Chapter 2. An *object* is an *instance* of a class. The `Point` class defines a type that is the set of all possible two-dimensional points. A `Point` object is a value of that type: it represents a single two-dimensional point.

Objects are usually created by *instantiating* a class with the `new` keyword and a constructor invocation, as shown here:

```
Point p = new Point(1.0, 2.0);
```

Constructors are covered in Section 3.3 later in this chapter.

A class definition consists of a *signature* and a *body*. The class signature defines the name of the class and may also specify other important information. The body of a class is a set of *members* enclosed in curly braces. The members of a class may include fields and methods, constructors and initializers, and nested types.

Members can be *static* or nonstatic. A static member belongs to the class itself while a nonstatic member is associated with the instances of a class (see Section 3.2 later in this chapter).

The signature of a class may declare that the class *extends* another class. The extended class is known as the *superclass* and the extension is known as the *subclass*. A subclass *inherits* the members of its superclass and may declare new members or *override* inherited methods with new implementations.

The signature of a class may also declare that the class *implements* one or more interfaces. An *interface* is a reference type that defines method signatures but does not include method bodies to implement the methods. A class that implements an interface is required to provide bodies for the interface's methods. Instances of such a class are also instances of the interface type that it implements.

The members of a class may have *access modifiers* `public` , `protected`, or `private`, which specify their visibility and accessibility to clients and to subclasses. This allows classes to hide members that are not part of their public API. When applied to fields, this ability to hide members enables an object-oriented design technique known as *data encapsulation* .

Classes and interfaces are the most important of the five fundamental reference types defined by Java. Arrays, enumerated types (or "enums") and annotation types are the other three. Arrays are covered in Chapter 2. Enumerated types and annotation types were introduced in Java 5.0 (see Chapter 4). Enums are a specialized kind of class and annotation types are a specialized kind of interface.

3.1. Class Definition Syntax

At its simplest level, a class definition consists of the keyword `class` followed by the name of the class and a set of class members within curly braces. The `class` keyword may be preceded by modifier keywords and annotations (see Chapter 4). If the class extends another class, the class name is followed by the `extends` keyword and the name of the class being extended. If the class implements one or more interfaces then the class name or the `extends` clause is followed by the `implements` keyword and a comma-separated list of interface names. For example:

```
public class Integer extends Number implements Serializable, Comparable {
    // class members go here
}
```

Generic class declarations include additional syntax that is covered in Chapter 4.

Class declarations may include zero or more of the following modifiers:

`public`

A `public` class is visible to classes defined outside of its package. See Section 3.6 later in this chapter.

`abstract`

An `abstract` class is one whose implementation is incomplete and cannot be instantiated. Any class with one or more `abstract` methods must be declared `abstract`.

`final`

The `final` modifier specifies that the class may not be extended. Declaring a class `final` may enable the Java VM to optimize its methods.

`strictfp`

If a class is declared `strictfp`, all its methods behave as if they were declared `strictfp`. This rarely used modifier is discussed in Section 2.6 in Chapter 2.

A class cannot be both `abstract` and `final`. By convention, if a class has more than one modifier, they appear in the order shown.

3.2. Fields and Methods

A class can be viewed as a collection of data and code to operate on that data. The data is stored in fields, and the code is organized into methods. This section covers fields and methods, the two most important kinds of class members. Fields and methods come in two distinct types: class members (also known as static members) are associated with the class itself, while instancemembers are associated with individual instances of the class (i.e., with objects). This gives us four kinds of members:

- Class fields
- Class methods
- Instance fields
- Instance methods

The simple class definition for the class `Circle`, shown in Example 3-1, contains all four types of members.

Example 3-1. A simple class and its members

```
public class Circle {
  // A class field
  public static final double PI= 3.14159;     // A useful constant

  // A class method: just compute a value based on the arguments
  public static double radiansToDegrees(double rads) {
    return rads * 180 / PI;
  }

  // An instance field
  public double r;                  // The radius of the circle

  // Two instance methods: they operate on the instance fields of an object
  public double area() {            // Compute the area of the circle
    return PI * r * r;
  }
  public double circumference() {   // Compute the circumference of the circle
    return 2 * PI * r;
  }
}
```

The following sections explain all four kinds of members. First, however, we cover field declaration syntax. (Method declaration syntax is covered in Section 2.6 later in this chapter.)

3.2.1. Field Declaration Syntax

Field declaration syntax is much like the syntax for declaring local variables (see Chapter 2) except that field definitions may also include modifiers. The simplest field declaration consists of the field type followed by the field name. The type may be preceded by zero or more modifier keywords or annotations (see Chapter 4), and the name may be followed by an equals sign and initializer expression that provides the initial value of the field. If two or more fields share the same type and modifiers, the type may be followed by a comma-separated list of field names and initializers. Here are some valid field declarations:

```
int x = 1;
private String name;
public static final DAYS_PER_WEEK = 7;
String[] daynames = new String[DAYS_PER_WEEK];
private int a = 17, b = 37, c = 53;
```

Field modifiers are comprised of zero or more of the following keywords:

`public` , `protected`, `private`

These access modifiers specify whether and where a field can be used outside of the class that defines it. These important modifiers are covered in Section 3.6 later in this chapter. No more than one of these access modifiers may appear in any field declaration.

`static`

If present, this modifier specifies that the field is associated with the defining class itself rather than with each instance of the class.

`final`

This modifier specifies that once the field has been initialized, its value may never be changed. Fields that are both `static` and `final` are compile-time constants that the compiler can inline. `final` fields can also be used to create classes whose instances are immutable.

`transient`

This modifier specifies that a field is not part of the persistent state of an object and that it need not be serialized along with the rest of the object. Serialization is covered in Chapter 5.

`volatile`

Roughly speaking, a `volatile` field is like a `synchronized` method: safe for concurrent use by two or more threads. More accurately, `volatile` says that the value of a field must always be read from and flushed to main memory, and that it may not be cached by a thread (in a register or CPU cache).

3.2.2. Class Fields

A *class field* is associated with the class in which it is defined rather than with an instance of the class. The following line declares a class field:

```
public static final double PI = 3.14159;
```

This line declares a field of type `double` named `PI` and assigns it a value of 3.14159. As you can see, a field declaration looks quite a bit like a local variable declaration. The difference, of course, is that variables are defined within methods while fields are members of classes.

The `static` modifier says that the field is a class field. Class fields are sometimes called static fields because of this `static` modifier. The `final` modifier says that the value of the field does not change. Since the field `PI` represents a constant, we declare it `final` so that it cannot be changed. It is a convention in Java (and many other languages) that constants are named with capital letters, which is why our field is named `PI`, not `pi`. Defining constants like this is a common use for class fields, meaning that the `static` and `final` modifiers are often used together. Not all class fields are constants, however. In other words, a field can be declared `static` without being declared `final`. Finally, the `public` modifier says that anyone can use the field. This is a visibility modifier, and we'll discuss it and related modifiers in more detail later in this chapter.

The key point to understand about a static field is that there is only a single copy of it. This field is associated with the class itself, not with instances of the class. If you look at the various methods of the `Circle` class, you'll see that they use this field. From inside the `Circle` class, the field can be referred to simply as `PI`. Outside the class, however, both class and field names are required to uniquely specify the field. Methods that are not part of `Circle` access this field as `Circle.PI`.

A `public` class field is essentially a global variable. The names of class fields are qualified by the unique names of the classes that contain them, however. Thus, Java does not suffer from the name collisions that can affect other languages when different modules of code define global variables with the same name.

3.2.3. Class Methods

As with class fields, *class methods* are declared with the `static` modifier:

```
public static double radiansToDegrees(double rads) { return rads * 180 / PI; }
```

This line declares a class method named `radiansToDegrees()`. It has a single parameter of type `double` and returns a `double` value. The body of the method is quite short; it performs a simple computation and returns the result.

Like class fields, class methods are associated with a class, rather than with an object.When invoking a class method from code that exists outside the class, you must specify both the name of the class and the method. For example:

```
// How many degrees is 2.0 radians?
double d = Circle.radiansToDegrees(2.0);
```

If you want to invoke a class method from inside the class in which it is defined, you don't have to specify the class name. However, it is often good style to specify the class name anyway, to make it clear that a class method is being invoked.

Note that the body of our `Circle.radiansToDegrees( )` method uses the class field `PI`. A class method can use any class fields and class methods of its own class (or of any other class). But it cannot use any instance fields or instance methods because class methods are not associated with an instance of the class. In other words, although the `radiansToDegrees()` method is defined in the `Circle` class, it does not use any `Circle` objects. The instance fields and instance methods of the class are associated with `Circle` objects, not with the class itself. Since a class method is not associated with an instance of its class, it cannot use any instance methods or fields.

As we discussed earlier, a class field is essentially a global variable. In a similar way, a class method is a global method, or global function. Although `radiansToDegrees()` does not operate on `Circle` objects, it is defined within the `Circle` class because it is a utility method that is sometimes useful when working with circles. In many nonobject-oriented programming languages, all methods, or functions, are global. You can write complex Java programs using only class methods. This is not object-oriented programming, however, and does not take advantage of the power of the Java language. To do true object-oriented programming, we need to add instance fields and instance methods to our repertoire.

3.2.4. Instance Fields

Any field declared without the `static` modifier is an *instance field*:

```
public double r;    // The radius of the circle
```

Instance fields are associated with instances of the class, rather than with the class itself. Thus, ever `Circle` object we create has its own copy of the `double` field `r`. In our example, `r` represents the radius of a circle. Thus, each `Circle` object can have a radius independent of all other `Circle` objects.

Inside a class definition, instance fields are referred to by name alone. You can see an example of this if you look at the method body of the `circumference()` instance method. In code outside the class, the name of an instance method must be prefixed with a reference to the object that contains it. For example, if the variable `c` holds a reference to a `Circle` object, we use the expression `c.r` to refer to the radius of that circle:

```
Circle c = new Circle(); // Create a Circle object; store a reference in c
c.r = 2.0;               // Assign a value to its instance field r
Circle d = new Circle(); // Create a different Circle object
d.r = c.r * 2;           // Make this one twice as big
```

Instance fields are key to object-oriented programming. Instance fields hold thestate of an object; the values of those fields make one object distinct from another.

3.2.5. Instance Methods

Any method not declared with the `static` keyword is an instance method. An *instance method* operates on an instance of a class (an object) instead of operating on the class itself. It is with instance methods that object-oriented programming starts to get interesting. The`Circle` class defined in Example 3-1 contains two instance methods, `area( )` and `circumference()`, that compute and return the area and circumference of the circle represented by a given`Circle` object.

To use an instance method from outside the class in which it is defined, we must prefix it with a reference to the instance that is to be operated on. For example:

```
Circle c = new Circle();   // Create a Circle object; store in variable c
c.r = 2.0;                 // Set an instance field of the object
double a = c.area();       // Invoke an instance method of the object
```

If you're new to object-oriented programming, that last line of code may look a little strange. We do not write:

```
a = area(c);
```

Instead, we write:

```
a = c.area();
```

This is why it is called object-oriented programming; the object is the focus here, not the function call. This small syntactic difference is perhaps the single most important feature of the object-oriented paradigm.

The point here is that we don't have to pass an argument to`c.area()`. The object we are operating on, `c`, is implicit in the syntax. Take a look atExample 3-1 again. You'll notice the same thing in the signature of the `area( )` method: it doesn't have a parameter. Now look at the body of the`area( )` method: it uses the instance field `r`. Because the `area()` method is part of the same class that defines this instance field, the method can use the unqualified name`r`. It is understood that this refers to the radius of whatever `Circle` instance invokes the method.

Another important thing to notice about the bodies of the`area( )` and `circumference()` methods is that they both use the class field `PI`. We saw earlier that class methods can use only class fields and class methods, not instance fields or methods. Instance methods are not restricted in this way: they can use any member of a class, whether it is declared`static` or not.

3.2.5.1 How instance methods work

Consider this line of code again:

```
a = c.area();
```

What's going on here? How can a method that has no parameters know what data to operate on? In fact, the `area( )` method does have a parameter. All instance methods are implemented with an implicit parameter not shown in the method signature. The implicit argument is named `this`; it holds a reference to the object through which the method is invoked. In our example, that object is a `Circle`.

The implicit `this` parameter is not shown in method signatures because it is usually not needed; whenever a Java method accesses the instance fields in its class, it is implicit that it is accessing field in the object referred to by the `this` parameter. The same is true when an instance method invokes another instance method in the same class. I said earlier that to invoke an instance method you mus prepend a reference to the object to be operated on. When an instance method is invoked within another instance method in the same class, however, you don't need to specify an object. In this case, it is implicit that the method is being invoked on the `this` object.

You can use the `this` keyword explicitly when you want to make it clear that a method is accessing its own fields and/or methods. For example, we can rewrite the `area()` method to use `this` explicitly to refer to instance fields:

```
public double area() { return Circle.PI * this.r * this.r; }
```

This code also uses the class name explicitly to refer to class field `PI`. In a method this simple, it is not necessary to be explicit. In more complicated cases, however, you may find that it increases the clarity of your code to use an explicit `this` where it is not strictly required.

In some cases, the `this` keyword *is* required, however. For example, when a method parameter or local variable in a method has the same name as one of the fields of the class, you must use `this` to refer to the field since the field name used alone refers to the method parameter or local variable. Fo example, we can add the following method to the `Circle` class:

```
public void setRadius(double r) {
  this.r = r;      // Assign the argument (r) to the field (this.r)
                   // Note that we cannot just say r = r
}
```

Finally, note that while instance methods can use the `this` keyword, class methods cannot. This is because class methods are not associated with objects.

3.2.5.2 Instance methods or class methods?

Instance methods are one of the key features of object-oriented programming. That doesn't mean, however, that you should shun class methods. In many cases, it is perfectly reasonable to define class methods. When working with the Circle class, for example, you might find that you often want to compute the area of a circle with a given radius but don't want to bother creating a Circle object to represent that circle. In this case, a class method is more convenient:

```
public static double area(double r) { return PI * r * r; }
```

It is perfectly legal for a class to define more than one method with the same name, as long as the methods have different parameters. Since this version of the area() method is a class method, it does not have an implicit this parameter and must have a parameter that specifies the radius of the circle. This parameter keeps it distinct from the instance method of the same name.

As another example of the choice between instance methods and class methods, consider defining a method named bigger( ) that examines two Circle objects and returns whichever has the larger radius. We can write bigger( ) as an instance method as follows:

```
// Compare the implicit "this" circle to the "that" circle passed
// explicitly as an argument and return the bigger one.
public Circle bigger(Circle that) {
  if (this.r > that.r) return this;
  else return that;
}
```

We can also implement bigger( ) as a class method as follows:

```
// Compare circle a to circle b and return the one with the larger radius
public static Circle bigger(Circle a, Circle b) {
  if (a.r > b.r) return a;
  else return b;
}
```

Given two Circle objects, x and y, we can use either the instance method or the class method to determine which is bigger. The invocation syntax differs significantly for the two methods, however:

```
Circle biggest = x.bigger(y);          // Instance method: also y.bigger(x)
Circle biggest = Circle.bigger(x, y);  // Static method
```

Both methods work well, and, from an object-oriented design standpoint, neither of these methods is "more correct" than the other. The instance method is more formally object-oriented, but its invocation syntax suffers from a kind of asymmetry. In a case like this, the choice between an instance method and a class method is simply a design decision. Depending on the circumstances, one or the other will likely be the more natural choice.

3.2.6. Case Study: System.out.println( )

Throughout this book, we've seen a method named System.out.println() used to display output to the terminal window or console. We've never explained why this method has such an long, awkward name or what those two periods are doing in it. Now that you understand class and instancefields and class and instance methods, it is easier to understand what is going on:`System` is a class. It has a class field named `out`. The field `System.out` refers to an object. The object `System.out` has an instance method named `println( )`. If you want to explore this in more detail, you can look up the `java.lang.System` class in the reference section. The class synopsis there tells you that the field`out` is of type `java.io.PrintStream`, and you can look up that class to find out about the`println( )` method.

3.3. Creating and Initializing Objects

Now that we've covered fields and methods, we move on to other important members of a class. Constructors and initializers are class members whose job is to initialize the fields of a class.

Take another look at how we've been creating Circle objects:

```
Circle c = new Circle();
```

What are those parentheses doing there? They make it look like we're calling a method. In fact, that is exactly what we're doing. Every class in Java has at least one *constructor*, which is a method that has the same name as the class and whose purpose is to perform any necessary initialization for a new object. Since we didn't explicitly define a constructor for our Circle class in Example 3-1, Java gave us a default constructor that takes no arguments and performs no special initialization.

Here's how a constructor works. The new operator creates a new, but uninitialized, instance of the class. The constructor method is then called, with the new object passed implicitly (a this reference, as we saw earlier) as well as whatever arguments that are specified between parentheses passed explicitly. The constructor can use these arguments to do whatever initialization is necessary.

3.3.1. Defining a Constructor

There is some obvious initialization we could do for our circle objects, so let's define a constructor. Example 3-2 shows a new definition for Circle that contains a constructor that lets us specify the radius of a new Circle object. The constructor also uses the this reference to distinguish between a method parameter and an instance field of the same name.

Example 3-2. A constructor for the Circle class

```
public class Circle {
    public static final double PI = 3.14159;  // A constant
    public double r;   // An instance field that holds the radius of the circle

    // The constructor method: initialize the radius field
    public Circle(double r) { this.r = r; }

    // The instance methods: compute values based on the radius
    public double circumference() { return 2 * PI * r; }
    public double area() { return PI * r*r; }
}
```

When we relied on the default constructor supplied by the compiler, we had to write code like this to initialize the radius explicitly:

```
Circle c = new Circle();
c.r = 0.25;
```

With this new constructor, the initialization becomes part of the object creation step:

```
Circle c = new Circle(0.25);
```

Here are some important notes about naming, declaring, and writing constructors:

- The constructor name is always the same as the class name.
- Unlike all other methods, a constructor is declared without a return type, not even `void`.
- The body of a constructor should initialize the `this` object.
- A constructor may not return `this` or any other value. A constructor may include a `return` statement, but only one that does not include a return value.

3.3.2. Defining Multiple Constructors

Sometimes you want to initialize an object in a number of different ways, depending on what is most convenient in a particular circumstance. For example, we might want to initialize the radius of a circle to a specified value or a reasonable default value. Since our `Circle` class has only a single instance field, we can't initialize it too many ways, of course. But in more complex classes, it is often convenient to define a variety of constructors. Here's how we can define two constructors for `Circle`:

```
public Circle() { r = 1.0; }
public Circle(double r) { this.r = r; }
```

It is perfectly legal to define multiple constructors for a class, as long as each constructor has a different parameter list. The compiler determines which constructor you wish to use based on the number and type of arguments you supply. This is simply an example of method overloading, as we discussed in Chapter 2.

3.3.3. Invoking One Constructor from Another

A specialized use of the `this` keyword arises when a class has multiple constructors; it can be used from a constructor to invoke one of the other constructors of the same class. In other words, we can rewrite the two previous `Circle` constructors as follows:

```
// This is the basic constructor: initialize the radius
public Circle(double r) { this.r = r; }
// This constructor uses this() to invoke the constructor above
```

```
public Circle() { this(1.0); }
```

The `this( )` syntax is a method invocation that calls one of the other constructors of the class. The particular constructor that is invoked is determined by the number and type of arguments, of course. This is a useful technique when a number of constructors share a significant amount of initialization code, as it avoids repetition of that code. This would be a more impressive example, of course, if the one-parameter version of the `Circle( )` constructor did more initialization than it does.

There is an important restriction on using `this()`: it can appear only as the first statement in a constructor. It may, of course, be followed by any additional initialization a particular version of the constructor needs to do. The reason for this restriction involves the automatic invocation of superclass constructor methods, which we'll explore later in this chapter.

3.3.4. Field Defaults and Initializers

Not every field of a class requires initialization. Unlike local variables, which have no default value an cannot be used until explicitly initialized, the fields of a class are automatically initialized to the default value `false`, '`\u0000`', `0`, `0.0`, or `null`, depending on their type. These default values are guaranteed by Java and apply to both instance fields and class fields.

If the default field value is not appropriate for your field, you can explicitly provide a different initial value. For example:

```
public static final double PI = 3.14159;
public double r = 1.0;
```

Field declarations and local variable declarations have similar syntax, but there is an important difference in how their initializer expressions are handled. As described inChapter 2, a local variable declaration is a statement that appears within a Java method; the variable initialization is performed when the statement is executed. Field declarations, however, are not part of any method, so they cannot be executed as statements are. Instead, the Java compiler generates instance-field initialization code automatically and puts it in theconstructor or constructors for the class. The initialization code is inserted into a constructor in the order in which it appears in the source code, which means that a field initializer can use the initial values of any fields declared before it. Consider the following code excerpt, which shows a constructor and two instance fields of a hypothetical class:

```
public class TestClass {
  public int len = 10;
  public int[] table = new int[len];

  public TestClass() {
    for(int i = 0; i < len; i++) table[i] = i;
  }

  // The rest of the class is omitted...
}
```

In this case, the code generated for the constructor is actually equivalent to the following:

```
public TestClass() {
  len = 10;
  table = new int[len];
  for(int i = 0; i < len; i++) table[i] = i;
}
```

If a constructor begins with a `this( )` call to another constructor, the field initialization code does not appear in the first constructor. Instead, the initialization is handled in the constructor invoked by the `this( )` call.

So, if instance fields are initialized in constructor methods, where are class fields initialized? These fields are associated with the class, even if no instances of the class are ever created, so they need to be initialized even before a constructor is called. To support this, the Java compiler generates a class initialization method automatically for every class. Class fields are initialized in the body of this method, which is invoked exactly once before the class is first used (often when the class is first loaded by the Java VM.)[2] As with instance field initialization, class field initialization expressions are inserted into the class initialization method in the order in which they appear in the source code. This means that the initialization expression for a class field can use the class fields declared before it. The class initialization method is an internal method that is hidden from Java programmers. In the class file, it bears the name `<clinit>`.

[2] It is actually possible to write a class initializer for a class C that calls a method of another class that creates an instance of C. In this contrived recursive case, an instance of C is created before the class C is fully initialized. This situation is not common in everyday practice, however.

3.3.4.1 Initializer blocks

So far, we've seen that objects can be initialized through the initialization expressions for their fields and by arbitrary code in their constructor methods. A class has a class initialization method, which is like a constructor, but we cannot explicitly define the body of this method as we can for a constructor. Java does allow us to write arbitrary code for the initialization of class fields, however, with a construct known as a *static initializer*. A static initializer is simply the keyword `static` followed by a block of code in curly braces. A static initializer can appear in a class definition anywhere a field or method definition can appear. For example, consider the following code that performs some nontrivial initialization for two class fields:

```
// We can draw the outline of a circle using trigonometric functions
// Trigonometry is slow, though, so we precompute a bunch of values
public class TrigCircle {
  // Here are our static lookup tables and their own simple initializers
  private static final int NUMPTS = 500;
  private static double sines[] = new double[NUMPTS];
  private static double cosines[] = new double[NUMPTS];

  // Here's a static initializer that fills in the arrays
  static {
    double x = 0.0;
    double delta_x = (Circle.PI/2)/(NUMPTS-1);
```

```
    for(int i = 0, x = 0.0; i < NUMPTS; i++, x += delta_x) {
      sines[i] = Math.sin(x);
      cosines[i] = Math.cos(x);
    }
  }
  // The rest of the class is omitted...
}
```

A class can have any number of static initializers. The body of each initializer block is incorporated into the class initialization method, along with any static field initialization expressions. A static initializer is like a class method in that it cannot use the `this` keyword or any instance fields or instance methods of the class.

In Java 1.1 and later, classes are also allowed to have instance initializers. An instance initializer is like a static initializer, except that it initializes an object, not a class. A class can have any number of instance initializers, and they can appear anywhere a field or method definition can appear. The body of each instance initializer is inserted at the beginning of every constructor for the class, along with any field initialization expressions. An instance initializer looks just like a static initializer, except that it doesn't use the `static` keyword. In other words, an instance initializer is just a block of arbitrary Java code that appears within curly braces.

Instance initializers can initialize arrays or other fields that require complex initialization. They are sometimes useful because they locate the initialization code right next to the field, instead of separating into a constructor method. For example:

```
private static final int NUMPTS = 100;
private int[] data = new int[NUMPTS];
{ for(int i = 0; i < NUMPTS; i++) data[i] = i; }
```

In practice, however, this use of instance initializers is fairly rare. Instance initializers were introduce in Java 1.1 to support anonymous inner classes, which are not allowed to define constructors. (Anonymous inner classes are covered in Section 3.10 later in this chapter.)

3.4. Destroying and Finalizing Objects

Now that we've seen how new objects are created and initialized in Java, we need to study the other end of the object life cycle and examine how objects are finalized and destroyed. *Finalization* is the opposite of initialization.

In Java, the memory occupied by an object is automatically reclaimed when the object is no longer needed. This is done through a process known as *garbage collection*. Garbage collection is a technique that has been around for years in languages such as Lisp. It takes some getting used to fo programmers accustomed to such languages as C and C++, in which you must call the `free()` function or the `delete` operator to reclaim memory. The fact that you don't need to remember to destroy every object you create is one of the features that makes Java a pleasant language to work with. It is also one of the features that makes programs written in Java less prone to bugs than those written in languages that don't support automatic garbage collection.

3.4.1. Garbage Collection

The Java interpreter knows exactly what objects and arrays it has allocated. It can also figure out which local variables refer to which objects and arrays and which objects and arrays refer to which other objects and arrays. Thus, the interpreter is able to determine when an allocated object is no longer referred to by any other active object or variable. When the interpreter finds such an object, it knows it can safely reclaim the object's memory and does so. The garbage collector can also detect and destroy cycles of objects that refer to each other, but are not referenced by any other active objects. Any such cycles are also reclaimed.

Different VM implementations handle garbage collection in different ways. It is reasonable, however, to imagine the garbage collector running as a low-priority background thread, so it does most of its work when nothing else is going on, such as during idle time while waiting for user input. The only time the garbage collector must run while something high-priority is going on (i.e., the only time it actually slows down the system) is when available memory has become dangerously low. This doesn't happen very often because the low-priority thread cleans things up in the background.

3.4.2. Memory Leaks in Java

The fact that Java supports garbage collection dramatically reduces the incidence of a class of bugs known as *memory leaks*. A memory leak occurs when memory is allocated and never reclaimed. At first glance, it might seem that garbage collection prevents all memory leaks because it reclaims all unused objects. A memory leak can still occur in Java, however, if a valid (but unused) reference to an unused object is left hanging around. For example, when a method runs for a long time (or forever), the local variables in that method can retain object references much longer than they are actually required. The following code illustrates:

```
public static void main(String args[]) {
  int big_array[] = new int[100000];
```

```
  // Do some computations with big_array and get a result.
  int result = compute(big_array);

  // We no longer need big_array. It will get garbage collected when there
  // are no more references to it. Since big_array is a local variable,
  // it refers to the array until this method returns. But this method
  // doesn't return. So we've got to explicitly get rid of the reference
  // ourselves, so the garbage collector knows it can reclaim the array.
  big_array = null;

  // Loop forever, handling the user's input
  for(;;) handle_input(result);
}
```

Memory leaks can also occur when you use a hash table or similar data structure to associate one object with another. Even when neither object is required anymore, the association remains in the hash table, preventing the objects from being reclaimed until the hash table itself is reclaimed. If the hash table has a substantially longer lifetime than the objects it holds, this can cause memory leaks.

The key to avoiding memory leaks is to set object references to `null` when they are no longer needed if the object that contains those references is going to continue to exist. One common source of leaks is in data structures in which an `Object` array is used to represent a collection of objects. It is common to use a separate `size` field to keep track of which elements of the array are currently valid. When removing an object from the collection, it is not sufficient to simply decrement this `size` field: you must also set the appropriate array element to `null` so that the obsolete object reference does not live on.

3.4.3. Object Finalization

A *finalizer* in Java is the opposite of a constructor. While a constructor method performs initialization for an object, a finalizer method can be used to perform cleanup or "finalization" for the object. Garbage collection automatically frees up the memory resources used by objects, but objects can hold other kinds of resources, such as open files and network connections. The garbage collector cannot free these resources for you, so you may occasionally want to write a finalizer method for any object that needs to perform such tasks as closing files, terminating network connections, deleting temporary files, and so on. This is particularly true for classes that use native methods: these classes may need a `native` finalizer to release native resources (including memory) that are not under the control of the Java garbage collector.

A finalizer is an instance method that takes no arguments and returns no value. There can be only one finalizer per class, and it must be named `finalize()`.[3] A finalizer can throw any kind of exception or error, but when a finalizer is automatically invoked by the garbage collector, any exception or error it throws is ignored and serves only to cause the finalizer method to return. Finalizer methods are typically declared `protected` (which we have not discussed yet) but can also be declared `public`. An example finalizer looks like this:

[3] C++ programmers should note that although Java constructor methods are named like C++ constructors, Java finalization methods are not named like C++ destructor methods. As we will see, they do not behave quite like C++ destructor methods either.

```
protected void finalize() throws Throwable {
  // Invoke the finalizer of our superclass
  // We haven't discussed superclasses or this syntax yet
  super.finalize();

  // Delete a temporary file we were using
  // If the file doesn't exist or tempfile is null, this can throw
  // an exception, but that exception is ignored.
  tempfile.delete();
}
```

Here are some important points about finalizers:

- If an object has a finalizer, the finalizer method is invoked sometime after the object becomes unused (or unreachable), but before the garbage collector reclaims the object.
- Java makes no guarantees about when garbage collection will occur or in what order objects wil be collected. Therefore, Java can make no guarantees about when (or even whether) a finalizer will be invoked, in what order finalizers will be invoked, or what thread will execute finalizers.
- The Java interpreter can exit without garbage collecting all outstanding objects, so some finalizers may never be invoked. In this case, resources such as network connections are closed and reclaimed by the operating system. Note, however, that if a finalizer that deletes a file does not run, that file will not be deleted by the operating system.
- To ensure that certain actions are taken before the VM exits, Java 1.1 provided the `Runtime` method `runFinalizersOnExit()`. Unfortunately, however, this method can cause deadlock and is inherently unsafe; it was deprecated in 1.2. In Java 1.3 and later, the `Runtime` method `addShutdownHook()` can safely execute arbitrary code before the Java interpreter exits.
- After a finalizer is invoked, objects are not freed right away. This is because a finalizer method can resurrect an object by storing the `this` pointer somewhere so that the object once again has references. Thus, after `finalize()` is called, the garbage collector must once again determine that the object is unreferenced before it can garbage-collect it. However, even if an object is resurrected, the finalizer method is never invoked more than once. Resurrecting an object is never a useful thing to dojust a strange quirk of object finalization.
- The `finalize( )` method is an instance method, and finalizers act on instances. There is no equivalent mechanism for finalizing a class.

In practice, it is quite rare for an application-level class to require a `finalize( )` method. Finalizer methods are more useful, however, when writing Java classes that interface to native platform code with `native` methods. In this case, the native implementation can allocate memory or other resources that are not under the control of the Java garbage collector and need to be reclaimed explicitly by a `native finalize()` method.

Furthermore, because of the uncertainty about when and whether a finalizer runs, it is best to avoid dependence on finalizers. For example, a class that includes a reference to a network socket should define a public `close()` method, which calls the `close( )` method of the socket. This way, when the user of your class is done with it, she can call `close( )` and be sure that the network connection is closed. You might, however, define a `finalize( )` method as backup in case the user of your class forgets to call `close( )` and allows an unclosed instance to be garbage-collected.

Team LiB

3.5. Subclasses and Inheritance

The Circle defined earlier is a simple class that distinguishes circle objects only by their radii. Suppose, instead, that we want to represent circles that have both a size and a position. For example, a circle of radius 1.0 centered at point 0,0 in the Cartesian plane is different from the circle of radius 1.0 centered at point 1,2. To do this, we need a new class, which we'll call PlaneCircle. We'd like to add the ability to represent the position of a circle without losing any of the existing functionality of the Circle class. This is done by defining PlaneCircle as a subclass of Circle so that PlaneCircle inherits the fields and methods of its superclass, Circle. The ability to add functionality to a class by subclassing, or extending, is central to the object-oriented programming paradigm.

3.5.1. Extending a Class

Example 3-3 shows how we can implement PlaneCircle as a subclass of the Circle class.

Example 3-3. Extending the Circle class

```
public class PlaneCircle extends Circle {
  // We automatically inherit the fields and methods of Circle,
  // so we only have to put the new stuff here.
  // New instance fields that store the center point of the circle
  public double cx, cy;

  // A new constructor method to initialize the new fields
  // It uses a special syntax to invoke the Circle() constructor
  public PlaneCircle(double r, double x, double y) {
    super(r);       // Invoke the constructor of the superclass, Circle()
    this.cx = x;    // Initialize the instance field cx
    this.cy = y;    // Initialize the instance field cy
  }

  // The area() and circumference() methods are inherited from Circle
  // A new instance method that checks whether a point is inside the circle
  // Note that it uses the inherited instance field r
  public boolean isInside(double x, double y) {
    double dx = x - cx, dy = y - cy;             // Distance from center
    double distance = Math.sqrt(dx*dx + dy*dy);  // Pythagorean theorem
    return (distance < r);                       // Returns true or false
  }
}
```

Note the use of the keyword extends in the first line of Example 3-3. This keyword tells Java that PlaneCircle extends, or subclasses, Circle, meaning that it inherits the fields and methods of that class.[4] The definition of the isInside() method shows field inheritance; this method uses the field r (defined by the Circle class) as if it were defined right in PlaneCircle itself. PlaneCircle also inherits the methods of Circle. Thus, if we have a PlaneCircle object referenced by variable pc, we can say:

[4] C++ programmers should note that extends is the Java equivalent of : in C++; both are used to indicate the superclass of a class.

```
double ratio = pc.circumference() / pc.area();
```

This works just as if the area( ) and circumference() methods were defined in PlaneCircle itself.

Another feature of subclassing is that every PlaneCircle object is also a perfectly legal Circle object. If pc refers to a PlaneCircle object, we can assign it to a Circle variable and forget all about its extra positioning capabilities:

```
PlaneCircle pc = new PlaneCircle(1.0, 0.0, 0.0);  // Unit circle at the origin
Circle c = pc;     // Assigned to a Circle variable without casting
```

This assignment of a PlaneCircle object to a Circle variable can be done without a cast. As we discussed in Section 2.9.6 in Chapter 2 a widening conversion like this is always legal. The value held in the Circle variable c is still a valid PlaneCircle object, but the compiler cannot know this for sure, so it doesn't allow us to do the opposite (narrowing) conversion without a cast:

```
// Narrowing conversions require a cast (and a runtime check by the VM)
PlaneCircle pc2 = (PlaneCircle) c;
boolean origininside = ((PlaneCircle) c).isInside(0.0, 0.0);
```

3.5.1.1 Final classes

When a class is declared with the final modifier, it means that it cannot be extended or subclassed. java.lang.String is an example of a final class. Declaring a class final prevents unwanted extensions to the class: if you invoke a method on a String object, you know that the method is the one defined by the String class itself, even if the String is passed to you from some unknown outside source. Because String is final, no one can create a subclass of it and change the meaning or behavior of its methods.

Declaring a class final also allows the compiler to make certain optimizations when invoking the methods of a class. We'll explore this when we talk about method overriding later in this chapter.

3.5.2. Superclasses, Object, and the Class Hierarchy

In our example, PlaneCircle is a subclass from Circle. We can also say that Circle is the superclass of PlaneCircle. The superclass of a class is specified in its extends clause:

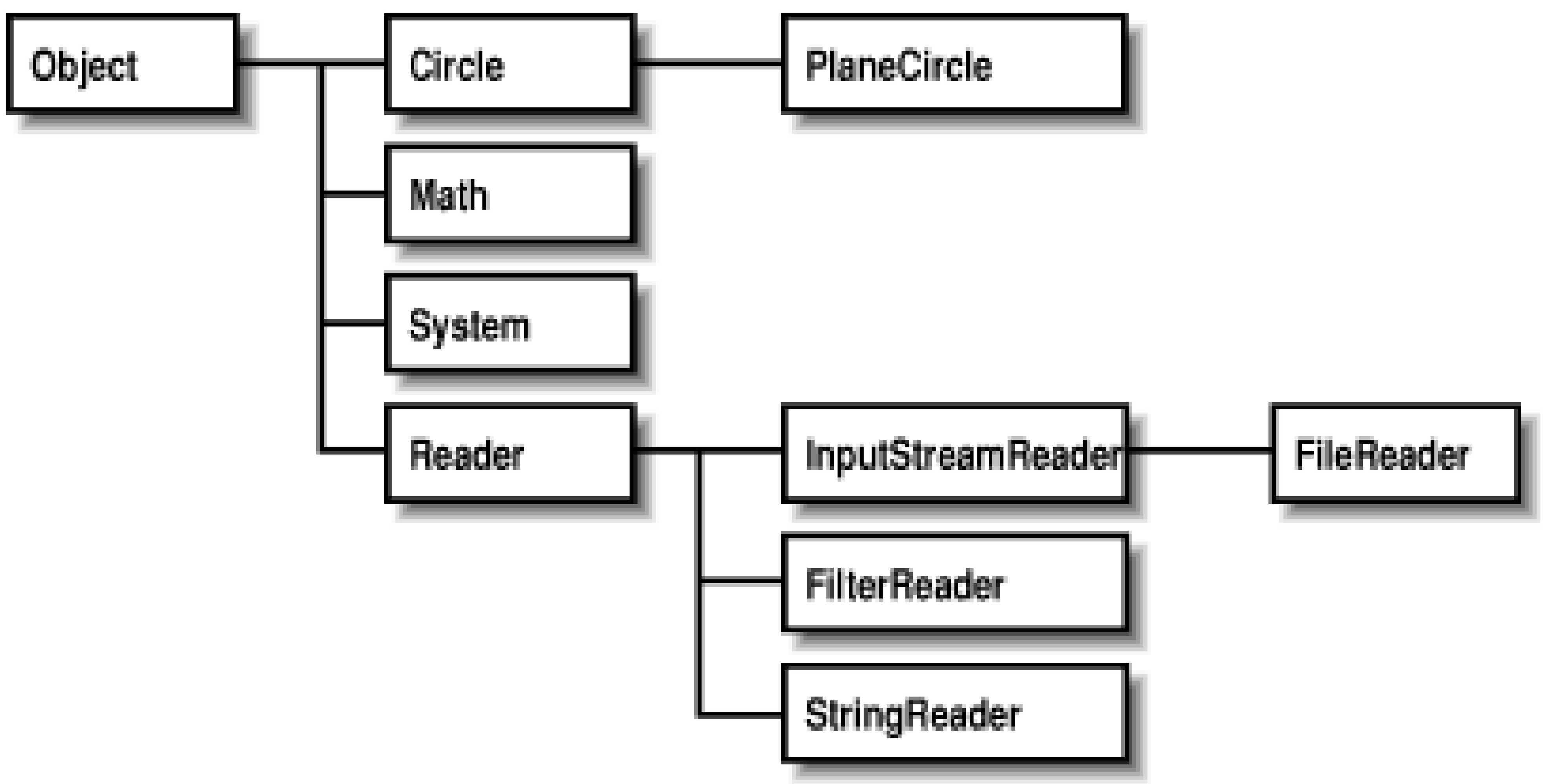
```
public class PlaneCircle extends Circle { ... }
```

Every class you define has a superclass. If you do not specify the superclass with an `extends` clause, the superclass is the class `java.lang.Object`. `Object` is a special class for a couple of reasons:

- It is the only class in Java that does not have a superclass.
- All Java classes inherit the methods of `Object`.

Because every class has a superclass, classes in Java form a class hierarchy, which can be represented as a tree with `Object` at its root. Figure 3-1 shows a partial class hierarchy diagram that includes our `Circle` and `PlaneCircle` classes, as well as some of the standard classes from the Java API.

Figure 3-1. A class hierarchy diagram



3.5.3. Subclass Constructors

Look again at the `PlaneCircle()` constructor method of Example 3-3:

```
public PlaneCircle(double r, double x, double y) {
  super(r);       // Invoke the constructor of the superclass, Circle()
  this.cx = x;    // Initialize the instance field cx
  this.cy = y;    // Initialize the instance field cy
}
```

This constructor explicitly initializes the `cx` and `cy` fields newly defined by `PlaneCircle`, but it relies on the superclass `Circle( )` constructor to initialize the inherited fields of the class. To invoke the superclass constructor, our constructor calls `super()`. `super` is a reserved word in Java. One of its uses is to invoke the constructor method of a superclass from within the constructor method of a subclass. This use is analogous to the use of `this( )` to invoke one constructor method of a class from within another constructor method of the same class. Invoking a constructor using `super()` is subject to the same restrictions as is using `this( )` :

- `super( )` can be used in this way only within a constructor method.
- The call to the superclass constructor must appear as the first statement within the constructor method, even before local variable declarations.

The arguments passed to `super( )` must match the parameters of the superclass constructor. If the superclass defines more than one constructor, `super( )` can be used to invoke any one of them, depending on the arguments passed.

3.5.4. Constructor Chaining and the Default Constructor

Java guarantees that the constructor method of a class is called whenever an instance of that class is created. It also guarantees that the constructor is called whenever an instance of any subclass is created. In order to guarantee this second point, Java must ensure that every constructor method calls its superclass constructor method. Thus, if the first statement in a constructor does not explicitly invoke another constructor with `this()` or `super( )`, Java implicitly inserts the call `super( )`, that is, it calls the superclass constructor with no arguments. If the superclass does not have a constructor that takes no arguments, this implicit invocation causes a compilation error.

Consider what happens when we create a new instance of the `PlaneCircle` class. First, the `PlaneCircle` constructor is invoked. This constructor explicitly calls `super(r)` to invoke a `Circle` constructor, and that `Circle()` constructor implicitly calls `super()` to invoke the constructor of its superclass, `Object`. The body of the `Object` constructor runs first. When it returns, the body of the `Circle( )` constructor runs. Finally, when the call to `super(r)` returns, the remaining statements of the `PlaneCircle( )` constructor are executed.

What all this means is that constructor calls are chained; any time an object is created, a sequence of constructor methods is invoked, from subclass to superclass on up to `Object` at the root of the class hierarchy. Because a superclass constructor is always invoked as the first statement of its subclass constructor, the body of the `Object` constructor always runs first, followed by the constructor of its subclass and on down the class hierarchy to the class that is being instantiated. There is an important implication here; when a constructor is invoked, it can count on the fields of its superclass to be initialized.

3.5.4.1 The default constructor

There is one missing piece in the previous description of constructor chaining. If a constructor does not invoke a superclass constructor, Java does so implicitly. But what if a class is declared without a constructor? In this case, Java implicitly adds a constructor to the class. This default constructor does nothing but invoke the superclass constructor. For example, if we don't declare a constructor for the `PlaneCircle` class, Java implicitly inserts this constructor:

```
public PlaneCircle() { super(); }
```

If the superclass, `Circle`, doesn't declare a no-argument constructor, the `super( )` call in this automatically inserted default constructor for `PlaneCircle( )` causes a compilation error. In general, if a class does not define a no-argument constructor, all its subclasses must define constructors that explicitly invoke the superclass constructor with the necessary arguments.

If a class does not declare any constructors, it is given a no-argument constructor by default. Classes declared `public` are given `public` constructors. All other classes are given a default constructor that is declared without any visibility modifier: such a constructor has default visibility. (The notion of visibility is explained later in this chapter.) If you are creating a `public` class that should not be publicly instantiated, you should declare at least one non-`public` constructor to prevent the insertion of a default `public` constructor. Classes that should never be instantiated (such as `java.lang.Math` or `java.lang.System`) should define a `private` constructor. Such a constructor can never be invoked from outside of the class, but it prevents the automatic insertion of the default constructor.

3.5.4.2 Finalizer chaining?

You might assume that since Java chains constructor methods, it also automatically chains the finalizer methods for an object. In other words, you might assume that the finalizer method of a class automatically invokes the finalizer of its superclass, and so on. In fact, Java does *not* do this. When you write a `finalize()` method, you must explicitly invoke the superclass finalizer. (You should do this even if you know that the superclass does not have a finalizer because a future implementation of the superclass might add a finalizer.)

As we saw in our example finalizer earlier in the chapter, you can invoke a superclass method with a special syntax that uses the `super` keyword:

```
// Invoke the finalizer of our superclass
super.finalize();
```

We'll discuss this syntax in more detail when we consider method overriding. In practice, the need for finalizer methods, and thus finalizer chaining, rarely arises.

3.5.5. Hiding Superclass Fields

For the sake of example, imagine that our `PlaneCircle` class needs to know the distance between the center of the circle and the origin (0,0). We can add another instance field to hold this value:

```
public double r;
```

Adding the following line to the constructor computes the value of the field:

```
this.r = Math.sqrt(cx*cx + cy*cy);  // Pythagorean theorem
```

But wait; this new field `r` has the same name as the radius field `r` in the `Circle` superclass. When this happens, we say that the field `r` of `PlaneCircle` *hides* the field `r` of `Circle`. (This is a contrived example, of course: the new field should really be called `distanceFromOrigin`. Although you should attempt to avoid it, subclass fields do sometimes hide fields of their superclass.)

With this new definition of PlaneCircle, the expressions r and this.r both refer to the field of PlaneCircle. How, then, can we refer to the field r of Circle that holds the radius of the circle? A special syntax for this uses the super keyword:

```
r        // Refers to the PlaneCircle field
this.r   // Refers to the PlaneCircle field
super.r  // Refers to the Circle field
```

Another way to refer to a hidden field is to cast this (or any instance of the class) to the appropriate superclass and then access the field:

```
((Circle) this).r   // Refers to field r of the Circle class
```

This casting technique is particularly useful when you need to refer to a hidden field defined in a class that is not the immediate superclass. Suppose, for example, that classes A, B, and C all define a field named x and that C is a subclass of B, which is a subclass of A. Then, in the methods of class C, you can refer to these different fields as follows:

```
x                // Field x in class C
this.x           // Field x in class C
super.x          // Field x in class B
((B)this).x      // Field x in class B
((A)this).x      // Field x in class A
super.super.x    // Illegal; does not refer to x in class A
```

You cannot refer to a hidden field x in the superclass of a superclass with super.super.x. This is not legal syntax.

Similarly, if you have an instance c of class C, you can refer to the three fields named x like this:

```
c.x              // Field x of class C
((B)c).x         // Field x of class B
((A)c).x         // Field x of class A
```

So far, we've been discussing instance fields. Class fields can also be hidden. You can use the same super syntax to refer to the hidden value of the field, but this is never necessary since you can always refer to a class field by prepending the name of the desired class. Suppose that the implementer of PlaneCircle decides that the Circle.PI field does not express to enough decimal places. She can define her own class field PI:

```
public static final double PI = 3.14159265358979323846;
```

Now, code in PlaneCircle can use this more accurate value with the expressions PI or PlaneCircle.PI. It can also refer to the old, less accurate value with the expressions super.PI and Circle.PI. Note, however, that the area( ) and circumference() methods inherited by

PlaneCircle are defined in the Circle class, so they use the value Circle.PI, even though that value is hidden now by PlaneCircle.PI.

3.5.6. Overriding Superclass Methods

When a class defines an instance method using the same name, return type, and parameters as a method in its superclass, that method *overrides* the method of the superclass. When the method is invoked for an object of the class, it is the new definition of the method that is called, not the superclass's old definition. In Java 5.0 and later, the return type of the overriding method may be a subclass of return type of the overridden method instead of being exactly the same type. This is known as a *covariant return* and is described in Section 2.6.5 in Chapter 2.

Method overriding is an important and useful technique in object-oriented programming. PlaneCircle does not override either of the methods defined by Circle, but suppose we define another subclass of Circle, named Ellipse.[5] In this case, it is important for Ellipse to override the area( ) and circumference() methods of Circle since the formulas used to compute the area and circumference of a circle do not work for ellipses.

[5] Mathematical purists may argue that since all circles are ellipses, Ellipse should be the superclass and Circle the subclass. A pragmatic engineer might counter that circles can be represented with fewer instance fields, so Circle objects should not be burdened by inheriting unnecessary fields from Ellipse. In any case, this is a useful example here.

The upcoming discussion of method overriding considers only instance methods. Class methods behave quite differently, and there isn't much to say. Like fields, class methods can be hidden by a subclass but not overridden. As noted earlier in this chapter, it is good programming style to always prefix a class method invocation with the name of the class in which it is defined. If you consider the class name part of the class method name, the two methods have different names, so nothing is actually hidden at all. It is, however, illegal for a class method to hide an instance method.

Before we go any further with the discussion of method overriding, you should understand the difference between method overriding and method overloading. As we discussed in Chapter 2, method overloading refers to the practice of defining multiple methods (in the same class) that have the same name but different parameter lists. This is very different from method overriding, so don't get them confused.

3.5.6.1 Overriding is not hiding

Although Java treats the fields and methods of a class analogously in many ways, method overriding is not like field hiding at all. You can refer to hidden fields simply by casting an object to an instance of the appropriate superclass, but you cannot invoke overridden instance methods with this technique. The following code illustrates this crucial difference:

```
class A {                          // Define a class named A
  int i = 1;                       // An instance field
  int f() { return i; }            // An instance method
  static char g() { return 'A'; }  // A class method
}

class B extends A {                // Define a subclass of A
```

```
  int i = 2;                         // Hides field i in class A
  int f() { return -i; }             // Overrides instance method f in class A
  static char g() { return 'B'; }  // Hides class method g() in class A
}

public class OverrideTest {
  public static void main(String args[]) {
    B b = new B();                 // Creates a new object of type B
    System.out.println(b.i);     // Refers to B.i; prints 2
    System.out.println(b.f());   // Refers to B.f(); prints -2
    System.out.println(b.g());   // Refers to B.g(); prints B
    System.out.println(B.g());   // This is a better way to invoke B.g()

    A a = (A) b;                   // Casts b to an instance of class A
    System.out.println(a.i);     // Now refers to A.i; prints 1
    System.out.println(a.f());   // Still refers to B.f(); prints -2
    System.out.println(a.g());   // Refers to A.g(); prints A
    System.out.println(A.g());   // This is a better way to invoke A.g()
  }
}
```

While this difference between method overriding and field hiding may seem surprising at first, a little thought makes the purpose clear. Suppose we are manipulating a bunch of `Circle` and `Ellipse` objects. To keep track of the circles and ellipses, we store them in an array of type `Circle[]`. (We can do this because `Ellipse` is a subclass of `Circle`, so all `Ellipse` objects are legal `Circle` objects.) When we loop through the elements of this array, we don't have to know or care whether the element is actually a `Circle` or an `Ellipse`. What we do care about very much, however, is that the correct value is computed when we invoke the `area()` method of any element of the array. In other words, we don't want to use the formula for the area of a circle when the object is actually an ellipse! Seen in this context, it is not surprising at all that method overriding is handled differently by Java than is field hiding.

3.5.6.2 Dynamic method lookup

If we have a `Circle[ ]` array that holds `Circle` and `Ellipse` objects, how does the compiler know whether to call the `area( )` method of the `Circle` class or the `Ellipse` class for any given item in the array? In fact, the compiler does not know this because it cannot know it. The compiler knows that it does not know, however, and produces code that uses dynamic method lookup at runtime. When the interpreter runs the code, it looks up the appropriate `area( )` method to call for each of the objects in the array. That is, when the interpreter interprets the expression `o.area()`, it checks the actual type of the object referred to by the variable `o` and then finds the `area( )` method that is appropriate for that type. It does not simply use the `area( )` method that is statically associated with the type of the variable `o`. This process of dynamic method lookup is sometimes also called virtual method invocation.[6]

[6] C++ programmers should note that dynamic method lookup is what C++ does for `virtual` functions. An important difference between Java and C++ is that Java does not have a `virtual` keyword. In Java, methods are virtual by default.

3.5.6.3 Final methods and static method lookup

Virtual method invocation is fast, but method invocation is faster when no dynamic lookup is necessary at runtime. Fortunately, Java does not always need to use dynamic method lookup. In particular, if a method is declared with the `final` modifier, it means that the method definition is the final one; it cannot be overridden by any subclasses. If a method cannot be overridden, the compiler knows that there is only one version of the method, and dynamic method lookup is not necessary.[7] In addition, all methods of a `final` class are themselves implicitly final and cannot be overridden. As we'll discuss later in this chapter, `private` methods are not inherited by subclasses and, therefore, cannot be overridden (i.e., all `private` methods are implicitly `final`). Finally, class methods behave like fields (i.e., they can be hidden by subclasses but not overridden). Taken together, this means that all methods of a class that is declared `final`, as well as all methods that are `final`, `private`, or `static`, are invoked without dynamic method lookup. These methods are also candidates for inlining at runtime by a just-in-time compiler (JIT) or similar optimization tool.

[7] In this sense, the `final` modifier is the opposite of the `virtual` modifier in C++. All non-`final` methods in Java are `virtual`.

3.5.6.4 Invoking an overridden method

We've seen the important differences between method overriding and field hiding. Nevertheless, the Java syntax for invoking an overridden method is quite similar to the syntax for accessing a hidden field: both use the `super` keyword. The following code illustrates:

```
class A {
  int i = 1;                  // An instance field hidden by subclass B
  int f() { return i; }       // An instance method overridden by subclass B
}

class B extends A {
  int i;                      // This field hides i in A
  int f() {                   // This method overrides f() in A
    i = super.i + 1;          // It can retrieve A.i like this
    return super.f() + i;     // It can invoke A.f() like this
  }
}
```

Recall that when you use `super` to refer to a hidden field, it is the same as casting `this` to the superclass type and accessing the field through that. Using `super` to invoke an overridden method, however, is not the same as casting `this`. In other words, in the previous code, the expression `super.f()` is not the same as `((A)this).f( )`.

When the interpreter invokes an instance method with this `super` syntax, a modified form of dynamic method lookup is performed. The first step, as in regular dynamic method lookup, is to determine the actual class of the object through which the method is invoked. Normally, the dynamic search for an appropriate method definition would begin with this class. When a method is invoked with the `super` syntax, however, the search begins at the superclass of the class. If the superclass implements the method directly, that version of the method is invoked. If the superclass inherits the method, the inherited version of the method is invoked.

Note that the `super` keyword invokes the most immediately overridden version of a method. Suppose class `A` has a subclass `B` that has a subclass `C` and that all three classes define the same method `f( )`. The method `C.f()` can invoke the method `B.f( )`, which it overrides directly, with `super.f( )`. But there is no way for `C.f()` to invoke `A.f( )` directly: `super.super.f( )` is not legal Java syntax. Of course, if `C.f()` invokes `B.f( )`, it is reasonable to suppose that `B.f( )` might also invoke `A.f()`. This kind of chaining is relatively common when working with overridden methods: it is a way of augmenting the behavior of a method without replacing the method entirely. We saw this technique in the the example `finalize()` method shown earlier in the chapter: that method invoked `super.finalize()` to run its superclass finalization method.

Don't confuse the use of `super` to invoke an overridden method with the `super()` method call used in constructor methods to invoke a superclass constructor. Although they both use the same keyword, these are two entirely different syntaxes. In particular, you can use `super` to invoke an overridden method anywhere in the overriding class while you can use `super()` only to invoke a superclass constructor as the very first statement of a constructor.

It is also important to remember that `super` can be used only to invoke an overridden method from within the class that overrides it. Given an `Ellipse` object `e`, there is no way for a program that uses an object (with or without the `super` syntax) to invoke the `area()` method defined by the `Circle` class on this object.

3.6. Data Hiding and Encapsulation

We started this chapter by describing a class as a collection of data and methods. One of the important object-oriented techniques we haven't discussed so far is hiding the data within the class and making it available only through the methods. This technique is known as *encapsulation* because it seals the data (and internal methods) safely inside the "capsule" of the class, where it can be accessed only by trusted users (i.e., the methods of the class).

Why would you want to do this? The most important reason is to hide the internal implementation details of your class. If you prevent programmers from relying on those details, you can safely modify the implementation without worrying that you will break existing code that uses the class.

Another reason for encapsulation is to protect your class against accidental or willful stupidity. A class often contains a number of interdependent fields that must be in a consistent state. If you allow a programmer (including yourself) to manipulate those fields directly, he may change one field without changing important related fields, leaving the class in an inconsistent state. If instead he has to call a method to change the field, that method can be sure to do everything necessary to keep the state consistent. Similarly, if a class defines certain methods for internal use only, hiding these methods prevents users of the class from calling them.

Here's another way to think about encapsulation: when all the data for a class is hidden, the methods define the only possible operations that can be performed on objects of that class. Once you have carefully tested and debugged your methods, you can be confident that the class will work as expected. On the other hand, if all the fields of the class can be directly manipulated, the number of possibilities you have to test becomes unmanageable.

Other reasons to hide fields and methods of a class include:

- Internal fields and methods that are visible outside the class just clutter up the API. Keeping visible fields to a minimum keeps your class tidy and therefore easier to use and understand.
- If a field or method is visible to the users of your class, you have to document it. Save yourself time and effort by hiding it instead.

3.6.1. Access Control

All the fields and methods of a class can always be used within the body of the class itself. Java defines access control rules that restrict members of a class from being used outside the class. In a number of examples in this chapter, you've seen the `public` modifier used in field and method declarations. This `public` keyword, along with `protected` and `private`, are *access control modifiers* ; they specify the access rules for the field or method.

3.6.1.1 Access to packages

A package is always accessible to code defined within the package. Whether it is accessible to code from other packages depends on the way the package is deployed on the host system. When the class files that comprise a package are stored in a directory, for example, a user must have read access to the directory and the files within it in order to have access to the package. Package access is not part of the Java language itself. Access control is usually done at the level of classes and members of classes instead.

3.6.1.2 Access to classes

By default, top-level classes are accessible within the package in which they are defined. However, if a top-level class is declared `public`, it is accessible everywhere (or everywhere that the package itself is accessible). The reason that we've restricted these statements to top-level classes is that, as we'll see later in this chapter, classes can also be defined as members of other classes. Because these inner classes are members of a class, they obey the member access-control rules.

3.6.1.3 Access to members

The members of a class are always accessible within the body of the class. By default, members are also accessible throughout the package in which the class is defined. This implies that classes placed in the same package should trust each other with their internal implementation details. This default level of access is often called *package access*. It is only one of four possible levels of access. The other three levels of access are defined by the `public`, `protected`, and `private` modifiers. Here is some example code that uses these modifiers:

```
public class Laundromat {       // People can use this class.
  private Laundry[] dirty;      // They cannot use this internal field,
  public void wash() { ... }    // but they can use these public methods
  public void dry() { ... }     // to manipulate the internal field.
  protected int temperature;    // A subclass might want to tweak this field
}
```

These access rules apply to members of a class:

- If a member of a class is declared with the `public` modifier, it means that the member is accessible anywhere the containing class is accessible. This is the least restrictive type of access control.
- If a member of a class is declared `private`, the member is never accessible, except within the class itself. This is the most restrictive type of access control.
- If a member of a class is declared `protected`, it is accessible to all classes within the package (the same as the default package accessibility) and also accessible within the body of any subclass of the class, regardless of the package in which that subclass is defined. This is more restrictive than `public` access, but less restrictive than package access.
- If a member of a class is not declared with any of these modifiers, it has the default package access: it is accessible to code within all classes that are defined in the same package but

inaccessible outside of the package.

`protected` access requires a little more elaboration. Suppose class `A` declares a `protected` field `x` and is extended by a class `B`, which is defined in a different package (this last point is important). Class `B` inherits the `protected` field `x`, and its code can access that field in the current instance of `B` or in any other instances of `B` that the code can refer to. This does not mean, however, that the code of class `B` can start reading the protected fields of arbitrary instances of `A`! If an object is an instance of `A` but is not an instance of `B`, its fields are obviously not inherited by `B`, and the code of class `B` cannot read them.

3.6.1.4 Access control and inheritance

The Java specification states that a subclass inherits all the instance fields and instance methods of its superclass accessible to it. If the subclass is defined in the same package as the superclass, it inherits all non-`private` instance fields and methods. If the subclass is defined in a different package however, it inherits all `protected` and `public` instance fields and methods. `private` fields and methods are never inherited; neither are class fields or class methods. Finally, constructors are not inherited; they are chained, as described earlier in this chapter.

The statement that a subclass does not inherit the inaccessible fields and methods of its superclass can be a confusing one. It would seem to imply that when you create an instance of a subclass, no memory is allocated for any `private` fields defined by the superclass. This is not the intent of the statement, however. Every instance of a subclass does, in fact, include a complete instance of the superclass within it, including all inaccessible fields and methods. It is simply a matter of terminology Because the inaccessible fields cannot be used in the subclass, we say they are not inherited. Earlier in this section we said that the members of a class are always accessible within the body of the class If this statement is to apply to all members of the class, including inherited members, we must defin "inherited members" to include only those members that are accessible. If you don't care for this definition, you can think of it this way instead:

- A class inherits *all* instance fields and instance methods (but not constructors) of its superclass.
- The body of a class can always access all the fields and methods it declares itself. It can also access the *accessible* fields and members it inherits from its superclass.

3.6.1.5 Member access summary

Table 3-1 summarizes the member access rules.

Table 3-1. Class member accessibility

	Member visibility			
Accessible to	Public	Protected	Package	Private
Defining class	Yes	Yes	Yes	Yes

	Member visibility			
Accessible to	Public	Protected	Package	Private
Class in same package	Yes	Yes	Yes	No
Subclass in different package	Yes	Yes	No	No
Non-subclass different package	Yes	No	No	No

Here are some simple rules of thumb for using visibility modifiers:

- Use `public` only for methods and constants that form part of the public API of the class. Certain important or frequently used fields can also be `public`, but it is common practice to make fields non-`public` and encapsulate them with `public` accessor methods.
- Use `protected` for fields and methods that aren't required by most programmers using the class but that may be of interest to anyone creating a subclass as part of a different package. Note that `protected` members are technically part of the exported API of a class. They should be documented and cannot be changed without potentially breaking code that relies on them.
- Use the default package visibility for fields and methods that are internal implementation details but are used by cooperating classes in the same package. You cannot take real advantage of package visibility unless you use the `package` directive to group your cooperating classes into a package.
- Use `private` for fields and methods that are used only inside the class and should be hidden everywhere else.

If you are not sure whether to use `protected`, package, or `private` accessibility, it is better to start with overly restrictive member access. You can always relax the access restrictions in future versions of your class, if necessary. Doing the reverse is not a good idea because increasing access restrictions is not a backward-compatible change and can break code that relies on access tothose members.

3.6.2. Data Accessor Methods

In the `Circle` example, we declared the circle radius to be a `public` field. The `Circle` class is one in which it may well be reasonable to keep that field publicly accessible; it is a simple enough class, with no dependencies between its fields. On the other hand, our current implementation of the class allows a `Circle` object to have a negative radius, and circles with negative radii should simply not exist. As long as the radius is stored in a `public` field, however, any programmer can set the field to any value she wants, no matter how unreasonable. The only solution is to restrict the programmer's direct access to the field and define `public` methods that provide indirect access to the field. Providing `public` methods to read and write a field is not the same as making the field itself `public`. The crucial difference is that methods can perform error checking.

Example 3-4 shows how we might reimplement `Circle` to prevent circles with negative radii. This version of `Circle` declares the `r` field to be `protected` and defines accessor methods named getradius( ) and setRadius() to read and write the field value while enforcing the restriction on negative radius values. Because the r field is protected, it is directly (and more efficiently) accessible to subclasses.

Example 3-4. The Circle class using data hiding and encapsulation

```
package shapes;           // Specify a package for the class

public class Circle {     // The class is still public
  // This is a generally useful constant, so we keep it public
  public static final double PI = 3.14159;

  protected double r;     // Radius is hidden but visible to subclasses

  // A method to enforce the restriction on the radius
  // This is an implementation detail that may be of interest to subclasses
  protected void checkRadius(double radius) {
    if (radius < 0.0)
      throw new IllegalArgumentException("radius may not be negative.");
  }

  // The constructor method
  public Circle(double r) {
    checkRadius(r);
    this.r = r;
  }

  // Public data accessor methods
  public double getRadius() { return r; }
  public void setRadius(double r) {
    checkRadius(r);
    this.r = r;
  }

  // Methods to operate on the instance field
  public double area() { return PI * r * r; }
  public double circumference() { return 2 * PI * r; }
}
```

We have defined the Circle class within a package named shapes. Since r is protected, any other classes in the shapes package have direct access to that field and can set it however they like. The assumption here is that all classes within the shapes package were written by the same author or a closely cooperating group of authors and that the classes all trust each other not to abuse their privileged level of access to each other's implementation details.

Finally, the code that enforces the restriction against negative radius values is itself placed within a protected method, checkRadius(). Although users of the Circle class cannot call this method, subclasses of the class can call it and even override it if they want to change the restrictions on the radius.

Note particularly the getradius() and setRadius( ) methods of Example 3-4. It is a common convention in Java that data accessor methods begin with the prefixes "get" and "set." If the field being accessed is of type boolean, however, the get() method may be replaced with an equivalent method that begins with "is." For example, the accessor method for a boolean field named readable is typically called isReadable( ) instead of getreadable(). In the programming conventions of the JavaBeans component model (covered in Chapter 7), a hidden field with one or more data accessor methods whose names begin with "get," "is," or "set" is called a *property*. An interesting way to study a complex class is to look at the set of properties it defines. Properties are particularly common in the AWT and Swing APIs, which are covered in *Java Foundation Classes in a Nutshell* (O'Reilly).

Team LiB

3.7. Abstract Classes and Methods

In Example 3-4, we declared our `Circle` class to be part of a package named `shapes`. Suppose we plan to implement a number of shape classes: `Rectangle`, `Square`, `Ellipse`, `triangle`, and so on. We can give these shape classes our two basic `area( )` and `circumference()` methods. Now, to make it easy to work with an array of shapes, it would be helpful if all our shape classes had a common superclass, `Shape`. If we structure our class hierarchy this way, every shape object, regardless of the actual type of shape it represents, can be assigned to variables, fields, or array elements of type `Shape`. We want the `Shape` class to encapsulate whatever features all our shapes have in common (e.g., the `area()` and `circumference( )` methods). But our generic `Shape` class doesn't represent any real kind of shape, so it cannot define useful implementations of the methods. Java handles this situation with *abstract methods*.

Java lets us define a method without implementing it by declaring the method with the `abstract` modifier. An `abstract` method has no body; it simply has a signature definition followed by a semicolon.[8] Here are the rules about `abstract` methods and the `abstract` classes that contain them:

[8] An `abstract` method in Java is something like a pure virtual function in C++ (i.e., a virtual function that is declared `= 0`). In C++, a class that contains a pure virtual function is called an abstract class and cannot be instantiated. The same is true of Java classes that contain `abstract` methods.

- Any class with an `abstract` method is automatically `abstract` itself and must be declared as such.
- An `abstract` class cannot be instantiated.
- A subclass of an `abstract` class can be instantiated only if it overrides each of the `abstract` methods of its superclass and provides an implementation (i.e., a method body) for all of them. Such a class is often called a *concrete* subclass, to emphasize the fact that it is not `abstract`.
- If a subclass of an `abstract` class does not implement all the `abstract` methods it inherits, that subclass is itself `abstract` and must be declared as such.
- `static`, `private`, and `final` methods cannot be `abstract` since these types of methods cannot be overridden by a subclass. Similarly, a `final` class cannot contain any `abstract` methods.
- A class can be declared `abstract` even if it does not actually have any `abstract` methods. Declaring such a class `abstract` indicates that the implementation is somehow incomplete and is meant to serve as a superclass for one or more subclasses that complete the implementation Such a class cannot be instantiated.

There is an important feature of the rules of `abstract` methods. If we define the `Shape` class to have `abstract area()` and `circumference( )` methods, any subclass of `Shape` is required to provide implementations of these methods so that it can be instantiated. In other words, every `Shape` object is guaranteed to have implementations of these methods defined. Example 3-5 shows how this might work. It defines an `abstract Shape` class and two concrete subclasses of it.

Example 3-5. An abstract class and concrete subclasses

```
public abstract class Shape {
  public abstract double area();            // Abstract methods: note
  public abstract double circumference();   // semicolon instead of body.
}

class Circle extends Shape {
  public static final double PI = 3.14159265358979323846;
  protected double r;                              // Instance data
  public Circle(double r) { this.r = r; }          // Constructor
  public double getRadius() { return r; }          // Accessor
  public double area() { return PI*r*r; }          // Implementations of
  public double circumference() { return 2*PI*r; } // abstract methods.
}

class Rectangle extends Shape {
  protected double w, h;                               // Instance data
  public Rectangle(double w, double h) {               // Constructor
    this.w = w;  this.h = h;
  }
  public double getWidth() { return w; }               // Accessor method
  public double getHeight() { return h; }              // Another accessor
  public double area() { return w*h; }                 // Implementations of
  public double circumference() { return 2*(w + h); }  // abstract methods.
}
```

Each abstract method in Shape has a semicolon right after its parentheses. They have no curly braces, and no method body is defined. Using the classes defined in Example 3-5, we can now write code such as:

```
Shape[] shapes = new Shape[3];          // Create an array to hold shapes
shapes[0] = new Circle(2.0);            // Fill in the array
shapes[1] = new Rectangle(1.0, 3.0);
shapes[2] = new Rectangle(4.0, 2.0);

double total_area = 0;
for(int i = 0; i < shapes.length; i++)
    total_area += shapes[i].area();     // Compute the area of the shapes
```

Notice two important points here:

- Subclasses of Shape can be assigned to elements of an array of Shape. No cast is necessary. This is another example of a widening reference type conversion (discussed in Chapter 2).
- You can invoke the area( ) and circumference() methods for any Shape object, even though the Shape class does not define a body for these methods. When you do this, the method to be

invoked is found using dynamic method lookup, so the area of a circle is computed using the method defined by `Circle`, and the area of a rectangle is computed using the method defined by `Rectangle`.

Team LiB

3.8. Important Methods of java.lang.Object

As we've noted, all classes extend, directly or indirectly, `java.lang.Object`. This class defines several important methods that you should consider overriding in every class you write. Example 3-6 shows a class that overrides these methods. The sections that follow the example document the default implementation of each method and explain why you might want to override it. You may also find it helpful to look up `Object` in the reference section for an API listing.

Some of the syntax in Example 3-6 may be unfamiliar to you. The example uses two Java 5.0 features. First, it implements a parameterized, or generic, version of the `Comparable` interface. Second, the example uses the `@Override` annotation to emphasize (and have the compiler verify) that certain methods override `Object`. Parameterized types and annotations are covered in Chapter 4.

Example 3-6. A class that overrides important Object methods

```
// This class represents a circle with immutable position and radius.
public class Circle implements Comparable<Circle> {
    // These fields hold the coordinates of the center and the radius.
    // They are private for data encapsulation and final for immutability
    private final int x, y, r;

    // The basic constructor: initialize the fields to specified values
    public Circle(int x, int y, int r) {
        if (r < 0) throw new IllegalArgumentException("negative radius");
        this.x = x; this.y = y; this.r = r;
    }

    // This is a "copy constructor"--a useful alternative to clone()
    public Circle(Circle original) {
        x = original.x;   // Just copy the fields from the original
        y = original.y;
        r = original.r;
    }

    // Public accessor methods for the private fields.
    // These are part of data encapsulation.
    public int getX() { return x; }
    public int getY() { return y; }
    public int getR() { return r; }

    // Return a string representation
    @Override public String toString() {
        return String.format("center=(%d,%d); radius=%d", x, y, r);
    }
```

```
    // Test for equality with another object
    @Override public boolean equals(Object o) {
        if (o == this) return true;               // Identical references?
        if (!(o instanceof Circle)) return false; // Correct type and non-null?
        Circle that = (Circle) o;                 // Cast to our type
        if (this.x == that.x && this.y == that.y && this.r == that.r)
            return true;                          // If all fields match
        else
            return false;                         // If fields differ
    }

    // A hash code allows an object to be used in a hash table.
    // Equal objects must have equal hash codes.  Unequal objects are allowed
    // to have equal hash codes as well, but we try to avoid that.
    // We must override this method since we also override equals().
    @Override public int hashCode() {
        int result = 17;          // This hash code algorithm from the book
        result = 37*result + x;   // _Effective Java_, by Joshua Bloch
        result = 37*result + y;
        result = 37*result + r;
        return result;
    }

    // This method is defined by the Comparable interface.
    // Compare this Circle to that Circle.  Return a value < 0 if this < that.
    // Return 0 if this == that. Return a value > 0 if this > that.
    // Circles are ordered top to bottom, left to right, and then by radius
    public int compareTo(Circle that) {
        long result = that.y - this.y;  // Smaller circles have bigger y values
        if (result == 0) result = this.x - that.x;  // If same compare l-to-r
        if (result == 0) result = this.r - that.r;  // If same compare radius

        // We have to use a long value for subtraction because the differences
        // between a large positive and large negative value could overflow
        // an int. But we can't return the long, so return its sign as an int.
        return Long.signum(result);  // new in Java 5.0
    }
}
```

3.8.1. toString()

The purpose of the `toString( )` method is to return a textual representation of an object. The method is invoked automatically on objects during string concatenation and by methods such as `System.out.println( )`. Giving objects a textual representation can be quite helpful for debugging or logging output, and a well-crafted `toString()` method can even help with tasks such as report generation.

The version of `toString()` inherited from `Object` returns a string that includes the name of the class of the object as well as a hexadecimal representation of the `hashCode()` value of the object (discussed later in this chapter). This default implementation provides basic type and identity information for an object but is not usually very useful. The toString( ) method in Example 3-6 instead returns a human-readable string that includes the value of each of the fields of the Circle class.

3.8.2. equals( )

The = = operator tests two references to see if they refer to the same object. If you want to test whether two distinct objects are equal to one another, you must use the equals() method instead. Any class can define its own notion of equality by overriding equals(). The Object.equals( ) method simply uses the == operator: this default method considers two objects equal only if they are actually the very same object.

The equals( ) method in Example 3-6 considers two distinct Circle objects to be equal if their fields are all equal. Note that it first does a quick identity test with = = as an optimization and then checks the type of the other object with instanceof: a Circle can be equal only to another Circle, and it is not acceptable for an equals() method to throw a ClassCastException. Note that the instanceof test also rules out null arguments: instanceof always evaluates to false if its left-hand operand is null.

3.8.3. hashCode( )

Whenever you override equals( ), you must also override hashCode( ) . This method returns an integer for use by hash table data structures. It is critical that two objects have the same hash code if they are equal according to the equals() method. It is important (for efficient operation of hash tables) but not required that unequal objects have unequal hash codes, or at least that unequal objects are unlikely to share a hash code. This second criterion can lead to hashCode() methods that involve mildly tricky arithmetic or bit-manipulation.

The Object.hashCode() method works with the Object.equals( ) method and returns a hash code based on object identity rather than object equality. (If you ever need an identity-based hash code, you can access the functionality of Object.hashCode() through the static method System.identityHashCode( ).) When you override equals( ), you must always override hashCode() to guarantee that equal objects have equal hash codes. Since the equals( ) method in Example 3-6 bases object equality on the values of the three fields, the hashCode( ) method computes its hash code based on these three fields as well. It is clear from the code that if two Circle objects have the same field values, they will have the same hash code.

Note that the hashCode( ) method in Example 3-6 does not simply add the three fields and return their sum. Such an implementation would be legal but not efficient because two circles with the same radius but whose X and Y coordinates were reversed would then have the same hash code. The repeated multiplication and addition steps "spread out" the range of hash codes and dramatically reduce the likelihood that two unequal Circle objects have the same code. *Effective Java Programming Guide* by Joshua Bloch (Addison Wesley) includes a helpful recipe for constructing efficient hashCode() methods like this one.

3.8.4. Comparable.compareTo( )

Example 3-6 includes a compareTo( ) method. This method is defined by the java.lang.Comparable interface rather than by Object. (It actually uses the generics features of Java 5.0 and implements a parameterized version of the interface: Comparable<Circle>, but we can ignore that fact until Chapter 4.) The purpose of Comparable and its compareTo( ) method is to allow instances of a class to be compared to each other in the way that the <, <=, > and >= operators compare numbers. If a class implements Comparable, we can say that one instance is less than, greater than, or equal to another instance. Instances of a Comparable class can be sorted.

Since compareTo( ) is defined by an interface, the Object class does not provide any default implementation. It is up to each individual class to determine whether and how its instances should be ordered and to include a compareTo() method that implements that ordering. The ordering defined by Example 3-6 compares Circle objects as if they were words on a page. Circles are first ordered from top to bottom: circles with larger Y coordinates are less than circles with smaller Y coordinates. If two circles have the same Y coordinate, they are ordered from left to right. A circle with a smaller X coordinate is less than a circle with a larger X coordinate. Finally, if two circles have the same X and Y coordinates, they are compared by radius. The circle with the smaller radius is smaller. Notice that under this ordering, two circles are equal only if all three of their fields are equal This means that the ordering defined by compareTo() is consistent with the equality defined by equals(). This is very desirable (but not strictly required).

The compareTo( ) method returns an int value that requires further explanation. compareTo() should return a negative number if the this object is less than the object passed to it. It should return 0 if the two objects are equal. And compareTo() should return a positive number if this is greater than the method argument.

3.8.5. clone()

Object defines a method named clone() whose purpose is to return an object with fields set identically to those of the current object. This is an unusual method for two reasons. First, it works only if the class implements the java.lang.Cloneable interface. Cloneable does not define any methods, so implementing it is simply a matter of listing it in the implements clause of the class signature. The other unusual feature of clone() is that it is declared protected (see Section 3.6 earlier in this chapter). This means that subclasses of Object can call and override Object.clone(), but other code cannot call it. Therefore, if you want your object to be cloneable, you must implement Cloneable and override the clone() method, making it public.

The Circle class of Example 3-6 does not implement Cloneable; instead it provides a *copy constructor* for making copies of Circle objects:

```
Circle original = new Circle(1, 2, 3);  // regular constructor
Circle copy = new Circle(original);     // copy constructor
```

It can be difficult to implement clone( ) correctly, and it is usually easier and safer to provide a copy constructor. To make the Circle class cloneable, you would add Cloneable to the implements clause and add the following method to the class body:

```
@Override public Object clone() {
    try { return super.clone(); }
    catch(CloneNotSupportedException e) { throw new AssertionError(e); }
}
```

See *Effective Java Programming Guide* by Joshua Bloch for a detailed discussion of the ins and outs of `clone()` and `Cloneable`.

Team LiB

3.9. Interfaces

Like a class, an *interface* defines a new reference type. Unlike classes, however, interfaces provide no implementation for the types they define. As its name implies, an interface specifies only an API: all of its methods are `abstract` and have no bodies. It is not possible to directly instantiate an interface and create a member of the interface type. Instead, a class must *implement* the interface to provide the necessary method bodies. Any instances of that class are members of both the type defined by the class and the type defined by the interface. Interfaces provide a limited but very powerful alternative to *multiple inheritance* .[9] Classes in Java can inherit members from only a single superclass, but they can implement any number of interfaces. Objects that do not share the same class or superclass may still be members of the same type by virtue of implementing the same interface.

[9] C++ supports multiple inheritance, but the ability of a class to have more than one superclass adds a lot of complexity to the language.

3.9.1. Defining an Interface

An interface definition is much like a class definition in which all the methods are abstract and the keyword `class` has been replaced with `interface`. For example, the following code shows the definition of an interface named `Centered`. A `Shape` class, such as those defined earlier in the chapter, might implement this interface if it wants to allow the coordinates of its center to be set and queried:

```
public interface Centered {
    void setCenter(double x, double y);
    double getCenterX();
    double getCenterY();
}
```

A number of restrictions apply to the members of an interface:

- An interface contains no implementation whatsoever. All methods of an interface are implicitly `abstract` and must have a semicolon in place of a method body. The `abstract` modifier is allowed but, by convention, is usually omitted. Since static methods may not be abstract, the methods of an interface may not be declared `static`.
- An interface defines a public API. All members of an interface are implicitly `public`, and it is conventional to omit the unnecessary `public` modifier. It is an error to define a `protected` or `private` method in an interface.
- An interface may not define any instance fields. Fields are an implementation detail, and an interface is a pure specification without any implementation. The only fields allowed in an interface definition are constants that are declared both `static` and `final`.

- An interface cannot be instantiated, so it does not define a constructor.
- Interfaces may contain nested types. Any such types are implicitly `public` and `static`. See Section 3.10 later in this chapter.

3.9.1.1 Extending interfaces

Interfaces may extend other interfaces, and, like a class definition, an interface definition may include an `extends` clause. When one interface extends another, it inherits all the abstract methods and constants of its superinterface and can define new abstract methods and constants. Unlike classes, however, the extends clause of an interface definition may include more than one superinterface. For example, here are some interfaces that extend other interfaces:

```
public interface Positionable extends Centered {
    void setUpperRightCorner(double x, double y);
    double getUpperRightX();
    double getUpperRightY();
}
public interface Transformable extends Scalable, Translatable, Rotatable {}
public interface SuperShape extends Positionable, Transformable {}
```

An interface that extends more than one interface inherits all the abstract methods and constants from each of those interfaces and can define its own additional abstract methods and constants. A class that implements such an interface must implement the abstract methods defined directly by the interface, as well as all the abstract methods inherited from all the superinterfaces.

3.9.2. Implementing an Interface

Just as a class uses `extends` to specify its superclass, it can use `implements` to name one or more interfaces it supports. `implements` is a Java keyword that can appear in a class declaration following the `extends` clause. `implements` should be followed by a comma-separated list of interfaces that the class implements.

When a class declares an interface in its `implements` clause, it is saying that it provides an implementation (i.e., a body) for each method of that interface. If a class implements an interface but does not provide an implementation for every interface method, it inherits those unimplemented `abstract` methods from the interface and must itself be declared `abstract`. If a class implements more than one interface, it must implement every method of each interface it implements (or be declared `abstract`).

The following code shows how we can define a `CenteredRectangle` class that extends the `Rectangle` class from earlier in the chapter and implements our `Centered` interface.

```
public class CenteredRectangle extends Rectangle implements Centered {
  // New instance fields
  private double cx, cy;

  // A constructor
```

```
  public CenteredRectangle(double cx, double cy, double w, double h) {
    super(w, h);
    this.cx = cx;
    this.cy = cy;
  }

  // We inherit all the methods of Rectangle but must
  // provide implementations of all the Centered methods.
  public void setCenter(double x, double y) { cx = x; cy = y; }
  public double getCenterX() { return cx; }
  public double getCenterY() { return cy; }
}
```

Suppose we implement `CenteredCircle` and `CenteredSquare` just as we have implemented this `CenteredRectangle` class. Since each class extends `Shape`, instances of the classes can be treated as instances of the `Shape` class, as we saw earlier. Since each class implements the `Centered` interface, instances can also be treated as instances of that type. The following code demonstrates how objects can be members of both a class type and an interface type:

```
Shape[] shapes = new Shape[3];          // Create an array to hold shapes

// Create some centered shapes, and store them in the Shape[]
// No cast necessary: these are all widening conversions
shapes[0] = new CenteredCircle(1.0, 1.0, 1.0);
shapes[1] = new CenteredSquare(2.5, 2, 3);
shapes[2] = new CenteredRectangle(2.3, 4.5, 3, 4);

// Compute average area of the shapes and average distance from the origin
double totalArea = 0;
double totalDistance = 0;
for(int i = 0; i < shapes.length; i++) {
  totalArea += shapes[i].area();       // Compute the area of the shapes
  if (shapes[i] instanceof Centered) { // The shape is a Centered shape
    // Note the required cast from Shape to Centered (no cast would
    // be required to go from CenteredSquare to Centered, however).
    Centered c = (Centered) shapes[i]; // Assign it to a Centered variable
    double cx = c.getCenterX();        // Get coordinates of the center
    double cy = c.getCenterY();        // Compute distance from origin
    totalDistance += Math.sqrt(cx*cx + cy*cy);
  }
}
System.out.println("Average area: " + totalArea/shapes.length);
System.out.println("Average distance: " + totalDistance/shapes.length);
```

This example demonstrates that interfaces are data types in Java, just like classes. When a class implements an interface, instances of that class can be assigned to variables of the interface type. Don't interpret this example to imply that you must assign a `CenteredRectangle` object to a `Centered` variable before you can invoke the `setCenter( )` method or to a `Shape` variable before you can invoke the `area()` method. `CenteredRectangle` defines `setCenter( )` and inherits `area()` from its `Rectangle` superclass, so you can always invoke these methods.

3.9.2.1 Implementing multiple interfaces

Suppose we want shape objects that can be positioned in terms of not only their center points but also their upper-right corners. And suppose we also want shapes that can be scaled larger and smaller. Remember that although a class can extend only a single superclass, it can implement any number of interfaces. Assuming we have defined appropriate `UpperRightCornered` and `Scalable` interfaces, we can declare a class as follows:

```
public class SuperDuperSquare extends Shape
    implements Centered, UpperRightCornered, Scalable {
   // Class members omitted here
}
```

When a class implements more than one interface, it simply means that it must provide implementations for all abstract methods in all its interfaces.

3.9.3. Interfaces vs. Abstract Classes

When defining an abstract type (e.g., `Shape`) that you expect to have many subtypes (e.g., `Circle`, `Rectangle`, `Square`), you are often faced with a choice between interfaces and abstract classes. Since they have similar features, it is not always clear which to use.

An interface is useful because any class can implement it, even if that class extends some entirely unrelated superclass. But an interface is a pure API specification and contains no implementation. If an interface has numerous methods, it can become tedious to implement the methods over and over especially when much of the implementation is duplicated by each implementing class.

An abstract class does not need to be entirely abstract; it can contain a partial implementation that subclasses can take advantage of. In some cases, numerous subclasses can rely on default method implementations provided by an abstract class. But a class that extends an abstract class cannot extend any other class, which can cause design difficulties in some situations.

Another important difference between interfaces and abstract classes has to do with compatibility. If you define an interface as part of a public API and then later add a new method to the interface, you break any classes that implemented the previous version of the interface. If you use an abstract class, however, you can safely add nonabstract methods to that class without requiring modifications to existing classes that extend the abstract class.

In some situations, it is clear that an interface or an abstract class is the right design choice. In other cases, a common design pattern is to use both. Define the type as a totally abstract interface, then create an abstract class that implements the interface and provides useful default implementations that subclasses can take advantage of. For example:

```
// Here is a basic interface. It represents a shape that fits inside
// of a rectangular bounding box. Any class that wants to serve as a
// RectangularShape can implement these methods from scratch.
public interface RectangularShape {
    void setSize(double width, double height);
```

```
    void setPosition(double x, double y);
    void translate(double dx, double dy);
    double area();
    boolean isInside();
}

// Here is a partial implementation of that interface. Many
// implementations may find this a useful starting point.
public abstract class AbstractRectangularShape implements RectangularShape {
    // The position and size of the shape
    protected double x, y, w, h;

    // Default implementations of some of the interface methods
    public void setSize(double width, double height) { w = width; h = height; }
    public void setPosition(double x, double y) { this.x = x; this.y = y; }
    public void translate (double dx, double dy) { x += dx; y += dy; }
}
```

3.9.4. Marker Interfaces

Sometimes it is useful to define an interface that is entirely empty. A class can implement this interface simply by naming it in its `implements` clause without having to implement any methods. In this case, any instances of the class become valid instances of the interface. Java code can check whether an object is an instance of the interface using the `instanceof` operator, so this technique is a useful way to provide additional information about an object.

The `java.io.Serializable` interface is a marker interface of this sort. A class implements `Serializable` interface to tell `ObjectOutputStream` that its instances may safely be serialized. `java.util.RandomAccess` is another example: `java.util.List` implementations implement this interface to advertise that they provide fast random access to the elements of the list. `ArrayList` implements `RandomAccess`, for example, while `LinkedList` does not. Algorithms that care about the performance of random-access operations can test for `RandomAccess` like this:

```
// Before sorting the elements of a long arbitrary list, we may want to make
// sure that the list allows fast random access.  If not, it may be quicker
// make a random-access copy of the list before sorting it.
// Note that this is not necessary when using java.util.Collections.sort().
List l = ...;  // Some arbitrary list we're given
if (l.size() > 2 && !(l instanceof RandomAccess))  l = new ArrayList(l);
sortListInPlace(l);
```

3.9.5. Interfaces and Constants

As noted earlier, constants can appear in an interface definition. Any class that implements an interface inherits the constants it defines and can use them as if they were defined directly in the class itself. Importantly, there is no need to prefix the constants with the name of the interface or provide any kind of implementation of the constants.

When a set of constants is used by more than one class, it is tempting to define the constants once in an interface and then have any classes that require the constants implement the interface. This situation might arise, for example, when client and server classes implement a network protocol whose details (such as the port number to connect to and listen on) are captured in a set of symbolic constants. As a concrete example, consider the `java.io.ObjectStreamConstants` interface, which defines constants for the object serialization protocol and is implemented by both `ObjectInputStream` and `ObjectOutputStream`.

The primary benefit of inheriting constant definitions from an interface is that it saves typing: you don't need to specify the type that defines the constants. Despite its use with `ObjectStreamConstants`, this is not a recommended technique. The use of constants is an implementation detail that is not appropriate to declare in the `implements` clause of a class signature.

A better approach is to define constants in a class and use the constants by typing the full class name and the constant name. In Java 5.0 and later, you can save typing by importing the constants from their defining class with the `import static` declaration. See Section 2.10 in Chapter 2 for details.

3.10. Nested Types

The classes, interfaces, and enumerated types we have seen so far in this book have all been defined as top-level classes. This means that they are direct members of packages, defined independently of other types. However, type definitions can also be nested within other type definitions. These *nested types*, commonly known as "inner classes," are a powerful and elegant feature of the Java language. A type can be nested within another type in four ways:

Static member types

A static member type is any type defined as a `static` member of another type. A `static` method is called a class method, so, by analogy, we could call this type of nested type a "class type," but this terminology would obviously be confusing. A static member type behaves much like an ordinary top-level type, but its name is part of the namespace, rather than the package of the containing type. Also, a static member type can access the `static` members of the class that contains it. Nested interfaces, enumerated types, and annotation types are implicitly static, whether or not the `static` keyword appears. Any type nested within an interface or annotation is also implicitly `static`. Static member types may be defined within top-level types or nested to any depth within other static member types. A static member type may not be defined within any other kind of nested type, however.

Nonstatic member classes

A "nonstatic member type" is simply a member type that is not declared `static`. Since interfaces, enumerated types, and annotations are always implicitly static, however, we usually use the term "nonstatic member class" instead. Nonstatic member classes may be defined within other classes or enumerated types and are analogous to instance methods or fields. An instance of a nonstatic member class is always associated with an instance of the enclosing type, and the code of a nonstatic member class has access to all the fields and methods (both `static` and non-`static`) of its enclosing type. Several features of Java syntax exist specifically to work with the enclosing instance of a nonstatic member class.

Local classes

A local class is a class defined within a block of Java code. Interfaces, enumerated types, and annotation types may not be defined locally. Like a local variable, a local class is visible only within the block in which it is defined. Although local classes are not member classes, they are still defined within an enclosing class, so they share many of the features of member classes. Additionally, however, a local class can access any `final` local variables or parameters that are accessible in the scope of the block that defines the class.

Anonymous classes

An anonymous class is a kind of local class that has no name; it combines the syntax for class definition with the syntax for object instantiation. While a local class definition is a Java statement, an anonymous class definition (and instantiation) is a Java expression, so it can appear as part of a larger expression, such as method invocation. Interfaces, enumerated types, and annotation types cannot be defined anonymously.

Nested types have no universally adopted nomenclature. The term "inner class" is commonly used. Sometimes, however, inner class is used to refer to a nonstatic member class, local class, or anonymous class, but not a static member type. Although the terminology for describing nested types is not always clear, the syntax for working with them is, and it is usually clear from context which kind of nested type is being discussed.

Now we'll describe each of the four kinds of nested types in greater detail. Each section describes the features of the nested type, the restrictions on its use, and any special Java syntax used with the type. These four sections are followed by an implementation note that explains how nested types work under the hood.

3.10.1. Static Member Types

A *static member type* is much like a regular top-level type. For convenience, however, it is nested within the namespace of another type. Example 3-7 shows a helper interface defined as a static member of a containing class. The example also shows how this interface is used both within the class that contains it and by external classes. Note the use of its hierarchical name in the external class.

Example 3-7. Defining and using a static member interface

```
// A class that implements a stack as a linked list
public class LinkedStack {
    // This static member interface defines how objects are linked
    // The static keyword is optional: all nested interfaces are static
    public static interface Linkable {
        public Linkable getNext();
        public void setNext(Linkable node);
    }

    // The head of the list is a Linkable object
    Linkable head;

    // Method bodies omitted
    public void push(Linkable node) { ... }
    public Object pop() { ... }
}

// This class implements the static member interface
```

```
class LinkableInteger implements LinkedStack.Linkable {
    // Here's the node's data and constructor
    int i;
    public LinkableInteger(int i) { this.i = i; }

    // Here are the data and methods required to implement the interface
    LinkedStack.Linkable next;
    public LinkedStack.Linkable getNext() { return next; }
    public void setNext(LinkedStack.Linkable node) { next = node; }
}
```

3.10.1.1 Features of static member types

A static member type is defined as a `static` member of a containing type. Any type (class, interface, enumerated type, or annotation type) may be defined as a static member of any other type. Interfaces, enumerated types, and annotation types are implicitly static, whether or not the `static` keyword appears in their definition.

A static member type is like the other static members of a class: static fields and static methods. Like a class method, a static member type is not associated with any instance of the containing class (i.e., there is no `this` object). A static member type does, however, have access to all the `static` members (including any other static member types) of its containing type. A static member type can use any other static member without qualifying its name with the name of the containing type.

A static member type has access to all static members of its containing type, including `private` members. The reverse is true as well: the methods of the containing type have access to all members of a static member type, including the `private` members. A static member type even has access to all the members of any other static member types, including the `private` members of those types.

Top-level types can be declared with or without the `public` modifier, but they cannot use the `private` and `protected` modifiers. Static member types, however, are members and can use any access control modifiers that other members of the containing type can. These modifiers have the same meanings for static member types as they do for other members of a type. In Example 3-7, the `Linkable` interface is declared `public`, so it can be implemented by any class that is interested in being stored on a `LinkedStack`. Recall that all members of interfaces (and annotation types) are implicitly `public`, so static member types nested within interfaces or annotation types cannot be `protected` or `private`.

3.10.1.2 Restrictions on static member types

A static member type cannot have the same name as any of its enclosing classes. In addition, static member types can be defined only within top-level types and other static member types. This is actually part of a larger prohibition against `static` members of any sort within member, local, and anonymous classes.

3.10.1.3 Syntax for static member types

In code outside the containing class, a static member type is named by combining the name of the outer type with the name of the inner type (e.g., `LinkedStack.Linkable`). You can use the `import` directive to import a static member type:

```
import pkg.LinkedStack.Linkable;  // Import a specific nested type
import pkg.LinkedStack.*;         // Import all nested types of LinkedStack
```

In Java 5.0 and later, you can also use the `import static` directive to import a static member type. See Section 2.10 in Chapter 2 for details on `import` and `import static`. Note that importing a nested type obscures the fact that that type is closely associated with its containing type, and it is no commonly done.

3.10.2. Nonstatic Member Classes

A *nonstatic member class* is a class that is declared as a member of a containing class or enumerated type without the `static` keyword. If a static member type is analogous to a class field or class method, a nonstatic member class is analogous to an instance field or instance method. Example 3-8 shows how a member class can be defined and used. This example extends the previous `LinkedStack` example to allow enumeration of the elements on the stack by defining an `iterator( )` method that returns an implementation of the `java.util.Iterator` interface. The implementation of this interface is defined as a member class. The example uses Java 5.0 generic type syntax in a couple of places, but this should not prevent you from understanding it. (Generics are covered in Chapter 4.)

Example 3-8. An iterator implemented as a member class

```
import java.util.Iterator;

public class LinkedStack {
    // Our static member interface
    public interface Linkable {
        public Linkable getNext();
        public void setNext(Linkable node);
    }

    // The head of the list
    private Linkable head;

    // Method bodies omitted here
    public void push(Linkable node) { ... }
    public Linkable pop() { ... }

    // This method returns an Iterator object for this LinkedStack
    public Iterator<Linkable> iterator() { return new LinkedIterator(); }

    // Here is the implementation of the Iterator interface,
    // defined as a nonstatic member class.
    protected class LinkedIterator implements Iterator<Linkable> {
```

```
        Linkable current;
        // The constructor uses the private head field of the containing class
        public LinkedIterator() { current = head; }
        // The following 3 methods are defined by the Iterator interface
        public boolean hasNext() {  return current != null; }
        public Linkable next() {
            if (current == null) throw new java.util.NoSuchElementException();
            Linkable value = current;
            current = current.getNext();
            return value;
        }
        public void remove() { throw new UnsupportedOperationException(); }
    }
}
```

Notice how the `LinkedIterator` class is nested within the `LinkedStack` class. Since `LinkedIterator` is a helper class used only within `LinkedStack`, there is real elegance to having it defined so close to where it is used by the containing class.

3.10.2.1 Features of member classes

Like instance fields and instance methods, every instance of a nonstatic member class is associated with an instance of the class in which it is defined. This means that the code of a member class has access to all the instance fields and instance methods (as well as the `static` members) of the containing class, including any that are declared `private`.

This crucial feature is illustrated in Example 3-8. Here is the `LinkedStack.LinkedIterator()` constructor again:

```
public LinkedIterator() { current = head; }
```

This single line of code sets the `current` field of the inner class to the value of the `head` field of the containing class. The code works as shown, even though `head` is declared as a `private` field in the containing class.

A nonstatic member class, like any member of a class, can be assigned one of three visibility levels: `public`, `protected`, or `private`. If none of these visibility modifiers is specified, the default package visibility is used. In Example 3-8, the `LinkedIterator` class is declared `protected`, so it is inaccessible to code (in a different package) that uses the `LinkedStack` class but is accessible to any class that subclasses `LinkedStack`.

3.10.2.2 Restrictions on member classes

Member classes have three important restrictions:

- A nonstatic member class cannot have the same name as any containing class or package. This is an important rule, one not shared by fields and methods.

- Nonstatic member classes cannot contain any static fields, methods, or types, except for constant fields declared both static and final. static members are top-level constructs not associated with any particular object while every member class is associated with an instance of its enclosing class. Defining a static top-level member within a member class that is not at the top level would cause confusion, so it is not allowed.
- Only classes may be defined as nonstatic members. Interfaces, enumerated types, and annotation types are all implicitly static, even if the static keyword is omitted.

3.10.2.3 Syntax for member classes

The most important feature of a member class is that it can access the instance fields and methods in its containing object. We saw this in the LinkedStack.LinkedIterator() constructor of Example 3-8:

```
public LinkedIterator() { current = head; }
```

In this example, head is a field of the LinkedStack class, and we assign it to the current field of the LinkedIterator class. What if we want to make these references explicit? We could try code like this:

```
public LinkedIterator() { this.current = this.head; }
```

This code does not compile, however. this.current is fine; it is an explicit reference to the current field in the newly created LinkedIterator object. It is the this.head expression that causes the problem; it refers to a field named head in the LinkedIterator object. Since there is no such field, the compiler generates an error. To solve this problem, Java defines a special syntax for explicitly referring to the containing instance of the this object. Thus, if we want to be explicit in our constructor, we can use the following syntax:

```
public LinkedIterator() { this.current = LinkedStack.this.head; }
```

The general syntax is *classname*.this, where *classname* is the name of a containing class. Note that member classes can themselves contain member classes, nested to any depth. Since no member class can have the same name as any containing class, however, the use of the enclosing class name prepended to this is a perfectly general way to refer to any containing instance. This syntax is needed only when referring to a member of a containing class that is hidden by a member of the same name in the member class.

3.10.2.3.1 Accessing superclass members of the containing class

When a class shadows or overrides a member of its superclass, you can use the keyword super to refer to the hidden member. This super syntax can be extended to work with member classes as well. On the rare occasion when you need to refer to a shadowed field f or an overridden method m of a superclass of a containing class C, use the following expressions:

```
C.super.f
C.super.m()
```

3.10.2.3.2 Specifying the containing instance

As we've seen, every instance of a member class is associated with an instance of its containing class. Look again at our definition of the iterator() method in Example 3-8:

```
public Iterator<Linkable> iterator() { return new LinkedIterator(); }
```

When a member class constructor is invoked like this, the new instance of the member class is automatically associated with the this object. This is what you would expect to happen and exactly what you want to occur in most cases. Occasionally, however, you may want to specify the containing instance explicitly when instantiating a member class. You can do this by preceding the new operator with a reference to the containing instance. Thus, the iterator() method shown earlier is shorthand for the following:

```
public Iterator<Linkable> iterator() { return this.new LinkedIterator(); }
```

Let's pretend we didn't define an iterator( ) method for LinkedStack. In this case, the code to obtain an LinkedIterator object for a given LinkedStack object might look like this:

```
LinkedStack stack = new LinkedStack();    // Create an empty stack
Iterator i = stack.new LinkedIterator();  // Create an Iterator for it
```

The containing instance implicitly specifies the containing class; it is a syntax error to explicitly specify the containing class name:

```
Iterator i = stack.new LinkedStack.LinkedIterator();  // Syntax error
```

One other special piece of Java syntax specifies an enclosing instance for a member class explicitly. Before we consider it, however, let me point out that you should rarely, if ever, need to use this syntax. It is one of the pathological cases that snuck into the language along with all the elegant features of nested types.

As strange as it may seem, it is possible for a top-level class to extend a member class. This means that the subclass does not have a containing instance, but its superclass does. When the subclass constructor invokes the superclass constructor, it must specify the containing instance. It does this by prepending the containing instance and a period to the super keyword. If we had not declared our LinkedIterator class to be a protected member of LinkedStack, we could subclass it. Although it is not clear why we would want to do so, we could write code like the following:

```
// A top-level class that extends a member class
class SpecialIterator extends LinkedStack.LinkedIterator {
  // The constructor must explicitly specify a containing instance
```

```
  // when invoking the superclass constructor.
  public SpecialIterator(LinkedStack s) { s.super(); }
    // Rest of class omitted...
}
```

3.10.2.4 Scope versus inheritance

We've just noted that a top-level class can extend a member class. With the introduction of nonstatic member classes, two separate hierarchies must be considered for any class. The first is the *inheritance hierarchy*, from superclass to subclass, that defines the fields and methods a member class inherits. The second is the *containment hierarchy*, from containing class to contained class, that defines a set of fields and methods that are in the scope of (and are therefore accessible to) the member class.

The two hierarchies are entirely distinct from each other; it is important that you do not confuse them. This should not be a problem if you refrain from creating naming conflicts, where a field or method in a superclass has the same name as a field or method in a containing class. If such a naming conflict does arise, however, the inherited field or method takes precedence over the field or method of the same name in the containing class. This behavior is logical: when a class inherits a field or method, that field or method effectively becomes part of that class. Therefore, inherited fields and methods are in the scope of the class that inherits them and take precedence over fields and methods by the same name in enclosing scopes.

A good way to prevent confusion between the class hierarchy and the containment hierarchy is to avoid deep containment hierarchies. If a class is nested more than two levels deep, it is probably going to cause more confusion than it is worth. Furthermore, if a class has a deep class hierarchy (i.e., it has many ancestors), consider defining it as a top-level class rather than as anonstatic member class.

3.10.3. Local Classes

A *local class* is declared locally within a block of Java code rather than as a member of a class. Only classes may be defined locally: interfaces, enumerated types and annotation types must be top-level or static member types. Typically, a local class is defined within a method, but it can also be defined within a static initializer or instance initializer of a class. Because all blocks of Java code appear within class definitions, all local classes are nested within containing classes. For this reason, local classes share many of the features of member classes. It is usually more appropriate, however, to think of them as an entirely separate kind of nested type. A local class has approximately the same relationship to a member class as a local variable has to an instance variable of a class.

The defining characteristic of a local class is that it is local to a block of code. Like a local variable, a local class is valid only within the scope defined by its enclosing block. If a member class is used only within a single method of its containing class, for example, there is usually no reason it cannot be coded as a local class rather than a member class. Example 3-9 shows how we can modify the `iterator()` method of the `LinkedStack` class so it defines `LinkedIterator` as a local class instead of a member class. By doing this, we move the definition of the class even closer to where it is used and hopefully improve the clarity of the code even further. For brevity, Example 3-9 shows only the `iterator( )` method, not the entire `LinkedStack` class that contains it.

Example 3-9. Defining and using a local class

```
// This method returns an Iterator object for this LinkedStack
public Iterator<Linkable> Iterator() {
    // Here's the definition of LinkedIterator as a local class
    class LinkedIterator implements Iterator<Linkable> {
        Linkable current;

        // The constructor uses the private head field of the containing class
        public LinkedIterator() { current = head; }
        // The following 3 methods are defined by the Iterator interface
        public boolean hasNext() {  return current != null; }
        public Linkable next() {
            if (current == null) throw new java.util.NoSuchElementException();
            Linkable value = current;
            current = current.getNext();
            return value;
        }
        public void remove() { throw new UnsupportedOperationException(); }
    }

    // Create and return an instance of the class we just defined
    return new LinkedIterator();
}
```

3.10.3.1 Features of local classes

Local classes have the following interesting features:

- Like member classes, local classes are associated with a containing instance and can access any members, including `private` members, of the containing class.
- In addition to accessing fields defined by the containing class, local classes can access any local variables, method parameters, or exception parameters that are in the scope of the local method definition and are declared `final`.

3.10.3.2 Restrictions on local classes

Local classes are subject to the following restrictions:

- The name of a local class is defined only within the block that defines it; it can never be used outside that block. (Note however that instances of a local class created within the scope of the class can continue to exist outside of that scope. This situation is described in more detail later in this section.)
- Local classes cannot be declared `public` , `protected`, `private`, or `static`. These modifiers are

for members of classes; they are not allowed with local variable declarations or local class declarations.

- Like member classes, and for the same reasons, local classes cannot contain static fields, methods, or classes. The only exception is for constants that are declared both static and final.
- Interfaces, enumerated types, and annotation types cannot be defined locally.
- A local class, like a member class, cannot have the same name as any of its enclosing classes.
- As noted earlier, a local class can use the local variables, method parameters, and even exception parameters that are in its scope but only if those variables or parameters are declared final. This is because the lifetime of an instance of a local class can be much longer than the execution of the method in which the class is defined. For this reason, a local class must have a private internal copy of all local variables it uses (these copies are automatically generated by the compiler). The only way to ensure that the local variable and the private copy are always the same is to insist that the local variable is final.

3.10.3.3 Syntax for local classes

In Java 1.0, only fields, methods, and classes could be declared final. The addition of local classes in Java 1.1 required a liberalization in the use of the final modifier. As of Java 1.1, final can be applied to local variables, method parameters, and even the exception parameter of a catch statement. The meaning of the final modifier remains the same in these new uses: once the local variable or parameter has been assigned a value, that value cannot be changed.

Instances of local classes, like instances of nonstatic member classes, have an enclosing instance that is implicitly passed to all constructors of the local class. Local classes can use the same this syntax as nonstatic member classes to refer explicitly to members of enclosing classes. Because local classes are never visible outside the blocks that define them, however, there is never a need to use the new and super syntax used by member classes to specify the enclosing instance explicitly.

3.10.3.4 Scope of a local class

In discussing nonstatic member classes, we saw that a member class can access any members inherited from superclasses and any members defined by its containing classes. The same is true for local classes, but local classes can also access final local variables and parameters. The following code illustrates the many fields and variables that may be accessible to a local class:

```
class A { protected char a = 'a'; }
class B { protected char b = 'b'; }

public class C extends A {
  private char c = 'c';         // Private fields visible to local class
  public static char d = 'd';
  public void createLocalObject(final char e)
  {
    final char f = 'f';
    int i = 0;                  // i not final; not usable by local class
```

```
    class Local extends B
    {
      char g = 'g';
      public void printVars()
      {
        // All of these fields and variables are accessible to this class
        System.out.println(g);  // (this.g) g is a field of this class
        System.out.println(f);  // f is a final local variable
        System.out.println(e);  // e is a final local parameter
        System.out.println(d);  // (C.this.d) d -- field of containing class
        System.out.println(c);  // (C.this.c) c -- field of containing class
        System.out.println(b);  // b is inherited by this class
        System.out.println(a);  // a is inherited by the containing class
      }
    }
    Local l = new Local();      // Create an instance of the local class
    l.printVars();              // and call its printVars() method.
  }
}
```

3.10.3.5 Local variables, lexical scoping, and closures

A local variable is defined within a block of code that defines its scope. A local variable ceases to exis outside of its scope. Java is a *lexically scoped* language, which means that its concept of scope has to do with the way the source code is written. Any code within the curly braces that define the boundaries of a block can use local variables defined in that block.[10]

[10] This section covers advanced material; first-time readers may want to skip it for now and return to it later.

Lexical scoping simply defines a segment of source code within which a variable can be used. It is common, however, to think of a scope as a temporal scopeto think of a local variable as existing fron the time the Java interpreter begins executing the block until the time the interpreter exits the block. This is usually a reasonable way to think about local variables and their scope.

The introduction of local classes confuses the picture, however, because local classes can use local variables, and instances of a local class can have a lifetime much longer than the time it takes the interpreter to execute the block of code. In other words, if you create an instance of a local class, the instance does not automatically go away when the interpreter finishes executing the block that defines the class, as shown in the following code:

```
public class Weird {
  // A static member interface used below
  public static interface IntHolder { public int getValue(); }

  public static void main(String[] args) {
    IntHolder[] holders = new IntHolder[10];  // An array to hold 10 objects
    for(int i = 0; i < 10; i++) {             // Loop to fill the array up
      final int fi = i;                       // A final local variable
      class MyIntHolder implements IntHolder {// A local class
        public int getValue() { return fi; }  // It uses the final variable
      }
```

```
      holders[i] = new MyIntHolder();         // Instantiate the local class
    }

    // The local class is now out of scope, so we can't use it. But we have
    // 10 valid instances of that class in our array. The local variable
    // fi is not in our scope here, but it is still in scope for the
    // getValue() method of each of those 10 objects. So call getValue()
    // for each object and print it out. This prints the digits 0 to 9.
    for(int i = 0; i < 10; i++) System.out.println(holders[i].getValue());
  }
}
```

The behavior of the previous program is pretty surprising. To make sense of it, remember that the lexical scope of the methods of a local class has nothing to do with when the interpreter enters and exits the block of code that defines the local class. Here's another way to think about it: each instance of a local class has an automatically created private copy of each of the final local variables it uses, so, in effect, it has its own private copy of the scope that existed when it was created.

The local class `MyIntHolder` is sometimes called a *closure*. In general terms, a closure is an object that saves the state of a scope and makes that scope available later. Closures are useful in some styles of programming, and different programming languages define and implement closures in different ways. Java's closures are relatively weak (and some would argue that they are not truly closures) because they retain the state of only `final` variables.

3.10.4. Anonymous Classes

An *anonymous class* is a local class without a name. An anonymous class is defined and instantiated in a single succinct expression using the `new` operator. While a local class definition is a statement in a block of Java code, an anonymous class definition is an expression, which means that it can be included as part of a larger expression, such as a method call. In practice, anonymous classes are much more common than local classes. If you find yourself defining a short local class and then instantiating it exactly once, consider rewriting it using anonymous class syntax, which places the definition and use of the class in exactly the same place.

Consider Example 3-10, which shows the `LinkedIterator` class implemented as an anonymous class within the `iterator( )` method of the `LinkedStack` class. Compare it with Example 3-9, which shows the same class implemented as a local class. The generic syntax in this example is covered in Chapter 4.

Example 3-10. An enumeration implemented with an anonymous class

```
public Iterator<Linkable> iterator() {
    // The anonymous class is defined as part of the return statement
    return new Iterator<Linkable>() {
        Linkable current;
        // Replace constructor with an instance initializer
        { current = head; }
```

```
        // The following 3 methods are defined by the Iterator interface
        public boolean hasNext() {  return current != null; }
        public Linkable next() {
            if (current == null) throw new java.util.NoSuchElementException();
            Linkable value = current;
            current = current.getNext();
            return value;
        }
        public void remove() { throw new UnsupportedOperationException(); }
    };  // Note the required semicolon. It terminates the return statement
}
```

One common use for an anonymous class is to provide a simple implementation of an adapter class. An *adapter class* is one that defines code that is invoked by some other object. Take, for example, the `list()` method of the `java.io.File` class. This method lists the files in a directory. Before it returns the list, though, it passes the name of each file to a `FilenameFilter` object you must supply. This `FilenameFilter` object accepts or rejects each file. When you implement the `FilenameFilter` interface, you are defining an adapter class for use with the `File.list()` method. Since the body of such a class is typically quite short, it is easy to define an adapter class as an anonymous class. Here's how you can define a `FilenameFilter` class to list only those files whose names end with *.java* :

```
File f = new File("/src");      // The directory to list

// Now call the list() method with a single FilenameFilter argument
// Define and instantiate an anonymous implementation of FilenameFilter
// as part of the method invocation expression.
String[] filelist = f.list(new FilenameFilter() {
  public boolean accept(File f, String s) { return s.endsWith(".java"); }
}); // Don't forget the parenthesis and semicolon that end the method call!
```

As you can see, the syntax for defining an anonymous class and creating an instance of that class uses the `new` keyword, followed by the name of a class and a class body definition in curly braces. If the name following the `new` keyword is the name of a class, the anonymous class is a subclass of the named class. If the name following `new` specifies an interface, as in the two previous examples, the anonymous class implements that interface and extends `Object`. The syntax does not include any way to specify an `extends` clause, an `implements` clause, or a name for the class.

Because an anonymous class has no name, it is not possible to define a constructor for it within the class body. This is one of the basic restrictions on anonymous classes. Any arguments you specify between the parentheses following the superclass name in an anonymous class definition are implicitly passed to the superclass constructor. Anonymous classes are commonly used to subclass simple classes that do not take any constructor arguments, so the parentheses in the anonymous class definition syntax are often empty. In the previous examples, each anonymous class implemented an interface and extended `Object`. Since the `Object( )` constructor takes no arguments, the parentheses were empty in those examples.

3.10.4.1 Features of anonymous classes

Anonymous classes allow you to define a one-shot class exactly where it is needed. Anonymous classes have all the features of local classes but use a more concise syntax that can reduce clutter in your code.

3.10.4.2 Restrictions on anonymous classes

Because an anonymous class is just a type of local class, anonymous classes and local classes share the same restrictions. An anonymous class cannot define any `static` fields, methods, or classes, except for `static final` constants. Interfaces, enumerated types, and annotation types cannot be defined anonymously. Also, like local classes, anonymous classes cannot be `public` , `private`, `protected`, or `static`.

Since an anonymous class has no name, it is not possible to define a constructor for an anonymous class. If your class requires a constructor, you must use a local class instead. However, you can often use an instance initializer as a substitute for a constructor.

The syntax for defining an anonymous class combines definition with instantiation. Using an anonymous class instead of a local class is not appropriate if you need to create more than a single instance of the class each time the containing block is executed.

3.10.4.3 Syntax for anonymous classes

We've already seen examples of the syntax for defining and instantiating an anonymous class. We can express that syntax more formally as:

```
new class-name ( [ argument-list ] ) { class-body }
```

or:

```
new interface-name () { class-body }
```

Although they are not limited to use with anonymous classes, instance initializers were introduced into the language for this purpose. As described earlier in this chapter in Section 3.3.4, an instance initializer is a block of initialization code contained within curly braces inside a class definition. The contents of all instance initializers for a class are automatically inserted into all constructors for the class, including any automatically created default constructor. An anonymous class cannot define a constructor, so it gets a default constructor. By using an instance initializer, you can get around the fact that you cannot define a constructor for an anonymous class.

3.10.4.4 When to use an anonymous class

As we've discussed, an anonymous class behaves just like a local class and is distinguished from a local class merely in the syntax used to define and instantiate it. In your own code, when you have to choose between using an anonymous class and a local class, the decision often comes down to a matter of style. You should use whichever syntax makes your code clearer. In general, you should consider using an anonymous class instead of a local class if:

- The class has a very short body.
- Only one instance of the class is needed.
- The class is used right after it is defined.
- The name of the class does not make your code any easier to understand.

3.10.4.5 Anonymous class indentation and formatting

The common indentation and formatting conventions we are familiar with for block-structured languages like Java and C begin to break down somewhat once we start placing anonymous class definitions within arbitrary expressions. Based on their experience with nested types, the engineers a Sun recommend the following formatting rules:

- The opening curly brace should not be on a line by itself; instead, it should follow the closing parenthesis of the `new` operator. Similarly, the `new` operator should, when possible, appear on the same line as the assignment or other expression of which it is a part.
- The body of the anonymous class should be indented relative to the beginning of the line that contains the `new` keyword.
- The closing curly brace of an anonymous class should not be on a line by itself either; it should be followed by whatever tokens are required by the rest of the expression. Often this is a semicolon or a closing parenthesis followed by a semicolon. This extra punctuation serves as a flag to the reader that this is not just an ordinary block of code and makes it easier to understand anonymous classes in a code listing.

3.10.5. How Nested Types Work

The preceding sections explained the features and behavior of the four kinds of nested types. Strictly speaking, that should be all you need to know about nested types. You may find it easier to understand nested types if you understand how they are implemented, however.

Nested types were added in Java 1.1. Despite the dramatic changes to the Java language, the introduction of nested types did not change the Java Virtual Machine or the Java class file format. As far as the Java interpreter is concerned, there is no such thing as a nested type: all classes are normal top-level classes. In order to make a nested type behave as if it is actually defined inside another class, the Java compiler ends up inserting hidden fields, methods, and constructor argument into the classes it generates. You may want to use the *javap* disassembler to disassemble some of the class files for nested types so you can see what tricks the compiler has used to make the nested types work. (See Chapter 8 for information on *javap*.)

3.10.5.1 Static member type implementation

Recall our first LinkedStack example (Example 3-7), which defined a static member interface named Linkable. When you compile this LinkedStack class, the compiler actually generates two class files. The first one is *LinkedStack.class*, as expected. The second class file, however, is called *LinkedStack$Linkable.class*. The $ in this name is automatically inserted by the Java compiler. This second class file contains the implementation of the static member interface.

As we discussed earlier, a static member type can access all the static members of its containing class. If a static member type does this, the compiler automatically qualifies the member access expression with the name of the containing class. A static member type is even allowed to access the private static fields of its containing class. Since the static member type is compiled into an ordinary top-level class, however, there is no way it can directly access the private members of its container. Therefore, if a static member type uses a private member of its containing type (or vice versa), the compiler generates synthetic non-private access methods and converts the expressions that access the private members into expressions that invoke these specially generated methods. These methods are given the default package access, which is sufficient, as the member class and its containing class are guaranteed to be in the same package.

3.10.5.2 Nonstatic member class implementation

A nonstatic member class is implemented much like a static member type. It is compiled into a separate top-level class file, and the compiler performs various code manipulations to make interclass member access work correctly.

The most significant difference between a nonstatic member class and a static member type is that each instance of a nonstatic member class is associated with an instance of the enclosing class. The compiler enforces this association by defining a synthetic field named this$0 in each member class. This field is used to hold a reference to the enclosing instance. Every nonstatic member class constructor is given an extra parameter that initializes this field. Every time a member class constructor is invoked, the compiler automatically passes a reference to the enclosing class for this extra parameter.

As we've seen, a nonstatic member class, like any member of a class, can be declared public, protected, or private, or given the default package visibility. Member classes are compiled to class files just like top-level classes, but top-level classes can have only public or package access. Therefore, as far as the Java interpreter is concerned, member classes can have only public or package visibility. This means that a member class declared protected is actually treated as a public class, and a member class declared private actually has package visibility. This does not mean you should never declare a member class as protected or private. Although the Java VM cannot enforce these access control modifiers, the modifiers are stored in the class file and conforming Java compilers do enforce them.

3.10.5.3 Local and anonymous class implementation

A local class is able to refer to fields and methods in its containing class for exactly the same reason that a nonstatic member class can; it is passed a hidden reference to the containing class in its constructor and saves that reference away in a private synthetic field added by the compiler. Also, like nonstatic member classes, local classes can use private fields and methods of their containing class because the compiler inserts any required accessor methods.

What makes local classes different from member classes is that they have the ability to refer to local variables in the scope that defines them. The crucial restriction on this ability, however, is that local classes can reference only local variables and parameters that are declared `final`. The reason for this restriction becomes apparent in the implementation. A local class can use local variables because the compiler automatically gives the class a `private` instance field to hold a copy of each local variable the class uses. The compiler also adds hidden parameters to each local class constructor to initialize these automatically created `private` fields. A local class does not actually access local variables but merely its own private copies of them. The only way this can work correctly is if the local variables are declared `final` so that they are guaranteed not to change. With this guarantee, the local class can be assured that its internal copies of the variables are always in sync with the real local variables.

Since anonymous classes have no names, you may wonder what the class files that represent them are named. This is an implementation detail, but Sun's Java compiler uses numbers to provide anonymous class names. If you compile the example code shown in Example 3-10, you'll find that it produces a class file for the anonymous class with a name like *LinkedStack$1.class*.

Team LiB

3.11. Modifier Summary

As we've seen, classes, interfaces, and their members can be declared with one or more *modifiers*keywords such as `public`, `static`, and `final`. Table 3-2 lists the Java modifiers, explains what types of Java constructs they can modify, and explains what they do. See alsoSection 3.1 and Section 3.2.1 earlier in this chapter, as well as Section 2.6.2 in Chapter 2.

Table 3-2. Java modifiers

Modifier	Used on	Meaning
`abstract`	Class	The class contains unimplemented methods and cannot be instantiated.
	Interface	All interfaces are `abstract`. The modifier is optional in interface declarations.
`abstract`	Method	No body is provided for the method; it is provided by a subclass. The signature is followed by a semicolon. The enclosing class must also be `abstract`.
`final`	Class	The class cannot be subclassed.
	Method	The method cannot be overridden (and is not subject to dynamic method lookup).
	Field	The field cannot have its value changed. `static final` fields are compile-time constants.
	Variable	A local variable, method parameter, or exception parameter cannot have its value changed. Useful with local classes.
`native`	Method	The method is implemented in some platform-dependent way (often in C). No body is provided; the signature is followed by a semicolon.
None (package)	Class	A non-`public` class is accessible only in its package.
	Interface	A non-`public` interface is accessible only in its package.
	Member	A member that is not `private`, `protected`, or `public` has package visibility and is accessible only within its package.
`private`	Member	The member is accessible only within the class that defines it.
`protected`	Member	The member is accessible only within the package in which it is defined and within subclasses.
`public`	Class	The class is accessible anywhere its package is.

Modifier	Used on	Meaning
	Interface	The interface is accessible anywhere its package is.
	Member	The member is accessible anywhere its class is.
`strictfp`	Class	All methods of the class are implicitly `strictfp`.
`strictfp`	Method	All floating-point computation done by the method must be performed in a way that strictly conforms to the IEEE 754 standard. In particular, all values, including intermediate results, must be expressed as IEEE `float` or `double` values and cannot take advantage of any extra precision or range offered by native platform floating-point formats or hardware. This modifier is rarely used.
`static`	Class	An inner class declared `static` is a top-level class, not associated with a member of the containing class.
	Method	A `static` method is a class method. It is not passed an implicit `this` object reference. It can be invoked through the class name.
	Field	A `static` field is a class field. There is only one instance of the field, regardless of the number of class instances created. It can be accessed through the class name.
	Initializer	The initializer is run when the class is loaded rather than when an instance is created.
`synchronized`	Method	The method makes nonatomic modifications to the class or instance, so care must be taken to ensure that two threads cannot modify the class or instance at the same time. For a `static` method, a lock for the class is acquired before executing the method. For a non-`static` method, a lock for the specific object instance is acquired.
`TRansient`	Field	The field is not part of the persistent state of the object and should not be serialized with the object. Used with object serialization; see `java.io.ObjectOutputStream`.
`volatile`	Field	The field can be accessed by unsynchronized threads, so certain optimizations must not be performed on it. This modifier can sometimes be used as an alternative to `synchronized`. This modifier is very rarely used.

3.12. C++ Features Not Found in Java

This chapter indicates similarities and differences between Java and C++ in footnotes. Java shares enough concepts and features with C++ to make it an easy language for C++ programmers to pick up. Several features of C++ have no parallel in Java, however. In general, Java does not adopt those features of C++ that make the language significantly more complicated.

C++ supports multiple inheritance of method implementations from more than one superclass at a time. While this seems like a useful feature, it actually introduces many complexities to the language. The Java language designers chose to avoid the added complexity by using interfaces instead. Thus, a class in Java can inherit method implementations only from a single superclass, but it can inherit method declarations from any number of interfaces.

C++ supports templates that allow you, for example, to implement a Stack class and then instantiate it as Stack<int> or Stack<double> to produce two separate types: a stack of integers and a stack of floating-point values. Java 5.0 introduces parameterized types or "generics" that provide similar functionality in a more robust fashion. Generics are covered in Chapter 4.

C++ allows you to define operators that perform arbitrary operations on instances of your classes. In effect, it allows you to extend the syntax of the language. This is a nifty feature, called operator overloading, that makes for elegant examples. In practice, however, it tends to make code quite difficult to understand. After much debate, the Java language designers decided to omit such operator overloading from the language. Note, though, that the use of the + operator for string concatenation in Java is at least reminiscent of operator overloading.

C++ allows you to define conversion functions for a class that automatically invokes an appropriate constructor method when a value is assigned to a variable of that class. This is simply a syntactic shortcut (similar to overriding the assignment operator) and is not included in Java.

In C++, objects are manipulated by value by default; you must use & to specify a variable or function argument automatically manipulated by reference. In Java, all objects are manipulated by reference, so there is no need for the & syntax.

Team LiB

Chapter 4. Java 5.0 Language Features

This chapter covers the three most important new language features of Java 5.0. *Generics* add type-safety and expressiveness to Java programs by allowing types to be parameterized with other types. A `List` that contains `String` objects, for example, can be written as `List<String>`. Using parameterized types makes Java code clearer and allows us to remove most casts from our programs.

Enumerated types, or *enums*, are a new category of reference type, like classes and interfaces. An enumerated type defines a finite ("enumerated") set of values, and, importantly, provides type-safety: a variable of enumerated type can hold only values of that enumerated type or `null`. Here is a simple enumerated type definition:

```
public enum Seasons { WINTER, SPRING, SUMMER, AUTUMN }
```

The third Java 5.0 feature discussed in this chapter is program annotations and the annotation types that define them. An *annotation* associates arbitrary data (or metadata) with a program element such as a class, method, field, or even a method parameter or local variable. The type of data held in an annotation is defined by its *annotation type*, which, like enumerated types, is another new category of reference type. The Java 5.0 platform includes three standard annotation types used to provide additional information to the Java compiler. Annotations will probably find their greatest use with code generation tools in Java enterprise programming.

Java 5.0 also introduces a number of other important new language features that don't require a special chapter to explain. Coverage of these changes is found in sections throughout Chapter 2. They include:

- Autoboxing and unboxing conversions
- The `for/in` looping statement, sometimes called "foreach"
- Methods with variable-length argument lists, also known as *varargs* methods
- The ability to narrow the return type of a method when overriding, known as a "covariant return"
- The `import static` directive, which imports the static members of a type into the namespace

4.1. Generic Types

Generic types and methods are the defining new feature of Java 5.0. A *generic type* is defined using one or more *type variables* and has one or more methods that use a type variable as a placeholder for an argument or return type. For example, the type `java.util.List<E>` is a generic type: a list that holds elements of some type represented by the placeholder `E`. This type has a method named `add()`, declared to take an argument of type `E`, and a method named `get()`, declared to return a value of type `E`.

In order to use a generic type like this, you specify actual types for the type variable (or variables), producing a *parameterized type* such as `List<String>`.[1] The reason to specify this extra type information is that the compiler can provide much stronger compile-time type checking for you, increasing the type safety of your programs. This type checking prevents you from adding a `String[]`, for example, to a `List` that is intended to hold only `String` objects. Also, the additional type information enables the compiler to do some casting for you. The compiler knows that the `get()` method of a `List<String>` (for example) returns a `String` object: you are no longer required to cast a return value of type `Object` to a `String`.

[1] Throughout this chapter, I've tried to consistently use the term " generic type" to mean a type that declares one or more type variables and the term "parameterized type" to mean a generic type that has had actual type arguments substituted for its type varaiables. In common usage, however, the distinction is not a sharp one and the terms are sometimes used interchangeably.

The collections classes of the `java.util` package have been made generic in Java 5.0, and you will probably use them frequently in your programs. Typesafe collections are the canonical use case for generic types. Even if you never define generic types of your own and never use generic types other than the collections classes in `java.util`, the benefits of typesafe collections are so significant that they justify the complexity of this major new language feature.

We begin by exploring the basic use of generics in typesafe collections, then delve into more complex details about the use of generic types. Next we cover type parameter wildcards and bounded wildcards. After describing how to use generic types, we explain how to write your own generic types and generic methods. Our coverage of generics concludes with a tour of important generic types in the core Java API. It explores these types and their use in depth in order to provide a deeper understanding of how generics work.

4.1.1. Typesafe Collections

The `java.util` package includes the Java Collections Framework for working with sets and lists of objects and mappings from key objects to value objects. Collections are covered in Chapter 5. Here, we discuss the fact that in Java 5.0 the collections classes use type parameters to identify the type of the objects in the collection. This is not the case in Java 1.4 and earlier. Without generics, the use of collections requires the programmer to remember the proper element type for each collection. When you create a collection in Java 1.4, you know what type of objects you intend to store in that collection, but the compiler cannot know this. You must be careful to add elements of the appropriate type. And when querying elements from a collection, you must write explicit casts to convert them from `Object` to their actual type. Consider the following Java 1.4 code:

```
public static void main(String[] args) {
    // This list is intended to hold only strings.
    // The compiler doesn't know that so we have to remember ourselves.
    List wordlist = new ArrayList();

    // Oops! We added a String[] instead of a String.
    // The compiler doesn't know that this is an error.
    wordlist.add(args);

    // Since List can hold arbitrary objects, the get() method returns
    // Object.  Since the list is intended to hold strings, we cast the
    // return value to String but get a ClassCastException because of
    // the error above.
    String word = (String)wordlist.get(0);
}
```

Generic types solve the type safety problem illustrated by this code. `List` and the other collection classes in `java.util` have been rewritten to be generic. As mentioned above, `List` has been redefined in terms of a type variable named `E` that represents the type of the elements of the list. The `add( )` method is redefined to expect an argument of type `E` instead of `Object` and `get( )` has been redefined to return `E` instead of `Object`.

In Java 5.0, when we declare a `List` variable or create an instance of an `ArrayList`, we specify the actual type we want `E` to represent by placing the actual type in angle brackets following the name of the generic type. A `List` that holds strings is a `List<String>`, for example. Note that this is much like passing an argument to a method, except that we use types rather than values and angle brackets instead of parentheses.

The elements of the `java.util` collection classes must be objects; they cannot be used with primitive values. The introduction of generics does not change this. Generics do not work with primitives: we can't declare a `Set<char>`, or a `List<int>` for example. Note, however, that the autoboxing and autounboxing features of Java 5.0 make working with a `Set<Character>` or a `List<Integer>` just as easy as working directly with `char` and `int` values. (See Chapter 2 for details on autoboxing and autounboxing).

In Java 5.0, the example above would be rewritten as follows:

```
public static void main(String[] args) {
    // This list can only hold String objects
    List<String> wordlist = new ArrayList<String>();

    // args is a String[], not String, so the compiler won't let us do this
    wordlist.add(args);  // Compilation error!

    // We can do this, though.
    // Notice the use of the new for/in looping statement
    for(String arg : args) wordlist.add(arg);

    // No cast is required.  List<String>.get() returns a String.
    String word = wordlist.get(0);
}
```

Note that this code isn't much shorter than the nongeneric example it replaces. The cast, which uses the word `String` in parentheses, is replaced with the type parameter, which places the word `String` in angle brackets. The difference is that the type parameter has to be declared only once, but the list can be used any number of times without a cast. This would be more apparent in a longer example. But even in cases where the generic syntax is more verbose than the nongeneric syntax, it is still very much worth using generics because the extra type information allows the compiler to perform much stronger error checking on your code. Errors that would only be apparent at runtime can now be detected at compile time. Furthermore, the compilation error appears at the exact line where the type safety violation occurs. Without generics, a `ClassCastException` can be thrown far from the actual source of the error.

Just as methods can have any number of arguments, classes can have more than one type variable. The `java.util.Map` interface is an example. A `Map` is a mapping from key objects to value objects. The `Map` interface declares one type variable to represent the type of the keys and one variable to represent the type of the values. As an example, suppose you want to map from `String` objects to `Integer` objects:

```
public static void main(String[] args) {
    // A map from strings to their position in the args[] array
    Map<String,Integer> map = new HashMap<String,Integer>();

    // Note that we use autoboxing to wrap i in an Integer object.
    for(int i=0; i < args.length; i++) map.put(args[i], i);

    // Find the array index of a word.  Note no cast is required!
    Integer position = map.get("hello");

    // We can also rely on autounboxing to convert directly to an int,
    // but this throws a NullPointerException if the key does not exist
    // in the map
    int pos = map.get("world");
}
```

A parameterized type like `List<String>` is itself a type and can be used as the value of a type parameter for some other type. You might see code like this:

```
// Look at all those nested angle brackets!
Map<String, List<List<int[]>>> map = getWeirdMap();

// The compiler knows all the types and we can write expressions
// like this without casting.  We might still get NullPointerException
// or ArrayIndexOutOfBounds at runtime, of course.
int value = map.get(key).get(0).get(0)[0];

// Here's how we break that expression down step by step.
List<List<int[]>> listOfLists = map.get(key);
List<int[]> listOfIntArrays = listOfLists.get(0);
int[] array = listOfIntArrays.get(0);
int element = array[0];
```

In the code above, the `get( )` methods of `java.util.List<E>` and `java.util.Map<K,V>` return a list or map element of type `E` and `V` respectively. Note, however, that generic types can use their variables in more sophisticated ways. Look up `List<E>` in the reference section of this book, and you'll find that its `iterator( )` method is declared to return an `Iterator<E>`. That is, the method returns an instance of a parameterized type whose actual type parameter is the same as the actual type parameter of the list. To illustrate this concretely, here is a way to obtain the first element of a `List<String>` without calling `get(0)`.

```
List<String> words = // ...initialized elsewhere...
Iterator<String> iterator = words.iterator();
String firstword = iterator.next();
```

4.1.2. Understanding Generic Types

This section delves deeper into the details of generic type usage, explaining the following topics:

- The consequences of using generic types *without* type parameters
- The parameterized type hierarchy
- A hole in the compile-time type safety of generic types and a patch to ensure runtime type safety
- Why arrays of parameterized types are not typesafe

4.1.2.1 Raw types and unchecked warnings

Even though the Java collection classes have been modified to take advantage of generics, you are not required to specify type parameters to use them. A generic type used without type parameters is known as a *raw type*. Existing pre-5.0 code continues to work: you simply write all the casts that you're already used to writing, and you put up with some pestering from the compiler. Consider the following code that stores objects of mixed types into a raw `List`:

```
List l = new ArrayList();
l.add("hello");
l.add(new Integer(123));
Object o = l.get(0);
```

This code works fine in Java 1.4. If we compile it using Java 5.0, however, *javac* compiles the code but prints this complaint:

```
Note: Test.java uses unchecked or unsafe operations.
Note: Recompile with -Xlint:unchecked for details.
```

When we recompile with the -Xlint option as suggested, we see these warnings:

```
Test.java:6: warning: [unchecked]
    unchecked call to add(E) as a member of the raw type java.util.List
        l.add("hello");
         ^
Test.java:7: warning: [unchecked]
    unchecked call to add(E) as a member of the raw type java.util.List
        l.add(new Integer(123));
         ^
```

The compiler warns us about the add( ) calls because it cannot ensure that the values being added to the list have the correct types. It is letting us know that because we've used a raw type, it cannot verify that our code is typesafe. Note that the call to get( ) is okay because it is extracting an element that is already safely in the list.

If you get unchecked warnings on files that do not use any of the new Java 5.0 features, you can simply compile them with the -source 1.4 flag, and the compiler won't complain. If you can't do that, you can ignore the warnings, suppress them with an @SuppressWarnings("unchecked") annotation (see Section 4.3 later in this chapter) or upgrade your code to specify a type parameter.[2] The following code, for example, compiles with no warnings and still allows you to add objects of mixed types to the list:

[2] At the time of this writing, *javac* does not yet honor the @SuppressWarnings annotation. It is expected to do so in Java 5.1.

```
List<Object> l = new ArrayList<Object>();
l.add("hello");
l.add(123);              // autoboxing
Object o = l.get(0);
```

4.1.2.2 The parameterized type hierarchy

Parameterized types form a type hierarchy, just as normal types do. The hierarchy is based on the base type, however, and not on the type of the parameters. Here are some experiments you can try:

```
ArrayList<Integer> l = new ArrayList<Integer>();
List<Integer> m = l;                            // okay
Collection<Integer> n = l;                      // okay
ArrayList<Number> o = l;                        // error
Collection<Object> p = (Collection<Object>)l;   // error, even with cast
```

A List<Integer> is a Collection<Integer>, but it is not a List<Object>. This is nonintuitive, and it is important to understand why generics work this way. Consider this code:

```
List<Integer> li = new ArrayList<Integer>();
li.add(123);

// The line below will not compile.  But for the purposes of this
```

```
// thought-experiment, assume that it does compile and see how much
// trouble we get ourselves into.
List<Object> lo = li;

// Now we can retrieve elements of the list as Object instead of Integer
Object number = lo.get(0);

// But what about this?
lo.add("hello world");

// If the line above is allowed then the line below throws ClassCastException
Integer i = li.get(1);  // Can't cast a String to Integer!
```

This then is the reason that a `List<Integer>` is not a `List<Object>`, even though all elements of a `List<Integer>` are in fact instances of `Object`. If the conversion to `List<Object>` were allowed, non-`Integer` objects could be added to the list.

4.1.2.3 Runtime type safety

As we've seen, a `List<X>` cannot be converted to a `List<Y>`, even when `X` *can* be converted to `Y`. A `List<X>` can be converted to a `List`, however, so that you can pass it to a legacy method that expects an argument of that type and has not been updated for generics.

This ability to convert parameterized types to nonparameterized types is essential for backward compatibility, but it does open up a hole in the type safety system that generics offer:

```
// Here's a basic parameterized list.
List<Integer> li = new ArrayList<Integer>();

// It is legal to assign a parameterized type to a nonparameterized variable
List l = li;

// This line is a bug, but it compiles and runs.
// The Java 5.0 compiler will issue an unchecked warning about it.
// If it appeared as part of a legacy class compiled with Java 1.4, however,
// then we'd never even get the warning.
l.add("hello");

// This line compiles without warning but throws ClassCastException at runtime.
// Note that the failure can occur far away from the actual bug.
Integer i = li.get(0);
```

Generics provide compile-time type safety only. If you compile all your code with the Java 5.0 compiler and do not get any unchecked warnings, these compile-time checks are enough to ensure that your code is also typesafe at runtime. But if you have unchecked warnings or are working with legacy code that manipulates your collections as raw types, you may want to take additional steps to ensure type safety at runtime. You can do this with methods like`checkedList()` and `checkedMap( )` of `java.util.Collections`. These methods enclose your collection in a wrapper collection that performs runtime type checks to ensure that only values of the correct type are added to the collection. For example, we could prevent the type safety hole shown above like this:

```
// Here's a basic parameterized list.
List<Integer> li = new ArrayList<Integer>();

// Wrap it for runtime type safety
List<Integer> cli = Collections.checkedList(li, Integer.class);

// Now widen the checked list to the raw type
List l = cli;

// This line compiles but fails at runtime with a ClassCastException.
// The exception occurs exactly where the bug is, rather than far away
l.add("hello");
```

4.1.2.4 Arrays of parameterized type

Arrays require special consideration when working with generic types. Recall that an array of type `S[ ]` is also of type `T[]`, if `T` is a superclass (or interface) of `S`. Because of this, the Java interpreter must perform a runtime check every time you store an object in an array to ensure that the runtime type of the object and of the array are compatible. For example, the following code fails this runtime chec and throws an `ArrayStoreException`:

```
String[] words = new String[10];
Object[] objs = words;
objs[0] = 1;  // 1 autoboxed to an Integer, throws ArrayStoreException
```

Although the compile-time type of `objs` is `Object[]`, its runtime type is `String[ ]`, and it is not legal to store an `Integer` in it.

When we work with generic types, the runtime check for array store exceptions is no longer sufficien because a check performed at runtime does not have access to the compile-time type parameter information. Consider this (hypothetical) code:

```
List<String>[] wordlists = new ArrayList<String>[10];
ArrayList<Integer> ali = new ArrayList<Integer>();
ali.add(123);
Object[] objs = wordlists;
objs[0] = ali;                       // No ArrayStoreException
String s = wordlists[0].get(0);      // ClassCastException!
```

If the code above were allowed, the runtime array store check would succeed: without compile-time type parameters, the code simply stores an `ArrayList` into an `ArrayList[]` array, which is perfectly legal. Since the compiler can't prevent you from defeating type safety in this way, it instead prevents you from creating any array of parameterized type. The scenario above can never occur because the compiler will refuse to compile the first line.

Note that this is not a blanket restriction on using arrays with generics; it is just a restriction on creating arrays of parameterized type. We'll return to this issue when we look at how to write generic methods.

4.1.3. Type Parameter Wildcards

Suppose we want to write a method to display the elements of a `List`.[3] Before `List` was a generic type, we'd just write code like this:

> [3] The three `printList()` methods shown in this section ignore the fact that the `List` implementations classes in `java.util` all provide working `toString()` methods. Notice also that the methods assume that the `List` implements `RandomAccess` and provides very poor performance on `LinkedList` instances.

```
public static void printList(PrintWriter out, List list) {
    for(int i=0, n=list.size(); i < n; i++) {
        if (i > 0) out.print(", ");
        out.print(list.get(i).toString());
    }
}
```

In Java 5.0, `List` is a generic type, and, if we try to compile this method, we'll get unchecked warnings. In order to get rid of those warnings, you might be tempted to modify the method as follows:

```
public static void printList(PrintWriter out, List<Object> list) {
    for(int i=0, n=list.size(); i < n; i++) {
        if (i > 0) out.print(", ");
        out.print(list.get(i).toString());
    }
}
```

This code compiles without warnings but isn't very useful because the only lists that can be passed to it are lists explicitly declared of type `List<Object>`. Remember that `List<String>` and `List<Integer>` (for example) cannot be widened or cast to `List<Object>`. What we really want is a typesafe `printList()` method to which we can pass any `List`, regardless of how it has been parameterized. The solution is to use a wildcard as the type parameter. The method would then be written like this:

```
public static void printList(PrintWriter out, List<?> list) {
    for(int i=0, n=list.size(); i < n; i++) {
        if (i > 0) out.print(", ");
        Object o = list.get(i);
        out.print(o.toString());
    }
}
```

This version of the method compiles without warnings and can be used the way we want it to be used. The `?` wildcard represents an unknown type, and the type `List<?>` is read as "List of unknown."

As a general rule, if a type is generic and you don't know or don't care about the value of the type variable, you should always use a `?` wildcard instead of using a raw type. Raw types are allowed only for backward compatibility and should be used only in legacy code. Note, however, that you cannot use a wildcard when invoking a constructor. The following code is not legal:

```
List<?> l = new ArrayList<?>();
```

There is no sense in creating a `List` of unknown type. If you are creating it, you should know what kind of elements it will hold. You may later want to pass such a list to a method that does not care about its element type, but you need to specify an element type when you create it. If what you really want is a `List` that can hold any type of object, do this:

```
List<Object> l = new ArrayList<Object>();
```

It should be clear from the `printList( )` variants above that a `List<?>` is not the same thing as a `List<Object>` and that neither is the same thing as a raw `List`. A `List<?>` has two important properties that result from the use of a wildcard. First, consider methods like `get()` that are declared to return a value of the same type as the type parameter. In this case, that type is unknown, so these methods return an `Object`. Since all we need to do with the object is invoke its `toString()` method, this is fine for our needs.

Second, consider `List` methods such as `add()` that are declared to accept an argument whose type is specified by the type parameter. This is the more surprising case: when the type parameter is unknown, the compiler does not let you invoke any methods that have a parameter of the unknown type because it cannot check that you are passing an appropriate value. A `List<?>` is effectively read-only since the compiler does not allow us to invoke methods like `add( )`, `set()`, and `addAll( )`.

4.1.3.1 Bounded wildcards

Let's continue now with a slightly more complex variant of our original example. Suppose that we want to write a `sumList()` method to compute the sum of a list of `Number` objects. As before, we could use a raw `List`, but we would give up type safety and have to deal with unchecked warnings from the compiler. Or we could use a `List<Number>`, but then we wouldn't be able to call the method for a `List<Integer>` or `List<Double>`, types we are more likely to use in practice. But if we use a wildcard, we don't actually get the type safety that we want because we have to trust that our method will be called with a `List` whose type parameter is actually `Number` or a subclass and not, say, a `String`. Here's what such a method might look like:

```
public static double sumList(List<?> list) {
    double total = 0.0;
    for(Object o : list) {
        Number n = (Number) o;  // A cast is required and may fail
        total += n.doubleValue();
    }
    return total;
}
```

To fix this method and make it truly typesafe, we need to use a *bounded wildcard* that states that the type parameter of the List is an unknown type that is either Number or a subclass of Number. The following code does just what we want:

```
public static double sumList(List<? extends Number> list) {
    double total = 0.0;
    for(Number n : list) total += n.doubleValue();
    return total;
}
```

The type List<? extends Number> could be read as "List of unknown descendant of Number." It is important to understand that, in this context, Number is considered a descendant of itself.

Note that the cast is no longer required. We don't know the type of the elements of the list, but we know that they have an "upper bound" of Number so we can extract them from the list as Number objects. The use of a for/in loop obscures the process of extracting elements from a list somewhat. The general rule is that when you use a bounded wildcard with an upper bound, methods (like the get() method of List) that return a value of the type parameter use the upper bound. So if we called list.get( ) instead of using a for/in loop, we'd also get a Number. The prohibition on calling methods like list.add( ) that have arguments of the type parameter type still stands: if the compiler allowed us to call those methods we could add an Integer to a list that was declared to hold only Short values, for example.

It is also possible to specify a lower-bounded wildcard using the keyword super instead of extends. This technique has a different impact on what methods can be called. Lower-bounded wildcards are much less commonly used than upper-bounded wildcards, and we discuss them later in the chapter.

4.1.4. Writing Generic Types and Methods

Creating a simple generic type is straightforward. First, declare your type variables by enclosing a comma-separated list of their names within angle brackets after the name of the class or interface. You can use those type variables anywhere a type is required in any instance fields or methods of the class. Remember, though, that type variables exist only at compile time, so you can't use a type variable with the runtime operators instanceof and new.

We begin this section with a simple generic type, which we will subsequently refine. This code defines a tree data structure that uses the type variable V to represent the type of the value held in each node of the tree:

```
import java.util.*;

/**
 * A tree is a data structure that holds values of type V.
 * Each tree has a single value of type V and can have any number of
 * branches, each of which is itself a Tree.
 */
public class Tree<V> {
    // The value of the tree is of type V.
```

```
    V value;

    // A Tree<V> can have branches, each of which is also a Tree<V>
    List<Tree<V>> branches = new ArrayList<Tree<V>>();

    // Here's the constructor.  Note the use of the type variable V.
    public Tree(V value) { this.value = value; }

    // These are instance methods for manipulating the node value and branches.
    // Note the use of the type variable V in the arguments or return types.
    V getValue() { return value; }
    void setValue(V value) { this.value = value; }
    int getNumBranches() { return branches.size(); }
    Tree<V> getBranch(int n) { return branches.get(n); }
    void addBranch(Tree<V> branch) { branches.add(branch); }
}
```

As you've probably noticed, the naming convention for type variables is to use a single capital letter. The use of a single letter distinguishes these variables from the names of actual types since real-world types always have longer, more descriptive names. The use of a capital letter is consistent with type naming conventions and distinguishes type variables from local variables, method parameters, and fields, which are sometimes written with a single lowercase letter. Collection classes like those in `java.util` often use the type variable `E` for "Element type." When a type variable can represent absolutely anything, `T` (for Type) and `S` are used as the most generic type variable names possible (like using `i` and `j` as loop variables).

Notice that the type variables declared by a generic type can be used only by the instance fields and methods (and nested types) of the type and not by static fields and methods. The reason, of course, is that it is instances of generic types that are parameterized. Static members are shared by all instances and parameterizations of the class, so static members do not have type parameters associated with them. Methods, including static methods, can declare and use their own type parameters, however, and each invocation of such a method can be parameterized differently. We'll cover this later in the chapter.

4.1.4.1 Type variable bounds

The type variable `V` in the declaration above of the `TRee<V>` class is unconstrained: `TRee` can be parameterized with absolutely any type. Often we want to place some constraints on the type that can be used: we might want to enforce that a type parameter implements one or more interfaces, or that it is a subclass of a specified class. This can be done by specifying a *bound* for the type variable. We've already seen upper bounds for wildcards, and upper bounds can also be specified for type variables using a similar syntax. The following code is the `tree` example rewritten to make `tree` objects `Serializable` and `Comparable`. In order to do this, the example uses a type variable bound to ensure that its value type is also `Serializable` and `Comparable`. Note how the addition of the `Comparable` bound on `V` enables us to write the `compareTo()` method `tree` by guaranteeing the existence of a `compareTo()` method on `V`.[4]

[4] The bound shown here requires that the value type `V` is comparable to itself, in other words, that it implements the `Comparable` interface directly. This rules out the use of types that inherit the `Comparable` interface from a superclass. We'll consider the `Comparable` interface in much more detail at the end of this section and present an alternative there.

```
import java.io.Serializable;
import java.util.*;

public class Tree<V extends Serializable & Comparable<V>>
    implements Serializable, Comparable<Tree<V>>
{
    V value;
    List<Tree<V>> branches = new ArrayList<Tree<V>>();

    public Tree(V value) { this.value = value; }

    // Instance methods
    V getValue() { return value; }
    void setValue(V value) { this.value = value; }
    int getNumBranches() { return branches.size(); }
    Tree<V> getBranch(int n) { return branches.get(n); }
    void addBranch(Tree<V> branch) { branches.add(branch); }

    // This method is a nonrecursive implementation of Comparable<Tree<V>>
    // It only compares the value of this node and ignores branches.
    public int compareTo(Tree<V> that) {
        if (this.value == null && that.value == null) return 0;
        if (this.value == null) return -1;
        if (that.value == null) return 1;
        return this.value.compareTo(that.value);
    }

    // javac -Xlint warns us if we omit this field in a Serializable class
    private static final long serialVersionUID = 833546143621133467L;
}
```

The bounds of a type variable are expressed by following the name of the variable with the word `extends` and a list of types (which may themselves be parameterized, as `Comparable` is). Note that with more than one bound, as in this case, the bound types are separated with an ampersand rather than a comma. Commas are used to separate type variables and would be ambiguous if used to separate type variable bounds as well. A type variable can have any number of bounds, including any number of interfaces and at most one class.

4.1.4.2 Wildcards in generic types

Earlier in the chapter we saw examples using wildcards and bounded wildcards in methods that manipulated parameterized types. They are also useful in generic types. Our current design of the `tree` class requires the value object of every node to have exactly the same type, `V`. Perhaps this is too strict, and we should allow branches of a tree to have values that are a subtype of `V` instead of requiring `V` itself. This version of the `tree` class (minus the `Comparable` and `Serializable` implementation) is more flexible:

```
public class Tree<V> {
    // These fields hold the value and the branches
```

```
    V value;
    List<Tree<? extends V>> branches = new ArrayList<Tree<? extends V>>();

    // Here's a constructor
    public Tree(V value) { this.value = value; }

    // These are instance methods for manipulating value and branches
    V getValue() { return value; }
    void setValue(V value) { this.value = value; }
    int getNumBranches() { return branches.size(); }
    Tree<? extends V> getBranch(int n) { return branches.get(n); }
    void addBranch(Tree<? extends V> branch) { branches.add(branch); }
}
```

The use of bounded wildcards for the branch type allow us to add a `tree<Integer>`, for example, as a branch of a `tree<Number>`:

```
Tree<Number> t = new Tree<Number>(0);  // Note autoboxing
t.addBranch(new Tree<Integer>(1));     // int 1 autoboxed to Integer
```

If we query the branch with the `getBranch( )` method, the value type of the returned branch is unknown, and we must use a wildcard to express this. The next two lines are legal, but the third is not:

```
Tree<? extends Number> b = t.getBranch(0);
Tree<?> b2 = t.getBranch(0);
Tree<Number> b3 = t.getBranch(0);  // compilation error
```

When we query a branch like this, we don't know the precise type of the value, but we do still have an upper bound on the value type, so we can do this:

```
Tree<? extends Number> b = t.getBranch(0);
Number value = b.getValue();
```

What we cannot do, however, is set the value of the branch, or add a new branch to that branch. As explained earlier in the chapter, the existence of the upper bound does not change the fact that the value type is unknown. The compiler does not have enough information to allow us to safely pass a value to `setValue()` or a new branch (which includes a value type) to `addBranch()`. Both of these lines of code are illegal:

```
b.setValue(3.0); // Illegal, value type is unknown
b.addBranch(new Tree<Double>(Math.PI));
```

This example has illustrated a typical trade-off in the design of a generic type: using a bounded wildcard made the data structure more flexible but reduced our ability to safely use some of its methods. Whether or not this was a good design is probably a matter of context. In general, generic types are more difficult to design well. Fortunately, most of us will use the preexisting generic types in the java.util package much more frequently than we will have to create our own.

4.1.4.3 Generic methods

As noted earlier, the type variables of a generic type can be used only in the instance members of the type, not in the static members. Like instance methods, however, static methods can use wildcards. And although static methods cannot use the type variables of their containing class, they can declare their own type variables. When a method declares its own type variable, it is called a *generic method*.

Here is a static method that could be added to the TRee class. It is not a generic method but uses a bounded wildcard much like the sumList() method we saw earlier in the chapter:

```
/** Recursively compute the sum of the values of all nodes on the tree */
public static double sum(Tree<? extends Number> t) {
    double total = t.value.doubleValue();
    for(Tree<? extends Number> b : t.branches) total += sum(b);
    return total;
}
```

This method could also be rewritten as a generic method by declaring a type variable to express the upper bound imposed by the wildcard:

```
public static <N extends Number> double sum(Tree<N> t) {
    N value = t.value;
    double total = value.doubleValue();
    for(Tree<? extends N> b : t.branches) total += sum(b);
    return total;
}
```

The generic version of sum() is no simpler than the wildcard version and the declaration of the type variable does not gain us anything. In a case like this, the wildcard solution is typically preferred over the generic solution. Generic methods are required where a single type variable is used to express a relationship between two parameters or between a parameter and a return value. The following method is an example:

```
// This method returns the largest of two trees, where tree size
// is computed by the sum() method.  The type variable ensures that
// both trees have the same value type and that both can be passed to sum().
public static <N extends Number> Tree<N> max(Tree<N> t, Tree<N> u) {
    double ts = sum(t);
    double us = sum(u);
    if (ts > us) return t;
    else return u;
}
```

This method uses the type variable N to express the constraint that both arguments and the return value have the same type parameter and that that type parameter is Number or a subclass.

It could be argued that constraining both arguments to have the same value type is too restrictive and that we should be allowed to call the `max( )` method on a `tree<Integer>` and a `tree<Double>`. One way to express this is to use two unrelated type variables to represent the two unrelated value types. Note, however, that we cannot use either variable in the return type of the method and must use a wildcard there:

```
public static <N extends Number, M extends Number>
    Tree<? extends Number> max(Tree<N> t, Tree<M> u) {...}
```

Since the two type variables `N` and `M` have no relation to each other, and since each is used in only a single place in the signature, they offer no advantage over bounded wildcards. The method is better written this way:

```
public static Tree<? extends Number> max(Tree<? extends Number> t,
                                         Tree<? extends Number> u) {...}
```

All the examples of generic methods shown here have been `static` methods. This is not a requirement: instance methods can declare their own type variables as well.

4.1.4.4 Invoking generic methods

When you use a generic type, you must specify the actual type parameters to be substituted for its type variables. The same is not generally true for generic methods: the compiler can almost always figure out the correct parameterization of a generic method based on the arguments you pass to the method. Consider the `max()` method defined above, for instance:

```
public static <N extends Number> Tree<N> max(Tree<N> t, Tree<N> u) {...}
```

You need not specify `N` when you invoke this method because `N` is implicitly specified in the values of the method arguments *t* and *u*. In the following code, for example, the compiler determines that `N` is `Integer`:

```
Tree<Integer> x = new Tree<Integer>(1);
Tree<Integer> y = new Tree<Integer>(2);
Tree<Integer> z = Tree.max(x, y);
```

The process the compiler uses to determine the type parameters for a generic method is called *type inference*. Type inference is relatively intuitive to understand, but the actual algorithm the compiler must use is surprisingly complex and is well beyond the scope of this book. Complete details are in Chapter 15 of *The Java Language Specification, Third Edition*.

Let's look at a slightly more complex version of type inference. Consider this method:

```
public class Util {
    /** Set all elements of a to the value v; return a. */
    public static <T> T[] fill(T[] a, T v) {
        for(int i = 0; i < a.length; i++) a[i] = v;
```

```
        return a;
    }
}
```

Here are two invocations of the method:

```
Boolean[] booleans = Util.fill(new Boolean[100], Boolean.TRUE);
Object o = Util.fill(new Number[5], new Integer(42));
```

In the first invocation, the compiler can easily determine that `T` is `Boolean`. In the second invocation, the compiler determines that `T` is `Number`.

In very rare circumstances you may need to explicitly specify the type parameters for a generic method. This is sometimes necessary, for example, when a generic method expects no arguments. Consider the `java.util.Collections.emptySet( )` method: it returns a set with no elements, but unlike the `Collections.singleton( )` method (you can look these up in the reference section), it takes no arguments that would specify the type parameter for the returned set. You can specify the type parameter explicitly by placing it in angle brackets *before* the method name:

```
Set<String> empty = Collections.<String>emptySet();
```

Type parameters cannot be used with an unqualified method name: they must follow a dot or come after the keyword `new` or before the keyword `this` or `super` used in a constructor.

It turns out that if you assign the return value of `Collections.emptySet()` to a variable, as we did above the type inference mechanism is able to infer the type parameter based on the variable type. Although the explicit type parameter specification in the code above can be a helpful clarification, it is not necessary and the line could be rewritten as:

```
Set<String> empty = Collections.emptySet();
```

An explicit type parameter is necessary when you use the return value of the `emptySet( )` method within a method invocation expression. For example, suppose you want to call a method named `printWords( )` that expects a single argument of type `Set<String>`. If you want to pass an empty set to this method, you could use this code:

```
printWords(Collections.<String>emptySet());
```

In this case, the explicit specification of the type parameter `String` is required.

4.1.4.5 Generic methods and arrays

Earlier in the chapter we saw that the compiler does not allow you to create an array whose type is parameterized. This is not, however, a restriction on all uses of arrays with generics. Consider the `Util.fill()` method defined above, for example. Its first argument and its return value are both of type `T[]`. The body of the method does not have to create an array whose element type is `T`, so the method is perfectly legal.

If you write a method that uses varargs (see Section 2.6.4 in Chapter 2) and a type variable, remember that invoking a varargs method performs an implicit array creation. Consider this method:

```
/** Return the largest of the specified values or null if there are none */
public static <T extends Comparable<T>> T max(T... values) { ...  }
```

You can invoke this method with parameters of type `Integer` because the compiler can insert the necessary array creation code for you when you call it. But you cannot call the method if you've cast the same arguments to be type `Comparable<Integer>` because it is not legal to create an array of type `Comparable<Integer>[ ]`.

4.1.4.6 Parameterized exceptions

Exceptions are thrown and caught at runtime, and there is no way for the compiler to perform type checking to ensure that an exception of unknown origin matches type parameters specified in a `catch` clause. For this reason, `catch` clauses may not include type variables or wildcards. Since it is not possible to catch an exception at runtime with compile-time type parameters intact, you are not allowed to make any subclass of `THRowable` generic. Parameterized exceptions are simply not allowed.

You can, however, use a type variable in the `throws` clause of a method signature. Consider this code, for example:

```
public interface Command<X extends Exception> {
    public void doit(String arg) throws X;
}
```

This interface represents a "command": a block of code with a single string argument and no return value. The code may throw an exception represented by the type parameter `X`. Here is an example that uses a parameterization of this interface:

```
Command<IOException> save = new Command<IOException>() {
    public void doit(String filename) throws IOException {
        PrintWriter out = new PrintWriter(new FileWriter(filename));
        out.println("hello world");
        out.close();
    }
};

try { save.doit("/tmp/foo");  }
catch(IOException e) { System.out.println(e); }
```

4.1.5. Generics Case Study: Comparable and Enum

The new generics features in Java 5.0 are used in the Java 5.0 APIs, most notably in `java.util` but also in java.lang, java.lang.reflect, and java.util.concurrent. These APIs were carefully created or reviewed by the inventors of generic types, and we can learn a lot about the good design of generic types and methods through the study of these APIs.

The generic types of java.util are relatively easy: for the most part they are collections classes, and type variables are used to represent the element type of the collection. Several important generic types in java.lang are more difficult. They are not collections, and it is not immediately apparent why they have been made generic. Studying these difficult generic types gives us a deeper understanding of how generics work and introduces some concepts that we have not yet covered in this chapter. Specifically, we'll examine the Comparable interface and the Enum class (the supertype of enumerated types, described later in this chapter) and will learn about an important but infrequently used feature of generics known as lower-bounded wildcards.

In Java 5.0, the Comparable interface has been made generic, with a type variable that specifies what a class is comparable to. Most classes that implement Comparable implement it on themselves. Consider Integer:

```
public final class Integer extends Number implements Comparable<Integer>
```

The raw Comparable interface is problematic from a type-safety standpoint. It is possible to have two Comparable objects that cannot be meaningfully compared to each other. Prior to Java 5.0, the nongeneric Comparable interface was useful but not fully satisfactory. The generic version of this interface, however, captures exactly the information we want: it tells us that a type is comparable and tells us what we can compare it to.

Now consider subclasses of comparable classes. Integer is final and cannot be subclassed, so let's look at java.math.BigInteger instead:

```
public class BigInteger extends Number implements Comparable<BigInteger>
```

If we implement a BiggerInteger subclass of BigInteger, it inherits the Comparable interface from its superclass. But note that it inherits Comparable<BigInteger> and not Comparable<BiggerInteger>. This means that BigInteger and BiggerInteger objects are mutually comparable, which is usually a good thing. BiggerInteger can override the compareTo( ) method of its superclass, but it is not allowed to implement a different parameterization of Comparable. That is, BiggerInteger cannot both extend BigInteger and implement Comparable<BiggerInteger>. (In general, a class is not allowed to implement two different parameterizations of the same interface: we cannot define a type that implements both Comparable<Integer> and Comparable<String>, for example.)

When you're working with comparable objects (as you do when writing sorting algorithms, for example), remember two things. First, it is not sufficient to use Comparable as a raw type: for type safety, you must also specify what it is comparable to. Second, types are not always comparable to themselves: sometimes they're comparable to one of their ancestors. To make this concrete, consider the java.util.Collections.max() method:

```
public static <T extends Comparable<? super T>> T max(Collection<? extends T> c)
```

This is a long, complex generic method signature. Let's walk through it:

- The method has a type variable `T` with complicated bounds that we'll return to later.
- The method returns a value of type T.
- The name of the method is `max( )`.
- The method's argument is a Collection. The element type of the collection is specified with a bounded wildcard. We don't know the exact type of the collection's elements, but we know that they have an upper bound of `T`. That is, we know that the elements of the collection are type `T` or a subclass of `T`. Any element of the collection could therefore be used as the return value of the method.

That much is relatively straightforward. We've seen upper-bounded wildcards elsewhere in this section. Now let's look again at the type variable declaration used by the `max( )` method:

```
<T extends Comparable<? super T>>
```

This says first that the type `T` must implement `Comparable`. (Generics syntax uses the keyword `extends` for all type variable bounds, whether classes or interfaces.) This is expected since the purpose of the method is to find the "maximum" object in a collection. But look at the parameterization of the `Comparable` interface. This is a wildcard, but it is bounded with the keyword `super` instead of the keyword `extends`. This is a lower-bounded wildcard. `? extends T` is the familiar upper bound: it means `T` or a subclass. `? super T` is less commonly used: it means `T` or a superclass.

To summarize, then, the type variable declaration states "`T` is a type that is comparable to itself or to some superclass of itself." The `Collections.min()` and `Collections.binarySearch( )` methods have similar signatures.

For other examples of lower-bounded wildcards (that have nothing to do with `Comparable`), consider the `addAll()`, `copy( )`, and `fill()` methods of `Collections`. Here is the signature for `addAll()`:

```
public static <T> boolean addAll(Collection<? super T> c, T... a)
```

This is a varargs method that accepts any number of arguments of type `T` and passes them as a `T[ ]` named *a*. It adds all the elements of *a* to the collection *c*. The element type of the collection is unknown but has a lower bound: the elements are all of type `T` or a superclass of `T`. Whatever the type is, we are assured that the elements of the array are instances of that type, and so it is always legal to add those array elements to the collection.

Recall from our earlier discussion of upper-bounded wildcards that if you have a collection whose element type is an upper-bounded wildcard, it is effectively read-only. Consider `List<? extends Serializable>`. We know that all elements are `Serializable`, so methods like `get()` return a value of type `Serializable`. The compiler won't let us call methods like `add()` because the actual element type of the list is unknown. You can't add arbitrary serializable objects to the list because their implementing class may not be of the correct type.

Since upper-bounded wildcards result in read-only collections, you might expect lower-bounded wildcards to result in write-only collections. This isn't actually the case, however. Suppose we have a `List<? super Integer>`. The actual element type is unknown, but the only possibilities are `Integer` or its ancestors Number and Object. Whatever the actual type is, it is safe to add Integer objects (but not Number or Object objects) to the list. And, whatever the actual element type is, all elements of the list are instances of Object, so List methods like get( ) return Object in this case.

Finally, let's turn our attention to the java.lang.Enum class. Enum serves as the supertype of all enumerated types (described later). It implements the Comparable interface but has a confusing generic signature:

```
public class Enum<E extends Enum<E>> implements Comparable<E>, Serializable
```

At first glance, the declaration of the type variable E appears circular. Take a closer look though: what this signature really says is that Enum must be parameterized by a type that is itself an Enum. The reason for this seemingly circular type variable declaration becomes apparent if we look at the implements clause of the signature. As we've seen, Comparable classes are usually defined to be comparable to themselves. And subclasses of those classes are comparable to their superclass instead. Enum, on the other hand, implements the Comparable interface not for itself but for a subclass E of itself!

4.2. Enumerated Types

In previous chapters, we've seen the `class` keyword used to define class types, and the `interface` keyword used to define interface types. This section introduces the `enum` keyword, which is used to define an enumerated type (informally called an enum). Enumerated types are new in Java 5.0, and the features described here cannot be used (although they can be partially simulated) prior to that release.

We begin with the basics: how to define and use an enumerated type, including common programming idioms involving enumerated types and values. Next, we discuss the more advanced features of enums and show how to simulate enums prior to Java 5.0.

4.2.1. Enumerated Types Basics

An *enumerated type* is a reference type with a finite (usually small) set of possible values, each of which is individually listed, or enumerated. Here is a simple enumerated type defined in Java:

```
public enum DownloadStatus { CONNECTING, READING, DONE, ERROR }
```

Like `class` and `interface`, the `enum` keyword defines a new reference type. The single line of Java code above defines an enumerated type named `DownloadStatus`. The body of this type is simply a comma-separated list of the four values of the type. These values are like `static final` fields (which is why their names are capitalized), and you refer to them with names like `DownloadStatus.CONNECTING`, `DownloadStatus.READING`, and so on. A variable of type `DownloadStatus` can be assigned one of these four values or `null` but nothing else. The values of an enumerated type are called *enumerated values* and are sometimes also referred to as *enum constants* .

It is possible to define more complex enumerated types than the one shown here, and we describe the complete `enum` syntax later in this chapter. For now, however, you can define simple, but very useful, enumerated types with this basic syntax.

4.2.1.1 Enumerated types are classes

Prior to the introduction of enumerated types in Java 5.0, the `DownloadStatus` values would probably have been implemented as integer constants with lines like the following in a class or interface:

```
public static final int CONNECTING = 1;
public static final int READING = 2;
public static final int DONE = 3;
public static final int ERROR = 4;
```

The use of integer constants has a number of shortcomings, the most important of which is its lack o type safety. If a method expects a download status constant value, for example, no error checking prevents me from passing an illegal value. The compiler can't tell me that I've used the constant `UploadStatus.DONE` when I should have used `DownloadStatus.DONE`.

Fortunately, enumerated types in Java are not simple integer constants. The type defined by an`enum` keyword is actually a class and its enumerated values are instances of that class. This providestype safety: if I try to pass a `DownloadStatus` value to a method that expects an `UploadStatus`, the compiler issues an error. Enumerated types do not have a public constructor, so a program cannot create a new undefined instance of the type. If a method expects a`DownloadStatus`, it can be confident that it will not be passed some unknown instance of the type.

If you are accustomed to writing code using integer constants instead of true enumerated types, you have probably already made a list of pragmatic advantages of integers over objects for enumerated values. Hold your judgment, however: the sections that follow illustrate common enumerated type programming idioms and demonstrate that anything you can do with integer constants can be done elegantly, efficiently, and more safely with `enums`. First, however, we consider the basic features of al enumerated types.

4.2.1.2 Features of enumerated types

The following list describes the basic facts about enumerated types. These are the features of enums that you need to know to understand and use them effectively:

- Enumerated types have no public constructor. The only instances of an enumerated type are those declared by the enum.
- Enums are not `Cloneable`, so copies of the existing instances cannot be created.
- Enums implement `java.io.Serializable` so they can be serialized, but the Java serialization mechanism handles them specially to ensure that no new instances are ever created.
- Instances of an enumerated type are immutable: each enum value retains its identity. (We'll see later in this chapter that you can add your own fields and methods to an enumerated type, which means that you can create enumerated values that have mutable portions. This is not recommended, but does not affect the basic identity of each value.)
- Instances of an enumerated type are stored in `public static final` fields of the type itself. Because these fields are `final`, they cannot be overwritten with inappropriate values: you can't assign the `DownloadStatus.ERROR` value to the `DownloadStatus.DONE` field, for example.
- By convention, the values of enumerated types are written using all capital letters, just as other `static final` fields are.
- Because there is a strictly limited set of distinct enumerated values, it is always safe to compare enum values using the `= =` operator instead of calling the `equals()` method.
- Enumerated types do have a working `equals( )` method, however. The method uses `= =` internally and is `final` so that it cannot be overridden. This working `equals( )` method allows enumerated values to be used as members of collections such as`Set`, `List`, and `Map`.

- Enumerated types have a working hashCode() method consistent with their equals( ) method. Like equals(), hashCode( ) is final. It allows enumerated values to be used with classes like java.util.HashMap.
- Enumerated types implement java.lang.Comparable, and the compareTo() method orders enumerated values in the order in which they appear in the enum declaration.
- Enumerated types include a working toString( ) method that returns the name of the enumerated value. For example, DownloadStatus.DONE.toString( ) returns the string "DONE" by default. This method is not final, and enum types can provide a custom implementation if they choose.
- Enumerated types provide a static valueOf( ) method that does the opposite of the default toString( ) method. For example, DownloadStatus.valueOf("DONE") would return DownloadStatus.DONE.
- Enumerated types define a final instance method named ordinal() that returns an integer for each enumerated value. The ordinal of an enumerated value represents its position (starting at zero) in the list of value names in the enum declaration. You do not typically need to use the ordinal( ) method, but it is used by a number of enum-related facilities, as described later in the chapter.
- Each enumerated type defines a static method named values( ) that returns an array of enumerated values of that type. This array contains the complete set of values, in the order they were declared, and is useful for iterating through the complete set of possible values. Because arrays are mutable, the values( ) method always returns a newly created and initialized array.
- Enumerated types are subclasses of java.lang.Enum, which is new in Java 5.0. (Enum is not itself an enumerated type.) You cannot produce an enumerated type by manually extending the Enum class, and it is a compilation error to attempt this. The only way to define an enumerated type is with the enum keyword.
- It is not possible to extend an enumerated type. Enumerated types are effectively final, but the final keyword is neither required nor permitted in their declarations. Because enums are effectively final, they may not be abstract. (We'll return to this point later in the chapter.)
- Like classes, enumerated types may implement interfaces. (We'll see how enumerated types may define methods later in the chapter.)

4.2.2. Using Enumerated Types

The following sections illustrate common idioms for working with enumerated types. They demonstrate the use of the switch statement with enumerated types and introduce the important new EnumSet and EnumMap collections.

4.2.2.1 Enums and the switch statement

In Java 1.4 and earlier, the switch statement works only with int, short, char, and byte values.

Because enumerated types have a finite set of values, they are ideally suited for use with the switch statement, and this statement has been extended in Java 5.0 to support the use of enumerated types. If the compile-time type of the switch expression is an enumerated type, the case labels must all be unqualified names of instances of that type. The following hypothetical code shows a switch statement used with the DownloadStatus enumerated type.

```
DownloadStatus status = imageLoader.getStatus();
switch(status) {
case CONNECTING:
    imageLoader.waitForConnection();
    imageLoader.startReading();
    break;
case READING:
    break;
case DONE:
    return imageLoader.getImage();
case ERROR:
    throw new IOException(imageLoader.getError());
}
```

Note that the case labels are just the constant name: the syntax of the switch statement does not allow the class name DownloadStatus to appear here. The ability to omit the class name is very convenient since it would otherwise appear in every single case. However the *requirement* that the class name be omitted is surprising since (in the absence of an import static declaration) the class name *is* required in every other context.

If the switch expression (status in the code above) evaluates to null, a NullPointerException is thrown. It is not legal to use null as the value of a case label.

If you use the switch statement on an enumerated type and do not include either a default: label or a case label for each enumerated value, the compiler will most likely issue an -Xlint warning letting you know that you have not written code to handle all possible values of the enumerated type.[5] Even when you do write a case for each enumerated value, you may still want to include a default: clause; this covers the possibility that a new value is added to the enumerated type after your switch statement has been compiled. The following default clause, for example, could be added to the switch statement shown earlier:

[5] At the time of this writing, this warning is expected to appear in Java 5.1.

```
default: throw new AssertionError("Unexpected enumerated value: " + status);
```

4.2.2.2 EnumMap

A common programming technique when using integer constants instead of true enumerated values is to use those constants as array indexes. For example, if the DownloadStatus values are defined as integers between 0 and 3, we can write code like this:

```
String[] statusLineMessages = new String[] {
    "Connecting...",   // CONNECTING
    "Loading...",      // READING
```

```
    "Done.",           // DONE
    "Download Failed." // ERROR
};

int status = getStatus();
String message = statusLineMessages[status];
```

In the big picture, this technique creates a mapping from enumerated integer constants to strings. We can't use Java's enumerated values as array indexes, but we can use them as keys in a `java.util.Map`. Because this is a common thing to do, Java 5.0 defines a new `java.util.EnumMap` class that is optimized for exactly this case. `EnumMap` requires an enumerated type as its key, and, relying on the fact the number of possible keys is finite, it uses an array to hold the corresponding values. This implementation means that `EnumMap` is more efficient than `HashMap`. The `EnumMap` equivalent of the code above is:

```
EnumMap<DownloadStatus,String> messages =
    new EnumMap<DownloadStatus,String>(DownloadStatus.class);
messages.put(DownloadStatus.CONNECTING, "Connecting...");
messages.put(DownloadStatus.READING,    "Loading...");
messages.put(DownloadStatus.DONE,       "Done.");
messages.put(DownloadStatus.ERROR,      "Download Failed.");

DownloadStatus status = getStatus();
String message = messages.get(status);
```

Like other collection classes in Java 5.0, `EnumMap` is a generic type that accepts type parameters.

The use of an `EnumMap` to associate a value with each instance of an enumerated type is appropriate when you're working with an enum defined elsewhere. If you defined the enum value yourself, you can create the necessary associations as part of the `enum` definition itself. We'll see how to do this later in the chapter.

4.2.2.3 EnumSet

Another common programming idiom when using integer-based constants instead of an enumerated type is to define all the constants as powers of two so that a set of those constants can be compactly represented as bit-flags in an integer. Consider the following flags that describe options that can apply to an American-style espresso drink:

```
public static final int SHORT      = 0x01;  // 8 ounces
public static final int TALL       = 0x02;  // 12 ounces
public static final int GRANDE     = 0x04;  // 16 ounces
public static final int DOUBLE     = 0x08;  // 2 shots of espresso
public static final int SKINNY     = 0x10;  // made with nonfat milk
public static final int WITH_ROOM  = 0x20;  // leave room for cream
public static final int SPLIT_SHOT = 0x40;  // half decaffeinated
public static final int DECAF      = 0x80;  // fully decaffeinated
```

These power-of-two constants can be combined with the bitwise OR operator (|) to create a compact set of constants that is easy to work with:

```
int drinkflags = DOUBLE | SHORT | WITH_ROOM;
```

The bitwise AND operator (&) can be used to test for the presence or absence of bits:

```
boolean isBig = (drinkflags & (TALL | GRANDE)) != 0;
```

If we step back from the binary representation of these bit flags and the boolean operators that manipulate them, we can see that integer bit flags are simply compact sets of values. For reference types such as Java's enumerated values, we can use a `java.util.Set` instead. Since this is an important and common thing to do with enumerated values, Java 5.0 provides the special-purpose `java.util.EnumSet` class. Like `EnumMap`, `EnumSet` is optimized for enumerated types. It requires that its members be values of the same enumerated type and uses a compact and fast representation of the set based on bit flags that correspond to the `ordinal()` of each enumerated value.

The espresso drink code above could be rewritten as follows using an `enum` and `EnumSet`:

```
public enum DrinkFlags {
    SHORT, TALL, GRANDE, DOUBLE, SKINNY, WITH_ROOM, SPLIT_SHOT, DECAF
}

EnumSet<DrinkFlags> drinkflags =
    EnumSet.of(DrinkFlags.DOUBLE, DrinkFlags.SHORT, DrinkFlags.WITH_ROOM);

boolean isbig =
    drinkflags.contains(DrinkFlags.TALL) ||
    drinkflags.contains(DrinkFlags.GRANDE);
```

Note that the code above can be made as compact as the integer-based code with a simple static import:

```
// Import all static DrinkFlag enum constants
import static com.davidflanagan.coffee.DrinkFlags.*;
```

See Section 2.10 in Chapter 2 for details on the `import static` declaration.

`EnumSet` defines a number of useful factory methods for initializing sets of enumerated values. The `of()` method shown above is overloaded: several versions of the method take different fixed numbers of arguments. A varargs (see Chapter 2) form that can accept any number of arguments is also defined. Here are some other ways that you can use `of()` and related `EnumSet` factories:

```
// Make the following examples fit on the page better
import static com.davidflanagan.coffee.DrinkFlags.*;

// We can remove individual members or sets of members from a set.
// Start with a set that includes all enumerated values, then remove a subset:
```

```
EnumSet<DrinkFlags> fullCaffeine = EnumSet.allOf(DrinkFlags.class);
fullCaffeine.removeAll(EnumSet.of(DECAF, SPLIT_SHOT));

// Here's another technique to achieve the same result:
EnumSet<DrinkFlags> fullCaffeine =
    EnumSet.complementOf(EnumSet.of(DECAF,SPLIT_SHOT));

// Here's an empty set if you ever need one
// Note that since we don't specify a value, we must specify the element type
EnumSet<DrinkFlags> plainDrink = EnumSet.noneOf(DrinkFlags.class);

// You can also easily describe a contiguous subset of values:
EnumSet<DrinkFlags> drinkSizes = EnumSet.range(SHORT, GRANDE);

// EnumSet is Iterable, and its iterator returns values in ordinal() order,
// so it is easy to loop through the elements of an EnumSet.
for(DrinkFlag size : drinkSizes) System.out.println(size);
```

The example code shown here demonstrates the use and capabilities of the `EnumSet` class. Note, however, that an `EnumSet<DrinkFlags>` is not really an appropriate representation for the description of an espresso drink. An `EnumSet<DrinkFlags>` might be overspecified, including both `SHORT` and `GRANDE`, for example, or it might be underspecified and include no drink size at all.

At the root, the problem is that the `DrinkFlag` type is a naive translation of the integer bit flags we began this section with. A better and more complete representation is captured by the following interface, which requires one value from each of five different enumerated types and a set of values from a sixth enum. The enums are defined as *nested types* within the interface itself (see Chapter 3). This example highlights the type safety provided by enumerated types. It is not possible (as it would be with integer constants) to specify a drink strength where a drink size is required, for example.

```
public interface Espresso {
    enum Drink { LATTE, MOCHA, AMERICANO, CAPPUCCINO, ESPRESSO }
    enum Size { SHORT, TALL, GRANDE }
    enum Strength { SINGLE, DOUBLE, TRIPLE, QUAD }
    enum Milk { SKINNY, ONE_PERCENT, TWO_PERCENT, WHOLE, SOY }
    enum Caffeine { REGULAR, SPLIT_SHOT, DECAF }
    enum Flags { WITH_ROOM, EXTRA_HOT, DRY }

    Drink getDrink();
    Size getSize();
    Strength getStrength();
    Milk getMilk();
    Caffeine getCaffeine();
    java.util.Set<Flags> getFlags();
}
```

4.2.3. Advanced Enum Syntax

The examples shown so far have all used the simplest `enum` syntax in which the body of the enum simply consists of a comma-separated list of value names. The full enum syntax actually provides quite a bit more power and flexibility:

- You can define your own fields, methods, and constructors for the enumerated type.
- If you define one or more constructors, you can invoke a constructor for each enumerated value by following the value name with constructor arguments in parentheses.
- Although an enum may not extend anything, it may implement one or more interfaces.
- Most esoterically, individual enumerated values can have their own class bodies that override methods defined by the type.

Rather than formally specifying the syntax for each of these advanced enum declarations, we'll demonstrate the syntax in the examples that follow.

4.2.3.1 The class body of an enumerated type

Consider the type Prefix, defined below. It is an enum that includes a regular class body following the list of enumerated values. It defines two instance fields and accessor methods for those fields. It defines a custom constructor that initializes the instance field. Each named value of the enumerated type is followed by constructor arguments in parentheses:

```
public enum Prefix {
    // These are the values of this enumerated type.
    // Each one is followed by constructor arguments in parentheses.
    // The values are separated from each other by commas, and the
    // list of values is terminated with a semicolon to separate it from
    // the class body that follows.
    MILLI("m",    .001),
    CENTI("c",    .01),
    DECI("d",     .1),
    DECA("D",   10.0),
    HECTA("h", 100.0),
    KILO("k", 1000.0);  // Note semicolon


    // This is the constructor invoked for each value above.
    Prefix(String abbrev, double multiplier) {
        this.abbrev = abbrev;
        this.multiplier = multiplier;
    }

    // These are the private fields set by the constructor
    private String abbrev;
    private double multiplier;

    // These are accessor methods for the fields.  They are instance methods
    // of each value of the enumerated type.
    public String abbrev() { return abbrev; }
```

```
    public double multiplier() { return multiplier; }
}
```

Note that enum syntax requires a semicolon after the last enumerated value if that value is followed by a class body. This semicolon may be omitted in the simple case where there is no class body. It is also worth noting that enum syntax allows a comma following the last enumerated value. A trailing comma looks somewhat odd but prevents syntax errors if in the future you add new enumerated values or rearrange existing ones.

4.2.3.2 Implementing an interface

An enum cannot be declared to extend a class or enumerated type. It is perfectly legal, however, for an enumerated type to implement one or more interfaces. Suppose, for example, that you defined a new enumerated type Unit with an abbrev( ) method like Prefix has. In this case, you might define an interface Abbrevable for any objects that have abbreviations. Your code might look like this:

```
public interface Abbrevable {
    String abbrev();
}

public enum Prefix implements Abbrevable {
    // the body of this enum type remains the same as above.
}
```

4.2.3.3 Value-specific class bodies

In addition to defining a class body for the enumerated type itself, you can also provide a class body for individual enumerated values within the type. We've seen above that we can add fields to an enumerated type and use a constructor to initialize those fields. This gives us value-specific data. The ability to define class bodies for each enumerated value means that we can write methods for each one: this gives us value-specific *behavior*. Value-specific behavior is useful when defining an enumerated type that represents an operator in an expression parser or an opcode in a virtual machine of some sort. The Operator.ADD constant might have a compute() method that behaves differently than the Operator.SUBTRACT constant, for example.

To define a class body for an individual enumerated value, simply follow the value name and its constructor arguments with the class body in curly braces. Individual values must still be separated from each other with commas, and the last value in the list must be separated from the type's class body with a semicolon: it can be easy to forget about this required punctuation with the presence of curly braces for class and method bodies.

Each value-specific class body you write results in the creation of ananonymous subclass of the enumerated type and makes the enumerated value a singleton instance of that anonymous subclass. (Enumerated types can not be extended, but they are not strictly final in the sense that final classes are since they can have these anonymous subclasses.) Because these subclasses are anonymous, you cannot refer to them in your code: the compile-time type of each enumerated value is the enumerated type, not the anonymous subclass specific to that value. Therefore, the only usefu thing you can do in value-specific class bodies is override methods defined by the type itself. If you define a new public field or method, you will not be able to refer to or invoke it. (It is perfectly legitimate, of course, to define helper methods or fields that you invoke or use from the overriding methods.)

A common pattern is to define default behavior in a method of the type-specific class body. Then, each enumerated value that requires behavior other than the default can override that method in its value-specific class body. A very useful variant of this pattern is to declare the method in the type-specific class body `abstract` and to define a value-specific implementation of the method for every enumerated value. If the type-specific method is `abstract`, the compiler forces you to implement that method for every enumerated value in the type: it is not possible to accidentally omit an implementation. Note that even though the type-specific class body contains an `abstract` method, the enumerated type as a whole is not `abstract` (and may not be declared `abstract`) since each value-specific class body implements the method.

The following code is an excerpt from a larger example that uses an enumerated type to represent the opcodes of a simulated stack-based CPU. The `Opcode` enumerated type defines an `abstract` method `perform()`, which is then implemented by the class body of each value of the type. The type includes a constructor to illustrate the full syntax for each enumerated value: name, constructor arguments, and class body. `enum` syntax requires the enumerated values and their class bodies to appear first. The code is easiest to understand, however, if you skip past the values and read the type-specific class body first:

```
// These are the opcodes that our stack machine can execute.
public enum Opcode {
    // Push the single operand onto the stack
    PUSH(1) {
        public void perform(StackMachine machine, int[] operands) {
            machine.push(operands[0]);
        }
    },   // Remember to separate enum values with commas

    // Add the top two values on the stack and push the result
    ADD(0) {
        public void perform(StackMachine machine, int[] operands) {
            machine.push(machine.pop() + machine.pop());
        }
    },

    /* Other opcode values have been omitted for brevity */

    // Branch if Equal to Zero
    BEZ(1) {
        public void perform(StackMachine machine, int[] operands) {
            if (machine.top() == 0) machine.setPC(operands[0]);
        }
    };    // Remember the required semicolon before the class body


    // This is the constructor for the type.
    Opcode(int numOperands) { this.numOperands = numOperands; }
```

```
    int numOperands;  // how many integer operands does it expect?

    // Each opcode constant must implement this abstract method in a
    // value-specific class body to perform the operation it represents.
    public abstract void perform(StackMachine machine, int[] operands);
}
```

4.2.3.3.1 When to use value-specific class bodies

Value-specific class bodies are an extremely powerful language feature when each enumerated value must perform a unique computation of some sort. Keep in mind, however, that value-specific class bodies are an advanced feature that is not commonly used and may be confusing to less experienced programmers. Before you decide to use this feature, be sure that it is necessary.

Before using value-specific class bodies, ensure that your design is neither too simple nor too complex for the feature. First, check that you do indeed require value-specific behavior and not simply value-specific data. Value-specific data can be encoded in constructor arguments as was shown in the `Prefix` example earlier. It would be unnecessary and inappropriate to rewrite that example to use value-specific versions of the `abbrev( )` method, for example.

Next, think about whether an enumerated type is sufficient for your needs. If your design requires value-specific methods with complex implementations or requires more than a few methods for each value, you may find it unwieldy to code everything within a single type. Instead, consider defining your own custom type hierarchy using traditional `class` and `interface` declarations and whatever singleton instances are necessary.

If value-specific behavior is indeed required within the framework of an enumerated type, value-specific class bodies are appropriate. Whether value-specific bodies are truly elegant or simply confusing is a matter of opinion, and some programmers prefer to avoid them when possible. An alternative that appeals to some is to encode the value-specific behavior in a type-specific method that uses a `switch` statement to treat each value as a separate `case`. The `compute( )` method of the following `enum` is an example. The simplicity of this enumerated type makes a `switch` statement a compelling alternative to value-specific class bodies:

```
public enum ArithmeticOperator {
    // The enumerated values
    ADD, SUBTRACT, MULTIPLY, DIVIDE;

    // Value-specific behavior using a switch statement
    public double compute(double x, double y) {
        switch(this) {
        case ADD:       return x + y;
        case SUBTRACT:  return x - y;
        case MULTIPLY:  return x * y;
        case DIVIDE:    return x / y;
        default: throw new AssertionError(this);
        }
    }

    // Test case for using this enum
    public static void main(String args[]) {
```

```
        double x = Double.parseDouble(args[0]);
        double y = Double.parseDouble(args[1]);
        for(ArithmeticOperator op : ArithmeticOperator.values())
            System.out.printf("%f %s %f = %f%n", x, op, y, op.compute(x,y));
    }
}
```

A shortcoming to the switch approach is that each time you add a new enumerated value, you must remember to add a corresponding case to the switch statement. And if there is more than one method that uses a switch statement, you'll have to maintain their switch statements in parallel. Forgetting to implement value-specific behavior using a switch statement leads to a runtime AssertionError. With a value-specific class body overriding an abstract method in the type-specific class body, the same omission leads to a compilation error and can be corrected sooner.

The performance of value-specific methods and switch statements in a type-specific method are quite similar. The overhead of virtual method invocation in one case is balanced by the overhead of the switch statement in the other. Value-specific class bodies result in the generation of additional class files, each of which has overhead in terms of storage space and loading time.

4.2.3.4 Restrictions on enum types

Java places a few restrictions on the code that can appear in an enumerated type. You won't encounter these restrictions that often in practice, but you should still be aware of them.

When you define an enumerated type, the compiler does a lot of work behind the scenes: it creates a class that extends java.lang.Enum and it generates the values() and valueOf() methods as well as the static fields that hold the enumerated values. If you include a class body for the type, you should not include members whose names conflict with the automatically generated members or with the final methods inherited from Enum.

enum types may not be declared final. Enumerated types are effectively final, and the compiler does not allow you to extend an enum. The class file generated for an enum is not technically declared final if the enum contains value-specific class bodies, however.

Types in Java may not be both final and abstract. Since enumerated types are effectively final, they may not be declared abstract. If the type-specific class body of an enum declaration contains an abstract method, the compiler requires that each enum value have a value-specific class body that includes an implementation of that abstract method. Considered as a self-contained whole, the enumerated type defined this way is not abstract.

The constructor, instance field initializers, and instance initializer blocks of an enumerated type are subject to a sweeping but obscure restriction: they may not use the static fields of the type (including the enumerated values themselves). The reason for this is that static initialization of enumerated types (and of all types) proceeds from top to bottom. The enumerated values are static fields that appear at the top of the type and are initialized first. Since they are self-typed fields, they invoke the constructor and any other instance initializer code of the type. This means that the instance initialization code is invoked before the static initialization of the class is complete. Since the static fields have not been initialized yet, the compiler does not allow them to be used. The only exception is static fields whose values are compile-time constant expressions (such as integers and strings) that the compiler resolves.

If you define a constructor for an enumerated type, it may not use the `super( )` keyword to invoke the superclass constructor. This is because the compiler automatically inserts hidden `name` and `ordinal` arguments into any constructor you define. If you define more than one constructor for the type, it is okay to use `this()` to invoke one constructor from the other. Remember that the class bodies of individual enumerated values (if you define any) are anonymous, which means that they cannot have any constructors at all.

4.2.4. The Typesafe Enum Pattern

For a deeper understanding of how the `enum` keyword works, or to be able to simulate enumerated types prior to Java 5.0, it is useful to understand the *Typesafe Enum Pattern*. This pattern is described definitively by Joshua Bloch[6] in his book *Effective Java Programming Language Guide* (Addison Wesley); we do not cover all the nuances here.

[6] Josh was cochair of the the JSR 201 committee that developed many of the new language features of Java 5.0. He is the creator of and the driving force behind enumerated types.

If you want to use the enumerated type `Prefix` (from earlier in the chapter) prior to Java 5.0, you could approximate it with a class like the following one. Note, however, that instances of this class won't work with the `switch` statement or with the `EnumSet` and `EnumMap` classes. Also, the code shown here does not include the `values()` or `valueOf( )` methods that the compiler generates automatically for true `enum` types. A class like this does not have special serialization support like an `enum` type does, so if you make it `Serializable`, you must provide a `readResolve( )` method to prevent deserialization from creating multiple instances of the enumerated values.

```
public final class Prefix {
    // These are the self-typed constants
    public static final Prefix MILLI = new Prefix("m",     .001);
    public static final Prefix CENTI = new Prefix("c",     .01);
    public static final Prefix DECI  = new Prefix("d",     .1);
    public static final Prefix DECA  = new Prefix("D",   10.0);
    public static final Prefix HECTA = new Prefix("h",  100.0);
    public static final Prefix KILO  = new Prefix("k", 1000.0);

    // Keep the fields private so the instances are immutable
    private String name;
    private double multiplier;

    // The constructor is private so no instances can be created except
    // for the ones above.
    private Prefix(String name, double multiplier) {
        this.name = name;
        this.multiplier = multiplier;
    }

    // These accessor methods are public
    public String toString() { return name; }
    public double getMultiplier() { return multiplier; }
}
```

4.3. Annotations

Annotations provide a way to associate arbitrary information or *metadata* with program elements. Syntactically, annotations are used like modifiers and can be applied to the declarations of packages, types, constructors, methods, fields, parameters, and local variables. The information stored in an annotation takes the form of *name=value* pairs, whose type is specified by the *annotation type*. The annotation type is a kind of interface that also serves to provide access to the annotation through the Java Reflection API.

Annotations can be used to associate any kind of information you want with a program element. The only fundamental rule is that an annotation cannot affect the way the program runs: the code must run identically even if you add or remove annotations. Another way to say this is that the Java interpreter ignores annotations (although it does make "runtime-visible" annotations available for reflective access through the Java Reflection API). Since the Java VM ignores annotations, an annotation type is not useful unless accompanied by a tool that can do something with the information stored in annotations of that type. In this chapter we'll cover standard annotation and meta-annotation types like `Override` and `Target`. The tool that accompanies these types is the Java compiler, which must process them in certain ways (as we'll describe later in this section).

It is easy to imagine any number of other uses for annotations.[7] A local variable might be annotated with a type named NonNull, as an assertion that the variable would never have a `null` value. An associated (hypothetical) code-analysis tool could then parse the code and attempt to verify the assertion. The JDK includes a tool named *apt* (for Annotation Processing Tool) that provides a framework for annotation processing tools: it scans source code for annotations and invokes specially written annotation processor classes that you provide. See Chapter 8 for more on *apt*. Annotations will probably find their widest use in enterprise programming where they may replace tools such as *XDoclet*, which processes metadata embedded in ad-hoc javadoc comments.

[7] We won't have to imagine these uses for long. At the time of this writing, JSR 250 is making its way through the Java Community Process to define a standard set of common annotations for J2SE and J2EE.

This section begins with an introduction to annotation-related terminology. We then cover the standard annotation types introduced in Java 5.0, annotations supported by *javac* that you can use in your programs right away. Next, we describe the syntax for writing arbitrary annotations and briefly cover the use of the Java Reflection API for querying annotations at runtime. At this point, we move on to more esoteric material on defining new annotation types, a task that few programmers will eve need to do. This final part of the chapter also discusses meta-annotations.

4.3.1. Annotation Concepts and Terminology

The key concept to understand about annotations is that an annotation simply associates information or metadata with a program element. Annotations *never affect the way a Java program runs*, but they may affect things like compiler warnings or the behavior of auxiliary tools such as documentation generators, stub generators, and so forth.

The following terms are used frequently when discussing annotations. Of particular importance is the distinction between *annotation* and *annotation type*.

annotation

An *annotation* associates arbitrary information or metadata with a Java program element. Annotations use new syntax introduced in Java 5.0 and behave like modifiers such as `public` or `final`. Each annotation has a name and zero or more members. Each member has a name and a value, and it is these *`name=value`* pairs that carry the annotation's information.

annotation type

The name of an annotation as well as the names, types, and default values of its members are defined by the *annotation type*. An annotation type is essentially a Java interface with some restrictions on its members and some new syntax used in its declaration. When you query an annotation using the Java Reflection API, the returned value is an object that implements the annotation type interface and allows individual annotation members to be queried. Java 5.0 includes three standard annotation types in the `java.lang` package. We'll see these annotations in Section 4.3.2 later in this chapter.

annotation member

The *members* of an annotation are declared in an annotation type as no-argument methods. The method name and return type define the name and type of the member. A special `default` syntax allows the declaration of a default value for any annotation member. An annotation appearing on a program element includes *`name=value`* pairs that define values for all annotation members that do not have default values and may also include values that override the defaults of other members.

marker annotation

An annotation type that defines no members is called a *marker annotation*. An annotation of this type carries information simply by its presence or absence.

meta-annotation

A *meta-annotation* is an annotation applied to the declaration of an annotation type. Java 5.0 includes several standard meta-annotation types in the `java.lang.annotation` package. They are used to specify things like which program elements the annotation can be applied to.

target

The *target* of an annotation is the program element that is annotated. Annotations can be applied to packages, types (classes, interfaces, enumerated types, and even annotation types) type members (methods, constructors, fields, and enumerated values), method parameters, and local variables (including loop variables and `catch` parameters). The declaration of an annotation type may include a *meta-annotation* that restricts the allowable targets for that type of annotation.

retention

The *retention* of an annotation specifies how long the information contained in the annotation is retained. Some annotations are discarded by the compiler and appear only in source code. Others are compiled into the class file. Of those that are compiled into the class file, some are ignored by the virtual machine, and others are read by the virtual machine when the class that contains them is loaded. The declaration of an annotation type can use a *meta-annotation* to specify the retention for annotations of that type. Annotations that are loaded by the VM are *runtime-visible* and can be queried by the reflective APIs of `java.lang.reflect`.

metadata

When discussing annotations, the term *metadata* commonly refers to the information carried by an annotation or to the annotation itself. Because this term is used in many different ways in computer programming literature, I have avoided using it in this chapter.

4.3.2. Using Standard Annotations

Java 5.0 defines three standard annotation types in the `java.lang` package. The following sections describe these annotation types and explain how to use them to annotate your code.

4.3.2.1 Override

`java.lang.Override` is a marker annotation type that can be used to annotate methods but no other program element. An annotation of this type serves as an assertion that the annotated method overrides a method of a superclass. If you use this annotation on a method that does not override a superclass method, the compiler issues a compilation error to alert you to this fact.

This annotation is intended to address a common category of programming errors that result when you attempt to override a superclass method but get the method name or signature wrong. In this case, you may have overloaded the method name but not actually overridden the method, and your code never gets invoked.

To use this annotation type, simply include `@Override` in the modifiers of the desired method. By convention, `@Override` comes before other modifiers. Also by convention, there is no space between the `@` character and the name `Override`, even though it is technically allowed. Note that because the `java.lang` package is always automatically imported, you never need to include the package name to use this annotation type. Here is an example in which the `@Override` annotation is used on a method that fails to correctly override the `toString()` method of its superclass.

```
@Override
public String toSting() {   // Oops.  Note the misspelling here!
    // Simply put square brackets around our superclass's output
    return "[" + super.toString() + "]";
}
```

Without the annotation, the typo might go unnoticed and we'd have a puzzling bug: why isn't the `toString( )` method working correctly? But with the annotation, the compiler gives us the answer: the `toString()` method does not work as expected because it is not actually overridden.

Note that the `@Override` annotation applies only to methods that are intended to override a superclass method and not to methods that are intended to implement a method defined in an interface. The compiler already produces an error if you fail to correctly implement an interface method.

4.3.2.2 Deprecated

`java.lang.Deprecated` is a marker annotation that is similar to the `@deprecated` javadoc tag. (See Chapter 7 for details on writing Java documentation comments.) If you annotate a type or type member with `@Deprecated`, it tells the compiler that use of the annotated element is discouraged. If you use (or extend or override) a deprecated type or member from code that is not itself declared `@Deprecated`, the compiler issues a warning.

Note that the `@Deprecated` annotation type does not deprecate the `@deprecated` javadoc tag. The `@Deprecated` annotation is intended for the Java compiler. The javadoc tag, on the other hand, is intended for the *javadoc* tool and serves as documentation: it may include a description of why the program element has been deprecated and what it has been superseded by or replaced with.

In Java 5.0, the compiler continues to look for `@deprecated` javadoc tags and uses them to generate warnings as it always has. This behavior may be phased out, however, and you should begin to use the `@Deprecated` annotation in addition to the `@deprecated` javadoc tag.

Here is an example that uses both the annotation and the javadoc tag:

```
/**
 * The Sony Betamax video cassette format.
 * @deprecated No one has players for this format any more.  Use VHS instead.
 */
@Deprecated public class Betamax { ... }
```

4.3.2.3 SuppressWarnings

The `@SuppressWarnings` annotation is used to selectively turn off compiler warnings for classes, methods, or field and variable initializers.[8] In Java 5.0, Sun's *javac* compiler has a powerful `-Xlint` option that causes it to issue warnings about "lint" in your program code that is legal but is likely to represent a programming error. These warnings include the "unchecked warning" that appears when you use a generic collection class without specifying a value for its type parameters, for example, or the warning that appears if a case in a switch statement does not end with a break, return, or tHRow and allows control to "fall through" to the next case.

[8] The *javac* compiler did not yet support the @SuppressWarnings annotation when this chapter was written. Full support is expected in Java 5.1.

Typically, when you see one of these lint warnings from the compiler, you should investigate the code that caused it. If it truly represents an error, you then correct it. If it simply represents sloppy programming, you may be able to rewrite your code so that the warning is no longer necessary. For example, if the warning tells you that you have not covered all possible cases in a switch statement on an enumerated type, you can avoid the warning by adding a defensive default case to the switch statement, even if you are sure that it will never be invoked.

On the other hand, sometimes there is nothing you can do to avoid the error. For example, if you use a generic collection class in code that must interact with nongeneric legacy code, you cannot avoid an unchecked warning. This is where @SuppressWarnings comes in: add this annotation to the nearest relevant set of modifiers (typically on method modifiers) to tell the compiler that you're aware of the issue and that it should stop pestering you about it.

Unlike Override and Deprecated, SuppressWarnings is not a marker annotation. It has a single member named value whose type is String[ ]. The value of this member is the names of the warnings to be suppressed. The SuppressWarnings annotation does not define what warning names are allowed: this is an issue for compiler implementors. For the *javac* compiler, the warning names accepted by the -Xlint option are also legal for the @SuppressWarnings annotation. It is legal to specify any warning names you want: compilers ignore (but may warn about) warning names they do not recognize.

So, to suppress warnings named unchecked and fallthrough, you could use an annotation that looks like the following. Annotation syntax follows the name of the annotation type with a parenthesized, comma-separated list of *name=value* pairs. In this case, the SuppressWarnings annotation type defines only a single member, so there is only a single pair within parentheses. Since the member value is an array, curly braces are used to delimit array elements:

```
@SuppressWarnings(value={"unchecked","fallthrough"})
public void lintTrap() { /* sloppy method body omitted */ }
```

We can abbreviate this annotation somewhat. When an annotation has a single member and that member is named "value", you are allowed (and encouraged) to omit the "value=" in the annotation. So the annotation above should be rewritten as:

```
@SuppressWarnings({"unchecked","fallthrough"})
```

Hopefully you will not often have more than one unresolvable lint warning in any particular method and will need to suppress only a single named warning. In this case, another annotation abbreviation is possible. When writing an array value that contains only a single member, you are allowed to omit the curly braces. In this case we might have an annotation like this:

```
@SuppressWarnings("unchecked")
```

4.3.3. Annotation Syntax

In the descriptions of the standard annotation types, we've seen the syntax for writing marker annotations and the syntax for writing single-member annotations, including the shortcut allowed when the single member is named "value" and the shortcut allowed when an array-typed member has only a single array element. This section describes the complete syntax for writing annotations.

An annotation consists of the `@` character followed by the name of the annotation type (which may include a package name) followed by a parenthesized, comma-separated list of *`name=value`* pairs for each of the members defined by the annotation type. Members may appear in any order and may be omitted if the annotation type defines a default value for that member. Each *`value`* must be a literal or compile-time constant, a nested annotation, or an array.

Near the end of this chapter, we define an annotation type named `Reviews` that has a single member that is an array of `@Review` annotations. The `Review` annotation type has three members: "reviewer" is a `String`, "comment" is an optional `String` with a default value, and "grade" is a value of the nested enumerated type `Review.Grade`. Assuming that the `Reviews` and `Review` types are properly imported, an annotation using these types might look like this (note the use of nested annotations, enumerated types, and arrays in this annotation):

```
@Reviews({  // Single-value annotation, so "value=" is omitted here
    @Review(grade=Review.Grade.EXCELLENT,
            reviewer="df"),
    @Review(grade=Review.Grade.UNSATISFACTORY,
            reviewer="eg",
            comment="This method needs an @Override annotation")
})
```

Another important rule of annotation syntax is that no program element may have more than one instance of the same annotation. It is not legal, for example, to simply place multiple `@Review` annotations on a class. This is why the `@Reviews` annotation is defined to allow an array of `@Review` annotations.

4.3.3.1 Annotation member types and values

The values of annotation members must be non-`null` compile-time constant expressions that are assignment-compatible with the declared type of the member. Allowed member types are the primitive types, `String`, `Class`, enumerated types, annotation types, and arrays of any of the above types (but not an array of arrays). For example, the expressions `2*Math.PI` and "`hello"+"world`" are legal values for members of type `double` and `String`, respectively.

Near the end of the chapter, we define an annotation type named `UncheckedExceptions` whose sole member is an array of classes that extend `RuntimeException`. An annotation of this type might look like this:

```
@UncheckedExceptions({
    IllegalArgumentException.class, StringIndexOutOfBoundsException.class
})
```

4.3.3.2 Annotation targets

Annotations are most commonly placed on type definitions (such as classes) and their members (such as methods and fields). Annotations may also appear on packages, parameters, and local variables. This section provides more information about these less common annotation targets.

A package annotation appears before the `package` declaration in a file named *package-info.java*. This file should not contain any type declarations ("package-info" is not a legal Java identifier, so it cannot contain any public type definitions). Instead, it should contain an optional javadoc comment, zero or more annotations, and a `package` declaration. For example:

```
/**
 * This package holds my custom annotation types.
 */
@com.davidflanagan.annotations.Author("David Flanagan")
package com.davidflanagan.annotations;
```

When the *package-info.java* file is compiled, it produces a class file named *package-info.class* that contains a synthetic interface declaration. This interface has no members, and its name, `package-info`, is not a legal Java identifier, so it cannot be used in Java source code. It exists simply as a placeholder for package annotations with class or runtime retention.

Note that package annotations appear outside the scope of any `package` or `import` declaration. This means that package annotations should always include the package name of the annotation type (unless the package is `java.lang`).

Annotations on method parameters, catch clause parameters, and local variables simply appear as part of the modifier list for those program elements. The Java class file format has no provision for storing annotations on local variables or catch clause parameters, so those annotations always have source retention. Method parameter annotations can be retained in the class file, however, and may have class or runtime retention.

Finally, note that the syntax for enumerated type definitions does not allow any modifiers to be specified for enumerated values. It does, however, allow annotations on any of the values.

4.3.3.3 Annotations and defaults

Annotations must include a value for every member that does not have a default value defined by the annotation type. Annotations may, of course, include values for other members as well.

There is one important detail to understand about how default values are handled. Default values are stored in the class file of the annotation type and are not compiled into annotations themselves. If you modify an annotation type so that the default value of one of its members changes, that change affects all annotations of that type that do not specify an explicit value for that member. Already-compiled annotations are affected, even if they are never recompiled after the change to the type.

4.3.4. Annotations and Reflection

The Reflection API of java.lang.reflect has been extended in Java 5.0 to support reading of runtime-visible annotations. (Remember that an annotation is only visible at runtime if its annotation type is specified to have runtime retention, that is, if the annotation is both stored in the class file and read by the Java VM when the class file is loaded.) This section briefly covers the new reflective capabilities. For full details, look up the interface java.lang.reflect.AnnotatedElement in the reference section. AnnotatedElement represents a program element that can be queried for annotations. It is implemented by java.lang.Package, java.lang.Class, and indirectly implemented by the Method, Constructor, and Field classes of java.lang.reflect. Annotations on method parameters can be queried with the getParameterAnnotations( ) method of the Method or Constructor class.

The following code uses the isAnnotationPresent( ) method of AnnotatedElement to determine whether a method is unstable by checking for an @Unstable annotation. It assumes that the Unstable annotation type, which we'll define later in the chapter, has runtime retention. Note that this code uses class literals to specify both the class to be checked and the annotation to check for:

```
import java.lang.reflect.*;

Class c = WhizzBangClass.class;
Method m = c.getMethod("whizzy", int.class, int.class);
boolean unstable = m.isAnnotationPresent(Unstable.class);
```

isAnnotationPresent() is useful for marker annotations. When working with annotations that have members, though, we typically want to know the value of those members. For this, we use the getAnnotation() method. And here we see the beauty of the Java annotation system: if the specified annotation exists, the object returned by this method implements the annotation type interface, and you can query the value of any member simply by invoking the annotation type method that defines that member. Consider the @Reviews annotation that appeared earlier in the chapter, for example. If the annotation type was declared with runtime retention, you could query it as follows:

```
AnnotatedElement target = WhizzBangClass.class; // the type to query
// Ask for the @Reviews annotation as an object that implements Reviews
Reviews annotation = target.getAnnotation(Reviews.class);
// Reviews has a single member named "value" that is an array of reviews
Review[] reviews = annotation.value();
// Loop through the reviews
for(Review r : reviews) {
    Review.Grade grade = r.grade();
    String reviewer = r.reviewer();
    String comment = r.comment();
    System.out.printf("%s assigned a grade of %s and comment '%s'%n",
                      reviewer, grade, comment);
}
```

Note that these reflective methods correctly resolve default annotation values for you. If an annotation does not include a value for a member with a default value, the default value is looked up within the annotation type itself.

4.3.5. Defining Annotation Types

An annotation type is an interface, but it is not a normal one. An annotation type differs from a normal interface in the following ways:

- An annotation type is defined with the keyword `@interface` rather than with `interface`. An `@interface` declaration implicitly extends the interface `java.lang.annotation.Annotation` and may not have an explicit `extends` clause of its own.
- The methods of an annotation type must be declared with no arguments and may not throw exceptions. These methods define annotation members: the method name becomes the member name, and the method return type becomes the member type.
- The return value of annotation methods may be a primitive type, a `String`, a `Class`, an enumerated type, another annotation type, or a single-dimensional array of one of those types.
- Any method of an annotation type may be followed by the keyword `default` and a value compatible with the return type of the method. This strange new syntax specifies the default value of the annotation member that corresponds to the method. The syntax for default values is the same as the syntax used to specify member values when writing an annotation. `null` is never a legal default value.
- Annotation types and their methods may not have type parametersannotation types and members cannot be made generic. The only valid use of generics in annotation types is for methods whose return type is `Class`. These methods may use a bounded wildcard to specify a constraint on the returned class.

In other ways, annotation types declared with `@interface` are just like regular interfaces. They may include constant definitions and static member types such as enumerated type definitions. Annotation types may also be implemented or extended just as normal interfaces are. (The classes and interfaces that result from doing this are not themselves annotation types, however: annotation types can be created only with an `@interface` declaration.)

We now define the annotation types used in our examples. These examples illustrate the syntax of annotation type declarations and demonstrate many of the differences between `@interface` and `interface`. We start with the simple marker annotation type `Unstable`. Because we used this type earlier in the chapter in a reflection example, its definition includes a meta-annotation that gives it runtime retention and makes it accessible to the reflection API. Meta-annotations are covered below.

```
package com.davidflanagan.annotations;
import java.lang.annotation.*;

/**
 * Specifies that the annotated element is unstable and its API is
 * subject to change.
 */
@Retention(RetentionPolicy.RUNTIME)
public @interface Unstable {}
```

The next annotation type defines a single member. By naming the member `value`, we enable a syntactic shortcut for anyone using the annotation:

```
/**
 * Specifies the author of a program element.
 */
public @interface Author {
    /** Return the name of the author */
    String value();
}
```

The next example is more complex. The Reviews annotation type has a single member, but the type of the member is complex: it is an array of Review annotations. The Review annotation type has three members, one of which has an enumerated type defined as a member of the Review type itself, and another of which has a default value. Because the Reviews annotation type is used in a reflection example, we've given it runtime retention with a meta-annotation:

```
import java.lang.annotation.*;

/**
 * An annotation of this type specifies the results of one or more
 * code reviews for the annotated element
 */
@Retention(RetentionPolicy.RUNTIME)
public @interface Reviews {
    Review[] value();
}

/**
 * An annotation of this type represents a single code review of the
 * annotated element.  Every review must specify the name of the reviewer
 * and the grade assigned to the code.  Optionally, reviews may also include
 * a comment string.
 */
public @interface Review {
    // Nested enumerated type
    public static enum Grade { EXCELLENT, SATISFACTORY, UNSATISFACTORY };

    // These methods define the annotation members
    Grade grade();                // member named "grade" with type Grade
    String reviewer();
    String comment() default "";  // Note default value here.
}
```

Finally, suppose we wanted to annotate methods to list the unchecked exceptions (but not errors) that they might throw. Our annotation type would have a single member of array type. Each element of the array would be the Class of an exception. In order to enforce the requirement that only unchecked exceptions are used, we use a bounded wildcard on Class:

```
public @interface UncheckedExceptions {
    Class<? extends RuntimeException>[] value();
```

```
}
```

4.3.6. Meta-Annotations

Annotation types can themselves be annotated. Java 5.0 defines four standard *meta-annotation* types that provide information about the use and meaning of other annotation types. These types and their supporting classes are in the `java.lang.annotation` package, and you can find complete details in the quick-reference section of the book.

4.3.6.1 Target

The `Target` meta-annotation type specifies the "targets" for an annotation type. That is, it specifies which program elements may have annotations of that type. If an annotation type does not have a `Target` meta-annotation, it can be used with any of the program elements described earlier. Some annotation types, however, make sense only when applied to certain program elements. `Override` is one example: it is only meaningful when applied to a method. An `@Target` meta-annotation applied to the declaration of the `Override` type makes this explicit and allows the compiler to reject an `@Override` when it appears in an inappropriate context.

The `Target` meta-annotation type has a single member named `value`. The type of this member is `java.lang.annotation.ElementType[]`. `ElementType` is an enumerated type whose enumerated values represent program elements that can be annotated.

4.3.6.2 Retention

We discussed annotation *retention* earlier in the chapter. It specifies whether an annotation is discarded by the compiler or retained in the class file, and, if it is retained in the class file, whether it is read by the VM when the class file is loaded. By default, annotations are stored in the class file but not available for runtime reflective access. The three possible retention values (source, class, and runtime) are described by the enumerated type `java.lang.annotation.RetentionPolicy`.

The `Retention` meta-annotation type has a single member named `value` whose type is `RetentionPolicy`.

4.3.6.3 Documented

`Documented` is a meta-annotation type used to specify that annotations of some other type should be considered part of the public API of the annotated program element and should therefore be documented by tools like *javadoc*. `Documented` is a marker annotation: it has no members.

4.3.6.4 Inherited

The `@Inherited` meta-annotation is a marker annotation that specifies that the annotated type is an inherited one. That is, if an annotation type `@Inherited` is used to annotate a class, the annotation applies to subclasses of that class as well.

Note that `@Inherited` annotation types are inherited only by subclasses of an annotated class. Classes do not inherit annotations from interfaces they implement, and methods do not inherit annotations from methods they override.

The Reflection API enforces the inheritance if the `@Inherited` annotation type is also annotated `@Retention(RetentionPolicy.RUNTIME)`. If you use `java.lang.reflect` to query a class for an annotation of an `@Inherited` type, the reflection code checks the specified class and each of its ancestors until an annotation of the specified type is found or the top of the class hierarchy is reached.

Chapter 5. The Java Platform

Chapters Chapter 2, Chapter 3, and Chapter 4 documented the Java programming language. This chapter switches gears and covers the Java platforma vast collection of predefined classes available to every Java program, regardless of the underlying host system on which it is running. The classes of the Java platform are collected into related groups, known as*packages*. This chapter begins with an overview of the packages of the Java platform that are documented in this book. It then moves on to demonstrate, in the form of short examples, the most useful classes in these packages. Most of the examples are code snippets only, not full programs you can compile and run. For fully fleshed-out, real-world examples, see *Java Examples in a Nutshell* (O'Reilly). That book expands greatly on this chapter and is intended as a companion to this book.

Team LiB

5.1. Java Platform Overview

Table 5-1 summarizes the key packages of the Java platform that are covered in this book.

Table 5-1. Key packages of the Java platform

Package	Description
`java.io`	Classes and interfaces for input and output. Although some of the classes in this package are for working directly with files, most are for working with streams of bytes or characters.
`java.lang`	The core classes of the language, such as `String`, `Math`, `System`, `THRead`, and `Exception`.
`java.lang.annotation`	Annotation types and other supporting types for the Java 5.0 annotation feature. (See Chapter 4.)
`java.lang.instrument`	Support classes for Java virtual machine instrumentation agents, which are allowed to modify the byte code of the program the JVM is running. New in Java 5.0.
`java.lang.management`	A framework for monitoring and managing a running Java virtual machine. New in Java 5.0.
`java.lang.ref`	Classes that define weak references to objects. A weak reference is one that does not prevent the referent object from being garbage-collected.
`java.lang.reflect`	Classes and interfaces that allow Java programs to reflect on themselves by examining the constructors, methods, and fields of classes.
`java.math`	A small package that contains classes for arbitrary-precision integer and floating-point arithmetic.
`java.net`	Classes and interfaces for networking with other systems.
`java.nio`	Buffer classes for the New I/O API. Added in Java 1.4.
`java.nio.channels`	Channel and selector interfaces and classes for high-performance, nonblocking I/O.
`java.nio.charset`	Character set encoders and decoders for converting Unicode strings to and from bytes.
`java.security`	Classes and interfaces for access control and authentication. This package and its subpackages support cryptographic message digests and digital signatures.

Package	Description
`java.text`	Classes and interfaces for working with text in internationalized applications.
`java.util`	Various utility classes, including the powerful collections framework for working with collections of objects.
`java.util.concurrent`	Thread pools and other utility classes for concurrent programming. Subpackages support atomic variables and locks. New in Java 5.0.
`java.util.jar`	Classes for reading and writing JAR files.
`java.util.logging`	A flexible logging facility. Added in Java 1.4.
`java.util.prefs`	An API to read and write user and system preferences. Added in Java 1.4.
`java.util.regex`	Text pattern matching using regular expressions. Added in Java 1.4.
`java.util.zip`	Classes for reading and writing ZIP files.
`javax.crypto`	Classes and interfaces for encryption and decryption of data.
`javax.net`	Defines factory classes for creating sockets and server sockets. Enables the creation of socket types other than the default.
`javax.net.ssl`	Classes for encrypted network communication using the Secure Sockets Layer (SSL).
`javax.security.auth`	The top-level package for the JAAS API for authentication and authorization. Various subpackages hold most of the actual classes. Added in Java 1.4.
`javax.xml.parsers`	A high-level API for parsing XML documents using pluggable DOM and SAX parsers.
`javax.xml.transform`	A high-level API for transforming XML documents using a pluggable XSLT transformation engine and for converting XML documents between streams, DOM trees, and SAX events. Subpackages provide support for DOM, SAX and stream transformations. Added in Java 1.4.

Table 5-1 does not list all the packages in the Java platform, only the most important of those documented in this book. Java also defines numerous packages for graphics andgraphical user interface programming and for distributed, or enterprise, computing. The graphics and GUI packages are `java.awt` and `javax.swing` and their many subpackages. These packages are documented in *Java Foundation Classes in a Nutshell* and *Java Swing*, both from O'Reilly. The enterprise packages of Java include `java.rmi`, `java.sql`, `javax.jndi`, `org.omg.CORBA`, `org.omg.CosNaming`, and all of their subpackages. These packages, as well as several standard extensions to the Java platform, are documented in *Java Enterprise in a Nutshell* (O'Reilly).

Team LiB

5.2. Text

Most programs manipulate text in one form or another, and the Java platform defines a number of important classes and interfaces for representing, formatting, and scanning text. The sections that follow provide an overview.

5.2.1. The String Class

Strings of text are a fundamental and commonly used data type. In Java, however, strings are not a primitive type, like `char`, `int`, and `float`. Instead, strings are represented by the `java.lang.String` class, which defines many useful methods for manipulating strings. `String` objects are *immutable*: once a `String` object has been created, there is no way to modify the string of text it represents. Thus, each method that operates on a string typically returns a new `String` object that holds the modified string.

This code shows some of the basic operations you can perform on strings:

```
// Creating strings
String s = "Now";                // String objects have a special literal syntax
String t = s + " is the time."; // Concatenate strings with + operator
String t1 = s + " " + 23.4;     // + converts other values to strings
t1 = String.valueOf('c');       // Get string corresponding to char value
t1 = String.valueOf(42);        // Get string version of integer or any value
t1 = object.toString();         // Convert objects to strings with toString()

// String length
int len = t.length();           // Number of characters in the string: 16

// Substrings of a string
String sub = t.substring(4);    // Returns char 4 to end: "is the time."
sub = t.substring(4, 6);        // Returns chars 4 and 5: "is"
sub = t.substring(0, 3);        // Returns chars 0 through 2: "Now"
sub = t.substring(x, y);        // Returns chars between pos x and y-1
int numchars = sub.length();    // Length of substring is always (y-x)

// Extracting characters from a string
char c = t.charAt(2);           // Get the 3rd character of t: w
char[] ca = t.toCharArray();    // Convert string to an array of characters
t.getChars(0, 3, ca, 1);        // Put 1st 3 chars of t into ca[1]-ca[3]

// Case conversion
String caps = t.toUpperCase();  // Convert to uppercase
String lower = t.toLowerCase(); // Convert to lowercase

// Comparing strings
```

```
boolean b1 = t.equals("hello");         // Returns false: strings not equal
boolean b2 = t.equalsIgnoreCase(caps);  // Case-insensitive compare: true
boolean b3 = t.startsWith("Now");       // Returns true
boolean b4 = t.endsWith("time.");       // Returns true
int r1 = s.compareTo("Pow");            // Returns < 0: s comes before "Pow"
int r2 = s.compareTo("Now");            // Returns 0: strings are equal
int r3 = s.compareTo("Mow");            // Returns > 0: s comes after "Mow"
r1 = s.compareToIgnoreCase("pow");      // Returns < 0 (Java 1.2 and later)

// Searching for characters and substrings
int pos = t.indexOf('i');         // Position of first 'i': 4
pos = t.indexOf('i', pos+1);      // Position of the next 'i': 12
pos = t.indexOf('i', pos+1);      // No more 'i's in string, returns -1
pos = t.lastIndexOf('i');         // Position of last 'i' in string: 12
pos = t.lastIndexOf('i', pos-1);  // Search backwards for 'i' from char 11

pos = t.indexOf("is");            // Search for substring: returns 4
pos = t.indexOf("is", pos+1);     // Only appears once: returns -1
pos = t.lastIndexOf("the ");      // Search backwards for a string
String noun = t.substring(pos+4); // Extract word following "the"

// Replace all instances of one character with another character
String exclaim = t.replace('.', '!');  // Works only with chars, not substrings

// Strip blank space off the beginning and end of a string
String noextraspaces = t.trim();

// Obtain unique instances of strings with intern()
String s1 = s.intern();        // Returns s1 equal to s
String s2 = "Now";             // String literals are automatically interned
boolean equals = (s1 == s2);   // Now can test for equality with ==
```

5.2.2. The Character Class

As you know, individual characters are represented in Java by the primitive char type. The Java platform also defines a Character class, which contains useful class methods for checking the type of a character and for converting the case of a character. For example:

```
char[] text;  // An array of characters, initialized somewhere else
int p = 0;    // Our current position in the array of characters
// Skip leading whitespace
while((p < text.length) && Character.isWhitespace(text[p])) p++;
// Capitalize the first word of text
while((p < text.length) && Character.isLetter(text[p])) {
  text[p] = Character.toUpperCase(text[p]);
  p++;
}
```

5.2.3. The StringBuffer Class

Since `String` objects are immutable, you cannot manipulate the characters of an instantiated `String`. If you need to do this, use a `java.lang.StringBuffer` or `java.lang.StringBuilder` instead. These two classes are identical except that `StringBuffer` has `synchronized` methods. `StringBuilder` was introduced in Java 5.0 and you should use it in preference to `StringBuffer` unless it might actually be manipulated by multiple threads. The following code demonstrates the `StringBuffer` API but could be easily changed to use `StringBuilder`:

```
// Create a string buffer from a string
StringBuffer b = new StringBuffer("Mow");

// Get and set individual characters of the StringBuffer
char c = b.charAt(0);        // Returns 'M': just like String.charAt()
b.setCharAt(0, 'N');         // b holds "Now": can't do that with a String!

// Append to a StringBuffer
b.append(' ');               // Append a character
b.append("is the time.");    // Append a string
b.append(23);                // Append an integer or any other value

// Insert Strings or other values into a StringBuffer
b.insert(6, "n't");          // b now holds: "Now isn't the time.23"

// Replace a range of characters with a string (Java 1.2 and later)
b.replace(4, 9, "is");       // Back to "Now is the time.23"

// Delete characters
b.delete(16, 18);            // Delete a range: "Now is the time"
b.deleteCharAt(2);           // Delete 2nd character: "No is the time"
b.setLength(5);              // Truncate by setting the length: "No is"

// Other useful operations
b.reverse();                 // Reverse characters: "si oN"
String s = b.toString();     // Convert back to an immutable string
s = b.substring(1,2);        // Or take a substring: "i"
b.setLength(0);              // Erase buffer; now it is ready for reuse
```

5.2.4. The CharSequence Interface

As of Java 1.4, both the `String` and the `StringBuffer` classes implement the `java.lang.CharSequence` interface, which is a standard interface for querying the length of and extracting characters and subsequences from a readable sequence of characters. This interface is also implemented by the `java.nio.CharBuffer` interface, which is part of the New I/O API that was introduced in Java 1.4. `CharSequence` provides a way to perform simple operations on strings of characters regardless of the underlying implementation of those strings. For example:

```
/**
 * Return a prefix of the specified CharSequence that starts at the first
```

```
 * character of the sequence and extends up to (and includes) the first
 * occurrence of the character c in the sequence. Returns null if c is
 * not found. s may be a String, StringBuffer, or java.nio.CharBuffer.
 */
public static CharSequence prefix(CharSequence s, char c) {
  int numChars = s.length();          // How long is the sequence?
  for(int i = 0; i < numChars; i++) { // Loop through characters in sequence
    if (s.charAt(i) == c)             // If we find c,
      return s.subSequence(0,i+1);    // then return the prefix subsequence
  }
  return null;                        // Otherwise, return null
}
```

5.2.5. The Appendable Interface

`Appendable` is a Java 5.0 interface that represents an object that can have a `char` or a `CharSequence` appended to it. Implementing classes include `StringBuffer`, `StringBuilder`, `java.nio.CharBuffer`, `java.io.PrintStream`, and `java.io.Writer` and all of its character output stream subclasses, including `PrintWriter`. Thus, the `Appendable` interface represents the common appendability of the text buffer classes and the text output stream classes. As we'll see below, a `Formatter` object can send its output to any `Appendable` object.

5.2.6. String Concatenation

The `+` operator concatenates two `String` objects or one `String` and one value of some other type, producing a new `String` object. Be aware that each time a string concatenation is performed and the result stored in a variable or passed to a method, a new `String` object has been created. In some circumstances, this can be inefficient and can result in poor performance. It is especially important to be careful when doing string concatenation within a loop. The following code is inefficient, for example:

```
// Inefficient: don't do this
public String join(List<String> words) {
    String sentence = "";
    // Each iteration creates a new String object and discards an old one.
    for(String word: words) sentence += word;
    return sentence;
}
```

When you find yourself writing code like this, switch to a `StringBuffer` or a `StringBuilder` and use the `append()` method:

```
// This is the right way to do it
public String join(List<String> words) {
    StringBuilder sentence = new StringBuilder();
    for(String word: words) sentence.append(word);
    return sentence.toString();
```

```
}
```

There is no need to be paranoid about string concatenation, however. Remember that string literals are concatenated by the compiler rather than the Java interpreter. Also, when a single expression contains multiple string concatenations, these are compiled efficiently using a `StringBuilder` (or `StringBuffer` prior to Java 5.0) and result in the creation of only a single new `String` object.

5.2.7. String Comparison

Since strings are objects rather than primitive values, they cannot, in general, be compared for equality with the `= =` operator. `==` compares references and can determine if two expressions evaluate to a reference to the same string. It cannot determine if two distinct strings contain the same text. To do that, use the `equals( )` method. In Java 5.0 you can compare the content of a string to any other `CharSequence` with the `contentEquals( )` method.

Similarly, the `<` and `>` relational operators do not work with strings. To compare the order of strings, use the `compareTo()` method, which is defined by the `Comparable<String>` interface and is illustrated in the sample code above. To compare strings without taking the case of the letters into account, use `compareToIgnoreCase( )` .

Note that `StringBuffer` and `StringBuilder` do not implement `Comparable` and do not override the default versions of `equals( )` and `hashCode()` that they inherit from `Object`. This means that it is not possible to compare the text held in two `StringBuffer` or `StringBuilder` objects for equality or for order.

One important, but little understood method of the `String` class is `intern( )`. When passed a string `s`, it returns a string `t` that is guaranteed to have the same content as `s`. What's important, though, is that for any given string content, it always returns a reference to the same `String` object. That is, if `s` and `t` are two `String` objects such that `s.equals(t)`, then:

```
s.intern() == t.intern()
```

This means that the `intern( )` method provides a way of doing fast string comparisons using `==`. Importantly, string literals are always implicitly interned by the Java VM, so if you plan to compare a string `s` against a number of string literals, you may want to intern `s` first and then do the comparison with `= =`.

The `compareTo()` and `equals( )` methods of the `String` class allow you to compare strings. `compareTo( )` bases its comparison on the character order defined by the Unicode encoding while `equals( )` defines string equality as strict character-by-character equality. These are not always the right methods to use, however. In some languages, the character ordering imposed by the Unicode standard does not match the dictionary ordering used when alphabetizing strings. In Spanish, for example, the letters "ch" are considered a single letter that comes after "c" and before "d." When comparing human-readable strings in an internationalized application, you should use the `java.text.Collator` class instead:

```
import java.text.*;

// Compare two strings; results depend on where the program is run
```

```
// Return values of Collator.compare() have same meanings as String.compareTo()
Collator c = Collator.getInstance();      // Get Collator for current locale
int result = c.compare("chica", "coche"); // Use it to compare two strings
```

5.2.8. Supplementary Characters

Java 5.0 has adopted the Unicode 4.0 standard, which, for the first time, has defined codepoints that fall outside the 16-bit range of the char type. When working with these "supplementary characters" (which are primarily Han ideographs), you must use int values to represent the individual character. In String objects, or for any other type that represents text as a sequence of char values, these supplementary characters are represented as a series of two char values known as a *surrogate pair*.

Although readers of the English edition of this book are unlikely to ever encounter supplementary characters, you should be aware of them if you are working on programs that might be localized for use in China or another country that uses Han ideographs. To help you work with supplementary characters, the Character, String, StringBuffer, and StringBuilder classes have been extended with new methods that operate on int codepoints rather than char values. The following code illustrates some of these methods. You can find other, similar methods in the reference section and read about them in the online javadoc documentation.

```
int codepoint = 0x10001;  // This codepoint doesn't fit in a char
// Get the UTF-16 surrogate pair of chars for the codepoint
char[] surrogatePair = Character.toChars(codepoint);
// Convert the chars to a string.
String s = new String(surrogatePair);

// Print string length in characters and codepoints
System.out.println(s.length());
System.out.println(s.codePointCount(0, s.length()-1));

// Print encoding of first character, then encoding of first codepoint.
System.out.println(Integer.toHexString(s.charAt(0)));
System.out.println(Integer.toHexString(s.codePointAt(0)));

// Here's how to safely loop through a string that may contain
// supplementary characters
String tricky = s + "Testing" + s + "!";
int i = 0, n = tricky.length();
while(i < n) {
    // Get the codepoint at the current position
    int cp = tricky.codePointAt(i);
    if (cp < '\uffff') System.out.println((char) cp);
    else System.out.println("\\u" + Integer.toHexString(cp));

    // Increment the string index by one codepoint (1 or 2 chars).
    i = tricky.offsetByCodePoints(i, 1);
}
```

5.2.9. Formatting Text with printf() and format( )

A common task when working with text output is to combine values of various types into a single block of human-readable text. One way to accomplish this relies on the string-conversion power of Java's string concatenation operator. It results in code like this:

```
System.out.println(username + " logged in after " + numattempts +
                   "attempts. Last login at: " + lastLoginDate);
```

Java 5.0 introduces an alternative that is familiar to C programmers: a `printf( )` method. "printf" is short for "print formatted" and it combines the printing and formatting functions into one call. The `printf( )` method has been added to the `PrintWriter` and `PrintStream` output stream classes in Java 5.0. It is a varargs method that expects one or more arguments. The first argument is the "format string." It specifies the text to be printed and typically includes one or more "format specifiers," which are escape sequences beginning with character `%`. The remaining arguments to `printf( )` are values to be converted to strings and substituted into the format string in place of the format specifiers. The format specifiers constrain the types of the remaining arguments and specify exactly how they are converted to strings. The string concatenation shown above can be rewritten as follows in Java 5.0:

```
System.out.printf("%s logged in after %d attempts. Last login at: %tc%n",
                  username, numattempts, lastLoginDate);
```

The format specifier `%s` simply substitutes a string. `%d` expects the corresponding argument to be an integer and displays it as such. `%tc` expects a `Date`, `Calendar`, or number of milliseconds and converts that value to text representation of the full date and time. `%n` performs no conversion: it simply outputs the platform-specific line terminator, just as the `println( )` method does.

The conversions performed by `printf()` are all properly localized. Times and dates are displayed with locale-appropriate punctuation, for example. And if you request that a number be displayed with a thousands separator, you'll get locale-specific punctuation there, too (a comma in England and a period in France, for example).

In addition to the basic `printf( )` method, `PrintWriter` and `PrintStream` also define a synonymous method named `format()` : it takes exactly the same arguments and behaves in exactly the same way. The `String` class also has a `format()` method in Java 5.0. This static `String.format()` method behaves like `PrintWriter.format( )` except that instead of printing the formatted string to a stream, it simply returns it:

```
// Format a string, converting a double value to text using two decimal
// places and a thousands separator.
double balance = getBalance();
String msg = String.format("Account balance: $%,.2f", balance);
```

The `java.util.Formatter` class is the general-purpose formatter class behind the `printf()` and `format( )` utility methods. It can format text to any `Appendable` object or to a named file. The following code uses a `Formatter` object to write a file:

```
public static void writeFile(String filename, String[] lines)
```

```
    throws IOException
{
    Formatter out = new Formatter(filename);  // format to a named file
    for(int i = 0; i < lines.length; i++) {
        // Write a line of the file
        out.format("%d: %s%n", i, lines[i]);
        // Check for exceptions
        IOException e = out.ioException();
        if (e != null) throw e;
    }
    out.close();
}
```

When you concatenate an object to a string, the object is converted to a string by calling its `toString()` method. This is what the `Formatter` class does by default as well. Classes that want more precise control over their formatting can implement the `java.util.Formattable` interface in addition to implementing `toString()`.

We'll see additional examples of formatting with `printf( )` when we cover the APIs for working with numbers, dates, and times. See `java.util.Formatter` for a complete list of available format specifiers and options.

5.2.10. Logging

Simple terminal-based programs can send their output and error messages to the console with `System.out.println()` or `System.out.print( )`. Server programs that run unattended for long periods need a different solution for output: the hardware they run on may not have a display terminal attached, and, if it does, there is unlikely to be anyone looking at it. Programs like this need *logging* functionality in which output messages are sent to a file for later analysis or through a network socket for remote monitoring. Java 1.4 provides a logging API in the `java.util.logging` package.

Typically, the application developer uses a `Logger` object associated with the class or package of the application to generate log messages at any of seven severity levels (see `java.util.logging.Level`). These messages may report errors and warnings or provide informational messages about interesting events in the application's life cycle. They can include debugging information or even trace the execution of important methods within the program.

The system administrator or end user of the application is responsible for setting up a logging configuration file that specifies where log messages are directed (the console, a file, a network socket, or a combination of these), how they are formatted (as plain text or XML documents), and at what severity threshold they are logged (log messages with a severity below the specified threshold are discarded with very little overhead and should not significantly impact the performance of the application). The logging level severity threshold can be configured independently so that `Logger` objects associated with different classes or packages can be "tuned in" or "tuned out." Because of this end-user configurability, you should feel free to use logging output liberally in your program. In normal operation, most log messages will be discarded efficiently and automatically. During program development, or when diagnosing a problem in a deployed application, however, the log messages can prove very valuable.

For most applications, using the Logging API is quite simple. Obtain a named Logger object whenever necessary by calling the static Logger.getLogger( ) method, passing the class or package name of the application as the logger name. Then, use one of the many Logger instance methods to generate log messages. The easiest methods to use have names that correspond to severity levels, such as severe() , warning( ), and info(). Here is some sample code:

```
import java.util.logging.*;

// Get a Logger object named after the current package
Logger logger = Logger.getLogger("com.davidflanagan.servers.pop");
logger.info("Starting server.");       // Log an informational message
ServerSocket ss;                       // Do some stuff
try { ss = new ServerSocket(110); }
catch(Exception e) {                   // Log exceptions
  logger.log(Level.SEVERE, "Can't bind port 110", e); // Complex log message
  logger.warning("Exiting");                          // Simple warning
  return;
}
logger.fine("got server socket"); // Fine-detail (low-severity) debug message
```

5.2.11. Pattern Matching with Regular Expressions

In Java 1.4 and later, you can perform textual pattern matching with regular expressions. Regular expression support is provided by the Pattern and Matcher classes of the java.util.regex package, but the String class defines a number of convenient methods that allow you to use regular expressions even more simply. Regular expressions use a fairly complex grammar to describe patterns of characters. The Java implementation uses the same regex syntax as the Perl 5 programming language. See the java.util.regex.Pattern class in the reference section for a summary of this syntax or consult a good Perl programming book for further details. For a complete tutorial on Perl-style regular expressions, see *Mastering Regular Expressions* (O'Reilly).

The simplest String method that accepts a regular expression argument is matches( ); it returns true if the string matches the pattern defined by the specified regular expression:

```
// This string is a regular expression that describes the pattern of a typical
// sentence. In Perl-style regular expression syntax, it specifies
// a string that begins with a capital letter and ends with a period,
// a question mark, or an exclamation point.
String pattern = "^[A-Z].*[\\.?!]$";
String s = "Java is fun!";
s.matches(pattern);  // The string matches the pattern, so this returns true.
```

The matches( ) method returns true only if the entire string is a match for the specified pattern. Perl programmers should note that this differs from Perl's behavior, in which a match means only that some portion of the string matches the pattern. To determine if a string or any substring matches a pattern, simply alter the regular expression to allow arbitrary characters before and after the desired pattern. In the following code, the regular expression characters .* match any number of arbitrary characters:

```
s.matches(".*\\bJava\\b.*"); // True if s contains the word "Java" anywhere
                             // The b specifies a word boundary
```

If you are already familiar with Perl's regular expression syntax, you know that it relies on the liberal use of backslashes to escape certain characters. In Perl, regular expressions are language primitives and their syntax is part of the language itself. In Java, however, regular expressions are described using strings and are typically embedded in programs using string literals. The syntax for Java string literals also uses the backslash as an escape character, so to include a single backslash in the regular expression, you must use two backslashes. Thus, in Java programming, you will often see double backslashes in regular expressions.

In addition to matching, regular expressions can be used for search-and-replace operations. The `replaceFirst( )` and `replaceAll( )` methods search a string for the first substring or all substrings that match a given pattern and replace the string or strings with the specified replacement text, returning a new string that contains the replacements. For example, you could use this code to ensure that the word "Java" is correctly capitalized in a string `s`:

```
s.replaceAll("(?i)\\bjava\\b",// Pattern: the word "java", case-insensitive
             "Java");         // The replacement string, correctly capitalized
```

The replacement string passed to `replaceAll()` and `replaceFirst( )` need not be a simple literal string; it may also include references to text that matched parenthesized subexpressions within the pattern. These references take the form of a dollar sign followed by the number of the subexpression. (If you are not familiar with parenthesized subexpressions within a regular expression, see `java.util.regex.Pattern` in the reference section.) For example, to search for words such as JavaBean, JavaScript, JavaOS, and JavaVM (but not Java or Javanese) and to replace the Java prefix with the letter J without altering the suffix, you could use code such as:

```
s.replaceAll("\\bJava([A-Z]\\w+)",  // The pattern
             "J$1");      // J followed by the suffix that matched the
                          // subexpression in parentheses: [A-Z]\\w+
```

The other `String` method that uses regular expressions is `split()`, which returns an array of the substrings of a string, separated by delimiters that match the specified pattern. To obtain an array of words in a string separated by any number of spaces, tabs, or newlines, do this:

```
String sentence = "This is a\n\ttwo-line sentence";
String[] words = sentence.split("[ \t\n\r]+");
```

An optional second argument specifies the maximum number of entries in the returned array.

The `matches( )`, `replaceFirst()`, `replaceAll( )`, and `split()` methods are suitable for when you use a regular expression only once. If you want to use a regular expression for multiple matches, you should explicitly use the `Pattern` and `Matcher` classes of the `java.util.regex` package. First, create a `Pattern` object to represent your regular expression with the static `Pattern.compile()` method. (Another reason to use the `Pattern` class explicitly instead of the `String` convenience methods is that `Pattern.compile( )` allows you to specify flags such as `Pattern.CASE_INSENSITIVE` that globally alter the way the pattern matching is done.) Note that the `compile()` method can throw a

PatternSyntaxException if you pass it an invalid regular expression string. (This exception is also thrown by the various String convenience methods.) The Pattern class defines split() methods that are similar to the String.split() methods. For all other matching, however, you must create a Matcher object with the matcher() method and specify the text to be matched against:

```
import java.util.regex.*;

Pattern javaword = Pattern.compile("\\bJava(\\w*)", Pattern.CASE_INSENSITIVE);
Matcher m = javaword.matcher(sentence);
boolean match = m.matches();  // True if text matches pattern exactly
```

Once you have a Matcher object, you can compare the string to the pattern in various ways. One of the more sophisticated ways is to find all substrings that match the pattern:

```
String text = "Java is fun; JavaScript is funny.";
m.reset(text);  // Start matching against a new string
// Loop to find all matches of the string and print details of each match
while(m.find()) {
  System.out.println("Found '" + m.group(0) + "' at position " + m.start(0));
  if (m.start(1) < m.end(1)) System.out.println("Suffix is " + m.group(1));
}
```

The Matcher class has been enhanced in several ways in Java 5.0. The most important of these is the ability to save the results of the most recent match in a MatchResult object. The previous algorithm that finds all matches in a string could be rewritten in Java 5.0 as follows:

```
import java.util.regex.*;
import java.util.*;

public class FindAll {
    public static void main(String[] args) {
        Pattern pattern = Pattern.compile(args[0]);
        String text = args[1];

        List<MatchResult> results = findAll(pattern, text);
        for(MatchResult r : results) {
            System.out.printf("Found '%s' at (%d,%d)%n",
                              r.group(), r.start(), r.end());
        }
    }

    public static List<MatchResult> findAll(Pattern pattern, CharSequence text)
    {
        List<MatchResult> results = new ArrayList<MatchResult>();
        Matcher m = pattern.matcher(text);
        while(m.find()) results.add(m.toMatchResult());
        return results;
    }
}
```

5.2.12. Tokenizing Text

java.util.Scanner is a general purpose text tokenizer, added in Java 5.0 to complement the java.util.Formatter class described earlier in this chapter. Scanner takes full advantage of Java regular expressions and can take its input text from a string, file, stream, or any object that implements the java.lang.Readable interface. Readable is also new in Java 5.0 and is the opposite of the Appendable interface.

A Scanner can break its input text into tokens separated by whitespace or any desired delimiter character or regular expression. It implements the Iterator<String> interface, which allows for simple looping through the returned tokens. Scanner also defines a variety of convenience methods for parsing tokens as boolean, integer, or floating-point values, with locale-sensitive number parsing It has skip( ) methods for skipping input text that matches a specified pattern and also has methods for searching ahead in the input text for text that matches a specified pattern.

Here's how you could use a Scanner to break a String into space-separated words:

```
public static List<String> getTokens(String line) {
    List<String> result = new ArrayList<String>();
    for(Scanner s = Scanner.create(line); s.hasNext(); )
        result.add(s.next());
    return result;
}
```

Here's how you might use a Scanner to break a file into lines:

```
public static void printLines(File f) throws IOException {
    Scanner s = Scanner.create(f);
    // Use a regex to specify line terminators as the token delimiter
    s.useDelimiter("\r\n|\n|\r");
    while(s.hasNext()) System.out.println(s.next());
}
```

The following method uses Scanner to parse an input line in the form x + y = z. It demonstrates the ability of a Scanner to scan numbers. Note that Scanner does not just parse Java-style integer literals: it supports thousands separators and does so in a locale-sensitive wayfor example, it would parse the integer 1,234 for an American user and 1.234 for a French user. This code also demonstrates the skip() method and shows that a Scanner can scan text directly from an InputStream.

```
public static boolean parseSum() {
    System.out.print("enter sum> "); // Prompt the user for input
    System.out.flush();          // Make sure prompt is visible immediately

    try {
        // Read and parse the user's input from the console
        Scanner s = Scanner.create(System.in);
        s.useDelimiter("");    // Don't require spaces between tokens
        int x = s.nextInt();   // Parse an integer
```

```
        s.skip("\\s*\\+\\s*"); // Skip optional space and literal +
        int y = s.nextInt();   // Parse another integer
        s.skip("\\s*=\\s*");   // Skip optional space and literal =
        int z = s.nextInt();   // Parse a third integer

        return x + y == z;
    }
    catch(InputMismatchException e) { // pattern does not match
        throw new IllegalArgumentException("syntax error");
    }
    catch(NoSuchElementException e) { // no more input available
        throw new IllegalArgumentException("syntax error");
    }
}
```

5.2.13. StringTokenizer

A number of other Java classes operate on strings and characters. One notable class is `java.util.StringTokenizer`, which you can use to break a string of text into its component words:

```
String s = "Now is the time";
java.util.StringTokenizer st = new java.util.StringTokenizer(s);
while(st.hasMoreTokens()) {
  System.out.println(st.nextToken());
}
```

You can even use this class to tokenize words that are delimited by characters other than spaces:

```
String s = "a:b:c:d";
java.util.StringTokenizer st = new java.util.StringTokenizer(s, ":");
```

`java.io.StreamTokenizer` is another tokenizing class. It has a more complicated API and has more powerful features than `StringTokenizer`.

5.3. Numbers and Math

Java provides the byte, short, int, long, float, and double primitive types for representing numbers. The java.lang package includes the corresponding Byte, Short, Integer, Long, Float, and Double classes, each of which is a subclass of Number. These classes can be useful as object wrappers around their primitive types, and they also define some useful constants:

```
// Integral range constants: Integer, Long, and Character also define these
Byte.MIN_VALUE      // The smallest (most negative) byte value
Byte.MAX_VALUE      // The largest byte value
Short.MIN_VALUE     // The most negative short value
Short.MAX_VALUE     // The largest short value

// Floating-point range constants: Double also defines these
Float.MIN_VALUE     // Smallest (closest to zero) positive float value
Float.MAX_VALUE     // Largest positive float value

// Other useful constants
Math.PI             // 3.14159265358979323846
Math.E              // 2.7182818284590452354
```

5.3.1. Mathematical Functions

The Math class defines a number of methods that provide trigonometric, logarithmic, exponential, and rounding operations, among others. This class is primarily useful with floating-point values. For the trigonometric functions, angles are expressed in radians. The logarithm and exponentiation functions are base *e*, not base 10. Here are some examples:

```
double d = Math.toRadians(27);       // Convert 27 degrees to radians
d = Math.cos(d);                     // Take the cosine
d = Math.sqrt(d);                    // Take the square root
d = Math.log(d);                     // Take the natural logarithm
d = Math.exp(d);                     // Do the inverse: e to the power d
d = Math.pow(10, d);                 // Raise 10 to this power
d = Math.atan(d);                    // Compute the arc tangent
d = Math.toDegrees(d);               // Convert back to degrees
double up = Math.ceil(d);            // Round to ceiling
double down = Math.floor(d);         // Round to floor
long nearest = Math.round(d);        // Round to nearest
```

In Java 5.0, several new functions have been added to the Math class, including the following:

```
double d = 27;
d = Math.cbrt(d);      // cube root
```

```
d = Math.log10(d);     // base-10 logarithm
d = Math.sinh(d);      // hyperbolic sine.  Also cosh() and tanh()
d = Math.hypot(3, 4);  // Hypotenuse
```

5.3.2. Random Numbers

The `Math` class also defines a rudimentary method for generating pseudo-random numbers, but the `java.util.Random` class is more flexible. If you need *very* random pseudo-random numbers, you can use the `java.security.SecureRandom` class:

```
// A simple random number
double r = Math.random();     // Returns d such that: 0.0 <= d < 1.0

// Create a new Random object, seeding with the current time
java.util.Random generator = new java.util.Random(System.currentTimeMillis());
double d = generator.nextDouble();   // 0.0 <= d < 1.0
float f = generator.nextFloat();     // 0.0 <= f < 1.0
long l = generator.nextLong();       // Chosen from the entire range of long
int i = generator.nextInt();         // Chosen from the entire range of int
i = generator.nextInt(limit);        // 0 <= i < limit (Java 1.2 and later)
boolean b = generator.nextBoolean(); // true or false (Java 1.2 and later)
d = generator.nextGaussian();        // Mean value: 0.0; std. deviation: 1.0
byte[] randomBytes = new byte[128];
generator.nextBytes(randomBytes);    // Fill in array with random bytes

// For cryptographic strength random numbers, use the SecureRandom subclass
java.security.SecureRandom generator2 = new java.security.SecureRandom();
// Have the generator generate its own 16-byte seed; takes a *long* time
generator2.setSeed(generator2.generateSeed(16)); // Extra random 16-byte seed
// Then use SecureRandom like any other Random object
generator2.nextBytes(randomBytes);   // Generate more random bytes
```

5.3.3. Big Numbers

The `java.math` package contains the `BigInteger` and `BigDecimal` classes. These classes allow you to work with arbitrary-size and arbitrary-precision integers and floating-point values. For example:

```
import java.math.*;

// Compute the factorial of 1000
BigInteger total = BigInteger.valueOf(1);
for(int i = 2; i <= 1000; i++)
  total = total.multiply(BigInteger.valueOf(i));
System.out.println(total.toString());
```

In Java 1.4, `BigInteger` has a method to randomly generate large prime numbers, which is useful in many cryptographic applications:

```
BigInteger prime =
  BigInteger.probablePrime(1024,        // 1024 bits long
                           generator2); // Source of randomness. From above.
```

The `BigDecimal` class has been overhauled in Java 5.0 and is much more usable in this release. In addition to its utility for representing very large or very precise floating point numbers, it is also useful for financial calculations because it relies on adecimal representation of fractions rather than a binary representation. `float` and `double` values cannot precisely represent a number as simple as 0.1, and this can cause rounding errors that are often unacceptable when representing monetary values. `BigDecimal` and its associated `MathContext` and `RoundingMode` types provide a solution. For example:

```
// Compute monthly interest payments on a loan
public static BigDecimal monthlyPayment(int amount, // amount of loan
                                        int years,  // term in years
                                        double apr) // annual interest %
{
    // Convert the loan amount to a BigDecimal
    BigDecimal principal = new BigDecimal(amount);

    // Convert term of loan in years to number of monthly payments
    int payments=years*12;

    // Convert interest from annual percent to a monthly decimal
    BigDecimal interest = BigDecimal.valueOf(apr);
    interest = interest.divide(new BigDecimal(100));     // as fraction
    interest = interest.divide(new BigDecimal(12));      // monthly

    // The monthly payment computation
    BigDecimal x = interest.add(BigDecimal.ONE).pow(payments);
    BigDecimal y = principal.multiply(interest).multiply(x);
    BigDecimal monthly = y.divide(x.subtract(BigDecimal.ONE),
                                  MathContext.DECIMAL64);  // note context

    // Convert to two decimal places
    monthly = monthly.setScale(2, RoundingMode.HALF_EVEN);

    return monthly;
}
```

5.3.4. Converting Numbers from and to Strings

A Java program that operates on numbers must get its input values from somewhere. Often, such a program reads a textual representation of a number and must convert it to a numeric representation The various `Number` subclasses define useful conversion methods:

```
String s = "-42";
byte b = Byte.parseByte(s);             // s as a byte
short sh = Short.parseShort(s);         // s as a short
```

```
int i = Integer.parseInt(s);           // s as an int
long l = Long.parseLong(s);            // s as a long
float f = Float.parseFloat(s);         // s as a float (Java 1.2 and later)
f = Float.valueOf(s).floatValue();     // s as a float (prior to Java 1.2)
double d = Double.parseDouble(s);      // s as a double (Java 1.2 and later)
d = Double.valueOf(s).doubleValue();   // s as a double (prior to Java 1.2)

// The integer conversion routines handle numbers in other bases
byte b = Byte.parseByte("1011", 2);      // 1011 in binary is 11 in decimal
short sh = Short.parseShort("ff", 16);   // ff in base 16 is 255 in decimal

// The valueOf() method can handle arbitrary bases between 2 and 36
int i = Integer.valueOf("egg", 17).intValue();   // Base 17!

// The decode() method handles octal, decimal, or hexadecimal, depending
// on the numeric prefix of the string
short sh = Short.decode("0377").byteValue();   // Leading 0 means base 8
int i = Integer.decode("0xff").shortValue();   // Leading 0x means base 16
long l = Long.decode("255").intValue();        // Other numbers mean base 10

// Integer class can convert numbers to strings
String decimal = Integer.toString(42);
String binary = Integer.toBinaryString(42);
String octal = Integer.toOctalString(42);
String hex = Integer.toHexString(42);
String base36 = Integer.toString(42, 36);
```

5.3.5. Formatting Numbers

The `printf()` and `format( )` methods of Java 5.0 described earlier in this chapter work well for formatting numbers. The `%d` format specifier is for formatting integers in decimal format:

```
// Format int, long and BigInteger to the string "1 10 100"
String s = String.format("%d %d %d", 1, 10L, BigInteger.TEN.pow(2));
// Add thousands separators
s = String.format("%,d", Integer.MAX_VALUE); // "2,147,483,647"
// Output value right-justified in a field 8 characters wide
s = String.format("%8d", 123);              // "     123"
// Pad on the left with zeros to make 5 digits total
s = String.format("%05d", 123);             // "00123"
```

Floating-point numbers can be formatted using `%f`, `%e`, or `%g` format specifiers, which differ in whether and when exponential notation is used:

```
double x = 1.234E9; // (1.234 billion)
// returns "1234000000.000000 1.234000e+09 1.234000e+09 1234.000000"
s = String.format("%f %e %g %g", x, x, x, x/1e6);
```

You'll notice that the numbers above are all formatted with six digits following the decimal point. This default can be altered by specifying a *precision* in the format string:

```
// display a BigDecimal with 2 significant digits
s = String.format("%.2f", new BigDecimal("1.234"));  // "1.23"
```

Other flags can be applied to floating-point conversions as well. The following code formats a column of numbers right-justified within a field 10 characters wide. Each number has two digits following the decimal place and includes thousands separators when necessary. Negative values are formatted in parentheses, a common formatting convention in accounting.

```
// A column of 4 numbers. %n is newline.
s = String.format("%(,10.2f%n%(,10.2f%n%(,10.2f%n%(,10.2f%n",
                  BigDecimal.TEN,                     //      10.00
                  BigDecimal.TEN.movePointRight(3),   //  10,000.00
                  BigDecimal.TEN.movePointLeft(3),    //       0.01
                  BigDecimal.TEN.negate());           //    (10.00)
```

See `java.util.Formatter` in the reference section for complete details on supported format specifiers and formatting options.

Prior to Java 5.0, numbers can be formatted using the `java.text.NumberFormat` class:

```
import java.text.*;

// Use NumberFormat to format and parse numbers for the current locale
NumberFormat nf = NumberFormat.getNumberInstance();  // Get a NumberFormat
System.out.println(nf.format(9876543.21)); // Format number for current locale
try {
  Number n = nf.parse("1.234.567,89");     // Parse strings according to locale
} catch (ParseException e) { /* Handle exception */ }

// Monetary values are sometimes formatted differently than other numbers
NumberFormat moneyFmt = NumberFormat.getCurrencyInstance();
System.out.println(moneyFmt.format(1234.56)); // Prints $1,234.56 in U.S.
```

5.4. Dates and Times

Java allows dates and times to be represented and manipulated in three forms: as `long` values or as `java.util.Date` or `java.util.Calendar` objects. Java 5.0 introduces the enumerated type `java.util.concurrent.TimeUnit`. The values of this type represent time granularities or units: seconds, milliseconds, microseconds, and nanoseconds. They have useful convenience methods but do not themselves represent a time value.

5.4.1. Milliseconds and Nanoseconds

At the lowest level, dates and times are represented as a `long` value that holds the positive or negative number of milliseconds since midnight on January 1, 1970. This special date and time is known as the epoch and is measured in Greenwich Mean Time (GMT) or Universal Time (UTC). To query the current time in this millisecond representation, use `System.currentTimeMillis()`

```
long now = System.currentTimeMillis();
```

In Java 5.0 and later, you can use `System.nanoTime()` to query time in nanoseconds. This method returns a `long` number of nanoseconds `long`. Unlike `currentTimeMillis( )`, the `nanoTime()` does not return a time relative to any defined epoch. `nanoTime()` is good for measuring relative or elapsed time (as long as the elapsed time is not more than 292 years) but is not suitable for absolute time:

```
long start = System.nanoTime();
doSomething();
long end = System.nanoTime();
long elapsedNanoSeconds = end - start;
```

5.4.2. The Date Class

`java.util.Date` is an object wrapper around a `long` that holds a number of milliseconds since the epoch. Using a `Date` object instead of a `long` allows simple conversion to a nonlocalized string with the `toString` method. `Date` objects can be compared for equality with the `equals( )` method and they can be compared for order with the `compareTo()` method or the `before( )` and `after()` methods.

The no-argument version of the `Date( )` constructor creates a `Date` that represents the current time. You can also pass a `long` number of milliseconds to create a `Date` that represents some other time. `getTime( )` returns the millisecond representation of the `Date`. `Date` is a mutable class, so you can also pass a number of milliseconds to `setTime( )`.

`Date` has a number of methods for querying and setting the year, month, day, hour, minute, and second. All of these methods have been deprecated, however, in favor of the `Calendar` class, described next.

5.4.3. The Calendar Class

The java.util.Calendar class is a properly localized version of Date. It is simply a wrapper around a long number of milliseconds but can represent that instant in time according to the calendar of the current locale (usually a Gregorian calendar) and the time zone of the current locale. Furthermore, it has methods for querying, setting, and doing arithmetic on the various fields of the date and time.

The code below shows common uses of the Calendar class. Note that the set( ), get(), and add( ) methods all take an initial argument that specifies what field of the date or time is being set, queried, or added to. Fields such as year, day of month, day of week, hour, minute, and second are defined by integer constants in the class. Other integer constants define values for the months and weekdays of the Gregorian calendar. The month constant UNDECIMBER represents a 13th month used in lunar calendars.

```
// Get a Calendar for current locale and time zone
Calendar cal = Calendar.getInstance();

// Figure out what day of the year today is
cal.setTimeInMillis(System.currentTimeMillis()); // Set to the current time
int dayOfYear = cal.get(Calendar.DAY_OF_YEAR);  // What day of the year is it?

// What day of the week does the leap day in the year 2008 occur on?
cal.set(2008, Calendar.FEBRUARY, 29);            // Set year, month, day fields
int dayOfWeek = cal.get(Calendar.DAY_OF_WEEK);   // Query a different field

// What day of the month is the 3rd Thursday of May, 2005?
cal.set(Calendar.YEAR, 2005);                    // Set the year
cal.set(Calendar.MONTH, Calendar.MAY);           // Set the month
cal.set(Calendar.DAY_OF_WEEK,Calendar.THURSDAY); // Set the day of week
cal.set(Calendar.DAY_OF_WEEK_IN_MONTH, 3);       // Set the week
int dayOfMonth = cal.get(Calendar.DAY_OF_MONTH); // Query the day in month

// Get a Date object that represents three months from now
cal.setTimeInMillis(System.currentTimeMillis()); // Current time
cal.add(Calendar.MONTH, 3);                      // Add 3 months
Date expiration = cal.getTime();                 // Retrieve result as a Date
long millis = cal.getTimeInMillis();             // or get it as a long
```

5.4.4. Formatting Dates and Times

The toString() method of Date produces a textual representation of a date and time but does no localization and allows no customization of which fields (day, month and year or hours and minutes, for example) are to be displayed. The toString( ) method should be used only to produce a machine-readable timestamp, not a human-readable string.

Like numbers, dates and times can be converted to strings using the String.format( ) method and the related java.util.Formatter class of Java 5.0. Format strings for displaying dates and times are all two-character sequences that begin with the letter t. The second letter of each sequence specifies the field or set of fields of the date or time to display. For example %tr displays the hours and minutes fields using 24-hour time, and %TD displays the month, day, and year fields separated by slashes. String.format( ) can format a date or time specified as a long, a Date, or a Calendar:

```
// current hours and minutes
long now = System.currentTimeMillis();
String s = String.format("%tR", now);         // "15:12"

// Current month/day/year
Date d = new Date(now);
s = String.format("%tD", d);                  // "07/13/04"

// Hours and minutes using 12-hour clock
Calendar c = Calendar.getInstance();
c.setTime(d);
s = String.format("%tl:%tM %tp", now, d, c);  // "3:12 pm"
```

Prior to Java 5.0 and its Formatter class, you can format dates and times using the java.text.DateFormat class, which automatically handles locale-specific conventions for date and time formatting. DateFormat even works correctly in locales that use a calendar other than the common era (Gregorian) calendar in use throughout much of the world:

```
import java.util.Date;
import java.text.*;

// Display today's date using a default format for the current locale
DateFormat defaultDate = DateFormat.getDateInstance();
System.out.println(defaultDate.format(new Date()));

// Display the current time using a short time format for the current locale
DateFormat shortTime = DateFormat.getTimeInstance(DateFormat.SHORT);
System.out.println(shortTime.format(new Date()));

// Display date and time using a long format for both
DateFormat longTimestamp =
  DateFormat.getDateTimeInstance(DateFormat.FULL, DateFormat.FULL);
System.out.println(longTimestamp.format(new Date()));

// Use SimpleDateFormat to define your own formatting template
// See java.text.SimpleDateFormat for the template syntax
DateFormat myformat = new SimpleDateFormat("yyyy.MM.dd");
System.out.println(myformat.format(new Date()));
try {   // DateFormat can parse dates too
  Date leapday = myformat.parse("2000.02.29");
}
catch (ParseException e) { /* Handle parsing exception */ }
```

Team LiB

5.5. Arrays

The `java.lang.System` class defines an `arraycopy( )` method that is useful for copying specified elements in one array to a specified position in a second array. The second array must be the same type as the first, and it can even be the same array:

```
char[] text = "Now is the time".toCharArray();
char[] copy = new char[100];
// Copy 10 characters from element 4 of text into copy, starting at copy[0]
System.arraycopy(text, 4, copy, 0, 10);

// Move some of the text to later elements, making room for insertions
System.arraycopy(copy, 3, copy, 6, 7);
```

In Java 1.2 and later, the `java.util.Arrays` class defines useful array-manipulation methods, including methods for sorting and searching arrays:

```
import java.util.Arrays;

int[] intarray = new int[] { 10, 5, 7, -3 }; // An array of integers
Arrays.sort(intarray);                       // Sort it in place
int pos = Arrays.binarySearch(intarray, 7);  // Value 7 is found at index 2
pos = Arrays.binarySearch(intarray, 12);     // Not found: negative return value

// Arrays of objects can be sorted and searched too
String[] strarray = new String[] { "now", "is", "the", "time" };
Arrays.sort(strarray);   // sorted to: { "is", "now", "the", "time" }

// Arrays.equals() compares all elements of two arrays
String[] clone = (String[]) strarray.clone();
boolean b1 = Arrays.equals(strarray, clone);  // Yes, they're equal

// Arrays.fill() initializes array elements
byte[] data = new byte[100];          // An empty array; elements set to 0
Arrays.fill(data, (byte) -1);         // Set them all to -1
Arrays.fill(data, 5, 10, (byte) -2);  // Set elements 5, 6, 7, 8, 9 to -2
```

Arrays can be treated and manipulated as objects in Java. Given an arbitrary object `o`, you can use code such as the following to find out if the object is an array and, if so, what type of array it is:

```
Class type = o.getClass();
if (type.isArray()) {
  Class elementType = type.getComponentType();
}
```

Team LiB

5.6. Collections

The Java Collections Framework is a set of important utility classes and interfaces in the `java.util` package for working with collections of objects. The Collections Framework defines two fundamental types of collections. A `Collection` is a group of objects while a `Map` is a set of mappings, or associations, between objects. A `Set` is a type of `Collection` with no duplicates, and a `List` is a `Collection` in which the elements are ordered. `SortedSet` and `SortedMap` are specialized sets and maps that maintain their elements in a sorted order. `Collection` , `Set` , `List` , `Map` , `SortedSet` , and `SortedMap` are all interfaces, but the `java.util` package also defines various concrete implementations, such as lists based on arrays and linked lists, and maps and sets based on hashtables or binary trees. Other important interfaces are `Iterator` and `ListIterator` , which allow you to loop through the objects in a collection. The Collections Framework was added in Java 1.2, but prior to that release you can use `Vector` and `Hashtable` , which are approximately the same as `ArrayList` and `HashMap` .

In Java 1.4, the Collections API added the `RandomAccess` marker interface, which is implemented by `List` implementations that support efficient random access (i.e., it is implemented by `ArrayList` and `Vector` but not by `LinkedList`). Java 1.4 also introduced `LinkedHashMap` and `LinkedHashSet` , which are hashtable-based maps and sets that preserve the insertion order of elements. Finally, `IdentityHashMap` is a hashtable-based `Map` implementation that uses the `==` operator to compare key objects rather than using the `equals()` method to compare them.

The Collections Framework has been overhauled in Java 5.0 to use generics (see Chapter 4). Java 5.0 also adds `EnumSet` and `EnumMap` classes that are specialized for working with enumerated values (see Chapter 4) and the `java.lang.Iterable` interface used by the new `for/in` looping statement. Finally, Java 5.0 adds the `Queue` interface. Most of the interesting `Queue` implementations are `BlockingQueue` implementations in `java.util.concurrent` .

5.6.1. The Collection Interface

`Collection<E>` is a parameterized interface that represents a generic group of objects of type `E` . The group may or may not allow duplicate elements and may or may not impose an ordering on the elements. Methods are defined for adding and removing objects from the group, testing an object for membership in the group, and iterating through all elements in the group. Additional methods return the elements of the group as an array and return the size of the collection.

The Java Collections Framework does not provide any implementations of `Collection` , but this interface is still very important because it defines the features common to all `Set` , `List` , and `Queue` implementations. The following code illustrates the operations you can perform on `Collection` objects:

```
// Create some collections to work with.
Collection<String> c = new HashSet<String>();  // An empty set
// We'll see these utility methods later
Collection<String> d = Arrays.asList("one", "two");    // immutable
Collection<String> e = Collections.singleton("three"); // immutable
```

```
// Add elements to a collection. These methods return true if the collection
// changes, which is useful with Sets that don't allow duplicates.
c.add("zero");           // Add a single element
c.addAll(d);             // Add a collection of elements

// Copy a collection: most implementations have a copy constructor
Collection<String> copy = new ArrayList<String>(c);

// Remove elements from a collection.
// All but clear() return true if the collection changes.
c.remove("zero");        // Remove a single element
c.removeAll(e);          // Remove a collection of elements
c.retainAll(d);          // Remove all elements that are not in e
c.clear();               // Remove all elements from the collection

// Querying collection size
boolean b = c.isEmpty(); // Collection is now empty
int s = c.size();        // Collection size is now 0.

// Restore collection from the copy we made
c.addAll(copy);

// Test membership in the collection.  Membership is based on the equals()
// method, not the == operator.
b = c.contains("zero");  // true
b = c.containsAll(d);    // true

// Iterate through collection elements with a while loop.
// Some implementations (such as lists) guarantee an order of iteration
// Others make no guarantees.
Iterator<String> iterator = c.iterator();
while(iterator.hasNext()) System.out.println(iterator.next());

// Iteration with a for loop
for(Iterator<String> i = c.iterator(); i.hasNext(); )
    System.out.println(i.next());

// Java 5.0 iteration using a for/in loop
for(String word : c) System.out.println(word);

// Most Collection implementations have a useful toString() method
System.out.println(c);   // As an alternative to the iterations above

// Obtain an array of collection elements.  If the iterator guarantees
// an order, this array has the same order. The array is a copy, not a
// reference to an internal data structure.
Object[] elements = c.toArray();

// If we want the elements in a String[], we must pass one in
String[] strings = c.toArray(new String[c.size()]);

// Or we can pass an empty String[] just to specify the type and
```

```
// the toArray() method will allocate an array for us
strings = c.toArray(new String[0]);
```

Remember that you can use any of the methods shown above with any `Set` , `List` , or `Queue` . These subinterfaces may impose membership restrictions or ordering constraints on the elements of the collection but still provide the same basic methods. Methods such as `add( )` , `remove()` , `clear( )` , and `retainAll()` that alter the collection are optional, and read-only implementations may throw `UnsupportedOperationException` .

`Collection` , `Map` , and their subinterfaces do *not* extend the `Cloneable` or `Serializable` interfaces. All of the collection and map implementation classes provided in the Java Collections Framework, however, do implement these interfaces.

Some collection implementations place restrictions on the elements that they can contain. An implementation might prohibit `null` as an element, for example. And `EnumSet` restricts membership to the values of a specified enumerated type. Attempting to add a prohibited element to a collection always throws an unchecked exception such as `NullPointerException` or `ClassCastException` . Checking whether a collection contains a prohibited element may also throw such an exception, or it may simply return `false` .

5.6.2. The Set Interface

A *set* is a collection of objects that does not allow duplicates: it may not contain two references to the same object, two references to `null` , or references to two objects `a` and `b` such that `a.equals(b)` . Most general-purpose `Set` implementations impose no ordering on the elements of the set, but ordered sets are not prohibited (see `SortedSet` and `LinkedHashSet`). Sets are further distinguished from ordered collections like lists by the general expectation that they have an efficient `contains( )` method that runs in constant or logarithmic time.

`Set` defines no additional methods beyond those defined by `Collection` but places additional restrictions on those methods. The `add( )` and `addAll()` methods of a `Set` are required to enforce the no-duplicates rules: they may not add an element to the `Set` if the set already contains that element. Recall that the `add()` and `addAll( )` methods defined by the `Collection` interface return `true` if the call resulted in a change to the collection and `false` if it did not. This return value is relevant for `Set` objects because the no-duplicates restriction means that adding an element does not always result in a change to the set.

Table 5-2 lists the implementations of the `Set` interface and summarizes their internal representation, ordering characteristics, member restrictions, and the performance of the basic `add( )` , `remove( )` , and `contains()` operations as well as iteration performance. You can read more about each class in the reference section. Note that `CopyOnWriteArraySet` is in the `java.util.concurrent` package; all the other implementations are part of `java.util` . Also note that `java.util.BitSet` is not a `Set` implementation. This legacy class is useful as a compact and efficient list of `boolean` values but is not part of the Java Collections Framework.

Table 5-2. Set Implementations

Class	Internal represen-tation	Element order	Member restric-tions	Basic opera-tions	Iteration perfor-mance	Notes
HashSet	hashtable	none	none	O(1)	O(capacity)	Best general-purpose implementation.
LinkedHashSet	linked hashtable	insertion order	none	O(1)	O(n)	Preserves insertion order.
EnumSet	bit fields	enum declaration	enum values	O(1)	O(n)	Holds non-`null` enum values only.
TreeSet	red-black tree	sorted ascending	comparable	O(log(n))	O(n)	`Comparable` elements or `Comparator` .
CopyOnWriteArraySet	array	insertion order	none	O(n)	O(n)	Threadsafe without synchronized methods.

The `treeSet` implementation uses a red-black tree data structure to maintain a set that is iterated in ascending order according to the natural ordering of `Comparable` objects or according to an ordering specified by a `Comparator` object. `TReeSet` actually implements the `SortedSet` interface, which is a subinterface of `Set` .

`SortedSet` offers several interesting methods that take advantage of its sorted nature. The following code illustrates:

```
public static void testSortedSet(String[] args) {
    // Create a SortedSet
    SortedSet<String> s = new TreeSet<String>(Arrays.asList(args));

    // Iterate set: elements are automatically sorted
    for(String word : s) System.out.println(word);

    // Special elements
    String first = s.first();  // First element
    String last = s.last();    // Last element
    // Subrange views of the set
    SortedSet<String> tail = s.tailSet(first+'\0'); // all elements but first
    SortedSet<String> head = s.headSet(last);       // all elements but last
    SortedSet<String> middle = s.subSet(first+'\0', // all but ends
                                        last);
}
```

5.6.3. The List Interface

A `List` is an ordered collection of objects. Each element of a list has a position in the list, and the `List` interface defines methods to query or set the element at a particular position, or *index*. In this respect a `List` is like an array whose size changes as needed to accommodate the number of elements it contains. Unlike sets, lists allow duplicate elements.

In addition to its index-based `get( )` and `set()` methods, the `List` interface defines methods to add or remove an element at a particular index and also defines methods to return the index of the first or las occurrence of a particular value in the list. The `add( )` and `remove()` methods inherited from `Collection` are defined to append to the list and to remove the first occurrence of the specified value from the list. The inherited `addAll()` appends all elements in the specified collection to the end of the list, and another version inserts the elements at a specified index. The `retainAll()` and `removeAll( )` methods behave as they do for any `Collection`, retaining or removing multiple occurrences of the same value, if needed.

The `List` interface does not define methods that operate on a range of list indexes. Instead it defines a single `subList` method that returns a `List` object that represents just the specified range of the original list. The sublist is backed by the parent list, and any changes made to the sublist are immediately visible in the parent list. Examples of `subList( )` and the other basic `List` manipulation methods are below.

```
// Create lists to work with
List<String> l = new ArrayList<String>(Arrays.asList(args));
List<String> words = Arrays.asList("hello", "world");

// Querying and setting elements by index
String first = l.get(0);             // First element of list
String last = l.get(l.size()-1);     // Last element of list
l.set(0, last);                      // The last shall be first

// Adding and inserting elements.  add() can append or insert
l.add(first);       // Append the first word at end of list
l.add(0, first);    // Insert first word at the start of the list again
l.addAll(words);    // Append a collection at the end of the list
l.addAll(1, words); // Insert collection after first word

// Sublists: backed by the original list
List<String> sub = l.subList(1,3);  // second and third elements
sub.set(0, "hi");                   // modifies 2nd element of l
// Sublists can restrict operations to a subrange of backing list
String s = Collections.min(l.subList(0,4));
Collections.sort(l.subList(0,4));
// Independent copies of a sublist don't affect the parent list.
List<String> subcopy = new ArrayList<String>(l.subList(1,3));

// Searching lists
int p = l.indexOf(last);  // Where does the last word appear?
p = l.lastIndexOf(last);  // Search backward

// Print the index of all occurrences of last in l.  Note subList()
int n = l.size();
p = 0;
do {
```

```
    // Get a view of the list that includes only the elements we
    // haven't searched yet.
    List<String> list = l.subList(p, n);
    int q = list.indexOf(last);
    if (q == -1) break;
    System.out.printf("Found '%s' at index %d%n", last, p+q);
    p += q+1;
} while(p < n);

// Removing elements from a list
l.remove(last);         // Remove first occurrence of the element
l.remove(0);            // Remove element at specified index
l.subList(0,2).clear(); // Remove a range of elements using subList()
l.retainAll(words);     // Remove all but elements in words
l.removeAll(words);     // Remove all occurrences of elements in words
l.clear();              // Remove everything
```

A general expectation of `List` implementations is that they can be efficiently iterated, typically in time proportional to the size of the list. Lists do not all provide efficient random-access to the elements at any index, however. Sequential-access lists, such as the `LinkedList` class, provide efficient insertion and deletion operations at the expense of random access performance. In Java 1.4 and later, implementations that provide efficient random access implement the `RandomAccess` marker interface, and you can test for this interface with `instanceof` if you need to ensure efficient list manipulations:

```
List<?> l = ...;  // Arbitrary list we're passed to manipulate
// Ensure we can do efficient random access.  If not, use a copy constructor
// to make a random-access copy of the list before manipulating it.
if (!(l instanceof RandomAccess)) l = new ArrayList<?>(l);
```

The `Iterator` returned by the `iterator()` method of a `List` iterates the list elements in the order that they occur in the list. `List` implements `Iterable`, and lists can be iterated with a `for/in` loop just as any other collection can.

To iterate just a portion of a list, you can use the `subList( )` method to create a sublist view:

```
List<String> words = ...;  // Get a list to iterate

// Iterate just all elements of the list but the first
for(String word : words.subList(1, words.size()))
    System.out.println(word);
```

In addition to normal iteration, lists also provide enhanced bidirectional iteration using a `ListIterator` object returned by the `listIterator()` method. To iterate backward through a `List`, for example, start with a `ListIterator` with its cursor positioned after the end of the list:

```
ListIterator<String> li = words.listIterator(words.size());
while(li.hasPrevious()) {
    System.out.println(li.previous());
}
```

Table 5-3 summarizes the five general-purpose List implementations in the Java platform. Vector and Stack are legacy implementations left over from Java 1.0. CopyOnWriteArrayList is a new in Java 5.0 and is part of the java.util.concurrent package.

Table 5-3. List implementations

Class	Representation	Random access	Notes
ArrayList	array	yes	Best all-around implementation.
LinkedList	double-linked list	no	Efficient insertion and deletion.
CopyOnWriteArrayList	array	yes	Threadsafe; fast traversal, slow modification.
Vector	array	yes	Legacy class; synchronized method.
Stack	array	yes	Extends Vector ; adds push( ) , pop() , peek( ) .

5.6.4. The Map Interface

A *map* is a set of *key* objects and a mapping from each member of that set to a *value* object. The Map interface defines an API for defining and querying mappings. Map is part of the Java Collections Framework, but it does not extend the Collection interface, so a Map is a little-c collection, not a big-C Collection . Map is a parameterized type with two type variables. Type variable K represents the type of keys held by the map, and type variable V represents the type of the values that the keys are mapped to. A mapping from String keys to Integer values, for example, can be represented with a Map<String,Integer> .

The most important Map methods are put() , which defines a key/value pair in the map, get( ) , which queries the value associated with a specified key, and remove( ) , which removes the specified key and its associated value from the map. The general performance expectation for Map implementations is that these three basic methods are quite efficient: they should usually run in constant time and certainly no worse than in logarithmic time.

An important feature of Map is its support for "collection views." Although a Map is not a Collection , its keys can be viewed as a Set , its values can be viewed as a Collection , and its mappings can be viewed as a Set of Map.Entry objects. (Map.Entry is a nested interface defined within Map : it simply represents a single key/value pair.)

The sample code below shows the get( ) , put() , remove( ) , and other methods of a Map and also demonstrates some common uses of the collection views of a Map :

```
// Create maps to work with
Map<String,Integer> m = new HashMap<String,Integer>();  // New, empty map
// Immutable Map containing a single key-value pair
```

```
Map<String,Integer> singleton = Collections.singletonMap("testing", -1);
// Note this rarely-used syntax to explicitly specify the parameter
// types of the generic emptyMap() method.  The returned map is immutable
Map<String,Integer> empty = Collections.<String,Integer>emptyMap();

// Populate the map using the put() method to define mappings from array
// elements to the index at which each element appears
String[] words = { "this", "is", "a", "test" };
for(int i = 0; i < words.length; i++)
    m.put(words[i], i);  // Note autoboxing of int to Integer

// Each key must map to a single value. But keys may map to the same value
for(int i = 0; i < words.length; i++)
    m.put(words[i].toUpperCase(), i);

// The putAll() method copies mappings from another Map
m.putAll(singleton);

// Query the mappings with the get() method
for(int i = 0; i < words.length; i++)
    if (m.get(words[i]) != i) throw new AssertionError();

// Key and value membership testing
m.containsKey(words[0]);        // true
m.containsValue(words.length);  // false

// Map keys, values, and entries can be viewed as collections
Set<String> keys = m.keySet();
Collection<Integer> values = m.values();
Set<Map.Entry<String,Integer>> entries = m.entrySet();

// The Map and its collection views typically have useful toString() methods
System.out.printf("Map: %s%nKeys: %s%nValues: %s%nEntries: %s%n",
                  m, keys, values, entries);

// These collections can be iterated.
// Most maps have an undefined iteration order (but see SortedMap)
for(String key : m.keySet()) System.out.println(key);
for(Integer value: m.values()) System.out.println(value);

// The Map.Entry<K,V> type represents a single key/value pair in a map
for(Map.Entry<String,Integer> pair : m.entrySet()) {
    // Print out mappings
    System.out.printf("'%s' ==> %d%n", pair.getKey(), pair.getValue());
    // And increment the value of each Entry
    pair.setValue(pair.getValue() + 1);
}

// Removing mappings
m.put("testing", null);   // Mapping to null can "erase" a mapping:
m.get("testing");         // Returns null
m.containsKey("testing"); // Returns true: mapping still exists
```

```
m.remove("testing");      // Deletes the mapping altogether
m.get("testing");         // Still returns null
m.containsKey("testing"); // Now returns false.

// Deletions may also be made via the collection views of a map.


// Additions to the map may not be made this way, however.
m.keySet().remove(words[0]);  // Same as m.remove(words[0]);
m.values().remove(2);         // Remove one mapping to the value 2
m.values().removeAll(Collections.singleton(4)); // Remove all mappings to 4
m.values().retainAll(Arrays.asList(2, 3));      // Keep only mappings to 2 & 3

// Deletions can also be done via iterators
Iterator<Map.Entry<String,Integer>> iter = m.entrySet().iterator();
while(iter.hasNext()) {
    Map.Entry<String,Integer> e = iter.next();
    if (e.getValue() == 2) iter.remove();
}

// Find values that appear in both of two maps.  In general, addAll() and
// retainAll() with
keySet() and values() allow union and intersection
Set<Integer> v = new HashSet<Integer>(m.values());
v.retainAll(singleton.values());

// Miscellaneous methods
m.clear();                // Deletes all mappings
m.size();                 // Returns number of mappings: currently 0
m.isEmpty();              // Returns true
m.equals(empty);          // true: Maps implementations override equals
```

The `Map` interface includes a variety of general-purpose and special-purpose implementations, which are summarized in Table 5-4 . As always, complete details are in the reference section. All classes in Table 5-4 are in the `java.util` package except `ConcurrentHashMap` , which is part of `java.util.concurrent` .

Table 5-4. Map implementations

Class	Representation	Since	null keys	null values	Notes
HashMap	hashtable	1.2	yes	yes	General-purpose implementation.
ConcurrentHashMap	hashtable	5.0	no	no	General-purpose threadsafe implementation; see `ConcurrentMap` interface.
EnumMap	array	5.0	no	yes	Keys are instances of an enum.

Class	Representation	Since	null keys	null values	Notes
LinkedHashMap	hashtable plus list	1.4	yes	yes	Preserves insertion or access order.
TreeMap	red-black tree	1.2	no	yes	Sorts by key value. Operations are O(log(n)). See `SortedMap` .
IdentityHashMap	hashtable	1.4	yes	yes	Compares with `= =` instead of `equals( )` .
WeakHashMap	hashtable	1.2	yes	yes	Doesn't prevent garbage collection of keys.
Hashtable	hashtable	1.0	no	no	Legacy class; synchronized methods.
Properties	hashtable	1.0	no	no	Extends `Hashtable` with `String` methods.

The `ConcurrentHashMap` class of the `java.util.concurrent` package implements the `ConcurrentMap` interface of the same package. `ConcurrentMap` extends `Map` and defines some additional atomic operations that are important in multithreaded programming. For example, the`putIfAbsent()` method is like `put( )` but adds the key/value pair to the map only if the key is not already mapped.

`treeMap` implements the `SortedMap` interface, which extends `Map` to add methods that take advantage of the sorted nature of the map. `SortedMap` is quite similar to the `SortedSet` interface. The `firstKey()` and `lastKey( )` methods return the first and last keys in the `keySet()` . And `headMap()` , `tailMap( )` , and `subMap()` return a restricted range of the original map.

5.6.5. The Queue and BlockingQueue Interfaces

A *queue* is an ordered collection of elements with methods for extracting elements, in order, from the *head* of the queue. Queue implementations are commonly based on insertion order as infirst-in, first-out (FIFO) queues or last in, first-out queues (LIFO queues are also known asstacks). Other orderings are possible, however: a *priority queue* orders its elements according to an external `Comparator` object, or according to the natural ordering of `Comparable` elements. Unlike a `Set` , `Queue` implementations typically allow duplicate elements. Unlike`List` , the `Queue` interface does not define methods for manipulating queue elements at arbitrary positions. Only the element at the head of the queue is available for examination. It is common for `Queue` implementations to have a fixed capacity: when a queue is full, it is not possible to add more elements. Similarly, when a queue is empty, it is no possible to remove any more elements. Because full and empty conditions are a normal part of many queue-based algorithms, the `Queue` interface defines methods that signal these conditions with return values rather than by throwing exceptions. Specifically, the`peek()` and `poll( )` methods return `null` to indicate that the queue is empty. For this reason, most`Queue` implementations do not allow `null` elements.

A *blocking queue* is a type of queue that defines blocking `put( )` and `take()` methods. The `put( )` method adds an element to the queue, waiting, if necessary, until there is space in the queue for the element. And the `take( )` method removes an element from the head of the queue, waiting, if necessary, until there is an element to remove. Blocking queues are an important part of many multithreaded algorithms, and the BlockingQueue interface (which extends Queue) is defined as part of the java.util.concurrent package. Queue , BlockingQueue , and their implementations are new in Java 5.0. See Section 5.7.7 later in this chapter for a list of BlockingQueue implementations.

Queues are not nearly as commonly used as sets, lists, and maps, except perhaps in certain multithreaded programming styles. In lieu of example code here, we'll try to clarify the confusing array of queue insertion and removal operations:

- Adding elements to queues

add()

This Collection method simply adds an element in the normal way. In bounded queues, this method may throw an exception if the queue is full.

offer()

This Queue method is like add( ) but returns false instead of throwing an exception if the element cannot be added because a bounded queue is full.

BlockingQueue defines a timeout version of offer( ) that waits up to a specified amount of time for space to become available in a full queue. Like the basic version of the method, it returns true if the element was inserted and false otherwise.

put( )

This BlockingQueue method blocks: if the element cannot be inserted because the queue is full, put( ) waits until some other thread removes an element from the queue, and space becomes available for the new element.

- Removing elements from queues

remove()

In addition to the Collection.remove( ) method, which removes a specified element from the queue, the Queue interface defines a no-argument version of remove( ) that removes and returns the element at the head of the queue. If the queue is empty, this method throws a NoSuchElementException .

poll( )

This `Queue` method removes and returns the element at the head of the queue, like `remove( )` does but returns `null` if the queue is empty instead of throwing an exception.

`BlockingQueue` defines a timeout version of `poll()` that waits up to a specified amount of time for an element to be added to an empty queue.

`take()`

This `BlockingQueue` method removes and returns the element at the head of the queue. If the queue is empty, it blocks until some other thread adds an element to the queue.

`drainTo( )`

This `BlockingQueue` method removes all available elements from the queue and adds them to a specified `Collection` . It does not block to wait for elements to be added to the queue. A variant of the method accepts a maximum number of elements to drain.

- Querying the element at the head, without removing it from the queue

`element( )`

This `Queue` method returns the element at the head of the queue but does not remove that element from the queue. If the queue is empty, it throws `NoSuchElementException` .

`peek( )`

This `Queue` method is like `element()` but returns `null` if the queue is empty.

The `LinkedList` class has been retrofitted, in Java 5.0, to implement `Queue` . It provides unbounded FIFO (first in, first out) ordering, and insertion and removal operations require constant time. `LinkedList` allows `null` elements, although their use is discouraged when the list is being used as a queue.

The only other `Queue` implementation in the `java.util` package is `PriorityQueue` , which orders its elements according to a `Comparator` or orders `Comparable` elements according to the order defined by their `compareTo( )` methods. The head of a `PriorityQueue` is always the the smallest element according to the defined ordering.

The `java.util.concurrent` package contains a number of `BlockingQueue` implementations; they are described later in the chapter. This package also contains `ConcurrentLinkedQueue` , an efficient threadsafe `Queue` implementation that does not suffer the overhead of `synchronized` methods.

5.6.6. Collection Wrappers

The java.util.Collections class is home to quite a few static utility methods designed for use with collections. One important group of these methods are the collection *wrapper* methods: they return a special-purpose collection wrapped around a collection you specify. The purpose of the wrapper collection is to wrap additional functionality around a collection that does not provide it itself. Wrappers exist to provide thread-safety, write-protection and runtime type checking. Wrapper collections are always *backed by* the original collection, which means that the methods of the wrapper simply dispatch to the equivalent methods of the wrapped collection. This means that changes made to the collection through the wrapper are visible through the wrapped collection and vice versa.

The first set of wrapper methods provides threadsafe wrappers around collections. Except for the legacy classes Vector and Hashtable , the collection implementations in java.util do not have synchronized methods and are not protected against concurrent access by multiple threads. If you need threadsafe collections, create them with code like this:

```
List<String> list = Collections.synchronizedList(new ArrayList<String>());
Set<Integer> set = Collections.synchronizedSet(new HashSet<Integer>());
Map<String,Integer> map =
    Collections.synchronizedMap(new HashMap<String,Integer>());
```

A second set of wrapper methods provides collection objects through which the underlying collection cannot be modified. They return a read-only view of a collection: any attempt to change the content of the collection results in an UnsupportedOperationException . These wrappers are useful when you must pass a collection to a method that must not be allowed to modify or mutate the content of the collection in any way:

```
List<Integer> primes = new ArrayList<Integer>();
List<Integer> readonly = Collections.unmodifiableList(primes);
// We can modify the list through primes
primes.addAll(Arrays.asList(2, 3, 5, 7, 11, 13, 17, 19));
// But we can't modify through the read-only wrapper
readonly.add(23);  // UnsupportedOperationException
```

The final set of wrapper methods provides runtime type checking of any values added to the collection. They were added in Java 5.0 to complement the compile-time type safety provided by generics. These wrappers are helpful when working with legacy code that has not been converted to use generics. If you have a SortedSet<String> , for example, and must pass it to a method that expects a Set , you can use a checked wrapper to ensure that that method cannot add anything to the set that is not a String :

```
SortedSet<String> words = new TreeSet<String>(); // A set
SortedSet<String> checkedWords =                 // A checked set
    Collections.checkedSortedSet(words, String.class);
addWordsFromFile(checkedWords, filename);        // Passed to legacy method
```

5.6.7. Special-Case Collections

In addition to its wrapper methods, the java.util.Collections class also defines utility methods for creating immutable collection instances that contain a single element and other methods for creating empty collections. singleton() , singletonList( ) , and singletonMap() return immutable Set , List , and Map objects that contain a single specified object or a single key/value pair. These methods are useful, for example, when you need to pass a single object to a method that expects a collection.

The Collections class also includes methods that return empty collections. If you are writing a method that returns a collection, it is usually best to handle the no-values-to-return case by returning an empty collection instead of a special-case value like null :

```
Set<Integer> si = Collections.emptySet();
List<String> ss = Collections.emptyList();
Map<String,Integer> m = Collections.emptyMap();
```

Finally, nCopies() returns an immutable List that contains a specified number of copies of a single specified object:

```
List<Integer> tenzeros = Collections.nCopies(10, 0);
```

5.6.8. Converting to and from Arrays

Arrays of objects and collections serve similar purposes. It is possible to convert from one to the other:

```
String[] a ={ "this", "is", "a", "test" };  // An array
List<String> l = Arrays.asList(a);          // View array as an ungrowable list
List<String> m = new ArrayList<String>(l);  // Make a growable copy of the view

// In Java 5.0, asList() is a varargs method so we can do this, too:
Set<Character> abc = new HashSet<Character>(Arrays.asList('a', 'b', 'c'));

// Collection defines the toArray() method.  The no-args version creates
// an Object[] array, copies collection elements to it and returns it
Object[] members = set.toArray();         // Get set elements as an array
Object[] items = list.toArray();          // Get list elements as an array
Object[] keys = map.keySet().toArray();   // Get map key objects as an array
Object[] values = map.values().toArray(); // Get map value objects as an array

// If you want the return value to be something other than Object[], pass
// in an array of the appropriate type.  If the array is not big enough,
// another one of the same type will be allocated.  If the array is too big,
// the collection elements copied to it will be null-terminated
String[] c = l.toArray(new String[0]);
```

5.6.9. Collections Utility Methods

Just as the java.util.Arrays class defined methods to operate on arrays, the java.util.Collections class defines methods to operate on collections. Most notable are methods to sort and search the elements of collections:

```
Collections.sort(list);
int pos = Collections.binarySearch(list, "key"); // list must be sorted first
```

Here are some other interesting `Collections` methods:

```
Collections.copy(list1, list2); // Copy list2 into list1, overwriting list1
Collections.fill(list, o);      // Fill list with Object o
Collections.max(c);             // Find the largest element in Collection c
Collections.min(c);             // Find the smallest element in Collection c

Collections.reverse(list);      // Reverse list
Collections.shuffle(list);      // Mix up list
```

5.6.10. Implementing Collections

The Java Collections Framework provides abstract classes that make it simple to implement common types of collections. The following code extends `AbstractList` to define a `QuadraticSequence` , a list implementation that computes list values on demand rather than actually storing them in memory anywhere. See also `AbstractSet` , `AbstractMap` , `AbstractQueue` , and `AbstractSequentialList` .

```
import java.util.*;

/** An immutable List<Double> representing the sequence ax^2 + bx + c */
public class QuadraticSequence extends AbstractList<Double> {
    final int size;
    final double a, b, c;

    QuadraticSequence(double a, double b, double c, int size) {
        this.a = a; this.b = b; this.c = c; this.size = size;
    }

    @Override public int size() { return size; }

    @Override public Double get(int index) {
        if (index<0 || index>=size) throw new ArrayIndexOutOfBoundsException();
        return a*index*index + b*index + c;
    }
}
```

5.7. Threads and Concurrency

The Java platform has supported multithreaded or *concurrent* programming with the Thread class and Runnable interface since Java 1.0. Java 5.0 bolsters that support with a comprehensive set of new utilities for concurrent programming.

5.7.1. Creating, Running, and Manipulating Threads

Java makes it easy to define and work with multiple threads of execution within a program. java.lang.Thread is the fundamental thread class in the Java API. There are two ways to define a thread. One is to subclass THRead, override the run( ) method and then instantiate your Thread subclass. The other is to define a class that implements the Runnable method (i.e., define a run() method) and then pass an instance of this Runnable object to the Thread() constructor. In either case, the result is a THRead object, where the run() method is the body of the thread. When you call the start() method of the THRead object, the interpreter creates a new thread to execute the run() method. This new thread continues to run until the run( ) method exits. Meanwhile, the original thread continues running itself, starting with the statement following the start() method. The following code demonstrates:

```
final List list; // Some long unsorted list of objects; initialized elsewhere

/** A Thread class for sorting a List in the background */
class BackgroundSorter extends Thread {
  List l;
  public BackgroundSorter(List l) { this.l = l; }    // Constructor
  public void run() { Collections.sort(l); }         // Thread body
}

// Create a BackgroundSorter thread
Thread sorter = new BackgroundSorter(list);
// Start it running; the new thread runs the run() method above while
// the original thread continues with whatever statement comes next.
sorter.start();

// Here's another way to define a similar thread
Thread t = new Thread(new Runnable() {          // Create a new thread
  public void run() { Collections.sort(list); } // to sort the list of objects.
});
t.start();                                      // Start it running
```

5.7.1.1 Thread lifecycle

A thread can be in one of six states. In Java 5.0, these states are represented by the THRead.State enumerated type, and the state of a thread can be queried with the getState( ) method. A listing of the Thread.State constants provides a good overview of the lifecycle of a thread:

NEW

The Thread has been created but its start( ) method has not yet been called. All threads start in this state.

RUNNABLE

The thread is running or is available to run when the operating system schedules it.

BLOCKED

The thread is not running because it is waiting to acquire a lock so that it can enter a synchronized method or block. We'll see more about synchronized methods and blocks later in this section.

WAITING

The thread is not running because it has called Object.wait() or Thread.join( ).

TIMED_WAITING

The thread is not running because it has called Thread.sleep() or has called Object.wait( ) or Thread.join() with a timeout value.

TERMINATED

The thread has completed execution. Its run( ) method has exited normally or by throwing an exception.

5.7.1.2 Thread priorities

Threads can run at different priority levels. A thread at a given priority level does not typically run unless no higher-priority threads are waiting to run. Here is some code you can use when working with thread priorities:

```
// Set a thread t to lower-than-normal priority
t.setPriority(Thread.NORM_PRIORITY-1);
```

```
// Set a thread to lower priority than the current thread
t.setPriority(Thread.currentThread().getPriority() - 1);

// Threads that don't pause for I/O should explicitly yield the CPU
// to give other threads with the same priority a chance to run.
Thread t = new Thread(new Runnable() {
  public void run() {
    for(int i = 0; i < data.length; i++) {  // Loop through a bunch of data
      process(data[i]);                     // Process it
      if ((i % 10) == 0)                    // But after every 10 iterations,
        Thread.yield();                     // pause to let other threads run.
    }
  }
});
```

5.7.1.3 Handling uncaught exceptions

A thread terminates normally when it reaches the end of its `run( )` method or when it executes a `return` statement in that method. A thread can also terminate by throwing an exception, however. When a thread exits in this way, the default behavior is to print the name of the thread, the type of the exception, the exception message, and a stack trace. In Java 5.0, you can install a custom handler for uncaught exceptions in a thread. For example:

```
// This thread just throws an exception
Thread t = new Thread() {
        public void run() {throw new UnsupportedOperationException();}
    };

// Giving threads a name helps with debugging
t.setName("My Broken Thread");

// Here's a handler for the error.
t.setUncaughtExceptionHandler(new Thread.UncaughtExceptionHandler() {
        public void uncaughtException(Thread t, Throwable e) {
            System.err.printf("Exception in thread %d '%s':" +
                              "%s at line %d of %s%n",
                              t.getId(),    // Thread id
                              t.getName(),  // Thread name
                              e.toString(), // Exception name and message
                              e.getStackTrace()[0].getLineNumber(), // line #
                              e.getStackTrace()[0].getFileName());  // filename
        }
    });
```

5.7.2. Making a Thread Sleep

Often, threads are used to perform some kind of repetitive task at a fixed interval. This is particularly true when doing graphical programming that involves animation or similar effects. The key to doing this is making a thread *sleep*, or stop running, for a specified amount of time. This is done with the static `THRead.sleep( )` method, or, in Java 5.0, with utility methods of enumerated constants of the `TimeUnit` class:

```
import static java.util.concurrent.TimeUnit.SECONDS;  // utility class

public class Clock extends Thread {
    // This field is volatile because two different threads may access it
    volatile boolean keepRunning = true;

    public Clock() {     // The constructor
        setDaemon(true); // Daemon thread: interpreter can exit while it runs
    }

    public void run() {        // The body of the thread
        while(keepRunning) {   // This thread runs until asked to stop
            long now = System.currentTimeMillis();    // Get current time
            System.out.printf("%tr%n", now);          // Print it out
            try { Thread.sleep(1000); }               // Wait 1000 milliseconds
            catch (InterruptedException e) { return; }// Quit on interrupt
        }
    }

    // Ask the thread to stop running.  An alternative to interrupt().
    public void pleaseStop() { keepRunning = false; }

    // This method demonstrates how to use the Clock class
    public static void main(String[] args) {
        Clock c = new Clock();                 // Create a Clock thread
        c.start();                             // Start it
        try {  SECONDS.sleep(10); }            // Wait 10 seconds
        catch(InterruptedException ignore) {}  // Ignore interrupts
        // Now stop the clock thread.  We could also use c.interrupt()
        c.pleaseStop();
    }
}
```

Notice the `pleaseStop()` method in this example: it is designed to stop the clock thread in a controlled way. The example is coded so that it can also be stopped by calling the `interrupt()` method it inherits from `Thread`. The `THRead` class defines a `stop()` method, but it is deprecated.

5.7.3. Running and Scheduling Tasks

Java provides a number of ways to run tasks asynchronously or to schedule them for future execution without having to explicitly create `Thread` objects. The following sections illustrate the `Timer` class added in Java 1.3 and the executors framework of the Java 5.0 `java.util.concurrent` package.

5.7.3.1 Scheduling tasks with Timer

Added in Java 1.3, the `java.util.Timer` and `java.util.TimerTask` classes make it easy to run repetitive tasks. Here is some code that behaves much like the `Clock` class shown earlier:

```
import java.util.*;

// Define the time-display task
TimerTask displayTime = new TimerTask() {
  public void run() { System.out.printf("%tr%n", System.currentTimeMillis()); }
};
// Create a timer object to run the task (and possibly others)
Timer timer = new Timer();
// Now schedule that task to be run every 1,000 milliseconds, starting now
timer.schedule(displayTime, 0, 1000);

// To stop the time-display task
displayTime.cancel();
```

5.7.3.2 The Executor interface

In Java 5.0, the `java.util.concurrent` package includes the `Executor` interface. An `Executor` is an object that can execute a `Runnable` object. A user of an `Executor` often does not need to be aware of just how the `Executor` accomplishes this: it just needs to know that the `Runnable` will, at some point, run. `Executor` implementations can be created to use a number of different threading strategies, as the following code makes clear. (Note that this example also demonstrates the use of a `BlockingQueue`.)

```
import java.util.concurrent.*;

/** Execute a Runnable in the current thread. */
class CurrentThreadExecutor implements Executor {
    public void execute(Runnable r) { r.run(); }
}

/** Execute each Runnable using a newly created thread */
class NewThreadExecutor implements Executor {
    public void execute(Runnable r) { new Thread(r).start(); }
}

/**
 * Queue up the Runnables and execute them in order using a single thread
 * created for that purpose.
 */
class SingleThreadExecutor extends Thread implements Executor {
    BlockingQueue<Runnable> q = new LinkedBlockingQueue<Runnable>();

    public void execute(Runnable r) {
        // Don't execute the Runnable here; just put it on the queue.
```

```
        // Our queue is effectively unbounded, so this should never block.
        // Since it never blocks, it should never throw InterruptedException.
        try { q.put(r); }
        catch(InterruptedException never) { throw new AssertionError(never); }
    }

    // This is the body of the thread that actually executes the Runnables
    public void run() {
        for(;;) {                   // Loop forever
            try {
                Runnable r = q.take();  // Get next Runnable, or wait
                r.run();                // Run it!
            }
            catch(InterruptedException e) {
                // If interrupted, stop executing queued Runnables.
                return;
            }
        }
    }
}
```

These sample implementations help demonstrate how an Executor works and how it separates the notion of executing a task from the scheduling policy and threading details of the implementation. It is rarely necessary to actually implement your own Executor, however, since java.util.concurrent provides the flexible and powerful THReadPoolExecutor class. This class is typically used via one of the static factory methods in the Executors class:

```
Executor oneThread = Executors.newSingleThreadExecutor(); // pool size of 1
Executor fixedPool = Executors.newFixedThreadPool(10); // 10 threads in pool
Executor unboundedPool = Executors.newCachedThreadPool(); // as many as needed
```

In addition to these convenient factory methods, you can also explicitly create a ThreadPoolExecutor if you want to specify a minimum and maximum size for the thread pool or want to specify the queue type (bounded, unbounded, priority-sorted, or synchronized, for example) to use for tasks that cannot immediately be run by a thread.

5.7.3.3 ExecutorService

If you've looked at the signature for ThreadPoolExecutor or for the Executors factory methods cited above, you'll see that it is an ExecutorService . The ExecutorService interface extends Executor and adds the ability to execute Callable objects. Callable is something like a Runnable. Instead of encapsulating arbitrary code in a run() method, however, a Callable puts that code in a call() method. call( ) differs from run() in two important ways: it returns a result, and it is allowed to throw exceptions.

Because call() returns a result, the Callable interface takes the result type as a parameter. A time-consuming chunk of code that computes a large prime number, for example, could be wrapped in a Callable<BigInteger>:

```
import java.util.concurrent.*;
import java.math.BigInteger;
import java.util.Random;
import java.security.SecureRandom;

/** This is a Callable implementation for computing big primes. */
public class RandomPrimeSearch implements Callable<BigInteger> {
    static Random prng = new SecureRandom();  // self-seeding
    int n;
    public RandomPrimeSearch(int bitsize) { n = bitsize; }
    public BigInteger call() { return BigInteger.probablePrime(n, prng); }
}
```

You can invoke the `call( )` method of any `Callable` object directly, of course, but to execute it using an `ExecutorService`, you pass it to the `submit()` method. Because `ExecutorService` implementations typically run tasks asynchronously, the `submit()` method cannot simply return the result of the `call( )` method. Instead, `submit()` returns a `Future` object. A `Future` is simply the promise of a result sometime in the future. It is parameterized with the type of the result, as shown in this code snippet:

```
// Try to compute two primes at the same time
ExecutorService threadpool = Executors.newFixedThreadPool(2);
Future<BigInteger> p = threadpool.submit(new RandomPrimeSearch(512));
Future<BigInteger> q = threadpool.submit(new RandomPrimeSearch(512));
```

Once you have a `Future` object, what can you do with it? You can call `isDone()` to see if the `Callable` has finished running. You can call `cancel()` to cancel execution of the `Callable` and can call `isCancelled()` to see if the `Callable` was canceled before it completed. But most of the time, you simply call `get( )` to get the result of the `call( )` method. `get()` blocks, if necessary, to wait for the `call( )` method to complete. Here is code you might use with the `Future` objects shown above:

```
BigInteger product = p.get().multiply(q.get());
```

Note that the `get()` method may throw an `ExecutionException`. Recall that `Callable.call( )` can throw any kind of exception. If this happens, the `Future` wraps that exception in an `ExecutionException` and throws it from `get()`. Note that the `Future.isDone()` method considers a `Callable` to be "done," even if the `call( )` method terminated abnormally with an exception.

5.7.3.4 ScheduledExecutorService

`ScheduledExecutorService` is an extension of `ExecutorService` that adds `Timer`-like scheduling capabilities. It allows you to schedule a `Runnable` or `Callable` to be executed once after a specified time delay or to schedule a `Runnable` for repeated execution. In each case, the result of scheduling a task for future execution is a `ScheduledFuture` object. This is simply a `Future` that also implements the `Delay` interface and provides a `geTDelay( )` method that can be used to query the remaining time before execution of the task.

The easiest way to obtain a ScheduledExecutorService is with factory methods of the Executors class. The following code uses a ScheduledExecutorService to repeatedly perform an action and also to cancel the repeated action after a fixed interval.

```
/**
 * Print random ASCII characters at a rate of cps characters per second
 * for a total of totalSeconds seconds.
 */
public static void spew(int cps, int totalSeconds) {
    final Random rng = new Random(System.currentTimeMillis());
    final ScheduledExecutorService executor =
        Executors.newSingleThreadScheduledExecutor();
    final ScheduledFuture<?> spewer =
        executor.scheduleAtFixedRate(new Runnable() {
                public void run() {
                    System.out.print((char)(rng.nextInt('~' - ' ') + ' '));
                    System.out.flush();
                }
            },
                                     0, 1000000/cps, TimeUnit.MICROSECONDS);
    executor.schedule(new Runnable() {
            public void run() {
                spewer.cancel(false);
                executor.shutdown();
                System.out.println();
            }
        },
                      totalSeconds, TimeUnit.SECONDS);
}
```

5.7.4. Exclusion and Locks

When using multiple threads, you must be very careful if you allow more than one thread to access the same data structure. Consider what would happen if one thread was trying to loop through the elements of a List while another thread was sorting those elements. Preventing this kind of unwanted concurrency is one of the central problems of multithreaded computing. The basic technique for preventing two threads from accessing the same object at the same time is to require a thread to obtain a lock on the object before the thread can modify it. While any one thread holds the lock, another thread that requests the lock has to wait until the first thread is done and releases the lock. Every Java object has the fundamental ability to provide such a locking capability.

The easiest way to keep objects threadsafe is to declare all sensitive methods synchronized. A thread must obtain a lock on an object before it can execute any of its synchronized methods, which means that no other thread can execute any other synchronized method at the same time. (If a static method is declared synchronized, the thread must obtain a lock on the class, and this works in the same manner.) To do finer-grained locking, you can specify synchronized blocks of code that hold a lock on a specified object for a short time:

```
// This method swaps two array elements in a synchronized block
public static void swap(Object[] array, int index1, int index2) {
```

```
  synchronized(array) {
    Object tmp = array[index1];
    array[index1] = array[index2];
    array[index2] = tmp;
  }
}

// The Collection, Set, List, and Map implementations in java.util do
// not have synchronized methods (except for the legacy implementations
// Vector and Hashtable). When working with multiple threads, you can
// obtain synchronized wrapper objects.
List synclist = Collections.synchronizedList(list);
Map syncmap = Collections.synchronizedMap(map);
```

5.7.4.1 The java.util.concurrent.locks package

Note that when you use the `synchronized` modifier or statement, the lock you acquire is block-scoped, and is automatically released when the thread exits the method or block. The `java.util.concurrent.locks` package in Java 5.0 provides an alternative: a `Lock` object that you explicitly lock and unlock. `Lock` objects are not automatically block-scoped and you must be careful to use `TRy/finally` constructs to ensure that locks are always released. On the other hand, `Lock` enables algorithms that are simply not possible with block-scoped locks, such as the following "hand-over-hand" linked list traversal:

```
import java.util.concurrent.locks.*;  // New in Java 5.0

/**
 * A partial implementation of a linked list of values of type E.
 * It demonstrates hand-over-hand locking with Lock
 */
public class LinkList<E> {
    E value;                // The value of this node of the list
    LinkList<E> rest;       // The rest of the list
    Lock lock;              // A lock for this node

    public LinkList(E value) {  // Constructor for a list
        this.value = value;          // Node value
        rest = null;                 // This is the only node in the list
        lock = new ReentrantLock();  // We can lock this node
    }

    /**
     * Append a node to the end of the list, traversing the list using
     * hand-over-hand locking. This method is threadsafe: multiple threads
     * may traverse different portions of the list at the same time.
     **/
    public void append(E value) {
        LinkList<E> node = this;  // Start at this node
        node.lock.lock();         // Lock it.
```

```
        // Loop 'till we find the last node in the list
        while(node.rest != null) {
            LinkList<E> next = node.rest;

            // This is the hand-over-hand part.  Lock the next node and then
            // unlock the current node.  We use a try/finally construct so
            // that the current node is unlocked even if the lock on the
            // next node fails with an exception.
            try { next.lock.lock(); }  // lock the next node
            finally { node.lock.unlock(); } // unlock the current node
            node = next;
        }

        // At this point, node is the final node in the list, and we have
        // a lock on it.  Use a try/finally to ensure that we unlock it.
        try {
            node.rest = new LinkList<E>(value); // Append new node
        }
        finally { node.lock.unlock(); }
    }
}
```

5.7.4.2 Deadlock

When you are using locking to prevent threads from accessing the same data at the same time, you must be careful to avoid *deadlock*, which occurs when two threads end up waiting for each other to release a lock they need. Since neither can proceed, neither one can release the lock it holds, and they both stop running. The following code is prone to deadlock. Whether or not a deadlock actually occurs may vary from system to system and from execution to execution.

```
// When two threads try to lock two objects, deadlock can occur unless
// they always request the locks in the same order.
final Object resource1 = new Object();   // Here are two objects to lock
final Object resource2 = new Object();
Thread t1 = new Thread(new Runnable() {  // Locks resource1 then resource2
  public void run() {
    synchronized(resource1) {
      synchronized(resource2) { compute(); }
    }
  }
});

Thread t2 = new Thread(new Runnable() {  // Locks resource2 then resource1
  public void run() {
    synchronized(resource2) {
      synchronized(resource1) { compute(); }
    }
  }
});
```

```
t1.start();  // Locks resource1
t2.start();  // Locks resource2 and now neither
thread can progress!
```

5.7.5. Coordinating Threads

It is common in multithreaded programming to require one thread to wait for another thread to take some action. The Java platform provides a number of ways to coordinate threads, including methods built into the `Object` and `Thread` classes, as well as "synchronizer" utility classes introduced in Java 5.0.

5.7.5.1 wait( ) and notify()

Sometimes a thread needs to stop running and wait until some kind of event occurs, at which point it is told to continue running. This is done with the`wait()` and `notify( )` methods. These aren't methods of the `Thread` class, however; they are methods of `Object`. Just as every Java object has a lock associated with it, every object can maintain a list of waiting threads. When a thread calls the `wait()` method of an object, any locks the thread holds are temporarily released, and the thread is added to the list of waiting threads for that object and stops running. When another thread calls the `notifyAll( )` method of the same object, the object wakes up the waiting threads and allows them to continue running:

```
import java.util.*;

/**
 * A queue. One thread calls push() to put an object on the queue.
 * Another calls pop() to get an object off the queue. If there is no
 * data, pop() waits until there is some, using wait()/notify().
 * wait() and notify() must be used within a synchronized method or
 * block. In Java 5.0, use a java.util.concurrent.BlockingQueue instead.
 */
public class WaitingQueue<E> {
    LinkedList<E> q = new LinkedList<E>();  // Where objects are stored
    public synchronized void push(E o) {
        q.add(o);         // Append the object to the end of the list
        this.notifyAll(); // Tell waiting threads that data is ready
    }
    public synchronized E pop() {
        while(q.size() == 0) {
            try { this.wait(); }
            catch (InterruptedException ignore) {}
        }
        return q.remove(0);
    }
}
```

Note that such a class is not necessary in Java 5.0 because`java.util.concurrent` defines the

BlockingQueue interface and general-purpose implementations such as ArrayBlockingQueue.

5.7.5.2 Waiting on a Condition

Java 5.0 provides an alternative to the wait() and notifyAll( ) methods of Object. java.util.concurrent.locks defines a Condition object with await() and signalAll() methods. Condition objects are always associated with Lock objects and are used in much the same way as the locking and waiting capability built into each Java object. The primary benefit is that it is possible to have more than one Condition for each Lock, something that is not possible with Object-based locking and waiting.

5.7.5.3 Waiting for a thread to finish

Sometimes one thread needs to stop and wait for another thread to complete. You can accomplish this with the join( ) method:

```
List list;  // A long list of objects to be sorted; initialized elsewhere

// Define a thread to sort the list: lower its priority, so it runs only
// when the current thread is waiting for I/O and then start it running.
Thread sorter = new BackgroundSorter(list);               // Defined earlier
sorter.setPriority(Thread.currentThread.getPriority()-1); // Lower priority
sorter.start();                                           // Start sorting

// Meanwhile, in this original thread, read data from a file
byte[] data = readData();  // Method defined elsewhere

// Before we can proceed, we need the list to be fully sorted, so
// we must wait for the sorter thread to exit, if it hasn't already.
try { sorter.join(); } catch(InterruptedException e) {}
```

5.7.5.4 Synchronizer utilities

java.util.concurrent includes four " synchronizer" classes that help to synchronize the state of a concurrent program by making threads wait until certain conditions hold:

Semaphore

: The Semaphore class models semaphores, a traditional concurrent programming construct. Conceptually, a semaphore represents one or more "permits." A thread that needs a permit calls acquire( ) and then calls release() when done with it. acquire() blocks if no permits are available, suspending the thread until another thread releases a permit.

`CountDownLatch`

A *latch* is conceptually any variable or concurrency construct that has two possible states and transitions from its initial state to its final state only once. Once the transition occurs, it remains in that final state forever. `CountDownLatch` is a concurrency utility that can exist in two states, closed and open. In its initial closed state, any threads that call the `await( )` method block and cannot proceed until it transitions to its latched open state. Once this transition occurs, all waiting threads proceed, and any threads that call `await()` in the future will not block at all. The transition from closed to open occurs when a specified number of calls to `countDown()` have occurred.

`Exchanger`

An `Exchanger` is a utility that allows two threads to *rendezvous* and exchange values. The first thread to call the `exchange( )` method blocks until a second thread calls the same method. When this happens, the argument passed to the `exchange()` method by the first thread becomes the return value of the method for the second thread and vice-versa. When the two `exchange()` invocations return, both threads are free to continue running concurrently. `Exchanger` is a generic type and uses its type parameter to specify the type of values to be exchanged.

`CyclicBarrier`

A `CyclicBarrier` is a utility that enables a group of N threads to wait for each other to reach a synchronization point. The number of threads is specified when the `CyclicBarrier` is first created. Threads call the `await( )` method to block until the last thread calls `await( )`, at which point all threads resume again. Unlike a `CountDownLatch`, a `CyclicBarrier` resets its count and is ready for immediate reuse. `CyclicBarrier` is useful in parallel algorithms in which a computation is decomposed into parts, and each part is handled by a separate thread. In such algorithms, the threads must typically rendezvous so that their partial solutions can be merged into a complete solution. To facilitate this, the `CyclicBarrier` constructor allows you to specify a `Runnable` object to be executed by the last thread that calls `await( )` before any of the other threads are woken up and allowed to resume. This `Runnable` can provide the coordination required to assemble a solution from the threads computations or to assign a new computation to each of the threads.

5.7.6. Thread Interruption

In the examples illustrating the `sleep( )`, `join()`, and `wait( )` methods, you may have noticed that calls to each of these methods are wrapped in a `TRy` statement that catches an `InterruptedException`. This is necessary because the `interrupt()` method allows one thread to interrupt the execution of another. The outcome of an interrupt depends on how you handle the `InterruptedException`. The response that is usually preferred is for an interrupted thread to stop running. On the other hand, if you simply catch and ignore the `InterruptedException`, an interrupt simply stops a thread from blocking.

If the `interrupt( )` method is called on a thread that is not blocked, the thread continues running, but its "interrupt status" is set to indicate that an interrupt has been requested. A thread can test its own interrupt status by calling the static `Thread.interrupted()` method, which returns `TRue` if the thread has been interrupted and, as a side effect, clears the interrupt status. One thread can test the interrupt status of another thread with the instance method `isInterrupted( )`, which queries the status but does not clear it.

If a thread calls `sleep( )`, `join()`, or `wait()` while its interrupt status is set, it does not block but immediately throws an `InterruptedException` (the interrupt status is cleared as a side effect of throwing the exception). Similarly, if the `interrupt( )` method is called on a thread that is already blocked in a call to `sleep( )`, `join()`, or `wait()`, that thread stops blocking by throwing an `InterruptedException`.

One of the most common times that threads block is while doing input/output; a thread often has to pause and wait for data to become available from the filesystem or from the network. (The `java.io`, `java.net`, and `java.nio` APIs for performing I/O operations are discussed later in this chapter.) Unfortunately, the `interrupt()` method does not wake up a thread blocked in an I/O method of the `java.io` package. This is one of the shortcomings of `java.io` that is cured by the New I/O API in `java.nio`. If a thread is interrupted while blocked in an I/O operation on any channel that implements `java.nio.channels.InterruptibleChannel`, the channel is closed, the thread's interrupt status is set, and the thread wakes up by throwing a `java.nio.channels.ClosedByInterruptException`. The same thing happens if a thread tries to call a blocking I/O method while its interrupt status is set. Similarly, if a thread is interrupted while it is blocked in the `select( )` method of a `java.nio.channels.Selector` (or if it calls `select( )` while its interrupt status is set), `select( )` will stop blocking (or will never start) and will return immediately. No exception is thrown in this case; the interrupted thread simply wakes up, and the `select()` call returns.

5.7.7. Blocking Queues

As noted in Section 5.6.5 earlier in this chapter, a *queue* is a collection in which elements are inserted at the "tail" and removed at the "head." The `Queue` interface and various implementations were added to `java.util` as part of Java 5.0. `java.util.concurrent` extends the `Queue` interface: `BlockingQueue` defines `put()` and `take( )` methods that allow you to add and remove elements of the queue, blocking if necessary until the queue has room, or until there is an element to be removed. The use of blocking queues is a common pattern in multithreaded programming: one thread produces objects and places them on a queue for consumption by another thread which removes them from the queue.

`java.util.concurrent` provides five implementations of `BlockingQueue`:

`ArrayBlockingQueue`

This implementation is based on an array, and, like all arrays, has a fixed capacity established when it is created. At the cost of reduced throughput, this queue can operate in a "fair" mode in which threads blocking to `put()` or `take( )` an element are served in the order in which they arrived.

`LinkedBlockingQueue`

This implementation is based on a linked-list data structure. It may have a maximum size specified, but, by default, it is essentially unbounded.

`PriorityBlockingQueue`

This unbounded queue does not implement FIFO (first-in, first-out) ordering. Instead, it orders its elements based on a specified `Comparator` object, or based on their natural ordering if they are `Comparable` objects and no `Comparator` is specified. The element returned by `take()` is the smallest element according to the `Comparator` or `Comparable` ordering. See also `java.util.PriorityQueue` for a nonblocking version.

`DelayQueue`

A `DelayQueue` is like a `PriorityBlockingQueue` for elements that implement the `Delayed` interface. `Delayed` is `Comparable` and orders elements by how long they are delayed. But `DelayQueue` is more than just an unbounded queue that sorts its elements. It also restricts `take( )` and related methods so that elements cannot be removed from the queue until their delay has elapsed.

`SynchronousQueue`

This class implements the degenerate case of a `BlockingQueue` with a capacity of zero. A call to `put()` blocks until some other thread calls `take( )`, and a call to `take( )` blocks until some other thread calls `put()`.

5.7.8. Atomic Variables

The `java.util.concurrent.atomic` package contains utility classes that permit *atomic* operations on fields without locking. An atomic operation is one that is indivisible: no other thread can observe an atomic variable in the middle of an atomic operation on it. These utility classes define `get()` and `set( )` accessor methods that have the properties of `volatile` fields but also define compound operations such as compare-and-set and get-and-increment that behave atomically. The code below demonstrates the use of `AtomicInteger` and contrasts it with the use of a traditional `synchronized` method:

```
// The count1(), count2() and count3() methods are all threadsafe.  Two
// threads can call these methods at the same time, and they will never
// see the same return value.
public class Counters {
    // A counter using a synchronized method and locking
    int count1 = 0;
    public synchronized int count1() { return count1++; }
```

```
    // A counter using an atomic increment on an AtomicInteger
    AtomicInteger count2 = new AtomicInteger(0);
    public int count2() { return count2.getAndIncrement(); }

    // An optimistic counter using compareAndSet()
    AtomicInteger count3 = new AtomicInteger(0);
    public int count3() {
        // Get the counter value with get() and set it with compareAndSet().
        // If compareAndSet() returns false, try again until we get
        // through the loop without interference.
        int result;
        do {
            result = count3.get();
        } while(!count3.compareAndSet(result, result+1));
        return result;
    }
}
```

5.8. Files and Directories

The `java.io.File` class represents a file or a directory and defines a number of important methods for manipulating files and directories. Note, however, that none of these methods allow you to read the contents of a file; that is the job of `java.io.FileInputStream`, which is just one of the many types of I/O streams used in Java and discussed in the next section. Here are some things you can do with `File`:

```
import java.io.*;
import java.util.*;

// Get the name of the user's home directory and represent it with a File
File homedir = new File(System.getProperty("user.home"));
// Create a File object to represent a file in that directory
File f = new File(homedir, ".configfile");

// Find out how big a file is and when it was last modified
long filelength = f.length();
Date lastModified = new java.util.Date(f.lastModified());

// If the file exists, is not a directory, and is readable,
// move it into a newly created directory.
if (f.exists() && f.isFile() && f.canRead()) {       // Check config file
  File configdir = new File(homedir, ".configdir"); // A new config directory
  configdir.mkdir();                                // Create that directory
  f.renameTo(new File(configdir, ".config"));       // Move the file into it
}

// List all files in the home directory
String[] allfiles = homedir.list();

// List all files that have a ".java" suffix
String[] sourcecode = homedir.list(new FilenameFilter() {
  public boolean accept(File d, String name) { return name.endsWith(".java"); }
});
```

The `File` class gained some important additional functionality as of Java 1.2:

```
// List all filesystem root directories; on Windows, this gives us
// File objects for all drive letters (Java 1.2 and later).
File[] rootdirs = File.listRoots();

// Atomically, create a lock file, then delete it (Java 1.2 and later)
File lock = new File(configdir, ".lock");
if (lock.createNewFile()) {
  // We successfully created the file.  Now arrange to delete it on exit
```

```
    lock.deleteOnExit();

    // Now run the application secure in the knowledge that no one else
    // is running it at the same time
    ...
  }
  else {
    // We didn't create the file; someone else has a lock
    System.err.println("Can't create lock file; exiting.");
    System.exit(1);
  }

  // Create a temporary file to use during processing (Java 1.2 and later)
  File temp = File.createTempFile("app", ".tmp");  // Filename prefix and suffix
  // Do something with the temp file
    ...
  // And delete it when we're done
  temp.delete();
```

5.8.1. RandomAccessFile

The `java.io` package also defines a `RandomAccessFile` class that allows you to read binary data from arbitrary locations in a file. This can be useful in certain situations, but most applications read files sequentially, using the stream classes described in the next section. Here is a short example of using `RandomAccessFile`:

```
// Open a file for read/write ("rw") access
File datafile = new File(configdir, "datafile");
RandomAccessFile f = new RandomAccessFile(datafile, "rw");
f.seek(100);                   // Move to byte 100 of the file
byte[] data = new byte[100];   // Create a buffer to hold data
f.read(data);                  // Read 100 bytes from the file
int i = f.readInt();           // Read a 4-byte integer from the file
f.seek(100);                   // Move back to byte 100
f.writeInt(i);                 // Write the integer first
f.write(data);                 // Then write the 100 bytes
f.close();                     // Close file when done with it
```

5.9. Input/Output with java.io

The `java.io` package defines a large number of classes for reading and writing streaming, or sequential, data. The `InputStream` and `OutputStream` classes are for reading and writing streams of bytes while the `Reader` and `Writer` classes are for reading and writing streams of characters. Streams can be nested, meaning you might read characters from a `FilterReader` object that reads and processes characters from an underlying `Reader` stream. This underlying `Reader` stream might read bytes from an `InputStream` and convert them to characters.

5.9.1. Reading Console Input

You can perform a number of common operations with streams. One is to read lines of input the user types at the console:

```
import java.io.*;

BufferedReader console = new BufferedReader(new InputStreamReader(System.in));
System.out.print("What is your name: ");
String name = null;
try {
  name = console.readLine();
}
catch (IOException e) { name = "<" + e + ">"; }  // This should never happen
System.out.println("Hello " + name);
```

5.9.2. Reading Lines from a Text File

Reading lines of text from a file is a similar operation. The following code reads an entire text file and quits when it reaches the end:

```
String filename = System.getProperty("user.home") + File.separator + ".cshrc";
try {
  BufferedReader in = new BufferedReader(new FileReader(filename));
  String line;
  while((line = in.readLine()) != null) {  // Read line, check for end-of-file
    System.out.println(line);              // Print the line
  }
  in.close();    // Always close a stream when you are done with it
}
catch (IOException e) {
  // Handle FileNotFoundException, etc. here
}
```

5.9.3. Writing Text to a File

Throughout this book, you've seen the use of the `System.out.println()` method to display text on the console. `System.out` simply refers to an output stream. You can print text to any output stream using similar techniques. The following code shows how to output text to a file:

```
try {
  File f = new File(homedir, ".config");
  PrintWriter out = new PrintWriter(new FileWriter(f));
  out.println("## Automatically generated config file. DO NOT EDIT!");
  out.close();  // We're done writing
}
catch (IOException e) { /* Handle exceptions */ }
```

5.9.4. Reading a Binary File

Not all files contain text, however. The following lines of code treat a file as a stream of bytes and read the bytes into a large array:

```
try {
  File f;                            // File to read; initialized elsewhere
  int filesize = (int) f.length();    // Figure out the file size
  byte[] data = new byte[filesize];   // Create an array that is big enough
  // Create a stream to read the file
  DataInputStream in = new DataInputStream(new FileInputStream(f));
  in.readFully(data);  // Read file contents into array
  in.close();
}
catch (IOException e) { /* Handle exceptions */ }
```

5.9.5. Compressing Data

Various other packages of the Java platform define specialized stream classes that operate on streaming data in some useful way. The following code shows how to use stream classes from `java.util.zip` to compute a checksum of data and then compress the data while writing it to a file:

```
import java.io.*;
import java.util.zip.*;

try {
  File f;                         // File to write to; initialized elsewhere
  byte[] data;                    // Data to write; initialized elsewhere
  Checksum check = new Adler32(); // An object to compute a simple checksum

  // Create a stream that writes bytes to the file f
  FileOutputStream fos = new FileOutputStream(f);
  // Create a stream that compresses bytes and writes them to fos
```

```
  GZIPOutputStream gzos = new GZIPOutputStream(fos);
  // Create a stream that computes a checksum on the bytes it writes to gzos
  CheckedOutputStream cos = new CheckedOutputStream(gzos, check);

  cos.write(data);             // Now write the data to the nested streams
  cos.close();                 // Close down the nested chain of streams
  long sum = check.getValue(); // Obtain the computed checksum
}
catch (IOException e) { /* Handle exceptions */ }
```

5.9.6. Reading ZIP Files

The `java.util.zip` package also contains a `ZipFile` class that gives you random access to the entries of a ZIP archive and allows you to read those entries through a stream:

```
import java.io.*;
import java.util.zip.*;

String filename;   // File to read; initialized elsewhere
String entryname;  // Entry to read from the ZIP file; initialized elsewhere
ZipFile zipfile = new ZipFile(filename);        // Open the ZIP file
ZipEntry entry = zipfile.getEntry(entryname);   // Get one entry
InputStream in = zipfile.getInputStream(entry); // A stream to read the entry
BufferedInputStream bis = new BufferedInputStream(in); // Improves efficiency
// Now read bytes from bis...
// Print out contents of the ZIP file
for(java.util.Enumeration e = zipfile.entries(); e.hasMoreElements();) {
  ZipEntry zipentry = (ZipEntry) e.nextElement();
  System.out.println(zipentry.getName());
}
```

5.9.7. Computing Message Digests

If you need to compute a cryptographic-strength checksum (also known as a message digest), use one of the stream classes of the `java.security` package. For example:

```
import java.io.*;
import java.security.*;
import java.util.*;


File f;          // File to read and compute digest on; initialized elsewhere
List text = new ArrayList();  // We'll store the lines of text here

// Get an object that can compute an SHA message digest
MessageDigest digester = MessageDigest.getInstance("SHA");
// A stream to read bytes from the file f
FileInputStream fis = new FileInputStream(f);
```

```
// A stream that reads bytes from fis and computes an SHA message digest
DigestInputStream dis = new DigestInputStream(fis, digester);
// A stream that reads bytes from dis and converts them to characters
InputStreamReader isr = new InputStreamReader(dis);
// A stream that can read a line at a time
BufferedReader br = new BufferedReader(isr);
// Now read lines from the stream
for(String line; (line = br.readLine()) != null; text.add(line)) ;
// Close the streams
br.close();
// Get the message digest
byte[] digest = digester.digest();
```

5.9.8. Streaming Data to and from Arrays

So far, we've used a variety of stream classes to manipulate streaming data, but the data itself ultimately comes from a file or is written to the console. The `java.io` package defines other stream classes that can read data from and write data to arrays of bytes or strings of text:

```
import java.io.*;

// Set up a stream that uses a byte array as its destination
ByteArrayOutputStream baos = new ByteArrayOutputStream();
DataOutputStream out = new DataOutputStream(baos);
out.writeUTF("hello");          // Write some string data out as bytes
out.writeDouble(Math.PI);       // Write a floating-point value out as bytes
byte[] data = baos.toByteArray(); // Get the array of bytes we've written
out.close();                      // Close the streams

// Set up a stream to read characters from a string
Reader in = new StringReader("Now is the time!");
// Read characters from it until we reach the end
int c;
while((c = in.read()) != -1) System.out.print((char) c);
```

Other classes that operate this way include `ByteArrayInputStream`, `StringWriter`, `CharArrayReader`, and `CharArrayWriter`.

5.9.9. Thread Communication with Pipes

`PipedInputStream` and `PipedOutputStream` and their character-based counterparts, `PipedReader` and `PipedWriter`, are another interesting set of streams defined by `java.io`. These streams are used in pairs by two threads that want to communicate. One thread writes bytes to a `PipedOutputStream` or characters to a `PipedWriter`, and another thread reads bytes or characters from the corresponding `PipedInputStream` or `PipedReader`:

```
// A pair of connected piped I/O streams forms a pipe. One thread writes
```

```
// bytes to the PipedOutputStream, and another thread reads them from the
// corresponding PipedInputStream. Or use PipedWriter/PipedReader for chars.
final PipedOutputStream writeEndOfPipe = new PipedOutputStream();
final PipedInputStream readEndOfPipe = new PipedInputStream(writeEndOfPipe);

// This thread reads bytes from the pipe and discards them
Thread devnull = new Thread(new Runnable() {
  public void run() {
    try { while(readEndOfPipe.read() != -1); }
    catch (IOException e) {}  // ignore it
  }
});
devnull.start();
```

5.10. Networking with java.net

The `java.net` package defines a number of classes that make writing networked applications surprisingly easy. Various examples follow.

5.10.1. Networking with the URL Class

The easiest networking class to use is `URL`, which represents a uniform resource locator. Different Java implementations may support different sets of URL protocols, but, at a minimum, you can rely on support for the `http://`, `ftp://`, and `file://` protocols. As of Java 1.4, secure HTTP is also supported with the `https://` protocol. Here are some ways you can use the `URL` class:

```
import java.net.*;
import java.io.*;

// Create some URL objects
URL url=null, url2=null, url3=null;
try {
  url = new URL("http://www.oreilly.com");        // An absolute URL
  url2 = new URL(url, "catalog/books/javanut4/"); // A relative URL
  url3 = new URL("http:", "www.oreilly.com", "index.html");
} catch (MalformedURLException e) { /* Ignore this exception */ }

// Read the content of a URL from an input stream
InputStream in = url.openStream();

// For more control over the reading process, get a URLConnection object
URLConnection conn = url.openConnection();

// Now get some information about the URL
String type = conn.getContentType();
String encoding = conn.getContentEncoding();
java.util.Date lastModified = new java.util.Date(conn.getLastModified());
int len = conn.getContentLength();

// If necessary, read the contents of the URL using this stream
InputStream in = conn.getInputStream();
```

5.10.2. Working with Sockets

Sometimes you need more control over your networked application than is possible with the `URL` class. In this case, you can use a `Socket` to communicate directly with a server. For example:

```
import java.net.*;
import java.io.*;

// Here's a simple client program that connects to a web server,
// requests a document and reads the document from the server.
String hostname = "java.oreilly.com";  // The server to connect to
int port = 80;                          // Standard port for HTTP
String filename = "/index.html";       // The file to read from the server
Socket s = new Socket(hostname, port); // Connect to the server

// Get I/O streams we can use to talk to the server
InputStream sin = s.getInputStream();
BufferedReader fromServer = new BufferedReader(new InputStreamReader(sin));
OutputStream sout = s.getOutputStream();
PrintWriter toServer = new PrintWriter(new OutputStreamWriter(sout));

// Request the file from the server, using the HTTP protocol
toServer.print("GET " + filename + " HTTP/1.0\r\n\r\n");
toServer.flush();

// Now read the server's response, assume it is a text file, and print it out
for(String l = null; (l = fromServer.readLine()) != null; )
  System.out.println(l);

// Close everything down when we're done
toServer.close();
fromServer.close();
s.close();
```

5.10.3. Secure Sockets with SSL

In Java 1.4, the Java Secure Socket Extension, or JSSE, was added to the core Java platform in the packages `javax.net` and `javax.net.ssl`.[1] This API enables encrypted network communication over sockets that use the SSL (Secure Sockets Layer, also known as TLS) protocol. SSL is widely used on the Internet: it is the basis for secure web communication using the `https://` protocol. In Java 1.4 and later, you can use `https://` with the `URL` class as previously shown to securely download documents from web servers that support SSL.

[1] An earlier version of JSSE using different package names is available as a separate download for use with Java 1.2 and Java 1.3. See http://java.sun.com/products/jsse/.

Like all Java security APIs, JSSE is highly configurable and gives low-level control over all details of setting up and communicating over an SSL socket. The `javax.net` and `javax.net.ssl` packages are fairly complex, but in practice, you need only a few classes to securely communicate with a server. The following program is a variant on the preceding code that uses HTTPS instead of HTTP to securely transfer the contents of the requested URL:

```
import java.io.*;
import java.net.*;
import javax.net.ssl.*;
```

```
import java.security.cert.*;

/**
 * Get a document from a web server using HTTPS. Usage:
 *   java HttpsDownload <hostname> <filename>
 **/
public class HttpsDownload {
    public static void main(String[] args) throws IOException {
        // Get a SocketFactory object for creating SSL sockets
        SSLSocketFactory factory =
            (SSLSocketFactory) SSLSocketFactory.getDefault();

        // Use the factory to create a secure socket connected to the
        // HTTPS port of the specified web server.
        SSLSocket sslsock=(SSLSocket)factory.createSocket(args[0], // Hostname
                                                         443); // HTTPS port

        // Get the certificate presented by the web server
        SSLSession session = sslsock.getSession();
        X509Certificate cert;
        try { cert = (X509Certificate)session.getPeerCertificates()[0]; }
        catch(SSLPeerUnverifiedException e) { // If no or invalid certificate
            System.err.println(session.getPeerHost() +
                               " did not present a valid certificate.");
            return;
        }

        // Display details about the certificate
        System.out.println(session.getPeerHost() +
                           " has presented a certificate belonging to:");
        System.out.println("\t[" + cert.getSubjectDN().getName() + "]");
        System.out.println("The certificate bears the valid signature of:");
        System.out.println("\t[" + cert.getIssuerDN().getName() + "]");

        // If the user does not trust the certificate, abort
        System.out.print("Do you trust this certificate (y/n)? ");
        System.out.flush();
        BufferedReader console =
            new BufferedReader(new InputStreamReader(System.in));
        if (Character.toLowerCase(console.readLine().charAt(0)) != 'y') return;

        // Now use the secure socket just as you would use a regular socket
        // First, send a regular HTTP request over the SSL socket
        PrintWriter out = new PrintWriter(sslsock.getOutputStream());
        out.print("GET " + args[1] + " HTTP/1.0\r\n\r\n");
        out.flush();

        // Next, read the server's response and print it to the console
        BufferedReader in =
         new BufferedReader(new InputStreamReader(sslsock.getInputStream()));
        String line;
        while((line = in.readLine()) != null) System.out.println(line);
```

```
        // Finally, close the socket
        sslsock.close();
    }
}
```

5.10.4. Servers

A client application uses a Socket to communicate with a server. The server does the same thing: it uses a Socket object to communicate with each of its clients. However, the server has an additional task in that it must be able to recognize and accept client connection requests. This is done with the ServerSocket class. The following code shows how you might use a ServerSocket. The code implements a simple HTTP server that responds to all requests by sending back (or mirroring) the exact contents of the HTTP request. A dummy server like this is useful when debugging HTTP clients:

```
import java.io.*;
import java.net.*;

public class HttpMirror {
  public static void main(String[] args) {
    try {
      int port = Integer.parseInt(args[0]);       // The port to listen on
      ServerSocket ss = new ServerSocket(port);   // Create a socket to listen
      for(;;) {                                   // Loop forever
        Socket client = ss.accept();              // Wait for a connection
        ClientThread t = new ClientThread(client);// A thread to handle it
        t.start();                                // Start the thread running
      }                                           // Loop again
    }
    catch (Exception e) {
      System.err.println(e.getMessage());
      System.err.println("Usage: java HttpMirror <port>;");
    }
  }

  static class ClientThread extends Thread {
    Socket client;
    ClientThread(Socket client) { this.client = client; }
    public void run() {
      try {
        // Get streams to talk to the client
        BufferedReader in =
          new BufferedReader(new InputStreamReader(client.getInputStream()));
        PrintWriter out =
          new PrintWriter(new OutputStreamWriter(client.getOutputStream()));

        // Send an HTTP response header to the client
        out.print("HTTP/1.0 200\r\nContent-Type: text/plain\r\n\r\n");

        // Read the HTTP request from the client and send it right back
```

```
        // Stop when we read the blank line from the client that marks
        // the end of the request and its headers.
        String line;
        while((line = in.readLine()) != null) {
          if (line.length() == 0) break;
          out.println(line);
        }

        out.close();
        in.close();
        client.close();
      }
      catch (IOException e) { /* Ignore exceptions */ }
    }
  }
}
```

This server code could be modified using JSSE to support SSL connections. Making a server secure is more complex than making a client secure, however, because a server must have a certificate it can present to the client. Therefore, server-side JSSE is not demonstrated here.

5.10.5. Datagrams

Both `URL` and `Socket` perform networking on top of a stream-based network connection. Setting up and maintaining a stream across a network takes work at the network level, however. Sometimes you need a low-level way to speed a packet of data across a network, but you don't care about maintaining a stream. If, in addition, you don't need a guarantee that your data will get there or that the packets of data will arrive in the order you sent them, you may be interested in the `DatagramSocket` and `DatagramPacket` classes:

```
import java.net.*;

// Send a message to another computer via a datagram
try {
  String hostname = "host.example.com";    // The computer to send the data to
  InetAddress address =                    // Convert the DNS hostname
    InetAddress.getByName(hostname);       // to a lower-level IP address.
  int port = 1234;                         // The port to connect to
  String message = "The eagle has landed.";  // The message to send
  byte[] data = message.getBytes();          // Convert string to bytes
  DatagramSocket s = new DatagramSocket();   // Socket to send message with
  DatagramPacket p =                         // Create the packet to send
    new DatagramPacket(data, data.length, address, port);
  s.send(p);                                // Now send it!
  s.close();                                // Always close sockets when done
}
catch (UnknownHostException e) {}  // Thrown by InetAddress.getByName()
catch (SocketException e) {}       // Thrown by new DatagramSocket()
catch (java.io.IOException e) {}   // Thrown by DatagramSocket.send()
```

```
// Here's how the other computer can receive the datagram
try {
  byte[] buffer = new byte[4096];              // Buffer to hold data

  DatagramSocket s = new DatagramSocket(1234); // Socket that receives it
                                               // through
  DatagramPacket p =
    new DatagramPacket(buffer, buffer.length); // The packet that receives it
  s.receive(p);                                // Wait for a packet to arrive
  String msg =                                 // Convert the bytes from the
    new String(buffer, 0, p.getLength());      // packet back to a string.
  s.close();                                   // Always close the socket
}
catch (SocketException e) {}       // Thrown by new DatagramSocket()
catch (java.io.IOException e) {}   // Thrown by DatagramSocket.receive()
```

5.10.6. Testing the Reachability of a Host

In Java 5.0 the `InetAddress` class has an `isReachable( )` method that attempts to determine whether the host is reachable. The following code uses it in a naive Java implementation of the Unix *ping* utility:

```
import java.io.IOException;
import java.net.InetAddress;
import java.net.UnknownHostException;

public class Ping {
    public static void main(String[] args) throws IOException {
        try {
            String hostname = args[0];
            int timeout = (args.length > 1)?Integer.parseInt(args[1]):2000;
            InetAddress[] addresses = InetAddress.getAllByName(hostname);
            for(InetAddress address : addresses) {
                if (address.isReachable(timeout))
                    System.out.printf("%s is reachable%n", address);
                else
                    System.out.printf("%s could not be contacted%n", address);
            }
        }
        catch (UnknownHostException e) {
            System.out.printf("Unknown host: %s%n", args[0]);
        }
        catch(IOException e) { System.out.printf("Network error: %s%n", e); }
        catch (Exception e) {
            // ArrayIndexOutOfBoundsException or NumberFormatException
            System.out.println("Usage: java Ping <hostname> [timeout in ms]");
        }
    }
}
```

5.11. I/O and Networking with java.nio

Java 1.4 introduced an entirely new API for high-performance, nonblocking I/O and networking. This API consists primarily of three new packages. java.nio defines Buffer classes that are used to store sequences of bytes or other primitive values. java.nio.channels defines *channels* through which data can be transferred between a buffer and a data source or sink, such as a file or a network socket. This package also contains important classes used for nonblocking I/O.Finally, the java.nio.charset package contains classes for efficiently converting buffers of bytes into buffers of characters. The sections that follow contain examples of using all three of these packages as well as examples of specific I/O tasks with the New I/O API.

5.11.1. Basic Buffer Operations

The java.nio package includes an abstract Buffer class, which defines generic operations on buffers. This package also defines type-specific subclasses such as ByteBuffer, CharBuffer, and IntBuffer. (See Buffer and ByteBuffer in the reference section for details on these classes and their various methods.) The following code illustrates typical sequences of buffer operations on a ByteBuffer. The other type-specific buffer classes have similar methods.

```
import java.nio.*;

// Buffers don't have public constructors. They are allocated instead.
ByteBuffer b = ByteBuffer.allocate(4096);  // Create a buffer for 4,096 bytes
// Or do this to try to get an efficient buffer from the low-level OS
ByteBuffer buf2 = ByteBuffer.allocateDirect(65536);
// Here's another way to get a buffer: by "wrapping" an array
byte[] data;  // Assume this array is created and initialized elsewhere
ByteBuffer buf3 = ByteBuffer.wrap(data); // Create buffer that uses the array
// It is also possible to create a "view buffer" to view bytes as other types
buf3.order(ByteOrder.BIG_ENDIAN);   // Specify the byte order for the buffer
IntBuffer ib = buf3.asIntBuffer();  // View those bytes as integers

// Now store some data in the buffer
b.put(data);       // Copy bytes from array to buffer at current position
b.put((byte)42);   // Store another byte at the new current position
b.put(0, (byte)9); // Overwrite first byte in buffer. Don't change position.
b.order(ByteOrder.BIG_ENDIAN);  // Set the byte order of the buffer
b.putChar('x');       // Store the two bytes of a Unicode character in buffer
b.putInt(0xcafebabe); // Store four bytes of an int into the buffer

// Here are methods for querying basic numbers about a buffer
int capacity = b.capacity();  // How many bytes can the buffer hold? (4,096)
int position = b.position();  // Where will the next byte be written or read?
// A buffer's limit specifies how many bytes of the buffer can be used.
// When writing into a buffer, this should be the capacity. When reading data
```

```
// from a buffer, it should be the number of bytes that were previously
// written.
int limit = b.limit();         // How many should be used?
int remaining = b.remaining(); // How many left? Return limit-position.
boolean more=b.hasRemaining(); // Test if there is still room in the buffer

// The position and limit can also be set with methods of the same name
// Suppose you want to read the bytes you've written into the buffer
b.limit(b.position());         // Set limit to current position
b.position(0);                 // Set limit to 0; start reading at beginning

// Instead of the two previous calls, you usually use a convenience method
b.flip();   // Set limit to position and position to 0; prepare for reading
b.rewind(); // Set position to 0; don't change limit; prepare for rereading
b.clear();  // Set position to 0 and limit to capacity; prepare for writing

// Assuming you've called flip(), you can start reading bytes from the buffer
buf2.put(b);        // Read all bytes from b and put them into buf2
b.rewind();         // Rewind b for rereading from the beginning
byte b0 = b.get();  // Read first byte; increment buffer position
byte b1 = b.get();  // Read second byte; increment buffer position
byte[] fourbytes = new byte[4];
b.get(fourbytes);   // Read next four bytes, add 4 to buffer position
byte b9 = b.get(9); // Read 10th byte, without changing current position
int i = b.getInt(); // Read next four bytes as an integer; add 4 to position

// Discard bytes you've already read; shift the remaining ones to the
// beginning of the buffer; set position to new limit and limit to capacity,
// preparing the buffer for writing more bytes into it.
b.compact();
```

You may notice that many buffer methods return the object on which they operate. This is done so that method calls can be "chained" in code, as follows:

```
ByteBuffer  bb=ByteBuffer.allocate(32).order(ByteOrder.BIG_ENDIAN).putInt(1234);
```

Many methods throughout `java.nio` and its subpackages return the current object to enable this kind of method chaining. Note that the use of this kind of chaining is a stylistic choice (which I have avoided in this chapter) and does not have any significant impact on efficiency.

`ByteBuffer` is the most important of the buffer classes. However, another commonly used class is `CharBuffer`. `CharBuffer` objects can be created by wrapping a string and can also be converted to strings. `CharBuffer` implements the new `java.lang.CharSequence` interface, which means that it can be used like a `String` or `StringBuffer` in certain applications (e.g., for regular expression pattern matching).

```
// Create a read-only CharBuffer from a string
CharBuffer cb = CharBuffer.wrap("This string is the data for the CharBuffer");
String s = cb.toString();  // Convert to a String with toString() method
System.out.println(cb);    // or rely on an implicit call to toString().
```

```
char c = cb.charAt(0);     // Use CharSequence methods to get characters
char d = cb.get(1);        // or use a CharBuffer absolute read.
// A relative read that reads the char and increments the current position
// Note that only the characters between the position and limit are used when
// a CharBuffer is converted to a String or used as a CharSequence.
char e = cb.get();
```

Bytes in a `ByteBuffer` are commonly converted to characters in a `CharBuffer` and vice versa. We'll see how to do this when we consider the `java.nio.charset` package.

5.11.2. Basic Channel Operations

Buffers are not all that useful on their ownthere isn't much point in storing bytes into a buffer only to read them out again. Instead, buffers are typically used with channels: your program stores bytes into a buffer, then passes the buffer to a channel, which reads the bytes out of the buffer and writes them to a file, network socket, or some other destination. Or, in the reverse, your program passes a buffer to a channel, which reads bytes from a file, socket, or other source and stores those bytes into the buffer, where they can then be retrieved by your program. The `java.nio.channels` package defines several channel classes that represent files, sockets, datagrams, and pipes. (We'll see examples of these concrete classes later in this chapter.) The following code, however, is based on the capabilities of the various channel interfaces defined by `java.nio.channels` and should work with any `Channel` object:

```
Channel c;  // Object that implements Channel interface; initialized elsewhere
if (c.isOpen()) c.close();  // These are the only methods defined by Channel

// The read() and write() methods are defined by the
// ReadableByteChannel and WritableByteChannel interfaces.
ReadableByteChannel source;      // Initialized elsewhere
WritableByteChannel destination; // Initialized elsewhere
ByteBuffer buffer = ByteBuffer.allocateDirect(16384); // Low-level 16 KB buffer

// Here is the basic loop to use when reading bytes from a source channel and
// writing them to a destination channel until there are no more bytes to read
// from the source and no more buffered bytes to write to the destination.
while(source.read(buffer) != -1 || buffer.position() > 0) {
  // Flip buffer: set limit to position and position to 0. This prepares
  // the buffer for reading (which is done by a channel *write* operation).
  buffer.flip();
  // Write some or all of the bytes in the buffer to the destination
  destination.write(buffer);
  // Discard the bytes that were written, copying the remaining ones to
  // the start of the buffer. Set position to limit and limit to capacity,
  // preparing the buffer for writing (done by a channel *read* operation).
  buffer.compact();
}

// Don't forget to close the channels
source.close();
```

```
destination.close();
```

In addition to the ReadableByteChannel and WritableByteChannel interfaces illustrated in the preceding code, java.nio.channels defines several other channel interfaces. ByteChannel simply extends the readable and writable interfaces without adding any new methods. It is a useful shorthand for channels that support both reading and writing. GatheringByteChannel is an extension of WritableByteChannel that defines write() methods that *gather* bytes from more than one buffer and write them out. Similarly, ScatteringByteChannel is an extension of ReadableByteChannel that defines read() methods that read bytes from the channel and *scatter* or distribute them into more than one buffer. The gathering and scattering write( ) and read() methods can be useful when working with network protocols that use fixed-size headers that you want to store in a buffer separate from the rest of the transferred data.

One confusing point to be aware of is that a channel read operation involves writing (or putting) bytes into a buffer, and a channel write operation involves reading (or getting) bytes from a buffer. Thus, when I say that the flip( ) method prepares a buffer for reading, I mean that it prepares a buffer for use in a channel write( ) operation! The reverse is true for the buffer's compact() method.

5.11.3. Encoding and Decoding Text with Charsets

A java.nio.charset.Charset object represents a character set plus an encoding for that character set. Charset and its associated classes, CharsetEncoder and CharsetDecoder, define methods for encoding strings of characters into sequences of bytes and decoding sequences of bytes into strings of characters. Since these classes are part of the New I/O API, they use the ByteBuffer and CharBuffer classes:

```
// The simplest case. Use Charset convenience routines to convert.
Charset charset = Charset.forName("ISO-8859-1"); // Get Latin-1 Charset
CharBuffer cb = CharBuffer.wrap("Hello World");  // Characters to encode
// Encode the characters and store the bytes in a newly allocated ByteBuffer
ByteBuffer bb = charset.encode(cb);
// Decode these bytes into a newly allocated CharBuffer and print them out
System.out.println(charset.decode(bb));
```

Note the use of the ISO-8859-1 (a.k.a. Latin-1) charset in this example. This 8-bit charset is suitable for most Western European languages, including English. Programmers who work only with English may also use the 7-bit US-ASCII charset. The Charset class does not do encoding and decoding itself, and the previous convenience routines create CharsetEncoder and CharsetDecoder classes internally. If you plan to encode or decode multiple times, it is more efficient to create these objects yourself:

```
Charset charset = Charset.forName("US-ASCII");   // Get the charset
CharsetEncoder encoder = charset.newEncoder();   // Create an encoder from it
CharBuffer cb = CharBuffer.wrap("Hello World!"); // Get a CharBuffer
WritableByteChannel destination;                 // Initialized elsewhere
destination.write(encoder.encode(cb));           // Encode chars and write
```

The preceding CharsetEncoder.encode( ) method must allocate a new ByteBuffer each time it is called. For maximum efficiency, you can call lower-level methods to do the encoding and decoding into an existing buffer:

```
ReadableByteChannel source;                       // Initialized elsewhere
Charset charset = Charset.forName("ISO-8859-1"); // Get the charset
CharsetDecoder decoder = charset.newDecoder();   // Create a decoder from it
ByteBuffer bb = ByteBuffer.allocateDirect(2048); // Buffer to hold bytes
CharBuffer cb = CharBuffer.allocate(2048);       // Buffer to hold characters

while(source.read(bb) != -1) {  // Read bytes from the channel until EOF
  bb.flip();                    // Flip byte buffer to prepare for decoding
  decoder.decode(bb, cb, true); // Decode bytes into characters
  cb.flip();                    // Flip char buffer to prepare for printing
  System.out.print(cb);         // Print the characters
  cb.clear();                   // Clear char buffer to prepare for decoding
  bb.clear();                   // Prepare byte buffer for next channel read
}
source.close();                 // Done with the channel, so close it
System.out.flush();             // Make sure all output characters appear
```

The preceding code relies on the fact that ISO-8859-1 is an 8-bit encoding charset and that there is one-to-one mapping between characters and bytes. For more complex charsets, such as the UTF-8 encoding of Unicode or the EUC-JP charset used with Japanese text; however, this does not hold, and more than one byte is required for some (or all) characters. When this is the case, there is no guarantee that all bytes in a buffer can be decoded at once (the end of the buffer may contain a partial character). Also, since a single character may encode to more than one byte, it can be tricky to know how many bytes a given string will encode into. The following code shows a loop you can use to decode bytes in a more general way:

```
ReadableByteChannel source;                       // Initialized elsewhere
Charset charset = Charset.forName("UTF-8");      // A Unicode encoding
CharsetDecoder decoder = charset.newDecoder();   // Create a decoder from it
ByteBuffer bb = ByteBuffer.allocateDirect(2048); // Buffer to hold bytes
CharBuffer cb = CharBuffer.allocate(2048);       // Buffer to hold characters

// Tell the decoder to ignore errors that might result from bad bytes
decoder.onMalformedInput(CodingErrorAction.IGNORE);
decoder.onUnmappableCharacter(CodingErrorAction.IGNORE);

decoder.reset();                 // Reset decoder if it has been used before
while(source.read(bb) != -1) {   // Read bytes from the channel until EOF
  bb.flip();                     // Flip byte buffer to prepare for decoding
  decoder.decode(bb, cb, false); // Decode bytes into characters
  cb.flip();                     // Flip char buffer to prepare for printing
  System.out.print(cb);          // Print the characters
  cb.clear();                    // Clear the character buffer
  bb.compact();                  // Discard already decoded bytes
}
source.close();                  // Done with the channel, so close it
```

```
// At this point, there may still be some bytes in the buffer to decode
bb.flip();                       // Prepare for decoding
decoder.decode(bb, cb, true);    // Pass true to indicate this is the last call
decoder.flush(cb);               // Output any final characters
cb.flip();                       // Flip char buffer
System.out.print(cb);            // Print the final characters
```

5.11.4. Working with Files

`FileChannel` is a concrete `Channel` class that performs file I/O and implements `ReadableByteChannel` and `WritableByteChannel` (although its `read()` method works only if the underlying file is open for reading, and its`write( )` method works only if the file is open for writing). Obtain a `FileChannel` object by using the `java.io` package to create a `FileInputStream`, a `FileOutputStream`, or a `RandomAccessFile` and then call the `getChannel()` method (added in Java 1.4) of that object. As an example, you can use two`FileChannel` objects to copy a file:

```
String filename = "test";   // The name of the file to copy
// Create streams to read the original and write the copy
FileInputStream fin = new FileInputStream(filename);
FileOutputStream fout = new FileOutputStream(filename + ".copy");
// Use the streams to create corresponding channel objects
FileChannel in = fin.getChannel();
FileChannel out = fout.getChannel();
// Allocate a low-level 8KB buffer for the copy
ByteBuffer buffer = ByteBuffer.allocateDirect(8192);
while(in.read(buffer) != -1 || buffer.position() > 0) {
  buffer.flip();      // Prepare to read from the buffer and write to the file
  out.write(buffer);  // Write some or all buffer contents
  buffer.compact();   // Discard all bytes that were written and prepare to
}                     // read more from the file and store them in the buffer.
in.close();           // Always close channels and streams when done with them
out.close();
fin.close();          // Note that closing a FileChannel does not
fout.close();         // automatically close the underlying stream.
```

`FileChannel` has special `transferTo( )` and `transferFrom()` methods that make it particularly easy (and on many operating systems, particularly efficient) to transfer a specified number of bytes from a `FileChannel` to some other specified channel, or from some other channel to a`FileChannel`. These methods allow us to simplify the preceding file-copying code to the following:

```
FileChannel in, out;              // Assume these are initialized as in the
                                  // preceding example.
long numbytes = in.size();        // Number of bytes in original file
in.transferTo(0, numbytes, out);  // Transfer that amount to output channel
```

This code could be equally well-written using`transferFrom( )` instead of `TRansferTo()` (note that these two methods expect their arguments in different orders):

```
long numbytes = in.size();
out.transferFrom(in, 0, numbytes);
```

FileChannel has other capabilities that are not shared by other channel classes. One of the most important is the ability to "memory map" a file or a portion of a file, i.e., to obtain a MappedByteBuffer (a subclass of ByteBuffer) that represents the contents of the file and allows you to read (and optionally write) file contents simply by reading from and writing to the buffer. Memory mapping a file is a somewhat expensive operation, so this technique is usually efficient only when you are working with a large file to which you need repeated access. Memory mapping offers you yet another way to perform the same file-copy operation shown previously:

```
long filesize = in.size();
ByteBuffer bb = in.map(FileChannel.MapMode.READ_ONLY, 0, filesize);
while(bb.hasRemaining()) out.write(bb);
```

The channel interfaces defined by java.nio.channels include ByteChannel but not CharChannel. The channel API is low-level and provides methods for reading bytes only. All of the previous examples have treated files as binary files. It is possible to use the CharsetEncoder and CharsetDecoder classes introduced earlier to convert between bytes and characters, but when you want to work with text files, the Reader and Writer classes of the java.io package are usually much easier to use than CharBuffer. Fortunately, the Channels class defines convenience methods that bridge between the old and new APIs. Here is code that wraps a Reader and a Writer object around input and output channels, reads lines of Latin-1 text from the input channel, and writes them back out to the output channel, with the encoding changed to UTF-8:

```
ReadableByteChannel in;      // Assume these are initialized elsewhere
WritableByteChannel out;
// Create a Reader and Writer from a FileChannel and charset name
BufferedReader reader=new BufferedReader(Channels.newReader(in, "ISO-8859-1"));
PrintWriter writer = new PrintWriter(Channels.newWriter(out, "UTF-8"));
String line;
while((line = reader.readLine()) != null) writer.println(line);
reader.close();
writer.close();
```

Unlike the FileInputStream and FileOutputStream classes, the FileChannel class allows random access to the contents of the file. The zero-argument position() method returns the *file pointer* (the position of the next byte to be read), and the one-argument position( ) method allows you to set this pointer to any value you want. This allows you to skip around in a file in the way that the java.io.RandomAccessFile does. Here is an example:

```
// Suppose you have a file that has data records scattered throughout, and the
// last 1,024 bytes of the file are an index that provides the position of
// those records. Here is code that reads the index of the file, looks up the
// position of the first record within the file and then reads that record.
FileChannel in = new FileInputStream("test.data").getChannel(); // The channel
ByteBuffer index = ByteBuffer.allocate(1024);   // A buffer to hold the index
long size = in.size();                          // The size of the file
in.position(size - 1024);                       // Position at start of index
```

```
in.read(index);                              // Read the index
int record0Position = index.getInt(0);       // Get first index entry
in.position(record0Position);                // Position file at that point
ByteBuffer record0 = ByteBuffer.allocate(128);  // Get buffer to hold data
in.read(record0);                            // Finally, read the record
```

The final feature of FileChannel that we'll consider here is its ability to lock a file or a portion of a file against all concurrent access (an exclusive lock) or against concurrent writes (a shared lock). (Note that some operating systems strictly enforce all locks while others provide only an advisory locking facility that requires programs to cooperate and to attempt to acquire a lock before reading o writing portions of a shared file.) In the previous random-access example, suppose we wanted to ensure that no other program was modifying the record data while we read it. We could acquire a shared lock on that portion of the file with the following code:

```
FileLock lock = in.lock(record0Position, // Start of locked region
                        128,     // Length of locked region
                        true);   // Shared lock: prevent concurrent updates
                                 // but allow concurrent reads.
in.position(record0Position);    // Move to start of index
in.read(record0);                // Read the index data
lock.release();                  // You're done with the lock, so release it
```

5.11.5. Client-Side Networking

The New I/O API includes networking capabilities as well as file-access capabilities. To communicate over the network, you can use the SocketChannel class. Create a SocketChannel with the static open() method, then read and write bytes from and to it as you would with any other channel object The following code uses SocketChannel to send an HTTP request to a web server and saves the server's response (including all of the HTTP headers) to a file.Note the use of java.net.InetSocketAddress, a subclass of java.net.SocketAddress, to tell the SocketChannel what to connect to. These classes were also introduced as part of the New I/O API.

```
import java.io.*;
import java.net.*;
import java.nio.*;
import java.nio.channels.*;
import java.nio.charset.*;

// Create a SocketChannel connected to the web server at www.oreilly.com
SocketChannel socket =
  SocketChannel.open(new InetSocketAddress("www.oreilly.com",80));
// A charset for encoding the HTTP request
Charset charset = Charset.forName("ISO-8859-1");
// Send an HTTP request to the server. Start with a string, wrap it to
// a CharBuffer, encode it to a ByteBuffer, then write it to the socket.
socket.write(charset.encode(CharBuffer.wrap("GET / HTTP/1.0\r\n\r\n")));
// Create a FileChannel to save the server's response to
FileOutputStream out = new FileOutputStream("oreilly.html");
FileChannel file = out.getChannel();
```

```
// Get a buffer for holding bytes while transferring from socket to file
ByteBuffer buffer = ByteBuffer.allocateDirect(8192);
// Now loop until all bytes are read from the socket and written to the file
while(socket.read(buffer) != -1 || buffer.position() > 0) {  // Are we done?
  buffer.flip();       // Prepare to read bytes from buffer and write to file
  file.write(buffer);  // Write some or all bytes to the file
  buffer.compact();    // Discard those that were written
}
socket.close();        // Close the socket channel
file.close();          // Close the file channel
out.close();           // Close the underlying file
```

Another way to create a `SocketChannel` is with the no-argument version of `open()`, which creates an unconnected channel. This allows you to call the `socket()` method to obtain the underlying socket, configure the socket as desired, and connect to the desired host with the connect method. For example:

```
SocketChannel sc = SocketChannel.open();  // Open an unconnected socket channel
Socket s = sc.socket();                   // Get underlying java.net.Socket
s.setSoTimeout(3000);                     // Time out after three seconds
// Now connect the socket channel to the desired host and port
sc.connect(new InetSocketAddress("www.davidflanagan.com", 80));

ByteBuffer buffer = ByteBuffer.allocate(8192);  // Create a buffer
try { sc.read(buffer); }                        // Try to read from socket
catch(SocketTimeoutException e) {               // Catch timeouts here
  System.out.println("The remote computer is not responding.");
  sc.close();
}
```

In addition to the `SocketChannel` class, the `java.nio.channels` package defines a `DatagramChannel` for networking with datagrams instead of sockets. `DatagramChannel` is not demonstrated here, but you can read about it in the reference section.

One of the most powerful features of the New I/O API is that channels such as `SocketChannel` and `DatagramChannel` can be used in nonblocking mode. We'll see examples of this in later sections.

5.11.6. Server-Side Networking

The `java.net` package defines a `Socket` class for communication between a client and a server and defines a `ServerSocket` class used by the server to listen for and accept connections from clients. The `java.nio.channels` package is analogous: it defines a `SocketChannel` class for data transfer and a `ServerSocketChannel` class for accepting connections. `ServerSocketChannel` is an unusual channel because it does not implement `ReadableByteChannel` or `WritableByteChannel`. Instead of `read()` and `write()` methods, it has an `accept()` method for accepting client connections and obtaining a `SocketChannel` through which it communicates with the client. Here is the code for a simple, single-threaded server that listens for connections on port 8000 and reports the current time to any client that connects:

```
import java.nio.*;
import java.nio.channels.*;
import java.nio.charset.*;

public class DateServer {
    public static void main(String[] args) throws java.io.IOException {
        // Get a CharsetEncoder for encoding the text sent to the client
        CharsetEncoder encoder = Charset.forName("US-ASCII").newEncoder();

        // Create a new ServerSocketChannel and bind it to port 8000
        // Note that this must be done using the underlying ServerSocket
        ServerSocketChannel server = ServerSocketChannel.open();
        server.socket().bind(new java.net.InetSocketAddress(8000));

        for(;;) {  // This server runs forever
            // Wait for a client to connect
            SocketChannel client = server.accept();
            // Get the current date and time as a string
            String response = new java.util.Date().toString() + "\r\n";
            // Wrap, encode, and send the string to the client
            client.write(encoder.encode(CharBuffer.wrap(response)));
            // Disconnect from the client
            client.close();
        }
    }
}
```

5.11.7. Nonblocking I/O

The preceding DateServer class is a simple network server. Because it does not maintain a connection with any client, it never needs to communicate with more than one at a time, and there is never more than one SocketChannel in use. More realistic servers must be able to communicate with more than one client at a time. The java.io and java.net APIs allow only blocking I/O, so servers written using these APIs must use a separate thread for each client. For large-scale servers with many clients, this approach does not scale well. To solve this problem, the New I/O API allows most channels (but not FileChannel) to be used in nonblocking mode and allows a single thread to manage all pending connections. This is done with a Selector object, which keeps track of a set of registered channels and can block until one or more of those channels is ready for I/O, as the following code illustrates. This is a longer example than most in this chapter, but it is a complete working server class that manages a ServerSocketChannel and any number of SocketChannel connections to clients through a single Selector object.

```
import java.io.*;
import java.net.*;
import java.nio.*;
import java.nio.channels.*;
import java.nio.charset.*;
import java.util.*;           // For Set and Iterator

public class NonBlockingServer {
```

```
    public static void main(String[] args) throws IOException {

        // Get the character encoders and decoders you'll need
        Charset charset = Charset.forName("ISO-8859-1");
        CharsetEncoder encoder = charset.newEncoder();
        CharsetDecoder decoder = charset.newDecoder();

        // Allocate a buffer for communicating with clients
        ByteBuffer buffer = ByteBuffer.allocate(512);

        // All of the channels in this code will be in nonblocking mode.
        // So create a Selector object that will block while monitoring
        // all of the channels and stop blocking only when one or more
        // of the channels is ready for I/O of some sort.
        Selector selector = Selector.open();

        // Create a new ServerSocketChannel and bind it to port 8000
        // Note that this must be done using the underlying ServerSocket
        ServerSocketChannel server = ServerSocketChannel.open();
        server.socket().bind(new java.net.InetSocketAddress(8000));
        // Put the ServerSocketChannel into nonblocking mode
        server.configureBlocking(false);
        // Now register it with the Selector (note that register() is called
        // on the channel, not on the selector object, however).
        // The SelectionKey represents the registration of this channel with
        // this Selector.
        SelectionKey serverkey = server.register(selector,
                                                 SelectionKey.OP_ACCEPT);

        for(;;) {  // The main server loop. The server runs forever.
            // This call blocks until there is activity on one of the
            // registered channels. This is the key method in nonblocking
            // I/O.
            selector.select();

            // Get a java.util.Set containing the SelectionKey objects for
            // all channels that are ready for I/O.
            Set keys = selector.selectedKeys();

            // Use a java.util.Iterator to loop through the selected keys
            for(Iterator i = keys.iterator(); i.hasNext(); ) {
                // Get the next SelectionKey in the set and remove it
                // from the set. It must be removed explicitly, or it will
                // be returned again by the next call to select().
                SelectionKey key = (SelectionKey) i.next();
                i.remove();

                // Check whether this key is the SelectionKey obtained when
                // you registered the ServerSocketChannel.
                if (key == serverkey) {
                    // Activity on the ServerSocketChannel means a client
                    // is trying to connect to the server.
```

```
            if (key.isAcceptable()) {
                // Accept the client connection and obtain a
                // SocketChannel to communicate with the client.
                SocketChannel client = server.accept();
                // Put the client channel in nonblocking mode
                client.configureBlocking(false);
                // Now register it with the Selector object,
                // telling it that you'd like to know when
                // there is data to be read from this channel.
                SelectionKey clientkey =
                    client.register(selector, SelectionKey.OP_READ);
                // Attach some client state to the key. You'll
                // use this state when you talk to the client.
                clientkey.attach(new Integer(0));
            }
        }
        else {
            // If the key obtained from the Set of keys is not the
            // ServerSocketChannel key, then it must be a key
            // representing one of the client connections.
            // Get the channel from the key.
            SocketChannel client = (SocketChannel) key.channel();

            // If you are here, there should be data to read from
            // the channel, but double-check.
            if (!key.isReadable()) continue;

            // Now read bytes from the client. Assume that all the
            // client's bytes are in one read operation.
            int bytesread = client.read(buffer);

            // If read() returns -1, it indicates end-of-stream,
            // which means the client has disconnected, so
            // deregister the selection key and close the channel.
            if (bytesread == -1) {
                key.cancel();
                client.close();
                continue;
            }

            // Otherwise, decode the bytes to a request string
            buffer.flip();
            String request = decoder.decode(buffer).toString();
            buffer.clear();
            // Now reply to the client based on the request string
            if (request.trim().equals("quit")) {
                // If the request was "quit", send a final message
                // Close the channel and deregister the
                // SelectionKey
                client.write(encoder.encode(CharBuffer.wrap("Bye.")));
                key.cancel();
                client.close();
```

```
                    }
                    else {
                        // Otherwise, send a response string comprised of
                        // the sequence number of this request plus an
                        // uppercase version of the request string. Note
                        // that you keep track of the sequence number by
                        // "attaching" an Integer object to the
                        // SelectionKey and incrementing it each time.

                        // Get sequence number from SelectionKey
                        int num = ((Integer)key.attachment()).intValue();
                        // For response string
                        String response = num + ": " +
                            request.toUpperCase();
                        // Wrap, encode, and write the response string
                        client.write(encoder.encode(CharBuffer.wrap(response)));
                        // Attach an incremented sequence nubmer to the key
                        key.attach(new Integer(num+1));
                    }
                }
            }
        }
    }
}
```

Nonblocking I/O is most useful for writing network servers. It is also useful in clients that have more than one network connection pending at the same time. For example, consider a web browser downloading a web page and the images referenced by that page at the same time. One other interesting use of nonblocking I/O is to perform nonblocking socket connection operations. The idea i that you can ask a `SocketChannel` to establish a connection to a remote host and then go do other stuff (such as build a GUI, for example) while the underlying OS is setting up the connection across the network. Later, you do a `select()` call to block until the connection has been established, if it hasn't been already. The code for a nonblocking connect looks like this:

```
// Create a new, unconnected SocketChannel. Put it in nonblocking
// mode, register it with a new Selector, and then tell it to connect.
// The connect call will return instead of waiting for the network
// connect to be fully established.
Selector selector = Selector.open();
SocketChannel channel = SocketChannel.open();
channel.configureBlocking(false);
channel.register(selector, SelectionKey.OP_CONNECT);
channel.connect(new InetSocketAddress(hostname, port));

// Now go do other stuff while the connection is set up
// For example, you can create a GUI here

// Now block if necessary until the SocketChannel is ready to connect.
// Since you've registered only one channel with this selector, you
// don't need to examine the key set; you know which channel is ready.
while(selector.select() == 0) /* empty loop */;
```

```
// This call is necessary to finish the nonblocking connections
channel.finishConnect();

// Finally, close the selector, which deregisters the channel from it
selector.close();
```

Team LiB

Team LiB

5.12. XML

Java 1.4 and Java 5.0 have added powerful XML processing features to the Java platform:

`org.xml.sax`

This package and its two subpackages define the de facto standard SAX API (SAX stands for Simple API for XML). SAX is an event-driven, XML-parsing API: a SAX parser invokes methods of a specified `ContentHandler` object (as well as some other related handler objects) as it parses an XML document. The structure and content of the document are fully described by the method calls. This is a streaming API that does not build any permanent representation of the document. It is up to the `ContentHandler` implementation to store any state or perform any actions that are appropriate. This package includes classes for the SAX 2 API and deprecated classes for SAX 1.

`org.w3c.dom`

This package defines interfaces that represent an XML document in tree form. The Document Object Model (DOM) is a recommendation (essentially a standard) of the World Wide Web Consortium (W3C). A DOM parser reads an XML document and converts it into a tree of nodes that represent the full content of the document. Once the tree representation of the document is created, a program can examine and manipulate it however it wants. Java 1.4 includes the core module of the Level 2 DOM, and Java 5.0 includes the core, events, and load/save modules of the Level 3 DOM.

`javax.xml.parsers`

This package provides high-level interfaces for instantiating SAX and DOM parsers for parsing XML documents.

`javax.xml.transform`

This package and its subpackages define a Java API for transforming XML document content and representation using the XSLT standard.

`javax.xml.validation`

This Java 5.0 package provides support for validating an XML document against a schema.

Implementations are required to support the W3C XML Schema standard and may also support other schema types as well.

`javax.xml.xpath`

This package, also new in Java 5.0, supports the evaluation of XPath for selecting nodes in an XML document.

Examples using each of these packages are presented in the following sections.

5.12.1. Parsing XML with SAX

The first step in parsing an XML document with SAX is to obtain a SAX parser. If you have a SAX parser implementation of your own, you can simply instantiate the appropriate parser class. It is usually simpler, however, to use the `javax.xml.parsers` package to instantiate whatever SAX parser is provided by the Java implementation. The code looks like this:

```
import javax.xml.parsers.*;

// Obtain a factory object for creating SAX parsers
SAXParserFactory parserFactory = SAXParserFactory.newInstance();

// Configure the factory object to specify attributes of the parsers it creates
parserFactory.setValidating(true);
parserFactory.setNamespaceAware(true);

// Now create a SAXParser object
SAXParser parser = parserFactory.newSAXParser();   // May throw exceptions
```

The `SAXParser` class is a simple wrapper around the `org.xml.sax.XMLReader` class. Once you have obtained one, as shown in the previous code, you can parse a document by simply calling one of the various `parse()` methods. Some of these methods use the deprecated SAX 1 `HandlerBase` class, and others use the current SAX 2 `org.xml.sax.helpers.DefaultHandler` class. The `DefaultHandler` class provides an empty implementation of all the methods of the `ContentHandler`, `ErrorHandler`, `DTDHandler`, and `EntityResolver` interfaces. These are all the methods that the SAX parser can call while parsing an XML document. By subclassing `DefaultHandler` and defining the methods you care about, you can perform whatever actions are necessary in response to the method calls generated by the parser. The following code shows a method that uses SAX to parse an XML file and determine the number of XML elements that appear in a document as well as the number of characters of plain text (possibly excluding "ignorable whitespace") that appear within those elements:

```
import java.io.*;
import javax.xml.parsers.*;
import org.xml.sax.*;
import org.xml.sax.helpers.*;

public class SAXCount {
    public static void main(String[] args)
```

```
        throws SAXException,IOException, ParserConfigurationException
    {
        // Create a parser factory and use it to create a parser
        SAXParserFactory parserFactory = SAXParserFactory.newInstance();
        SAXParser parser = parserFactory.newSAXParser();
        // This is the name of the file you're parsing
        String filename = args[0];
        // Instantiate a DefaultHandler subclass to do your counting for you
        CountHandler handler = new CountHandler();
        // Start the parser. It reads the file and calls methods of the handler.
        parser.parse(new File(filename), handler);
        // When you're done, report the results stored by your handler object
        System.out.println(filename + " contains " + handler.numElements +
                           " elements and " + handler.numChars +
                           " other characters ");
    }

    // This inner class extends DefaultHandler to count elements and text in
    // the XML file and saves the results in public fields. There are many
    // other DefaultHandler methods you could override, but you need only
    // these.
    public static class CountHandler extends DefaultHandler {
        public int numElements = 0, numChars = 0;  // Save counts here
        // This method is invoked when the parser encounters the opening tag
        // of any XML element. Ignore the arguments but count the element.
        public void startElement(String uri, String localname, String qname,
                                 Attributes attributes) {
            numElements++;
        }

        // This method is called for any plain text within an element
        // Simply count the number of characters in that text
        public void characters(char[] text, int start, int length) {
            numChars += length;
        }
    }
}
```

5.12.2. Parsing XML with DOM

The DOM API is much different from the SAX API. While SAX is an efficient way to scan an XML document, it is not well-suited for programs that want to modify documents. Instead of converting an XML document into a series of method calls, a DOM parser converts the document into an `org.w3c.dom.Document` object, which is a tree of `org.w3c.dom.Node` objects. The conversion of the complete XML document to tree form allows random access to the entire document but can consume substantial amounts of memory.

In the DOM API, each node in the document tree implements the `Node` interface and a type-specific subinterface. (The most common types of node in a DOM document are `Element` and `Text` nodes.) When the parser is done parsing the document, your program can examine and manipulate that tree using the various methods of Node and its subinterfaces. The following code uses JAXP to obtain a DOM parser (which, in JAXP parlance, is called a DocumentBuilder). It then parses an XML file and builds a document tree from it. Next, it examines the Document tree to search for <sect1> elements and prints the contents of the <title> of each.

```
import java.io.*;
import javax.xml.parsers.*;
import org.w3c.dom.*;

public class GetSectionTitles {
    public static void main(String[] args)
        throws IOException, ParserConfigurationException,
               org.xml.sax.SAXException
    {
        // Create a factory object for creating DOM parsers and configure it
        DocumentBuilderFactory factory = DocumentBuilderFactory.newInstance();
        factory.setIgnoringComments(true); // We want to ignore comments
        factory.setCoalescing(true);       // Convert CDATA to Text nodes
        factory.setNamespaceAware(false);  // No namespaces: this is default
        factory.setValidating(false);      // Don't validate DTD: also default

        // Now use the factory to create a DOM parser, a.k.a. DocumentBuilder
        DocumentBuilder parser = factory.newDocumentBuilder();

        // Parse the file and build a Document tree to represent its content
        Document document = parser.parse(new File(args[0]));

        // Ask the document for a list of all <sect1> elements it contains
        NodeList sections = document.getElementsByTagName("sect1");
        // Loop through those <sect1> elements one at a time
        int numSections = sections.getLength();
        for(int i = 0; i < numSections; i++) {
            Element section = (Element)sections.item(i);  // A <sect1>
            // The first Element child of each <sect1> should be a <title>
            // element, but there may be some whitespace Text nodes first, so
            // loop through the children until you find the first element
            // child.
            Node title = section.getFirstChild();
            while(title != null && title.getNodeType() != Node.ELEMENT_NODE)
                title = title.getNextSibling();
            // Print the text contained in the Text node child of this element
            if (title != null)
                System.out.println(title.getFirstChild().getNodeValue());
        }
    }
}
```

5.12.3. Transforming XML Documents

The javax.xml.transform package defines a TRansformerFactory class for creating TRansformer objects. A transformer can transform a document from its Source representation into a new Result representation and optionally apply an XSLT transformation to the document content in the process. Three subpackages define concrete implementations of the Source and Result interfaces, which allow documents to be transformed among three representations:

javax.xml.transform.stream

Represents documents as streams of XML text.

javax.xml.transform.dom

Represents documents as DOM Document TRees.

javax.xml.transform.sax

Represents documents as sequences of SAX method calls.

The following code shows one use of these packages to transform the representation of a document from a DOM Document tree into a stream of XML text. An interesting feature of this code is that it does not create the Document TRee by parsing a file; instead, it builds it up from scratch.

```
import javax.xml.transform.*;
import javax.xml.transform.dom.*;
import javax.xml.transform.stream.*;
import javax.xml.parsers.*;
import org.w3c.dom.*;

public class DOMToStream {
    public static void main(String[] args)
        throws ParserConfigurationException,
               TransformerConfigurationException,
               TransformerException
    {
        // Create a DocumentBuilderFactory and a DocumentBuilder
        DocumentBuilderFactory dbf = DocumentBuilderFactory.newInstance();
        DocumentBuilder db = dbf.newDocumentBuilder();
        // Instead of parsing an XML document, however, just create an empty
        // document that you can build up yourself.
        Document document = db.newDocument();

        // Now build a document tree using DOM methods
        Element book = document.createElement("book"); // Create new element
        book.setAttribute("id", "javanut4");           // Give it an attribute
        document.appendChild(book);                    // Add to the document
        for(int i = 1; i <= 3; i++) {                  // Add more elements
            Element chapter = document.createElement("chapter");
```

```
            Element title = document.createElement("title");
            title.appendChild(document.createTextNode("Chapter " + i));
            chapter.appendChild(title);
            chapter.appendChild(document.createElement("para"));
            book.appendChild(chapter);
        }

        // Now create a TransformerFactory and use it to create a Transformer
        // object to transform our DOM document into a stream of XML text.
        // No arguments to newTransformer() means no XSLT stylesheet
        TransformerFactory tf = TransformerFactory.newInstance();
        Transformer transformer = tf.newTransformer();

        // Create the Source and Result objects for the transformation
        DOMSource source = new DOMSource(document);          // DOM document
        StreamResult result = new StreamResult(System.out);  // to XML text

        // Finally, do the transformation
        transformer.transform(source, result);
    }
}
```

The most interesting uses of `javax.xml.transform` involve XSLT stylesheets. XSLT is a complex but powerful XML grammar that describes how XML document content should be converted to another form (e.g., XML, HTML, or plain text). A tutorial on XSLT stylesheets is beyond the scope of this book but the following code (which contains only six key lines) shows how you can apply such a stylesheet (which is an XML document itself) to another XML document and write the resulting document to a stream:

```
import java.io.*;
import javax.xml.transform.*;
import javax.xml.transform.stream.*;
import javax.xml.parsers.*;
import org.w3c.dom.*;

public class Transform {
    public static void main(String[] args)
        throws TransformerConfigurationException,
               TransformerException
    {
        // Get Source and Result objects for input, stylesheet, and output
        StreamSource input = new StreamSource(new File(args[0]));
        StreamSource stylesheet = new StreamSource(new File(args[1]));
        StreamResult output = new StreamResult(new File(args[2]));

        // Create a transformer and perform the transformation
        TransformerFactory tf = TransformerFactory.newInstance();
        Transformer transformer = tf.newTransformer(stylesheet);
        transformer.transform(input, output);
    }
}
```

5.12.4. Validating XML Documents

The javax.xml.validation package allows you to validate XML documents against a schema. SAX and DOM parsers obtained from the javax.xml.parsers package can perform validation against a DTD during the parsing process, but this package separates validation from parsing and also provides general support for arbitrary schema types. All implementations must support W3C XML Schema and are allowed to support other schema types, such as RELAX NG.

To use this package, begin with a SchemaFactory instancea parser for a specific type of schema. Use this parser to parse a schema file into a Schema object. Obtain a Validator from the Schema, and then use the Validator to validate your XML document. The document is specified as a SAXSource or DOMSource object. You may recall these classes from the subpackages of javax.xml.transform.

If the document is valid, the validate( ) method of the Validator object returns normally. If it is not valid, validate( ) throws a SAXException. You can install an org.xml.sax.ErrorHandler object for the Validator to provide some control over the kinds of validation errors that cause exceptions.

```
import javax.xml.XMLConstants;
import javax.xml.validation.*;
import javax.xml.transform.sax.SAXSource;
import org.xml.sax.*;
import java.io.*;

public class Validate {
    public static void main(String[] args) throws IOException {
        File documentFile = new File(args[0]);  // 1st arg is document
        File schemaFile = new File(args[1]);    // 2nd arg is schema

        // Get a parser to parse W3C schemas.  Note use of javax.xml package
        // This package contains just one class of constants.
        SchemaFactory factory =
            SchemaFactory.newInstance(XMLConstants.W3C_XML_SCHEMA_NS_URI);

        // Now parse the schema file to create a Schema object
        Schema schema = null;
        try { schema = factory.newSchema(schemaFile); }
        catch(SAXException e) { fail(e); }

        // Get a Validator object from the Schema.
        Validator validator = schema.newValidator();

        // Get a SAXSource object for the document
        // We could use a DOMSource here as well
        SAXSource source =
            new SAXSource(new InputSource(new FileReader(documentFile)));

        // Now validate the document
        try { validator.validate(source); }
```

```
        catch(SAXException e) { fail(e); }

        System.err.println("Document is valid");
    }

    static void fail(SAXException e) {
        if (e instanceof SAXParseException) {
            SAXParseException spe = (SAXParseException) e;
            System.err.printf("%s:%d:%d: %s%n",
                              spe.getSystemId(), spe.getLineNumber(),
                              spe.getColumnNumber(), spe.getMessage());
        }
        else {
            System.err.println(e.getMessage());
        }
        System.exit(1);
    }
}
```

5.12.5. Evaluating XPath Expressions

XPath is a language for referring to specific nodes in an XML document. For example, the XPath expression "//section/title/text( )" refers to the text inside of a `<title>` element inside a `<section>` element at any depth within the document. A full description of the XPath language is beyond the scope of this book. The `javax.xml.xpath` package, new in Java 5.0, provides a way to find all nodes in a document that match an `XPath` expression.

```
import javax.xml.xpath.*;
import javax.xml.parsers.*;
import org.w3c.dom.*;

public class XPathEvaluator {
    public static void main(String[] args)
        throws ParserConfigurationException, XPathExpressionException,
               org.xml.sax.SAXException, java.io.IOException
    {
        String documentName = args[0];
        String expression = args[1];

        // Parse the document to a DOM tree
        // XPath can also be used with a SAX InputSource
        DocumentBuilder parser =
            DocumentBuilderFactory.newInstance().newDocumentBuilder();
        Document doc = parser.parse(new java.io.File(documentName));

        // Get an XPath object to evaluate the expression
        XPath xpath = XPathFactory.newInstance().newXPath();

        System.out.println(xpath.evaluate(expression, doc));
```

```
        // Or evaluate the expression to obtain a DOM NodeList of all matching
        // nodes.  Then loop through each of the resulting nodes
        NodeList nodes = (NodeList)xpath.evaluate(expression, doc,
                                                  XPathConstants.NODESET);
        for(int i = 0, n = nodes.getLength(); i < n; i++) {
            Node node = nodes.item(i);
            System.out.println(node);
        }
    }
}
```

Team LiB

5.13. Types, Reflection, and Dynamic Loading

The `java.lang.Class` class represents data types in Java and, along with the classes in the `java.lang.reflect` package, gives Java programs the capability of introspection (or self-reflection); a Java class can look at itself, or any other class, and determine its superclass, what methods it defines, and so on.

5.13.1. Class Objects

You can obtain a `Class` object in Java in several ways:

```
// Obtain the Class of an arbitrary object o
Class c = o.getClass();

// Obtain a Class object for primitive types with various predefined constants
c = Void.TYPE;          // The special "no-return-value" type
c = Byte.TYPE;          // Class object that represents a byte
c = Integer.TYPE;       // Class object that represents an int
c = Double.TYPE;        // etc; see also Short, Character, Long, Float

// Express a class literal as a type name followed by ".class"
c = int.class;          // Same as Integer.TYPE
c = String.class;       // Same as "dummystring".getClass()
c = byte[].class;       // Type of byte arrays
c = Class[][].class;    // Type of array of arrays of Class objects
```

5.13.2. Reflecting on a Class

Once you have a `Class` object, you can perform some interesting reflective operations with it:

```
import java.lang.reflect.*;

Object o;                   // Some unknown object to investigate
Class c = o.getClass();     // Get its type

// If it is an array, figure out its base type
while (c.isArray()) c = c.getComponentType();

// If c is not a primitive type, print its class hierarchy
if (!c.isPrimitive()) {
  for(Class s = c; s != null; s = s.getSuperclass())
    System.out.println(s.getName() + " extends");
}
```

```
// Try to create a new instance of c; this requires a no-arg constructor
Object newobj = null;
try { newobj = c.newInstance(); }
catch (Exception e) {
  // Handle InstantiationException, IllegalAccessException
}

// See if the class has a method named setText that takes a single String
// If so, call it with a string argument
try {
    Method m = c.getMethod("setText", new Class[] { String.class });
    m.invoke(newobj, new Object[] { "My Label" });
} catch(Exception e) { /* Handle exceptions here */ }

// These are varargs methods in Java 5.0 so the syntax is much cleaner.
// Look for and invoke a method named "put" that takes two Object arguments
try {
    Method m = c.getMethod("add", Object.class, Object.class);
    m.invoke(newobj, "key", "value");
} catch(Exception e) { System.out.println(e); }

// In Java 5.0 we can use reflection on enumerated types and constants
Class<Thread.State> ts = Thread.State.class;  // Thread.State type
if (ts.isEnum()) {  // If it is an enumerated type
    Thread.State[] constants = ts.getEnumConstants(); // get its constants
}
try {
    Field f = ts.getField("RUNNABLE");       // Get the field named "RUNNABLE"
    System.out.println(f.isEnumConstant());  // Is it an enumerated constant?
}
catch(Exception e) { System.out.println(e); }

// The VM discards generic type information at runtime, but it is stored
// in the class file for the compiler and is accessible through reflection
try {
    Class map = Class.forName("java.util.Map");

    TypeVariable<?>[] typevars = map.getTypeParameters();
    for(TypeVariable<?> typevar : typevars) {
        System.out.print(typevar.getName());
        Type[] bounds = typevar.getBounds();
        if (bounds.length > 0) System.out.print(" extends ");
        for(int i = 0; i < bounds.length; i++) {
            if (i > 0) System.out.print(" & ");
            System.out.print(bounds[i]);
        }
        System.out.println();
    }
}
catch(Exception e) { System.out.println(e); }
```

```
// In Java 5.0, reflection can also be used on annotation types and to
// determine the values of runtime visible annotations
Class<?> a = Override.class;  // an annotation class
if (a.isAnnotation()) {       // is this an annotation type?
    // Look for some meta-annotations
    java.lang.annotation.Retention retention =
        a.getAnnotation(java.lang.annotation.Retention.class);
    if (retention != null)
        System.out.printf("Retention: %s%n", retention.value());
}
```

5.13.3. Dynamic Class Loading

Class also provides a simple mechanism for dynamic class loading in Java. For more complete control over dynamic class loading, however, you should use ajava.lang.ClassLoader object, typically a java.net.URLClassLoader. This technique is useful, for example, when you want to load a class that is named in a configuration file instead of being hardcoded into your program:

```
// Dynamically load a class specified by name in a config file
String classname =                     // Look up the name of the class
    config.getProperty("filterclass",  // The property name
                       "com.davidflanagan.filters.Default"); // A default

try {
  Class c = Class.forName(classname);  // Dynamically load the class
  Object o = c.newInstance();          // Dynamically instantiate it
} catch (Exception e) { /* Handle exceptions */ }
```

The preceding code works only if the class to be loaded is in the class path. If this is not the case, yo can create a custom ClassLoader object to load a class from a path (or URL) you specify yourself:

```
import java.net.*;
String classdir = config.getProperty("filterDirectory"); // Look up class path
try {
  ClassLoader loader = new URLClassLoader(new URL[] { new URL(classdir) });
  Class c = loader.loadClass(classname);
}
catch (Exception e) { /* Handle exceptions */ }
```

5.13.4. Dynamic Proxies

The Proxy class and InvocationHandler interface to the java.lang.reflect package were added to Java 1.3. Proxy is a powerful but infrequently used class that allows you to dynamically create a new class or instance that implements a specified interface or set of interfaces. It also dispatches invocations of the interface methods to an InvocationHandler object.

5.14. Object Persistence

The Java platform provides two mechanisms for object persistence: the ability to save object state so that the object can later be recreated. Both mechanisms involve serialization; the second is aimed particularly at JavaBeans.

5.14.1. Serialization

One of the most important features of the `java.io` package is the ability to *serialize* objects: to convert an object into a stream of bytes that can later be deserialized back into a copy of the original object. The following code shows how to use serialization to save an object to a file and later read it back:

```
Object o;  // The object we are serializing; it must implement Serializable
File f;    // The file we are saving it to

try {
  // Serialize the object
  ObjectOutputStream oos = new ObjectOutputStream(new FileOutputStream(f));
  oos.writeObject(o);
  oos.close();

  // Read the object back in
  ObjectInputStream ois = new ObjectInputStream(new FileInputStream(f));
  Object copy = ois.readObject();
  ois.close();
}
catch (IOException e) { /* Handle input/output exceptions */ }
catch (ClassNotFoundException cnfe) { /* readObject() can throw this */ }
```

The previous example serializes to a file, but remember, you can write serialized objects to any type of stream. Thus, you can write an object to a byte array, then read it back from the byte array, creating a deep copy of the object. You can write the object's bytes to a compression stream or even write the bytes to a stream connected across a network to another program!

5.14.2. JavaBeans Persistence

Java 1.4 introduced a serialization mechanism intended for use with JavaBeans components. `java.io` serialization works by saving the state of the internal fields of an object. `java.beans` persistence, on the other hand, works by saving a bean's state as a sequence of calls to the public methods defined by the class. Since it is based on the public API rather than on the internal state, the JavaBeans persistence mechanism allows interoperability between different implementations of the same API, handles version skew more robustly, and is suitable for longer-term storage of serialized objects.

A bean and any descendant beans or other objects that are serialized with `java.beans.XMLEncoder` can be deserialized with `java.beans.XMLDecoder`. These classes write to and read from specified streams, but they are not stream classes themselves. Here is how you might encode a bean:

```
// Create a JavaBean, and set some properties on it
javax.swing.JFrame bean = new javax.swing.JFrame("PersistBean");
bean.setSize(300, 300);
// Now save its encoded form to the file bean.xml
BufferedOutputStream out =                // Create an output stream
    new BufferedOutputStream(new FileOutputStream("bean.xml"));
XMLEncoder encoder = new XMLEncoder(out);  // Create encoder for stream
encoder.writeObject(bean);                // Encode the bean
encoder.close();                          // Close encoder and stream
```

Here is the corresponding code to decode the bean from its serialized form:

```
BufferedInputStream in =                  // Create input stream
    new BufferedInputStream(new FileInputStream("bean.xml"));
XMLDecoder decoder = new XMLDecoder(in);   // Create decoder for stream
Object b = decoder.readObject();          // Decode a bean
decoder.close();                          // Close decoder and stream
bean = (javax.swing.JFrame) b;            // Cast bean to proper type
bean.setVisible(true);                    // Start using it
```

5.15. Security

The java.security package defines quite a few classes related to the Java access-control architecture, which is discussed in more detail in Chapter 6. These classes allow Java programs to run untrusted code in a restricted environment from which it can do no harm. While these are important classes, you rarely need to use them. The more interesting classes are the ones used for message digests and digital signatures; they are demonstrated in the sections that follow.

5.15.1. Message Digests

A *message digest* is a value, also known as cryptographic checksum or secure hash, that is computed over a sequence of bytes. The length of the digest is typically much smaller than the length of the data for which it is computed, but any change, no matter how small, in the input bytes produces a change in the digest. When transmitting data (a message), you can transmit a message digest along with it. The recipient of the message can then recompute the message digest on the received data and, by comparing the computed digest to the received digest, determine whether the message or the digest was corrupted or tampered with during transmission. We saw a way to compute a message digest earlier in the chapter when we discussed streams. A similar technique can be used to compute a message digest for nonstreaming binary data:

```
import java.security.*;

// Obtain an object to compute message digests using the "Secure Hash
// Algorithm"; this method can throw a NoSuchAlgorithmException.
MessageDigest md = MessageDigest.getInstance("SHA");

byte[] data, data1, data2, secret;  // Some byte arrays initialized elsewhere

// Create a digest for a single array of bytes
byte[] digest = md.digest(data);

// Create a digest for several chunks of data
md.reset();             // Optional: automatically called by digest()
md.update(data1);       // Process the first chunk of data
md.update(data2);       // Process the second chunk of data
digest = md.digest();   // Compute the digest

// Create a keyed digest that can be verified if you know the secret bytes
md.update(data);             // The data to be transmitted with the digest
digest = md.digest(secret);  // Add the secret bytes and compute the digest

// Verify a digest like this
byte[] receivedData, receivedDigest;  // The data and the digest we received
byte[] verifyDigest = md.digest(receivedData);  // Digest the received data
// Compare computed digest to the received digest
```

```
boolean verified =  java.util.Arrays.equals(receivedDigest, verifyDigest);
```

5.15.2. Digital Signatures

A *digital signature* combines a message-digest algorithm with public-key cryptography. The sender of a message, Alice, can compute a digest for a message and then encrypt that digest with her private key. She then sends the message and the encrypted digest to a recipient, Bob. Bob knows Alice's public key (it is public, after all), so he can use it to decrypt the digest and verify that the message has not been tampered with. In performing this verification, Bob also learns that the digest was encrypted with Alice's private key since he was able to decrypt the digest successfully using Alice's public key. As Alice is the only one who knows her private key, the message must have come from Alice. A digital signature is called such because, like a pen-and-paper signature, it serves to authenticate the origin of a document or message. Unlike a pen-and-paper signature, however, a digital signature is very difficult, if not impossible, to forge, and it cannot simply be cut and pasted onto another document.

Java makes creating digital signatures easy. In order to create a digital signature, however, you need a `java.security.PrivateKey` object. Assuming that a keystore exists on your system (see the *keytool* documentation in Chapter 8), you can get one with code like the following:

```
// Here is some basic data we need
File homedir = new File(System.getProperty("user.home"));
File keyfile = new File(homedir, ".keystore"); // Or read from config file
String filepass = "KeyStore password"          // Password for entire file
String signer = "david";                       // Read from config file
String password = "No one can guess this!";    // Better to prompt for this
PrivateKey key;  // This is the key we want to look up from the keystore

try {
  // Obtain a KeyStore object and then load data into it
  KeyStore keystore = KeyStore.getInstance(KeyStore.getDefaultType());
  keystore.load(new BufferedInputStream(new FileInputStream(keyfile)),
                filepass.toCharArray());
  // Now ask for the desired key
  key = (PrivateKey) keystore.getKey(signer, password.toCharArray());
}
catch (Exception e) { /* Handle various exception types here */ }
```

Once you have a `PrivateKey` object, you can create a digital signature with a `java.security.Signature` object:

```
PrivateKey key;             // Initialized as shown previously
byte[] data;                // The data to be signed
Signature s =               // Obtain object to create and verify signatures
  Signature.getInstance("SHA1withDSA");  // Can throw a
                                         // NoSuchAlgorithmException
s.initSign(key);             // Initialize it; can throw an InvalidKeyException
s.update(data);              // Data to sign; can throw a SignatureException
/* s.update(data2); */       // Call multiple times to specify all data
```

```
byte[] signature = s.sign(); // Compute signature
```

A `Signature` object can verify a digital signature:

```
byte[] data;        // The signed data; initialized elsewhere
byte[] signature;   // The signature to be verified; initialized elsewhere
String signername;  // Who created the signature; initialized elsewhere
KeyStore keystore;  // Where certificates stored; initialize as shown earlier

// Look for a public-key certificate for the signer
java.security.cert.Certificate cert = keystore.getCertificate(signername);
PublicKey publickey = cert.getPublicKey();  // Get the public key from it

Signature s = Signature.getInstance("SHA1withDSA"); // Or some other algorithm
s.initVerify(publickey);                            // Setup for verification
s.update(data);                                     // Specify signed data
boolean verified = s.verify(signature);             // Verify signature data
```

5.15.3. Signed Objects

The `java.security.SignedObject` class is a convenient utility for wrapping a digital signature around an object. The `SignedObject` can then be serialized and transmitted to a recipient, who can deserialize it and use the `verify( )` method to verify the signature:

```
Serializable o;  // The object to be signed; must be Serializable
PrivateKey k;    // The key to sign with; initialized elsewhere
Signature s = Signature.getInstance("SHA1withDSA"); // Signature "engine"
SignedObject so = new SignedObject(o, k, s);        // Create the SignedObject

// The SignedObject encapsulates the object o; it can now be serialized
// and transmitted to a recipient.

// Here's how the recipient verifies the SignedObject
SignedObject so;           // The deserialized SignedObject
Object o;                  // The original object to extract from it
PublicKey pk;              // The key to verify with
Signature s = Signature.getInstance("SHA1withDSA"); // Verification "engine"
if (so.verify(pk,s))       // If the signature is valid,
  o = so.getObject();      // retrieve the encapsulated object.
```

5.16. Cryptography

The `java.security` package includes cryptography-based classes, but it does not contain classes for actual encryption and decryption. That is the job of the `javax.crypto` package. This package supports symmetric-key cryptography, in which the same key is used for both encryption and decryption and must be known by both the sender and the receiver of encrypted data.

5.16.1. Secret Keys

The `SecretKey` interface represents an encryption key; the first step of any cryptographic operation is to obtain an appropriate `SecretKey`. Unfortunately, the *keytool* program supplied with the JDK cannot generate and store secret keys, so a program must handle these tasks itself. Here is some code that shows various ways to work with `SecretKey` objects:

```
import javax.crypto.*;
import javax.crypto.spec.*;

// Generate encryption keys with a KeyGenerator object
KeyGenerator desGen = KeyGenerator.getInstance("DES");       // DES algorithm
SecretKey desKey = desGen.generateKey();                     // Generate a key
KeyGenerator desEdeGen = KeyGenerator.getInstance("DESede"); // Triple DES
SecretKey desEdeKey = desEdeGen.generateKey();               // Generate a key

// SecretKey is an opaque representation of a key. Use SecretKeyFactory to
// convert to a transparent representation that can be manipulated: saved
// to a file, securely transmitted to a receiving party, etc.
SecretKeyFactory desFactory = SecretKeyFactory.getInstance("DES");
DESKeySpec desSpec = (DESKeySpec)
  desFactory.getKeySpec(desKey, javax.crypto.spec.DESKeySpec.class);
byte[] rawDesKey = desSpec.getKey();
// Do the same for a DESede key
SecretKeyFactory desEdeFactory = SecretKeyFactory.getInstance("DESede");
DESedeKeySpec desEdeSpec = (DESedeKeySpec)
  desEdeFactory.getKeySpec(desEdeKey, javax.crypto.spec.DESedeKeySpec.class);
byte[] rawDesEdeKey = desEdeSpec.getKey();

// Convert the raw bytes of a key back to a SecretKey object
DESedeKeySpec keyspec = new DESedeKeySpec(rawDesEdeKey);
SecretKey k = desEdeFactory.generateSecret(keyspec);

// For DES and DESede keys, there is an even easier way to create keys
// SecretKeySpec implements SecretKey, so use it to represent these keys
byte[] desKeyData = new byte[8];        // Read 8 bytes of data from a file
byte[] tripleDesKeyData = new byte[24]; // Read 24 bytes of data from a file
SecretKey myDesKey = new SecretKeySpec(desKeyData, "DES");
```

```
SecretKey myTripleDesKey = new SecretKeySpec(tripleDesKeyData, "DESede");
```

5.16.2. Encryption and Decryption with Cipher

Once you have obtained an appropriate `SecretKey` object, the central class for encryption and decryption is `Cipher`. Use it like this:

```
SecretKey key;     // Obtain a SecretKey as shown earlier
byte[] plaintext;  // The data to encrypt; initialized elsewhere

// Obtain an object to perform encryption or decryption
Cipher cipher = Cipher.getInstance("DESede");  // Triple-DES encryption
// Initialize the cipher object for encryption
cipher.init(Cipher.ENCRYPT_MODE, key);
// Now encrypt data
byte[] ciphertext = cipher.doFinal(plaintext);

// If we had multiple chunks of data to encrypt, we can do this
cipher.update(message1);
cipher.update(message2);
byte[] ciphertext = cipher.doFinal();

// We simply reverse things to decrypt
cipher.init(Cipher.DECRYPT_MODE, key);
byte[] decryptedMessage = cipher.doFinal(ciphertext);

// To decrypt multiple chunks of data
byte[] decrypted1 = cipher.update(ciphertext1);
byte[] decrypted2 = cipher.update(ciphertext2);
byte[] decrypted3 = cipher.doFinal(ciphertext3);
```

5.16.3. Encrypting and Decrypting Streams

The `Cipher` class can also be used with `CipherInputStream` or `CipherOutputStream` to encrypt or decrypt while reading or writing streaming data:

```
byte[] data;                               // The data to encrypt
SecretKey key;                             // Initialize as shown earlier
Cipher c = Cipher.getInstance("DESede");  // The object to perform encryption
c.init(Cipher.ENCRYPT_MODE, key);         // Initialize it

// Create a stream to write bytes to a file
FileOutputStream fos = new FileOutputStream("encrypted.data");

// Create a stream that encrypts bytes before sending them to that stream
// See also CipherInputStream to encrypt or decrypt while reading bytes
CipherOutputStream cos = new CipherOutputStream(fos, c);
```

```
cos.write(data);                  // Encrypt and write the data to the file
cos.close();                      // Always remember to close streams
java.util.Arrays.fill(data, (byte)0); // Erase the unencrypted data
```

5.16.4. Encrypted Objects

Finally, the `javax.crypto.SealedObject` class provides an especially easy way to perform encryption. This class serializes a specified object and encrypts the resulting stream of bytes. The `SealedObject` can then be serialized itself and transmitted to a recipient. The recipient can retrieve the original object only if she knows the required `SecretKey`:

```
Serializable o;           // The object to be encrypted; must be Serializable
SecretKey key;                              // The key to encrypt it with
Cipher c = Cipher.getInstance("Blowfish");  // Object to perform encryption
c.init(Cipher.ENCRYPT_MODE, key);           // Initialize it with the key
SealedObject so = new SealedObject(o, c);   // Create the sealed object

// Object so is a wrapper around an encrypted form of the original object o;
// it can now be serialized and transmitted to another party.
// Here's how the recipient decrypts the original object
Object original = so.getObject(key);        // Must use the same SecretKey
```

5.17. Miscellaneous Platform Features

The following sections detail important but miscellaneous features of the Java platform, including properties, preferences, processes, and management and instrumentation.

5.17.1. Properties

`java.util.Properties` is a subclass of `java.util.Hashtable`, a legacy collections class that predates the Collections API introduced in Java 1.2. A `Properties` object maintains a mapping between string keys and string values and defines methods that allow the mappings to be written to and read from a simple text file or (in Java 5.0) an XML file. This makes the `Properties` class ideal for configuration and user preference files. The `Properties` class is also used for the system properties returned by `System.getProperty( )`:

```
import java.util.*;
import java.io.*;

// Note: many of these system properties calls throw a security exception if
// called from untrusted code such as applets.
String homedir = System.getProperty("user.home"); // Get a system property
Properties sysprops = System.getProperties();     // Get all system properties

// Print the names of all defined system properties
for(Enumeration e = sysprops.propertyNames(); e.hasMoreElements();)
  System.out.println(e.nextElement());

sysprops.list(System.out); // Here's an even easier way to list the properties

// Read properties from a configuration file
Properties options = new Properties();             // Empty properties list
File configfile = new File(homedir, ".config");    // The configuration file
try {
  options.load(new FileInputStream(configfile));   // Load props from the file
} catch (IOException e) { /* Handle exception here */ }

// Query a property ("color"), specifying a default ("gray") if undefined
String color = options.getProperty("color", "gray");

// Set a property named "color" to the value "green"
options.setProperty("color", "green");

// Store the contents of the Properties object back into a file
try {
  options.store(new FileOutputStream(configfile),  // Output stream
                "MyApp Config File");              // File header comment text
```

```
} catch (IOException e) { /* Handle exception */ }

// In Java 5.0 properties can be written to or read from XML files
try {
  options.storeToXML(new FileOutputStream(configfile),  // Output stream
                     "MyApp Config File");              // Comment text
  options.loadFromXML(new FileInputStream(configfile)); // Read it back in
}
catch(IOException e) { /* Handle exception */ }
catch(InvalidPropertiesFormatException e) { /* malformed input */ }
```

5.17.2. Preferences

Java 1.4 introduced the Preferences API, which is specifically tailored for working with user and systemwide preferences and is more useful than Properties for this purpose. The Preferences API is defined by the `java.util.prefs` package. The key class in that package is `Preferences`. You can obtain a `Preferences` object that contains user-specific preferences with the static method `Preferences.userNodeForPackage()` and obtain a `Preferences` object that contains systemwide preferences with `Preferences.systemNodeForPackage()`. Both methods take a `java.lang.Class` object as their sole argument and return a `Preferences` object shared by all classes in that package. (This means that the preference names you use must be unique within the package.) Once you have a `Preferences` object, use the `get( )` method to query the string value of a named preference, or use other type-specific methods such as `getInt( )`, `getBoolean()`, and `getByteArray()`. Note that to query preference values, a default value must be passed for all methods. This default value is returned if no preference with the specified name has been registered or if the file or database that holds the preference data cannot be accessed. A typical use of `Preferences` is the following:

```
package com.davidflanagan.editor;
import java.util.prefs.Preferences;

public class TextEditor {
  // Fields to be initialized from preference values
  public int width;             // Screen width in columns
  public String dictionary;     // Dictionary name for spell checking

  public void initPrefs() {
    // Get Preferences objects for user and system preferences for this package
    Preferences userprefs = Preferences.userNodeForPackage(TextEditor.class);
    Preferences sysprefs = Preferences.systemNodeForPackage(TextEditor.class);

    // Look up preference values. Note that you always pass a default value.
    width = userprefs.getInt("width", 80);
    // Look up a user preference using a system preference as the default
    dictionary = userprefs.get("dictionary",
                           sysprefs.get("dictionary",
                                        "default_dictionary"));
  }
}
```

In addition to the `get( )` methods for querying preference values, there are corresponding `put()` methods for setting the values of named preferences:

```
// User has indicated a new preference, so store it
userprefs.putBoolean("autosave", false);
```

If your application wants to be notified of user or system preference changes while the application is in progress, it may register a `PreferenceChangeListener` with `addPreferenceChangeListener()`. A `Preferences` object can export the names and values of its preferences as an XML file and can read preferences from such an XML file. (See `importPreferences( )`, `exportNode()`, and `exportSubtree( )` in `java.util.pref.Preferences` in the reference section.) `Preferences` objects exist in a hierarchy that typically corresponds to the hierarchy of package names. Methods for navigating this hierarchy exist but are not typically used by ordinary applications.

5.17.3. Processes

Earlier in the chapter, we saw how easy it is to create and manipulate multiple threads of execution running within the same Java interpreter. Java also has a `java.lang.Process` class that represents an operating system process running externally to the interpreter. A Java program can communicate with an external process using streams in the same way that it might communicate with a server running on some other computer on the network. Using a `Process` is always platform-dependent and is rarely portable, but it is sometimes a useful thing to do:

```
// Maximize portability by looking up the name of the command to execute
// in a configuration file.
java.util.Properties config;
String cmd = config.getProperty("sysloadcmd");
if (cmd != null) {
  // Execute the command; Process p represents the running command
  Process p = Runtime.getRuntime().exec(cmd);         // Start the command
  InputStream pin = p.getInputStream();               // Read bytes from it
  InputStreamReader cin = new InputStreamReader(pin); // Convert them to chars
  BufferedReader in = new BufferedReader(cin);        // Read lines of chars
  String load = in.readLine();                        // Get the command output
  in.close();                                         // Close the stream
}
```

In Java 5.0 the `java.lang.ProcessBuilder` class provides a more flexible way to launch new processes than the `Runtime.exec()` method. `ProcessBuilder` allows control of environment variables through a `Map` and makes it simple to set the working directory. It also has an option to automatically redirect the standard error stream of the processes it launches to the standard output stream, which makes it much easier to read all output of a `Process`.

```
import java.util.Map;
import java.io.*

public class JavaShell {
    public static void main(String[] args) {
```

```
// We use this to start commands
ProcessBuilder launcher = new ProcessBuilder();
// Our inherited environment vars.  We may modify these below
Map<String,String> environment = launcher.environment();
// Our processes will merge error stream with standard output stream
launcher.redirectErrorStream(true);
// Where we read the user's input from
BufferedReader console =
    new BufferedReader(new InputStreamReader(System.in));

while(true) {
    try {
        System.out.print("> ");               // display prompt
        System.out.flush();                   // force it to show
        String command = console.readLine();  // Read input

        if (command.equals("exit")) return;   // Exit command

        else if (command.startsWith("cd ")) { // change directory
            launcher.directory(new File(command.substring(3)));
        }

        else if (command.startsWith("set ")) {// set environment var
            command = command.substring(4);
            int pos = command.indexOf('=');
            String name = command.substring(0,pos).trim();
            String var = command.substring(pos+1).trim();
            environment.put(name, var);
        }

        else { // Otherwise it is a process to launch
            // Break command into individual tokens
            String[] words = command.split(" ");
            launcher.command(words);      // Set the command
            Process p = launcher.start(); // And launch a new process

            // Now read and display output from the process
            // until there is no more output to read
            BufferedReader output = new BufferedReader(
                     new InputStreamReader(p.getInputStream()));
            String line;
            while((line = output.readLine()) != null)
                System.out.println(line);

            // The process should be done now, but wait to be sure.
            p.waitFor();
        }
    }
    catch(Exception e) {
        System.out.println(e);
    }
}
```

```
    }
}
```

5.17.4. Management and Instrumentation

Java 5.0 includes the powerful JMX API for remote monitoring and management of running applications. The full `javax.management` API is beyond the scope of this book. The reference section does cover the `java.lang.management` package, however: this package is an application of JMX for the monitoring and management of the Java virtual machine itself. `java.lang.instrument` is another Java 5.0 package: it allows the definition of "agents" that can be used to instrument the running JVM. In VMs that support it, `java.lang.instrument` can be used to redefine class files as they are loaded to add profiling or coverage testing code, for example. Class redefinition is beyond the scope of this chapter, but the following code uses the new instrumentation and management features of Java 5.0 to determine resource usages of a Java program. The example also demonstrates the `Runtime.addShutdownHook()` method, which registers code to be run when the VM starts shutting down.

```
import java.lang.instrument.*;
import java.lang.management.*;
import java.util.List;
import java.io.*;

public class ResourceUsageAgent {
    // A Java agent class defines a premain() method to run before main()
    public static void premain(final String args, final Instrumentation inst) {
       // This agent simply registers a shutdown hook to run when the VM exits
        Runtime.getRuntime().addShutdownHook(new Thread() {
                public void run() {
                    // This code runs when the VM exits
                    try {
                        // Decide where to send our output
                        PrintWriter out;
                        if (args != null && args.length() > 0)
                            out = new PrintWriter(new FileWriter(args));
                        else
                            out = new PrintWriter(System.err);

                        // Use java.lang.management to query peak thread usage
                        ThreadMXBean tb = ManagementFactory.getThreadMXBean();
                        out.printf("Current thread count: %d%n",
                                   tb.getThreadCount());
                        out.printf("Peak thread count: %d%n",
                                   tb.getPeakThreadCount());

                        // Use java.lang.management to query peak memory usage
                        List<MemoryPoolMXBean> pools =
                            ManagementFactory.getMemoryPoolMXBeans();
                        for(MemoryPoolMXBean pool: pools) {
                            MemoryUsage peak = pool.getPeakUsage();
                            out.printf("Peak %s memory used: %,d%n",
```

```
                                pool.getName(), peak.getUsed());
                    out.printf("Peak %s memory reserved: %,d%n",
                                pool.getName(), peak.getCommitted());
                }

                // Use the Instrumentation object passed to premain()
                // to get a list of all classes that have been loaded
                Class[] loaded = inst.getAllLoadedClasses();
                out.println("Loaded classes:");
                for(Class c : loaded) out.println(c.getName());

                out.close();  // close and flush the output stream
            }
            catch(Throwable t) {
                // Exceptions in shutdown hooks are ignored so
                // we've got to print this out explicitly
                System.err.println("Exception in agent: " + t);
            }
        }
    });
  }
}
```

To monitor the resource usage of a Java program with this agent, you first must compile the class normally. You then store the generated class files in a JAR file with a manifest that specifies the class that contains the `premain()` method. Create a manifest file that contains this line:

```
Premain-Class: ResourceUsageAgent
```

Create the JAR file with a command like this:

```
% jar cmf manifest agent.jar ResourceUsageAgent*.class
```

Finally, to use the agent, specify the JAR file and the agent arguments with the `-javaagent` flag to the Java interpreter:

```
% java -javaagent:agent.jar=/tmp/usage.info my.java.Program
```

Chapter 6. Java Security

Java programs can dynamically load Java classes from a variety of sources, including untrusted sources, such as web sites reached across an insecure network. The ability to create and work with such mobile code is one of the great strengths and features of Java. To make it work successfully, however, Java puts great emphasis on a security architecture that allows untrusted code to run safely, without fear of damage to the host system.

The need for a security system in Java is most acutely demonstrated by appletsminiature Java applications designed to be embedded in web pages.[1] When a user visits a web page (with a Java-enabled web browser) that contains an applet, the web browser downloads the Java class files that define that applet and runs them. In the absence of a security system, an applet could wreak havoc on the user's system by deleting files, installing a virus, stealing confidential information, and so on. Somewhat more subtly, an applet could take advantage of the user's system to forge email, generate spam, or launch hacking attempts on other systems.

[1] Applets are documented in *Java Foundation Classes in a Nutshell* (O'Reilly) and are not covered in this book. Still, they serve as good examples here.

Java's main line of defense against such malicious code is *access control*: untrusted code is simply not given access to certain sensitive portions of the core Java API. For example, an untrusted applet is not typically allowed to read, write, or delete files on the host system or connect over the network to any computer other than the web server from which it was downloaded. This chapter describes the Java access control architecture and a few other facets of the Java security system.

Team LiB

6.1. Security Risks

Java has been designed from the ground up with security in mind; this gives it a great advantage over many other existing systems and platforms. Nevertheless, no system can guarantee 100% security, and Java is no exception.

The Java security architecture was designed by security experts and has been studied and probed by many other security experts. The consensus is that the architecture itself is strong and robust, theoretically without any security holes (at least none that have been discovered yet). The implementation of the security architecture is another matter, however, and there is a long history of security flaws being found and patched in particular implementations of Java. For example, in April 1999, a flaw was found in Sun's implementation of the class verifier in Java 1.1. Patches for Java 1.1.6 and 1.1.7 were issued and the problem was fixed in Java 1.1.8. In August 1999, a severe flaw was found in Microsoft's Java Virtual Machine. Microsoft fixed the problem, and no longer distributes their VM with the latest versions of their web browser.

In all likelihood, security flaws will continue to be discovered (and patched) in Java VM implementations. Despite this, Java remains perhaps the most secure platform currently available. There have been few, if any, reported instances of malicious Java code exploiting security holes "in the wild." For practical purposes, the Java platform appears to be adequately secure, especially when contrasted with some of the insecure and virus-ridden alternatives.

6.2. Java VM Security and Class File Verification

The lowest level of the Java security architecture involves the design of the Java Virtual Machine and the byte codes it executes. The Java VM does not allow any kind of direct access to individual memory addresses of the underlying system, which prevents Java code from interfering with the native hardware and operating system. These intentional restrictions on the VM are reflected in the Java language itself, which does not support pointers or pointer arithmetic. The language does not allow an integer to be cast to an object reference or vice versa, and there is no way whatsoever to obtain an object's address in memory. Without capabilities like these, malicious code simply cannot gain a foothold.

In addition to the secure design of the Virtual Machine instruction set, the VM goes through a process known as *byte-code verification* whenever it loads an untrusted class. This process ensures that the byte codes of a class (and their operands) are all valid; that the code never underflows or overflows the VM stack; that local variables are not used before they are initialized; that field, method, and class access control modifiers are respected; and so on. The verification step is designed to prevent the VM from executing byte codes that might crash it or put it into an undefined and untested state where it might be vulnerable to other attacks by malicious code. Byte-code verification is a defense against malicious hand-crafted Java byte codes and untrusted Java compilers that might output invalid byte codes.

6.3. Authentication and Cryptography

The `java.security` package (and its subpackages) provides classes and interfaces for *authentication*. As described in Chapter 5, this piece of the security architecture allows Java code to create and verify message digests and digital signatures. These technologies can ensure that any data (such as a Java class file) is authentic: that it originates from the person who claims to have originated it and has not been accidentally or maliciously modified in transit.

The Java Cryptography Extension, or JCE, consists of the `javax.crypto` package and its subpackages. These packages define classes for encryption and decryption of data. This is an important security-related feature for many applications, but is not directly relevant to the basic problem of preventing untrusted code from damaging the host system, so it is not discussed in this chapter.

Team LiB

6.4. Access Control

As we noted at the beginning of this chapter, the heart of the Java security architecture is access control: untrusted code simply must not be granted access to the sensitive parts of the Java API that would allow it to do malicious things. As we'll discuss in the following sections, the Java access contro model evolved significantly between Java 1.0 and Java 1.2. Since then, the access control model has been relatively stable; it has not changed significantly since Java 1.2. The next sections provide a brief history of the evolution of Java security as it developed from Java 1.0 to Java 1.2, which marked the last major changes to the security model.

6.4.1. Java 1.0: The Sandbox

In this first release of Java, all Java code installed locally on the system is trusted implicitly. All code downloaded over the network, however, is untrusted and run in a restricted environment playfully called "the sandbox." The access control policies of the sandbox are defined by the currently installed `java.lang.SecurityManager` object. When system code is about to perform a restricted operation, such as reading a file from the local filesystem, it first calls an appropriate method (such as `checkRead( )`) of the currently installed `SecurityManager` object. If untrusted code is running, the `SecurityManager` tHRows a `SecurityException` that prevents the restricted operation from taking place.

The most common user of the `SecurityManager` class is a Java-enabled web browser, which installs a `SecurityManager` object to allow applets to run without damaging the host system. The precise details of the security policy are an implementation detail of the web browser, of course, but applets are typically restricted in the following ways:

- An applet cannot read, write, rename, or delete files. It cannot query the length or modification date of a file or even check whether a given file exists. Similarly, an applet cannot create, list, or delete a directory.
- An applet cannot connect to or accept a connection from any computer other than the one it was downloaded from. It cannot use any privileged ports (i.e., ports below and including port 1024).
- An applet cannot perform system-level functions, such as loading a native library, spawning a new process, or exiting the Java interpreter. An applet cannot manipulate any threads or threac groups, except for those it creates itself. In Java 1.1 and later, applets cannot use the Java Reflection API to obtain information about the nonpublic members of classes, except for classes that were downloaded with the applet.
- An applet cannot access certain graphics- and GUI-related facilities. It cannot initiate a print job or access the system clipboard or event queue. In addition, all windows created by an applet typically display a prominent visual indicator that they are "insecure" to prevent an applet from spoofing the appearance of some other application.

- An applet cannot read certain system properties, notably the `user.home` and `user.dir` properties, that specify the user's home directory and current working directory.
- An applet cannot circumvent these security restrictions by registering a new `SecurityManager` object.

6.4.1.1 How the sandbox works

Suppose that an applet (or some other untrusted code running in the sandbox) attempts to read the contents of the file */etc/passwd* by passing this filename to the `FileInputStream()` constructor. The programmers who wrote the `FileInputStream` class were aware that the class provides access to a system resource (a file), so use of the class should therefore be subject to access control. For this reason, they coded the `FileInputStream( )` constructor to use the `SecurityManager` class.

Every time `FileInputStream( )` is called, it checks to see if a `SecurityManager` object has been installed. If so, the constructor calls the `checkRead()` method of that `SecurityManager` object, passing the filename (*/etc/passwd*, in this case) as the sole argument. The `checkRead()` method has no return value; it either returns normally or throws a `SecurityException`. If the method returns, the `FileInputStream()` constructor simply proceeds with whatever initialization is necessary and returns. Otherwise, it allows the `SecurityException` to propagate to the caller. When this happens, no `FileInputStream` object is created, and the applet does not gain access to the */etc/passwd* file.

6.4.2. Java 1.1: Digitally Signed Classes

Java 1.1 retained the sandbox model of Java 1.0 but added the `java.security` package and its digital signature capabilities. With these capabilities, Java classes can be digitally signed and verified. Thus, web browsers and other Java installations can be configured to trust downloaded code that bears a valid digital signature of a trusted entity. Such code is treated as if it were installed locally, s it is given full access to the Java APIs. In this release, the *javakey* program manages keys and digitally signs JAR files of Java code. Although Java 1.1 added the important ability to trust digitally signed code that would otherwise be untrusted, it sticks to the basic sandbox model: trusted code gets full access and untrusted code gets totally restricted access.

6.4.3. Java 1.2: Permissions and Policies

Java 1.2 introduced substantial access control features into the Java security architecture. These features are implemented by classes in the `java.security` package. The `Policy` class is one of the most important: it defines a Java security policy. A `Policy` object maps `CodeSource` objects to associated sets of `Permission` objects. A `CodeSource` object represents the source of a piece of Java code, which includes both the URL of the class file (and can be a local file) and a list of entities that have applied their digital signatures to the class file. The `Permission` objects associated with a `CodeSource` in the `Policy` define the permissions that are granted to code from a given source. Various Java APIs include subclasses of `Permission` that represent different types of permissions. These include `java.lang.RuntimePermission`, `java.io.FilePermission`, and `java.net.SocketPermission`, for example.

Under this access control model, the `SecurityManager` class continues to be the central class; access control requests are still made by invoking methods of a `SecurityManager`. However, the default `SecurityManager` implementation delegates most of those requests to an `AccessController` class that makes access decisions based on the `Permission` and `Policy` architecture.

The Java 1.2 access control architecture has several important features:

- Code from different sources can be given different sets of permissions. In other words, the architecture supports fine-grained levels of trust. Even locally installed code can be treated as untrusted or partially untrusted. Under this architecture, only system classes and standard extensions run as fully trusted.
- It is no longer necessary to define a custom subclass of `SecurityManager` to define a security policy. Policies can be configured by a system administrator by editing a text file or using the *policytool* program, described in Chapter 8.
- The architecture is not limited to a fixed set of access control methods in the `SecurityManager` class. `Permission` subclasses can be defined easily to govern access to system resources (which might be exposed, for example, by standard extensions that include native code).

6.4.3.1 How policies and permissions work

Let's return to the example of an applet that attempts to create a `FileInputStream` to read the file */etc/passwd*. In Java 1.2 and later, the `FileInputStream( )` constructor behaves exactly the same as it does in Java 1.0 and Java 1.1: it looks to see if a `SecurityManager` is installed and, if so, calls its `checkRead()` method, passing the name of the file to be read.

What changed as of Java 1.2 is the default behavior of the `checkRead( )` method. Unless a program has replaced the default security manager with one of its own, the default implementation creates a `FilePermission` object to represent the access being requested. This `FilePermission` object has a *target* of "/etc/passwd" and an *action* of "read." The `checkRead()` method passes this `FilePermission` object to the static `checkPermission()` method of the `java.security.AccessController` class.

It is the `AccessController` and its `checkPermission( )` method that do the real work of access control as of Java 1.2. The method determines the `CodeSource` of each calling method and uses the current `Policy` object to determine the `Permission` objects associated with it. With this information, the `AccessController` can determine whether read access to the */etc/passwd* file should be allowed.

The `Permission` class represents both the permissions granted by a `Policy` and the permissions requested by a method like the `FileInputStream()` constructor. When requesting a permission, Java typically uses a `FilePermission` (or other `Permission` subclass) with a very specific target, like "/etc/passwd". When granting a permission, however, a `Policy` commonly uses a `FilePermission` object with a wildcard target, such as "/etc/*", to represent many files. One of the key features of a `Permission` subclass such as `FilePermission` is that it defines an `implies()` method that can determine whether permission to read "/etc/*" implies permission to read "/etc/passwd".

Team LiB

6.5. Security for Everyone

Programmers, system administrators, and end users all have different security concerns and, thus, different roles to play in the Java security architecture.

6.5.1. Security for System Programmers

System programmers are the people who define new Java APIs that allow access to sensitive system resources. These programmers are typically working with native methods that have unprotected access to the system. They need to use the Java access control architecture to prevent untrusted code from executing those native methods. To do this, system programmers must carefully insert `SecurityManager` calls at appropriate places in their code. A system programmer may choose to use an existing `Permission` subclass to govern access to the system resources exposed by her API, or she may decide to define a specialized subclass of `Permission`.

The system programmer carries a tremendous security burden: if she does not perform appropriate access control checks in her code, she compromises the security of the entire Java platform. The details are complex and are beyond the scope of this book. Fortunately, however, system programming that involves native methods is rare in Java; almost all of us are application programmers who can simply rely on the existing APIs.

6.5.2. Security for Application Programmers

Programmers who use the core Java APIs and standard extensions but do not define new extensions or write native methods can simply rely on the security efforts of the system programmers who created those APIs. In other words, most of us Java programmers can simply use the Java APIs and need not worry about introducing security holes into the Java platform.

In fact, application programmers rarely have to use the access control architecture. If you are writing Java code that may be run as untrusted code, you should be aware of the restrictions placed on untrusted code by typical security policies. Keep in mind that some methods (such as methods that read or write files) can throw `SecurityException` objects, but don't feel you must write your code to catch these exceptions. Often, the appropriate response to a `SecurityException` is to allow it to propagate uncaught so that it terminates the application.

Sometimes, as an application programmer, you want to write an application (such as an applet viewer) that can load untrusted classes and run them subject to access control checks. To do this in Java 1.2 and later, you must first install a security manager:

```
System.setSecurityManager(new SecurityManager());
```

You then use `java.net.URLClassLoader` to load the untrusted classes. `URLClassLoader` assigns a default set of safe permissions to the classes it loads, but in some cases you may want to modify the permissions granted to the loaded code through the Policy and PermissionCollection classes.

6.5.3. Security for System Administrators

In Java 1.2 and later, system administrators are responsible for defining the default security policy for the computers at their site. The default policy is stored in the file *lib/security/java.policy* in the Java installation. A system administrator can edit this text file by hand or use the *policytool* program from Sun to edit the file graphically. *policytool* is the preferred way to define policies, so the syntax of the underlying policy file is not documented in this book.

The default *java.policy* file defines a policy that is much like the policy of Java 1.0 and Java 1.1: system classes and installed extensions are fully trusted, while all other code is untrusted and only allowed a few simple permissions. While this default policy is adequate for many purposes, it may not be appropriate for all sites. For example, at some organizations, it may be appropriate to grant extra permissions to code downloaded from a secure intranet.

In order to define effective security policies, a system administrator must understand the various Permission subclasses of the Java platform, the target and action names they support, and the security implications of granting any particular permission. These topics are explained well in a document titled "Permissions in the Java 2 Standard Edition Development Kit (JDK)," which is available online at http://java.sun.com/j2se/1.5.0/docs/guide/security/permissions.html.

6.5.4. Security for End Users

Most end users do not have to think about security at all: their Java programs should simply run in a secure way with no intervention from them. Some sophisticated end users may want to define their own security policies, however. An end user can do this by running *policytool* himself to define personal policy files that augment the system policy. The default personal policy is stored in a file named *.java.policy* in the user's home directory. By default, Java loads this policy file and uses it to augment the system policy file.

In Java 1.2 and later, a user can specify an additional policy file to use when starting up the Java interpreter. To do so, you use the -D option to define the java.security.policy property. For example:

```
C:\> java -Djava.security.policy=policyfile UntrustedApp
```

This line runs the class UntrustedApp after augmenting the default system and user policies with the policy specified in the file or URL *policyfile*. To replace the system and user policies instead of augmenting them, use a double equals sign in the property specification:

```
C:\> java -Djava.security.policy= =policyfile UntrustedApp
```

Note, however, that specifying a policy file is useful only if there is a SecurityManager installed. If a user doesn't trust an application, he presumably doesn't trust that application to voluntarily install its own security manager. In this case, he can define the java.security.manager system property:

```
C:\> java -Djava.security.manager -Djava.security.policy=policyfile
          \ UntrustedApp
```

The value of this property does not matter; simply defining it is enough to tell the Java interpreter to automatically install a default `SecurityManager` object that subjects an application to the access control policies described in the system, user, and `java.security.policy` policy files.

Team LiB

6.6. Permission Classes

Table 6-1 lists some important `Permission` subclasses defined by the core Java platform and summarizes the permissions they represent. See the reference section for more information on the individual classes. See http://java.sun.com/j2se/1.5.0/docs/guide/security/permissions.html for a complete list and detailed description of these permissions classes, along with their target and action names and a list of methods and the permissions they require (this document is part of the standard documentation bundle that can be downloaded along with the JDK).

Table 6-1. Java permission classes

Permission class	Description
`java.security.AllPermission`	An instance of this special permission class implies all other permissions.
`javax.sound.sampled.AudioPermission`	Controls the ability to play and record sound.
`javax.security.auth.AuthPermission`	Controls access to authentication methods in `javax.security.auth` and its subpackages.
`java.awt.AWTPermission`	Controls access to sensitive methods in `java.awt` and its subpackages.
`java.io.FilePermission`	Governs access to the filesystem.
`java.util.logging.LoggingPermission`	Controls the ability of a program to modify the logging configuration.
`java.net.NetPermission`	Governs access to networking-related resources such as stream handlers and HTTP authentication. See also `java.net.SocketPermission`.
`java.util.PropertyPermission`	Governs access to system properties.
`java.lang.reflect.ReflectPermission`	Governs access through the `java.lang.reflect` package to classes and class members that would normally be inaccessible.
`java.lang.RuntimePermission`	Governs access to a number of methods and resources. Many of the controlled methods are defined by `java.lang.System` and `java.lang.Runtime`.
`java.security.SecurityPermission`	Governs access to various security-related methods.
`java.io.SerializablePermission`	Governs access to serialization-related methods.
`java.net.SocketPermission`	Governs access to the network.

Permission class	Description
`java.sql.SQLPermission`	Governs the ability to specify logging streams in the `java.sql` JDBC API.

Team LiB

Chapter 7. Programming and Documentation Conventions

This chapter explains a number of important and useful Java programming and documentation conventions. It covers:

- General naming and capitalization conventions
- Portability tips and conventions
- Javadoc documentation comment syntax and conventions
- JavaBeans conventions

None of the conventions described here are mandatory. Following them, however, will make your code easier to read and maintain, portable, and self-documenting.

7.1. Naming and Capitalization Conventions

The following widely adopted naming conventions apply to packages, reference types, methods, fields, and constants in Java. Because these conventions are almost universally followed and because they affect the public API of the classes you define, they should be followed carefully:

Packages

Ensure that your publicly visible package names are unique by prefixing them with the inverted name of your Internet domain (e.g., `com.davidflanagan.utils`). All package names should be lowercase. Packages of code used internally by applications distributed in self-contained JAR files are not publicly visible and need not follow this convention. It is common in this case to use the application name as the package name or as a package prefix.

Reference types

A type name should begin with a capital letter and be written in mixed case (e.g.,`String`). If a class name consists of more than one word, each word should begin with a capital letter (e.g., `StringBuffer`). If a type name, or one of the words of a type name, is an acronym, the acronym can be written in all capital letters (e.g.,`URL`, `HTMLParser`).

Since classes and enumerated types are designed to represent objects, you should choose class names that are nouns (e.g., `THRead`, `Teapot`, `FormatConverter`).

When an interface is used to provide additional information about the classes that implement it, it is common to choose an interface name that is an adjective (e.g.,`Runnable`, `Cloneable`, `Serializable`). Annotation types are also commonly named in this way. When an interface works more like an abstract superclass, use a name that is a noun (e.g.,`Document`, `FileNameMap`, `Collection`).

Methods

A method name always begins with a lowercase letter. If the name contains more than one word, every word after the first begins with a capital letter (e.g.,`insert( )`, `insertObject()`, `insertObjectAt( )`). Method names are typically chosen so that the first word is a verb. Method names can be as long as is necessary to make their purpose clear, but choose succinct names where possible.

Fields and constants

Nonconstant field names follow the same capitalization conventions as method names. If a field is a `static final` constant, it should be written in uppercase. If the name of a constant includes more than one word, the words should be separated with underscores (e.g., `MAX_VALUE`). A field name should be chosen to best describe the purpose of the field or the value it holds.

The constants defined by `enum` types are also typically written in all capital letters. Because other programming languages use lowercase or mixed case for enumerated values, however, this convention is not as strong as the convention for capital letters in the `static final` fields of classes and interfaces.

Parameters

Method parameters follow the same capitalization conventions as nonconstant fields. The names of method parameters appear in the documentation for a method, so you should choose names that make the purpose of the parameters as clear as possible. Try to keep parameter names to a single word and use them consistently. For example, if a `WidgetProcessor` class defines many methods that accept a `Widget` object as the first parameter, name this parameter `widget` or even `w` in each method.

Local variables

Local variable names are an implementation detail and never visible outside your class. Nevertheless, choosing good names makes your code easier to read, understand, and maintain. Variables are typically named following the same conventions as methods and fields.

In addition to the conventions for specific types of names, there are conventions regarding the characters you should use in your names. Java allows the `$` character in any identifier, but, by convention, its use is reserved for synthetic names generated by source-code processors. (It is used by the Java compiler, for example, to make inner classes work.) Also, Java allows names to use any alphanumeric characters from the entire Unicode character set. While this can be convenient for non-English-speaking programmers, the use of Unicode characters should typically be restricted to local variables, private methods and fields, and other names that are not part of the public API of a class.

Team LiB

7.2. Portability Conventions and Pure Java Rules

Sun's motto, or core value proposition, for Java is "Write once, run anywhere." Java makes it easy to write portable programs, but Java programs do not automatically run successfully on any Java platform. The following tips help to avoid portability problems. Portability rules like those listed here were the focus of Sun's now-defunct "100% Pure Java" certification program and branding campaign

Native methods

Portable Java code can use any methods in the core Java APIs, including methods implemented as `native` methods. However, portable code must not define its own native methods. By their very nature, native methods must be ported to each new platform, so they directly subvert the "Write once, run anywhere" promise of Java.

The `Runtime.exec( )` method

Calling the `Runtime.exec( )` method to spawn a process and execute an external command on the native system is rarely allowed in portable code. This is because the native OS command to be executed is never guaranteed to exist or behave the same way on all platforms. The only time it is legal to use `Runtime.exec( )` is when the user is allowed to specify the command to run, either by typing the command at runtime or by specifying the command in a configuration file or preferences dialog box.

The `System.getenv()` method

Using `System.getenv()` is nonportable. The method was deprecated but has been reintroduced in Java 5.0.

Undocumented classes

Portable Java code must use only classes and interfaces that are a documented part of the Java platform. Most Java implementations ship with additional undocumented public classes that are part of the implementation but not part of the Java platform specification. Nothing prevents a program from using and relying on these undocumented classes, but doing so is not portable because the classes are not guaranteed to exist in all Java implementations or on all platforms.

The `java.awt.peer` package

The interfaces in the `java.awt.peer` package are part of the Java platform but are documented for use by AWT implementors only. Applications that use these interfaces directly are not portable.

Implementation-specific features

Portable code must not rely on features specific to a single implementation. For example, Microsoft distributed a version of the Java runtime system that included a number of additional methods that were not part of the Java platform as defined by Sun. Any program that depends on such extensions is obviously not portable to other platforms.Microsoft's proprietary extension of the Java platform resulted in legal action between Sun and Microsoft and ultimately caused Microsoft to discontinue ongoing support for Java.

Implementation-specific bugs

Just as portable code must not depend on implementation-specific features, it must not depend on implementation-specific bugs. If a class or method behaves differently than the specification says it should, a portable program cannot rely on this behavior, which may be different on different platforms, and ultimately may be fixed.

Implementation-specific behavior

Sometimes different platforms and different implementations present different behaviors, all of which are legal according to the Java specification. Portable code must not depend on any one specific behavior. For example, the Java specification does not indicate whether threads of equal priority share the CPU or if one long-running thread can starve another thread at the same priority. If an application assumes one behavior or the other, it may not run properly on all platforms.

Standard extensions

Portable code can rely on standard extensions to the Java platform, but, if it does so, it should clearly specify which extensions it uses and exit cleanly with an appropriate error message when run on a system that does not have the extensions installed.

Complete programs

Any portable Java program must be complete and self-contained: it must supply all the classes it uses, except core platform and standard extension classes.

Defining system classes

Portable Java code never defines classes in any of the system or standard extension packages. Doing so violates the protection boundaries of those packages and exposes package-visible implementation details.

Hardcoded filenames

A portable program contains no hardcoded file or directory names. This is because different platforms have significantly different filesystem organizations and use different directory separator characters. If you need to work with a file or directory, have the user specify the filename, or at least the base directory beneath which the file can be found. This specification can be done at runtime, in a configuration file, or as a command-line argument to the program. When concatenating a file or directory name to a directory name, use the `File( )` constructor or the `File.separator` constant.

Line separators

Different systems use different characters or sequences of characters as line separators. Do not hardcode `\n`, `\r`, or `\r\n` as the line separator in your program. Instead, use the `println()` method of `PrintStream` or `PrintWriter`, which automatically terminates a line with the line separator appropriate for the platform, or use the value of the `line.separator` system property. In Java 5.0 and later, you can also use the "%n" format string to `printf( )` and `format()` methods of `java.util.Formatter` and related classes.

Team LiB

7.3. Java Documentation Comments

Most ordinary comments within Java code explain the implementation details of that code. By contrast, the Java language specification defines a special type of comment known as a *doc comment* that serves to document the API of your code. A doc comment is an ordinary multiline comment that begins with `/**` (instead of the usual `/*`) and ends with `*/`. A doc comment appears immediately before a type or member definition and contains documentation for that type or member. The documentation can include simple HTML formatting tags and other special keywords that provide additional information. Doc comments are ignored by the compiler, but they can be extracted and automatically turned into online HTML documentation by the *javadoc* program. (See Chapter 8 for more information about *javadoc*.) Here is an example class that contains appropriate doc comments:

```
/**
 * This immutable class represents <i>complex numbers</i>.
 *
 * @author David Flanagan
 * @version 1.0
 */
public class Complex {
    /**
     * Holds the real part of this complex number.
     * @see #y
     */
    protected double x;

    /**
     * Holds the imaginary part of this complex number.
     * @see #x
     */
    protected double y;

    /**
     * Creates a new Complex object that represents the complex number x+yi.
     * @param x The real part of the complex number.
     * @param y The imaginary part of the complex number.
     */
    public Complex(double x, double y) {
        this.x = x;
        this.y = y;
    }

    /**
     * Adds two Complex objects and produces a third object that represents
     * their sum.
     * @param c1 A Complex object
     * @param c2 Another Complex object
     * @return  A new Complex object that represents the sum of
```

```
     *          <code>c1</code> and <code>c2</code>.
     * @exception java.lang.NullPointerException
     *            If either argument is <code>null</code>.
     */
    public static Complex add(Complex c1, Complex c2) {
        return new Complex(c1.x + c2.x, c1.y + c2.y);
    }
}
```

7.3.1. Structure of a Doc Comment

The body of a doc comment should begin with a one-sentence summary of the type or member being documented. This sentence may be displayed by itself as summary documentation, so it should be written to stand on its own. The initial sentence may be followed by any number of other sentences and paragraphs that describe the class, interface, method, or field in full detail.

After the descriptive paragraphs, a doc comment can contain any number of other paragraphs, each of which begins with a special doc-comment tag, such as `@author`, `@param`, or `@returns`. These tagged paragraphs provide specific information about the class, interface, method, or field that the *javadoc* program displays in a standard way. The full set of doc-comment tags is listed in the next section.

The descriptive material in a doc comment can contain simple HTML markup tags, such as such as `<i>` for emphasis, `<code>` for class, method, and field names, and `<pre>` for multiline code examples. It can also contain `<p>` tags to break the description into separate paragraphs and `<ul>`, `<li>`, and related tags to display bulleted lists and similar structures. Remember, however, that the material you write is embedded within a larger, more complex HTML document. For this reason, doc comments should not contain major structural HTML tags, such as `<h2>` or `<hr>`, that might interfere with the structure of the larger document.

Avoid the use of the `<a>` tag to include hyperlinks or cross-references in your doc comments. Instead, use the special `{@link}` doc-comment tag, which, unlike the other doc-comment tags, can appear anywhere within a doc comment. As described in the next section, the `{@link}` tag allows you to specify hyperlinks to other classes, interfaces, methods, and fields without knowing the HTML-structuring conventions and filenames used by *javadoc*.

If you want to include an image in a doc comment, place the image file in a *doc-files* subdirectory of the source code directory. Give the image the same name as the class, with an integer suffix. For example, the second image that appears in the doc comment for a class named `Circle` can be included with this HTML tag:

```
<img src="doc-files/Circle-2.gif">
```

Because the lines of a doc comment are embedded within a Java comment, any leading spaces and asterisks (`*`) are stripped from each line of the comment before processing. Thus, you don't need to worry about the asterisks appearing in the generated documentation or about the indentation of the comment affecting the indentation of code examples included within the comment with a `<pre>` tag.

7.3.2. Doc-Comment Tags

javadoc recognizes a number of special tags, each of which begins with an `@` character. These doc-comment tags allow you to encode specific information into your comments in a standardized way, and they allow *javadoc* to choose the appropriate output format for that information. For example, the `@param` tag lets you specify the name and meaning of a single parameter for a method. *javadoc* can extract this information and display it using an HTML `<dl>` list, an HTML `<table>`, or however it sees fit.

The following doc-comment tags are recognized by *javadoc*; a doc comment should typically use these tags in the order listed here:

`@author` *`name`*

Adds an "Author:" entry that contains the specified name. This tag should be used for every class or interface definition but must not be used for individual methods and fields. If a class has multiple authors, use multiple `@author` tags on adjacent lines. For example:

```
@author David Flanagan
@author Paula Ferguson
```

List the authors in chronological order, with the original author first. If the author is unknown, you can use "unascribed." *javadoc* does not output authorship information unless the `-author` command-line argument is specified.

`@version` *`text`*

Inserts a "Version:" entry that contains the specified text. For example:

```
@version 1.32, 08/26/04
```

This tag should be included in every class and interface doc comment but cannot be used for individual methods and fields. This tag is often used in conjunction with the automated version-numbering capabilities of a version control system, such as SCCS, RCS, or CVS. *javadoc* does not output version information in its generated documentation unless the `-version` command-line argument is specified.

`@param` *`parameter-name description`*

Adds the specified parameter and its description to the "Parameters:" section of the current method. The doc comment for a method or constructor must contain one `@param` tag for each parameter the method expects. These tags should appear in the same order as the parameters specified by the method. The tag can be used only in doc comments for methods and constructors. You are encouraged to use phrases and sentence fragments where possible to keep the descriptions brief. However, if a parameter requires detailed documentation, the description can wrap onto multiple lines and include as much text as necessary. For readability in source-code form, consider using spaces to align the descriptions with each other. For example:

```
@param o      the object to insert
@param index  the position to insert it at
```

`@return` *`description`*

Inserts a "Returns:" section that contains the specified description. This tag should appear in every doc comment for a method, unless the method returns `void` or is a constructor. The description can be as long as necessary, but consider using a sentence fragment to keep it short. For example:

```
@return <code>true</code> if the insertion is successful, or
        <code>false</code> if the list already contains the specified object.
```

`@exception` *`full-classname description`*

Adds a "Throws:" entry that contains the specified exception name and description. A doc comment for a method or constructor should contain an `@exception` tag for every checked exception that appears in its `throws` clause. For example:

```
@exception java.io.FileNotFoundException
           If the specified file could not be found
```

The `@exception` tag can optionally be used to document unchecked exceptions (i.e., subclasses of `RuntimeException`) the method may throw, when these are exceptions that a user of the method may reasonably want to catch. If a method can throw more than one exception, use multiple `@exception` tags on adjacent lines and list the exceptions in alphabetical order. The description can be as short or as long as necessary to describe the significance of the exception. This tag can be used only for method and constructor comments. The `@throws` tag is a synonym for `@exception`.

`@throws` *`full-classname description`*

This tag is a synonym for `@exception`.

`@see` *`reference`*

Adds a "See Also:" entry that contains the specified reference. This tag can appear in any kind of doc comment. The syntax for the *reference* is explained in Section 7.3.4 later in this chapter.

`@deprecated` *`explanation`*

This tag specifies that the following type or member has been deprecated and that its use should be avoided. *javadoc* adds a prominent "Deprecated" entry to the documentation and includes the specified *`explanation`* text. This text should specify when the class or member was deprecated and, if possible, suggest a replacement class or member and include a link to it. For example:

```
@deprecated As of Version 3.0, this method is replaced
            by {@link #setColor}.
```

Although the Java compiler ignores all comments, it does take note of the `@deprecated` tag in doc comments. When this tag appears, the compiler notes the deprecation in the class file it produces. This allows it to issue warnings for other classes that rely on the deprecated feature.

`@since` *`version`*

Specifies when the type or member was added to the API. This tag should be followed by a version number or other version specification. For example:

```
@since JNUT 3.0
```

Every doc comment for a type should include an `@since` tag, and any members added after the initial release of the type should have `@since` tags in their doc comments.

`@serial` *`description`*

Technically, the way a class is serialized is part of its public API. If you write a class that you expect to be serialized, you should document its serialization format using `@serial` and the related tags listed below. `@serial` should appear in the doc comment for any field that is part of the serialized state of a `Serializable` class. For classes that use the default serialization mechanism, this means all fields that are not declared `transient`, including fields declared `private`. The *`description`* should be a brief description of the field and of its purpose within a serialized object.

As of Java 1.4, you can also use the `@serial` tag at the class and package level to specify whether a "serialized form page" should be generated for the class or package. The syntax is:

```
@serial include
```

`@serial exclude`

`@serialField` *`name type description`*

A `Serializable` class can define its serialized format by declaring an array of `ObjectStreamField` objects in a field named `serialPersistentFields`. For such a class, the doc comment for `serialPersistentFields` should include an `@serialField` tag for each element of the array. Each tag specifies the name, type, and description for a particular field in the serialized state of the class.

`@serialData` *`description`*

A `Serializable` class can define a `writeObject( )` method to write data other than that written by the default serialization mechanism. An `Externalizable` class defines a `writeExternal()` method responsible for writing the complete state of an object to the serialization stream. The `@serialData` tag should be used in the doc comments for these `writeObject( )` and `writeExternal()` methods, and the *`description`* should document the serialization format used by the method.

7.3.3. Inline Doc Comment Tags

In addition to the preceding tags, *javadoc* also supports several *inline tags* that may appear anywhere that HTML text appears in a doc comment. Because these tags appear directly within the flow of HTML text, they require the use of curly braces as delimiters to separate the tagged text from the HTML text. Supported inline tags include the following:

`{@link` *`reference`*`}`

In Java 1.2 and later, the `{@link}` tag is like the `@see` tag except that instead of placing a link to the specified *`reference`* in a special "See Also:" section, it inserts the link inline. An `{@link}` tag can appear anywhere that HTML text appears in a doc comment. In other words, it can appear in the initial description of the class, interface, method, or field and in the descriptions associated with the `@param`, `@returns`, `@exception`, and `@deprecated` tags. The *`reference`* for the `{@link}` tag uses the syntax described next in Section 7.3.4. For example:

```
@param regexp The regular expression to search for. This string
              argument must follow the syntax rules described for
              {@link java.util.regex.Pattern}.
```

`{@linkplain` *`reference`*`}`

In Java 1.4 and later, the `{@linkplain}` tag is just like the `{@link}` tag, except that the text of the link is formatted using the normal font rather than the code font used by the `{@link}` tag. This is most useful when *`reference`* contains both a *`feature`* to link to and a *`label`* that specifies alternate text to be displayed in the link. See Section 7.3.4 for a discussion of the *`feature`* and *`label`* portions of the *`reference`* argument.

`{@inheritDoc}`

When a method overrides a method in a superclass or implements a method in an interface, you can omit a doc comment, and *javadoc* automatically inherits the documentation from the overridden or implemented method. As of Java 1.4, however, the `{@inheritDoc}` tag allows you to inherit the text of individual tags. This tag also allows you to inherit and augment the descriptive text of the comment. To inherit individual tags, use it like this:

```
@param index @{inheritDoc}
@return @{inheritDoc}
```

To inherit the entire doc comment, including your own text before and after it, use the tag like this:

```
This method overrides {@link java.langObject#toString}, documented as follows:
<P>{@inheritDoc}
<P>This overridden version of the method returns a string of the form...
```

`{@docRoot}`

This inline tag takes no parameters and is replaced with a reference to the root directory of the generated documentation. It is useful in hyperlinks that refer to an external file, such as an image or a copyright statement:

```
<img src="{@docroot}/images/logo.gif">
This is <a href="{@docRoot}/legal.html">Copyrighted</a> material.
```

`{@docRoot}` was introduced in Java 1.3.

`{@literal` *`text`*`}`

This inline tag displays *`text`* literally, escaping any HTML in it and ignoring any javadoc tags it may contain. It does not retain whitespace formatting but is useful when used within a `<pre>` tag. `{@literal}` is available in Java 5.0 and later.

`{@code` *`text`*`}`

This tag is like the `{@literal}` tag, but displays the literal *`text`* in code font. Equivalent to:

```
<code>{@literal text}</code>
```

`{@code}` is available in Java 5.0 and later.

`{@value}`

The `{@value}` tag, with no arguments, is used inline in doc comments for `static final` fields and is replaced with the constant value of that field. This tag was introduced in Java 1.4 and is used only for constant fields.

`{@value` *`reference`*`}`

This variant of the `{@value}` tag includes a *`reference`* to a `static final` field and is replaced with the constant value of that field. Although the no-argument version of the `{@value}` tag was introduced in Java 1.4, this version is available only in Java 5.0 and later. See Section 7.3.4 for the syntax of the reference.

7.3.4. Cross-References in Doc Comments

The `@see` tag and the inline tags `{@link}`, `{@linkplain}` and `{@value}` all encode a cross-reference to some other source of documentation, typically to the documentation comment for some other type or member.

`reference` can take three different forms. If it begins with a quote character, it is taken to be the name of a book or some other printed resource and is displayed as is. If *`reference`* begins with a < character, it is taken to be an arbitrary HTML hyperlink that uses the `<a>` tag and the hyperlink is inserted into the output documentation as is. This form of the `@see` tag can insert links to other online documents, such as a programmer's guide or user's manual.

If *`reference`* is not a quoted string or a hyperlink, it is expected to have the following form:

```
feature label
```

In this case, *javadoc* outputs the text specified by *`label`* and encodes it as a hyperlink to the specified *`feature`*. If *`label`* is omitted (as it usually is), *javadoc* uses the name of the specified *`feature`* instead.

`feature` can refer to a package, type, or type member, using one of the following forms:

pkgname

A reference to the named package. For example:

```
@see java.lang.reflect
```

pkgname.*typename*

A reference to a class, interface, enumerated type, or annotation type specified with its full package name. For example:

```
@see java.util.List
```

typename

A reference to a type specified without its package name. For example:

```
@see List
```

javadoc resolves this reference by searching the current package and the list of imported classes for a class with this name.

typename# *methodname*

A reference to a named method or constructor within the specified type. For example:

```
@see java.io.InputStream#reset
@see InputStream#close
```

If the type is specified without its package name, it is resolved as described for*typename*. This syntax is ambiguous if the method is overloaded or the class defines a field by the same name.

typename# *methodname*(*paramtypes*)

A reference to a method or constructor with the type of its parameters explicitly specified. This is useful when cross-referencing an overloaded method. For example:

```
@see InputStream#read(byte[], int, int)
```

 # methodname

A reference to a nonoverloaded method or constructor in the current class or interface or one of the containing classes, superclasses, or superinterfaces of the current class or interface. Use this concise form to refer to other methods in the same class. For example:

```
@see #setBackgroundColor
```

 # methodname(paramtypes)

A reference to a method or constructor in the current class or interface or one of its superclasses or containing classes. This form works with overloaded methods because it lists the types of the method parameters explicitly. For example:

```
@see #setPosition(int, int)
```

typename# fieldname

A reference to a named field within the specified class. For example:

```
@see java.io.BufferedInputStream#buf
```

If the type is specified without its package name, it is resolved as described for *typename*.

 # fieldname

A reference to a field in the current type or one of the containing classes, superclasses, or superinterfaces of the current type. For example:

```
@see #x
```

7.3.5. Doc Comments for Packages

Documentation comments for classes, interfaces, methods, constructors, and fields appear in Java source code immediately before the definitions of the features they document. *javadoc* can also read and display summary documentation for packages. Since a package is defined in a directory, not in a single file of source code, *javadoc* looks for the package documentation in a file named *package.html* in the directory that contains the source code for the classes of the package.

The *package.html* file should contain simple HTML documentation for the package. It can also contain `@see`, `@link`, `@deprecated`, and `@since` tags. Since *package.html* is not a file of Java source code, the documentation it contains should be HTML and should *not* be a Java comment (i.e., it should not be enclosed within `/**` and `*/` characters). Finally, any `@see` and `@link` tags that appear in *package.html* must use fully qualified class names.

In addition to defining a *package.html* file for each package, you can also provide high-level documentation for a group of packages by defining an *overview.html* file in the source tree for those packages. When *javadoc* is run over that source tree, it uses *overview.html* as the highest level overview it displays.

Team LiB

7.4. JavaBeans Conventions

JavaBeans is a framework for defining reusable modular software components. The JavaBeans specification includes the following definition of a bean: "a reusable software component that can be manipulated visually in a builder tool." As you can see, this is a rather loose definition; beans can take a variety of forms. The most common use of beans is for graphical user interface components, such as components of the `java.awt` and `javax.swing` packages, which are documented in *Java Foundation Classes in a Nutshell* and *Java Swing*, both from O'Reilly. Although all beans can be manipulated visually, this does not mean every bean has its own visual representation. For example, the `javax.sql.RowSet` class (documented in O'Reilly's *Java Enterprise in a Nutshell*) is a JavaBeans component that represents the data resulting from a database query. There are no limits on the simplicity or complexity of a JavaBeans component. The simplest beans are typically basic graphical interface components, such as a `java.awt.Button` object. But even complex systems, such as an embeddable spreadsheet application, can function as individual beans.

The JavaBeans component model consists of the `java.beans`, the `java.beans.beancontext` packages, and a number of important naming and API conventions to which conforming beans and bean-manipulation tools must adhere. These conventions are not part of the JavaBeans API itself but are in many ways more important to bean developers than the API itself. The conventions are sometimes referred to as *design patterns*; they specify such things as method names and signatures for property accessor methods defined by a bean. If the class you are writing is not intended to be a bean, suitable for visual manipulation in a builder tool, you don't need to follow these conventions. The JavaBeans conventions are widely used and well-understood, however, and you can improve the usability and reusabilty of your code by following the relevant ones. This is particularly true of the property accessor method naming conventions.

We cover the conventions themselves later in this section. First, however, an overview of the JavaBeans model is in order.

7.4.1. Bean Basics

Any object that conforms to certain basic rules can be a bean; there is no `Bean` class that all beans are required to subclass. Many beans are GUI components, but it is also quite possible, and often useful, to write "invisible" beans that do not have an onscreen appearance. (A bean having no onscreen appearance in a finished application does not mean it cannot be visually manipulated by a beanbox tool, however.)

A bean is characterized by the properties, events, and methods it exports. It is these properties, events, and methods that an application designer manipulates in a beanbox tool. A *property* is a piece of the bean's internal state that can be programmatically set and/or queried, usually through a standard pair of `get` and `set` accessor methods.

A bean communicates with the application in which it is embedded as well as with other beans by generating *events*. The JavaBeans API uses the same event model that AWT and Swing components use. The model is based on the `java.util.EventObject` class and the `java.util.EventListener` interface; it is described in detail in *Java Foundation Classes in a Nutshell* (O'Reilly). In brief, the event model works like this:

- A bean defines an event if it provides `add` and `remove` methods for registering and deregistering listener objects for that event.
- An application that wants to be notified when an event of that type occurs uses these methods to register an event listener object of the appropriate type.
- When the event occurs, the bean notifies all registered listeners by passing an event object that describes the event to a method defined by the event listener interface.

A *unicast event* is a rare kind of event for which there can be only a single registered listener object. The `add` registration method for a unicast event throws a `TooManyListenersException` if an attempt is made to register more than a single listener.

The *methods* exported by a bean are simply any public methods defined by the bean, excluding those methods that get and set property values and register and remove event listeners.

In addition to the regular sort of properties described earlier, the JavaBeans API also supports several specialized property subtypes. An *indexed property* is a property that has an array value, as well as getter and setter methods that access both individual elements of the array and the entire array. A *bound property* is one that sends a `PropertyChangeEvent` to any interested `PropertyChangeListener` objects whenever the value of the property changes. A *constrained property* is one that can have any changes vetoed by any interested listener. When the value of a constrained property of a bean changes, the bean must send out a `PropertyChangeEvent` to the list of interested `VetoableChangeListener` objects. If any of these objects throws a `PropertyVetoException`, the property value is not changed, and the `PropertyVetoException` is propagated back to the property setter method.

7.4.2. Bean Classes

A bean class itself must adhere to the following conventions:

Class name

There are no restrictions on the class name of a bean.

Superclass

A bean can extend any other class. Beans are often AWT or Swing components, but there are no restrictions.

Instantiation

A bean should provide a no-parameter constructor so bean manipulation tools can easily instantiate the bean.

7.4.3. Properties

A bean defines a property *p* of type *T* if it has accessor methods that follow these patterns (if *T* is `boolean`, a special form of getter method is allowed):

Getter

`public T getP( )`

Boolean getter

`public boolean isP( )`

Setter

`public void setP(T)`

Exceptions

Property accessor methods can throw any type of checked or unchecked exceptions.

7.4.4. Indexed Properties

An indexed property is a property of array type that provides accessor methods that get and set the entire array as well as methods that get and set individual elements of the array. A bean defines an indexed property *p* of type `T[ ]` if it defines the following accessor methods:

Array getter

`public T[ ] getP()`

Element getter

```
public T getP(int)
```

Array setter

```
public void setP(T[])
```

Element setter

```
public void setP(int,T)
```

Exceptions

Indexed property accessor methods can throw any type of checked or unchecked exceptions. They should throw an `ArrayIndexOutOfBoundsException` if the supplied index is out of bounds.

7.4.5. Bound Properties

A bound property is one that generates a `PropertyChangeEvent` when its value changes. Here are the conventions for a bound property:

Accessor methods

The getter and setter methods for a bound property follow the same conventions as a regular property.

Listener registration

A bean that defines one or more bound properties must define a pair of methods for the registration of listeners that are notified when any bound property value changes. The methods must have these signatures:

```
public void addPropertyChangeListener(PropertyChangeListener)
public void removePropertyChangeListener(PropertyChangeListener)
```

Named property listener registration

A bean can optionally provide additional methods that allow event listeners to be registered for changes to a single bound property value. These methods are passed the name of a property and have the following signatures:

```
public void addPropertyChangeListener(String, PropertyChangeListener)
public void removePropertyChangeListener(String, PropertyChangeListener)
```

Per-property listener registration

A bean can optionally provide additional event listener registration methods that are specific to a single property. For a property *p*, these methods have the following signatures:

```
public void addPListener(PropertyChangeListener)
public void removePListener(PropertyChangeListener)
```

Methods of this type allow a beanbox to distinguish a bound property from an unbound property.

Notification

When the value of a bound property changes, the bean should update its internal state to reflect the change and then pass a `PropertyChangeEvent` to the `propertyChange()` method of every `PropertyChangeListener` object registered for the bean or the specific bound property.

Support

`java.beans.PropertyChangeSupport` is a helpful class for implementing bound properties.

7.4.6. Constrained Properties

A constrained property is one for which any changes can be vetoed by registered listeners. Most constrained properties are also bound properties. Here are the conventions for a constrained property:

Getter

The getter method for a constrained property is the same as the getter method for a regular property.

Setter

The setter method of a constrained property throws a `PropertyVetoException` if the property change is vetoed. For a property *p* of type *T*, the signature looks like this:

```
public void setP(T) throws PropertyVetoException
```

Listener registration

A bean that defines one or more constrained properties must define a pair of methods for the registration of listeners that are notified when any constrained property value changes. The methods must have these signatures:

```
public void addVetoableChangeListener(VetoableChangeListener)
public void removeVetoableChangeListener(VetoableChangeListener)
```

Named property listener registration

A bean can optionally provide additional methods that allow event listeners to be registered for changes to a single constrained property value. These methods are passed the name of a property and have the following signatures:

```
public void addVetoableChangeListener(String, VetoableChangeListener)
public void removeVetoableChangeListener(String, VetoableChangeListener)
```

Per-property listener registration

A bean can optionally provide additional listener registration methods that are specific to a single constrained property. For a property *p*, these methods have the following signatures:

```
public void addPListener(VetoableChangeListener)
public void removePListener(VetoableChangeListener)
```

Notification

When the setter method of a constrained property is invoked, the bean must generate a `PropertyChangeEvent` that describes the requested change and pass that event to the `vetoableChange( )` method of every `VetoableChangeListener` object registered for the bean or the specific constrained property. If any listener vetoes the change by throwing a `PropertyVetoException`, the bean must send out another `PropertyChangeEvent` to revert the property to its original value. It should then throw a `PropertyVetoException` itself. If, on the other hand, the property change is not vetoed, the bean should update its internal state to reflect the change. If the constrained property is also a bound property, the bean should notify `PropertyChangeListener` objects at this point.

Support

`java.beans.VetoableChangeSupport` is a helpful class for implementing constrained properties.

7.4.7. Events

In addition to `PropertyChangeEvent` events generated when bound and constrained properties are changed, a bean can generate other types of events. An event named *E* should follow these conventions:

Event class

The event class should directly or indirectly extend `java.util.EventObject` and should be named *E*`Event`.

Listener interface

The event must be associated with an event listener interface that extends `java.util.EventListener` and is named *E*`Listener`.

Listener methods

The event listener interface can define any number of methods that take a single argument of type *E*`Event` and return `void`.

Listener registration

The bean must define a pair of methods for registering event listeners that want to be notified when an *E* event occurs. The methods should have the following signatures:

```
public void addEListener(EListener)
public void removeEListener(EListener)
```

Unicast events

A unicast event allows only one listener object to be registered at a single time. If *E* is a unicast event, the listener registration method should have this signature:

```
public void addEListener(EListener) throws TooManyListenersException
```

Team LiB

Team LiB

Chapter 8. Java Development Tools

Sun's implementation of Java includes a number of tools for Java developers. Chief among these are the Java interpreter and the Java compiler, of course, but there are a number of others as well. This chapter documents most tools shipped with the JDK. Notable omissions are the RMI and IDL tools that are specific to enterprise programming and which are documented in *Java Enterprise in a Nutshell* (O'Reilly).

The tools documented here are part of Sun's development kit; they are implementation details and not part of the Java specification itself. If you are using a Java development environment other than Sun's JDK, you should consult your vendor's tool documentation.

Some examples in this chapter use Unix conventions for file and path separators. If Windows is your development platform, change forward slashes in filenames to backward slashes, and colons in path specifications to semicolons.

Synopsis

`apt [options] sourcefiles`

Description

apt reads and parses the specified *`sourcefiles`*. Any annotations it finds are passed to appropriate annotation processor factory objects, which can use the annotations to produce auxiliary source or resource files based on annotation content. *apt* next compiles *`sourcefiles`* and generated files.

Annotation processor classes and factory classes are defined with the `com.sun.mirror.apt` API and other subpackages of `com.sun.mirror`.

Options

apt shares several options with *javac*. If a command-line argument begins with `@`, *apt* treats it as a file and reads options and source files from that specified file. See *javac* for more on this.

`-A` *`name=value`*

Passes the *`name=value`* pair as an argument to annotation processors.

`-cp` *`path`*

`-classpath` *`path`*

Sets the classpath. See *javac*.

`-d` *`dir`*

The directory under which to place class files. See *javac*.

`-factory` *`classname`*

Explicitly specifies the class name of the annotation processor factory to use.

`-factorypath` *`path`*

A path to search for annotation processor factories instead of searching the classpath.

`-help`

Prints usage information and exits.

`-nocompile`

Tells *apt* not to compile the *`sourcefiles`* or any generated files.

`-print`

Simply parses the specified *`sourcefiles`* and prints a synopsis of the types they define. Does not process annotations or compile any files.

`-s` *`dir`*

Specifies the root directory beneath which generated source files will be stored.

`-source` *`version`*

Specifies what version of the language to accept. See *javac*.

`-version`

Prints *apt* version information.

`-X`

Displays information about nonstandard options.

See also

javac, Chapter 4

Team LiB

extcheck JAR Version Conflict Utility

Synopsis

`extcheck [-verbose] jarfile`

Description

extcheck checks to see if the extension contained in the specified `jarfile` (or a newer version of that extension) has already been installed on the system. It does this by reading the `Specification-Title` and `Specification-Version` manifest attributes from the specified `jarfile` and from all of the JAR files found in the system extensions directory.

extcheck is designed for use in automated installation scripts. Without the `-verbose` option, it does not print the results of its check. Instead, it sets its exit code to 0 if the specified extension does not conflict with any installed extensions and can be safely installed. It sets its exit code to a nonzero value if an extension with the same name is already installed and has a specification version number equal to or greater than the version of the specified file.

Options

`-verbose`

Lists the installed extensions as they are checked and displays the results of the check.

See also

jar

jarsigner *JAR Signing and Verification Tool*

Synopsis

```
jarsigner [options] jarfile signer
jarsigner -verify jarfile
```

Description

jarsigner adds a digital signature to the specified `jarfile`, or, if the `-verify` option is specified, it verifies the digital signature or signatures already attached to the JAR file. The specified `signer` is a case-insensitive nickname or alias for the entity whose signature is to be used. The specified `signer` name is used to look up the private key that generates the signature.

When you apply your digital signature to a JAR file, you are implicitly vouching for the contents of the archive. You are offering your personal word that the JAR file contains only nonmalicious code, files that do not violate copyright laws, and so forth. When you verify a digitally signed JAR file, you can determine who the signer or signers of the file are and (if the verification succeeds) that the contents of the JAR file have not been changed, corrupted, or tampered with since the signature or signatures were applied. Verifying a digital signature is entirely different from deciding whether or not you trust the person or organization whose signature you verified.

jarsigner and the related *keytool* program replace the *javakey* program of Java 1.1.

Options

jarsigner defines a number of options, many of which specify how a private key is to be found for the specified `signer`. Most of these options are unnecessary when using the `-verify` option to verify a signed JAR file:

`-certs`

If this option is specified along with either the `-verify` or `-verbose` option, it causes *jarsigner* to display details of the public key certificates associated with the signed JAR file.

`-J javaoption`

Passes the specified `javaoption` directly to the Java interpreter.

`-keypass` *password*

Specifies the password that encrypts the private key of the specified *signer*. If this option is not specified, *jarsigner* prompts you for the password.

`-keystore` *url*

A *keystore* is a file that contains keys and certificates. This option specifies the filename or URL of the keystore in which the private and public key certificates of the specified *signer* are looked up. The default is the file named *.keystore* in the user's home directory (the value of the system property `user.home`). This is also the default location of the keystore managed by *keytool*.

`-sigfile` *basename*

Specifies the base names of the *.SF* and *.DSA* files added to the *META-INF/* directory of the JAR file. If you leave this option unspecified, the base filename is chosen based on the *signer* name.

`-signedjar` *outputfile*

Specifies the name for the signed JAR file created by *jarsigner*. If this option is not specified, *jarsigner* overwrites the *jarfile* specified on the command line.

`-storepass` *password*

Specifies the password that verifies the integrity of the keystore (but does not encrypt the private key). If this option is omitted, *jarsigner* prompts you for the password.

`-storetype` *type*

Specifies the type of keystore specified by the `-keystore` option. The default is the system-default keystore type, which on most systems is the Java Keystore type, known as `JKS`. If you have the Java Cryptography Extension installed, you may want to use a `JCEKS` keystore instead.

`-verbose`

Displays extra information about the signing or verification process.

`-verify`

Specifies that *jarsigner* should verify the specified JAR file rather than sign it.

See also

jar, *keytool*, *javakey*

Team LiB

Synopsis

```
jar c|t|u|x[f][m][M][0][v] [jar-file] [manifest] [-C directory] [input-files]
jar i [jar-file]
```

Description

jar is a tool that can create and manipulate Java Archive (JAR) files. A JAR file is a ZIP file that contains Java class files, auxiliary resource files required by those classes, and optional meta-information. This meta-information includes a manifest file that lists the contents of the JAR archive and provides auxiliary information about each file.

The *jar* command can create JAR files, list the contents of JAR files, and extract files from a JAR archive. In Java 1.2 and later, it can also add files to an existing archive or update the manifest file o an archive. In Java 1.3 and later, *jar* can also add an index entry to a JAR file.

The syntax of the *jar* command is reminiscent of the Unix *tar* (tape archive) command. Most options to *jar* are specified as a block of concatenated letters passed as a single argument rather than as individual command-line arguments. The first letter of the first argument specifies what action *jar* is to perform; it is required. Other letters are optional. The various file arguments depend on which letters are specified.

As in *javac*, any command-line argument that begins with @ is taken to be the name of a file that contains options or filenames.

Command options

The first letter of the first option to *jar* specifies the basic operation *jar* is to perform. The available options are:

`c`

Creates a new JAR archive. A list of input files and/or directories must be specified as the final arguments to *jar*. The newly created JAR file has a *META-INF/MANIFEST.MF* file as its first entry. This automatically created manifest lists the contents of the JAR file and contains a message digest for each file.

`i`

Indexes the contents of this JAR file as well as the contents of all JAR files it refers to in the `Class-Path` manifest attribute. The resulting index is stored in the JAR file as *META-INF/INDEX.LIST* and can be used by a Java interpreter or applet viewer to optimize its class and resource lookup algorithm and avoid downloading unnecessary JAR files. This `i` option must be followed by the name of the JAR file to be indexed. No other options are allowed. Java 1.3 and later.

`t`

Lists the contents of a JAR archive.

`u`

Updates the contents of a JAR archive. Any files listed on the command line are added to the archive. When used with the `m` option, this adds the specified manifest information to the JAR file. Java 1.2 and later.

`x`

Extracts the contents of a JAR archive. The files and directories specified on the command line are extracted and created in the current working directory. If no file or directory names are specified, all the files and directories in the JAR file are extracted.

Modifier options

Each of the four command specifier letters can be followed by additional letters that provide further detail about the operation to be performed:

`f`

Indicates that *jar* is to operate on a JAR file whose name is specified on the command line. If this option is not present, *jar* reads a JAR file from standard input and/or writes a JAR file to standard output. If the `f` option is present, the command line must contain the name of the JAR file to operate on.

`m`

When *jar* creates or updates a JAR file, it automatically creates (or updates) a manifest file named *META-INF/MANIFEST.MF* in the JAR archive. This default manifest simply lists the contents of the JAR file. Many JAR files require additional information to be specified in the manifest; the `m` option tells the *jar* command that a manifest template is specified on the command line. *jar* reads this manifest file and stores all the information it contains into the *META-INF/MANIFEST.MF* file it creates. This `m` option should be used only with the `c` or `u` commands, not with the `t` or `x` commands.

`M`

Used with the `c` and `u` commands to tell *jar* not to create a default manifest file.

`v`

Tells *jar* to produce verbose output.

`0`

Used with the `c` and `u` commands to tell *jar* to store files in the JAR archive without compressing them. Note that this option is the digit zero, not the letter O.

Files

The first option to *jar* consists of an initial command letter and various option letters. This first option is followed by a list of files:

`jar-file`

If the first option contains the letter `f`, that option must be followed by the name of the JAR file to create or manipulate.

`manifest-file`

If the first option contains the letter `m`, that option must be followed by the name of the file that contains manifest information. If the first option contains both the letters `f` and `m`, the JAR and manifest files should be listed in the same order the `f` and `m` options appear. *jar* automatically creates a manifest for the JAR file it creates unless the `M` option is specified. The *`manifest-file`* specified with the `m` option should contain additional manifest entries to be placed in the manifest in addition to the automatically generated entries.

`files`

The list of one or more files and/or directories to be inserted into or extracted from the JAR archive.

Additional options

In addition to all the options listed previously, *jar* also supports the following:

`-C` *`dir`*

Used within the list of files to process; it tells *jar* to change to the specified *`dir`* while processing the subsequent files and directories. The subsequent file and directory names are interpreted relative to *`dir`* and are inserted into the JAR archive without *`dir`* as a prefix. Any number of `-C` options can be used; each remains in effect until the next is encountered. The directory specified by a `-C` option is interpreted relative to the current working directory, not the directory specified by the previous `-C` option. Java 1.2 and later.

`-J` *`javaopt`*

Passes the option *javaopt* to the Java interpreter.

Examples

The *jar* command has a confusing array of options, but, in most cases, its use is quite simple. To create a simple JAR file that contains all the class files in the current directory and all files in a subdirectory called *images*, you can type:

```
% jar cf my.jar *.class images
```

To verbosely list the contents of a JAR archive:

```
% jar tvf your.jar
```

To extract the manifest file from a JAR file for examination or editing:

```
% jar xf the.jar META-INF/MANIFEST.MF
```

To update the manifest of a JAR file:

```
% jar ufm my.jar manifest.template
```

See also

jarsigner

Team LiB

downloaded from: lib.ommolketab.ir

Synopsis

```
java [ interpreter-options ] classname [ program-arguments ]
java [ interpreter-options ] -jar jarfile [ program-arguments ]
```

Description

java is the Java byte-code interpreter; it runs Java programs. The program to be run is the class specified by `classname`. This must be a fully qualified name: it must include the package name of the class but not the *.class* file extension. For example:

```
% java david.games.Checkers
% java Test
```

The specified class must define a `main( )` method with exactly the following signature:

```
public static void main(String[] args)
```

This method serves as the program entry point: the interpreter begins execution here.

In Java 1.2 and later, a program can be packaged in an executable JAR file. To run a program packaged in this fashion, use the `-jar` option to specify the JAR file. The manifest of an executable JAR file must contain a `Main-Class` attribute that specifies which class within the JAR file contains the `main( )` method at which the interpreter is to begin execution.

Any command-line options that precede the name of the class or JAR file to execute are options to the Java interpreter itself. Any options that follow the class name or JAR filename are options to the program; they are ignored by the Java interpreter and passed as an array of strings to the `main()` method of the program.

The Java interpreter runs until the `main( )` method exits, and any threads (except for threads marked as daemon threads) created by the program have also exited.

Interpreter versions

The *java* program is the basic version of the Java interpreter. In addition to this program, however, there are several other versions of the Java interpreter. Each of these versions is similar to *java* but has a specialized function. This list includes all the interpreter versions, including those that are no longer in use.

java

This is the basic version of the Java interpreter; it is usually the correct one to use.

javaw

This version of the interpreter is included only on Windows platforms. Use *javaw* when you want to run a Java program (from a script, for example) without forcing a console window to appear.

Client or Server VM

Sun's "HotSpot" virtual machine comes in two versions: one is tuned for use with short-lived client applications and one is for use with long-running server code. As of Java 1.4, you can select the server version of the VM with the `-server` option. You can specify the client VM (which is the default) with the `-client` option. In Java 5.0, the interpreter automatically enters server mode if it detects that it is running on "server-class" hardware (typically a computer with multiple CPUs).

Legacy interpreter versions

oldjava

This version of the interpreter was included in Java 1.2 and Java 1.3 for compatibility with the Java 1.1 interpreter. It loaded classes using the Java 1.1 class-loading scheme. Very few Java applications needed to use this version of the interpreter, and it was removed in Java 1.4.

oldjavaw

In Java 1.2 and 1.3, this version of the interpreter, included only on Windows platforms, combined the features of *oldjava* and *javaw*.

java_g

In Java 1.0 and Java 1.1, *java_g* was a debugging version of the Java interpreter. It included a few specialized command-line options. Windows platforms also had a *javaw_g* program. *java_g* is not included in Java 1.2 or later versions.

Classic VM

In Java 1.3, you could use the -classic option to specify that you wanted to use the "Classic VM" (essentially the same as the Java 1.2 VM) instead of the HotSpot VM (which uses incremental compilation). This option was removed in Java 1.4.

Just-in-time compiler

In Java 1.2 and Java 1.3 when you specified the -classic option, the Java interpreter used a just-in-time compiler (if one were available for your platform). A JIT converts Java byte codes to native machine instructions at runtime and significantly speeds up the execution of a typical Java program. If you do not want to use the JIT, you can disable it by setting the JAVA_COMPILER environment variable to "NONE" or the java.compiler system property to "NONE" using the -D option:

```
% setenv JAVA_COMPILER NONE                        // Unix csh syntax
% java -Djava.compiler=NONE MyProgram
```

If you want to use a different JIT compiler implementation, set the environment variable or system property to the name of the desired implementation. This environment variable and property are no longer used as of Java 1.4, which uses the HotSpot VM, which includes efficient JIT technology.

Threading systems

On Solaris and related Unix platforms, you had a choice of the type of threads used by the Java 1.2 interpreter and the "Classic VM" of Java 1.3. To use native OS threads, you could specify -native. To use nonnative, or green, threads (the default), you could specify -green. In Java 1.3, the default "Client VM" used native threads. Specifying -green or -native in Java 1.3 implicitly specified -classic as well. These options are no longer supported (or necessary) as of Java 1.4.

Common options

The following options are the most commonly used.

-classpath *path*

Specifies the directories and JAR files *java* searches when trying to load a class. In Java 1.2 and later, this option specifies only the location of application classes. In Java 1.0 and 1.1, and with the *oldjava* interpreter, this option specified the location of system classes, extension classes, and application classes.

-cp

A synonym for `-classpath`. Java 1.2 and later.

`-D` *`propertyname= value`*

Defines *`propertyname`* to equal *`value`* in the system properties list. Your Java program can then look up the specified value by its property name. You can specify any number of `-D` options. For example:

```
% java -Dawt.button.color=gray -Dmy.class.pointsize=14 my.class
```

`-fullversion`

Prints the full Java version string, including build number, and exits. Compare with `-version`.

`-help`, `-?`

Prints a usage message and exits. See also `-X`.

`-jar` *`jarfile`*

Runs the specified executable *`jarfile`*. The manifest of the specified *`jarfile`* must contain a `Main-Class` attribute that identifies the class with the `main()` method at which program execution is to begin. Java 1.2 and later.

`-showversion`

Works like the `-version` option, except that the interpreter continues running after printing the version information. Java 1.3 and later.

`-version`

Prints the version of the Java interpreter and exits.

`-X`

Displays usage information for the nonstandard interpreter options (those beginning with `-X`) and exits. See also `-help`. Java 1.2 and later.

`-Xbootclasspath` :*`path`*

Specifies a search path consisting of directories, ZIP files, and JAR files the*java* interpreter should use to look up system classes. Use of this option is very rare. Java 1.2 and later.

`-Xbootclasspath/a` :*`path`*

Appends the specified *`path`* to the system classpath. Java 1.3 and later.

`-Xbootclasspath/p` :*`path`*

Prepends the specified *`path`* to the system boot classpath. Java 1.3 and later.

Assertion options

The following options specify whether and whereassertions are tested. These options were added in Java 1.4.

`-disableassertions[` :*`where`*`]`

Disables assertions. It is new in Java 1.4 and can be abbreviated`-da`. Used alone, it disables al assertions (except those in the system classes), which is the default. To disable assertions in a single class, follow the option with a colon and the fully qualified class name. To disable assertions in an entire package (and all of its subpackages), follow this option with a colon, the name of the package, and three dots. See also `-enableassertions` and `-disablesystemassertions`.

`-da[` :*`where`*`]`

Disables assertions. See `-disableassertions`.

`-disablesystemassertions`

Disables assertions in all system classes (which is the default). It can be abbreviated`-dsa` and takes no options.

`-dsa`

An abbreviation for `-disablesystemassertions`.

`-enableassertions[ :where]`

Enables assertions. This option can be abbreviated `-ea`. Used alone, it enables all assertions (except in system classes). To enable assertions in a single class, follow the option with a colon and the full class name. To enable assertions in an entire package (and its subpackages), follow the option with a colon, the package name, and three dots. See also `-disableassertions` and `-enablesystemassertions`.

`-ea[ :where]`

Enables assertions. An abbreviation for `-enableassertions`.

`-enablesystemassertions`

Enables assertions in all system classes. May be abbreviated `-esa`.

`-esa`

An abbreviation for `-enablesystemassertions`.

Performance tuning options

The following options select which version of the VM is to be run and fine-tune its memory allocation, garbage collection, and incremental compilation. Options beginning with `-X` are nonstandard and may change from release to release.

`-classic`

Runs the "Classic VM" instead of the default high-performance "Client VM." Java 1.3 only.

`-client`

Optimizes the incremental compilation of the HotSpot VM for typical client-side applications. This option typically defers some compilation to favor quicker application launch times. Java 1.4 and later. See also the `-server` option.

`-d32`

Runs in 32-bit mode. This option is valid in Java 1.4 and later but is currently implemented only for Solaris platforms.

`-d64`

Runs in 64-bit mode. This option is valid in Java 1.4 and later but is currently implemented only for Solaris platforms.

`-green`

Selects nonnative, or green, threads on operating systems such as Solaris and Linux that support multiple styles of threading. This is the default in Java 1.2. In Java 1.3, using this option also selects the `-classic` option. See also `-native`. Java 1.2 and 1.3 only.

`-native`

Selects native threads, instead of the default green threads, on operating systems such as Solaris that support multiple styles of threading. Using native threads can be advantageous in some circumstances, such as when running on a multi-CPU computer. In Java 1.3, the default HotSpot virtual machine uses native threads. Java 1.2 and 1.3 only.

`-server`

Optimizes the incremental compilation of the VM for server-class applications. In general, this option results in slower startup time but better subsequent performance. Java 1.4 and later. In Java 5.0 and later, many VMs automatically select this option if they are running on "server-class" hardware such as a dual-processor machine. See also `-client`.

`-Xbatch`

Tells the HotSpot VM to perform all just-in-time compilation in the foreground, regardless of the time required for compilation. Without this option, the VM compiles methods in the background while interpreting them in the foreground. Java 1.3 and later.

`-Xincgc`

Uses incremental garbage collection. In this mode, the garbage collector runs continuously in the background, and a running program is rarely, if ever, subject to noticeable pauses while garbage collection occurs. Using this option typically results in a 10% decrease in overall performance, however. Java 1.3 and later.

`-Xint`

Tells the HotSpot VM to operate in interpreted mode only, without performing any just-in-time compilation. Java 1.3 and later.

`-Xmixed`

Tells the HotSpot VM to perform just-in-time compilation on frequently used methods ("hotspots") and execute other methods in interpreted mode. This is the default behavior. Contrast with `-Xbatch` and `-Xint`. Java 1.3 and later.

`-Xms` *`initmem`*`[k|m]`

Specifies how much memory is allocated for the heap when the interpreter starts up. By default, *`initmem`* is specified in bytes. You can specify it in kilobytes by appending the letter `k` or in megabytes by appending the letter `m`. The default is 2 MB. For large or memory-intensive applications (such as the Java compiler), you can improve runtime performance by starting the interpreter with a larger amount of memory. You must specify an initial heap size of at least 1 MB. Java 1.2 and later. Prior to Java 1.2, use `-ms`.

`-Xmx` *`maxmem`*`[k|m]`

Specifies the maximum heap size the interpreter uses for dynamically allocated objects and arrays. *`maxmem`* is specified in bytes by default. You can specify *`maxmem`* in kilobytes by appending the letter `k` and in megabytes by appending the letter `m`. The default is 64 MB. You cannot specify a heap size less than 2 MB. Java 1.2 and later. Prior to Java 1.2, use `-mx`.

`-Xnoclassgc`

Does not garbage-collect classes. Java 1.2 and later. In Java 1.1, use `-noclassgc`.

`-Xss` *`size`*`[k|m]`

Sets the thread stack size in bytes, kilobytes, or megabytes. Java 1.3 and later.

Instrumentation options

The following options support debugging, profiling, and other VM instrumentation. Options beginning with `-X` are nonstandard and may change from release to release.

`-agentlib` :*`agent[=options]`*

New in Java 5.0, this option specifies a JVMTI agent, and options for it, to be started along with the interpeter. JVMTI is the Java Virtual Machine Tool Interface, and it is slated to supercede the JVMDI and JVMPI (debugging and profiling interfaces) in a future release. This means that the general `-agentlib` option will replace tool-specific options such as `-Xdebug` and `-Xrunhprof`. Examples:

```
% java -agentlib:hprof=help
% java -agentlib:jdwp=help
```

`-agentpath` :*`path-to-agent[=options]`*

Like `-agentlib`, but with an explicitly specified path to the agent library. Java 5.0 and later.

`-debug`

Causes *java* to start up in a way that allows the *jdb* debugger to attach itself to the interpreter session. In Java 1.2 and later, this option has been replaced with `-Xdebug`.

`-javaagent` :*`jarfile[=options]`*

Load a Java-language instrumentation agent when the interpreter starts. The specified *jarfile* must have a manifest that includes an `Agent-Class` attribute. This attribute must name a class that includes the agent's `premain()` method. Any *`options`* will be passed to this `premain( )` method along with a `java.lang.instrument.Instrumentation` object. See `java.lang.instrument` for further detail.

`-verbose`, `-verbose:class`

Prints a message each time *java* loads a class. In Java 1.2 and later, you can use `-verbose:class` as a synonym.

`-verbose:gc`

Prints a message when garbage collection occurs. Java 1.2 and later. Prior to Java 1.2, use `-verbosegc`.

`-verbose:jni`

Prints a message when native methods are called. Java 1.2 and later.

`-Xcheck:jni`

Performs additional validity checks when using Java Native Interface functions. Java 1.2 and later.

`-Xdebug`

Starts the interpreter in a way that allows a debugger to communicate with it. Java 1.2 and later. Prior to Java 1.2, use `-debug`. Deprecated in Java 5.0 in favor of the `-agentlib` option.

`-Xfuture`

Strictly checks the format of all class files loaded. Without this option, *java* performs the same checks that were performed in Java 1.1. Java 1.2 and later.

`-Xloggc` :*`filename`*

Logs garbage collection events with timestamps to the named file.

`-Xprof`

Prints profiling output to standard output. Java 1.3 and later. In Java 1.2, or when using the `-classic` option, use `-Xrunhprof`. Prior to Java 1.2, use `-prof`.

`-Xrunhprof` :*`suboptions`*

Turns on CPU, heap, or monitor profiling. *`suboptions`* is a comma-separated list of `name=value` pairs. Use `-Xrunhprof:help` for a list of supported options and values. Java 1.2 and later. Deprecated in Java 5.0 in favor of the `-agentlib` option.

Advanced options

The Java interpreter also supports quite a few advanced configuration options that begin with `-XX`. These options are release and platform-dependent, and Sun's documentation describes them as "not recommended for casual use." If you want to fine-tune the threading, memory allocation, garbage collection, signal-handling, or just-in-time compilation performance of a production application, however, you may be interested in them. See http://java.sun.com/docs/hotspot/.

Loading classes

The Java interpreter knows where to find the system classes that comprise the Java platform. In Java 1.2 and later, it also knows where to find the class files for all extensions installed in the system extensions directory. However, the interpreter must be told where to find the nonsystem classes that comprise the application to be run.

Class files are stored in a directory that corresponds to their package name. For example, the class `com.davidflanagan.utils.Util` is stored in a file *com/davidflanagan/utils/Util.class*. By default, the interpreter uses the current working directory as the root and looks for all classes in and beneath this directory.

The interpreter can also search for classes within ZIP and JAR files. To tell the interpreter where to look for classes, you specify a *classpath*: a list of directories and ZIP and JAR archives. When looking for a class, the interpreter searches each of the specified locations in the order in which they are specified.

The easiest way to specify a classpath is to set the `CLASSPATH` environment variable, which works much like the `PATH` variable used by a Unix shell or a Windows command-interpreter path. To specify a classpath in Unix, you might type a command like this:

```
% setenv CLASSPATH .:~/myclasses:/usr/lib/javautils.jar:/usr/lib/javaapps
```

On a Windows system, you might use a command like the following:

```
C:\> set CLASSPATH=.;c:\myclasses;c:\javatools\classes.zip;d:\javaapps
```

Note that Unix and Windows use different characters to separate directory and path components.

You can also specify a classpath with the `-classpath` or `-cp` options to the Java interpreter. A path specified with one of these options overrides any path specified by the `CLASSPATH` environment variable. In Java 1.2 and later, the `-classpath` option specifies only the search path for application and user classes. Prior to Java 1.2, or when using the *oldjava* interpreter, this option specified the search path for all classes, including system classes and extension classes.

See also

javac, *jdb*

Synopsis

```
javac [ options ] files
```

Description

javac is the Java compiler; it compiles Java source code (in *.java* files) into Java byte codes (in *.class* files). The Java compiler is itself written in Java.

javac can be passed any number of Java source files, whose names must all end with the *.java* extension. *javac* produces a separate *.class* class file for each class defined in the source files. Each source file can contain any number of classes, although only one can be a `public` top-level class. The name of the source file (minus the *.java* extension) must match the name of the `public` class it contains.

In Java 1.2 and later, if a filename specified on the command line begins with the character `@`, that file is taken not as a Java source file but as a list of compiler options and Java source files. Thus, if you keep a list of Java source files for a particular project in a file named *project.list*, you can compile all those files at once with the command:

```
% javac @project.list
```

To compile a source file, *javac* must be able to find definitions of all classes used in the source file. It looks for definitions in both source-file and class-file form, automatically compiling any source files that have no corresponding class files or that have been modified since they were most recently compiled.

Common options

The most commonly used compilation options include the following:

`-classpath` *path*

Specifies the path *javac* uses to look up classes referenced in the specified source code. This option overrides any path specified by the `CLASSPATH` environment variable. The *path* specified is an ordered list of directories, ZIP files, and JAR archives, separated by colons on Unix systems or semicolons on Windows systems. If the `-sourcepath` option is not set, this option also specifies the search path for source files.

`-d` *`directory`*

Specifies the directory in which (or beneath which) class files should be stored. By default, *javac* stores the *.class* files it generates in the same directory as the *.java* files those classes were defined in. If the `-d` option is specified, however, the specified *`directory`* is treated as the root of the class hierarchy, and *.class* files are placed in this directory or the appropriate subdirectory below it, depending on the package name of the class. Thus, the following command:

```
% javac -d /java/classes Checkers.java
```

places the file *Checkers.class* in the directory */java/classes* if the *Checkers.java* file has no `package` statement. On the other hand, if the source file specifies that it is in a package:

```
package com.davidflanagan.games;
```

the *.class* file is stored in */java/classes/com/davidflanagan/games*. When the `-d` option is specified, *javac* automatically creates any directories it needs to store its class files in the appropriate place.

`-encoding` *`encoding-name`*

Specifies the name of the character encoding used by the source files if it differs from the default platform encoding.

`-g`

Tells *javac* to add line number, source file, and local variable information to the output class files, for use by debuggers. By default, *javac* generates only the line numbers.

`-g:none`

Tells *javac* to include no debugging information in the output class files. Java 1.2 and later.

`-g` :*`keyword-list`*

Tells *javac* to output the types of debugging information specified by the comma-separated *`keyword-list`*. The valid keywords are: `source`, which specifies source-file information; `lines`, which specifies line number information; and `vars`, which specifies local variable debugging information. Java 1.2 and later.

`-help`

Prints a list of options. See also `-X`.

`-J` *`javaoption`*

Passes the argument *`javaoption`* directly through to the Java interpreter. For example: `-J-Xmx32m`. *`javaoption`* should not contain spaces; if multiple arguments must be passed to the interpreter, use multiple `-J` options. Java 1.1 and later.

`-source` *`release-number`*

Specifies the version of Java the code is written in. Legal values of *release-number* are 5, 1.5, 1.4, and 1.3. The options 5 and 1.5 are synonyms and are the default: the compiler accepts all Java 5.0 language features. Use `-source 1.4` to have the compiler ignore Java 5.0 language features such as the `enum` keyword. Use `-source 1.3` to have the compiler ignore the `assert` keyword that was introduced in Java 1.4. This option is available in Java 1.4 and later.

`-sourcepath` *`path`*

Specifies the list of directories, ZIP files, and JAR archives that *javac* searches when looking for source files. The files found in this source path are compiled if no corresponding class files are found or if the source files are newer than the class files. By default, source files are searched for in the same places class files are searched for. Java 1.2 and later.

`-verbose`

Tells the compiler to display messages about what it is doing. In particular, it causes *javac* to list all the source files it compiles, including files that did not appear on the command line.

`-X`

Tells the *javac* compiler to display usage information for its nonstandard options (all of which begin with `-X`). Java 1.2 and later.

Warning options

The following options control the generation of warning messages by *javac* :

`-deprecation`

Tells *javac* to issue a warning for every use of a deprecated API. By default, *javac* issues only a single warning for each source file that uses deprecated APIs. Java 1.1 and later. In Java 5.0, this is a synonym for `-Xlint:deprecation`.

`-nowarn`

Tells *javac* not to print warning messages. Errors are still reported as usual.

`-Xlint`

Enables all recommended warnings about program "lint." At the time of this writing, all the warnings detailed below are recommended.

`-Xlint` :*`warnings`*

Enables or disables a comma-separated list of named warning types. At the time of this writing the available warning types are the following. A named warning can be suppressed by preceding it with a minus sign:

`all`

Enables all lint warnings.

`deprecation`

Warns about the use of deprecated APIs. See also `-deprecation`.

`fallthrough`

Warns when a `case` in a `switch` statement "falls through" to the next case. See also `-Xswitchcheck`.

`finally`

Warns when a `finally` clause cannot complete normally.

`path`

Warns if any path directories specified elsewhere on the command line are nonexistent.

`serial`

Warns about `Serializable` classes that do not have a `serialVersionUID` field.

`unchecked`

Provides detailed warnings about each unchecked use of a generic type.

`-Xmaxerrors` *`num`*

Don't print more than *`num`* errors.

`-Xmaxwarns` *`num`*

Don't print more than *`num`* warnings.

`-Xstdout` *`filename`*

Tells *javac* to send warning and error messages to the specified file instead of writing them to the console. Java 1.4 and later.

`-Xswitchcheck`

Warns about `case` clauses in `switch` statements that "fall through." In Java 5.0, use `-Xlint:fallthrough`.

Cross-compilation options

The following options are useful when using *javac* to compile class files intended to run under a different version of Java:

`-bootclasspath` *`path`*

Specifies the search path *javac* uses to look up system classes. This option does not specify the system classes used to run the compiler itself, only the system classes read by the compiler. Java 1.2 and later.

`-endorseddirs` *path*

Overrides the directories to search for endorsed standards JAR files.

`-extdirs` *path*

Specifies a list of directories to search for standard extension JAR files. Java 1.2 and later.

`-target` *version*

Specifies the class file format version to use for the generated class files. *version* may be 1.1, 1.2, 1.3, 1.4, 1.5, or 5. The options 1.5 and 5 are synonyms and are the default in Java 5.0, unless `-source 1.4` is specified, in which case `-target 1.4` is the default. Use of this flag sets the class file version number so that the resulting class file cannot be run by VMs from previous releases.

`-Xbootclasspath` :*path*

An alternative to `-bootclasspath`

`-Xbootclasspath/a` :*path*

Appends the specified *path* to the bootclasspath. Java 1.3 and later.

`-Xbootclasspath/p` :*path*

Prefixes the bootclasspath with the specified *path*.

Environment

`CLASSPATH`

Specifies an ordered list (colon-separated on Unix, semicolon-separated on Windows systems) of directories, ZIP files, and JAR archives in which *javac* should look for user class files and source files. This variable is overridden by the `-classpath` option.

See also

java, *jdb*

javadoc — *The Java Documentation Generator*

Synopsis

`javadoc [ options ] @list package... sourcefiles...`

Description

javadoc generates API documentation for any number of packages and classes you specify. The *javadoc* command line can list any number of package names and any number of Java source files. For convenience, when working with a large number of command-line options, or a large number of package or class names, you can place them all in an auxiliary file and specify the name of that file on the command line, preceded by an `@` character.

javadoc uses the *javac* compiler to process all the specified Java source files and all the Java source files in all the specified packages. It uses the information it gleans from this processing to generate detailed API documentation. Most importantly, the generated documentation includes the contents of all documentation comments included in the source files. See Chapter 7 for information about writing doc comments in your own Java code.

When you specify a Java source file for *javadoc* to process, you must specify the name of the file that contains the source, including a complete path to the file. It is more common, however, to use *javadoc* to create documentation for entire packages of classes. When you specify a package for *javadoc* to process, you specify the package name, not the directory that contains the source code for the package. In this case, you may need to specify the `-sourcepath` option so that *javadoc* can find your package source code correctly if it is not stored in a location already listed in your default classpath.

javadoc creates HTML documentation by default, but you can customize its behavior by defining a doclet class that generates documentation in whatever format you desire. You can write your own doclets using the doclet API defined by the `com.sun.javadoc` package. Documentation for this package is included in the standard documentation bundle for Java 1.2 and later.

javadoc gained significant new functionality in Java 1.2. Here we document Java 1.2 and later versions of the program and do not distinguish these features from those in previous versions.

Options

javadoc defines a large number of options. Some are standard options that are always recognized by *javadoc*. Other options are defined by the doclet that produces the documentation. The options for the standard HTML doclet are included in the following list:

-1.1

Simulates the output style and directory structure of the Java 1.1 version of *javadoc*. This option existed in Java 1.2 and 1.3 and was removed in Java 1.4.

-author

Includes authorship information specified with @author in the generated documentation. Default doclet only.

-bootclasspath

Specifies the location of an alternate set of system classes. This can be useful when cross-compiling. See *javac* for more information on this option.

-bottom *text*

Displays *text* at the bottom of each generated HTML file. *text* can contain HTML tags. See also -footer. Default doclet only.

-breakiterator

Uses the java.text.BreakIterator algorithm for determining the end of the summary sentence in doc comments. Default doclet only.

-charset *encoding*

Specifies the character encoding for the output. This depends on the encoding used in the documentation comments of your source code, of course. The *encoding* value is used in a <meta> tag in the HTML output. Default doclet only.

-classpath *path*

Specifies a path *javadoc* uses to look up both class files and, if you do not specify the -sourcepath option, source files. Because *javadoc* uses the *javac* compiler, it needs to be able to locate class files for all classes referenced by the packages being documented. See *java* and *javac* for more information about this option and the default value provided by the CLASSPATH environment variable.

`-d` *`directory`*

Specifies the directory in and beneath which *javadoc* should store the HTML files it generates. If this option is omitted, the current directory is used. Default doclet only.

`-docencoding` *`encoding`*

Specifies the encoding to be used for output HTML documents. The name of the encoding specified here may not exactly match the name of the charset specified with the `-charset` option. Default doclet only.

`-docfilessubdirs`

Recursively copies any subdirectories of a *doc-files* directory instead of simply copying the files contained directly within *doc-files*. Default doclet only.

`-doclet` *`classname`*

Specifies the name of the doclet class to use to generate the documentation. If this option is not specified, *javadoc* generates documentation using the default HTML doclet.

`-docletpath` *`classpath`*

Specifies a path from which the class specified by the `-doclet` tag can be loaded if it is not available from the default classpath.

`-doctitle` *`text`*

Provides a title to display at the top of the documentation overview file. This file is often the first thing readers see when they browse the generated documentation. The title can contain HTML tags. Default doclet only.

`-encoding` *`encoding-name`*

Specifies the character encoding of the input source files and the documentation comments they contain. This can be different from the desired output encoding specified by `-docencoding`. The default is the platform default encoding.

`-exclude` *`packages`*

Excludes the named packages from the set of packages defined by a `-subpackages` option. *`packages`* is a colon-separated list of package names. Default doclet only.

`-excludedocfilessubdir` *`dirs`*

Excludes specified subdirectories of a *doc-files* directory when `-docfilessubdirs` is specified. This is useful for excluding version control directories, for example. *`dirs`* is a colon-separated list of directory names relative to the *doc-files* directory. Default doclet only.

`-extdirs` *`dirlist`*

Specifies a list of directories to search for standard extensions. Only necessary when cross-compiling with `-bootclasspath`. See *javac* for details.

`-footer` *`text`*

Specifies text to be displayed near the bottom of each file to the right of the navigation bar. *`text`* can contain HTML tags. See also `-bottom` and `-header`. Default doclet only.

`-group` *`title packagelist`*

javadoc generates a top-level overview page that lists all packages in the generated document. By default, these packages are listed in alphabetical order in a single table. You can break them into groups of related packages with this option, however. The *`title`* specifies the title of the package group, such as "Core Packages." The *`packagelist`* is a colon-separated list of package names, each of which can include a trailing `*` character as a wildcard. The *javadoc* command line can contain any number of `-group` options. For example:

```
% javadoc -group "AWT Packages" java.awt* \
-group "Swing Packages" javax.accessibility:javax.swing*
```

`-header` *`text`*

Specifies text to be displayed near the top of file, to the right of the upper navigation bar. *`text`* can contain HTML tags. See also `-footer`, `-doctitle`, and `-windowtitle`. Default doclet only.

`-help`

Displays a usage message for *javadoc*.

`-helpfile` *`file`*

Specifies the name of an HTML file that contains help for using the generated documentation. *javadoc* includes links to this help file in all files it generates. If this option is not specified, *javadoc* creates a default help file. Default doclet only.

`-J` *`javaoption`*

Passes the argument *javaoption* directly through to the Java interpreter. When processing a large number of packages, you may need to use this option to increase the amount of memory *javadoc* is allowed to use. For example:

```
% javadoc -J-Xmx64m
```

Note that because `-J` options are passed directly to the Java interpreter before *javadoc* starts up, they cannot be included in an external file specified on the command line with the `@list` syntax.

`-keywords`

Tells *javadoc* to include type and member names in `<Meta>` tag keyword lists. Default doclet only.

`-link` *`url`*

Specifies an absolute or relative URL of the top-level directory of another *javadoc*-generated document. *javadoc* uses this URL as the base URL for links from the current document to packages, classes, methods, and fields that are not documented in the current document. For example, when using *javadoc* to produce documentation for your own packages, you can use this option to link your documentation to the *javadoc* documentation for the core Java APIs. Default doclet only.

The directory specified by *`url`* must contain a file named *package-list*, and *javadoc* must be able to read this file at runtime. This file is automatically generated by a previous run of *javadoc*; it contains a list of all packages documented at the *`url`*.

More than one `-link` option can be specified, although this does not work properly in early releases of Java 1.2. If no `-link` option is specified, references in the generated documentation to classes and members that are external to the documentation are not hyperlinked.

`-linkoffline` *`url packagelist`*

Similar to the `-link` option, except that the *`packagelist`* file is explicitly specified on the command line. This is useful when the directory specified by *`url`* does not have a *package-list* file or when that file is not available when *javadoc* is run. Default doclet only.

`-linksource`

Creates an HTML version of each source file read and includes links to it from the documentation pages. Default doclet only.

`-locale` *`language_country_variant`*

Specifies the locale to use for generated documentation. This is used to look up a resource file that contains localized messages and text for the output files.

`-nocomment`

Ignores all doc comments and generates documentation that includes only raw API information without any accompanying prose. Default doclet only.

`-nodeprecated`

Tells *javadoc* to omit documentation for deprecated features. This option implies `-nodeprecatedlist`. Default doclet only.

`-nodeprecatedlist`

Tells *javadoc* not to generate the *deprecated-list.html* file and not to output a link to it on the navigation bar. Default doclet only.

`-nohelp`

Tells *javadoc* not to generate a help file or a link to it in the navigation bar. Default doclet only.

`-noindex`

Tells *javadoc* not to generate index files. Default doclet only.

`-nonavbar`

Tells *javadoc* to omit the navigation bars from the top and bottom of every file. Also omits the text specified by `-header` and `-footer`. This is useful when generating documentation to be printed. Default doclet only.

`-noqualifier` *`packages`* `| all`

javadoc omits package names in its generated documentation for classes in the same package being documented. This option tells it to additionally omit package names for classes in the specified packages, or, if the `all` keyword is used, in all packages. *`packages`* is a colon-separated list of package names, which may include the `*` wildcard to indicate subpackages. For example, `-noqualifier java.io:java.nio.*` would exclude package names for all classes in the `java.io` package and in `java.nio` and its subpackages. Default doclet only.

`-nosince`

Ignores `@since` tags in doc comments. Default doclet only.

`-notimestamp`

Don't output timestamps in HTML comments. Default doclet only.

`-notree`

Tells *javadoc* not to generate the *tree.html* class hierarchy diagram or a link to it in the navigation bar. Default doclet only.

`-overview` *`filename`*

Reads an overview doc comment from *`filename`* and uses that comment in the overview page. This file does not contain Java source code, so the doc comment should not actually appear between `/**` and `*/` delimiters.

`-package`

Includes package-visible classes and members in the output, as well as `public` and `protected` classes and members.

`-private`

Includes all classes and members, including `private` and package-visible classes and members, in the generated documentation.

`-protected`

Includes `public` and `protected` classes and members in the generated output. This is the default.

`-public`

Includes only `public` classes and members in the generated output. Omits `protected`, `private`, and package-visible classes and members.

`-quiet`

Suppresses output except warnings and error messages.

`-serialwarn`

Issues warnings about serializable classes that do not adequately document their serialization format with `@serial` and related doc-comment tags. Default doclet only.

`-source` *`release`*

Specifies the *`release`* of Java for which the source files were written. See the `-source` option of *javac*. Legal values are 5, 1.5, 1.4, and 1.3. The options 1.5 and 5 are synonyms and are the default.

`-sourcepath` *`path`*

Specifies a search path for source files, typically set to a single root directory. *javadoc* uses this path when looking for the Java source files that implement a specified package.

`-splitindex`

Generates multiple index files, one for each letter of the alphabet. Use this option when documenting large amounts of code. Otherwise, the single index file generated by *javadoc* will be too large to be useful. Default doclet only.

`-stylesheetfile` *`file`*

Specifies a file to use as a CSS stylesheet for the generated HTML. *javadoc* inserts appropriate links to this file in the generated documentation. Default doclet only.

`-subpackages` *`packages`*

Specifies that *javadoc* should process the specified packages and all of their subpackages. *`packages`* is a colon-separated list of package names or package name prefixes. Using this option is often easier than explicitly listing all desired package names. For example:

```
-subpackages java:javax
```

See also `-exclude`. Default doclet only.

`-tag` *`tagname`*:*`where`*:*`header-text`*

Specifies that *javadoc* should handle a doc-comment tag named *tagname* by outputting the text *`header-text`* followed by whatever text follows the tag. This enables the use of simple custom tags (with the same syntax as `@return` and `@author`) in doc comments. *`where`* is a string of characters that specifies the types of doc comments in which this custom tag is allowed. The characters and their meanings are `a` (all: valid everywhere), `p` (packages), `t` (types: classes and interfaces), `c` (constructors), `m` (methods), and `f` (fields).

A secondary purpose of the `-tag` option is to specify the order in which tags are processed and in which their output appears. You can include the names of standard tags after the `-tag` option to specify this ordering. Custom tags and taglets can be included within this list of standard `-tag` options. Default doclet only.

`-taglet` *`classname`*

Specifies the classname of a "taglet" class to process a custom tag. Writing taglets is not covered here. `-taglet` tags may be interspersed with `-tag` tags to specify the order in which tags should be processed and output. Default doclet only.

`-tagletpath` *`classpath`*

Specifies a colon-separated list of JAR files or directories that form the classpath to be searche
for taglet classes. Default doclet only.

`-use`

Generates and inserts links to an additional file for each class and package that lists the uses o
the class or package.

`-verbose`

Displays additional messages while processing source files.

`-version`

Includes information from `@version` tags in the generated output. This option does *not* tell *javadoc* to print its own version number. Default doclet only.

`-windowtitle` *`text`*

Specifies *`text`* to be output in the `<Title>` tag of each generated file. This title typically appears as the title of the web browser window and in history and bookmark lists. *`text`* should not contain HTML tags. See also `-doctitle` and `-header`. Default doclet only.

Environment

`CLASSPATH`

This environment variable specifies the default classpath *javadoc* uses to find the class files and source files. It is overridden by the `-classpath` and `-sourcepath` options. See *java* and *javac* for further discussion of the classpath.

See also

java, *javac*

javah — *Native Method C Stub Generator*

Synopsis

`javah [ options ] classnames`

Description

javah generates C header and source files (*.h* and *.c* files) that are used when implementing Java native methods in C. The preferred native method interface changed between Java 1.0 and Java 1.1. In Java 1.1 and earlier, *javah* generated files for old-style native methods. In Java 1.1, the `-jni` option specified that *javah* should generate new-style files. In Java 1.2 and later, this option is the default.

This section describes only how to use *javah*. A full description of how to implement Java native methods in C is beyond the scope of this book.

Options

`-bootclasspath`

Specifies the path to search for system classes. See *javac* for further discussion. Java 1.2 and later.

`-classpath` *`path`*

Specifies the path *javah* uses to look up the classes named on the command line. This option overrides any path specified by the `CLASSPATH` environment variable. Prior to Java 1.2, this option can specify the location of the system classes and extensions. In Java 1.2 and later, it specifies only the location of application classes. See `-bootclasspath`. See also *java* for further discussion of the classpath.

`-d` *`directory`*

Specifies the directory into which *javah* stores the files it generates. By default, it stores them in the current directory. This option cannot be used with `-o`.

`-force`

Causes *javah* to always write output files, even if they contain no useful content.

`-help`

Causes *javah* to display a simple usage message and exit.

`-J` *`javaopt`*

Passes the option *javaopt* to the Java interpreter.

`-jni`

Specifies that *javah* should output header files for use with the Java Native Interface (JNI) rather than the old JDK 1.0 native interface. This option is the default in Java 1.2 and later. See also `-old`. Java 1.1 and later.

`-o` *`outputfile`*

Combines all output into a single file, *`outputfile`*, instead of creating separate files for each specified class.

`-old`

Outputs files for Java 1.0-style native methods. Prior to Java 1.2, this was the default. See also `-jni`. Java 1.2 and later.

`-stubs`

Generates *.c* stub files for the class or classes instead of header files. This option is only for the Java 1.0 native methods interface. See `-old`.

`-trace`

Specifies that *javah* should include tracing output commands in the stub files it generates. In Java 1.2 and later, this option is obsolete and has been removed. In its place, you can use the `-verbose:jni` option of the Java interpreter.

`-v`, `-verbose`

Specifies verbose mode. Causes *javah* to print messages about what it is doing. In Java 1.2 and later, `-verbose` is a synonym.

`-version`

Causes *javah* to display its version number.

Environment

`CLASSPATH`

Specifies the default classpath *javah* searches to find the specified classes. See *java* for a further discussion of the classpath.

See also

java, *javac*

Synopsis

`javap [ options ] classnames`

Description

javap reads the class files specified by the class names on the command line and prints a human-readable version of the API defined by those classes. *javap* can also disassemble the specified classes, displaying the Java VM byte codes for the methods they contain.

Options

`-b`

Enables backward compatibility with the output of the Java 1.1 version of *javap*. This option exists for programs that depend on the precise output format of *javap*. Java 1.2 and later.

`-bootclasspath` *path*

Specifies the search path for the system classes. See *javac* for information about this rarely used option. Java 1.2 and later.

`-c`

Displays the code (i.e., Java VM byte codes) for each method of each specified class. This option always disassembles all methods, regardless of their visibility level.

`-classpath` *path*

Specifies the path *javap* uses to look up the classes named on the command line. This option overrides the path specified by the `CLASSPATH` environment variable. Prior to Java 1.2, this argument specifies the path for all system classes, extensions, and application classes. In Java 1.2 and later, it specifies only the application classpath. See also `-bootclasspath` and `-`

exTDirs. See *java* and *javac* for more information on the classpath.

-extdirs *dirs*

Specifies one or more directories that should be searched for extension classes. See *javac* for information about this rarely used option. Java 1.2 and later.

-J *javaopt*

Pass the option *javaopt* to the Java interpreter.

-l

Displays tables of line numbers and local variables, if available in the class files. This option is typically useful only when used with -c. The *javac* compiler does not include local variable information in its class files by default. See -g and related options to *javac*.

-help

Prints a usage message and exits.

-J *javaoption*

Passes the specified *javaoption* directly to the Java interpreter.

-package

Displays package-visible, protected, and public class members, but not private members. This is the default.

-private

Displays all class members, including private members.

-protected

Displays only protected and public members.

`-public`

Displays only `public` members of the specified classes.

`-s`

Outputs the class member declarations using the internal VM type and method signature format instead of the more readable source-code format.

`-verbose`

Specifies verbose mode. Outputs additional information (in the form of Java comments) about each member of each specified class.

Environment

`CLASSPATH`

Specifies the default search path for application classes. The`-classpath` option overrides this environment variable. See *java* for a discussion of the classpath.

See also

java, *javac*

javaws — *Java Web Start launcher*

Synopsis

```
javaws
javaws [ options ] url
```

Description

javaws is the command-line interface to the Java Web Start network application launcher. When started without a `url`, *javaws* displays a graphical cache viewer which allows cached applications to be launched and Java Web Start to be configured.

If the URL of a JNLP (Java Network Launching Protocol) is specified on the command line, *javaws* launches the specified application.

Options

`-association`

Allows the creation of file associations during a `-silent -import`.

`-codebase` *`url`*

Overrides the codebase in the JNLP file with the specified *`url`*.

`-import`

Imports the specified application to the user cache but does not run it.

`-offline`

Runs in offline mode.

`-online`

Starts in online mode. This is the default behavior.

`-shortcut`

Allows desktop shortcuts to be created during a `-silent -import`.

`-silent`

When used with `-import`, this option prevents a GUI window from appearing.

`-system`

Uses the system cache.

`-uninstall`

Removes the application identified by *`url`* from the user's cache and exits.

`-updateVersions`

Updates the *javaws* configuration file (such as after upgrading to a newer version of Java).

`-userConfig` *`name`* [*`value`*]

Sets the deployment property *`name`* or, if *`value`* is specified, sets it to the specified value.

`-viewer`

Launches the cache viewer application. This is the default behavior if *javaws* is invoked with no arguments.

`-wait`

Does not exit until the launched application exits.

`-Xclearcache`

Clears the user's cache and exits.

`-Xnosplash`

Does not display the Java Web Start splash screen.

Team LiB

Synopsis

```
jconsole [ options ]
jconsole [ options ] pid
jconsole [ options ] host:port
```

Description

jconsole is a graphical interface to the memory, thread, class loading, and other monitoring tools provided by the `java.lang.management` package. It can monitor one or more local or remote Java processes. Processes can be monitored only if started with special system properties set. To allow a Java VM to be monitored locally, start it with:

```
% jconsole -Dcom.sun.management.jmxremote=true
```

To allow a Java VM to be monitored remotely, start it with:

```
% jconsole -Dcom.sun.management.jmxremote.port= port
```

where `port` is the remote port to which *jconsole* will connect.

You may start *jconsole* with no local or remote process specified and use its Connection menu to establish connections. This is the only way to connect *jconsole* to more than one Java process.

To connect *jconsole* to a local process when it starts up, simply list the process id on the command line. See *jps* to determine process ids.

To connect *jconsole* to a remote process when it starts up, specify the hostname and port number on the command line. The port should be the same as that specified by the `com.sun.management.jmxremote.port` system property of the target process.

Options

`-help`

Display a usage message.

`-interval=` *n*

Set the update interval to *n* seconds. The default is 4.

`-version`

Display the *jconsole* version and exit.

See also

jps, *jstat*

Synopsis

```
jdb [ options ] class [ program options ]
jdb connect options
```

Description

jdb is a debugger for Java classes. It is text-based, command-line-oriented, and has a command syntax like that of the Unix *dbx* or *gdb* debuggers used with C and C++ programs.

jdb is written in Java, so it runs within a Java interpreter. When *jdb* is invoked with the name of a Java class, it starts another copy of the *java* interpreter, using any interpreter options specified on the command line. The new interpreter is started with special options that enable it to communicate with *jdb*. The new interpreter loads the specified class file and then stops and waits for debugging commands before executing the first byte code.

jdb can also debug a program that is already running in another Java interpreter. Doing so requires that special options be passed to both the *java* interpreter and to *jdb*. See the `-attach` option below.

jdb expression syntax

jdb debugging commands such as `print`, `dump`, and `suspend` allow you to refer to classes, objects, methods, fields, and threads in the program being debugged. You can refer to classes by name, with or without their package names. You can also refer to `static` class members by name. You can refer to individual objects by object ID, which is an eight-digit hexadecimal integer. Or, when the classes you are debugging contain local variable information, you can often use local variable names to refer to objects. You can use normal Java syntax to refer to the fields of an object and the elements of an array; you can also use this syntax to write quite complex expressions. As of Java 1.3, *jdb* even supports method invocation using standard Java syntax.

Options

When invoking *jdb* with a specified class file, any of the *java* interpreter options can be specified. See the *java* reference page for an explanation of these options. In addition, *jdb* supports the following options:

`-attach` [*host*:]*port*

Specifies that *jdb* should connect to the Java VM that is already running on the specified host (or the local host, if unspecified) and listening for debugging connections on the specified port. Java 1.3 and later.

In order to use *jdb* to connect to a running VM in this way, the VM must have been started with special command-line options. In Java 1.3 and 1.4, use these options:

```
% java -Xdebug -Xrunjdwp:transport=dt_socket,address=8000,server=y,suspend=n
```

In Java 5.0, use these options instead:

```
% java -agentlib:jdwp=transport=dt_socket,address=8000,server=y,suspend=n
```

The Java debugging architecture allows a complex set of interpreter-to-debugger connection options, and *java* and *jdb* provide a complex set of options and suboptions to enable it. A detailed description of those options is beyond the scope of this book.

`-connect` *`connector`*`:`*`args`*

This option provides the most general and flexible method for connecting *jdb* to the process to be debugged. Specify the name of a *`connector`* (a Java class) followed by a colon and a comma-separated list of arguments in name=value form. Java 1.4 and later. See `-listconnectors` for available connectors and their arguments.

`-help`

Displays a usage message listing supported options.

`-launch`

Starts the specified application when *jdb* starts. This avoids the need to explicitly use the `run` command to start it. Java 1.3 and later.

`-listconnectors`

List available connection methods. Each connector is a Java class and a list of arguments. Java 5.0 and later. See the `-connect` option.

`-listen` *`port`*

Listens on the specified *`port`* for a Java VM to connect to the debugger. To make this work, the VM must be with options like these:

```
% java -agentlib:jdwp=transport=dt_socket,address=8000,server=n,suspend=y
```

Java 1.4 and later.

`-listenany`

Like the `-listen` option but *jdb* picks a port to listen on and prints out the port number for use when launching the Java process to debug. Java 1.4 and later.

`-sourcepath` *path*

Specifies the locations *jdb* searches when attempting to find source files that correspond to the class files being debugged. If unspecified, *jdb* uses the classpath by default. Java 1.3 and later.

`-tclient`

Tells *jdb* to invoke the client version of the Java interpreter.

`-tserver`

Tells *jdb* to invoke the server version of the Java interpreter.

`-version`

Displays the *jdb* version number and exits.

Commands

jdb understands the following debugging commands. Use the `help` command for more.

`?` or `help`

Lists all supported commands, with a short explanation of each.

`!!`

A shorthand command that is replaced with the text of the last command entered. It can be followed with additional text to append to that command.

`catch` [*`exception-class`*]

Causes a breakpoint whenever the specified exception is thrown. If no exception is specified, the command lists the exceptions currently being caught. Use `ignore` to stop these breakpoints from occurring.

`classes`

Lists all classes that have been loaded.

`clear`

Lists all currently set breakpoints.

`clear` *`class`*.*`method`* [(*`param-type...`*)]

Clears the breakpoint set in the specified method of the specified class.

`clear` [*`class`*:*`line`*]

Removes the breakpoint set at the specified line of the specified class.

`cont`

Resumes execution. This command should be used when the current thread is stopped at a breakpoint.

`down` [*n*]

Moves down *n* frames in the call stack of the current thread. If *n* is not specified, moves down one frame.

`dump` *`id...`*

Prints the value of all fields of the specified object or objects. If you specify the name of a class, `dump` displays all class (static) methods and variables of the class and also displays the superclass and list of implemented interfaces. Objects and classes can be specified by name or by their eight-digit hexadecimal ID numbers. Threads can also be specified with the shorthand `t@`*`thread-number`*.

`exit` or `quit`

Quits *jdb*.

`gc`

Runs the garbage collector to force unused objects to be reclaimed.

`ignore` *`exception-class`*

Does not treat the specified exception as a breakpoint. This command turns off a `catch` command. This command does not cause the Java interpreter to ignore exceptions; it merely tells *jdb* to ignore them.

`list` [*`line-number`*]

Lists the specified line of source code as well as several lines that appear before and after it. If no line number is specified, uses the line number of the current stack frame of the current thread. The lines listed are from the source file of the current stack frame of the current thread. Use the `use` command to tell *jdb* where to find source files.

`list` *`method`*

Displays the source code of the specified method.

`load` *`classname`*

Loads the specified class into *jdb*.

`locals`

Displays a list of local variables for the current stack frame. Java code must be compiled with the `-g` option in order to contain local variable information.

`methods` *`class`*

Lists all methods of the specified class. Use `dump` to list the instance variables of an object or the class (static) variables of a class.

`print` *`id...`*

Prints the value of the specified item or items. Each item can be a class, object, field, or local variable, and can be specified by name or by eight-digit hexadecimal ID number. You can also refer to threads with the special syntax `t@`*`thread-number`*. The `print` command displays an object's value by invoking its `toString()` method.

`next`

Executes the current line of source code, including any method calls it makes. See also `step`.

`resume` [*`thread-id...`*]

Resumes execution of the specified thread or threads. If no threads are specified, all suspended threads are resumed. See also `suspend`.

`run` [*`class`*] [*`args`*]

Runs the `main()` method of the specified class, passing the specified arguments to it. If no class or arguments are specified, uses the class and arguments specified on the *jdb* command line.

`step`

Runs the current line of the current thread and stops again. If the line invokes a method, steps into that method and stops. See also `next`.

`stepi`

Executes a single Java VM instruction.

`step up`

Runs until the current method returns to its caller and stops again.

`stop`

Lists current breakpoints.

`stop at` *`class`*:*`line`*

Sets a breakpoint at the specified line of the specified class. Program execution stops when it reaches this line. Use `clear` to remove a breakpoint.

`stop in` *`class`*.*`method`* [`(` *`param-type...`*`)`]

Sets a breakpoint at the beginning of the specified method of the specified class. Program execution stops when it enters the method. Use `clear` to remove a breakpoint.

`suspend` [*`thread-id...`*]

Suspends the specified thread or threads. If no threads are specified, suspends all running threads. Use `resume` to restart them.

`thread` *`thread-id`*

Sets the current thread to the specified thread number. This thread is used implicitly by a number of other *jdb* commands.

`threadgroup` *`name`*

Sets the current thread group.

`threadgroups`

Lists all thread groups running in the Java interpreter session being debugged.

`threads` [*`threadgroup`*]

Lists all threads in the named thread group. If no thread group is specified, lists all threads in the current thread group (specified by `threadgroup`).

`up` [*`n`*]

Moves up *`n`* frames in the call stack of the current thread. If `n` is not specified, moves up one frame.

`use` [*`source-file-path`*]

Sets the path used by *jdb* to look up source files for the classes being debugged. If no path is specified, displays the current source path.

`where` [*`thread-id`*] [`all`]

Displays a stack trace for the specified thread. If no thread is specified, displays a stack trace for the current thread. If `all` is specified, displays a stack trace for all threads.

`wherei` [*`thread-id`* x]

Displays a stack trace for the specified or current thread, including detailed program counter information.

Environment

`CLASSPATH`

Specifies an ordered list (colon-separated on Unix, semicolon-separated on Windows systems) of directories, ZIP files, and JAR archives in which *jdb* should look for class definitions. When a path is specified with this environment variable, *jdb* always implicitly appends the location of the system classes to the end of the path. If this environment variable is not specified, the default path is the current directory and the system classes. This variable is overridden by the `-classpath` option.

See also

java

Team LiB

jinfo — *Display configuration of a Java process*

Synopsis

```
jinfo [ options ] pid                          // info on local process
jinfo [ options ] executable core            // info from core file
jinfo [ options ] [process-name@]hostname   // info from remote process
```

Description

jinfo prints the system properties and JVM command-line options for a running Java process or core file. *jinfo* can be started in one of three ways:

- Specify the process id of a Java process running locally to obtain configuration information about it. See *jps* to list local processes.
- To obtain post-mortem configuration information from a core file, specify the java executable that produced the core file and the core file itself on the command line.
- To obtain configuration information about a Java process running remotely, specify the name of the remote host, optionally prefixed by a remote process name.*jsadebugd* must be running on the remote host.

In Java 5.0, *jinfo* is experimental, unsupported, and not available on all platforms.

Options

These options are mutually exclusive; only one may be specified.

`-flags`

Prints only JVM flags, not system properties.

`-help, -h`

Prints a help message.

`-sysprops`

Prints only system properties, not JVM flags.

See also

jps, *jsadebugd*

jmap *Display memory usage*

Synopsis

```
jmap [ options ] pid                         // local process
jmap [ options ] executable core             // core file
jmap [ options ] [process-name@]hostname     // remote process
```

Description

jmap prints memory usage information for a local or remote Java process or a Java core file. Depending on the option it is invoked with, *jmap* displays one of four memory usage reports. See the Options section for details. *jmap* can be started in three ways:

- Specify the process id of a Java process running locally to obtain configuration information about it. See *jps* to list local processes.
- To obtain post-mortem configuration information from a core file, specify the java executable that produced the core file and the core file itself on the command line.
- To obtain configuration information about a Java process running remotely, specify the name of the remote host, optionally prefixed by a remote process name and @ sign. *jsadebugd* must be running on the remote host.

In Java 5.0, *jmap* is experimental, unsupported, and not available on all platforms.

Options

When invoked with no options, *jmap* prints a memory map of the shared objects or libraries loaded by the VM. Other reports can be produced by using the options below. These options are mutually exclusive; only one may be specified.

`-heap`

Displays a summary of heap memory usage.

`-help, -h`

Prints a help message.

`-histo`

Displays a histogram of heap usage by class.

`-permstat`

Displays memory used by loaded classes, grouped by class loader.

See also

jps, *jsadebugd*

Team LiB

jps — *List Java processes*

Synopsis

`jps [ options ] [ hostname[:port ] ]`

Description

jps lists the Java processes running on the local host or on the specified remote host. If a remote host is specified, it must be running the *jstatd* daemon. For each Java process, it displays a process id and names the class or JAR file that the process is executing. Process ids are used by a number of other Java tools, such as *jconsole*, *jstat*, and *jmap*.

Options

The options below alter the default *jps* display. The single-letter options, except for `-q`, may be combined into a single command-line argument, such as `-lmv`:

`-help`

Displays a usage message.

`-l`

Lists the full package name of the main class or the full path of the JAR file running in each Java process.

`-m`

Lists the arguments passed to `main( )` method of each Java process.

`-q`

Lists only Java process identifiers, without application name or any additional information.

`-v`

Lists arguments passed to the Java interpreter for each Java process.

`-V`

Lists arguments passed to the interpreter through a flags file such as *.hotspotrc*.

See also

jstatd

Team LiB

Team LiB

jsadebugd — *Daemon process for remote debugging*

Synopsis

```
jsadebugd pid [ process-name ]              // running process
jsadebugd executable core [ process-name ]  // core file
```

Description

jsadebugd is a server process that allows remote invocations of *jinfo*, *jmap*, and *jstack* on a local Java process or core file. Invoke *jsadebugd* by specifying either the process id of a running Java process or an executable file and core file pair on the command line. If more than one *jsadebugd* server will run on the same host at the same time, follow these arguments with an identifying process name that remote clients can use to identify the desired process.

jsadebugd starts the *rmiregistry* server.

In Java 5.0, *jsadebugd* is experimental, unsupported, and not available on all platforms.

See also

jinfo, *jmap*, *jstack*

jstack — *Display stack traces for a Java process*

Synopsis

```
jstack [ options ] pid                          // local process
jstack [ options ] executable core              // core file
jstack [ options ] [process-name@]hostname    // remote process
```

Description

jstack prints stack traces for each of the Java threads running in the specified Java process.*jstack* can be started in three ways:

- Specify the process id of a Java process running locally to obtain configuration information about it. See *jps* to list local processes.
- To obtain post-mortem configuration information from a core file, specify the Java executable that produced the core file and the core file itself on the command line.
- To obtain configuration information about a Java process running remotely, specify the name of the remote host, optionally prefixed by a remote process name and @ sign.*jsadebugd* must be running on the remote host.

In Java 5.0, *jstack* is experimental, unsupported, and not available on all platforms.

Options

`-help, -h`

Prints a help message.

`-m`

Displays stack traces in "mixed mode," that is, displays both Java and native method stack frames. Without this option, the default is to display Java stack frames only.

See also

jps, *jsadebugd*

jstat — *Java VM statistics*

Synopsis

```
jstat [ options ] pid [ interval[s|ms] [ count ]]
jstat [ options ] pid@hostname[:port] [ interval[s|ms] [ count ]]
```

Description

jstat probes a running JVM once or repeatedly and displays statistics about its class loading, just-in-time compilation, memory, or garbage collection performance. The type of information to be displayed is specified by *options*. A local process to be probed is specified by its process id, as returned, for example, by *jps*. A remote Java process may be probed by specifying the remote process id, the remote host name, and the port number on which the remote host's *rmiregistry* server is running (if other than the default of 1099). The remote host must also be running the *jstatd* server.

By default, *jstat* probes the specified Java VM once. You may also specify a probe interval, in milliseconds or seconds, to have it probe repeatedly. If you do this, you may additionally specify a total number of probes it should conduct.

jconsole can report many of the same statistics that *jstat* does but displays them in graphical rather than tabular form. In Java 5.0, *jinfo* is experimental, unsupported, and not available on all platforms.

Options

`-help`

Displays a help message.

`-options`

Displays a list of report types that *jstat* can display. You must use one of the listed options each time you run *jstat*.

`-version`

Displays the *jstat* version information and exits.

`-h` *n*

When *jstat* probes the Java process repeatedly, this option specifies how often it should repeat the table headers in its output. This option must follow one of the report type options below.

`-t`

Adds a Timestamp column to the report generated by *jstat*. The column displays elapsed time (in seconds) since the target Java process was started.

The following options specify the type of statistics to be reported by *jstat*. Unless you run *jstat* with `-help`, `-options` or `-version`, you must specify exactly one of these options, and it must be the first option on the command line. Most of the options produce detailed reports of garbage collection minutiae. Consult Sun's tool documentation (part of the JDK documentation bundle) for the interpretation of these reports.

`-class`

Reports the number of classes loaded and their size in kilobytes.

`-compiler`

Reports the amount of just-in-time compilation that has been performed, and how long it has taken.

`-gc`

Reports heap garbage collection statistics.

`-gccapacity`

Reports capacity information of the garbage collector's various memory pools.

`-gccause`

Like the `-gcutil` report but includes information about the cause of the most recent garbage collection.

`-gcnew`

Reports information on the "new generation" memory pools of the garbage collector.

`-gcnewcapacity`

Reports capacity information for the garbage collector's "new generation" memory pools.

`-gcold`

Reports information on the old generation and permanent memory pools of the garbage collector.

`-gcoldcapacity`

Reports capacity information for the garbage collector's old generation memory pools.

`-gcpermcapacity`

Reports capacity information for the garbage collector's permanent generation.

`-gcutil`

Reports garbage collection summaries.

`-printcompilation`

Reports additional information about just-in-time compilation, including the method names of compiled methods.

See also

jconsole, *jps*, *jstatd*

Team LiB

jstatd — *jstat daemon*

Synopsis

`jstatd` *`options`*

Description

jstatd is a server that provides information about local Java processes to the *jps* and *jstat* programs running on remote hosts.

jstatd uses RMI and requires special security permissions to run successfully. To start *jstatd*, create the following file and name it *jstatd.policy*:

```
grant codebase "file:${java.home}../lib/tools.jar {
    permission java.security.AllPermission
}
```

This policy grants all permissions to any class loaded from the JDK's *tools.jar* JAR file. To launch *jstatd* with this policy, use this command line:

```
% jstatd -J-Djava.security.policy=jstat.policy
```

If an existing *rmiregistry* server is running, *jstatd* uses it. Otherwise, it creates its own RMI registry.

Options

`-n` *`rminame`*

Binds the *jstatd* remote object to the name *rminame* in the RMI registry. The default name is "JStatRemoteHost", which is what *jps* and *jstat* look for. Use of this option requires *`rminame`* to be used in remote *jps* and *jstat* invocations.

`-nr`

Tells `jstatd` that not to start an internal RMI registry if none are already running.

`-p` *`port`*

Looks for an existing RMI registry on *`port`*, or starts one on that port if no existing registry is found.

See also

jps, *jstat*

Team LiB

keytool *Key and Certificate Management Tool*

Synopsis

`keytool command options`

Description

keytool manages and manipulates a *keystore*, a repository for public and private keys and public key certificates. *keytool* defines various commands for generating keys, importing data into the keystore, and exporting and displaying keystore data. Keys and certificates are stored in a keystore using a case-insensitive name or *alias*. *keytool* uses this alias to refer to a key or certificate.

The first option to *keytool* always specifies the basic command to be performed. Subsequent options provide details about how the command is to be performed. Only the command must be specified. If a command requires an option that does not have a default value, *keytool* prompts you interactively for the value.

Commands

`-certreq`

Generates a certificate signing request in PKCS#10 format for the specified alias. The request is written to the specified file or to the standard output stream. The request should be sent to a certificate authority (CA), which authenticates the requestor and sends back a signed certificate authenticating the requestor's public key. This signed certificate can then be imported into the keystore with the `-import` command. This command uses the following options: `-alias`, `-file`, `-keypass`, `-keystore`, `-sigalg`, `-storepass`, `-storetype`, and `-v`.

`-delete`

Deletes a specified alias from a specified keystore. This command uses the following options: `-alias`, `-keystore`, `-storepass`, `-storetype`, and `-v`.

`-export`

Writes the certificate associated with the specified alias to the specified file or to standard output. This command uses the following options: `-alias`, `-file`, `-keystore`, `-rfc`, `-storepass`, `-storetype`, and `-v`.

`-genkey`

Generates a public/private key pair and a self-signed X.509 certificate for the public key. Self-signed certificates are not often useful by themselves, so this command is often followed by `-certreq`. This command uses the following options: `-alias`, `-dname`, `-keyalg`, `-keypass`, `-keysize`, `-keystore`, `-sigalg`, `-storepass`, `-storetype`, `-v`, and `-validity`.

`-help`

Lists all available *keytool* commands and their options. This command is not used with any other options.

`-identitydb`

Reads keys and certificates from a legacy identity database managed with the deprecated *javakey* program and stores them into a keystore so that they can be manipulated by *keytool*. The identity database is read from the specified file or from standard input if no file is specified The keys and certificates are written into the specified keystore file, which is automatically created if it does not exist yet. This command uses the following options: `-file`, `-keystore`, `-storepass`, `-storetype`, and `-v`.

`-import`

Reads a certificate or PKCS#7-formatted certificate chain from a specified file or from standard input and stores it as a trusted certificate in the keystore with the specified alias. This command uses the following options: `-alias`, `-file`, `-keypass`, `-keystore`, `-noprompt`, `-storepass`, `-storetype`, `-TRustcacerts`, and `-v`.

`-keyclone`

Duplicates the keystore entry of a specified alias and stores it in the keystore under a new alias. This command uses the following options: `-alias`, `-dest`, `-keypass`, `-keystore`, `-new`, `-storepass`, `-storetype`, and `-v`.

`-keypasswd`

Changes the password that encrypts the private key associated with a specified alias. This command uses the following options: `-alias`, `-keypass`, `-new`, `-storetype`, and `-v`.

`-list`

Displays (on standard output) the fingerprint of the certificate associated with the specified alias. With the `-v` option, prints certificate details in human-readable format. With `-rfc`, prints certificate contents in a machine-readable, printable-encoding format. This command uses the following options: `-alias`, `-keystore`, `-rfc`, `-storepass`, `-storetype`, and `-v`.

`-printcert`

Displays the contents of a certificate read from the specified file or from standard input. Unlike most *keytool* commands, this one does not use a keystore. This command uses the following options: `-file` and `-v`.

`-selfcert`

Creates a self-signed certificate for the public key associated with the specified alias and uses i to replace any certificate or certificate chain already associated with that alias. This command uses the following options: `-alias`, `-dname`, `-keypass`, `-keystore`, `-sigalg`, `-storepass`, `-storetype`, `-v`, and `-validity`.

`-storepasswd`

Changes the password that protects the integrity of the keystore as a whole. The new password must be at least six characters long. This command uses the following options: `-keystore`, `-new`, `-storepass`, `-storetype`, and `-v`.

Options

The various *keytool* commands can be passed various options from the following list. Many of these options have reasonable default values. *keytool* interactively prompts for any unspecified options that do not have defaults:

`-alias` *`name`*

Specifies the alias to be manipulated in the keystore. The default is "mykey".

`-dest` *`newalias`*

Specifies the new alias name (the destination alias) for the `-keyclone` command. If not specified, *keytool* prompts for a value.

`-dname` *`X.500-distinguished-name`*

Specifies the X.500 distinguished name to appear on the certificate generated by `-selfcert` or `-genkey`. A distinguished name is a highly qualified name intended to be globally unique. For example:

```
CN=David Flanagan, OU=Editorial, O=OReilly, L=Cambridge, S=Massachusetts, C=US
```

The `-genkey` command of *keytool* prompts for a distinguished name if none is specified. The `-selfcert` command uses the distinguished name of the current certificate if no replacement name is specified.

`-file` *`file`*

Specifies the input or output file for many of the *keytool* commands. If left unspecified, *keytool* reads from the standard input or writes to the standard output.

`-keyalg` *`algorithm-name`*

Used with `-genkey` to specify what type of cryptographic keys to generate. In the default Java implementation shipped from Sun, the only supported algorithm is "DSA"; this is the default if this option is omitted.

`-keypass` *`password`*

Specifies the password that encrypts a private key in the keystore. If this option is unspecified, *keytool* first tries the `-storepass` password. If that does not work, it prompts for the appropriate password.

`-keysize` *`size`*

Used with the `-genkey` command to specify the length in bits of the generated keys. If unspecified, the default is 1024.

`-keystore` *`filename`*

Specifies the location of the keystore file. If unspecified, a file named *.keystore* in the user's home directory is used.

`-new` *`new-password-or-alias`*

Used with the `-keyclone` command to specify the new alias name and with `-keypasswd` and `-storepasswd` to specify the new password. If unspecified, *keytool* prompts for the value of this option.

`-noprompt`

Used with the `-import` command to disable interactive prompting of the user when a chain of trust cannot be established for an imported certificate. If this option is not specified, the `-import` command prompts the user.

`-rfc`

Used with the `-list` and `-export` commands to specify that certificate output should be in the printable encoding format specified by RFC 1421. If this option is not specified, `-export` outputs the certificate in binary format, and `-list` lists only the certificate fingerprint. This option cannot be combined with `-v` in the `-list` command.

`-sigalg` *`algorithm-name`*

Specifies a digital signature algorithm that signs a certificate. If omitted, the default for this option depends on the type of underlying public key. If it is a DSA key, the default algorithm is "SHA1withDSA". If the key is an RSA key, the default signature algorithm is "MD5withRSA".

`-storepass` *`password`*

Specifies a password that protects the integrity of the entire keystore file. This password also serves as a default password for any private keys that do not have their own `-keypass` specified. If `-storepass` is not specified, *keytool* prompts for it. The password must be at least six characters long.

`-storetype` *`type`*

Specifies the type of the keystore to be used. If this option is not specified, the default is taken from the system security properties file. Often, the default is "JKS"Sun's Java Keystore type.

`-trustcacerts`

Used with the `-import` command to specify that the self-signed certificate authority certificates contained in the keystore in the *jre/lib/security/cacerts* file should be considered trusted. If this option is omitted, *keytool* ignores that file.

`-v`

Specifies verbose mode, if present, and makes many *keytool* commands produce additional output.

`-validity` *`time`*

Used with the `-genkey` and `-selfcert` commands to specify the period of validity (in days) of the generated certificate. If unspecified, the default is 90 days.

See also

jarsigner, *policytool*

Team LiB

native2ascii — *Convert text to ASCII with Unicode escapes*

Synopsis

`native2ascii [ options ] [ inputfile [ outputfile ]]`

Description

native2ascii is a simple program that reads a text file (usually of Java source code) encoded using a local encoding and converts it to a Latin-1-plus-ASCII-encoded-Unicode form allowed by the Java Language Specification. This is helpful when you must edit a file of Java code but do not have an editor that can handle the encoding of the file.

The *`inputfile`* and *`outputfile`* are optional. If unspecified, standard input and standard output are used, making *native2ascii* suitable for use in pipes.

Options

`-encoding` *`encoding-name`*

Specifies the encoding used by source files. If this option is not specified, the encoding is taken from the `file.encoding` system property.

`-reverse`

Specifies that the conversion should be done in reversefrom encoded`\u`*`xxxx`* characters to characters in the native encoding.

See also

`java.io.InputStreamReader`, `java.io.OutputStreamWriter`

pack200 — *Compress a JAR file*

Synopsis

`pack200 [options] outputfile jarfile`

Description

pack200 tightly compresses a JAR file using the compression algorithm defined by JSR 200 and the standard gzip compression algorithm. Notice that the output file is specified on the command line before the input JAR file.

Basic options

All *pack200* options exist in both a long form that begins with a double dash and a single-letter form that begins with a single dash. When the option requires a value, the value should be separated from the long form of the option with an equals sign and no space or should immediately follow the short form with no intervening space or punctuation.

`--config-file=` *`file`*, `-f` *`file`*

> Reads options from the specified configuration file. *`file`* should be a `java.util.Properties` file in `name=value` format. Supported property names are the same as the long-form option names listed here, with with hyphens converted to periods.

`--effort=` *`value`*, `-E` *`value`*

> Specifies how hard to try to pack the JAR file. *`value`* must be a digit between 0 and 9. 0 means no compression at all and simply produces a copy of the input JAR file. The default is 5.

`--help`, `-h`

> Displays a help message and exits.

`--log-file=` *`file`*, `-l` *`file`*

Log output to *`file`*.

`--no-gzip`, `-g`

Tells *pack200* not to apply gzip compression to the packed JAR file. Use this option if you want to apply a different compression filter, such as *bzip2*. The default is `--gzip`.

`--no-keep-file-order`, `-o`

Allows *pack200* to reorder the elements of the JAR file. `--keep-file-order` is the default.

`--quiet`, `-q`

Suppresses output messages.

`--pass-file=` *`file`*, `-P` *`file`*

Passes the specified *`file`* without compression. If *`file`* ends with a `/`, all files in the directory are passed through without packing. This option may be specified multiple times.

`--repack`, `-r`

Packs the specified JAR file, and then immediately unpacks it. In this case, the *`outputfile`* specified on the command line should be the name of a JAR file. It is important to do a pack/unpack cycle on a JAR file before signing it with *jarsigner* because the pack/unpack cycle reorders some internal elements of a class file and invalidates any digital signatures or checksums in the JAR file manifest.

`--strip-debug`, `-G`

Permanently strips debugging attributes from the Java class files instead of compressing them. This makes it harder to debug the resulting JAR file.

`--verbose`, `-v`

Displays more output messages.

`--version`, `-V`

Displays version number and exits.

Advanced packing options

The following options provide fine control over the compression performed by *pack200*.

`--deflate-hint=` *value*, `-H` *value*

Specifies whether *pack200* should preserve the deflation status of each entry in the input JAR file. The default *value* is `keep`, which preserves the status. A *value* of `TRue` places a hint in the packed archive that the unpacker should deflate all entries after unpacking them. A *value* of `true` places a hint in the packed archive that the unpacker should store each entry in the JAR file without deflation. Using a value of `TRue` or `false` reduces the packed file size slightly because deflation hints do not need to be stored for each entry.

`--modification-time=` *value*, `-m` *value*

With the default *value* of `keep`, *pack200* transmits the modification time of each entry in the JAR file. If you specify `latest` instead, only the most recent modification time is transmitted, and is applied to all entries when they are unpacked.

`--segment-limit=` *n*, `-S` *n*

Sets a target segment size of *n*. Pack200 files may be divided into separately packed segments in order to reduce the amount of memory required by the unpacker. This option sets the approximate size of each segment. The default value is one million bytes. The value `-1` produces a single large segment, and the value 0 produces a single segment for each class file Larger segment sizes result in better compression ratios, but require additional memory to unpack.

`--unknown-attribute=` *action*, `-U` *action*

Specifies how *pack200* should handle unknown class file attributes. The default *action* is `pass`, which specifies that the entire class file will be transmitted with no compression. An *action* of `error` specifies that *pack200* should produce an error message. An *action* of `strip` says that the attribute should be stripped from the class file.

`--class-attribute=` *name*=*action*, `-C` *name*=*action*,

`--code-attribute=` *name*=*action*, `-D` *name*=*action*,

`--field-attribute=` *`name`*`=`*`action`*, `-F` *`name`*`=`*`action`*,

`--method-attribute=` *`name`*`=`*`action`*, `-M` *`name`*`=`*`action`*,

These four options specify how *pack200* should handle specific named class, field, method, and code attributes in a class file. The name of the attribute is specified by *`name`*. The *`action`* may be any of the `pass`, `strip`, and `error` values supported by the `--unknown-attribute` option. The *`action`* may also be a "layout string" that specifies how the attribute should be packed. See the Pack200 specification for details on the layout language. These options may be repeated to specify handling for more than one attribute.

See also

unpack200

policytool — *Policy File Creation and Management Tool*

Synopsis

`policytool`

Description

policytool displays a Swing user interface that makes it easy to edit security policy configuration files. The Java security architecture is based on policy files, which specify sets of permissions to be granted to code from various sources. By default, the Java security policy is defined by a system policy file stored in the *jre/lib/security/java.policy* file and a user policy file stored in the *.java.policy* file in the user's home directory. System administrators and users can edit these files with a text editor, but the syntax of the file is somewhat complex, so it is usually easier to use *policytool* to define and edit security policies.

Selecting the policy file to edit

When *policytool* starts up, it opens the *.java.policy* file in the user's home directory by default. Use the New, Open, and Save commands in the File menu to create a new policy file, open an existing file, and save an edited file, respectively.

Editing the policy file

The main *policytool* window displays a list of the entries contained in the policy file. Each entry specifies a code source and the permissions that are to be granted to code from that source. The window also contains buttons that allow you to add a new entry, edit an existing entry, or delete an entry from the policy file. If you add or edit an entry, *policytool* opens a new window that displays the details of that policy entry.

With the addition of the JAAS API to the core Java platform in Java 1.4, *policytool* allows the specification of a `Principal` to whom a set of permissions is granted.

Every policy file has an associated keystore from which it obtains the certificates it needs when verifying the digital signatures of Java code. You can usually rely on the default keystore, but if you need to specify the keystore explicitly for a policy file, use the Change Keystore command in the Edit menu of the main *policytool* window.

Adding or editing a policy entry

The policy entry editor window displays the code source for the policy entry and a list of permissions associated with that code source. It also contains buttons that allow you to add a new permission, delete a permission, or edit an existing permission.

When defining a new policy entry, the first step is to specify the code source. A code source is defined by a URL from which the code is downloaded and/or a list of digital signatures that must appear on the code. Specify one or both of these values by typing in a URL and/or a comma-separated list of aliases. These aliases identify trusted certificates in the keystore associated with the policy file.

After you have defined the code source for a policy entry, you must define the permissions to be granted to code from that source. Use the Add Permission and Edit Permission buttons to add and edit permissions. These buttons bring up yet another *policytool* window.

Defining a permission

To define a permission in the permission editor window, first select the desired permission type from the Permission pulldown menu, then select an appropriate target value from the Target Name menu. The choices in this menu are customized depending on the permission type you selected. Some types of permissions, such as `FilePermission`, do not have a fixed set of possible targets, and you usually have to type in the target you want. For example, you might type "/tmp" to specify the directory */tmp*, "/tmp/*" to specify all the files in that directory, or "/tmp/-" to specify all the files in the directory, and, recursively, any subdirectories. See the documentation of the individual `Permission` classes for a description of the targets they support.

Depending on the type of permission you select, you may also have to select one or more action values from the Actions menu. When you have selected a permission and appropriate target and action values, click the Okay button to dismiss the window.

See also

jarsigner, *keytool*

serialver *Class Version Number Generator*

Synopsis

```
serialver [ -classpath path ] classnames...
serialver [ -classpath path ] -show
```

Description

serialver displays the version number of a class or classes. This version number is used for the purposes of serialization: the version number must change each time the serialization format of the class changes.

If the specified class declares a `long serialVersionUID` constant, the value of that field is displayed. Otherwise, a unique version number is computed by applying theSecure Hash Algorithm (SHA) to the API defined by the class. This program is primarily useful for computing an initial unique version number for a class, which is then declared as a constant in the class. The output of*serialver* is a line of legal Java code, suitable for pasting into a class definition.

Options

`-classpath` *`path`*

Specifies the search path for classes.

`-show`

When the `-show` option is specified, *serialver* displays a simple graphical interface that allows the user to type in a single class name at a time and obtain its serialization UID. When using`-show`, no class names can be specified on the command line.

Environment

`CLASSPATH`

serialver is written in Java, so it is sensitive to the `CLASSPATH` environment variable in the same way the *java* interpreter is. The specified classes are looked up relative to this classpath.

See also

`java.io.ObjectStreamClass`

unpack200 — Unpack a JAR file

Synopsis

`unpack200 [options] packedfile jarfile`

Description

unpack200 unpacks a JAR file that has been compressed, or *packed*, by the *pack200* tool, and optionally additionally compressed with *gzip*. Specify the name of the packed file and the name of the JAR file to unpack it to on the command line.

Because *unpack200* is used as part of the Java installation process, it is a native application that can run on a system without a Java interpreter.

Options

All `unpack200` options exist in both a long form that begins with a double dash and a single-letter form that begins with a single dash. When the option requires a value, the value should be separated from the long form of the option with an equals sign and no space or should immediately follow the short form with no intervening space or punctuation.

`--deflate-hint=` *`value`* `-H` *`value`*

Specifies whether *unpack200* should compress individual entries in the resulting JAR file. *`value`* must be `true`, `false`, or `keep`. The default is `keep`, which specifies that each JAR entry should have the same compression that it had in the original JAR file.

`--help`, `-h`

Displays a help message and exits.

`--log-file=` *`file`*, `-l` *`file`*

Logs output to *`file`*.

`--quiet`, `-q`

Suppresses output messages.

`--remove-pack-file`, `-r`

Deletes the packed file after unpacking it.

`--verbose`, `-v`

Displays more output messages.

`--version`, `-V`

Displays version number and exits.

See also

jar, *pack200*

Part II: API Quick Reference

Part II provides quick-reference material for the essential APIs of the Java platform. Please read the following section, *How to Use This Quick Reference*, to learn how to get the most out of this material.

How to Use This Quick Reference

The quick-reference section that follows packs a lot of information into a small space. This introduction explains how to get the most out of that information. It describes how the quick reference is organized and how to read the individual quick-reference entries.

Finding a Quick-Reference Entry

The quick reference is organized into chapters, each of which documents a single package of the Java platform or a group of related packages. Packages are listed alphabetically within and between chapters, so you never really need to know which chapter documents which package: you can simply search alphabetically, as you might do in a dictionary. The documentation for each package begins with a quick-reference entry for the package itself. This entry includes a short overview of the package and a listing of the classes and interfaces included in the package. In this listing of package contents, package members are first grouped by general category (interfaces, eumerated types, classes and exceptions, for example). Within each category, they are grouped by class hierarchy, with indentation to indicate the level of the hierarchy. Finally, classes and interfaces at the same hierarchy level are listed alphabetically.

Each package overview is followed by individual quick-reference entries, in alphabetical order, for the types defined in the package. The overall organization of the quick-reference is therefore alphabetical by the fully-qualified name of the type. To look up a quick-reference entry for a particular type, you must also know the name of the package that defines that type. Use the dictionary-style headers on the upper corner of each page to help you quickly find the package and class you need.

Usually, the package name of a type is obvious from its context, and you should have no trouble looking up the quick-reference entry you want. Occasionally, you may need to look up a type for which you do not already know the package. In this case, refer to the Chapter 23. This index allows you to look up a class by class name and find out what package it is part of.

Reading a Quick-Reference Entry

The quick-reference entries for classes and interfaces contain quite a bit of information. The sections that follow describe the structure of a quick-reference entry, explaining what information is available, where it is found, and what it means. While reading the descriptions that follow, you may find it helpful to flip through the reference section itself to find examples o the features being described.

Class Name, Package Name, Availability, and Flags

Each quick-reference entry begins with a four-part title that specifies the name, package name, and availability of the class, and may also specify various additional flags that describe the class. The class name appears in bold at the upper left of the title. The package name appears, in smaller print, in the lower left, below the class name.

The upper-right portion of the title indicates the availability of the class; it specifies the earliest release that contained the class. If a class was introduced in Java 1.1, for example, this portion of the title reads "Java 1.1". The availability section of the title is also used to indicate whether a class has been deprecated, and, if so, in what release. For example, it might read "Java 1.1; Deprecated in Java 1.2".

In the lower-right corner of the title you may find a list of flags that describe the class. Java 5.0 annotations and meta-annotations are listed here, as are the following flags:

annotation

The type is an annotation type.

appendable

The class implements `java.lang.Appendable`.

checked

The class is a checked exception, meaning that it extends `java.lang.Exception`, but not `java.lang.RuntimeException`. In other words, it must be declared in the `throws` clause of any method that may throw it.

cloneable

The class, or a superclass, implements `java.lang.Cloneable`.

closeable

The class implements `java.io.Closeable`.

collection

The class, or a superclass, implements `java.util.Collection` or `java.util.Map`.

comparable

The class, or a superclass, implements `java.lang.Comparable`.

enum

The type is an enumerated type.

error

The class extends `java.lang.Error`.

flushable

The class implements `java.io.Flushable`.

readable

The class implements `java.lang.Readable`.

runnable

The class, or a superclass, implements `java.lang.Runnable`.

serializable

The class, or a superclass, implements `java.io.Serializable`.

unchecked

The class is an unchecked exception, meaning that it extends `java.lang.RuntimeException` and therefore does not need to be declared in the `throws` clause of a method that may throw it.

Description

The title of each quick-reference entry is followed by a short description of the most important features of the class or interface. This description is typically about two paragraphs long.

Hierarchy

If a class or interface has a nontrivial class hierarchy, the "Description" section is followed by a figure that illustrates the hierarchy and helps you understand the class in the context of that hierarchy. The name of each class or interface in the diagram appears in a box; classes and enumerated types appear in rectangles (except for abstract classes, which appear in skewed rectangles or parallelograms). Interfaces and annotation types appear in rounded rectangles, in which the corners have been replaced by arcs. The current classthe one that is the subject of the diagramappears in a box that is bolder than the others. The boxes are connected by lines: solid lines indicate an "extends" relationship, and dotted lines indicate an "implements" relationship. The superclass-to-subclass hierarchy reads from left to right in the top row (or only row) of boxes in the figure. Interfaces are usually positioned beneath the classes that implement them, although in simple cases an interface is sometimes positioned on the same line as the class that implements it, resulting in a more compact figure. Note that the hierarchy figure shows only the superclasses of a class. If a class has subclasses, those are listed in the cross-reference section at the end of the quick-reference entry for the class.

Synopsis

The most important part of every quick-reference entry is the synopsis, which follows the title and description. The synopsis for a type looks a lot like the source code for the type, except that the method bodies are omitted and some additional annotations are added. If you know Java syntax, you know how to read the synopsis.

The first line of the synopsis contains information about the class itself. It begins with a list of modifiers, such as `public`, `abstract`, and `final`. These modifiers are followed by the `class`, `interface`, `enum`, or `@interface` keyword and then by the name of the class. The class name may be followed by type variables, an `extends` clause that specifies the superclass, and an `implements` clause that specifies any interfaces the class implements.

The class definition line is followed by a list of the fields, methods, and nested types that the class defines. Once again, if you understand basic Java syntax, you should have no trouble making sense of these lines. The listing for each member includes the modifiers, type, and name of the member. For methods, the synopsis also includes the type and name of each method parameter and an optional `tHRows` clause that lists the exceptions the method can throw. The member names are in boldface, so it is easy to scan the list of members looking for the one you want. The names of method parameters are in italics to indicate that they are not to be used literally. The member listings are printed on alternating gray and white backgrounds to keep them visually separate.

Member availability and flags

Each member listing is a single line that defines the API for that member. These listings use Java syntax, so their meaning is immediately clear to any Java programmer. There is some auxiliary information associated with each member synopsis that requires explanation, however

Recall that each quick-reference entry begins with a title section that includes the release in which the class was first defined. When a member is introduced into a class after the initial release of the class, the version in which the member was introduced appears, in small print, to the left of the member synopsis. For example, if a class was first introduced in Java 1.1, but ha a new method added in Java 1.2 the title contains the string "1.1", and the listing for the new member is preceded by the number "1.2". Furthermore, if a member has been deprecated, that fact is indicated with a hash mark (#) to the left of the member synopsis.

The area to the right of the member synopsis is used to display a variety of flags that provide additional information about the member. Some of these flags indicate additional specification details that do not appear in the member API itself. Other flags contain implementation-specific information. This information can be quite useful in understanding the class and in debugging your code, but be aware that it may differ between implementations. The implementation-specific flags displayed in this book are based on Sun's Linux implementation of Java.

The following flags may be displayed to the right of a member synopsis:

native

An implementation-specific flag that indicates that a method is implemented in native code. Although `native` is a Java keyword and can appear in method signatures, it is part of the method implementation, not part of its specification. Therefore, this information is included with the member flags, rather than as part of the member listing. This flag is useful as a hint about the expected performance of a method.

synchronized

An implementation-specific flag that indicates that a method implementation is declared `synchronized`, meaning that it obtains a lock on the object or class before executing. Lik the `native` keyword, the `synchronized` keyword is part of the method implementation, not part of the specification, so it appears as a flag, not in the method synopsis itself. Thi flag is a useful hint that the method is probably implemented in a threadsafe manner.

Whether or not a method is thread-safe is part of the method specification, and this information *should* appear (although it often does not) in the method documentation. There are a number of different ways to make a method threadsafe, however, and declaring the method with the `synchronized` keyword is only one possible implementation. In other words, a method that does not bear the `synchronized` flag can still be threadsafe.

Overrides:

This flag indicates that a method overrides a method in one of its superclasses. The flag is followed by the name of the superclass that the method overrides. This is a specification detail, not an implementation detail. As we'll see in the next section, overriding methods are usually grouped together in their own section of the class synopsis. The `Overrides`: flag is only used when an overriding method is not grouped in that way.

Implements:

This flag indicates that a method implements a method in an interface. The flag is followed by the name of the interface that is implemented. This is a specification detail, not an implementation detail. As we'll see in the next section, methods that implement an interface are usually grouped into a special section of the class synopsis. The `Implements`: flag is only used for methods that are not grouped in this way.

empty

This flag indicates that the implementation of the method has an empty body. This can be a hint to the programmer that the method may need to be overridden in a subclass.

constant

An implementation-specific flag that indicates that a method has a trivial implementation. Only methods with a `void` return type can be truly empty. Any method declared to return a value must have at least a `return` statement. The `constant` flag indicates that the method implementation is empty except for a `return` statement that returns a constant value. Such a method might have a body like `return null;` or `return false;`. Like the `empty` flag, this flag may indicate that a method needs to be overridden.

default:

This flag is used with property accessor methods that read the value of a property (i.e., methods whose names begins with get and take no arguments). The flag is followed by the default value of the property. Strictly speaking, default property values are a specification detail. In practice, however, these defaults are not always documented, and care should be taken, because the default values may change between implementations.

Not all property accessors have a default: flag. A default value is determined by dynamically loading the class in question, instantiating it using a no-argument constructor, and then calling the method to find out what it returns. This technique can be used only on classes that can be dynamically loaded and instantiated and that have no-argument constructors, so default values are shown for those classes only. Furthermore, note that when a class is instantiated using a different constructor, the default values for its properties may be different.

=

For `static final` fields, this flag is followed by the constant value of the field. Only constants of primitive and `String` types and constants with the value `null` are displayed. Some constant values are specification details, while others are implementation details. The reason that symbolic constants are defined, however, is so you can write code that does not rely directly upon the constant value. Use this flag to help you understand the class, but do not rely upon the constant values in your own programs.

Functional grouping of members

Within a class synopsis, the members are not listed in strict alphabetical order. Instead, they are broken down into functional groups and listed alphabetically within each group. Constructors, methods, fields, and inner classes are all listed separately. Instance methods are kept separate from static (class) methods. Constants are separated from non-constant fields. Public members are listed separately from protected members. Grouping members by category breaks a class down into smaller, more comprehensible segments, making the class easier to understand. This grouping also makes it easier for you to find a desired member.

Functional groups are separated from each other in a class synopsis with Java comments, such as `// Public Constructors`, `// Inner Classes`, and `// Methods Implementing DataInput`. The various functional categories are as follows (in the order in which they appear in a class synopsis):

Constructors

Displays the constructors for the class. Public constructors and protected constructors are displayed separately in subgroupings. If a class defines no constructor at all, the Java compiler adds a default no-argument constructor that is displayed here. If a class defines only private constructors, it cannot be instantiated, so a special, empty grouping entitled "No Constructor" indicates this fact. Constructors are listed first because the first thing you do with most classes is instantiate them by calling a constructor.

Constants

Displays all of the constants (i.e., fields that are declared `static` and `final`) defined by the class. Public and protected constants are displayed in separate subgroups. Constants are listed here, near the top of the class synopsis, because constant values are often used throughout the class as legal values for method parameters and return values.

Inner classes

Groups all of the inner classes and interfaces defined by the class or interface. For each inner class, there is a single-line synopsis. Each inner class also has its own quick-reference entry that includes a full class synopsis for the inner class. Like constants, inner classes are listed near the top of the class synopsis because they are often used by a number of other members of the class.

Static methods

Lists the static methods (class methods) of the class, broken down into subgroups for public static methods and protected static methods.

Event listener registration methods

Lists the public instance methods that register and deregister event listener objects with the class. The names of these methods begin with the words "add" and "remove" and end in "Listener". These methods are always passed a `java.util.EventListener` object. The methods are typically defined in pairs, so the pairs are listed together. The methods are listed alphabetically by event name rather than by method name.

Public instance methods

Contains all of the public instance methods that are not grouped elsewhere.

Implementing methods

Groups the methods that implement the same interface. There is one subgroup for each interface implemented by the class. Methods that are defined by the same interface are almost always related to each other, so this is a useful functional grouping of methods. If a class is modified so that it implements an interface after its initial release, the methods of that interface will be grouped here, but will also appear in the "Public Instance methods" section.

Overriding methods

Groups the methods that override methods of a superclass broken down into subgroups by superclass. This is typically a useful grouping, because it helps to make it clear how a class modifies the default behavior of its superclasses. In practice, it is also often true that methods that override the same superclass are functionally related to each other.

Protected instance methods

Contains all of the protected instance methods that are not grouped elsewhere.

Fields

Lists all the nonconstant fields of the class, breaking them down into subgroups for public and protected static fields and public and protected instance fields. Many classes do not define any publicly accessible fields. For those that do, many object-oriented programmers prefer not to use those fields directly, but instead to use accessor methods when such methods are available.

Deprecated members

Deprecated methods and deprecated fields are grouped at the very bottom of the class synopsis. Use of these members is strongly discouraged.

Cross-References

The synopsis section of a quick-reference entry is followed by a number of optional cross-reference sections that indicate other, related classes and methods that may be of interest. These sections are the following:

Subclasses

This section lists the subclasses of this class, if there are any.

Implementations

This section lists classes that implement this interface.

Passed To

This section lists all of the methods and constructors that are passed an object of this type as an argument. This is useful when you have an object of a given type and want to figure out what you can do with it. Methods defined by this type itself are not included in the list.

Returned By

This section lists all of the methods (but not constructors) that return an object of this type. This is useful when you know that you want to work with an object of this type, but don't know how to obtain one. Methods of this type itself are excluded.

Thrown By

For checked exception classes, this section lists all of the methods and constructors that throw exceptions of this type. This material helps you figure out when a given exception or error may be thrown. Note, however, that this section is based on the exception types listed in the `throws` clauses of methods and constructors. Subclasses of `RuntimeException` and `Error` do not have to be listed in `throws` clauses, so it is not possible to generate a complete cross-reference of methods that throw these types of unchecked exceptions.

Type Of

This section lists all of the fields and constants that are of this type, which can help you figure out how to obtain an object of this type. If the type defines self-typed fields or constants, they are not included on this list.

A Note About Class Names

Throughout the quick reference, you'll notice that classes are sometimes referred to by class name alone and at other times referred to by class name and package name. If package names were always used, the class synopses would become long and hard to read. On the other hand, if package names were never used, it would sometimes be difficult to know what class was being referred to. The rules for including or omitting the package name are complex. They can be summarized approximately as follows, however:

- If the class name alone is ambiguous, the package name is always used. The name `Annotation` is ambiguous, for example, because it can refer to either `java.lang.annotation.Annotation` or `java.text.Annotation`.
- If the class is part of the `java.lang` package or is a very commonly used class, such as `java.io.Serializable`, the package name is omitted.
- If the class being referred to is part of the current package (and has a quick-reference entry in the current chapter), the package name is omitted.

Chapter 9 *java.io*
Chapter 10 *java.lang and Subpackages*
Chapter 11 *java.math*
Chapter 12 *java.net*
Chapter 13 *java.nio and Subpackages*
Chapter 14 *java.security and Subpackages*
Chapter 15 *java.text*
Chapter 16 *java.util and Subpackages*
Chapter 17 *java.crypto and Subpackages*
Chapter 18 *java.net and javax.net.ssl*
Chapter 19 *javax.security.auth and Subpackages*

Chapter 20 *javax.xml and Subpackages*
Chapter 21 *org.w3c.dom*
Chapter 22 *org.xml.sax and Subpackages*
Chapter 23 *Class, Method, and Field Index*

Team LiB

Team LiB

Chapter 9. java.io

Package java.io

BufferedInputStream

BufferedOutputStream

BufferedReader

BufferedWriter

ByteArrayInputStream

ByteArrayOutputStream

CharArrayReader

CharArrayWriter

CharConversionException

Closeable

DataInput

DataInputStream

DataOutput

DataOutputStream

EOFException

Externalizable

File

FileDescriptor

FileFilter

FileInputStream

FilenameFilter

FileNotFoundException

FileOutputStream

FilePermission

FileReader

FileWriter

FilterInputStream

FilterOutputStream

FilterReader

FilterWriter

Flushable

InputStream

InputStreamReader

InterruptedIOException

InvalidClassException

InvalidObjectException

IOException

LineNumberInputStream

LineNumberReader

NotActiveException

NotSerializableException

ObjectInput

ObjectInputStream

ObjectInputStream.GetField

ObjectInputValidation

ObjectOutput

ObjectOutputStream

ObjectOutputStream.PutField

ObjectStreamClass

ObjectStreamConstants

downloaded from: lib.ommolketab.ir

ObjectStreamException

ObjectStreamField

OptionalDataException

OutputStream

OutputStreamWriter

PipedInputStream

PipedOutputStream

PipedReader

PipedWriter

PrintStream

PrintWriter

PushbackInputStream

PushbackReader

RandomAccessFile

Reader

SequenceInputStream

Serializable

SerializablePermission

StreamCorruptedException

StreamTokenizer

StringBufferInputStream

StringReader

StringWriter

SyncFailedException

UnsupportedEncodingException

UTFDataFormatException

WriteAbortedException

Writer

Team LiB

Package java.io

Java 1.0

The java.io package is large, but most of the classes it contains fall into a well-structured hierarchy. Most of the package consists of byte streamssubclasses of InputStream or OutputStream and character streamssubclasses of Reader or Writer. Each of these stream subtypes has a specific purpose, and, despite its size, java.io is a straightforward package to understand and to use. In Java 1.4, the java.io package was complemented by a "New I/O API" defined in the java.nio package and its subpackages. The java.nio package is totally new, although it included some compatibility with the classes in this package. It was designed for high-performance I/O, particularly for use in servers and has a lower-level API than this package does. The I/O facilities of java.io are still quite adequate for most of the I/O required by typical client-side applications.

Before we consider the stream classes that comprise the bulk of this package, let's examine the important nonstream classes. File represents a file or directory name in a system-independent way and provides methods for listing directories, querying file attributes, and renaming and deleting files. FilenameFilter is an interface that defines a method that accepts or rejects specified filenames. It is used by File to specify what types of files should be included in directory listings. RandomAccessFile allows you to read from or write to arbitrary locations of a file. Often, though, you'll prefer sequential access to a file and should use one of the stream classes.

InputStream and OutputStream are abstract classes that define methods for reading and writing bytes. Their subclasses allow bytes to be read from and written to a variety of sources and sinks. FileInputStream and FileOutputStream read from and write to files. ByteArrayInputStream and ByteArrayOutputStream read from and write to an array of bytes in memory. PipedInputStream reads bytes from a PipedOutputStream, and PipedOutputStream writes bytes to a PipedInputStream. These classes work together to implement a *pipe* for communication between threads.

FilterInputStream and FilterOutputStream are special; they filter input and output bytes. When you create a FilterInputStream, you specify an InputStream for it to filter. When you call the read( ) method of a FilterInputStream, it calls the read( ) method of its InputStream, processes the bytes it reads, and returns the filtered bytes. Similarly, when you create a FilterOutputStream, you specify an OutputStream to be filtered. Calling the write( ) method of a FilterOutputStream causes it to process your bytes in some way and then pass those filtered bytes to the write( ) method of its OutputStream.

FilterInputStream and FilterOutputStream do not perform any filtering themselves; this is done by their subclasses. BufferedInputStream and BufferedOutputStream are filtered streams that provide input and output buffering and can increase I/O efficiency. DataInputStream reads raw bytes from a stream and interprets them in various binary formats. It has various methods to read primitive Java data types in their standard binary formats. DataOutputStream allows you to write Java primitive data types in binary format. The ObjectInputStream and ObjectOutputStream classes are special. These byte-stream classes are used for serializing and deserializing the internal state of objects for storage or interprocess communication.

The byte streams just described are complemented by an analogous set of character input and output streams. `Reader` is the superclass of all character input streams, and `Writer` is the superclass of all character output streams. Most of the `Reader` and `Writer` streams have obvious byte-stream analogs. `BufferedReader` is a commonly used stream; it provides buffering for efficiency and also has a `readLine( )` method to read a line of text at a time. `PrintWriter` is another very common stream; its methods allow output of a textual representation of any primitive Java type or of any object (via the object's `toString( )` method).

Java 5.0 adds the `Closeable` and `Flushable` interfaces to identify types that have `close( )` and `flush( )` methods. All streams have a `close( )` method and implement the `Closeable` interface. And all byte and character output streams have a `flush( )` method and implement `Flushable`. In a related change, all character output streams (and the byte stream `PrintStream`) implement the (new in Java 5.0) interface `java.lang.Appendable`, making them suitable for use with the `java.util.Formatter` class. Similarly, all character input streams implement the `java.lang.Readable` interface, making them suitable for use with the `java.util.Scanner` class. Finally, both `PrintStream` and `PrintWriter` have been enhanced in two ways for Java 5.0. Both now include constructors for creating a stream that writes directly to a file. And both include formatted-text output methods `printf( )` and `format( )`. See `java.util.Formatter` for details.

Interfaces

```
public interface Closeable;
public interface DataInput;
public interface DataOutput;
public interface Externalizable extends Serializable;
public interface FileFilter;
public interface FilenameFilter;
public interface Flushable;
public interface ObjectInput extends DataInput;
public interface ObjectInputValidation;
public interface ObjectOutput extends DataOutput;
public interface ObjectStreamConstants;
public interface Serializable;
```

Classes

```
public class File implements Serializable, Comparable<File>;
public final class FileDescriptor;
public final class FilePermission extends java.security.Permission implements
   Serializable;
public abstract class InputStream implements Closeable;
   public class ByteArrayInputStream extends InputStream;
   public class FileInputStream extends InputStream;
   public class FilterInputStream extends InputStream;
      public class BufferedInputStream extends FilterInputStream;
      public class DataInputStream extends FilterInputStream implements
      DataInput;
      public class LineNumberInputStream extends FilterInputStream;
      public class PushbackInputStream extends FilterInputStream;
```

```
   public class ObjectInputStream extends InputStream implements ObjectInput,
      ObjectStreamConstants;
   public class PipedInputStream extends InputStream;
   public class SequenceInputStream extends InputStream;
   public class StringBufferInputStream extends InputStream;
public abstract static class ObjectInputStream.GetField;
public abstract static class ObjectOutputStream.PutField;
public class ObjectStreamClass implements Serializable;
public class ObjectStreamField implements Comparable<Object>;
public abstract class OutputStream implements Closeable, Flushable;
   public class ByteArrayOutputStream extends OutputStream;
   public class FileOutputStream extends OutputStream;
   public class FilterOutputStream extends OutputStream;
      public class BufferedOutputStream extends FilterOutputStream;
      public class DataOutputStream extends FilterOutputStream implements
      DataOutput;
      public class PrintStream extends FilterOutputStream implements Appendable,
      Closeable;
   public class ObjectOutputStream extends OutputStream implements ObjectOutput,
      ObjectStreamConstants;
   public class PipedOutputStream extends OutputStream;
public class RandomAccessFile implements Closeable, DataInput, DataOutput;
public abstract class Reader implements Closeable, Readable;
   public class BufferedReader extends Reader;
      public class LineNumberReader extends BufferedReader;
   public class CharArrayReader extends Reader;
   public abstract class FilterReader extends Reader;
      public class PushbackReader extends FilterReader;
   public class InputStreamReader extends Reader;
      public class FileReader extends InputStreamReader;
   public class PipedReader extends Reader;
   public class StringReader extends Reader;
public final class SerializablePermission extends java.security.BasicPermission;
public class StreamTokenizer;
public abstract class Writer implements Appendable, Closeable, Flushable;
   public class BufferedWriter extends Writer;
   public class CharArrayWriter extends Writer;
   public abstract class FilterWriter extends Writer;
   public class OutputStreamWriter extends Writer;
      public class FileWriter extends OutputStreamWriter;
   public class PipedWriter extends Writer;
   public class PrintWriter extends Writer;
   public class StringWriter extends Writer;
```

Exceptions

```
public class IOException extends Exception;
   public class CharConversionException extends IOException;
   public class EOFException extends IOException;
   public class FileNotFoundException extends IOException;
```

```
public class InterruptedIOException extends IOException;
public abstract class ObjectStreamException extends IOException;
   public class InvalidClassException extends ObjectStreamException;
   public class InvalidObjectException extends ObjectStreamException;
   public class NotActiveException extends ObjectStreamException;
   public class NotSerializableException extends ObjectStreamException;
   public class OptionalDataException extends ObjectStreamException;
   public class StreamCorruptedException extends ObjectStreamException;
   public class WriteAbortedException extends ObjectStreamException;
public class SyncFailedException extends IOException;
public class UnsupportedEncodingException extends IOException;
public class UTFDataFormatException extends IOException;
```

BufferedInputStream java.io

Java 1.0 *closeable*

This class is a `FilterInputStream` that provides input data buffering; efficiency is increased by reading in a large amount of data and storing it in an internal buffer. When data is requested, it is usually available from the buffer. Thus, most calls to read data do not actually have to read data from a disk, network, or other slow source. Create a `BufferedInputStream` by specifying the `InputStream` that is to be buffered in the call to the constructor. See also `BufferedReader` .

Figure 9-1. java.io.BufferedInputStream


```
public class BufferedInputStream extends FilterInputStream {
// Public Constructors
     public BufferedInputStream(InputStream in);
     public BufferedInputStream(InputStream in, int size);
// Public Methods Overriding FilterInputStream
     public int available( ) throws IOException;                    synchronized
1.2  public void close( ) throws IOException;
     public void mark(int readlimit);                   synchronized
     public boolean markSupported( );                                       constant
     public int read( ) throws IOException;                         synchronized
     public int read(byte[ ] b, int off, int len) throws IOException;      synchronized
     public void reset( ) throws IOException;                       synchronized
     public long skip(long n) throws IOException;                 synchronized
// Protected Instance Fields
     protected volatile byte[ ] buf;
     protected int count;
     protected int marklimit;
     protected int markpos;
     protected int pos;
}
```

BufferedOutputStream java.io

Java 1.0 *closeable flushable*

This class is a `FilterOutputStream` that provides output data buffering; output efficiency is increased b storing values to be written in a buffer and actually writing them out only when the buffer fills up or whe the `flush( )` method is called. Create a `BufferedOutputStream` by specifying the `OutputStream` that is to be buffered in the call to the constructor. See also `BufferedWriter` .

Figure 9-2. java.io.BufferedOutputStream


```
public class BufferedOutputStream extends FilterOutputStream {
// Public Constructors
     public BufferedOutputStream(OutputStream out);
     public BufferedOutputStream(OutputStream out, int size);
// Public Methods Overriding FilterOutputStream
     public void flush( ) throws IOException;                      synchronized
     public void write(int b) throws IOException;                  synchronized
     public void write(byte[ ] b, int off, int len) throws IOException;     synchronize
// Protected Instance Fields
     protected byte[ ] buf;
     protected int count;
}
```

BufferedReader java.io

Java 1.1 *readable closeable*

This class applies buffering to a character input stream, thereby improving the efficiency of character input. You create a BufferedReader by specifying some other character input stream from which it is to buffer input. (You can also specify a buffer size at this time, although the default size is usually fine.) Typically, you use this sort of buffering with a FileReader or InputStreamReader. BufferedReader defines the standard set of Reader methods and provides a readLine( ) method that reads a line of text (not including the line terminator) and returns it as a String. BufferedReader is the character-stream analog of BufferedInputStream. It also provides a replacement for the deprecated readLine( ) method of DataInputStream, which did not properly convert bytes into characters.

Figure 9-3. java.io.BufferedReader

```
public class BufferedReader extends Reader {
// Public Constructors
     public BufferedReader(Reader in);
     public BufferedReader(Reader in, int sz);
// Public Instance Methods
     public String readLine( ) throws IOException;
// Public Methods Overriding Reader
     public void close( ) throws IOException;
     public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );                           constant
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
}
```

Subclasses

LineNumberReader

BufferedWriter java.io

Java 1.1 *appendable closeable flushable*

This class applies buffering to a character output stream, improving output efficiency by coalescing many small write requests into a single larger request. You create a `BufferedWriter` by specifying some other character output stream to which it sends its buffered and coalesced output. (You can also specify a buffer size at this time, although the default size is usually satisfactory.) Typically, you use this sort of buffering with a `FileWriter` or `OutputStreamWriter`. `BufferedWriter` defines the standard `write( )`, `flush( )`, and `close( )` methods all output streams define, but it adds a `newLine( )` method that outputs the platform-dependent line separator (usually a newline character, a carriage-return character, or both) to the stream. `BufferedWriter` is the character-stream analog of `BufferedOutputStream`.

Figure 9-4. java.io.BufferedWriter

```
public class BufferedWriter extends Writer {
// Public Constructors
     public BufferedWriter(Writer out);
     public BufferedWriter(Writer out, int sz);
// Public Instance Methods
     public void newLine( ) throws IOException;
// Public Methods Overriding Writer
     public void close( ) throws IOException;
     public void flush( ) throws IOException;
     public void write(int c) throws IOException;
     public void write(char[ ] cbuf, int off, int len) throws IOException;
     public void write(String s, int off, int len) throws IOException;
}
```

ByteArrayInputStream java.io

Java 1.0 *closeable*

This class is a subclass of `InputStream` in which input data comes from a specified array of `byte` values. This is useful when you want to read data in memory as if it were coming from a file, pipe, or socket. Note that the specified array of bytes is not copied when a `ByteArrayInputStream` is created. See also `CharArrayReader`.

Figure 9-5. java.io.ByteArrayInputStream


```
public class ByteArrayInputStream extends InputStream {
// Public Constructors
     public ByteArrayInputStream(byte[ ] buf);
     public ByteArrayInputStream(byte[ ] buf, int offset, int length);
// Public Methods Overriding InputStream
     public int available( );                              synchronized
1.2  public void close( ) throws IOException;                         empty
1.1  public void mark(int readAheadLimit);
1.1  public boolean markSupported( );                                 constant
     public int read( );                                   synchronized
     public int read(byte[ ] b, int off, int len);               synchronized
     public void reset( );                                 synchronized
     public long skip(long n);                            synchronized
// Protected Instance Fields
     protected byte[ ] buf;
     protected int count;
1.1  protected int mark;
     protected int pos;
}
```

ByteArrayOutputStream java.io

Java 1.0 *closeable flushable*

This class is a subclass of `OutputStream` in which output data is stored in an internal `byte` array. The internal array grows as necessary and can be retrieved with `toByteArray( )` or `toString( )`. The `reset( )` method discards any data currently stored in the internal array and stores data from the beginning again. See also `CharArrayWriter`.

Figure 9-6. java.io.ByteArrayOutputStream


```
public class ByteArrayOutputStream extends OutputStream {
// Public Constructors
     public ByteArrayOutputStream( );
     public ByteArrayOutputStream(int size);
// Public Instance Methods
     public void reset( );                                 synchronized
     public int size( );
     public byte[ ] toByteArray( );                 synchronized
1.1  public String toString(String enc) throws UnsupportedEncodingException;
     public void writeTo(OutputStream out) throws IOException;          synchronized
// Public Methods Overriding OutputStream
1.2  public void close( ) throws IOException;                       empty
     public void write(int b);                             synchronized
     public void write(byte[ ] b, int off, int len);             synchronized
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected byte[ ] buf;
     protected int count;
// Deprecated Public Methods
#    public String toString(int hibyte);
}
```

CharArrayReader java.io

Java 1.1 *readable closeable*

This class is a character input stream that uses a character array as the source of the characters it returns. You create a `CharArrayReader` by specifying the character array (or portion of an array) it is to read from. `CharArrayReader` defines the usual `Reader` methods and supports the `mark( )` and `reset( )` methods. Note that the character array you pass to the `CharArrayReader( )` constructor is not copied. This means that changes you make to the elements of the array after you create the input stream affect the values read from the array. `CharArrayReader` is the character-array analog of `ByteArrayInputStream` and is similar to `StringReader`.

Figure 9-7. java.io.CharArrayReader

```
public class CharArrayReader extends Reader {
// Public Constructors
     public CharArrayReader(char[ ] buf);
     public CharArrayReader(char[ ] buf, int offset, int length);
// Public Methods Overriding Reader
     public void close( );
     public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );                              constant
     public int read( ) throws IOException;
     public int read(char[ ] b, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
// Protected Instance Fields
     protected char[ ] buf;
     protected int count;
     protected int markedPos;
     protected int pos;
}
```

CharArrayWriter java.io

Java 1.1 *appendable closeable flushable*

This class is a character output stream that uses an internal character array as the destination of characters written to it. When you create a `CharArrayWriter`, you may optionally specify an initial size for the character array, but you do not specify the character array itself; this array is managed internally by the `CharArrayWriter` and grows as necessary to accommodate all the characters written to it. The `toString( )` and `toCharArray( )` methods return a copy of all characters written to the stream, as a string and an array of characters, respectively. `CharArrayWriter` defines the standard `write( )`, `flush( )`, and `close( )` methods all `Writer` subclasses define. It also defines a few other useful methods. `size( )` returns the number of characters that have been written to the stream. `reset( )` resets the stream to its initial state, with an empty character array; this is more efficient than creating a new `CharArrayWriter`. Finally, `writeTo( )` writes the contents of the internal character array to some other specified character stream. `CharArrayWriter` is the character-stream analog of `ByteArrayOutputStream` and is quite similar to `StringWriter`.

Figure 9-8. java.io.CharArrayWriter

```
public class CharArrayWriter extends Writer {
// Public Constructors
     public CharArrayWriter( );
     public CharArrayWriter(int initialSize);
// Public Instance Methods
5.0  public CharArrayWriter append(CharSequence csq);
5.0  public CharArrayWriter append(char c);
5.0  public CharArrayWriter append(CharSequence csq, int start, int end);
     public void reset( );
     public int size( );
     public char[ ] toCharArray( );
     public void writeTo(Writer out) throws IOException;
// Public Methods Overriding Writer
     public void close( );                                          empty
     public void flush( );                                          empty
     public void write(int c);
     public void write(char[ ] c, int off, int len);
     public void write(String str, int off, int len);
// Public Methods Overriding Object
     public String toString( );
```

```
// Protected Instance Fields
     protected char[ ] buf;
     protected int count;
}
```

Team LiB

CharConversionException java.io

Java 1.1 *serializable checked*

Signals an error when converting bytes to characters or vice versa.

Figure 9-9. java.io.CharConversionException


```
public class CharConversionException extends IOException {
// Public Constructors
     public CharConversionException( );
     public CharConversionException(String s);
}
```

Team LiB

Closeable java.io

Java 5.0 *closeable*

This interface defines a `close( )` method and is implemented by closeable objects such as `java.io` streams and `java.nio` channels. This interface was added in Java 5.0 to enable `java.util.Formatter` to distinguish `java.lang.Appendable` objects that need to be closed (such as streams) from those that do not (such as `StringBuilder` objects). See also `Flushable`.

```
public interface Closeable {
// Public Instance Methods
     void close( ) throws IOException;
}
```

Implementations

`InputStream`, `OutputStream`, `PrintStream`, `RandomAccessFile`, `Reader`, `Writer`, `java.nio.channels.Channel`, `java.util.Formatter`

DataInput java.io

Java 1.0

This interface defines the methods required forstreams that can read Java primitive data types in a machine-independent binary format. It is implemented byDataInputStream and RandomAccessFile. See DataInputStream for more information on the methods.

```
public interface DataInput {
// Public Instance Methods
     boolean readBoolean( ) throws IOException;
     byte readByte( ) throws IOException;
     char readChar( ) throws IOException;
     double readDouble( ) throws IOException;
     float readFloat( ) throws IOException;
     void readFully(byte[ ] b) throws IOException;
     void readFully(byte[ ] b, int off, int len) throws IOException;
     int readInt( ) throws IOException;
     String readLine( ) throws IOException;
     long readLong( ) throws IOException;
     short readShort( ) throws IOException;
     int readUnsignedByte( ) throws IOException;
     int readUnsignedShort( ) throws IOException;
     String readUTF( ) throws IOException;
     int skipBytes(int n) throws IOException;
}
```

Implementations

DataInputStream, ObjectInput, RandomAccessFile

Passed To

DataInputStream.readUTF( )

DataInputStream java.io

Java 1.0 *closeable*

This class is a type of `FilterInputStream` that allows you to read binary representations of Java primiti data types in a portable way. Create a `DataInputStream` by specifying the `InputStream` that is to be filt in the call to the constructor. `DataInputStream` reads only primitive Java types; use `ObjectInputStrea` read object values.

Many of the methods read and return a single Java primitive type, in binary format, from the stream. `readUnsignedByte( )` and `readUnsignedShort( )` read unsigned values and return them as `int` values since unsigned `byte` and `short` types are not supported in Java. `read( )` reads data into an array of byt blocking until at least some data is available. By contrast, `readFully( )` reads data into an array of byte blocks until all requested data becomes available. `skipBytes( )` blocks until the specified number of byt have been read and discarded. `readLine( )` reads characters from the stream until it encounters a newl carriage return, or a newline/carriage return pair. The returned string is not terminated with a newline o carriage return. This method is deprecated as of Java 1.1; see `BufferedReader` for an alternative. `readU` reads a string of Unicode text encoded in a slightly modified version of the UTF-8 transformation format is an ASCII-compatible encoding of Unicode characters that is often used for the transmission and stora Unicode text. This class uses a modified UTF-8 encoding that never contains embedded null characters.

Figure 9-10. java.io.DataInputStream

```
public class DataInputStream extends FilterInputStream implements DataInput {
// Public Constructors
     public DataInputStream(InputStream in);
// Public Class Methods
     public static final String readUTF(DataInput in) throws IOException;
// Methods Implementing DataInput
     public final boolean readBoolean( ) throws IOException;
     public final byte readByte( ) throws IOException;
     public final char readChar( ) throws IOException;
     public final double readDouble( ) throws IOException;
     public final float readFloat( ) throws IOException;
     public final void readFully(byte[ ] b) throws IOException;
     public final void readFully(byte[ ] b, int off, int len) throws IOException;
     public final int readInt( ) throws IOException;
     public final long readLong( ) throws IOException;
     public final short readShort( ) throws IOException;
     public final int readUnsignedByte( ) throws IOException;
```

```
    public final int readUnsignedShort( ) throws IOException;
    public final String readUTF( ) throws IOException;
    public final int skipBytes(int n) throws IOException;
// Public Methods Overriding FilterInputStream
    public final int read(byte[ ] b) throws IOException;
    public final int read(byte[ ] b, int off, int len) throws IOException;
// Deprecated Public Methods
#   public final String readLine( ) throws IOException;                 Implements:Data
}
```

Team LiB

DataOutput java.io

Java 1.0

This interface defines the methods required for streams that can write Java primitive data types in a machine-independent binary format. It is implemented by DataOutputStream and RandomAccessFile. See DataOutputStream for more information on the methods.

```
public interface DataOutput {
// Public Instance Methods
     void write(byte[ ] b) throws IOException;
     void write(int b) throws IOException;
     void write(byte[ ] b, int off, int len) throws IOException;
     void writeBoolean(boolean v) throws IOException;
     void writeByte(int v) throws IOException;
     void writeBytes(String s) throws IOException;
     void writeChar(int v) throws IOException;
     void writeChars(String s) throws IOException;
     void writeDouble(double v) throws IOException;
     void writeFloat(float v) throws IOException;
     void writeInt(int v) throws IOException;
     void writeLong(long v) throws IOException;
     void writeShort(int v) throws IOException;
     void writeUTF(String str) throws IOException;
}
```

Implementations

DataOutputStream, ObjectOutput, RandomAccessFile

DataOutputStream java.io

Java 1.0 *closeable flushable*

This class is a subclass of `FilterOutputStream` that allows you to write Java primitive data types in a portable binary format. Create a `DataOutputStream` by specifying the `OutputStream` that is to be filtered in the call to the constructor. `DataOutputStream` has methods that output only primitive types; use `ObjectOutputStream` to output object values.

Many of this class's methods write a single Java primitive type, in binary format, to the output stream. `write( )` writes a single byte, an array, or a subarray of bytes. `flush( )` forces any buffered data to be output. `size( )` returns the number of bytes written so far. `writeUTF( )` outputs a Java string of Unicode characters using a slightly modified version of the UTF-8 transformation format. UTF-8 is an ASCII-compatible encoding of Unicode characters that is often used for the transmission and storage of Unicode text. Except for the `writeUTF( )` method, this class is used for binary output of data. Textual output should be done with `PrintWriter` (or `PrintStream` in Java 1.0).

Figure 9-11. java.io.DataOutputStream

```
public class DataOutputStream extends FilterOutputStream implements DataOutput {
// Public Constructors
     public DataOutputStream(OutputStream out);
// Public Instance Methods
     public final int size( );
// Methods Implementing DataOutput
     public void write(int b) throws IOException;                  synchronized
     public void write(byte[ ] b, int off, int len) throws IOException;     synchronize
     public final void writeBoolean(boolean v) throws IOException;
     public final void writeByte(int v) throws IOException;
     public final void writeBytes(String s) throws IOException;
     public final void writeChar(int v) throws IOException;
     public final void writeChars(String s) throws IOException;
     public final void writeDouble(double v) throws IOException;
     public final void writeFloat(float v) throws IOException;
     public final void writeInt(int v) throws IOException;
     public final void writeLong(long v) throws IOException;
     public final void writeShort(int v) throws IOException;
     public final void writeUTF(String str) throws IOException;
// Public Methods Overriding FilterOutputStream
```

```
    public void flush( ) throws IOException;
// Protected Instance Fields
    protected int written;
}
```

EOFException java.io

Java 1.0 *serializable checked*

An IOException that signals the end-of-file.

Figure 9-12. java.io.EOFException


```
public class EOFException extends IOException {
// Public Constructors
     public EOFException( );
     public EOFException(String s);
}
```

Externalizable java.io

Java 1.1 *serializable*

This interface defines the methods that must be implemented by an object that wants complete control over the way it is serialized. The `writeExternal( )` and `readExternal( )` methods should be implemented to write and read object data in some arbitrary format, using the methods of the `DataOutput` and `DataInput` interfaces. `Externalizable` objects must serialize their own fields and are also responsible for serializing the fields of their superclasses. Most objects do not need to define a custom output format and can use the `Serializable` interface instead of `Externalizable` for serialization.

Figure 9-13. java.io.Externalizable

```
public interface Externalizable extends Serializable {
// Public Instance Methods
     void readExternal(ObjectInput in) throws IOException, ClassNotFoundException;
     void writeExternal(ObjectOutput out) throws IOException;
}
```

Team LiB

File java.io

Java 1.0 *serializable comparable*

This class supports a platform-independent definition of file anddirectory names. It also provides methoc list the files in a directory; check the existence, readability, writability, type, size, and modification time and directories; make new directories; rename files and directories; delete files and directories; and cre delete temporary and lock files. The constants defined by this class are the platform-dependent directory path-separator characters, available as a `String` and a `char` .

`getName( )` returns the name of the `File` with any directory names omitted. `getPath( )` returns the ful of the file, including the directory name. `getParent( )` and `getParentFile( )` return the directory that contains the `File` ; the only difference between the two methods is that one returns a `String` , while the returns a `File` . `isAbsolute( )` tests whether the `File` is an absolute specification. If not, `getAbsolute( )` returns an absolute filename created by appending the relative filename to the current working directc `getAbsoluteFile( )` returns the equivalent absolute `File` object. `getCanonicalPath( )` and `getCanonicalFile( )` are similar methods: they return an absolute filename or `File` object that has be converted to its system-dependent canonical form. This can be useful when comparing two `File` objects if they refer to the same file or directory. In Java 1.4 and later, the `toURI( )` method returns a `java.ne` object that uses a `file` : scheme to name this file. This file-to-URI transformation can be reversed by pa `file` : URI object to the `File( )` constructor.

`exists( )` , `canWrite( )` , `canRead( )` , `isFile( )` , `isDirectory( )` , and `isHidden( )` perform the obvious tests on the specified `File` . `length( )` returns the length of the file. `lastModified( )` returns modification time of the file (which should be used for comparison with other file times only and not inte as any particular time format). `setLastModified( )` allows the modification time to be set; `setReadOnl` makes a file or directory read-only.

`list( )` returns the names of all entries in a directory that are not rejected by an optional `FilenameFil` `listFiles( )` returns an array of `File` objects that represent all entries in a directory not rejected by a optional `FilenameFilter` or `FileFilter` . `listRoots( )` returns an array of `File` objects representing a directories on the system. Unix systems typically have only one root, */* . Windows systems have a differe for each drive letter: *c:* , *d:* , and *e:* , for example.

`mkdir( )` creates a directory, and `mkdirs( )` creates all the directories in a `File` specification. `renameTc` renames a file or directory; `delete( )` deletes a file or directory. Prior to Java 1.2, the `File` class doesn' provide any way to create a file; that task is accomplished typically with `FileOutputStream` . Two specia purpose file creation methods have were added in Java 1.2. The static `createTempFile( )` method retur `File` object that refers to a newly created empty file with a unique name that begins with the specified p (which must be at least three characters long) and ends with the specified suffix. One version of this me creates the file in a specified directory, and the other creates it in the system temporary directory. Appli can use temporary files for any purpose without worrying about overwriting files belonging to other applications. The other file-creation method of Java 1.2 is `createNewFile( )` . This instance method atte to create a new, empty file with the name specified by the `File` object. If it succeeds, it returns `TRue` . However, if the file already exists, it returns `false` . `createNewFile( )` works atomically and is therefor useful for file locking and other mutual-exclusion schemes. When working with `createTempFile( )` or `createNewFile( )`, consider using `deleteOnExit( )` to request that the files be deleted when the Java exits normally.

Figure 9-14. java.io.File

```
public class File implements Serializable, Comparable<File> {
// Public Constructors
1.4  public File(java.net.URI uri);
     public File(String pathname);
     public File(File parent, String child);
     public File(String parent, String child);
// Public Constants
     public static final String pathSeparator;
     public static final char pathSeparatorChar;
     public static final String separator;
     public static final char separatorChar;
// Public Class Methods
1.2  public static File createTempFile(String prefix, String suffix) throws IOException
1.2  public static File createTempFile(String prefix, String suffix, File directory) th
     IOException;
1.2  public static File[ ] listRoots( );
// Public Instance Methods
     public boolean canRead( );
     public boolean canWrite( );
1.2  public boolean createNewFile( ) throws IOException;
     public boolean delete( );
1.2  public void deleteOnExit( );
     public boolean exists( );
1.2  public File getAbsoluteFile( );
     public String getAbsolutePath( );
1.2  public File getCanonicalFile( ) throws IOException;
1.1  public String getCanonicalPath( ) throws IOException;
     public String getName( );
     public String getParent( );
1.2  public File getParentFile( );
     public String getPath( );
     public boolean isAbsolute( );
     public boolean isDirectory( );
     public boolean isFile( );
1.2  public boolean isHidden( );
     public long lastModified( );
     public long length( );
     public String[ ] list( );
     public String[ ] list(FilenameFilter filter);
1.2  public File[ ] listFiles( );
```

```
1.2  public File[ ] listFiles(FilenameFilter filter);
1.2  public File[ ] listFiles(FileFilter filter);
     public boolean mkdir( );
     public boolean mkdirs( );
     public boolean renameTo(File dest);
1.2  public boolean setLastModified(long time);
1.2  public boolean setReadOnly( );
1.4  public java.net.URI toURI( );
1.2  public java.net.URL toURL( ) throws java.net.MalformedURLException;
// Methods Implementing Comparable
1.2  public int compareTo(File pathname);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

Too many methods to list.

Returned By

`ProcessBuilder.directory( )`

FileDescriptor java.io

Java 1.0

This class is a platform-independent representation of a low-levelhandle to an open file or socket. The static `in` , `out`, and `err` variables are `FileDescriptor` objects that represent the standard input, output, and error streams, respectively. There is no public constructor method to create a `FileDescriptor` object. You can obtain one with the `getFD( )` method of `FileInputStream`, `FileOutputStream`, or `RandomAccessFile`.

```
public final class FileDescriptor {
// Public Constructors
     public FileDescriptor( );
// Public Constants
     public static final FileDescriptor err;
     public static final FileDescriptor in;
     public static final FileDescriptor out;
// Public Instance Methods
1.1  public void sync( ) throws SyncFailedException;                  native
     public boolean valid( );
}
```

Passed To

`FileInputStream.FileInputStream( )`, `FileOutputStream.FileOutputStream( )`, `FileReader.FileReader( )`, `FileWriter.FileWriter( )`, `SecurityManager.{checkRead( ), checkWrite( )}`

Returned By

`FileInputStream.getFD( )`, `FileOutputStream.getFD( )`, `RandomAccessFile.getFD( )`, `java.net.DatagramSocketImpl.getFileDescriptor( )`, `java.net.SocketImpl.getFileDescriptor( )`

Type Of

`java.net.DatagramSocketImpl.fd`, `java.net.SocketImpl.fd`

FileFilter java.io

Java 1.2

This interface, added in Java 1.2, defines an `accept( )` method that filters a list of files. You can list the contents of a directory by calling the `listFiles( )` method of the `File` object that represents the desired directory. If you want a filtered listing, such as a listing of files but not subdirectories or a listing of files whose names end in *.class*, you can pass a `FileFilter` object to `listFiles( )`. For each entry in the directory, a `File` object is passed to the `accept( )` method. If `accept( )` returns `true`, that `File` is included in the return value of `listFiles( )`. If `accept( )` returns false, that entry is not included in the listing. Use `FilenameFilter` if compatibility with previous releases of Java is required or if you prefer to filter filenames (i.e., `String` objects) rather than `File` objects.

```
public interface FileFilter {
// Public Instance Methods
     boolean accept(File pathname);
}
```

Passed To

`File.listFiles( )`

FileInputStream java.io

Java 1.0 *closeable*

This class is a subclass of `InputStream` that reads bytes from a file specified by name or by a `File` or `FileDescriptor` object. `read( )` reads a byte or array of bytes from the file. It returns -1 when the end-of-file has been reached. To read binary data, you typically use this class in conjunction with a `BufferedInputStream` and `DataInputStream`. To read text, you typically use it with an `InputStreamReader` and `BufferedReader`. Call `close( )` to close the file when input is no longer needed.

In Java 1.4 and later, use `getChannel( )` to obtain a `FileChannel` object for reading from the underlying file using the New I/O API of `java.nio` and its subpackages.

Figure 9-15. java.io.FileInputStream

```
public class FileInputStream extends InputStream {
// Public Constructors
     public FileInputStream(String name) throws FileNotFoundException;
     public FileInputStream(File file) throws FileNotFoundException;
     public FileInputStream(FileDescriptor fdObj);
// Public Instance Methods
1.4  public java.nio.channels.FileChannel getChannel( );
     public final FileDescriptor getFD( ) throws IOException;
// Public Methods Overriding InputStream
     public int available( ) throws IOException;                    native
     public void close( ) throws IOException;
     public int read( ) throws IOException;                         native
     public int read(byte[ ] b) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
     public long skip(long n) throws IOException;                   native
// Protected Methods Overriding Object
     protected void finalize( ) throws IOException;
}
```

FilenameFilter java.io

Java 1.0

This interface defines the `accept( )` method that must be implemented by any object that filters filenames (i.e., selects a subset of filenames from a list of filenames). There are no standard `FilenameFilter` classes implemented by Java, but objects that implement this interface are used by the `java.awt.FileDialog` object and the `File.list( )` method. A typical `FilenameFilter` object might check that the specified `File` represents a file (not a directory), is readable (and possibly writable as well), and that its name ends with some desired extension.

```
public interface FilenameFilter {
// Public Instance Methods
     boolean accept(File dir, String name);
}
```

Passed To

`File.{list( )`, `listFiles( )}`

Team LiB

FileNotFoundException java.io

Java 1.0 *serializable checked*

An `IOException` that signals that a specified file cannot be found.

Figure 9-16. java.io.FileNotFoundException


```
public class FileNotFoundException extends IOException {
// Public Constructors
     public FileNotFoundException( );
     public FileNotFoundException(String s);
}
```

Thrown By

Too many methods to list.

Team LiB

FileOutputStream java.io

Java 1.0 *closeable flushable*

This class is a subclass of `OutputStream` that writes data to a file specified by name or by a `File` or `FileDescriptor` object. If the specified file already exists, a `FileOutputStream` can be configured to overwrite or append to the existing file. `write( )` writes a byte or array of bytes to the file. To write bina data, you typically use this class in conjunction with a `BufferedOutputStream` and a `DataOutputStream` To write text, you typically use it with a `PrintWriter` , `BufferedWriter` and an `OutputStreamWriter` (o you use the convenience class `FileWriter`). Use `close( )` to close a `FileOutputStream` when no furth output will be written to it.

In Java 1.4 and later, use `getChannel( )` to obtain a `FileChannel` object for writing to the underlying fi using the New I/O API of `java.nio` and its subpackages.

Figure 9-17. java.io.FileOutputStream

```
public class FileOutputStream extends OutputStream {
// Public Constructors
     public FileOutputStream(FileDescriptor fdObj);
     public FileOutputStream(File file) throws FileNotFoundException;
     public FileOutputStream(String name) throws FileNotFoundException;
1.1  public FileOutputStream(String name, boolean append) throws FileNotFoundException;
1.4  public FileOutputStream(File file, boolean append) throws FileNotFoundException;
// Public Instance Methods
1.4  public java.nio.channels.FileChannel getChannel( );
     public final FileDescriptor getFD( ) throws IOException;
// Public Methods Overriding OutputStream
     public void close( ) throws IOException;
     public void write(int b) throws IOException;                       native
     public void write(byte[ ] b) throws IOException;
     public void write(byte[ ] b, int off, int len) throws IOException;
// Protected Methods Overriding Object
     protected void finalize( ) throws IOException;
}
```

FilePermission java.io

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that governs access to the local filesystem. A `FilePermissio` a name, or target, which specifies what file or files it pertains to, and a commaseparated list of actions t may be performed on the file or files. The supported actions areread, write, delete, and execute. Read a write permission are required by any methods that read or write a file. Delete permission is required by `File.delete( )`, and execute permission is required by `Runtime.exec( )`.

The name of a `FilePermission` may be as simple as a file or directory name. `FilePermission` also supp the use of certain wildcards, however, to specify a permission that applies to more than one file. If the n of the `FilePermission` is a directory name followed by `/*` (`\*` on Windows platforms), it specifies all file the named directory. If the name is a directory name followed by `/-` (`\-` on Windows), it specifies all files the directory, and, recursively, all files in all subdirectories. A `*` alone specifies all files in the current dire and a `-` alone specifies all files in or beneath the current directory. Finally, the special name <<ALL FILE matches all files anywhere in the filesystem.

Applications do not need to use this class directly. Programmers writing system-level code and system administrators configuring security policies may need to use it, however. Be very careful when granting type of `FilePermission`. Restricting access (especially write access) to files is one of the cornerstones Java security model with regard to untrusted code.

Figure 9-18. java.io.FilePermission

```
public final class FilePermission extends java.security.Permission implements Serializal
// Public Constructors
     public FilePermission(String path, String actions);
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(java.security.Permission p);
     public java.security.PermissionCollection newPermissionCollection( );
}
```

FileReader java.io

Java 1.1 *readable closeable*

FileReader is a convenience subclass of InputStreamReader that is useful when you want to read text (as opposed to binary data) from a file. You create a FileReader by specifying the file to be read in any of three possible forms. The FileReader constructor internally creates a FileInputStream to read bytes from the specified file and uses the functionality of its superclass, InputStreamReader, to convert those bytes from characters in the local encoding to theUnicode characters used by Java. Because FileReader is a trivial subclass of InputStreamReader, it does not define any read( ) methods or other methods of its own. Instead, it inherits all its methods from its superclass. If you want to read Unicode characters from a file that uses some encoding other than the default encoding for the locale, you must explicitly create your own InputStreamReader to perform the byte-to-character conversion.

Figure 9-19. java.io.FileReader

```
public class FileReader extends InputStreamReader {
// Public Constructors
     public FileReader(FileDescriptor fd);
     public FileReader(File file) throws FileNotFoundException;
     public FileReader(String fileName) throws FileNotFoundException;
}
```

FileWriter java.io

Java 1.1 *appendable closeable flushable*

FileWriter is a convenience subclass of OutputStreamWriter that is useful when you want to write text (as opposed to binary data) to a file. You create a FileWriter by specifying the file to be written to and, optionally, whether the data should be appended to the end of an existing file instead of overwriting that file. The FileWriter class creates an internal FileOutputStream to write bytes to the specified file and uses the functionality of its superclass, OutputStreamWriter, to convert the Unicode characters written to the stream into bytes using the default encoding of the default locale. (If you want to use an encoding other than the default, you cannot use FileWriter; in that case you must create your own OutputStreamWriter and FileOutputStream.) Because FileWriter is a trivial subclass of OutputStreamWriter, it does not define any methods of its own, but simply inherits them from its superclass.

Figure 9-20. java.io.FileWriter

```
public class FileWriter extends OutputStreamWriter {
// Public Constructors
     public FileWriter(File file) throws IOException;
     public FileWriter(FileDescriptor fd);
     public FileWriter(String fileName) throws IOException;
1.4  public FileWriter(File file, boolean append) throws IOException;
     public FileWriter(String fileName, boolean append) throws IOException;
}
```

Team LiB

FilterInputStream java.io

Java 1.0 *closeable*

This class provides method definitions required to filter data obtained from the `InputStream` specified when the `FilterInputStream` is created. It must be subclassed to perform some sort of filtering operation and cannot be instantiated directly. See the subclasses `BufferedInputStream`, `DataInputStream`, and `PushbackInputStream`.

Figure 9-21. java.io.FilterInputStream


```
public class FilterInputStream extends InputStream {
// Protected Constructors
     protected FilterInputStream(InputStream in);
// Public Methods Overriding InputStream
     public int available( ) throws IOException;
     public void close( ) throws IOException;
     public void mark(int readlimit);                    synchronized
     public boolean markSupported( );
     public int read( ) throws IOException;
     public int read(byte[ ] b) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
     public void reset( ) throws IOException;                       synchronized
     public long skip(long n) throws IOException;
// Protected Instance Fields
     protected volatile InputStream in;
}
```

Subclasses

`BufferedInputStream`, `DataInputStream`, `LineNumberInputStream`, `PushbackInputStream`, `java.security.DigestInputStream`, `java.util.zip.CheckedInputStream`, `java.util.zip.InflaterInputStream`, `javax.crypto.CipherInputStream`

FilterOutputStream java.io

Java 1.0 *closeable flushable*

This class provides method definitions required to filter the data to be written to the `OutputStream` specified when the `FilterOutputStream` is created. It must be subclassed to perform some sort of filtering operation and may not be instantiated directly. See the subclasses `BufferedOutputStream` and `DataOutputStream`.

Figure 9-22. java.io.FilterOutputStream


```
public class FilterOutputStream extends OutputStream {
// Public Constructors
     public FilterOutputStream(OutputStream out);
// Public Methods Overriding OutputStream
     public void close( ) throws IOException;
     public void flush( ) throws IOException;
     public void write(int b) throws IOException;
     public void write(byte[ ] b) throws IOException;
     public void write(byte[ ] b, int off, int len) throws IOException;
// Protected Instance Fields
     protected OutputStream out;
}
```

Subclasses

`BufferedOutputStream`, `DataOutputStream`, `PrintStream`, `java.security.DigestOutputStream`, `java.util.zip.CheckedOutputStream`, `java.util.zip.DeflaterOutputStream`, `javax.crypto.CipherOutputStream`

FilterReader java.io

Java 1.1 *readable closeable*

This abstract class is intended to act as a superclass for character input streams that read data from some other character input stream, filter it in some way, and then return the filtered data when a `read( )` method is called. `FilterReader` is declared `abstract` so that it cannot be instantiated. But none of its methods are themselves abstract: they all simply call the requested operation on the input stream passed to the `FilterReader( )` constructor. If you were allowed to instantiate a `FilterReader`, you'd find that it is a null filter (i.e., it simply reads characters from the specified input stream and returns them without any kind of filtering).

Because `FilterReader` implements a null filter, it is an ideal superclass for classes that want to implement simple filters but do not want to override all the methods of `Reader`. In order to create your own filtered character input stream, you should subclass `FilterReader` and override both its `read( )` methods to perform the desired filtering operation. Note that you can implement one of the `read( )` methods in terms of the other, and thus only implement the filtration once. Recall that the other `read( )` methods defined by `Reader` are implemented in terms of these methods, so you do not need to override those. In some cases, you may need to override other methods of `FilterReader` and provide methods or constructors that are specific to your subclass. `FilterReader` is the character-stream analog to `FilterInputStream`.

Figure 9-23. java.io.FilterReader

```
public abstract class FilterReader extends Reader {
// Protected Constructors
     protected FilterReader(Reader in);
// Public Methods Overriding Reader
     public void close( ) throws IOException;
     public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
// Protected Instance Fields
     protected Reader in;
}
```

Subclasses

`PushbackReader`

Team LiB

FilterWriter java.io

Java 1.1 *appendable closeable flushable*

This abstract class is intended to act as a superclass for character output streams that filter the data written to them before writing it to some other character output stream. `FilterWriter` is declared `abstract` so that it cannot be instantiated. But none of its methods are themselves abstract: they all simply invoke the corresponding method on the output stream that was passed to the `FilterWriter` constructor. If you were allowed to instantiate a `FilterWriter` object, you'd find that it acts as a null filter (i.e., it simply passes the characters written to it along, without any filtration).

Because `FilterWriter` implements a null filter, it is an ideal superclass for classes that want to implement simple filters without having to override all of the methods of `Writer`. In order to create your own filtered character output stream, you should subclass `FilterWriter` and override all its `write( )` methods to perform the desired filtering operation. Note that you can implement two of the `write( )` methods in terms of the third and thus implement your filtering algorithm only once. In some cases, you may want to override other `Writer` methods and add other methods or constructors that are specific to your subclass. `FilterWriter` is the character-stream analog of `FilterOutputStream`.

Figure 9-24. java.io.FilterWriter

```
public abstract class FilterWriter extends Writer {
// Protected Constructors
     protected FilterWriter(Writer out);
// Public Methods Overriding Writer
     public void close( ) throws IOException;
     public void flush( ) throws IOException;
     public void write(int c) throws IOException;
     public void write(char[ ] cbuf, int off, int len) throws IOException;
     public void write(String str, int off, int len) throws IOException;
// Protected Instance Fields
     protected Writer out;
}
```

Flushable java.io

Java 5.0 *flushable*

This interface defines a `flush( )` method and is implemented by flushable objects such as `java.io` streams. This interface was added in Java 5.0 to enable `java.util.Formatter` to distinguish `java.lang.Appendable` objects that need to be flushed (such as streams) from those that do not (such as `StringBuilder` objects). See also `Closeable`.

```
public interface Flushable {
// Public Instance Methods
     void flush( ) throws IOException;
}
```

Implementations

`OutputStream`, `Writer`, `java.util.Formatter`

Team LiB

InputStream java.io

Java 1.0 *closeable*

This abstract class is the superclass of all input streams. It defines the basic input methods all input stream classes provide. read( ) reads a single byte or an array (or subarray) of bytes. It returns the bytes read, the number of bytes read, or -1 if the end-of-file has been reached. skip( ) skips a specified number of bytes of input. available( ) returns the number of bytes that can be read without blocking. close( ) closes the input stream and frees up any system resources associated with it. The stream should not be used after close( ) has been called.

If markSupported( ) returns TRue for a given InputStream, that stream supports mark( ) and reset( ) methods. mark( ) marks the current position in the input stream so that reset( ) can return to that position (as long as no more than the specified number of bytes have been read between the calls to mark( ) and reset( )). See also Reader.

Figure 9-25. java.io.InputStream

```
public abstract class InputStream implements Closeable {
// Public Constructors
     public InputStream( );
// Public Instance Methods
     public int available( ) throws IOException;                       constant
     public void close( ) throws IOException;    Implements:Closeable empty
     public void mark(int readlimit);                       synchronized empty
     public boolean markSupported( );                                  constant
     public abstract int read( ) throws IOException;
     public int read(byte[ ] b) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
     public void reset( ) throws IOException;                      synchronized
     public long skip(long n) throws IOException;
// Methods Implementing Closeable
     public void close( ) throws IOException;                          empty
}
```

Subclasses

ByteArrayInputStream, FileInputStream, FilterInputStream, ObjectInputStream, `PipedInputStream`, `SequenceInputStream`, `StringBufferInputStream`

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

`FilterInputStream.in`, `System.in`

Team LiB

InputStreamReader java.io

Java 1.1 *readable closeable*

This class is a character input stream that uses a byte input stream as its data source. It reads bytes from a specified `InputStream` and translates them into Unicode characters according to a particular platform- and locale-dependent character encoding. This is an important internationalization feature in Java 1.1 and later. `InputStreamReader` supports the standard `Reader` methods. It also has a `getEncoding( )` method that returns the name of the encoding being used to convert bytes to characters.

When you create an `InputStreamReader` , you specify an `InputStream` from which the `InputStreamReader` is to read bytes and, optionally, the name of the character encoding used by those bytes. If you do not specify an encoding name, the `InputStreamReader` uses the default encoding for the default locale, which is usually the correct thing to do. In Java 1.4 and later, this clas uses the charset conversion facilities of the `java.nio.charset` package and allows you to explicitly specify the `Charset` or `CharsetDecoder` to be used. Prior to Java 1.4, the class allows you to specify only the name of the desired charset encoding.

Figure 9-26. java.io.InputStreamReader

```
public class InputStreamReader extends Reader {
// Public Constructors
     public InputStreamReader(InputStream in);
     public InputStreamReader(InputStream in, String charsetName) throws
     UnsupportedEncodingException;
1.4  public InputStreamReader(InputStream in, java.nio.charset.Charset cs);
1.4  public InputStreamReader(InputStream in, java.nio.charset.CharsetDecoder dec);
// Public Instance Methods
     public String getEncoding( );
// Public Methods Overriding Reader
     public void close( ) throws IOException;
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int offset, int length) throws IOException;
     public boolean ready( ) throws IOException;
}
```

Subclasses

FileReader

InterruptedIOException java.io

Java 1.0 *serializable checked*

An `IOException` that signals that an input or output operation was interrupted. The `bytesTransferred` field contains the number of bytes read or written before the operation was interrupted.

Figure 9-27. java.io.InterruptedIOException


```
public class InterruptedIOException extends IOException {
// Public Constructors
     public InterruptedIOException( );
     public InterruptedIOException(String s);
// Public Instance Fields
     public int bytesTransferred;
}
```

Subclasses

`java.net.SocketTimeoutException`

InvalidClassException java.io

Java 1.1 *serializable checked*

Signals that the serialization mechanism has encountered one of several possible problems with the class of an object that is being serialized or deserialized. The `classname` field should contain the name of the class in question, and the `getMessage( )` method is overridden to return this class name with the message.

Figure 9-28. java.io.InvalidClassException


```
public class InvalidClassException extends ObjectStreamException {
// Public Constructors
     public InvalidClassException(String reason);
     public InvalidClassException(String cname, String reason);
// Public Methods Overriding Throwable
     public String getMessage( );
// Public Instance Fields
     public String classname;
}
```

InvalidObjectException java.io

Java 1.1 *serializable checked*

This exception should be thrown by the `validateObject( )` method of an object that implements the `ObjectInputValidation` interface when a deserialized object fails an input validation test for any reason.

Figure 9-29. java.io.InvalidObjectException


```
public class InvalidObjectException extends ObjectStreamException {
// Public Constructors
     public InvalidObjectException(String reason);
}
```

Thrown By

`ObjectInputStream.registerValidation( )`, `ObjectInputValidation.validateObject( )`, `java.text.AttributedCharacterIterator.Attribute.readResolve( )`, `java.text.DateFormat.Field.readResolve( )`, `java.text.MessageFormat.Field.readResolve( )`, `java.text.NumberFormat.Field.readResolve( )`

IOException java.io

Java 1.0 *serializable checked*

Signals that an exceptional condition has occurred during input or output. This class has several more specific subclasses. See `EOFException`, `FileNotFoundException`, `InterruptedIOException`, and `UTFDataFormatException`.

Figure 9-30. java.io.IOException


```
public class IOException extends Exception {
// Public Constructors
     public IOException( );
     public IOException(String s);
}
```

Subclasses

`CharConversionException`, `EOFException`, `FileNotFoundException`, `InterruptedIOException`, `ObjectStreamException`, `SyncFailedException`, `UnsupportedEncodingException`, `UTFDataFormatException`, `java.net.HttpRetryException`, `java.net.MalformedURLException`, `java.net.ProtocolException`, `java.net.SocketException`, `java.net.UnknownHostException`, `java.net.UnknownServiceException`, `java.nio.channels.ClosedChannelException`, `java.nio.channels.FileLockInterruptionException`, `java.nio.charset.CharacterCodingException`, `java.util.InvalidPropertiesFormatException`, `java.util.zip.ZipException`, `javax.net.ssl.SSLException`

Passed To

`java.net.ProxySelector.connectFailed( )`

Returned By

`java.util.Formatter.ioException( )`, `java.util.Scanner.ioException( )`

Thrown By

Too many methods to list.

LineNumberInputStream java.io

Java 1.0; Deprecated in 1.1 *@Deprecated closeable*

This class is a `FilterInputStream` that keeps track of the number of lines of data that have been read. `getLineNumber( )` returns the current line number; `setLineNumber( )` sets the line number of the current line. Subsequent lines are numbered starting from that number. This class is deprecated as of Java 1.1 because it does not properly convert bytes to characters. Use `LineNumberReader` instead.

Figure 9-31. java.io.LineNumberInputStream

```
public class LineNumberInputStream extends FilterInputStream {
// Public Constructors
     public LineNumberInputStream(InputStream in);
// Public Instance Methods
     public int getLineNumber( );
     public void setLineNumber(int lineNumber);
// Public Methods Overriding FilterInputStream
     public int available( ) throws IOException;
     public void mark(int readlimit);
     public int read( ) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
}
```

LineNumberReader java.io

Java 1.1 *readable closeable*

This class is a character input stream that keeps track of the number of lines of text that have been read from it. It supports the usual `Reader` methods and also the `readLine( )` method introduced by its superclass. In addition to these methods, you can call `getLineNumber( )` to query the number of lines set so far. You can also call `setLineNumber( )` to set the line number for the current line. Subsequent lines are numbered sequentially from this specified starting point. This class is a character-stream analog to `LineNumberInputStream`, which has been deprecated as of Java 1.1.

Figure 9-32. java.io.LineNumberReader


```
public class LineNumberReader extends BufferedReader {
// Public Constructors
     public LineNumberReader(Reader in);
     public LineNumberReader(Reader in, int sz);
// Public Instance Methods
     public int getLineNumber( );
     public void setLineNumber(int lineNumber);
// Public Methods Overriding BufferedReader
     public void mark(int readAheadLimit) throws IOException;
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int off, int len) throws IOException;
     public String readLine( ) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
}
```

NotActiveException java.io

Java 1.1 *serializable checked*

This exception is thrown in several circumstances. It indicates that the invoked method was not invoked at the right time or in the correct context. Typically, it means that an`ObjectOutputStream` or `ObjectInputStream` is not currently active and therefore the requested operation cannot be performed.

Figure 9-33. java.io.NotActiveException


```
public class NotActiveException extends ObjectStreamException {
// Public Constructors
     public NotActiveException( );
     public NotActiveException(String reason);
}
```

Thrown By

`ObjectInputStream.registerValidation( )`

NotSerializableException java.io

Java 1.1 *serializable checked*

Signals that an object cannot be serialized. It is thrown when serialization is attempted on an instance of a class that does not implement the `Serializable` interface. Note that it is also thrown when an attempt is made to serialize a `Serializable` object that refers to (or contains) an object that is not `Serializable`. A subclass of a class that is `Serializable` can prevent itself from being serialized by throwing this exception from its `writeObject( )` and/or `readObject( )` methods.

Figure 9-34. java.io.NotSerializableException


```
public class NotSerializableException extends ObjectStreamException {
// Public Constructors
     public NotSerializableException( );
     public NotSerializableException(String classname);
}
```

ObjectInput java.io

Java 1.1

This interface extends the `DataInput` interface and adds methods for deserializing objects and reading bytes and arrays of bytes.

Figure 9-35. java.io.ObjectInput


```
public interface ObjectInput extends DataInput {
// Public Instance Methods
     int available( ) throws IOException;
     void close( ) throws IOException;
     int read( ) throws IOException;
     int read(byte[ ] b) throws IOException;
     int read(byte[ ] b, int off, int len) throws IOException;
     Object readObject( ) throws ClassNotFoundException, IOException;
     long skip(long n) throws IOException;
}
```

Implementations

`ObjectInputStream`

Passed To

`Externalizable.readExternal( )`

ObjectInputStream java.io

Java 1.1 *closeable*

ObjectInputStream deserializes objects, arrays, and other values from a stream that was previously created with an ObjectOutputStream . The readObject( ) method deserializes objects and arrays (which should then be cast to the appropriate type); various other methods read primitive data values from the stream. Note that only objects that implement the Serializable or Externalizable interface can be serialized and deserialized.

A class may implement its own private readObject(ObjectInputStream) method to customize the way it is deserialized. If you define such a method, there are several ObjectInputStream methods you can use to help deserialize the object. defaultReadObject( ) is the easiest. It reads the content of the object just as an ObjectInputStream would normally do. If you wrote additional data before or after the default object contents, you should read that data before or after calling defaultReadObject( ) . When working with multiple versions or implementations of a class, you may have to deserialize a set of fields that do not match the fields of your class. In this case, give your class a static field named serialPersistentFields whose value is an array of ObjectStreamField objects that describe the fields to be deserialized. If you do this, your readObject( ) method can call readFields( ) to read the specified fields from the stream and return them in a ObjectInputStream.GetField object. See ObjectStreamField and ObjectInputStream.GetField for more details. Finally, you can call registerValidation( ) from a custom readObject( ) method. This method registers an ObjectInputValidation object (typically the object being deserialized) to be notified when a complete tree of objects has been deserialized, and the original call to the readObject( ) method of the ObjectInputStream is about to return to its caller.

The remaining methods include miscellaneous stream-manipulation methods and several protected methods for use by subclasses that want to customize the deserialization behavior of ObjectInputStream .

Figure 9-36. java.io.ObjectInputStream

```
public class ObjectInputStream extends InputStream implements ObjectInput,
     ObjectStreamConstants {
// Public Constructors
     public ObjectInputStream(InputStream in) throws IOException;
// Protected Constructors
1.2  protected ObjectInputStream( ) throws IOException, SecurityException;
// Nested Types
1.2  public abstract static class GetField;
```

```
// Public Instance Methods
     public void defaultReadObject( ) throws IOException, ClassNotFoundException;
1.2  public ObjectInputStream.GetField readFields( ) throws IOException,
     ClassNotFoundException;
1.4  public Object readUnshared( ) throws IOException, ClassNotFoundException;
     public void registerValidation(ObjectInputValidation obj, int prio) throws
     NotActiveException, InvalidObjectException;
// Methods Implementing DataInput
     public boolean readBoolean( ) throws IOException;
     public byte readByte( ) throws IOException;
     public char readChar( ) throws IOException;
     public double readDouble( ) throws IOException;
     public float readFloat( ) throws IOException;
     public void readFully(byte[ ] buf) throws IOException;
     public void readFully(byte[ ] buf, int off, int len) throws IOException;
     public int readInt( ) throws IOException;
     public long readLong( ) throws IOException;
     public short readShort( ) throws IOException;
     public int readUnsignedByte( ) throws IOException;
     public int readUnsignedShort( ) throws IOException;
     public String readUTF( ) throws IOException;
     public int skipBytes(int len) throws IOException;
// Methods Implementing ObjectInput
     public int available( ) throws IOException;
     public void close( ) throws IOException;
     public int read( ) throws IOException;
     public int read(byte[ ] buf, int off, int len) throws IOException;
     public final Object readObject( ) throws IOException, ClassNotFoundException;
// Protected Instance Methods
     protected boolean enableResolveObject(boolean enable) throws SecurityException;
1.3  protected ObjectStreamClass readClassDescriptor( ) throws IOException,
     ClassNotFoundException;
1.2  protected Object readObjectOverride( ) throws IOException,
     ClassNotFoundException;     constant
     protected void readStreamHeader( ) throws IOException, StreamCorruptedException;
     protected Class<?> resolveClass(ObjectStreamClass desc) throws IOException,
     ClassNotFoundException;
     protected Object resolveObject(Object obj) throws IOException;
1.3  protected Class<?> resolveProxyClass(String[ ] interfaces) throws IOException,
     ClassNotFoundException;
// Deprecated Public Methods
#    public String readLine( ) throws IOException;              Implements:DataInput
}
```

Team LiB

ObjectInputStream.GetField java.io

Java 1.2

This class holds the values of named fields read by an `ObjectInputStream`. It gives the programmer precise control over the deserialization process and is typically used when implementing an object with a set of fields that do not match the set of fields (and the serialization stream format) of the original implementation of the object. This class allows the implementation of a class to change without breaking serialization compatibility.

In order to use the `GetField` class, your class must implement a private `readObject( )` method that is responsible for custom deserialization. Typically, when using the `GetField` class, you have also specified an array of `ObjectStreamField` objects as the value of a private static field named `serialPersistentFields`. This array specifies the names and types of all fields expected to be found when reading from a serialization stream. If there is no `serialPersistentField` field, the array of `ObjectStreamField` objects is created from the actual fields (excluding `static` and `TRansient` fields) of the class.

Within the `readObject( )` method of your class, call the `readFields( )` method of `ObjectInputStream( )`. This method reads the values of all fields from the stream and stores them in an `ObjectInputStream.GetField` object that it returns. This `GetField` object is essentially a mapping from field names to field values, and you can extract the values of whatever fields you need in order to restore the proper state of the object being deserialized. The various `get( )` methods return the values of named fields of specified types. Each method takes a default value as an argument, in case no value for the named field was present in the serialization stream. (This can happen when deserializing an object written by an earlier version of the class, for example.) Use the `defaulted( )` method to determine whether the `GetField` object contains a value for the named field. If this method returns `true`, the named field had no value in the stream, so the `get( )` method of the `GetField` object has to return the specified default value. The `getObjectStreamClass( )` method of a `GetField` object returns the `ObjectStreamClass` object for the object being deserialized. This `ObjectStreamClass` can obtain the array of `ObjectStreamField` objects for the class.

See also

`ObjectOutputStream.PutField`

```
public abstract static class ObjectInputStream.GetField {
// Public Constructors
     public GetField( );
// Public Instance Methods
     public abstract boolean defaulted(String name) throws IOException;
     public abstract boolean get(String name, boolean val) throws IOException;
     public abstract byte get(String name, byte val) throws IOException;
```

```
    public abstract char get(String name, char val) throws IOException;
    public abstract short get(String name, short val) throws IOException;
    public abstract int get(String name, int val) throws IOException;
    public abstract long get(String name, long val) throws IOException;
    public abstract float get(String name, float val) throws IOException;
    public abstract double get(String name, double val) throws IOException;
    public abstract Object get(String name, Object val) throws IOException;
    public abstract ObjectStreamClass getObjectStreamClass( );
}
```

Returned By

ObjectInputStream.readFields( )

ObjectInputValidation java.io

Java 1.1

A class implements this interface and defines the `validateObject( )` method in order to validate itself when it and all the objects it depends on have been completely deserialized from an `ObjectInputStream`. The `validateObject( )` method is only invoked, however, if the object is passed to `ObjectInputStream.registerValidation( )`; this must be done from the `readObject( )` method of the object. Note that if an object is deserialized as part of a larger object graph, its `validateObject( )` method is not invoked until the entire graph is read, and the original call to `ObjectInputStream.readObject( )` is about to return. `validateObject( )` should throw an `InvalidObjectException` if the object fails validation. This stops object serialization, and the origina call to `ObjectInputStream.readObject( )` terminates with the `InvalidObjectException` exception.

```
public interface ObjectInputValidation {
// Public Instance Methods
     void validateObject( ) throws InvalidObjectException;
}
```

Passed To

`ObjectInputStream.registerValidation( )`

Team LiB

ObjectOutput java.io

Java 1.1

This interface extends the `DataOutput` interface and adds methods for serializing objects and writing bytes and arrays of bytes.

Figure 9-37. java.io.ObjectOutput


```
public interface ObjectOutput extends DataOutput {
// Public Instance Methods
     void close( ) throws IOException;
     void flush( ) throws IOException;
     void write(byte[ ] b) throws IOException;
     void write(int b) throws IOException;
     void write(byte[ ] b, int off, int len) throws IOException;
     void writeObject(Object obj) throws IOException;
}
```

Implementations

`ObjectOutputStream`

Passed To

`Externalizable.writeExternal( )`, `ObjectOutputStream.PutField.write( )`

ObjectOutputStream java.io

Java 1.1 *closeable flushable*

The `ObjectOutputStream` serializes objects, arrays, and other values to a stream. The `writeObject( )` method serializes an object or array, and various other methods write primitive data values to the stream. Note that only objects that implement the `Serializable` or `Externalizable` interface can be serialized.

A class that wants to customize the way instances are serialized should declare a private `writeObject(ObjectOutputStream)` method. This method is invoked when an object is being serialized and can use several additional methods of `ObjectOutputStream`. `defaultWriteObject( )` performs the same serialization that would happen if no `writeObject( )` method existed. An object can call this method to serialize itself and then use other methods of `ObjectOutputStream` to write additional data to the serialization stream. The class must define a matching `readObject( )` method to read that additional data, of course. When working with multiple versions or implementations of a class you may have to serialize a set of fields that do not precisely match the fields of your class. In this case, give your class a static field named `serialPersistentFields` whose value is an array of `ObjectStreamField` objects that describe the fields to be serialized. In your `writeObject( )` method, call `putFields( )` to obtain an `ObjectOutputStream.PutField` object. Store field names and values into this object, and then call `writeFields( )` to write them out to the serialization stream. See `ObjectStreamField` and `ObjectOutputStream.PutField` for further details.

The remaining methods of `ObjectOutputStream` are miscellaneous stream-manipulation methods and protected methods for use by subclasses that want to customize its serialization behavior.

Figure 9-38. java.io.ObjectOutputStream

```
public class ObjectOutputStream extends OutputStream implements ObjectOutput,
     ObjectStreamConstants {
// Public Constructors
     public ObjectOutputStream(OutputStream out) throws IOException;
// Protected Constructors
1.2  protected ObjectOutputStream( ) throws IOException, SecurityException;
// Nested Types
1.2  public abstract static class PutField;
// Public Instance Methods
     public void defaultWriteObject( ) throws IOException;
1.2  public ObjectOutputStream.PutField putFields( ) throws IOException;
     public void reset( ) throws IOException;
```

```
1.2  public void useProtocolVersion(int version) throws IOException;
1.2  public void writeFields( ) throws IOException;
1.4  public void writeUnshared(Object obj) throws IOException;
// Methods Implementing DataOutput
     public void writeBoolean(boolean val) throws IOException;
     public void writeByte(int val) throws IOException;
     public void writeBytes(String str) throws IOException;
     public void writeChar(int val) throws IOException;
     public void writeChars(String str) throws IOException;
     public void writeDouble(double val) throws IOException;
     public void writeFloat(float val) throws IOException;
     public void writeInt(int val) throws IOException;
     public void writeLong(long val) throws IOException;
     public void writeShort(int val) throws IOException;
     public void writeUTF(String str) throws IOException;
// Methods Implementing ObjectOutput
     public void close( ) throws IOException;
     public void flush( ) throws IOException;
     public void write(int val) throws IOException;
     public void write(byte[ ] buf) throws IOException;
     public void write(byte[ ] buf, int off, int len) throws IOException;
     public final void writeObject(Object obj) throws IOException;
// Protected Instance Methods
     protected void annotateClass(Class<?> cl) throws IOException;     empty
1.3  protected void annotateProxyClass(Class<?> cl) throws IOException;     empty
     protected void drain( ) throws IOException;
     protected boolean enableReplaceObject(boolean enable) throws SecurityException;
     protected Object replaceObject(Object obj) throws IOException;
1.3  protected void writeClassDescriptor(ObjectStreamClass desc) throws IOException;
1.2  protected void writeObjectOverride(Object obj) throws IOException;     empty
     protected void writeStreamHeader( ) throws IOException;
}
```

Team LiB

ObjectOutputStream.PutField java.io

Java 1.2

This class holds values of named fields and allows them to be written to an `ObjectOutputStream` during the process of object serialization. It gives the programmer precise control over the serialization process and is typically used when the set of fields defined by a class does not match the set of fields (and the serialization stream format) defined by the original implementation of the class. In other words, `ObjectOutputStream.PutField` allows the implementation of a class to change without breaking serialization compatibility.

In order to use the `PutField` class, you typically define a private static `serialPersistentFields` field that refers to an array of `ObjectStreamField` objects. This array defines the set of fields written to the `ObjectOutputStream` and therefore defines the serialization format. If you do not declare a `serialPersistentFields` field, the set of fields is all fields of the class, excluding `static` and `TRansient` fields.

In addition to the `serialPersistentFields` field, your class must also define a private `writeObject( )` method that is responsible for the custom serialization of your class. In this method call the `putFields( )` method of `ObjectOutputStream` to obtain an `ObjectOutputStream.PutField` object. Once you have this object, use its various `put( )` methods to specify the names and values of the field to be written out. The set of named fields should match those specified by `serialPersistentFields`. You may specify the fields in any order; the `PutField` class is responsible for writing them out in the correct order. Once you have specified the values of all fields, call the `write( )` method of your `PutField` object in order to write the field values out to the serialization stream.

To reverse this custom serialization process, see `ObjectInputStream.GetField`.

```
public abstract static class ObjectOutputStream.PutField {
// Public Constructors
     public PutField( );
// Public Instance Methods
     public abstract void put(String name, long val);
     public abstract void put(String name, int val);
     public abstract void put(String name, float val);
     public abstract void put(String name, Object val);
     public abstract void put(String name, double val);
     public abstract void put(String name, byte val);
     public abstract void put(String name, boolean val);
     public abstract void put(String name, short val);
     public abstract void put(String name, char val);
// Deprecated Public Methods
#    public abstract void write(ObjectOutput out) throws IOException;
}
```

Returned By

`ObjectOutputStream.putFields( )`

ObjectStreamClass java.io

Java 1.1 *serializable*

This class represents a class that is being serialized. An `ObjectStreamClass` object contains the name of a class, its unique version identifier, and the name and type of the fields that constitute the serialization format for the class. `getSerialVersionUID( )` returns a unique version identifier for the class. It returns either the value of the private `serialVersionUID` field of the class or a computed value that is based upon the public API of the class. In Java 1.2 and later, `getFields( )` returns an array of `ObjectStreamField` objects that represent the names and types of the fields of the class to be serialized. `getField( )` returns a single `ObjectStreamField` object that represents a single named field. By default, these methods use all the fields of a class except those that are `static` or `transient`. However, this default set of fields can be overridden by declaring a private `serialPersistentFields` field in the class. The value of this field should be the desired array of `ObjectStreamField` objects.

`ObjectStreamClass` class does not have a constructor; you should use the static `lookup( )` method to obtain an `ObjectStreamClass` object for a given `Class` object. The `forClass( )` instance method performs the opposite operation; it returns the `Class` object that corresponds to a given `ObjectStreamClass`. Most applications never need to use this class.

Figure 9-39. java.io.ObjectStreamClass

```
public class ObjectStreamClass implements Serializable {
// No Constructor
// Public Constants
1.2  public static final ObjectStreamField[ ] NO_FIELDS;
// Public Class Methods
     public static ObjectStreamClass lookup(Class<?> cl);
// Public Instance Methods
     public Class<?> forClass( );
1.2  public ObjectStreamField getField(String name);
1.2  public ObjectStreamField[ ] getFields( );
     public String getName( );
     public long getSerialVersionUID( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`ObjectInputStream.resolveClass( )`, `ObjectOutputStream.writeClassDescriptor( )`

Returned By

`ObjectInputStream.readClassDescriptor( )`,
`ObjectInputStream.GetField.getObjectStreamClass( )`

Team LiB

ObjectStreamConstants java.io

Java 1.2

This interface defines various constants used by the Java object-serialization mechanism. Two important constants are PROTOCOL_VERSION_1 and PROTOCOL_VERSION_2 , which specify the version of the serialization protocol to use. In Java 1.2, you can pass either of these values to the useProtocolVersion( ) method of an ObjectOutputStream . By default, Java 1.2 uses Version 2 of the protocol, and Java 1.1 uses Version 1 when serializing objects. Java 1.2 can deserialize objects written using either version of the protocol, as can Java 1.1.7 and later. If you want to serialize an object so that it can be read by versions of Java prior to Java 1.1.7, use PROTOCOL_VERSION_1 .

The other constants defined by this interface are low-level values used by the serialization protocol. You do not need to use them unless you are reimplementing the serialization mechanism yourself.

```
public interface ObjectStreamConstants {
// Public Constants
     public static final int baseWireHandle;                                   =8257536
     public static final int PROTOCOL_VERSION_1;                               =1
     public static final int PROTOCOL_VERSION_2;                               =2
     public static final byte SC_BLOCK_DATA;                                   =8
5.0  public static final byte SC_ENUM; =16
     public static final byte SC_EXTERNALIZABLE;                               =4
     public static final byte SC_SERIALIZABLE;                                 =2
     public static final byte SC_WRITE_METHOD;                                 =1
     public static final short STREAM_MAGIC;                                   =-21267
     public static final short STREAM_VERSION;                                 =5
     public static final SerializablePermission SUBCLASS_IMPLEMENTATION_PERMISSION;
     public static final SerializablePermission SUBSTITUTION_PERMISSION;
     public static final byte TC_ARRAY;    =117
     public static final byte TC_BASE;     =112
     public static final byte TC_BLOCKDATA;                                    =119
     public static final byte TC_BLOCKDATALONG;                                =122
     public static final byte TC_CLASS;    =118
     public static final byte TC_CLASSDESC;                                    =114
     public static final byte TC_ENDBLOCKDATA;                                 =120
5.0  public static final byte TC_ENUM; =126
     public static final byte TC_EXCEPTION;                                    =123
1.3  public static final byte TC_LONGSTRING;                              =124
     public static final byte TC_MAX;      =126
     public static final byte TC_NULL;     =112
     public static final byte TC_OBJECT;   =115
1.3  public static final byte TC_PROXYCLASSDESC;                          =125
     public static final byte TC_REFERENCE;                                    =113
```

```
    public static final byte TC_RESET;     =121
    public static final byte TC_STRING;    =116
}
```

Implementations

ObjectInputStream , ObjectOutputStream

Team LiB

ObjectStreamException java.io

Java 1.1 *serializable checked*

This class is the superclass of a number of more specific exception types that may be raised in the process of serializing and deserializing objects with the `ObjectOutputStream` and `ObjectInputStream` classes.

Figure 9-40. java.io.ObjectStreamException


```
public abstract class ObjectStreamException extends IOException {
// Protected Constructors
     protected ObjectStreamException( );
     protected ObjectStreamException(String classname);
}
```

Subclasses

`InvalidClassException`, `InvalidObjectException`, `NotActiveException`, `NotSerializableException`, `OptionalDataException`, `StreamCorruptedException`, `WriteAbortedException`

Thrown By

`java.security.KeyRep.readResolve( )`, `java.security.cert.Certificate.writeReplace( )`, `java.security.cert.Certificate.CertificateRep.readResolve( )`, `java.security.cert.CertPath.writeReplace( )`, `java.security.cert.CertPath.CertPathRep.readResolve( )`

ObjectStreamField java.io

Java 1.2 *comparable*

This class represents a named field of a specified type (i.e., a specified `Class`). When a class serializes itself by writing a set of fields that are different from the fields it uses in its own implementation, it defines the set of fields to be written with an array of `ObjectStreamField` objects. This array should be the value of a private static field named `serialPersistentFields`. The methods of this class are used internally by the serialization mechanism and are not typically used elsewhere. See also `ObjectOutputStream.PutField` and `ObjectInputStream.GetField`.

Figure 9-41. java.io.ObjectStreamField


```
public class ObjectStreamField implements Comparable<Object> {
// Public Constructors
     public ObjectStreamField(String name, Class<?> type);
1.4  public ObjectStreamField(String name, Class<?> type, boolean unshared);
// Public Instance Methods
     public String getName( );
     public int getOffset( );
     public Class<?> getType( );
     public char getTypeCode( );
     public String getTypeString( );
     public boolean isPrimitive( );
1.4  public boolean isUnshared( );
// Methods Implementing Comparable
     public int compareTo(Object obj);
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Methods
     protected void setOffset(int offset);
}
```

Returned By

`ObjectStreamClass.{getField( ), getFields( )}`

Type Of

`ObjectStreamClass.NO_FIELDS`

OptionalDataException java.io

Java 1.1 *serializable checked*

Thrown by the `readObject( )` method of an `ObjectInputStream` when it encounters primitive type data where it expects object data. Despite the exception name, this data is not optional, and object deserialization is stopped.

Figure 9-42. java.io.OptionalDataException


```java
public class OptionalDataException extends ObjectStreamException {
// No Constructor
// Public Instance Fields
     public boolean eof;
     public int length;
}
```

OutputStream java.io

Java 1.0 *closeable flushable*

This abstract class is the superclass of all output streams. It defines the basic output methods all output stream classes provide. `write( )` writes a single byte or an array (or subarray) of bytes. `flush( )` forces any buffered output to be written. `close( )` closes the stream and frees up any system resources associated with it. The stream may not be used once `close( )` has been called. See also `Writer`.

Figure 9-43. java.io.OutputStream


```
public abstract class OutputStream implements Closeable, Flushable {
// Public Constructors
     public OutputStream( );
// Public Instance Methods
     public void close( ) throws IOException;  Implements:Closeable empty
     public void flush( ) throws IOException;  Implements:Flushable empty
     public abstract void write(int b) throws IOException;
     public void write(byte[ ] b) throws IOException;
     public void write(byte[ ] b, int off, int len) throws IOException;
// Methods Implementing Closeable
     public void close( ) throws IOException;                    empty
// Methods Implementing Flushable
     public void flush( ) throws IOException;                    empty
}
```

Subclasses

`ByteArrayOutputStream`, `FileOutputStream`, `FilterOutputStream`, `ObjectOutputStream`, `PipedOutputStream`

Passed To

Too many methods to list.

Returned By

Process.getOutputStream( ), Runtime.getLocalizedOutputStream( ), java.net.CacheRequest.getBody( ), java.net.Socket.getOutputStream( ), java.net.SocketImpl.getOutputStream( ), java.net.URLConnection.getOutputStream( ), java.nio.channels.Channels.newOutputStream( ), javax.xml.transform.stream.StreamResult.getOutputStream( )

Type Of

FilterOutputStream.out

OutputStreamWriter java.io

Java 1.1 *appendable closeable flushable*

This class is a character output stream that uses a byte output stream as the destination for its data. When characters are written to an `OutputStreamWriter` , it translates them into bytes according to a particular locale- and/or platform-specific character encoding and writes those bytes to the specified `OutputStream` . This is a very important internationalization feature in Java 1.1 and later. `OutputStreamWriter` supports the usual `Writer` methods. It also has a `getEncoding( )` method that returns the name of the encoding being used to convert characters to bytes.

When you create an `OutputStreamWriter` , specify the `OutputStream` to which it writes bytes and, optionally, the name of the character encoding that should be used to convert characters to bytes. If yo do not specify an encoding name, the `OutputStreamWriter` uses the default encoding of the default locale, which is usually the correct thing to do. In Java 1.4 and later, this class uses the charset conversion facilities of the `java.nio.charset` package and allows you to explicitly specify the `Charset` o `CharsetEncoder` to be used. Prior to Java 1.4, the class allows you to specify only the name of the desir charset encoding.

Figure 9-44. java.io.OutputStreamWriter

```
public class OutputStreamWriter extends Writer {
// Public Constructors
     public OutputStreamWriter(OutputStream out);
     public OutputStreamWriter(OutputStream out, String charsetName) throws
     UnsupportedEncodingException;
1.4  public OutputStreamWriter(OutputStream out, java.nio.charset.CharsetEncoder enc);
1.4  public OutputStreamWriter(OutputStream out, java.nio.charset.Charset cs);
// Public Instance Methods
     public String getEncoding( );
// Public Methods Overriding Writer
     public void close( ) throws IOException;
     public void flush( ) throws IOException;
     public void write(int c) throws IOException;
     public void write(char[ ] cbuf, int off, int len) throws IOException;
     public void write(String str, int off, int len) throws IOException;
}
```

Subclasses

FileWriter

Team LiB

PipedInputStream java.io

Java 1.0 *closeable*

This class is an `InputStream` that implements one half of a pipe and is useful for communication between threads. A `PipedInputStream` must be connected to a `PipedOutputStream` object, which may be specified when the `PipedInputStream` is created or with the `connect( )` method. Data read from a `PipedInputStream` object is received from the `PipedOutputStream` to which it is connected. See `InputStream` for information on the low-level methods for reading data from a `PipedInputStream` . A `FilterInputStream` can provide a higher-level interface for reading data from a `PipedInputStream` .

Figure 9-45. java.io.PipedInputStream


```
public class PipedInputStream extends InputStream {
// Public Constructors
     public PipedInputStream( );
     public PipedInputStream(PipedOutputStream src) throws IOException;
// Protected Constants
1.1  protected static final int PIPE_SIZE;                          =1024
// Public Instance Methods
     public void connect(PipedOutputStream src) throws IOException;
// Public Methods Overriding InputStream
     public int available( ) throws IOException;                synchronized
     public void close( ) throws IOException;
     public int read( ) throws IOException;                     synchronized
     public int read(byte[ ] b, int off, int len) throws IOException;     synchronized
// Protected Instance Methods
1.1  protected void receive(int b) throws IOException;          synchronized
// Protected Instance Fields
1.1  protected byte[ ] buffer;
1.1  protected int in;
1.1  protected int out;
}
```

Passed To

`PipedOutputStream.{connect( ) , PipedOutputStream( )}`

PipedOutputStream java.io

Java 1.0 *closeable flushable*

This class is an `OutputStream` that implements one half a pipe and is useful for communication between threads. A `PipedOutputStream` must be connected to a `PipedInputStream`, which may be specified when the `PipedOutputStream` is created or with the `connect( )` method. Data written to the `PipedOutputStream` is available for reading on the `PipedInputStream`. See `OutputStream` for information on the low-level methods for writing data to a `PipedOutputStream`. A `FilterOutputStream` can provide a higher-level interface for writing data to a `PipedOutputStream`.

Figure 9-46. java.io.PipedOutputStream


```
public class PipedOutputStream extends OutputStream {
// Public Constructors
     public PipedOutputStream( );
     public PipedOutputStream(PipedInputStream snk) throws IOException;
// Public Instance Methods
     public void connect(PipedInputStream snk) throws IOException;      synchronized
// Public Methods Overriding OutputStream
     public void close( ) throws IOException;
     public void flush( ) throws IOException;                           synchronized
     public void write(int b) throws IOException;
     public void write(byte[ ] b, int off, int len) throws IOException;
}
```

Passed To

`PipedInputStream.{connect( ), PipedInputStream( )}`

Team LiB

PipedReader java.io

Java 1.1 *readable closeable*

PipedReader is a character input stream that reads characters from a PipedWriter character output stream to which it is connected. PipedReader implements one half of a pipe and is useful for communication between two threads of an application. A PipedReader cannot be used until it is connected to a PipedWriter object, which may be passed to the PipedReader( ) constructor or to the connect( ) method. PipedReader inherits most of the methods of its superclass. See Reader for more information. PipedReader is the character-stream analog of PipedInputStream .

Figure 9-47. java.io.PipedReader


```
public class PipedReader extends Reader {
// Public Constructors
     public PipedReader( );
     public PipedReader(PipedWriter src) throws IOException;
// Public Instance Methods
     public void connect(PipedWriter src) throws IOException;
// Public Methods Overriding Reader
     public void close( ) throws IOException;
1.2  public int read( ) throws IOException;                          synchronized
     public int read(char[ ] cbuf, int off, int len) throws IOException;     synchroniz
1.2  public boolean ready( ) throws IOException;                     synchronized
}
```

Passed To

PipedWriter.{connect( ) , PipedWriter( )}

Team LiB

PipedWriter java.io

Java 1.1 *appendable closeable flushable*

PipedWriter is a character output stream that writes characters to the PipedReader character input stream to which it is connected. PipedWriter implements one half of a pipe and is useful for communication between two threads of an application. A PipedWriter cannot be used until it is connected to a PipedReader object, which may be passed to the PipedWriter( ) constructor or to the connect( ) method. PipedWriter inherits most of the methods of its superclass. See Writer for more information. PipedWriter is the character-stream analog of PipedOutputStream.

Figure 9-48. java.io.PipedWriter


```
public class PipedWriter extends Writer {
// Public Constructors
     public PipedWriter( );
     public PipedWriter(PipedReader snk) throws IOException;
// Public Instance Methods
     public void connect(PipedReader snk) throws IOException;           synchronized
// Public Methods Overriding Writer
     public void close( ) throws IOException;
     public void flush( ) throws IOException;                       synchronized
1.2  public void write(int c) throws IOException;
     public void write(char[ ] cbuf, int off, int len) throws IOException;
}
```

Passed To

PipedReader.{connect( ), PipedReader( )}

Team LiB

PrintStream java.io

Java 1.0 *appendable closeable flushable*

This class is a byte output stream that implements a number of methods for displayingtextual representations of Java primitive data types. `System.out` and `System.err` are `PrintStream` objects. `PrintStream` converts characters to bytes using the platform's default charset, or the charset or encoding named in the `PrintStream( )` constructor invocation. In Java 5.0, convenience constructors allow you to specify a file (either as a file name or a `File` object) as the destination of a `PrintStream` . Prior to Java 5.0 the destination had to be another `OutputStream` object.

The `print( )` methods output standard textual representations of each data type. The `println( )` methods do the same and follow the representations with newlines. Each method converts a Java primitive type to a `String` representation and outputs the resulting string. When an `Object` is passed to a `print( )` or `println( )` , it is converted to a `String` by calling its `toString( )` method. In Java 5.0, you can also use the `printf( )` methods (or the `format( )` methods that behave identically) for formatted output. These methods behave like the `format( )` method of a `java.util.Formatter` object that uses the `PrintStream` as its destination.

This class implements the `java.lang.Appendable` interface in Java 5.0, which makes it suitable for use with a `java.util.Formatter` .

See also `PrintWriter` for a character output stream with similar functionality. And see `DataOutputStream` for a byte output stream that outputs binary, rather than textual, representations of Java's primitive types.

Figure 9-49. java.io.PrintStream

```
public class PrintStream extends FilterOutputStream implements Appendable, Closeable {
// Public Constructors
5.0  public PrintStream(File file) throws FileNotFoundException;
5.0  public PrintStream(String fileName) throws FileNotFoundException;
     public PrintStream(OutputStream out);
5.0  public PrintStream(String fileName, String csn) throws FileNotFoundException,
     UnsupportedEncodingException;
     public PrintStream(OutputStream out, boolean autoFlush);
5.0  public PrintStream(File file, String csn) throws FileNotFoundException,
     UnsupportedEncodingException;
1.4  public PrintStream(OutputStream out, boolean autoFlush, String encoding) throws
     UnsupportedEncodingException;
```

```
// Public Instance Methods
5.0  public PrintStream append(char c);
5.0  public PrintStream append(CharSequence csq);
5.0  public PrintStream append(CharSequence csq, int start, int end);
     public boolean checkError( );
     public void close( );                              Implements:Closeable
5.0  public PrintStream format(String format, Object... args);
5.0  public PrintStream format(java.util.Locale l, String format, Object... args);
     public void print(double d);
     public void print(float f);
     public void print(char[ ] s);
     public void print(Object obj);
     public void print(String s);
     public void print(long l);
     public void print(boolean b);
     public void print(char c);
     public void print(int i);
5.0  public PrintStream printf(String format, Object... args);
5.0  public PrintStream printf(java.util.Locale l, String format, Object... args);
     public void println( );
     public void println(char[ ] x);
     public void println(double x);
     public void println(Object x);
     public void println(String x);
     public void println(float x);
     public void println(char x);
     public void println(boolean x);
     public void println(long x);
     public void println(int x);
// Methods Implementing Closeable
     public void close( );
// Public Methods Overriding FilterOutputStream
     public void flush( );
     public void write(int b);
     public void write(byte[ ] buf, int off, int len);
// Protected Instance Methods
1.1  protected void setError( );
}
```

Passed To

System.{setErr( ) , setOut( )} , THRowable.printStackTrace( ) , java.util.Formatter.Formatter( ) , java.util.Properties.list( ) , javax.xml.transform.TransformerException.printStackTrace( ) , javax.xml.xpath.XPathException.printStackTrace( )

Type Of

`System.{err , out}`

Team LiB

Team LiB

PrintWriter java.io

Java 1.1 *appendable closeable flushable*

This class is a character output stream that implements a number of `print( )` and `println( )` methods that output textual representations of primitive values and objects. When you create a `PrintWriter` object, you specify a character or byte output stream that it should write its characters to and, optionally, whether the `PrintWriter` stream should be automatically flushed whenever `println( )` is called. If you specify a byte output stream as the destination, the `PrintWriter( )` constructor automatically creates the necessary `OutputStreamWriter` object to convert characters to bytes using the default encoding. In Java 5.0, convenience constructors allow you to specify a file (either as a file name or a `File` object) as the destination. You may optionally specify the name of a charset to use for character-to-byte conversion when writing to the file.

`PrintWriter` implements the normal `write( )`, `flush( )`, and `close( )` methods all `Writer` subclasses define. It is more common to use the higher-level `print( )` and `println( )` methods, each of which converts its argument to a string before outputting it. `println( )` can also terminate the line (and optionally flush the buffer) after printing its argument. In Java 5.0, you can also use the `printf( )` methods (or the `format( )` methods that behave identically) for formatted output. These methods behave like the `format( )` method of a `java.util.Formatter` object that uses the `PrintWriter` as its destination.

The methods of `PrintWriter` never throw exceptions. Instead, when errors occur, they set an internal flag you can check by calling `checkError( )`. `checkError( )` first flushes the internal stream and then returns `true` if any exception has occurred while writing values to that stream. Once an error has occurred on a `PrintWriter` object, all subsequent calls to `checkError( )` return `true`; there is no way to reset the error flag.

`PrintWriter` is the character stream analog to `PrintStream`, which it supersedes. You can usually easily replace any `PrintStream` objects in a program with `PrintWriter` objects. This is particularly important for internationalized programs. The only valid remaining use for the `PrintStream` class is for the `System.out` and `System.err` standard output streams. See `PrintStream` for details.

Figure 9-50. java.io.PrintWriter

```
public class PrintWriter extends Writer {
// Public Constructors
5.0  public PrintWriter(String fileName) throws FileNotFoundException;
5.0  public PrintWriter(File file) throws FileNotFoundException;
     public PrintWriter(OutputStream out);
```

```
     public PrintWriter(Writer out);
5.0  public PrintWriter(File file, String csn) throws FileNotFoundException,
     UnsupportedEncodingException;
5.0  public PrintWriter(String fileName, String csn) throws FileNotFoundException,
     UnsupportedEncodingException;
     public PrintWriter(OutputStream out, boolean autoFlush);
     public PrintWriter(Writer out, boolean autoFlush);
// Public Instance Methods
5.0  public PrintWriter append(char c);
5.0  public PrintWriter append(CharSequence csq);
5.0  public PrintWriter append(CharSequence csq, int start, int end);
     public boolean checkError( );
5.0  public PrintWriter format(String format, Object... args);
5.0  public PrintWriter format(java.util.Locale l, String format, Object... args);
     public void print(double d);
     public void print(float f);
     public void print(long l);
     public void print(Object obj);
     public void print(String s);
     public void print(char[ ] s);
     public void print(boolean b);
     public void print(char c);
     public void print(int i);
5.0  public PrintWriter printf(String format, Object... args);
5.0  public PrintWriter printf(java.util.Locale l, String format, Object... args);
     public void println( );
     public void println(double x);
     public void println(float x);
     public void println(char[ ] x);
     public void println(Object x);
     public void println(String x);
     public void println(char x);
     public void println(boolean x);
     public void println(long x);
     public void println(int x);
// Public Methods Overriding Writer
     public void close( );
     public void flush( );
     public void write(String s);
     public void write(char[ ] buf);
     public void write(int c);
     public void write(String s, int off, int len);
     public void write(char[ ] buf, int off, int len);
// Protected Instance Methods
     protected void setError( );
// Protected Instance Fields
1.2  protected Writer out;
}
```

Passed To

THRowable.printStackTrace( ), java.util.Properties.list( ), javax.xml.transform.TransformerException.printStackTrace( ), javax.xml.xpath.XPathException.printStackTrace( )

downloaded from: lib.ommolketab.ir

Team LiB

PushbackInputStream java.io

Java 1.0 *closeable*

This class is a FilterInputStream that implements a one-byte pushback buffer or, as of Java 1.1, a pushback buffer of a specified length. The unread( ) methods push bytes back into the stream; these bytes are the first ones read by the next call to a read( ) method. This class is sometimes useful when writing parsers. See also PushbackReader.

Figure 9-51. java.io.PushbackInputStream


```
public class PushbackInputStream extends FilterInputStream {
// Public Constructors
     public PushbackInputStream(InputStream in);
1.1  public PushbackInputStream(InputStream in, int size);
// Public Instance Methods
     public void unread(int b) throws IOException;
1.1  public void unread(byte[ ] b) throws IOException;
1.1  public void unread(byte[ ] b, int off, int len) throws IOException;
// Public Methods Overriding FilterInputStream
     public int available( ) throws IOException;
1.2  public void close( ) throws IOException;                  synchronized
5.0  public void mark(int readlimit);                         synchronized empty
     public boolean markSupported( );                                  constant
     public int read( ) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
5.0  public void reset( ) throws IOException;                  synchronized
1.2  public long skip(long n) throws IOException;
// Protected Instance Fields
1.1  protected byte[ ] buf;
1.1  protected int pos;
}
```

PushbackReader java.io

Java 1.1 *readable closeable*

This class is a character input stream that uses another input stream as its input source and adds the ability to push characters back onto the stream. This feature is often useful when writing parsers. When you create a `PushbackReader` stream, you specify the stream to be read from and, optionally, the size of the pushback buffer (i.e., the number of characters that may be pushed back onto the stream or unread). If you do not specify a size for this buffer, the default size is one character. `PushbackReader` inherits or overrides all standard `Reader` methods and adds three `unread( )` methods that push a single character, an array of characters, or a portion of an array of characters back onto the stream. This class is the character stream analog of `PushbackInputStream`.

Figure 9-52. java.io.PushbackReader

```
public class PushbackReader extends FilterReader {
// Public Constructors
     public PushbackReader(Reader in);
     public PushbackReader(Reader in, int size);
// Public Instance Methods
     public void unread(int c) throws IOException;
     public void unread(char[ ] cbuf) throws IOException;
     public void unread(char[ ] cbuf, int off, int len) throws IOException;
// Public Methods Overriding FilterReader
     public void close( ) throws IOException;
1.2  public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );                              constant
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;
1.2  public void reset( ) throws IOException;
1.4  public long skip(long n) throws IOException;
}
```

RandomAccessFile java.io

Java 1.0 *closeable*

This class allows you to read and write arbitrary bytes, text, and primitive Java data types from or to any specified location in a file. Because this class provides random, rather than sequential, access to files, it is neither a subclass of `InputStream` nor of `OutputStream` , but provides an entirely independent method for reading and writing data from or to files. `RandomAccessFile` implements the same interfaces as `DataInputStream` and `DataOutputStream` , and thus defines the same methods for reading and writing data as those classes do.

The `seek( )` method provides random access to the file; it is used to select the position in the file where data should be read or written. The various read and write methods update this file position so that a sequence of read or write operations can be performed on a contiguous portion of the file without having to call the `seek( )` method before each read or write.

The *mode* argument to the constructor methods should be "r" for a file that is to be read-only or "rw" for a file that is to be written (and perhaps read as well). In Java 1.4 and later, two other values for the *mode* argument are allowed as well. A mode of "rwd" opens the file for reading and writing, and requires that (if the file resides on a local filesystem) every update to the file content be written synchronously to the underlying file. The "rws" mode is similar, but requires synchronous updates to both the file's content and its metadata (which includes things such as file access times). Using "rws" mode may require that the file metadata be modified every time the file is read.

In Java 1.4 and later, use the `getChannel( )` method to obtain a `FileChannel` object that you can use to access the file using the New I/O API of `java.nio` and its subpackages. If the `RandomAccessFile` was opened with a mode of "r", the `FileChannel` allows only reading. Otherwise, it allows both reading and writing.

Figure 9-53. java.io.RandomAccessFile

```
public class RandomAccessFile implements Closeable, DataInput, DataOutput {
// Public Constructors
     public RandomAccessFile(File file, String mode) throws FileNotFoundException;
     public RandomAccessFile(String name, String mode) throws FileNotFoundException;
// Public Instance Methods
     public void close( ) throws IOException;          Implements:Closeable
1.4  public final java.nio.channels.FileChannel getChannel( );
     public final FileDescriptor getFD( ) throws IOException;
     public long getFilePointer( ) throws IOException;                    native
```

```
     public long length( ) throws IOException;                        native
     public int read( ) throws IOException;                           native
     public int read(byte[ ] b) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
     public void seek(long pos) throws IOException;                  native
1.2  public void setLength(long newLength) throws IOException;      native
// Methods Implementing Closeable
     public void close( ) throws IOException;
// Methods Implementing DataInput
     public final boolean readBoolean( ) throws IOException;
     public final byte readByte( ) throws IOException;
     public final char readChar( ) throws IOException;
     public final double readDouble( ) throws IOException;
     public final float readFloat( ) throws IOException;
     public final void readFully(byte[ ] b) throws IOException;
     public final void readFully(byte[ ] b, int off, int len) throws IOException;
     public final int readInt( ) throws IOException;
     public final String readLine( ) throws IOException;
     public final long readLong( ) throws IOException;
     public final short readShort( ) throws IOException;
     public final int readUnsignedByte( ) throws IOException;
     public final int readUnsignedShort( ) throws IOException;
     public final String readUTF( ) throws IOException;
     public int skipBytes(int n) throws IOException;
// Methods Implementing DataOutput
     public void write(int b) throws IOException;                    native
     public void write(byte[ ] b) throws IOException;
     public void write(byte[ ] b, int off, int len) throws IOException;
     public final void writeBoolean(boolean v) throws IOException;
     public final void writeByte(int v) throws IOException;
     public final void writeBytes(String s) throws IOException;
     public final void writeChar(int v) throws IOException;
     public final void writeChars(String s) throws IOException;
     public final void writeDouble(double v) throws IOException;
     public final void writeFloat(float v) throws IOException;
     public final void writeInt(int v) throws IOException;
     public final void writeLong(long v) throws IOException;
     public final void writeShort(int v) throws IOException;
     public final void writeUTF(String str) throws IOException;
}
```

Reader java.io

Java 1.1 *readable closeable*

This abstract class is the superclass of all character input streams. It is an analog to InputStream, which is the superclass of all byte input streams. Reader defines the basic methods that all character output streams provide. read( ) returns a single character or an array (or subarray) of characters, blocking if necessary; it returns -1 if the end of the stream has been reached. ready( ) returns true if there are characters available for reading. If ready( ) returns TRue, the next call to read( ) is guaranteed not to block. close( ) closes the character input stream. skip( ) skips a specified number of characters in the input stream. If markSupported( ) returns true, mark( ) marks a position in the stream and, if necessary, creates a look-ahead buffer of the specified size. Future calls to reset( ) restore the stream to the marked position if they occur within the specified look-ahead limit. Note that not all stream types support this mark-and-reset functionality. To create a subclass o Reader, you need only implement the three-argument version of read( ) and the close( ) method. Most subclasses implement additional methods, however.

Figure 9-54. java.io.Reader

```
public abstract class Reader implements Closeable, Readable {
// Protected Constructors
     protected Reader( );
     protected Reader(Object lock);
// Public Instance Methods
     public abstract void close( ) throws IOException; Implements:Closeable
     public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );                                    constant
     public int read( ) throws IOException;
     public int read(char[ ] cbuf) throws IOException;
     public abstract int read(char[ ] cbuf, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;                         constant
     public void reset( ) throws IOException;
     public long skip(long n) throws IOException;
// Methods Implementing Closeable
     public abstract void close( ) throws IOException;
// Methods Implementing Readable
5.0  public int read(java.nio.CharBuffer target) throws IOException;
// Protected Instance Fields
     protected Object lock;
```

```
}
```

Subclasses

BufferedReader, CharArrayReader, FilterReader, InputStreamReader, PipedReader, StringReader

Passed To

BufferedReader.BufferedReader( ), FilterReader.FilterReader( ), LineNumberReader.LineNumberReader( ), PushbackReader.PushbackReader( ), StreamTokenizer.StreamTokenizer( ), javax.xml.transform.stream.StreamSource.{setReader( ), StreamSource( )}, org.xml.sax.InputSource.{InputSource( ), setCharacterStream( )}

Returned By

java.nio.channels.Channels.newReader( ), javax.xml.transform.stream.StreamSource.getReader( ), org.xml.sax.InputSource.getCharacterStream( )

Type Of

FilterReader.in

SequenceInputStream java.io

Java 1.0 *closeable*

This class provides a way of seamlessly concatenating the data from two or more input streams. It provides an `InputStream` interface to a sequence of `InputStream` objects. Data is read from the streams in the order in which the streams are specified. When the end of one stream is reached, data is automatically read from the next stream. This class might be useful, for example, when implementing an include file facility for a parser.

Figure 9-55. java.io.SequenceInputStream


```
public class SequenceInputStream extends InputStream {
// Public Constructors
     public SequenceInputStream(java.util.Enumeration<? extends InputStream> e);
     public SequenceInputStream(InputStream s1, InputStream s2);
// Public Methods Overriding InputStream
1.1  public int available( ) throws IOException;
     public void close( ) throws IOException;
     public int read( ) throws IOException;
     public int read(byte[ ] b, int off, int len) throws IOException;
}
```

Serializable java.io

Java 1.1 *serializable*

The `Serializable` interface defines no methods or constants. A class should implement this interface simply to indicate that it allows itself to be serialized and deserialized with `ObjectOutputStream.writeObject( )` and `ObjectInputStream.readObject( )`.

Objects that need special handling during serialization or deserialization may implement one or both of the following methods; note, however, that these methods are not part of the `Serializable` interface):

```
private void writeObject(java.io.ObjectOutputStream out) throws IOException;
private void readObject(java.io.ObjectInputStream in) throws IOException,
             ClassNotFoundException;
```

Typically, the `writeObject( )` method performs any necessary cleanup or preparation for serialization, invokes the `defaultWriteObject( )` method of the `ObjectOutputStream` to serialize the nontransient fields of the class, and optionally writes any additional data that is required. Similarly, the `readObject( )` method typically invokes the `defaultReadObject( )` method of the `ObjectInputStream`, reads any additional data written by the corresponding `writeObject( )` method, and performs any extra initialization required by the object. The `readObject( )` method may also register an `ObjectInputValidation` object to validate the object once it is completely deserialized.

```
public interface Serializable {
}
```

Implementations

Too many classes to list.

Passed To

`java.security.SignedObject.SignedObject( )`, `javax.crypto.SealedObject.SealedObject( )`

Team LiB

SerializablePermission java.io

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that governs the use of certain sensitive features of serialization. `SerializablePermission` objects have a name, or target, but do not have an action list. The name "enableSubclassImplementation" represents permission to serialize and deserialize objects using subclasses of `ObjectOutputStream` and `ObjectInputStream`. This capability is protected by a permission because malicious code can define object stream subclasses that incorrectly serialize and deserialize objects.

The only other name supported by `SerializablePermission` is "enableSubstitution," which represents permission for one object to be substituted for another during serialization or deserialization. Permission of this type is required by the `ObjectOutputStream.enableReplaceObject( )` and `ObjectInputStream.enableResolveObject( )` methods.

Applications never need to use this class. Programmers writing system-level code may use it, and system administrators configuring security policies should be familiar with it.

Figure 9-56. java.io.SerializablePermission

```
public final class SerializablePermission extends java.security.BasicPermission {
// Public Constructors
     public SerializablePermission(String name);
     public SerializablePermission(String name, String actions);
}
```

Type Of

`ObjectStreamConstants.{SUBCLASS_IMPLEMENTATION_PERMISSION, SUBSTITUTION_PERMISSION}`

StreamCorruptedException java.io

Java 1.1 *serializable checked*

Signals that the data stream being read by an `ObjectInputStream` has been corrupted and does not contain valid serialized object data.

Figure 9-57. java.io.StreamCorruptedException


```
public class StreamCorruptedException extends ObjectStreamException {
// Public Constructors
     public StreamCorruptedException( );
     public StreamCorruptedException(String reason);
}
```

Thrown By

`ObjectInputStream.readStreamHeader( )`

Team LiB

StreamTokenizer java.io

Java 1.0

This class performs lexical analysis of a specified input stream and breaks the input into tokens. It can be extremely useful when writing simple parsers. `nextToken( )` returns the next token in the stream; this is either one of the constants defined by the class (which represent end-of-file, end-of-line, a parsed floating-point number, and a parsed word) or a character value. `pushBack( )` pushes the token back onto the stream, so that it is returned by the next call to `nextToken( )`. The public variables `sval` and `nval` contain the string and numeric values (if applicable) of the most recently read token. They are applicable when the returned token is `TT_WORD` or `TT_NUMBER`. `lineno( )` returns the current line number.

The remaining methods allow you to specify how tokens are recognized. `wordChars( )` specifies a range of characters that should be treated as parts of words. `whitespaceChars( )` specifies a range of characters that serve to delimit tokens. `ordinaryChars( )` and `ordinaryChar( )` specify characters that are never part of tokens and should be returned as-is. `resetSyntax( )` makes all characters ordinary. `eolIsSignificant( )` specifies whether end-of-line is significant. If so, the `TT_EOL` constant is returned for end-of-lines; otherwise, they are treated as whitespace. `commentChar( )` specifies a character that begins a comment that lasts until the end of the line. No characters in the comment are returned. `slashStarComments( )` and `slashSlashComments( )` specify whether the `StreamTokenizer` should recognize C- and C++-style comments. If so, no part of the comment is returned as a token. `quoteChar( )` specifies a character used to delimit strings. When a string token is parsed, the quote character is returned as the token value, and the body of the string is stored in the `sval` variable. `lowerCaseMode( )` specifies whether `TT_WORD` tokens should be converted to all lowercase characters before being stored in `sval`. `parseNumbers( )` specifies that the `StreamTokenizer` should recognize and return double-precision floating-point number tokens.

```
public class StreamTokenizer {
// Public Constructors
#    public StreamTokenizer(InputStream is);
1.1  public StreamTokenizer(Reader r);
// Public Constants
     public static final int TT_EOF;       =-1
     public static final int TT_EOL;       =10
     public static final int TT_NUMBER;    =-2
     public static final int TT_WORD;      =-3
// Public Instance Methods
     public void commentChar(int ch);
     public void eolIsSignificant(boolean flag);
     public int lineno( );
     public void lowerCaseMode(boolean fl);
     public int nextToken( ) throws IOException;
     public void ordinaryChar(int ch);
     public void ordinaryChars(int low, int hi);
```

```
    public void parseNumbers( );
    public void pushBack( );
    public void quoteChar(int ch);
    public void resetSyntax( );
    public void slashSlashComments(boolean flag);
    public void slashStarComments(boolean flag);
    public void whitespaceChars(int low, int hi);
    public void wordChars(int low, int hi);
// Public Methods Overriding Object
    public String toString( );
// Public Instance Fields
    public double nval;
    public String sval;
    public int ttype;
}
```

StringBufferInputStream java.io

Java 1.0; Deprecated in 1.1 *@Deprecated closeable*

This class is a subclass of `InputStream` in which input bytes come from the characters of a specified `String` object. This class does not correctly convert the characters of a `StringBuffer` into bytes and is deprecated as of Java 1.1. Use `StringReader` instead to convert characters into bytes or use `ByteArrayInputStream` to read bytes from an array of bytes.

Figure 9-58. java.io.StringBufferInputStream


```
public class StringBufferInputStream extends InputStream {
// Public Constructors
     public StringBufferInputStream(String s);
// Public Methods Overriding InputStream
     public int available( );                           synchronized
     public int read( );                                synchronized
     public int read(byte[ ] b, int off, int len);      synchronized
     public void reset( );                              synchronized
     public long skip(long n);                          synchronized
// Protected Instance Fields
     protected String buffer;
     protected int count;
     protected int pos;
}
```

StringReader java.io

Java 1.1 *readable closeable*

This class is a character input stream that uses a `String` object as the source of the characters it returns. When you create a `StringReader`, you must specify the `String` to read from. `StringReader` defines the normal `Reader` methods and supports `mark( )` and `reset( )`. If `reset( )` is called before `mark( )` has been called, the stream is reset to the beginning of the specified string. `StringReader` is a character stream analog to `StringBufferInputStream`, which is deprecated as of Java 1.1. `StringReader` is also similar to `CharArrayReader`.

Figure 9-59. java.io.StringReader


```
public class StringReader extends Reader {
// Public Constructors
     public StringReader(String s);
// Public Methods Overriding Reader
     public void close( );
     public void mark(int readAheadLimit) throws IOException;
     public boolean markSupported( );                                    constant
     public int read( ) throws IOException;
     public int read(char[ ] cbuf, int off, int len) throws IOException;
     public boolean ready( ) throws IOException;
     public void reset( ) throws IOException;
     public long skip(long ns) throws IOException;
}
```

Team LiB

StringWriter java.io

Java 1.1 *appendable closeable flushable*

This class is a character output stream that uses an internal `StringBuffer` object as the destination of the characters written to the stream. When you create a `StringWriter`, you may optionally specify an initial size for the `StringBuffer`, but you do not specify the `StringBuffer` itself; it is managed internally by the `StringWriter` and grows as necessary to accommodate the characters written to it. `StringWriter` defines the standard `write( )`, `flush( )`, and `close( )` methods all `Writer` subclasses define, as well as two methods to obtain the characters that have been written to the stream's internal buffer. `toString( )` returns the contents of the internal buffer as a `String`, and `getBuffer( )` returns the buffer itself. Note that `getBuffer( )` returns a reference to the actual internal buffer, not a copy of it, so any changes you make to the buffer are reflected in subsequent calls to `toString( )`. `StringWriter` is quite similar to `CharArrayWriter`, but does not have a byte-stream analog.

Figure 9-60. java.io.StringWriter

```
public class StringWriter extends Writer {
// Public Constructors
     public StringWriter( );
     public StringWriter(int initialSize);
// Public Instance Methods
5.0  public StringWriter append(CharSequence csq);
5.0  public StringWriter append(char c);
5.0  public StringWriter append(CharSequence csq, int start, int end);
     public StringBuffer getBuffer( );
// Public Methods Overriding Writer
     public void close( ) throws IOException;                        empty
     public void flush( );                                           empty
     public void write(int c);
     public void write(String str);
     public void write(String str, int off, int len);
     public void write(char[ ] cbuf, int off, int len);
// Public Methods Overriding Object
     public String toString( );
}
```

SyncFailedException java.io

Java 1.1 *serializable checked*

Signals that a call to `FileDescriptor.sync( )` did not complete successfully.

Figure 9-61. java.io.SyncFailedException


```
public class SyncFailedException extends IOException {
// Public Constructors
     public SyncFailedException(String desc);
}
```

Thrown By

`FileDescriptor.sync( )`

UnsupportedEncodingException java.io

Java 1.1 *serializable checked*

Signals that a requested character encoding is not supported by the currentJava Virtual Machine.

Figure 9-62. java.io.UnsupportedEncodingException


```
public class UnsupportedEncodingException extends IOException {
// Public Constructors
     public UnsupportedEncodingException( );
     public UnsupportedEncodingException(String s);
}
```

Thrown By

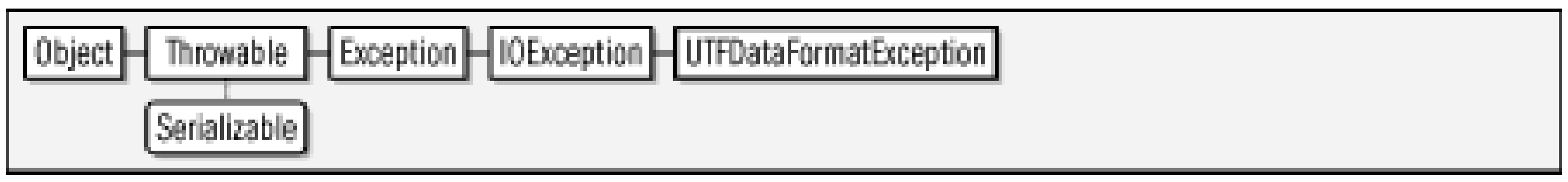
Too many methods to list.

UTFDataFormatException java.io

Java 1.0 *serializable checked*

An `IOException` that signals that a malformed UTF-8 string has been encountered by a class that implements the `DataInput` interface. UTF-8 is an ASCII-compatible transformation format for Unicode characters that is often used to store and transmit Unicode text.

Figure 9-63. java.io.UTFDataFormatException




```
public class UTFDataFormatException extends IOException {
// Public Constructors
     public UTFDataFormatException( );
     public UTFDataFormatException(String s);
}
```

WriteAbortedException java.io

Java 1.1 *serializable checked*

Thrown when reading a stream of data that is incomplete because an exception was thrown while it was being written. The `detail` field may contain the exception that terminated the output stream. In Java 1.4 and later, this exception can also be obtained with the standard `Throwable getCause( )` method. The `getMessage( )` method has been overridden to include the message of this `detail` exception, if any.

Figure 9-64. java.io.WriteAbortedException


```
public class WriteAbortedException extends ObjectStreamException {
// Public Constructors
     public WriteAbortedException(String s, Exception ex);
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );
     public String getMessage( );
// Public Instance Fields
     public Exception detail;
}
```

Writer java.io

Java 1.1 *appendable closeable flushable*

This abstract class is the superclass of all character output streams. It is an analog to `OutputStream`, which is the superclass of all byte output streams. `Writer` defines the basic `write( )`, `flush( )`, and `close( )` methods all character output streams provide. The five versions of the `write( )` method write a single character, a character array or subarray, or a string or substring to the destination of the stream. The most general version of this methodthe one that writes a specified portion of a character arrayis abstract and must be implemented by all subclasses. By default, the other `write( )` methods are implemented in terms of this abstract one. The `flush( )` method is another abstract method all subclasses must implement. It should force any output buffered by the stream to be written to its destination. If that destination is itself a character or byte output stream, it should invoke the `flush( )` method of the destination stream as well. The `close( )` method is also abstract. A subclass must implement this method so that it flushes and then closes the current stream and also closes whatever destination stream it is connected to. Once the stream is closed, any future calls to `write( )` or `flush( )` should throw an `IOException`.

In Java 5.0, this class has been modified to implement the `Closeable` and `Flushable` interfaces. It has also changed to implement `java.lang.Appendable`, which means that any `Writer` object can be used as the destination for a `java.util.Formatter`.

Figure 9-65. java.io.Writer

```
public abstract class Writer implements Appendable, Closeable, Flushable {
// Protected Constructors
     protected Writer( );
     protected Writer(Object lock);
// Public Instance Methods
5.0  public Writer append(char c) throws IOException;
5.0  public Writer append(CharSequence csq) throws IOException;
5.0  public Writer append(CharSequence csq, int start, int end) throws IOException;
     public abstract void close( ) throws IOException; Implements:Closeable
     public abstract void flush( ) throws IOException; Implements:Flushable
     public void write(int c) throws IOException;
     public void write(String str) throws IOException;
     public void write(char[ ] cbuf) throws IOException;
     public abstract void write(char[ ] cbuf, int off, int len) throws IOException;
     public void write(String str, int off, int len) throws IOException;
// Methods Implementing Closeable
```

```
    public abstract void close( ) throws IOException;
// Methods Implementing Flushable
    public abstract void flush( ) throws IOException;
// Protected Instance Fields
    protected Object lock;
}
```

Subclasses

BufferedWriter , CharArrayWriter , FilterWriter , OutputStreamWriter , PipedWriter ,PrintWriter , StringWriter

Passed To

BufferedWriter.BufferedWriter( ) , CharArrayWriter.writeTo( ) , FilterWriter.FilterWriter( ) , PrintWriter.PrintWriter( ) , javax.xml.transform.stream.StreamResult.{setWriter( ) , StreamResult( )}

Returned By

CharArrayWriter.append( ) , PrintWriter.append( ) , StringWriter.append( ) , java.nio.channels.Channels.newWriter( ) , javax.xml.transform.stream.StreamResult.getWriter( )

Type Of

FilterWriter.out , PrintWriter.out

Chapter 10. java.lang and Subpackages

This chapter covers the `java.lang` package which defines the core classes and interfaces that are indispensable to the Java platform and the Java programming language. It also covers more specialized subpackages:

`java.lang.annotation`

Defines the `Annotation` interface that all annotation types extend, and also defines meta-annotation types and related enumerated types. Added in Java 5.0.

`java.lang.instrument`

Provides support for Java-based "agents" that can instrument a Java program by transforming class files as they are loaded. Added in Java 5.0.

`java.lang.management`

Defines "management bean" interfaces for remote monitoring and management of a running Java interpreter.

`java.lang.ref`

Defines "reference" classes that are used to refer to objects without preventing the garbage collector from reclaiming those objects.

`java.lang.reflect`

Allows Java programs to examine the members of arbitrary classes, invoking methods, and querying and setting the value of fields.

Team LiB

Package java.lang

Java 1.0

The java.lang package contains the classes that are most central to the Java language. Object is the ultimate superclass of all Java classes and is therefore at the top of all class hierarchies. Class is a class that describes a Java class. There is one Class object for each class that is loaded into Java.

Boolean , Character , Byte , Short , Integer , Long , Float , and Double are immutable class wrappers around each of the primitive Java data types. These classes are useful when you need to manipulate primitive types as objects. They also contain useful conversion and utility methods. Void is a related class that defines a representation for the void method return type, but that defines no methods. String and StringBuffer are objects that represent strings. String is an immutable type, while StringBuffer can have its string changed in place. In Java 5.0, StringBuilder is like StringBuffer but without synchronized methods, which makes it the preferred choice in most applications. String , StringBuffer and StringBuilder implement the Java 1.4 interface CharSequence which allows instances of these classes to be manipulated through a simple shared API.

String and the various primitive type wrapper classes all implement the Comparable interface which defines an ordering for instances of those classes and enables sorting and searching algorithms (such as those of java.util.Arrays and java.util.Collections , for example). Cloneable is an important marker interface that specifies that the Object.clone( ) method is allowed to make copies of an object.

The Math class (and, in Java 1.3, the StrictMath class) defines static methods for various floating-point mathematical functions.

The THRead class provides support for multiple threads of control running within the same Java interpreter. The Runnable interface is implemented by objects that have a run( ) method that can serve as the body of a thread.

System provides low-level system methods. Runtime provides similar low-level methods, including an exec( ) method that, along with the Process class, defines a platform-dependent API for running external processes. Java 5.0 allows Process objects to be created more easily with the ProcessBuilder class.

Throwable is the root class of the exception and error hierarchy. THRowable objects are used with the Java tHRow and catch statements. java.lang defines quite a few subclasses of Throwable . Exception and Error are the superclasses of all exceptions and errors. RuntimeException defines a special class of "unchecked exceptions" that do not need to be declared in a method's throws clause. The Throwable class was overhauled in Java 1.4, adding the ability to "chain" exceptions, and the ability to obtain the stack trace of an exception as an array of StackTraceElement objects.

Java 5.0 adds three important interfaces to this package. Iterable marks types that have an iterator( ) method and enables iteration with the for/in looping statement introduced in Java 5.0. The Appendable interface is implemented by classes (such as StringBuilder and character output streams) that can have characters appended to them. Implementing this interface enables formatted text output with a java.util.Formatter . The Readable interface is implemented by classes (such as character input streams) that can sequentially copy characters into a buffer. It enables interaction with a `java.util.Scanner` .

Also new in Java 5.0 is `Enum` , which serves as the superclass of all enumerated types declared with the new `enum` keyword. `Deprecated` , `Override` , and `SuppressWarnings` are annotation types that provide metadata for the compiler.

Interfaces

```
public interface Appendable;
public interface CharSequence;
public interface Cloneable;
public interface Comparable<T>;
public interface Iterable<T>;
public interface Readable;
public interface Runnable;
public interface Thread.UncaughtExceptionHandler;
```

Enumerated Types

```
public enum Thread.State;
```

Annotation Types

```
public @interface Deprecated;
public @interface Override;
public @interface SuppressWarnings;
```

Classes

```
public class Object;
   abstract class AbstractStringBuilder implements Appendable, CharSequence;
      public final class StringBuffer extends AbstractStringBuilder implements
      CharSequence, Serializable;
      public final class StringBuilder extends AbstractStringBuilder implements
      CharSequence, Serializable;
   public final class Boolean implements Serializable, Comparable<Boolean>;
   public final class Character implements Serializable, Comparable<Character>;
   public static class Character.Subset;
      public static final class Character.UnicodeBlock extends Character.Subset;
   public final class Class<T> implements Serializable, java.lang.reflect.
      GenericDeclaration, java.lang.reflect.Type, java.lang.reflect.AnnotatedElement;
   public abstract class ClassLoader;
   public final class Compiler;
   public abstract class Enum<E extends Enum<E>> implements Comparable<E>,
```

```
        Serializable;
    public final class Math;
    public abstract class Number implements Serializable;
        public final class Byte extends Number implements Comparable<Byte>;
        public final class Double extends Number implements Comparable<Double>;
        public final class Float extends Number implements Comparable<Float>;
        public final class Integer extends Number implements Comparable<Integer>;
        public final class Long extends Number implements Comparable<Long>;
        public final class Short extends Number implements Comparable<Short>;
    public class Package implements java.lang.reflect.AnnotatedElement;
    public abstract class Process;
    public final class ProcessBuilder;
    public class Runtime;
    public class SecurityManager;
    public final class StackTraceElement implements Serializable;
    public final class StrictMath;
    public final class String implements Serializable, Comparable<String>, CharSequence;
    public final class System;
    public class Thread implements Runnable;
    public class ThreadGroup implements Thread.UncaughtExceptionHandler;
    public class ThreadLocal<T>;
        public class InheritableThreadLocal<T> extends ThreadLocal<T>;
    public class Throwable implements Serializable;
    public final class Void;
public final class RuntimePermission extends java.security.BasicPermission;
```

Exceptions

```
public class Exception extends Throwable;
    public class ClassNotFoundException extends Exception;
    public class CloneNotSupportedException extends Exception;
    public class IllegalAccessException extends Exception;
    public class InstantiationException extends Exception;
    public class InterruptedException extends Exception;
    public class NoSuchFieldException extends Exception;
    public class NoSuchMethodException extends Exception;
    public class RuntimeException extends Exception;
        public class ArithmeticException extends RuntimeException;
        public class ArrayStoreException extends RuntimeException;
        public class ClassCastException extends RuntimeException;
        public class EnumConstantNotPresentException extends RuntimeException;
        public class IllegalArgumentException extends RuntimeException;
            public class IllegalThreadStateException extends IllegalArgumentException;
            public class NumberFormatException extends IllegalArgumentException;
        public class IllegalMonitorStateException extends RuntimeException;
        public class IllegalStateException extends RuntimeException;
        public class IndexOutOfBoundsException extends RuntimeException;
            public class ArrayIndexOutOfBoundsException extends IndexOutOfBoundsException;
            public class StringIndexOutOfBoundsException extends IndexOutOfBoundsException
        public class NegativeArraySizeException extends RuntimeException;
```

```
      public class NullPointerException extends RuntimeException;
      public class SecurityException extends RuntimeException;
      public class TypeNotPresentException extends RuntimeException;
      public class UnsupportedOperationException extends RuntimeException;
```

Errors

```
public class Error extends Throwable;
   public class AssertionError extends Error;
   public class LinkageError extends Error;
      public class ClassCircularityError extends LinkageError;
      public class ClassFormatError extends LinkageError;
         public class UnsupportedClassVersionError extends ClassFormatError;
      public class ExceptionInInitializerError extends LinkageError;
      public class IncompatibleClassChangeError extends LinkageError;
         public class AbstractMethodError extends IncompatibleClassChangeError;
         public class IllegalAccessError extends IncompatibleClassChangeError;
         public class InstantiationError extends IncompatibleClassChangeError;
         public class NoSuchFieldError extends IncompatibleClassChangeError;
         public class NoSuchMethodError extends IncompatibleClassChangeError;
      public class NoClassDefFoundError extends LinkageError;
      public class UnsatisfiedLinkError extends LinkageError;
      public class VerifyError extends LinkageError;
   public class ThreadDeath extends Error;
   public abstract class VirtualMachineError extends Error;
      public class InternalError extends VirtualMachineError;
      public class OutOfMemoryError extends VirtualMachineError;
      public class StackOverflowError extends VirtualMachineError;
      public class UnknownError extends VirtualMachineError;
```

AbstractMethodError java.lang

Java 1.0 *serializable error*

Signals an attempt to invoke an abstract method.

Figure 10-1. java.lang.AbstractMethodError


```
public class AbstractMethodError extends IncompatibleClassChangeError {
// Public Constructors
     public AbstractMethodError( );
     public AbstractMethodError(String s);
}
```

Team LiB

AbstractStringBuilder java.lang

Java 5.0 *appendable*

This package-private class is the abstract superclass of `StringBuffer` and `StringBuilder` . Because this
not public, you may not use it directly. It is included in this quick-reference to fully document the shared
its two subclasses.

Note that many of the methods of this class are declared to return an `AbstractStringBuilder` object.
`StringBuilder` and `StringBuffer( )` override those methods and narrow the return type to `StringBui`
`StringBuffer` . (This is an example of "covariant returns," which are allowed in Java 5.0 and later.)

Figure 10-2. java.lang.AbstractStringBuilder


```
abstract class AbstractStringBuilder implements Appendable, CharSequence {
// No Constructor
// Public Instance Methods
     public AbstractStringBuilder append(char[ ] str);
     public AbstractStringBuilder append(boolean b);
     public AbstractStringBuilder append(char c);
     public AbstractStringBuilder append(Object obj);
     public AbstractStringBuilder append(CharSequence s);
     public AbstractStringBuilder append(StringBuffer sb);
     public AbstractStringBuilder append(String str);
     public AbstractStringBuilder append(int i);
     public AbstractStringBuilder append(double d);
     public AbstractStringBuilder append(float f);
     public AbstractStringBuilder append(long l);
     public AbstractStringBuilder append(char[ ] str, int offset, int len);
     public AbstractStringBuilder append(CharSequence s, int start, int end);
     public AbstractStringBuilder appendCodePoint(int codePoint);
     public int capacity( );
     public int codePointAt(int index);
     public int codePointBefore(int index);
     public int codePointCount(int beginIndex, int endIndex);
     public AbstractStringBuilder delete(int start, int end);
     public AbstractStringBuilder deleteCharAt(int index);
     public void ensureCapacity(int minimumCapacity);
     public void getChars(int srcBegin, int srcEnd, char[ ] dst, int dstBegin);
```

```
    public int indexOf(String str);
    public int indexOf(String str, int fromIndex);
    public AbstractStringBuilder insert(int offset, char c);
    public AbstractStringBuilder insert(int offset, boolean b);
    public AbstractStringBuilder insert(int dstOffset, CharSequence s);
    public AbstractStringBuilder insert(int offset, int i);
    public AbstractStringBuilder insert(int offset, double d);
    public AbstractStringBuilder insert(int offset, float f);
    public AbstractStringBuilder insert(int offset, long l);
    public AbstractStringBuilder insert(int offset, char[ ] str);
    public AbstractStringBuilder insert(int offset, Object obj);
    public AbstractStringBuilder insert(int offset, String str);
    public AbstractStringBuilder insert(int index, char[ ] str, int offset, int len);
    public AbstractStringBuilder insert(int dstOffset, CharSequence s, int start, int
    public int lastIndexOf(String str);
    public int lastIndexOf(String str, int fromIndex);
    public int offsetByCodePoints(int index, int codePointOffset);
    public AbstractStringBuilder replace(int start, int end, String str);
    public AbstractStringBuilder reverse( );
    public void setCharAt(int index, char ch);
    public void setLength(int newLength);
    public String substring(int start);
    public String substring(int start, int end);
    public void trimToSize( );
// Methods Implementing CharSequence
    public char charAt(int index);
    public int length( );
    public CharSequence subSequence(int start, int end);
    public abstract String toString( );
}
```

Subclasses

StringBuffer , StringBuilder

Returned By

Too many methods to list.

Appendable java.lang

Java 5.0 *appendable*

Objects that implement this interface can have characters or character sequences appended to them. `Appendable` was added in Java 5.0 as a simple unifying API for `StringBuffer` and `StringBuilder`, `java.nio.CharBuffer`, and character output stream subclasses of `java.io.Writer`. The `java.util.Formatter` class can send formatted output to any `Appendable` object. See also `Readable`.

```
public interface Appendable {
// Public Instance Methods
     Appendable append(char c) throws java.io.IOException;
     Appendable append(CharSequence csq) throws java.io.IOException;
     Appendable append(CharSequence csq, int start, int end) throws java.io.IOException
}
```

Implementations

`java.io.PrintStream`, `java.io.Writer`, `java.nio.CharBuffer`

Passed To

`java.util.Formatter.Formatter( )`

Returned By

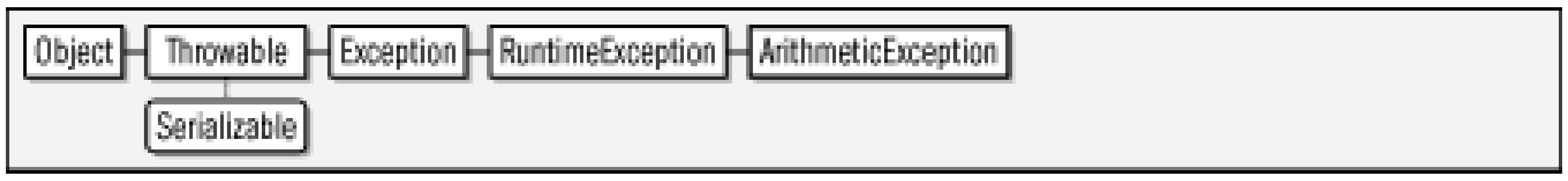
Too many methods to list.

ArithmeticException java.lang

Java 1.0 *serializable unchecked*

A `RuntimeException` that signals an exceptional arithmetic condition, such as integer division by zero.

Figure 10-3. java.lang.ArithmeticException



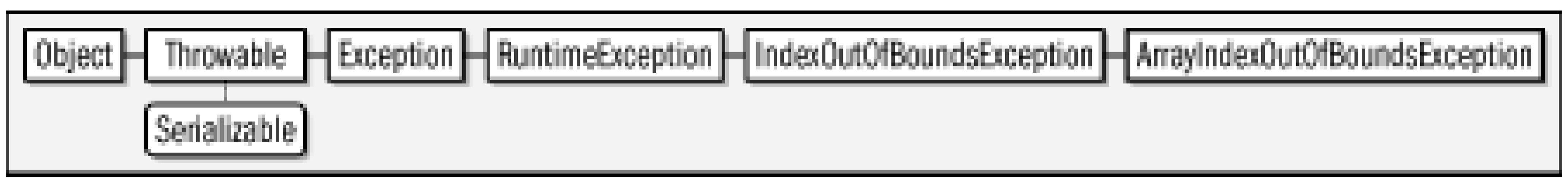

```
public class ArithmeticException extends RuntimeException {
// Public Constructors
     public ArithmeticException( );
     public ArithmeticException(String s);
}
```

ArrayIndexOutOfBoundsException java.lang

Java 1.0 *serializable unchecked*

Signals that an array index less than zero or greater than or equal to the array size has been used.

Figure 10-4. java.lang.ArrayIndexOutOfBoundsException




```
public class ArrayIndexOutOfBoundsException extends IndexOutOfBoundsException {
// Public Constructors
     public ArrayIndexOutOfBoundsException( );
     public ArrayIndexOutOfBoundsException(String s);
     public ArrayIndexOutOfBoundsException(int index);
}
```

Thrown By

Too many methods to list.

ArrayStoreException java.lang

Java 1.0 *serializable unchecked*

Signals an attempt to store the wrong type of object into an array.

Figure 10-5. java.lang.ArrayStoreException


```
public class ArrayStoreException extends RuntimeException {
// Public Constructors
     public ArrayStoreException( );
     public ArrayStoreException(String s);
}
```

AssertionError java.lang

Java 1.4 *serializable error*

An instance of this class is thrown if when an assertion fails. This happens when assertions are enabled, and the expression following an `assert` statement does not evaluate to `true`. If an assertion fails, and the `assert` statement has a second expression separated from the first by a colon, then the second expression is evaluated and the resulting value is passed to the `AssertionError( )` constructor, where it is converted to a string and used as the error message.

Figure 10-6. java.lang.AssertionError


```
public class AssertionError extends Error {
// Public Constructors
     public AssertionError( );
     public AssertionError(long detailMessage);
     public AssertionError(float detailMessage);
     public AssertionError(double detailMessage);
     public AssertionError(int detailMessage);
     public AssertionError(Object detailMessage);
     public AssertionError(boolean detailMessage);
     public AssertionError(char detailMessage);
}
```

Boolean java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around the `boolean` primitive type. Note that the `trUE` and `FALSE` constants are `Boolean` objects; they are not the same as the `TRue` and `false` `boolean` values. As of Java 1.1, this class defines a `Class` constant that represents the `boolean` type. `booleanValue( )` returns the `boolean` value of a `Boolean` object. The class method `getBoolean( )` retrieves the `boolean` value of a named property from the system property list. The static method `valueOf( )` parses a string and returns the `Boolean` object it represents. Java 1.4 added two static methods that convert primitive `boolean` values to `Boolean` and `String` objects. In Java 5.0, the `parseBoolean( )` method behaves like `valueOf( )` but returns a primitive `boolean` value instead of a `Boolean` object.

Prior to Java 5.0, this class does not implement the `Comparable` interface.

Figure 10-7. java.lang.Boolean

```
public final class Boolean implements Serializable, Comparable<Boolean> {
// Public Constructors
     public Boolean(String s);
     public Boolean(boolean value);
// Public Constants
     public static final Boolean FALSE;
     public static final Boolean TRUE;
1.1  public static final Class<Boolean> TYPE;
// Public Class Methods
     public static boolean getBoolean(String name);
5.0  public static boolean parseBoolean(String s);
1.4  public static String toString(boolean b);
1.4  public static Boolean valueOf(boolean b);
     public static Boolean valueOf(String s);
// Public Instance Methods
     public boolean booleanValue( );
// Methods Implementing Comparable
5.0  public int compareTo(Boolean b);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
```

```
    public String toString( );
}
```

Team LiB

Byte java.lang

Java 1.1 *serializable comparable*

This class provides an immutable object wrapper around the `byte` primitive type. It defines useful constants for the minimum and maximum values that can be stored by the `byte` type and a `Class` object constant that represents the `byte` type. It also provides various methods for converting `Byte` values to and from strings and other numeric types.

Most of the static methods of this class can convert a `String` to a `Byte` object or a `byte` value: the four `parseByte( )` and `valueOf( )` methods parse a number from the specified string using an optionally specified radix and return it in one of these two forms. The `decode( )` method parses a byte specified in base 10, base 8, or base 16 and returns it as a `Byte`. If the string begins with "0x" or "#", it is interpreted as a hexadecimal number. If it begins with "0", it is interpreted as an octal number. Otherwise, it is interpreted as a decimal number.

Note that this class has two `toString( )` methods. One is static and converts a `byte` primitive value to a string; the other is the usual `toString( )` method that converts a `Byte` object to a string. Most of the remaining methods convert a `Byte` to various primitive numeric types.

Figure 10-8. java.lang.Byte

```
public final class Byte extends Number implements Comparable<Byte> {
// Public Constructors
     public Byte(byte value);
     public Byte(String s) throws NumberFormatException;
// Public Constants
     public static final byte MAX_VALUE;    =127
     public static final byte MIN_VALUE;    =-128
5.0  public static final int SIZE;      =8
     public static final Class<Byte> TYPE;
// Public Class Methods
     public static Byte decode(String nm) throws NumberFormatException;
     public static byte parseByte(String s) throws NumberFormatException;
     public static byte parseByte(String s, int radix) throws NumberFormatException;
     public static String toString(byte b);
     public static Byte valueOf(String s) throws NumberFormatException;
5.0  public static Byte valueOf(byte b);
     public static Byte valueOf(String s, int radix) throws NumberFormatException;
// Methods Implementing Comparable
```

```
1.2  public int compareTo(Byte anotherByte);
// Public Methods Overriding Number
     public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );  yu
     public int intValue( );
     public long longValue( );
     public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Team LiB

Character java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around the primitive `char` data type. `charValue( )` returns the `char` value of a `Character` object. The `compareTo( )` method implements the `Comparable` interface so that `Character` objects can be ordered and sorted. The static methods are the most interesting thing about this class, however: they categorize `char` values based on the categories defined by the `Unicode` standard. (Some of the methods are only useful if you have a detailed understanding of that standard.) Static methods beginning with "is" test whether a character is in a given category. `isDigit( )` , `isLetter( )` , `isWhitespace( )` , `isUpperCase( )` and `isLowerCase( )` are some of the most useful. Note that these methods work for any Unicode character, not just with the familiar Latin letters and Arabic numbers of the ASCII character set. `getType( )` returns a constant that identifies the category of a character. `getdirectionality( )` returns a separate `DIRECTIONALITY_` constant that specifies the "directionality category" of a character.

In addition to testing the category of a character, this class also defines static methods for converting characters. `toUpperCase( )` returns the uppercase equivalent of the specified character (or returns the character itself if the character is uppercase or has no uppercase equivalent). `toLowerCase( )` converts instead to lowercase. `digit( )` returns the integer equivalent of a given character in a given radix (or base; for example, use 16 for hexadecimal). It works with any Unicode digit character, and also (for sufficiently large radix values) the ASCII letters a-z and A-Z. `forDigit( )` returns the ASCII character that corresponds to the specified value (0-35) for the specified radix. `getNumericValue( )` is similar, bu also works with any Unicode character including those, such as Roman numerals, that represent numbe but are not decimal digits. Finally, the static `toString( )` method returns a `String` of length 1 that contains the specified `char` value.

Java 5.0 introduces many new methods to this class to accommodate Unicode supplementary characters that use 21 bits and do not fit in a single `char` value. The two representations for these supplementary characters are as an `int` codepoint in the range 0 through 0x10ffff, or as a sequence of two `char` values known as a " surrogate pair." The first `char` of such a pair should fall in the "high surrogate" range and t second `char` should fall in the "low surrogate" range. `toChars( )` converts an `int` codepoint into one or two `char` values. `toCodePoint( )` , `codePointAt( )` , and `codePointBefore( )` convert one or two `cha` values into the corresponding `int` value. `codePointCount( )` returns the number of characters in a `char` array or `CharSequence` , counting surrogate pairs as a single supplementary character. `offsetByCodePoints( )` tells you how many `char` indexes to advance in a run of text if you want to ski over the specified number of code points. Finally, the various character type testing and case conversio methods such as `isWhitespace( )` and `toUpperCase( )` are available in new versions that take an `int` codepoint argument instead of a single `char` argument.

Figure 10-9. java.lang.Character

```
public final class Character implements Serializable, Comparable<Character> {
// Public Constructors
     public Character(char value);
// Public Constants
1.1  public static final byte COMBINING_SPACING_MARK;                =8
1.1  public static final byte CONNECTOR_PUNCTUATION;                 =23
1.1  public static final byte CONTROL; =15
1.1  public static final byte CURRENCY_SYMBOL;                       =26
1.1  public static final byte DASH_PUNCTUATION;                      =20
1.1  public static final byte DECIMAL_DIGIT_NUMBER;                  =9
1.4  public static final byte DIRECTIONALITY_ARABIC_NUMBER;          =6
1.4  public static final byte DIRECTIONALITY_BOUNDARY_NEUTRAL;       =9
1.4  public static final byte DIRECTIONALITY_COMMON_NUMBER_SEPARATOR;     =7
1.4  public static final byte DIRECTIONALITY_EUROPEAN_NUMBER;        =3
1.4  public static final byte DIRECTIONALITY_EUROPEAN_NUMBER_SEPARATOR;     =4
1.4  public static final byte DIRECTIONALITY_EUROPEAN_NUMBER_TERMINATOR;     =5
1.4  public static final byte DIRECTIONALITY_LEFT_TO_RIGHT;          =0
1.4  public static final byte DIRECTIONALITY_LEFT_TO_RIGHT_EMBEDDING;     =14
1.4  public static final byte DIRECTIONALITY_LEFT_TO_RIGHT_OVERRIDE;     =15
1.4  public static final byte DIRECTIONALITY_NONSPACING_MARK;        =8
1.4  public static final byte DIRECTIONALITY_OTHER_NEUTRALS;         =13
1.4  public static final byte DIRECTIONALITY_PARAGRAPH_SEPARATOR;     =10
1.4  public static final byte DIRECTIONALITY_POP_DIRECTIONAL_FORMAT;     =18
1.4  public static final byte DIRECTIONALITY_RIGHT_TO_LEFT;          =1
1.4  public static final byte DIRECTIONALITY_RIGHT_TO_LEFT_ARABIC;     =2
1.4  public static final byte DIRECTIONALITY_RIGHT_TO_LEFT_EMBEDDING;     =16
1.4  public static final byte DIRECTIONALITY_RIGHT_TO_LEFT_OVERRIDE;     =17
1.4  public static final byte DIRECTIONALITY_SEGMENT_SEPARATOR;      =11
1.4  public static final byte DIRECTIONALITY_UNDEFINED;              =-1
1.4  public static final byte DIRECTIONALITY_WHITESPACE;             =12
1.1  public static final byte ENCLOSING_MARK;                        =7
1.1  public static final byte END_PUNCTUATION;                       =22
1.4  public static final byte FINAL_QUOTE_PUNCTUATION;               =30
1.1  public static final byte FORMAT;  =16
1.4  public static final byte INITIAL_QUOTE_PUNCTUATION;             =29
1.1  public static final byte LETTER_NUMBER;                         =10
1.1  public static final byte LINE_SEPARATOR;                        =13
1.1  public static final byte LOWERCASE_LETTER;                      =2
1.1  public static final byte MATH_SYMBOL;                           =25
5.0  public static final int MAX_CODE_POINT;                         =1114111
5.0  public static final char MAX_HIGH_SURROGATE;                    = \uDBFF
5.0  public static final char MAX_LOW_SURROGATE;                     = \uDFFF
     public static final int MAX_RADIX;    =36
5.0  public static final char MAX_SURROGATE;                         = \uDFFF
     public static final char MAX_VALUE;   = \uFFFF
5.0  public static final int MIN_CODE_POINT;                         =0
5.0  public static final char MIN_HIGH_SURROGATE;                    = \uD800
5.0  public static final char MIN_LOW_SURROGATE;                     = \uDC00
```

```
     public static final int MIN_RADIX;    =2
5.0  public static final int MIN_SUPPLEMENTARY_CODE_POINT;          =65536
5.0  public static final char MIN_SURROGATE;                        = \uD800
     public static final char MIN_VALUE;   = \0
1.1  public static final byte MODIFIER_LETTER;                      =4
1.1  public static final byte MODIFIER_SYMBOL;                      =27
1.1  public static final byte NON_SPACING_MARK;                     =6
1.1  public static final byte OTHER_LETTER;                         =5
1.1  public static final byte OTHER_NUMBER;                         =11
1.1  public static final byte OTHER_PUNCTUATION;                    =24
1.1  public static final byte OTHER_SYMBOL;                         =28
1.1  public static final byte PARAGRAPH_SEPARATOR;                  =14
1.1  public static final byte PRIVATE_USE;                          =18
5.0  public static final int SIZE;     =16
1.1  public static final byte SPACE_SEPARATOR;                      =12
1.1  public static final byte START_PUNCTUATION;                    =21
1.1  public static final byte SURROGATE;                            =19
1.1  public static final byte TITLECASE_LETTER;                     =3
1.1  public static final Class<Character> TYPE;
1.1  public static final byte UNASSIGNED;                           =0
1.1  public static final byte UPPERCASE_LETTER;                     =1
// Nested Types
1.2  public static class Subset;
1.2  public static final class UnicodeBlock extends Character.Subset;
// Public Class Methods
5.0  public static int charCount(int codePoint);
5.0  public static int codePointAt(char[ ] a, int index);
5.0  public static int codePointAt(CharSequence seq, int index);
5.0  public static int codePointAt(char[ ] a, int index, int limit);
5.0  public static int codePointBefore(CharSequence seq, int index);
5.0  public static int codePointBefore(char[ ] a, int index);
5.0  public static int codePointBefore(char[ ] a, int index, int start);
5.0  public static int codePointCount(char[ ] a, int offset, int count);
5.0  public static int codePointCount(CharSequence seq, int beginIndex, int endIndex);
5.0  public static int digit(int codePoint, int radix);
     public static int digit(char ch, int radix);
     public static char forDigit(int digit, int radix);
1.4  public static byte getDirectionality(char ch);
5.0  public static byte getDirectionality(int codePoint);
1.1  public static int getNumericValue(char ch);
5.0  public static int getNumericValue(int codePoint);
1.1  public static int getType(char ch);
5.0  public static int getType(int codePoint);
5.0  public static boolean isDefined(int codePoint);
     public static boolean isDefined(char ch);
5.0  public static boolean isDigit(int codePoint);
     public static boolean isDigit(char ch);
5.0  public static boolean isHighSurrogate(char ch);
5.0  public static boolean isIdentifierIgnorable(int codePoint);
```

```
1.1  public static boolean isIdentifierIgnorable(char ch);
1.1  public static boolean isISOControl(char ch);
5.0  public static boolean isISOControl(int codePoint);
1.1  public static boolean isJavaIdentifierPart(char ch);
5.0  public static boolean isJavaIdentifierPart(int codePoint);
1.1  public static boolean isJavaIdentifierStart(char ch);
5.0  public static boolean isJavaIdentifierStart(int codePoint);
     public static boolean isLetter(char ch);
5.0  public static boolean isLetter(int codePoint);
     public static boolean isLetterOrDigit(char ch);
5.0  public static boolean isLetterOrDigit(int codePoint);
5.0  public static boolean isLowerCase(int codePoint);
     public static boolean isLowerCase(char ch);
5.0  public static boolean isLowSurrogate(char ch);
5.0  public static boolean isMirrored(int codePoint);
1.4  public static boolean isMirrored(char ch);
5.0  public static boolean isSpaceChar(int codePoint);
1.1  public static boolean isSpaceChar(char ch);
5.0  public static boolean isSupplementaryCodePoint(int codePoint);
5.0  public static boolean isSurrogatePair(char high, char low);
     public static boolean isTitleCase(char ch);
5.0  public static boolean isTitleCase(int codePoint);
1.1  public static boolean isUnicodeIdentifierPart(char ch);
5.0  public static boolean isUnicodeIdentifierPart(int codePoint);
5.0  public static boolean isUnicodeIdentifierStart(int codePoint);
1.1  public static boolean isUnicodeIdentifierStart(char ch);
     public static boolean isUpperCase(char ch);
5.0  public static boolean isUpperCase(int codePoint);
5.0  public static boolean isValidCodePoint(int codePoint);
5.0  public static boolean isWhitespace(int codePoint);
1.1  public static boolean isWhitespace(char ch);
5.0  public static int offsetByCodePoints(CharSequence seq, int index,
      int codePointOffset);
5.0  public static int offsetByCodePoints(char[ ] a, int start, int count,
      int index, int codePointOffset);
5.0  public static char reverseBytes(char ch);
5.0  public static char[ ] toChars(int codePoint);
5.0  public static int toChars(int codePoint, char[ ] dst, int dstIndex);
5.0  public static int toCodePoint(char high, char low);
     public static char toLowerCase(char ch);
5.0  public static int toLowerCase(int codePoint);
1.4  public static String toString(char c);
     public static char toTitleCase(char ch);
5.0  public static int toTitleCase(int codePoint);
     public static char toUpperCase(char ch);
5.0  public static int toUpperCase(int codePoint);
5.0  public static Character valueOf(char c);
// Public Instance Methods
     public char charValue( );
```

```
// Methods Implementing Comparable
1.2  public int compareTo(Character anotherCharacter);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
// Deprecated Public Methods
#    public static boolean isJavaLetter(char ch);
#    public static boolean isJavaLetterOrDigit(char ch);
#    public static boolean isSpace(char ch);
}
```

Character.Subset java.lang

Java 1.2

This class represents a named subset of the Unicode character set. The `toString( )` method returns the name of the subset. This is a base class intended for further subclassing. Note, in particular, that it does not provide a way to list the members of the subset, nor a way to test for membership in the subset. See `Character.UnicodeBlock`.

```
public static class Character.Subset {
// Protected Constructors
     protected Subset(String name);
// Public Methods Overriding Object
     public final boolean equals(Object obj);
     public final int hashCode( );
     public final String toString( );
}
```

Subclasses

`Character.UnicodeBlock`

Character.UnicodeBlock java.lang

Java 1.2

This subclass of Character.Subset defines a number of constants that represent named subsets of the Unicode character set. The subsets and their names are the character blocks defined by the Unicode specification (see http://www.unicode.org/). Java 1.4 and 5.0 both update this class to a new version of the Unicode standard and define a number of new block constants. The static method of( ) takes a character or int codepoint and returns the Character.UnicodeBlock to which it belongs, or null if it is part of any defined block. When presented with an unknown Unicode character, this method provides a useful way to determine what alphabet it belongs to. In Java 5.0, the forName( ) factory method allows lookup of a UnicodeBlock by name.

```
public static final class Character.UnicodeBlock extends Character.Subset {
// No Constructor
// Public Constants
5.0  public static final Character.UnicodeBlock AEGEAN_NUMBERS;
     public static final Character.UnicodeBlock ALPHABETIC_PRESENTATION_FORMS;
     public static final Character.UnicodeBlock ARABIC;
     public static final Character.UnicodeBlock ARABIC_PRESENTATION_FORMS_A;
     public static final Character.UnicodeBlock ARABIC_PRESENTATION_FORMS_B;
     public static final Character.UnicodeBlock ARMENIAN;
     public static final Character.UnicodeBlock ARROWS;
     public static final Character.UnicodeBlock BASIC_LATIN;
     public static final Character.UnicodeBlock BENGALI;
     public static final Character.UnicodeBlock BLOCK_ELEMENTS;
     public static final Character.UnicodeBlock BOPOMOFO;
1.4  public static final Character.UnicodeBlock BOPOMOFO_EXTENDED;
     public static final Character.UnicodeBlock BOX_DRAWING;
1.4  public static final Character.UnicodeBlock BRAILLE_PATTERNS;
5.0  public static final Character.UnicodeBlock BUHID;
5.0  public static final Character.UnicodeBlock BYZANTINE_MUSICAL_SYMBOLS;
1.4  public static final Character.UnicodeBlock CHEROKEE;
     public static final Character.UnicodeBlock CJK_COMPATIBILITY;
     public static final Character.UnicodeBlock CJK_COMPATIBILITY_FORMS;
     public static final Character.UnicodeBlock CJK_COMPATIBILITY_IDEOGRAPHS;
5.0  public static final Character.UnicodeBlock CJK_COMPATIBILITY_IDEOGRAPHS_SUPPLEMENT
1.4  public static final Character.UnicodeBlock CJK_RADICALS_SUPPLEMENT;
     public static final Character.UnicodeBlock CJK_SYMBOLS_AND_PUNCTUATION;
     public static final Character.UnicodeBlock CJK_UNIFIED_IDEOGRAPHS;
1.4  public static final Character.UnicodeBlock CJK_UNIFIED_IDEOGRAPHS_EXTENSION_A;
5.0  public static final Character.UnicodeBlock CJK_UNIFIED_IDEOGRAPHS_EXTENSION_B;
     public static final Character.UnicodeBlock COMBINING_DIACRITICAL_MARKS;
     public static final Character.UnicodeBlock COMBINING_HALF_MARKS;
     public static final Character.UnicodeBlock COMBINING_MARKS_FOR_SYMBOLS;
```

```
     public static final Character.UnicodeBlock CONTROL_PICTURES;
     public static final Character.UnicodeBlock CURRENCY_SYMBOLS;
5.0  public static final Character.UnicodeBlock CYPRIOT_SYLLABARY;
     public static final Character.UnicodeBlock CYRILLIC;
5.0  public static final Character.UnicodeBlock CYRILLIC_SUPPLEMENTARY;
5.0  public static final Character.UnicodeBlock DESERET;
     public static final Character.UnicodeBlock DEVANAGARI;
     public static final Character.UnicodeBlock DINGBATS;
     public static final Character.UnicodeBlock ENCLOSED_ALPHANUMERICS;
     public static final Character.UnicodeBlock ENCLOSED_CJK_LETTERS_AND_MONTHS;
1.4  public static final Character.UnicodeBlock ETHIOPIC;
     public static final Character.UnicodeBlock GENERAL_PUNCTUATION;
     public static final Character.UnicodeBlock GEOMETRIC_SHAPES;
     public static final Character.UnicodeBlock GEORGIAN;
5.0  public static final Character.UnicodeBlock GOTHIC;
     public static final Character.UnicodeBlock GREEK;
     public static final Character.UnicodeBlock GREEK_EXTENDED;
     public static final Character.UnicodeBlock GUJARATI;
     public static final Character.UnicodeBlock GURMUKHI;
     public static final Character.UnicodeBlock HALFWIDTH_AND_FULLWIDTH_FORMS;
     public static final Character.UnicodeBlock HANGUL_COMPATIBILITY_JAMO;
     public static final Character.UnicodeBlock HANGUL_JAMO;
     public static final Character.UnicodeBlock HANGUL_SYLLABLES;
5.0  public static final Character.UnicodeBlock HANUNOO;
     public static final Character.UnicodeBlock HEBREW;
5.0  public static final Character.UnicodeBlock HIGH_PRIVATE_USE_SURROGATES;
5.0  public static final Character.UnicodeBlock HIGH_SURROGATES;
     public static final Character.UnicodeBlock HIRAGANA;
1.4  public static final Character.UnicodeBlock IDEOGRAPHIC_DESCRIPTION_CHARACTERS;
     public static final Character.UnicodeBlock IPA_EXTENSIONS;
     public static final Character.UnicodeBlock KANBUN;
1.4  public static final Character.UnicodeBlock KANGXI_RADICALS;
     public static final Character.UnicodeBlock KANNADA;
     public static final Character.UnicodeBlock KATAKANA;
5.0  public static final Character.UnicodeBlock KATAKANA_PHONETIC_EXTENSIONS;
1.4  public static final Character.UnicodeBlock KHMER;
5.0  public static final Character.UnicodeBlock KHMER_SYMBOLS;
     public static final Character.UnicodeBlock LAO;
     public static final Character.UnicodeBlock LATIN_1_SUPPLEMENT;
     public static final Character.UnicodeBlock LATIN_EXTENDED_A;
     public static final Character.UnicodeBlock LATIN_EXTENDED_ADDITIONAL;
     public static final Character.UnicodeBlock LATIN_EXTENDED_B;
     public static final Character.UnicodeBlock LETTERLIKE_SYMBOLS;
5.0  public static final Character.UnicodeBlock LIMBU;
5.0  public static final Character.UnicodeBlock LINEAR_B_IDEOGRAMS;
5.0  public static final Character.UnicodeBlock LINEAR_B_SYLLABARY;
5.0  public static final Character.UnicodeBlock LOW_SURROGATES;
     public static final Character.UnicodeBlock MALAYALAM;
5.0  public static final Character.UnicodeBlock MATHEMATICAL_ALPHANUMERIC_SYMBOLS;
     public static final Character.UnicodeBlock MATHEMATICAL_OPERATORS;
5.0  public static final Character.UnicodeBlock MISCELLANEOUS_MATHEMATICAL_SYMBOLS_A;
```

```
5.0  public static final Character.UnicodeBlock MISCELLANEOUS_MATHEMATICAL_SYMBOLS_B;
     public static final Character.UnicodeBlock MISCELLANEOUS_SYMBOLS;
5.0  public static final Character.UnicodeBlock MISCELLANEOUS_SYMBOLS_AND_ARROWS;
     public static final Character.UnicodeBlock MISCELLANEOUS_TECHNICAL;
1.4  public static final Character.UnicodeBlock MONGOLIAN;
5.0  public static final Character.UnicodeBlock MUSICAL_SYMBOLS;
1.4  public static final Character.UnicodeBlock MYANMAR;
     public static final Character.UnicodeBlock NUMBER_FORMS;
1.4  public static final Character.UnicodeBlock OGHAM;
5.0  public static final Character.UnicodeBlock OLD_ITALIC;
     public static final Character.UnicodeBlock OPTICAL_CHARACTER_RECOGNITION;
     public static final Character.UnicodeBlock ORIYA;
5.0  public static final Character.UnicodeBlock OSMANYA;
5.0  public static final Character.UnicodeBlock PHONETIC_EXTENSIONS;
     public static final Character.UnicodeBlock PRIVATE_USE_AREA;
1.4  public static final Character.UnicodeBlock RUNIC;
5.0  public static final Character.UnicodeBlock SHAVIAN;
1.4  public static final Character.UnicodeBlock SINHALA;
     public static final Character.UnicodeBlock SMALL_FORM_VARIANTS;
     public static final Character.UnicodeBlock SPACING_MODIFIER_LETTERS;
     public static final Character.UnicodeBlock SPECIALS;
     public static final Character.UnicodeBlock SUPERSCRIPTS_AND_SUBSCRIPTS;
5.0  public static final Character.UnicodeBlock SUPPLEMENTAL_ARROWS_A;
5.0  public static final Character.UnicodeBlock SUPPLEMENTAL_ARROWS_B;
5.0  public static final Character.UnicodeBlock SUPPLEMENTAL_MATHEMATICAL_OPERATORS;
5.0  public static final Character.UnicodeBlock SUPPLEMENTARY_PRIVATE_USE_AREA_A;
5.0  public static final Character.UnicodeBlock SUPPLEMENTARY_PRIVATE_USE_AREA_B;
1.4  public static final Character.UnicodeBlock SYRIAC;
5.0  public static final Character.UnicodeBlock TAGALOG;
5.0  public static final Character.UnicodeBlock TAGBANWA;
5.0  public static final Character.UnicodeBlock TAGS;
5.0  public static final Character.UnicodeBlock TAI_LE;
5.0  public static final Character.UnicodeBlock TAI_XUAN_JING_SYMBOLS;
     public static final Character.UnicodeBlock TAMIL;
     public static final Character.UnicodeBlock TELUGU;
1.4  public static final Character.UnicodeBlock THAANA;
     public static final Character.UnicodeBlock THAI;
     public static final Character.UnicodeBlock TIBETAN;
5.0  public static final Character.UnicodeBlock UGARITIC;
1.4  public static final Character.UnicodeBlock UNIFIED_CANADIAN_ABORIGINAL_SYLLABICS;
5.0  public static final Character.UnicodeBlock VARIATION_SELECTORS;
5.0  public static final Character.UnicodeBlock VARIATION_SELECTORS_SUPPLEMENT;
1.4  public static final Character.UnicodeBlock YI_RADICALS;
1.4  public static final Character.UnicodeBlock YI_SYLLABLES;
5.0  public static final Character.UnicodeBlock YIJING_HEXAGRAM_SYMBOLS;
// Public Class Methods
5.0  public static final Character.UnicodeBlock forName(String blockName);
5.0  public static Character.UnicodeBlock of(int codePoint);
     public static Character.UnicodeBlock of(char c);
// Deprecated Public Fields
```

```
#    public static final Character.UnicodeBlock SURROGATES_AREA;
}
```

CharSequence java.lang

Java 1.4

This interface defines a simple API for read-only access to sequences of characters. In the core platform it is implemented by the `String`, `StringBuffer` and `java.nio.CharBuffer` classes. `charAt( )` returns the character at a specified position in the sequence. `length( )` returns the number of characters in the sequence. `subSequence( )` returns a `CharSequence` that consists of the characters starting at, and including, the specified *start* index, and continuing up to, but not including the specified *end* index. Finally, `toString( )` returns a `String` version of the sequence.

Note that `CharSequence` implementations do not typically have interoperable `equals( )` or `hashCode( )` methods, and it is not usually possible to compare two `CharSequence` objects or use multiple sequences in a set or hashtable unless they are instances of the same implementing class.

```
public interface CharSequence {
// Public Instance Methods
     char charAt(int index);
     int length( );
     CharSequence subSequence(int start, int end);
     String toString( );
}
```

Implementations

`String`, `StringBuffer`, `StringBuilder`, `java.nio.CharBuffer`

Passed To

Too many methods to list.

Returned By

`String.subSequence( )`, `StringBuffer.subSequence( )`, `java.nio.CharBuffer.subSequence( )`

Team LiB

Class<T> java.lang

Java 1.0 *serializable*

This class represents a Java type. There is one Class object for each class that is loaded into the Java Virtual Machine, and, as of Java 1.1, there are special Class objects that represent the Java primitive types. The TYPE constants defined by Boolean, Integer, and the other primitive wrapper classes hold these special Class objects. Array types are also represented by Class objects in Java 1.1.

There is no constructor for this class. You can obtain a Class object by calling the getClass( ) method of any instance of the desired class. In Java 1.1 and later, you can also refer to a Class object by appending .class to the name of a class. Finally, and most interestingly, a class can be dynamically loaded by passing its fully qualified name (i.e., package name plus class name) to the static Class.forName( ) method. This method loads the named class (if it is not already loaded) into the Java interpreter and returns a Class object for it. Classes can also be loaded with a ClassLoader object.

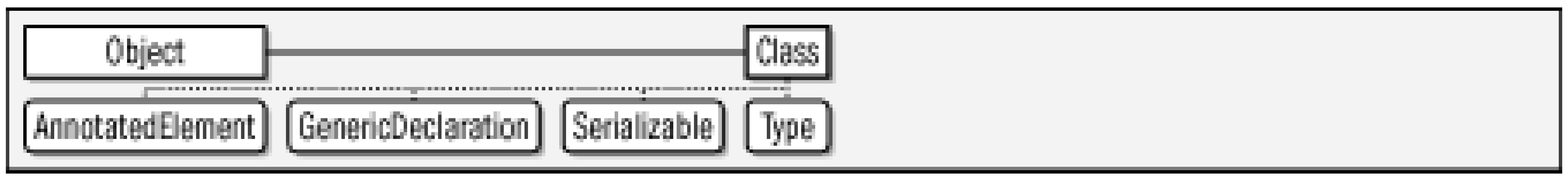
The newInstance( ) method creates an instance of a given class; this allows you to create instances of dynamically loaded classes for which you cannot use the new keyword. Note that this method works only when the target class has a no-argument constructor. See newInstance( ) in java.lang.reflect.Constructor for a more powerful way to instantiate dynamically loaded classes. In Java 5.0, Class is a generic type and the type variable *T* specifies the type that is returned by the newInstance( ) method.

getName( ) returns the name of the class. getSuperclass( ) returns its superclass. isInterface( ) tests whether the Class object represents an interface, and getInterfaces( ) returns an array of the interfaces that this class implements. In Java 1.2 and later, getPackage( ) returns a Package object that represents the package containing the class. getProtectionDomain( ) returns the java.security.ProtectionDomain to which this class belongs. The various other get( ) and is( ) methods return other information about the represented class; they form part of the Java Reflection API, along with the classes in java.lang.reflect.

Java 5.0 adds a number of methods to support the new language features it defines. isAnnotation( ) tests whether a type is an annotation type. Class implements java.lang.reflect.AnnotatedElement in Java 5.0 and the getAnnotation( ) and related methods allow the retrieval of annotations (with runtime retention) on the class. isEnum( ) tests whether a Class object represents an enumerated type and getEnumConstants( ) returns an array of the constants defined by an enumerated type. getTypeParameters( ) returns the type variables declared by a generic type. getGenericSuperclass( ) and getGenericInterfaces( ) are the generic variants of the getSuperclass( ) and getInterfaces( ) methods, returning the generic type information that appears in the extends and implements clause of the class declaration. See java.lang.reflect.Type for more information.

Java 5.0 also adds methods that are useful for reflection on inner classes. isMemberClass( ), isLocalClass( ), and isAnonymousClass( ) determine whether a Class represents one of these kinds of nested types. `getEnclosingClass( )` , `getEnclosingMethod( )`, and `getEnclosingConstructor( )` return the type, method, or constructor that an inner class is nested within. Finally, `getSimpleName( )` returns the name of a type as it would appear in Java source code This is typically more useful than the Java VM formatted names returned by`getName( )`.

Figure 10-10. java.lang.Class<T>




```
public final class Class<T>
        implements Serializable, java.lang.reflect.GenericDeclaration,
        java.lang.reflect.Type, java.lang.reflect.AnnotatedElement {
// No Constructor
// Public Class Methods
     public static Class<?> forName(String className)
     throws ClassNotFoundException;
1.2  public static Class<?> forName(String name, boolean initialize,
        ClassLoader loader) throws ClassNotFoundException;
// Public Instance Methods
5.0  public <U> Class<? extends U> asSubclass(Class<U> clazz);
5.0  public T cast(Object obj);
1.4  public boolean desiredAssertionStatus( );
5.0  public String getCanonicalName( );
1.1  public Class[ ] getClasses( );
     public ClassLoader getClassLoader( );
1.1  public Class<?> getComponentType( );                    native
1.1  public java.lang.reflect.Constructor<T> getConstructor(Class ...
        parameterTypes) throws NoSuchMethodException, SecurityException
1.1  public java.lang.reflect.Constructor[ ] getConstructors( )
        throws SecurityException;
1.1  public Class[ ] getDeclaredClasses( )
        throws SecurityException;
1.1  public java.lang.reflect.Constructor<T> getDeclaredConstructor(Class ...
parameterTypes) throws NoSuchMethodException, SecurityException;
1.1  public java.lang.reflect.Constructor[ ] getDeclaredConstructors( )
        throws SecurityException;
1.1  public java.lang.reflect.Field getDeclaredField(String name)
        throws NoSuchFieldException, SecurityException;
1.1  public java.lang.reflect.Field[ ] getDeclaredFields( )
        throws SecurityException;
1.1  public java.lang.reflect.Method getDeclaredMethod(String name, Class...
parameterTypes) throws NoSuchMethodException, SecurityException;
1.1  public java.lang.reflect.Method[ ] getDeclaredMethods( )
        throws SecurityException;
1.1  public Class<?> getDeclaringClass( );                   native
5.0  public Class<?> getEnclosingClass( );
```

```
5.0  public java.lang.reflect.Constructor<?> getEnclosingConstructor( );
5.0  public java.lang.reflect.Method getEnclosingMethod( );
5.0  public T[ ] getEnumConstants( );
1.1  public java.lang.reflect.Field getField(String name)
        throws NoSuchFieldException, SecurityException;
1.1  public java.lang.reflect.Field[ ] getFields( ) throws SecurityException;
5.0  public java.lang.reflect.Type[ ] getGenericInterfaces( );
5.0  public java.lang.reflect.Type getGenericSuperclass( );
     public Class[ ] getInterfaces( );                             native
1.1  public java.lang.reflect.Method getMethod(String name, Class...
parameterTypes) throws NoSuchMethodException, SecurityException;
1.1  public java.lang.reflect.Method[ ] getMethods( ) throws SecurityException;
1.1  public int getModifiers( );                                       native
     public String getName( );
1.2  public Package getPackage( );
1.2  public java.security.ProtectionDomain getProtectionDomain( );
1.1  public java.net.URL getResource(String name);
1.1  public java.io.InputStream getResourceAsStream(String name);
1.1  public Object[ ] getSigners( );                             native
5.0  public String getSimpleName( );
     public Class<? super T> getSuperclass( );                    native
5.0  public boolean isAnnotation( );
5.0  public boolean isAnonymousClass( );
1.1  public boolean isArray( );                                  native
1.1  public boolean isAssignableFrom(Class<?> cls);         native
5.0  public boolean isEnum( );
1.1  public boolean isInstance(Object obj);                         native
     public boolean isInterface( );                                 native
5.0  public boolean isLocalClass( );
5.0  public boolean isMemberClass( );
1.1  public boolean isPrimitive( );                                   native
5.0  public boolean isSynthetic( );
     public T newInstance( )
        throws InstantiationException, IllegalAccessException;
// Methods Implementing AnnotatedElement
5.0  public <A extends java.lang.annotation.Annotation> A getAnnotation
(Class<A> annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getAnnotations( );
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
5.0  public boolean isAnnotationPresent(Class<? extends java.lang.annotation.
Annotation> annotationClass);
// Methods Implementing GenericDeclaration
5.0  public java.lang.reflect.TypeVariable<Class<T>>[ ] getTypeParameters( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

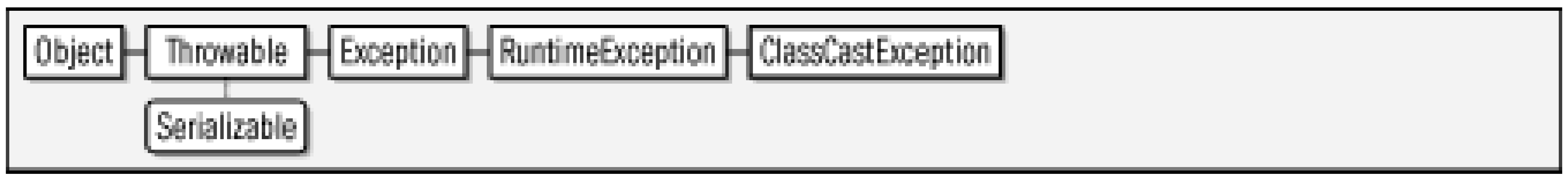
Boolean.TYPE, Byte.TYPE, Character.TYPE, Double.TYPE, Float.TYPE, Integer.TYPE, Long.TYPE, Short.TYPE, Void.TYPE

ClassCastException java.lang

Java 1.0 *serializable unchecked*

Signals an invalid cast of an object to a type of which it is not an instance.

Figure 10-11. java.lang.ClassCastException




```
public class ClassCastException extends RuntimeException {
// Public Constructors
     public ClassCastException( );
     public ClassCastException(String s);
}
```

Thrown By

`org.xml.sax.helpers.ParserFactory.makeParser( )`

ClassCircularityError java.lang

Java 1.0 *serializable error*

Signals that a circular dependency has been detected while performing initialization for a class.

Figure 10-12. java.lang.ClassCircularityError

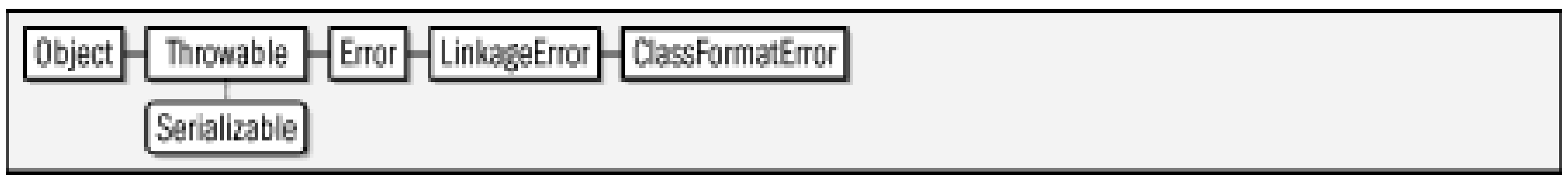

```
public class ClassCircularityError extends LinkageError {
// Public Constructors
     public ClassCircularityError( );
     public ClassCircularityError(String s);
}
```

ClassFormatError java.lang

Java 1.0 *serializable error*

Signals an error in the binary format of a class file.

Figure 10-13. java.lang.ClassFormatError




```
public class ClassFormatError extends LinkageError {
// Public Constructors
     public ClassFormatError( );
     public ClassFormatError(String s);
}
```

Subclasses

UnsupportedClassVersionError, java.lang.reflect.GenericSignatureFormatError

Thrown By

ClassLoader.defineClass( )

ClassLoader java.lang

Java 1.0

This class is the abstract superclass of objects that know how to load Java classes into a Java VM. Given object, you can dynamically load a class by calling the public loadClass( ) method, specifying the full n desired class. You can obtain a resource associated with a class by calling getresource( ) , geTResourc getresourceAsStream( ) . Many applications do not need to use ClassLoader directly; these applicatio Class.forName( ) and Class.getResource( ) methods to dynamically load classes and resources usin ClassLoader object that loaded the application itself.

In order to load classes over the network or from any source other than the class path, you must use a ClassLoader object that knows how to obtain data from that source. A java.net.URLClassLoader is su purpose for almost all applications. Only rarely should an application need to define a ClassLoader subcl When this is necessary, the subclass should typically extend java.security.SecureClassLoader and ov findClass( ) method. This method must find the bytes that comprise the named class, then pass them defineClass( ) method and return the resulting Class object. In Java 1.2 and later, the findClass( ) also define the Package object associated with the class, if it has not already been defined. It can use ge and definePackage( ) for this purpose. Custom subclasses of ClassLoader should also override findRe and findResources( ) to enable the public geTResource( ) and getresources( ) methods.

In Java 1.4 and later you can specify whether the classes loaded through a ClassLoader should have ass (assert statements) enabled. setDefaultAssertionStatus( ) enables or disables assertions for all loa setPackageAssertionStatus( ) and setClassAssertionStatus( ) allow you to override the default a for a named package or a named class. Finally, clearAssertionStatus( ) sets the default status to fal discards the assertions status for any named packages and classes.

```
public abstract class ClassLoader {
// Protected Constructors
     protected ClassLoader( );
1.2  protected ClassLoader(ClassLoader parent);
// Public Class Methods
1.2  public static ClassLoader getSystemClassLoader( );
1.1  public static java.net.URL getSystemResource(String name);
1.1  public static java.io.InputStream getSystemResourceAsStream(String name);
1.2  public static java.util.Enumeration<java.net.URL> getSystemResources(String name)
throws java.io.IOException;
// Public Instance Methods
1.4  public void clearAssertionStatus( );                       synchronized
1.2  public final ClassLoader getParent( );
1.1  public java.net.URL getResource(String name);
1.1  public java.io.InputStream getResourceAsStream(String name);
1.2  public java.util.Enumeration<java.net.URL> getResources(String name) throws
java.io.IOException;
1.1  public Class<?> loadClass(String name) throws ClassNotFoundException;
```

```
1.4  public void setClassAssertionStatus(String className, boolean enabled);     synchr
1.4  public void setDefaultAssertionStatus(boolean enabled);        synchronized
1.4  public void setPackageAssertionStatus(String packageName, boolean enabled);     sy
// Protected Instance Methods
5.0  protected final Class<?> defineClass(String name, java.nio.ByteBuffer b,
java.security.ProtectionDomain protectionDomain)
throws ClassFormatError;
1.1  protected final Class<?> defineClass(String name, byte[ ] b, int off, int len)
throws ClassFormatError;
1.2  protected final Class<?> defineClass(String name, byte[ ] b, int off, int len,
java.security.ProtectionDomain protectionDomain)
throws ClassFormatError;
1.2  protected Package definePackage(String name, String specTitle, String specVersion,
String specVendor, String implTitle, String implVersion, String implVendor, java.net.UR
throws IllegalArgumentException;
1.2  protected Class<?> findClass(String name) throws ClassNotFoundException;
1.2  protected String findLibrary(String libname);                  constant
1.1  protected final Class<?> findLoadedClass(String name);
1.2  protected java.net.URL findResource(String name);              constant
1.2  protected java.util.Enumeration<java.net.URL> findResources(String name) throws
java.io.IOException;
     protected final Class<?> findSystemClass(String name) throws ClassNotFoundExceptio
1.2  protected Package getPackage(String name);
1.2  protected Package[ ] getPackages( );
     protected Class<?> loadClass(String name, boolean resolve)
throws ClassNotFoundException;     synchronized
     protected final void resolveClass(Class<?> c);
1.1  protected final void setSigners(Class<?> c, Object[ ] signers);
// Deprecated Protected Methods
#    protected final Class<?> defineClass(byte[ ] b, int off, int len) throws ClassForm
}
```

Subclasses

java.security.SecureClassLoader

Passed To

Class.forName( ) , THRead.setContextClassLoader( ) , java.lang.instrument.ClassFileTransformer.transform( ) , java.lang.instrument.Instrumentation.getInitiatedClasses( ) , java.lang.reflect.Proxy.{g) , newProxyInstance( )} , java.net.URLClassLoader.{newInstance( ) , URLClassLoader( )} , java.security.ProtectionDomain.ProtectionDomain( ) , java.security.SecureClassLoader.SecureClassLoader( ) , java.util.ResourceBundle.getBundle

Returned By

Class.getClassLoader( ) , SecurityManager.currentClassLoader( ) , Thread.getContextClassLo

```
java.security.ProtectionDomain.getClassLoader( )
```

ClassNotFoundException java.lang

Java 1.0 *serializable checked*

Signals that a class to be loaded cannot be found. If an exception of this type was caused by some underlying exception, you can query that lower-level exeption with `getException( )` or with the newer, more general `getCause( )`.

Figure 10-14. java.lang.ClassNotFoundException


```
public class ClassNotFoundException extends Exception {
// Public Constructors
     public ClassNotFoundException( );
     public ClassNotFoundException(String s);
1.2  public ClassNotFoundException(String s, Throwable ex);
// Public Instance Methods
1.2  public Throwable getException( );                              default:null
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );                                  default:null
}
```

Thrown By

Too many methods to list.

Cloneable java.lang

Java 1.0 *cloneable*

This interface defines no methods or variables, but indicates that the class that implements it may be cloned (i.e., copied) by calling the `Object` method `clone( )`. Calling `clone( )` for an object that does not implement this interface (and does not override `clone( )` with its own implementation) causes a `CloneNotSupportedException` to be thrown.

```
public interface Cloneable {
}
```

Implementations

Too many classes to list.

CloneNotSupportedException java.lang

Java 1.0 *serializable checked*

Signals that the `clone( )` method has been called for an object of a class that does not implement the `Cloneable` interface.

Figure 10-15. java.lang.CloneNotSupportedException

```
public class CloneNotSupportedException extends Exception {
// Public Constructors
     public CloneNotSupportedException( );
     public CloneNotSupportedException(String s);
}
```

Thrown By

`Enum.clone( )`, `Object.clone( )`, `java.security.MessageDigest.clone( )`, `java.security.MessageDigestSpi.clone( )`, `java.security.Signature.clone( )`, `java.security.SignatureSpi.clone( )`, `java.util.AbstractMap.clone( )`, `java.util.EnumMap.clone( )`, `java.util.EnumSet.clone( )`, `javax.crypto.Mac.clone( )`, `javax.crypto.MacSpi.clone( )`

Team LiB

Comparable<T> java.lang

Java 1.2 *comparable*

This interface defines a single method, `compareTo( )`, that is responsible for comparing one object to another and determining their relative order, according to some natural ordering for that class of objects. Any general-purpose class that represents a value that can be sorted or ordered should implement this interface. Any class that does implement this interface can make use of various powerful methods such as `java.util.Collections.sort( )` and `java.util.Arrays.binarySearch( )`. Many of the key classes in the Java API implement this interface. In Java 5.0, this interface has been made generic. The type variable *T* represents the type of the object that is passed to the `compareTo( )` method.

The `compareTo( )` method compares this object to the object passed as an argument. It should assume that the supplied object is of the appropriate type; if it is not, it should throw a `ClassCastException`. If this object is less than the supplied object or should appear before the supplied object in a sorted list, `compareTo( )` should return a negative number. If this object is greater than the supplied object or should come after the supplied object in a sorted list, `compareTo( )` should return a positive integer. If the two objects are equivalent, and their relative order in a sorted list does not matter, `compareTo( )` should return 0. If `compareTo( )` returns 0 for two objects, the `equals( )` method should typically return `true`. If this is not the case, the `Comparable` objects are not suitable for use in `java.util.TreeSet` and `java.util.TreeMap` classes.

See `java.util.Comparator` for a way to define an ordering for objects that do not implement `Comparable` or to define an ordering other than the natural ordering defined by a `Comparable` class.

```
public interface Comparable<T> {
// Public Instance Methods
     int compareTo(T o);
}
```

Implementations

Too many classes to list.

Compiler java.lang

Java 1.0

The static methods of this class provide an interface to the just-in-time (JIT)byte-code-to-native code compiler in use by the Java interpreter. If no JIT compiler is in use by the VM, these methods d‹ nothing. `compileClass( )` asks the JIT compiler to compile the specified class. `compileClasses( )` asks the JIT compiler to compile all classes that match the specified name. These methods return `true` if the compilation was successful, or `false` if it failed or if there is no JIT compiler on the system. `enable( )` and `disable( )` turn just-in-time compilation on and off. `command( )` asks the JIT compiler to perform some compiler-specific operation; this is a hook for vendor extensions. No standard operations have been defined.

```
public final class Compiler {
// No Constructor
// Public Class Methods
     public static Object command(Object any);                          native
     public static boolean compileClass(Class<?> clazz);        native
     public static boolean compileClasses(String string);               native
     public static void disable( );                                       native
     public static void enable( );                                        native
}
```

Team LiB

Deprecated java.lang

Java 5.0 *@Documented @Retention(RUNTIME) annotation*

This annotation type marks the annotated program element as deprecated. The Java compiler issues a warning if the annotated element is used or overrided in code that is not itself `@Deprecated`.

In Java 5.0, the `@Deprecated` annotation works in the same way as the `@deprecated` javadoc tag. In future releases of Java, the compiler may ignore `@deprecated` javadoc tag and rely only on the `@Deprecated` annotation.

This annotation type has source retention and does not have an `@Target` meta-annotation, which means it may be applied to any program element. `Deprecated` has an `@Documented` meta-annotation, meaning that the presence of an `@Deprecated` annotation should be a documented part of the annotated element's API.

Figure 10-16. java.lang.Deprecated

```
public @interface Deprecated {
}
```

Double java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around the `double` primitive data type. `doubleValue( )` returns the primitive `double` value of a `Double` object, and there are other methods (which override `Number` methods and whose names all end in "Value") for returning a the wrapped `double` value as a variety of other primitive types.

This class also provides some useful constants and static methods for testing `double` values. `MIN_VALUE` and `MAX_VALUE` are the smallest (closest to zero) and largest representable `double` values. `POSITIVE_INFINITY` and `NEGATIVE_INFINITY` are the `double` representations of infinity and negative infinity, and `NaN` is special `double` "not a number" value. `isInfinite( )` in class and instance method forms tests whether a `double` or a `Double` has an infinite value. Similarly, `isNaN( )` tests whether a `double` or `Double` is not-a-number; this is a comparison that cannot be done directly because the `NaN` constant never tests equal to any other value, including itself.

The static `parseDouble( )` method converts a `String` to a `double`. The static `valueOf( )` converts a `String` to a `Double`, and is basically equivalent to the `Double( )` constructor that takes a `String` argument. The static and instance `toString( )` methods perform the opposite conversion: they convert a `double` or a `Double` to a `String`. See also `java.text.NumberFormat` for more flexible number parsing and formatting.

The `compareTo( )` method makes `Double` object `Comparable` which is useful for ordering and sorting. The static `compare( )` method is similar (its return values have the same meaning as those of `Comparable.compareTo( )`) but works on primitive values rather than objects and is useful when ordering and sorting arrays of `double` values.

`doubleToLongBits( )`, `doubleToRawBits( )` and `longBitsToDouble( )` allow you to manipulate the bit representation (defined by IEEE 754) of a `double` directly (which is not something that most applications ever need to do).

Figure 10-17. java.lang.Double

```
public final class Double extends Number implements Comparable<Double> {
// Public Constructors
     public Double(String s) throws NumberFormatException;
     public Double(double value);
// Public Constants
     public static final double MAX_VALUE; =1.7976931348623157E308
```

```
     public static final double MIN_VALUE; =4.9E-324
     public static final double NaN;       =NaN
     public static final double NEGATIVE_INFINITY;                       =-Infinity
     public static final double POSITIVE_INFINITY;                       =Infinity
5.0  public static final int SIZE;     =64
1.1  public static final Class<Double> TYPE;
// Public Class Methods
1.4  public static int compare(double d1, double d2);
     public static long doubleToLongBits(double value);                 native
1.3  public static long doubleToRawLongBits(double value);          native
     public static boolean isInfinite(double v);
     public static boolean isNaN(double v);
     public static double longBitsToDouble(long bits);                  native
1.2  public static double parseDouble(String s) throws NumberFormatException;
5.0  public static String toHexString(double d);
     public static String toString(double d);
     public static Double valueOf(String s) throws NumberFormatException;
5.0  public static Double valueOf(double d);
// Public Instance Methods
     public boolean isInfinite( );
     public boolean isNaN( );
// Methods Implementing Comparable
1.2  public int compareTo(Double anotherDouble);
// Public Methods Overriding Number
1.1  public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
1.1  public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Team LiB

Enum<E extends Enum<E>> java.lang

Java 5.0 *serializable comparable*

This class is the common superclass of all enumerated types. It is not itself an `enum` type, however, and a Java compiler does not allow other classes to extend it. Subclasses of `Enum` may be only created with `enum` declarations. `Enum` is a generic type, and the type variable *`E`* represents the concrete enumerated type that actually extends `Enum`. This type variable exists so that `Enum` can implement `Comparable<E>`.

Every enumerated constant has a name (the name it was declared with) and an ordinal valuethe first constant in an `enum` declaration has an ordinal of 0, the second has an ordinal of 1, and so on. The `final` methods `name( )` and `ordinal( )` return these values. Most users of enumerated constants will use `toString( )` instead of `name( )`. The implementation of `toString( )` defined by `Enum` returns the same value as `name( )`. The `toString( )` method is not `final`, however, and it can be overridden in `enum` declarations.

`Enum` implements a number of `Object` and `Comparable` methods and makes its implementations `final` so that they are inherited by all `enum` types and may not be overridden. `equals( )` compares enumerated constants with the `= =` operator, and `hashCode( )` returns the `System.identityHashCode( )` value. In order to make this identity-based `equals( )` implementation work, `Enum` overrides the protected `clone( )` method to throw `CloneNotSupportedException`, preventing additional copies of enumerated values from being created. Finally, the `compareTo( )` method of the `Comparable` interface is defined to compare enumerated values based on their `ordinal( )` value.

`getdeclaringClass( )` returns the `Class` object that represents the `enum` type of which the constant is a part. It is like the `getClass( )` method inherited from `Object`, but the return values of these two methods will be different for enumerated constants that have value-specific class bodies, since those constants are instances of an anonymous subclass of the `enum` type.

The static `valueOf( )` method is passed the type and name of an enumerated constant and returns the object that represents that constant (or throws an `IllegalArgumentException`).

Figure 10-18. java.lang.Enum<E extends Enum<E>>

```
public abstract class Enum<E extends Enum<E>> implements Comparable<E>, Serializable {
// Protected Constructors
     protected Enum(String name, int ordinal);
// Public Class Methods
```

```
    public static <T extends Enum<T>> T valueOf(Class<T> enumType, String name);
// Public Instance Methods
    public final Class<E> getDeclaringClass( );
    public final String name( );
    public final int ordinal( );
// Methods Implementing Comparable
    public final int compareTo(E o);
// Public Methods Overriding Object
    public final boolean equals(Object other);
    public final int hashCode( );
    public String toString( );
// Protected Methods Overriding Object
    protected final Object clone( ) throws CloneNotSupportedException;
}
```

Subclasses

THRead.State , java.lang.annotation.ElementType , java.lang.annotation.RetentionPolicy , java.lang.management.MemoryType , java.math.RoundingMode , java.net.Authenticator.RequestorType , java.net.Proxy.Type , java.security.KeyRep.Type , java.util.Formatter.BigDecimalLayoutForm , java.util.concurrent.TimeUnit , javax.net.ssl.SSLEngineResult.HandshakeStatus , javax.net.ssl.SSLEngineResult.Status

Passed To

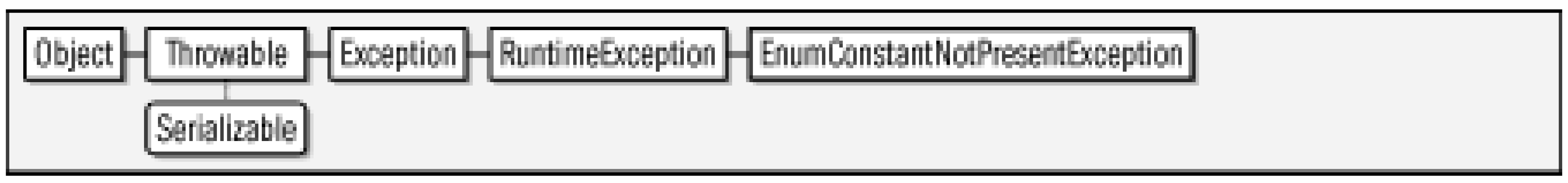
Too many methods to list.

EnumConstantNotPresentException java.lang

Java 5.0 *serializable unchecked*

This unchecked exception is thrown when Java code attempts to use an enum constant that no longer exists. This can happen only if the enumerated constant was removed from its enumerated type after the referencing code was compiled. The methods of the exception provide the `Class` of the enumerated type and the name of the nonexistent constant.

Figure 10-19. java.lang.EnumConstantNotPresentException




```
public class EnumConstantNotPresentException extends RuntimeException {
// Public Constructors
     public EnumConstantNotPresentException(Class<? extends Enum> enumType,
     String constantName);
// Public Instance Methods
     public String constantName( );
     public Class<? extends Enum> enumType( );
}
```

Error java.lang

Java 1.0 *serializable error*

This class forms the root of the error hierarchy in Java. Subclasses of `Error`, unlike subclasses of `Exception`, should not be caught and generally cause termination of the program. Subclasses of `Error` need not be declared in the `throws` clause of a method definition. This class inherits methods from `THRowable` but declares none of its own. Each of its constructors simply invokes the corresponding `Throwable( )` constructor. See `Throwable` for details.

Figure 10-20. java.lang.Error


```
public class Error extends Throwable {
// Public Constructors
     public Error( );
1.4  public Error(Throwable cause);
     public Error(String message);
1.4  public Error(String message, Throwable cause);
}
```

Subclasses

`AssertionError`, `LinkageError`, `ThreadDeath`, `VirtualMachineError`, `java.lang.annotation.AnnotationFormatError`, `java.nio.charset.CoderMalfunctionError`, `javax.xml.parsers.FactoryConfigurationError`, `javax.xml.transform.TransformerFactoryConfigurationError`

Exception java.lang

Java 1.0 *serializable checked*

This class forms the root of the exception hierarchy in Java. An `Exception` signals an abnormal condition must be specially handled to prevent program termination. Exceptions may be caught and handled. An e that is not a subclass of `RuntimeException` must be declared in the `throws` clause of any method that ca throw it. This class inherits methods from `THRowable` but declares none of its own. Each of its constructo simply invokes the corresponding `Throwable( )` constructor. See `Throwable` for details.

Figure 10-21. java.lang.Exception


```
public class Exception extends Throwable {
// Public Constructors
     public Exception( );
1.4  public Exception(Throwable cause);
     public Exception(String message);
1.4  public Exception(String message, Throwable cause);
}
```

Subclasses

Too many classes to list.

Passed To

`java.io.WriteAbortedException.WriteAbortedException( )`, `java.nio.charset.CoderMalfunctionError.CoderMalfunctionError( )`, `java.security.PrivilegedActionException.PrivilegedActionException( )`, `java.util.logging.ErrorManager.error( )`, `java.util.logging.Handler.reportError( )`, `javax.xml.parsers.FactoryConfigurationError.FactoryConfigurationError( )`, `javax.xml.transform.TransformerFactoryConfigurationError.TransformerFactoryConfiguratio )`, `org.xml.sax.SAXException.SAXException( )`, `org.xml.sax.SAXParseException.SAXParseExcep )`

Returned By

java.security.PrivilegedActionException.getException( ) , javax.xml.parsers.FactoryConfigurationError.getException( ) , javax.xml.transform.TransformerFactoryConfigurationError.getException( ) , org.xml.sax.SAXException.getException( )

Thrown By

java.security.PrivilegedExceptionAction.run( ) , java.util.concurrent.Callable.call( )

Type Of

java.io.WriteAbortedException.detail

Team LiB

ExceptionInInitializerError java.lang

Java 1.1 *serializable error*

This error is thrown by the Java Virtual Machine when an exception occurs in the static initializer of a class. You can use the `getException( )` method to obtain the `Throwable` object that was thrown from the initializer. In Java 1.4 and later, `getException( )` has been superseded by the more general `getCause( )` method of the `THRowable` class.

Figure 10-22. java.lang.ExceptionInInitializerError


```
public class ExceptionInInitializerError extends LinkageError {
// Public Constructors
     public ExceptionInInitializerError( );
     public ExceptionInInitializerError(String s);
     public ExceptionInInitializerError(Throwable thrown);
// Public Instance Methods
     public Throwable getException( );                         default:null
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );                          default:null
}
```

Team LiB

Float java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around a primitive `float` value. `floatValue( )` returns the primitive `float` value of a `Float` object, and there are methods for returning the value of a `Float` as a variety of other primitive types. This class is very similar to `Double`, and defines the same set of useful methods and constants as that class does. See `Double` for details.

Figure 10-23. java.lang.Float


```
public final class Float extends Number implements Comparable<Float> {
// Public Constructors
     public Float(double value);
     public Float(String s) throws NumberFormatException;
     public Float(float value);
// Public Constants
     public static final float MAX_VALUE;  =3.4028235E38
     public static final float MIN_VALUE;  =1.4E-45
     public static final float NaN;        =NaN
     public static final float NEGATIVE_INFINITY;                        =-Infinity
     public static final float POSITIVE_INFINITY;                        =Infinity
5.0  public static final int SIZE;     =32
1.1  public static final Class<Float> TYPE;
// Public Class Methods
1.4  public static int compare(float f1, float f2);
     public static int floatToIntBits(float value);                     native
1.3  public static int floatToRawIntBits(float value);              native
     public static float intBitsToFloat(int bits);                      native
     public static boolean isInfinite(float v);
     public static boolean isNaN(float v);
1.2  public static float parseFloat(String s) throws NumberFormatException;
5.0  public static String toHexString(float f);
     public static String toString(float f);
     public static Float valueOf(String s) throws NumberFormatException;
5.0  public static Float valueOf(float f);
// Public Instance Methods
     public boolean isInfinite( );
```

```
     public boolean isNaN( );
// Methods Implementing Comparable
1.2  public int compareTo(Float anotherFloat);
// Public Methods Overriding Number
1.1  public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
1.1  public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

IllegalAccessError java.lang

Java 1.0 *serializable error*

Signals an attempted use of a class, method, or field that is not accessible.

Figure 10-24. java.lang.IllegalAccessError


```
public class IllegalAccessError extends IncompatibleClassChangeError {
// Public Constructors
     public IllegalAccessError( );
     public IllegalAccessError(String s);
}
```

IllegalAccessException java.lang

Java 1.0 *serializable checked*

Signals that a class or initializer is not accessible. Thrown by`Class.newInstance( )`.

Figure 10-25. java.lang.IllegalAccessException


```
public class IllegalAccessException extends Exception {
// Public Constructors
     public IllegalAccessException( );
     public IllegalAccessException(String s);
}
```

Thrown By

Too many methods to list.

IllegalArgumentException java.lang

Java 1.0 *serializable unchecked*

Signals an illegal argument to a method. See subclasses `IllegalThreadStateException` and `NumberFormatException`.

Figure 10-26. java.lang.IllegalArgumentException


```
public class IllegalArgumentException extends RuntimeException {
// Public Constructors
     public IllegalArgumentException( );
5.0  public IllegalArgumentException(Throwable cause);
     public IllegalArgumentException(String s);
5.0  public IllegalArgumentException(String message, Throwable cause);
}
```

Subclasses

`IllegalThreadStateException`, `NumberFormatException`, `java.nio.channels.IllegalSelectorException`, `java.nio.channels.UnresolvedAddressException`, `java.nio.channels.UnsupportedAddressTypeException`, `java.nio.charset.IllegalCharsetNameException`, `java.nio.charset.UnsupportedCharsetException`, `java.security.InvalidParameterException`, `java.util.IllegalFormatException`, `java.util.regex.PatternSyntaxException`

Thrown By

Too many methods to list.

IllegalMonitorStateException java.lang

Java 1.0 *serializable unchecked*

Signals an illegal monitor state. It is thrown by the `Object` `notify( )` and `wait( )` methods used for thread synchronization.

Figure 10-27. java.lang.IllegalMonitorStateException


```
public class IllegalMonitorStateException extends RuntimeException {
// Public Constructors
     public IllegalMonitorStateException( );
     public IllegalMonitorStateException(String s);
}
```

IllegalStateException java.lang

Java 1.1 *serializable unchecked*

Signals that a method has been invoked on an object that is not in an appropriate state to perform the requested operation.

Figure 10-28. java.lang.IllegalStateException


```
public class IllegalStateException extends RuntimeException {
// Public Constructors
     public IllegalStateException( );
5.0  public IllegalStateException(Throwable cause);
     public IllegalStateException(String s);
5.0  public IllegalStateException(String message, Throwable cause);
}
```

Subclasses

java.nio.InvalidMarkException , java.nio.channels.AlreadyConnectedException ,java.nio.channels.CancelledKeyException , java.nio.channels.ClosedSelectorException ,java.nio.channels.ConnectionPendingException , java.nio.channels.IllegalBlockingModeException ,java.nio.channels.NoConnectionPendingException , java.nio.channels.NonReadableChannelException , java.nio.channels.NonWritableChannelException , java.nio.channels.NotYetBoundException ,java.nio.channels.NotYetConnectedException , java.nio.channels.OverlappingFileLockException ,java.util.FormatterClosedException , java.util.concurrent.CancellationException

Thrown By

Too many methods to list.

IllegalThreadStateException java.lang

Java 1.0 *serializable unchecked*

Signals that a thread is not in the appropriate state for an attempted operation to succeed.

Figure 10-29. java.lang.IllegalThreadStateException

```
public class IllegalThreadStateException extends IllegalArgumentException {
// Public Constructors
     public IllegalThreadStateException( );
     public IllegalThreadStateException(String s);
}
```

IncompatibleClassChangeError java.lang

Java 1.0 *serializable error*

This is the superclass of a group of related error types. It signals an illegal use of a legal class.

Figure 10-30. java.lang.IncompatibleClassChangeError

```
public class IncompatibleClassChangeError extends LinkageError {
// Public Constructors
     public IncompatibleClassChangeError( );
     public IncompatibleClassChangeError(String s);
}
```

Subclasses

AbstractMethodError, IllegalAccessError, InstantiationError, NoSuchFieldError, NoSuchMethodError

Team LiB

IndexOutOfBoundsException java.lang

Java 1.0 *serializable unchecked*

Signals that an index is out of bounds. See the subclasses `ArrayIndexOutOfBoundsException` and `StringIndexOutOfBoundsException`.

Figure 10-31. java.lang.IndexOutOfBoundsException

```
public class IndexOutOfBoundsException extends RuntimeException {
// Public Constructors
     public IndexOutOfBoundsException( );
     public IndexOutOfBoundsException(String s);
}
```

Subclasses

`ArrayIndexOutOfBoundsException`, `StringIndexOutOfBoundsException`

InheritableThreadLocal<T> java.lang

Java 1.2

This class holds a thread-local value that is inherited by child threads. See `ThreadLocal` for a discussion of thread-local values. Note that the inheritance referred to in the name of this class is not from superclass to subclass; it is inheritance from parent thread to child thread. Like its superclass, this class has been made generic in Java 5.0. The type variable *T* represents the type of the referenced object.

This class is best understood by example. Suppose that an application has defined an `InheritableThreadLocal` object and that a certain thread (the parent thread) has a thread-local value stored in that object. Whenever that thread creates a new thread (a child thread), the `InheritableThreadLocal` object is automatically updated so that the new child thread has the same value associated with it as the parent thread. Note that the value associated with the child thread is independent from the value associated with the parent thread. If the child thread subsequently alters its value by calling the `set( )` method of the `InheritableThreadLocal`, the value associated with the parent thread does not change.

By default, a child thread inherits a parent's values unmodified. By overriding the `childValue( )` method, however, you can create a subclass of `InheritableThreadLocal` in which the child thread inherits some arbitrary function of the parent thread's value.

Figure 10-32. java.lang.InheritableThreadLocal<T>

```
public class InheritableThreadLocal<T> extends ThreadLocal<T> {
// Public Constructors
     public InheritableThreadLocal( );
// Protected Instance Methods
     protected T childValue(T parentValue);
}
```

InstantiationError java.lang

Java 1.0 *serializable error*

Signals an attempt to instantiate an interface or abstract class.

Figure 10-33. java.lang.InstantiationError

```
public class InstantiationError extends IncompatibleClassChangeError {
// Public Constructors
     public InstantiationError( );
     public InstantiationError(String s);
}
```

InstantiationException java.lang

Java 1.0 *serializable checked*

Signals an attempt to instantiate an interface or an abstract class.

Figure 10-34. java.lang.InstantiationException


```
public class InstantiationException extends Exception {
// Public Constructors
     public InstantiationException( );
     public InstantiationException(String s);
}
```

Thrown By

`Class.newInstance( )`, `java.lang.reflect.Constructor.newInstance( )`, `org.xml.sax.helpers.ParserFactory.makeParser( )`

Integer java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around the `int` primitive data type. This class also contains useful minimum and maximum constants and useful conversion methods. `parseInt( )` and `valueOf( )` convert a string to an `int` or to an `Integer` , respectively. Each can take a radix argument to specify the base the value is represented in. `decode( )` also converts a `String` to an `Integer` . It assumes a hexadecimal number if the string begins with "0X" or "0x", or an octal number if the string begins with "0". Otherwise, a decimal number is assumed. `toString( )` converts in the other direction, and the `static` version takes a radix argument. `toBinaryString( )` , `toOctalString( )` , and `toHexString( )` convert an `int` to a string using base 2, base 8, and base 16. These methods treat the integer as an unsigned value. Other routines return the value of an `Integer` as various primitive types, and, finally, the `getInteger( )` methods return the integer value of a named property from the system property list, or the specified default value.

Java 5.0 adds a number of static methods that operate on the bits of an `int` value. `rotateLeft( )` and `rotateRight( )` shift the bits the specified distance in the specified direction, with bits shifted off one end being shifted in on the other end. `signum( )` returns the sign of the integer as -1, 0, or 1. `highestOneBit( )` , `numberOfTrailingZeros( )` , `bitCount( )` and related methods can be useful if you use an `int` value as a set of bits and want to iterate through the ones bits in the set.

Figure 10-35. java.lang.Integer

```
public final class Integer extends Number implements Comparable<Integer> {
// Public Constructors
     public Integer(int value);
     public Integer(String s) throws NumberFormatException;
// Public Constants
     public static final int MAX_VALUE;    =2147483647
     public static final int MIN_VALUE;    =-2147483648
5.0  public static final int SIZE;     =32
1.1  public static final Class<Integer> TYPE;
// Public Class Methods
5.0  public static int bitCount(int i);
1.1  public static Integer decode(String nm) throws NumberFormatException;
     public static Integer getInteger(String nm);
     public static Integer getInteger(String nm, int val);
     public static Integer getInteger(String nm, Integer val);
```

```
5.0  public static int highestOneBit(int i);
5.0  public static int lowestOneBit(int i);
5.0  public static int numberOfLeadingZeros(int i);
5.0  public static int numberOfTrailingZeros(int i);
     public static int parseInt(String s) throws NumberFormatException;
     public static int parseInt(String s, int radix) throws NumberFormatException;
5.0  public static int reverse(int i);
5.0  public static int reverseBytes(int i);
5.0  public static int rotateLeft(int i, int distance);
5.0  public static int rotateRight(int i, int distance);
5.0  public static int signum(int i);
     public static String toBinaryString(int i);
     public static String toHexString(int i);
     public static String toOctalString(int i);
     public static String toString(int i);
     public static String toString(int i, int radix);
5.0  public static Integer valueOf(int i);
     public static Integer valueOf(String s) throws NumberFormatException;
     public static Integer valueOf(String s, int radix) throws NumberFormatException;
// Methods Implementing Comparable
1.2  public int compareTo(Integer anotherInteger);
// Public Methods Overriding Number
1.1  public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
1.1  public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

InternalError java.lang

Java 1.0 *serializable error*

Signals an internal error in the Java interpreter.

Figure 10-36. java.lang.InternalError

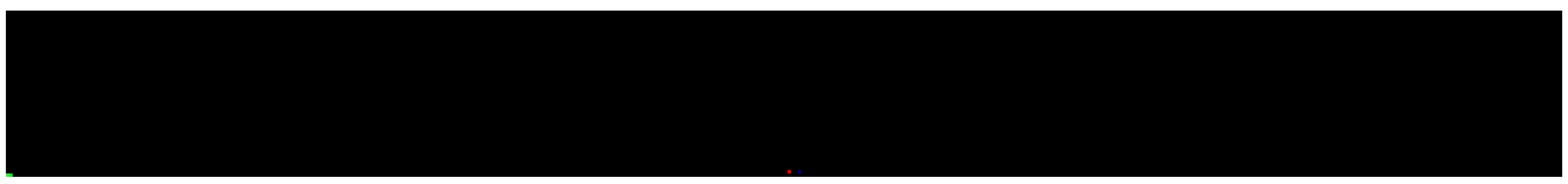
```
public class InternalError extends VirtualMachineError {
// Public Constructors
     public InternalError( );
     public InternalError(String s);
}
```

InterruptedException java.lang

Java 1.0 *serializable checked*

Signals that the thread has been interrupted.

Figure 10-37. java.lang.InterruptedException



```
public class InterruptedException extends Exception {
// Public Constructors
     public InterruptedException( );
     public InterruptedException(String s);
}
```

Thrown By

Too many methods to list.

Iterable<T> java.lang

Java 5.0

This interface defines a single method for returning a `java.util.Iterator` object. `Iterable` was added in Java 5.0 to support the `for/in` loop, which is also new in Java 5.0. The `Collection`, `List`, `Set`, and `Queue` collection interfaces of `java.util` extend this interface, making all collections other than maps `Iterable`. You can implement this interface in your own classes if you want to allow them to be iterated with the `for/in` loop.

The type variable `T` specifies the type parameter of the returned `Iterator` object, which, in turn, specifies the element type of the collection being iterated over.

```
public interface Iterable<T> {
// Public Instance Methods
     java.util.Iterator<T> iterator( );
}
```

Implementations

`java.util.Collection`

LinkageError java.lang

Java 1.0 *serializable error*

The superclass of a group of errors that signal problems linking a class or resolving dependencies between classes.

Figure 10-38. java.lang.LinkageError

```
public class LinkageError extends Error {
// Public Constructors
     public LinkageError( );
     public LinkageError(String s);
}
```

Subclasses

ClassCircularityError, ClassFormatError, ExceptionInInitializerError, IncompatibleClassChangeError, NoClassDefFoundError, UnsatisfiedLinkError, VerifyError

downloaded from: lib.ommolketab.ir

Long java.lang

Java 1.0 *serializable comparable*

This class provides an immutable object wrapper around the `long` primitive data type. This class also contains useful minimum and maximum constants and useful conversion methods. `parseLong( )` and `valueOf( )` convert a string to a `long` or to a `Long` , respectively. Each can take a radix argument to specify the base the value is represented in. `toString( )` converts in the other direction and may also take a radix argument. `toBinaryString( )` , `toOctalString( )` , and `toHexString( )` convert a `long` to a string using base 2, base 8, and base 16. These methods treat the `long` as an unsigned value. Other routines return the value of a `Long` as various primitive types, and, finally, the `getLong( )` methods return the `long` value of a named property or the value of the specified default.

Java 5.0 adds a number of static methods that operate on the bits of a `long` value. Except for their argument type and return type, they are the same as the `Integer` methods of the same name.

Figure 10-39. java.lang.Long

```
public final class Long extends Number implements Comparable<Long> {
// Public Constructors
     public Long(long value);
     public Long(String s) throws NumberFormatException;
// Public Constants
     public static final long MAX_VALUE;   =9223372036854775807
     public static final long MIN_VALUE;   =-9223372036854775808
5.0  public static final int SIZE;     =64
1.1  public static final Class<Long> TYPE;
// Public Class Methods
5.0  public static int bitCount(long i);
1.2  public static Long decode(String nm) throws NumberFormatException;
     public static Long getLong(String nm);
     public static Long getLong(String nm, Long val);
     public static Long getLong(String nm, long val);
5.0  public static long highestOneBit(long i);
5.0  public static long lowestOneBit(long i);
5.0  public static int numberOfLeadingZeros(long i);
5.0  public static int numberOfTrailingZeros(long i);
     public static long parseLong(String s) throws NumberFormatException;
     public static long parseLong(String s, int radix) throws NumberFormatException;
```

```
5.0  public static long reverse(long i);
5.0  public static long reverseBytes(long i);
5.0  public static long rotateLeft(long i, int distance);
5.0  public static long rotateRight(long i, int distance);
5.0  public static int signum(long i);
     public static String toBinaryString(long i);
     public static String toHexString(long i);
     public static String toOctalString(long i);
     public static String toString(long i);
     public static String toString(long i, int radix);
5.0  public static Long valueOf(long l);
     public static Long valueOf(String s) throws NumberFormatException;
     public static Long valueOf(String s, int radix) throws NumberFormatException;
// Methods Implementing Comparable
1.2  public int compareTo(Long anotherLong);
// Public Methods Overriding Number
1.1  public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
1.1  public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Math java.lang

Java 1.0

This class defines constants for the mathematical values *e* and and defines static methods for floating-point trigonometry, exponentiation, and other operations. It is the equivalent of the C <*math.h*> functions. It also contains methods for computing minimum and maximum values and for generating pseudorandom numbers.

Most methods of `Math` operate on `float` and `double` floating-point values. Remember that these values are only approximations of actual real numbers. To allow implementations to take full advantage of the floating-point capabilities of a native platform, the methods of `Math` are not required to return exactly the same values on all platforms. In other words, the results returned by different implementations may differ slightly in the least-significant bits. As of Java 1.3, applications that require strict platform-independence of results should use `StrictMath` instead.

Java 5.0 adds several methods including `log10( )` to compute the base-ten logarithm, `cbrt( )` to compute the cube root of a number, and `signum( )` to compute the sign of a number as well as `sinh( )` , `cosh( )`, and `tanh( )` hyperbolic trigonometric functions.

```
public final class Math {
// No Constructor
// Public Constants
     public static final double E;         =2.718281828459045
     public static final double PI;        =3.141592653589793
// Public Class Methods
     public static int abs(int a);
     public static long abs(long a);
     public static float abs(float a);
     public static double abs(double a);
     public static double acos(double a);
     public static double asin(double a);
     public static double atan(double a);
     public static double atan2(double y, double x);
5.0  public static double cbrt(double a);
     public static double ceil(double a);
     public static double cos(double a);
5.0  public static double cosh(double x);
     public static double exp(double a);
5.0  public static double expm1(double x);
     public static double floor(double a);
5.0  public static double hypot(double x, double y);
     public static double IEEEremainder(double f1, double f2);
     public static double log(double a);
5.0  public static double log10(double a);
```

```
5.0  public static double log1p(double x);
     public static int max(int a, int b);
     public static long max(long a, long b);
     public static float max(float a, float b);
     public static double max(double a, double b);
     public static int min(int a, int b);
     public static long min(long a, long b);
     public static float min(float a, float b);
     public static double min(double a, double b);
     public static double pow(double a, double b);
     public static double random( );
     public static double rint(double a);
     public static int round(float a);
     public static long round(double a);
5.0  public static float signum(float f);
5.0  public static double signum(double d);
     public static double sin(double a);
5.0  public static double sinh(double x);
     public static double sqrt(double a);
     public static double tan(double a);
5.0  public static double tanh(double x);
1.2  public static double toDegrees(double angrad);
1.2  public static double toRadians(double angdeg);
5.0  public static float ulp(float f);
5.0  public static double ulp(double d);
}
```

NegativeArraySizeException java.lang

Java 1.0 *serializable unchecked*

Signals an attempt to allocate an array with fewer than zero elements.

Figure 10-40. java.lang.NegativeArraySizeException

```
public class NegativeArraySizeException extends RuntimeException {
// Public Constructors
     public NegativeArraySizeException( );
     public NegativeArraySizeException(String s);
}
```

Thrown By

`java.lang.reflect.Array.newInstance( )`

Team LiB

NoClassDefFoundError java.lang

Java 1.0 *serializable error*

Signals that the definition of a specified class cannot be found.

Figure 10-41. java.lang.NoClassDefFoundError

```
public class NoClassDefFoundError extends LinkageError {
// Public Constructors
     public NoClassDefFoundError( );
     public NoClassDefFoundError(String s);
}
```

NoSuchFieldError java.lang

Java 1.0 *serializable error*

Signals that a specified field cannot be found.

Figure 10-42. java.lang.NoSuchFieldError

```
public class NoSuchFieldError extends IncompatibleClassChangeError {
// Public Constructors
     public NoSuchFieldError( );
     public NoSuchFieldError(String s);
}
```

NoSuchFieldException java.lang

Java 1.1 *serializable checked*

This exception signals that the specified field does not exist in the specified class.

Figure 10-43. java.lang.NoSuchFieldException

```
public class NoSuchFieldException extends Exception {
// Public Constructors
     public NoSuchFieldException( );
     public NoSuchFieldException(String s);
}
```

Thrown By

`Class.{getDeclaredField( )`, `getField( )}`

downloaded from: lib.ommolketab.ir

NoSuchMethodError java.lang

Java 1.0 *serializable error*

Signals that a specified method cannot be found.

Figure 10-44. java.lang.NoSuchMethodError

```
public class NoSuchMethodError extends IncompatibleClassChangeError {
// Public Constructors
     public NoSuchMethodError( );
     public NoSuchMethodError(String s);
}
```

NoSuchMethodException java.lang

Java 1.0 *serializable checked*

Signals that the specified method does not exist in the specified class.

Figure 10-45. java.lang.NoSuchMethodException


```
public class NoSuchMethodException extends Exception {
// Public Constructors
     public NoSuchMethodException( );
     public NoSuchMethodException(String s);
}
```

Thrown By

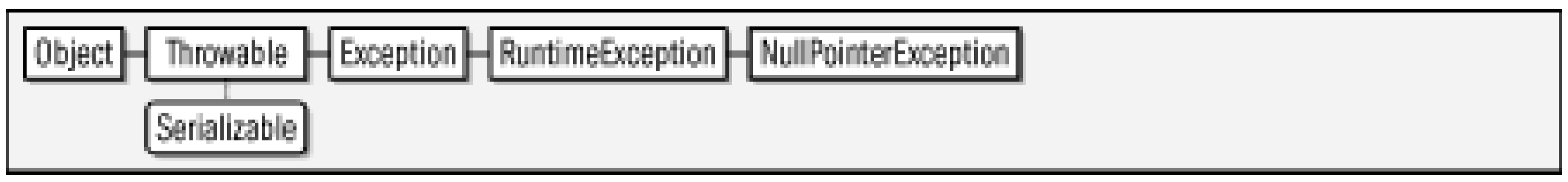
Class.{getConstructor( ), getdeclaredConstructor( ), getdeclaredMethod( ), getMethod( )}

NullPointerException java.lang

Java 1.0 *serializable unchecked*

Signals an attempt to access a field or invoke a method of a `null` object.

Figure 10-46. java.lang.NullPointerException




```
public class NullPointerException extends RuntimeException {
// Public Constructors
     public NullPointerException( );
     public NullPointerException(String s);
}
```

Thrown By

`org.xml.sax.helpers.ParserFactory.makeParser( )`

Number java.lang

Java 1.0 *serializable*

This is an abstract class that is the superclass of `Byte`, `Short`, `Integer`, `Long`, `Float`, and `Double`. It defines the conversion functions those types implement.

Figure 10-47. java.lang.Number


```
public abstract class Number implements Serializable {
// Public Constructors
     public Number( );
// Public Instance Methods
1.1  public byte byteValue( );
     public abstract double doubleValue( );
     public abstract float floatValue( );
     public abstract int intValue( );
     public abstract long longValue( );
1.1  public short shortValue( );
}
```

Subclasses

`Byte`, `Double`, `Float`, `Integer`, `Long`, `Short`, `java.math.BigDecimal`, `java.math.BigInteger`, `java.util.concurrent.atomic.AtomicInteger`, `java.util.concurrent.atomic.AtomicLong`

Returned By

`java.text.ChoiceFormat.parse( )`, `java.text.DecimalFormat.parse( )`, `java.text.NumberFormat.parse( )`, `javax.xml.datatype.Duration.getField( )`

Team LiB

NumberFormatException java.lang

Java 1.0 *serializable unchecked*

Signals an illegal number format.

Figure 10-48. java.lang.NumberFormatException


```
public class NumberFormatException extends IllegalArgumentException {
// Public Constructors
     public NumberFormatException( );
     public NumberFormatException(String s);
}
```

Thrown By

Too many methods to list.

Object java.lang

Java 1.0

This is the root class in Java. All classes are subclasses of Object, and thus all objects can invoke the public and protected methods of this class. For classes that implement the Cloneable interface, clone( ) makes a byte-for-byte copy of an Object. getClass( ) returns the Class object associated with any Object, and the notify( ) , notifyAll( ), and wait( ) methods are used for thread synchronization on a given Object.

A number of these Object methods should be overridden by subclasses of Object. For example, a subclass should provide its own definition of the toString( ) method so that it can be used with the string concatenation operator and with the PrintWriter.println( ) methods. Defining the toString( ) method for all objects also helps with debugging.

The default implementation of the equals( ) method simply uses the = = operator to test whether this object reference and the specified object reference refer to the same object. Many subclasses override this method to compare the individual fields of two distinct objects (i.e., they override the method to test for the equivalence of distinct objects rather than the equality of object references). Some classes, particularly those that override equals( ), may also want to override the hashCode( ) method to provide an appropriate hashcode to be used when storing instances in a Hashtable data structure.

A class that allocates system resources other than memory (such as file descriptors or windowing system graphic contexts) should override the finalize( ) method to release these resources when the object is no longer referred to and is about to be garbage-collected.

```
public class Object {
// Public Constructors
     public Object( );                                                  empty
// Public Instance Methods
     public boolean equals(Object obj);
     public final Class<? extends Object> getClass( );          native
     public int hashCode( );                                            native
     public final void notify( );                                       native
     public final void notifyAll( );                                    native
     public String toString( );
     public final void wait( ) throws InterruptedException;
     public final void wait(long timeout) throws InterruptedException;     native
     public final void wait(long timeout, int nanos) throws InterruptedException;
// Protected Instance Methods
     protected Object clone( ) throws CloneNotSupportedException;       native
     protected void finalize( ) throws Throwable;                       empty
}
```

Subclasses

Too many classes to list.

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

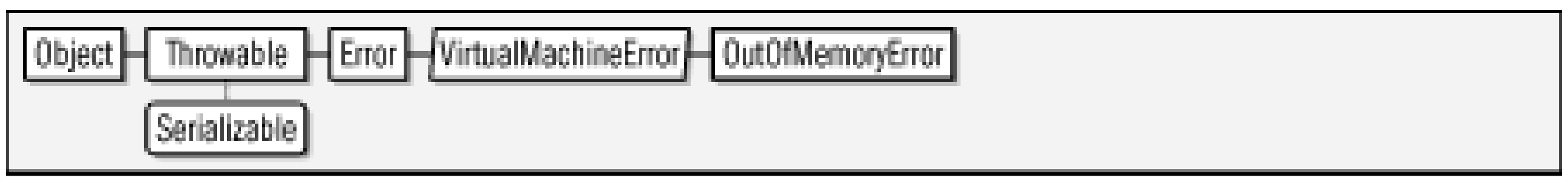
java.io.Reader.lock, java.io.Writer.lock, java.util.EventObject.source, java.util.Vector.elementData, java.util.prefs.AbstractPreferences.lock

OutOfMemoryError java.lang

Java 1.0 *serializable error*

Signals that the interpreter has run out of memory (and that garbage collection is unable to free any memory).

Figure 10-49. java.lang.OutOfMemoryError




```
public class OutOfMemoryError extends VirtualMachineError {
// Public Constructors
     public OutOfMemoryError( );
     public OutOfMemoryError(String s);
}
```

Override java.lang

Java 5.0 *@Target(METHOD) @Retention(SOURCE) annotation*

An annotation of this type may be applied to methods and indicates that the programmer intends for the method to override a method from a superclass. In effect, it is an assertion for the compiler to verify. If a method annotated `@Override` does not, in fact, override another method (perhaps because the method name was misspelled or an argument was incorrectly typed), the compiler issues an error. This annotation type has source retention.

Figure 10-50. java.lang.Override

```
public @interface Override {
}
```

Package java.lang

Java 1.2

This class represents a Java package. You can obtain the Package object for a given Class by calling the getPackage( ) method of the Class object. The static Package.getPackage( ) method returns a Package object for the named package, if any such package has been loaded by the current class loader. Similarly, the static Package.getPackages( ) returns all Package objects that have been loaded by the current class loader. Note that a Package object is not defined unless at least one class has been loaded from that package. Although you can obtain the Package of a given Class, you cannot obtain an array of Class objects contained in a specified Package.

If the classes that comprise a package are contained in a JAR file that has the appropriate attributes set in its manifest file, the Package object allows you to query the title, vendor, and version of both the package specification and the package implementation; all six values are strings. The specification version string has a special format. It consists of one or more integers, separated from each other by periods. Each integer can have leading zeros, but is not considered an octal digit. Increasing numbers indicate later versions. The isCompatibleWith( ) method calls getSpecificationVersion( ) to obtain the specification version and compares it with the version string supplied as an argument. If the package-specification version is the same as or greater than the specified string, isCompatibleWith( ) returns TRue. This allows you to test whether the version of a package (typically a standard extension) is new enough for the purposes of your application.

Packages may be sealed, which means that all classes in the package must come from the same JAR file. If a package is sealed, the no-argument version of isSealed( ) returns true. The one-argument version of isSealed( ) returns TRue if the specified URL represents the JAR file from which the package is loaded.

Figure 10-51. java.lang.Package

```
public class Package implements java.lang.reflect.AnnotatedElement {
// No Constructor
// Public Class Methods
     public static Package getPackage(String name);
     public static Package[ ] getPackages( );
// Public Instance Methods
     public String getImplementationTitle( );
     public String getImplementationVendor( );
     public String getImplementationVersion( );
     public String getName( );
     public String getSpecificationTitle( );
```

```
    public String getSpecificationVendor( );
    public String getSpecificationVersion( );
    public boolean isCompatibleWith(String desired) throws NumberFormatException;
    public boolean isSealed( );
    public boolean isSealed(java.net.URL url);
// Methods Implementing AnnotatedElement
5.0  public <A extends java.lang.annotation.Annotation> A getAnnotation(Class<A>
annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getAnnotations( );
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
5.0  public boolean isAnnotationPresent(Class<? extends java.lang.annotation.
Annotation> annotationClass);
// Public Methods Overriding Object
    public int hashCode( );
    public String toString( );
}
```

Returned By

Class.getPackage( ), ClassLoader.{definePackage( ), getPackage( ), getPackages( )}, java.net.URLClassLoader.definePackage( )

Process java.lang

Java 1.0

This class describes a process that is running externally to the Java interpreter. Note that a Process is very different from a Thread; the Process class is abstract and cannot be instantiated. Call one of the Runtime.exec( ) methods to start a process and return a corresponding Process object.

waitFor( ) blocks until the process exits. exitValue( ) returns the exit code of the process. destroy( ) kills the process. getErrorStream( ) returns an InputStream from which you can read any bytes the process sends to its standard error stream. getInputStream( ) returns an InputStream from which you can read any bytes the process sends to its standard output stream. getOutputStream( ) returns an OutputStream you can use to send bytes to the standard input stream of the process.

```
public abstract class Process {
// Public Constructors
     public Process( );
// Public Instance Methods
     public abstract void destroy( );
     public abstract int exitValue( );
     public abstract java.io.InputStream getErrorStream( );
     public abstract java.io.InputStream getInputStream( );
     public abstract java.io.OutputStream getOutputStream( );
     public abstract int waitFor( ) throws InterruptedException;
}
```

Returned By

ProcessBuilder.start( ), Runtime.exec( )

Team LiB

ProcessBuilder java.lang

Java 5.0

This class launches operating system processes, producing Process objects. Specify the operating system command when you invoke the ProcessBuilder( ) constructor or with the command( ) method. Commands are specified with one or more strings, typically the filename of the executable to run followed by the command-line arguments for the executable. Specify these strings in a List, a String[ ], or, most conveniently, using a variable-length argument list of strings.

Before launching the command you have specified, you can configure the ProcessBuilder. Query the current working directory with the no-argument version of directory( ) and set it with the one-argument version of the method. Query the mapping of environment variables to values with the environment( ) method. You can alter the mappings in the returned Map to specify the environment you want the child process to run in. Pass TRue to redirectErrorStream( ) if you would like both the standard output and the standard error stream of the child process to be merged into a single stream that you can obtain with Process.getInputStream( ). If you do so, you do not have to arrange to read two separate input streams to get the output of the process.

Once you have specified a command and configured your ProcessBuilder as desired, call the start( ) method to launch the process. You then use methods of the returned Process to provide input to the process, read output from the process, or wait for the process to exit. start( ) may throw an IOException. This may occur, for example, if the executable filename you have specified does not exist. The command( ) and directory( ) methods do not perform error checking on the values you provide them; these checks are performed by the start( ) method, so it is also possible for start( ) to throw exceptions based on bad input to the configuration methods.

Note that a ProcessBuilder can be reused: once you have established a working directory and environment variables, you can change the command( ) and launch multiple processes with repeated calls to start( ).

```
public final class ProcessBuilder {
// Public Constructors
     public ProcessBuilder(java.util.List<String> command);
     public ProcessBuilder(String... command);
// Public Instance Methods
     public java.util.List<String> command( );
     public ProcessBuilder command(String... command);
     public ProcessBuilder command(java.util.List<String> command);
     public java.io.File directory( );
     public ProcessBuilder directory(java.io.File directory);
     public java.util.Map<String,String> environment( );
     public boolean redirectErrorStream( );
     public ProcessBuilder redirectErrorStream(boolean redirectErrorStream);
     public Process start( ) throws java.io.IOException;
}
```

Readable java.lang

Java 5.0 *readable*

Objects that implement this interface can serve as a source of characters and can transfer one or more at a time to a `java.nio.CharBuffer`. `Readable` was added in Java 5.0 as a simple unifying API for `java.nio.CharBuffer` and character input stream subclasses of `java.io.Reader`. The `java.util.Scanner` class can parse input from any `Readable` object. See also `Appendable`.

```
public interface Readable {
// Public Instance Methods
     int read(java.nio.CharBuffer cb) throws java.io.IOException;
}
```

Implementations

`java.io.Reader`, `java.nio.CharBuffer`

Passed To

`java.util.Scanner.Scanner( )`

Runnable java.lang

Java 1.0 *runnable*

This interface specifies the `run( )` method that is required to use with the `Thread` class. Any class that implements this interface can provide the body of a thread. See`THRead` for more information.

```
public interface Runnable {
// Public Instance Methods
     void run( );
}
```

Implementations

`THRead`, `java.util.TimerTask`, `java.util.concurrent.FutureTask`

Passed To

Too many methods to list.

Returned By

`javax.net.ssl.SSLEngine.getDelegatedTask( )`

Runtime java.lang

Java 1.0

This class encapsulates a number of platform-dependent system functions. The static method getruntim) returns the Runtime object for the current platform; this object can perform system functions in a platform-independent way.

exit( ) causes the Java interpreter to exit and return a specified return code. This method is usually invoked through System.exit( ) . In Java 1.3, addShutdownHook( ) registers an unstarted Thread obj that is run when the virtual machine shuts down, either through a call to exit( ) or through a user interrupt (a CTRL-C, for example). The purpose of a shutdown hook is to perform necessary cleanup, su as shutting down network connections, deleting temporary files, and so on. Any number of hooks can be registered with addShutdownHook( ) . Before the interpreter exits, it starts all registered shutdown-hoo threads and lets them run concurrently. Any hooks you write should perform their cleanup operation an exit promptly so they do not delay the shutdown process. To remove a shutdown hook before it is run, removeShutdownHook( ) . To force an immediate exit that does not invoke the shutdown hooks, call hal) .

exec( ) starts a new process running externally to the interpreter. Note that any processes run outside Java may be system-dependent.

freeMemory( ) returns the approximate amount of free memory. totalMemory( ) returns the total amount of memory available to the Java interpreter. gc( ) forces the garbage collector to run synchronously, which may free up more memory. Similarly, runFinalization( ) forces the finalize(methods of unreferenced objects to be run immediately. This may free up system resources those objec were holding.

load( ) loads a dynamic library with a fully specified pathname. loadLibrary( ) loads a dynamic librar with only the library name specified; it looks in platform-dependent locations for the specified library. Th libraries generally contain native code definitions for native methods.

traceInstructions( ) and TRaceMethodCalls( ) enable and disable tracing by the interpreter. These methods are used for debugging or profiling an application. It is not specified how the VM emits the trac information, and VMs are not even required to support this feature.

Note that some of the Runtime methods are more commonly called via the static methods of the System class.

```
public class Runtime {
// No Constructor
// Public Class Methods
     public static Runtime getRuntime( );
// Public Instance Methods
1.3  public void addShutdownHook(Thread hook);
1.4  public int availableProcessors( );                               native
```

```
     public Process exec(String[ ] cmdarray) throws java.io.IOException;
     public Process exec(String command) throws java.io.IOException;
     public Process exec(String command, String[ ] envp) throws java.io.IOException;
     public Process exec(String[ ] cmdarray, String[ ] envp) throws java.io.IOException;
1.3  public Process exec(String[ ] cmdarray, String[ ] envp, java.io.File dir)
     throws java.io.IOException;
1.3  public Process exec(String command, String[ ] envp, java.io.File dir) throws
     java.io.IOException;
     public void exit(int status);
     public long freeMemory( );                                           native
     public void gc( );                                                   native
1.3  public void halt(int status);
     public void load(String filename);
     public void loadLibrary(String libname);
1.4  public long maxMemory( );                                        native
1.3  public boolean removeShutdownHook(Thread hook);
     public void runFinalization( );
     public long totalMemory( );                                          native
     public void traceInstructions(boolean on);                          native
     public void traceMethodCalls(boolean on);                           native
// Deprecated Public Methods
#    public java.io.InputStream getLocalizedInputStream(java.io.InputStream in);
#    public java.io.OutputStream getLocalizedOutputStream(java.io.OutputStream out);
1.1#  public static void runFinalizersOnExit(boolean value);
}
```

RuntimeException java.lang

Java 1.0 *serializable unchecked*

This exception type is not used directly, but serves as a superclass of a group of run-time exceptions that need not be declared in the `throws` clause of a method definition. These exceptions need not be declared because they are runtime conditions that can generally occur in any Java method. Thus, declaring them would be unduly burdensome, and Java does not require it.

This class inherits methods from `Throwable` but declares none of its own. Each of the `RuntimeException` constructors simply invokes the corresponding `Exception( )` and `Throwable( )` constructor. See `THRowable` for details.

Figure 10-52. java.lang.RuntimeException

```
public class RuntimeException extends Exception {
// Public Constructors
     public RuntimeException( );
1.4  public RuntimeException(Throwable cause);
     public RuntimeException(String message);
1.4  public RuntimeException(String message, Throwable cause);
}
```

Subclasses

Too many classes to list.

RuntimePermission java.lang

Java 1.2 serializable permission

This class is a `java.security.Permission` that represents access to various important system facilities. A `RuntimePermission` has a name, or target, that represents the facility for which permission is being sought or granted. The name "exitVM" represents permission to call `System.exit( )`, and the name "accessClassInPackage.java.lang" represents permission to read classes from the `java.lang` package. The name of a `RuntimePermission` may use a ".*" suffix as a wildcard. For example, the name "accessClassInPackage.java.*" represents permission to read classes from any package whose name begins with "java.". `RuntimePermission` does not use action list strings as some `Permission` classes do; the name of the permission alone is enough.

The following are supported `RuntimePermssion` names:

accessClassInPackage.*package*	getProtectionDomain	setFactory
accessDeclaredMembers	loadLibrary.*library_name*	setIO
createClassLoader	modifyThread	setSecurityManager
createSecurityManager	modifyThreadGroup	stopThread
defineClassInPackage.*package*	queuePrintJob	writeFileDescriptor
exitVM	readFileDescriptor	
getClassLoader	set-ContextClassLoader	

System administrators configuring security policies should be familiar with these permission names, the operations they govern access to, and with the risks inherent in granting any of them. Although system programmers may need to work with this class, application programmers should never need to use `RuntimePermssion` directly.

Figure 10-53. java.lang.RuntimePermission

```
public final class RuntimePermission extends java.security.BasicPermission {
// Public Constructors
     public RuntimePermission(String name);
```

```
    public RuntimePermission(String name, String actions);
}
```

SecurityException java.lang

Java 1.0 *serializable unchecked*

Signals that an operation is not permitted for security reasons.

Figure 10-54. java.lang.SecurityException


```
public class SecurityException extends RuntimeException {
// Public Constructors
     public SecurityException( );
5.0  public SecurityException(Throwable cause);
     public SecurityException(String s);
5.0  public SecurityException(String message, Throwable cause);
}
```

Subclasses

java.security.AccessControlException

Thrown By

Too many methods to list.

SecurityManager java.lang

Java 1.0

This class defines the methods necessary to implement asecurity policy for the safe execution of untrust code. Before performing potentially sensitive operations, Java calls methods of the SecurityManager obj currently in effect to determine whether the operations are permitted. These methods throw a SecurityException if the operation is not permitted. Typical applications do not need to use or subclas SecurityManager . It is typically used only by web browsers, applet viewers, and other programs that n to run untrusted code in a controlled environment.

Prior to Java 1.2, this class is abstract , and the default implementation of each check( ) method throv a SecurityException unconditionally. The Java security mechanism has been overhauled as of Java 1.2 As part of the overhaul, this class is no longer abstract and its methods have useful default implementations, so there is rarely a need to subclass it. checkPermission( ) operates by invoking the checkPermission( ) method of the system java.security.AccessController object. In Java 1.2 and later, all other check( ) methods of SecurityManager are now implemented on top of checkPermissio) .

```
public class SecurityManager {
// Public Constructors
     public SecurityManager( );
// Public Instance Methods
     public void checkAccept(String host, int port);
     public void checkAccess(ThreadGroup g);
     public void checkAccess(Thread t);
1.1  public void checkAwtEventQueueAccess( );
     public void checkConnect(String host, int port);
     public void checkConnect(String host, int port, Object context);
     public void checkCreateClassLoader( );
     public void checkDelete(String file);
     public void checkExec(String cmd);
     public void checkExit(int status);
     public void checkLink(String lib);
     public void checkListen(int port);
1.1  public void checkMemberAccess(Class<?> clazz, int which);
1.1  public void checkMulticast(java.net.InetAddress maddr);
     public void checkPackageAccess(String pkg);
     public void checkPackageDefinition(String pkg);
1.2  public void checkPermission(java.security.Permission perm);
1.2  public void checkPermission(java.security.Permission perm, Object context);
1.1  public void checkPrintJobAccess( );
     public void checkPropertiesAccess( );
     public void checkPropertyAccess(String key);
     public void checkRead(String file);
```

```
     public void checkRead(java.io.FileDescriptor fd);
     public void checkRead(String file, Object context);
1.1  public void checkSecurityAccess(String target);
     public void checkSetFactory( );
1.1  public void checkSystemClipboardAccess( );
     public boolean checkTopLevelWindow(Object window);
     public void checkWrite(java.io.FileDescriptor fd);
     public void checkWrite(String file);
     public Object getSecurityContext( );                     default:AccessControlCont
1.1  public ThreadGroup getThreadGroup( );
// Protected Instance Methods
     protected Class[ ] getClassContext( );                        native
// Deprecated Public Methods
1.1#  public void checkMulticast(java.net.InetAddress maddr, byte ttl);
#    public boolean getInCheck( );                                      default:false
// Deprecated Protected Methods
#    protected int classDepth(String name);                           native
#    protected int classLoaderDepth( );
#    protected ClassLoader currentClassLoader( );
1.1#  protected Class<?> currentLoadedClass( );
#    protected boolean inClass(String name);
#    protected boolean inClassLoader( );
// Deprecated Protected Fields
#    protected boolean inCheck;
}
```

Passed To

`System.setSecurityManager( )`

Returned By

`System.getSecurityManager( )`

Short java.lang

Java 1.1 *serializable comparable*

This class provides an object wrapper around the `short` primitive type. It defines useful constants for the minimum and maximum values that can be stored by the `short` type, and also a `Class` object constant that represents the `short` type. It also provides various methods for converting `Short` values to and from strings and other numeric types.

Most of the static methods of this class can convert a `String` to a `Short` object or a `short` value; the fou `parseShort( )` and `valueOf( )` methods parse a number from the specified string using an optionally specified radix and return it in one of these two forms. The `decode( )` method parses a number specified in base 10, base 8, or base 16 and returns it as a `Short`. If the string begins with "0x" or "#", it is interpreted as a hexadecimal number; if it begins with "0", it is interpreted as an octal number. Otherwise, it is interpreted as a decimal number.

Note that this class has two different `toString( )` methods. One is static and converts a `short` primitive value to a string. The other is the usual `toString( )` method that converts a `Short` object to a string. Most of the remaining methods convert a `Short` to various primitive numeric types.

Figure 10-55. java.lang.Short

```
public final class Short extends Number implements Comparable<Short> {
// Public Constructors
     public Short(short value);
     public Short(String s) throws NumberFormatException;
// Public Constants
     public static final short MAX_VALUE;  =32767
     public static final short MIN_VALUE;  =-32768
5.0  public static final int SIZE;     =16
     public static final Class<Short> TYPE;
// Public Class Methods
     public static Short decode(String nm) throws NumberFormatException;
     public static short parseShort(String s) throws NumberFormatException;
     public static short parseShort(String s, int radix) throws NumberFormatException;
5.0  public static short reverseBytes(short i);
     public static String toString(short s);
     public static Short valueOf(String s) throws NumberFormatException;
5.0  public static Short valueOf(short s);
     public static Short valueOf(String s, int radix) throws NumberFormatException;
```

```
// Methods Implementing Comparable
1.2  public int compareTo(Short anotherShort);
// Public Methods Overriding Number
     public byte byteValue( );
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
     public short shortValue( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

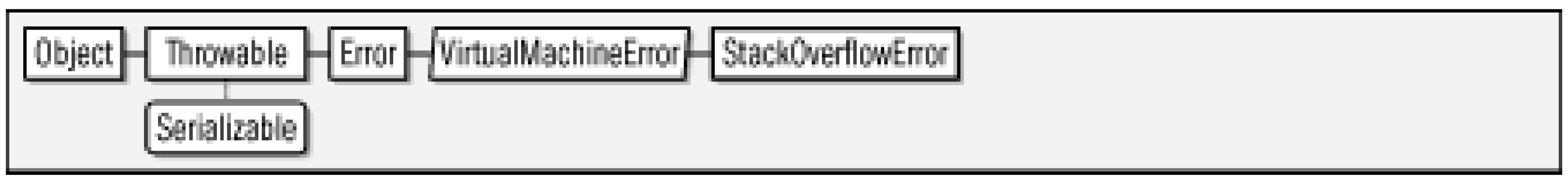
Team LiB

StackOverflowError java.lang

Java 1.0 *serializable error*

Signals that a stack overflow has occurred within the Java interpreter.

Figure 10-56. java.lang.StackOverflowError




```
public class StackOverflowError extends VirtualMachineError {
// Public Constructors
     public StackOverflowError( );
     public StackOverflowError(String s);
}
```

StackTraceElement java.lang

Java 1.4 *serializable*

Instances of this class are returned in an array by `Throwable.getStackTrace( )`. Each instance represents one frame in the stack trace associated with an exception or error. `getClassName( )` and `getMethodName( )` return the name of the class (including package name) and method that contain the point of execution that the stack frame represents. If the class file contains sufficient information `getFileName( )` and `getLineNumber( )` return the source file and line number associated with the frame. `getFileName( )` returns `null` and `getLineNumber( )` returns a negative value if source or line number information is not available. `isNativeMethod( )` returns `TRue` if the named method is a native method (and therefore does not have a meaningful source file or line number).

Figure 10-57. java.lang.StackTraceElement

```
public final class StackTraceElement implements Serializable {
// Public Constructors
5.0  public StackTraceElement(String declaringClass, String methodName,
     String fileName, int lineNumber);
// Public Instance Methods
     public String getClassName( );
     public String getFileName( );
     public int getLineNumber( );
     public String getMethodName( );
     public boolean isNativeMethod( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

`Throwable.setStackTrace( )`

Returned By

`Thread.getStackTrace( )`, `Throwable.getStackTrace( )`, `java.lang.management.ThreadInfo.getStackTrace( )`

StrictMath java.lang

Java 1.3

This class is identical to the Math class, but additionally requires that its methods strictly adhere to the behavior of certain published algorithms. The methods of StrictMath are intended to operate identically on all platforms, and must produce exactly the same result (down to the very least significant bit) as certain well-known standard algorithms. When strict platform-independence of floating-point results is not required, use the Math class for better performance.

```
public final class StrictMath {
// No Constructor
// Public Constants
     public static final double E;          =2.718281828459045
     public static final double PI;         =3.141592653589793
// Public Class Methods
     public static int abs(int a);
     public static long abs(long a);
     public static float abs(float a);
     public static double abs(double a);
     public static double acos(double a);                              native
     public static double asin(double a);                              native
     public static double atan(double a);                              native
     public static double atan2(double y, double x);                   native
5.0  public static double cbrt(double a);                          native
     public static double ceil(double a);                              native
     public static double cos(double a);                               native
5.0  public static double cosh(double x);                          native
     public static double exp(double a);                               native
5.0  public static double expm1(double x);                         native
     public static double floor(double a);                             native
5.0  public static double hypot(double x, double y);               native
     public static double IEEEremainder(double f1, double f2);         native
     public static double log(double a);                               native
5.0  public static double log10(double a);                         native
5.0  public static double log1p(double x);                         native
     public static int max(int a, int b);
     public static long max(long a, long b);
     public static float max(float a, float b);
     public static double max(double a, double b);
     public static int min(int a, int b);
     public static long min(long a, long b);
     public static float min(float a, float b);
     public static double min(double a, double b);
```

```
    public static double pow(double a, double b);                     native
    public static double random( );
    public static double rint(double a);
    public static int round(float a);
    public static long round(double a);
5.0 public static float signum(float f);
5.0 public static double signum(double d);
    public static double sin(double a);                               native
5.0 public static double sinh(double x);                          native
    public static double sqrt(double a);                              native
    public static double tan(double a);                               native
5.0 public static double tanh(double x);                          native
    public static double toDegrees(double angrad);
 strictfp
    public static double toRadians(double angdeg);
 strictfp
5.0 public static float ulp(float f);
5.0 public static double ulp(double d);
}
```

String java.lang

Java 1.0 *serializable comparable*

The `String` class represents a read-only string of characters. A `String` object is created by the Java com encounters a string in double quotes; this method of creation is typically simpler than using a constructo) factory methods create new `String` objects that hold the textual representation of various Java primiti also `valueOf( )` methods, `copyValueOf( )` methods and `String( )` constructors for creating a `String` copy of the text contained in another `String` , `StringBuffer` , `StringBuilder` , or a `char` or `int` array. `String( )` constructor to create a `String` object from an array of bytes. If you do this, you may explicit the charset (or character encoding) to be used to decode the bytes into characters, or you can rely on tl your platform. (See `java.nio.charset.Charset` for more on charset names.)

In Java 5.0, the static `format( )` methods provide another useful way to create `String` objects that hol These utility methods create and use a new `java.util.Formatter` object and behave like the `sprintf(` programming language.

`length( )` returns the number of characters in a string. `charAt( )` extracts a character from a string. Y methods to iterate through the characters of a string. You can obtain a `char` array that holds the charact `toCharArray( )` , or use `getChars( )` to copy just a selected region of the string into an existing array you want to obtain an array of bytes that contains the encoded form of the characters in a string, using default encoding or a named encoding.

This class defines many methods for comparing strings and substrings. `equals( )` returns `TRue` if two `St` the same text, and `equalsIgnoreCase( )` returns `true` if two strings are equal when uppercase and low ignored. As of Java 1.4, the `contentEquals( )` method compares a string to a specified `StringBuffer` o if they contain the same text. `startsWith( )` and `endsWith( )` return `true` if a string starts with the sp ends with the specified suffix string. A two-argument version of `startsWith( )` allows you to specify a p string at which the prefix comparison is to be done. The `regionMatches( )` method is a generalized vers `startsWith( )` method. It returns `TRue` if the specified region of the specified string matches the charac specified position within this string. The five-argument version of this method allows you to perform this the case of the characters being compared. The final string comparison method is `matches( )` , which, a compares a string to a regular expression pattern.

`compareTo( )` is another string comparison method, but it is used for comparing the order of two string comparing them for equality. `compareTo( )` implements the `Comparable` interface and enables sorting o `String` objects. See `Comparable` for more information. `compareToIgnoreCase( )` is like `compareTo( )` b the two strings when doing the comparison. The `CASE_INSENSITIVE_ORDER` constant is a `Comparator` for way that ignores the case of their characters. (The `java.util.Comparator` interface is similar to the `Com` allows the definition of object orderings that are different from the default ordering defined by `Comparabl`) and `compareToIgnoreCase( )` methods and the `CASE_INSENSITIVE_ORDER` `Comparator` object order st the numeric ordering of the Unicode encoding of their characters. This is not always the preferred "alpha some languages. See `java.text.Collator` for a more general technique for collating strings.

`indexOf( )` and `lastIndexOf( )` search forward and backward in a string for a specified character or su the position of the match, or -1 if there is no match. The one argument versions of these methods start end of the string, and the two-argument versions start searching from a specified character position.

Java 5.0 adds new comparison methods that work with any CharSequence . A new version of contentEq comparison of a string with any CharSequence , including StringBuilder objects. The contains( ) met the string contains any sequence of characters equal to the specified CharSequence .

substring( ) returns a string that consists of the characters from (and including) the specified start po including) the specified end position. A one-argument version returns all characters from (and including) position to the end of the string. As of Java 1.4, the String class implements the CharSequence interfac subSequence( ) method, which works just like the two-argument version of substring( ) but returns t characters as a CharSequence rather than as a String .

Several methods return new strings that contain modified versions of the text held by the original string remains unchanged). replace( ) creates a new string with all occurrences of one character replaced by adds a generalized version of replace( ) that replaces all occurrences of one CharSequence with anothe methods, replaceAll( ) and replaceFirst( ) , use regular expression pattern matching; they are de section. toUpperCase( ) and toLowerCase( ) return a new string in which all characters are converted lowercase respectively. These case-conversion methods take an optional Locale argument to perform lo conversion. trim( ) is a utility method that returns a new string in which all leading and trailing whitesp removed. concat( ) returns the new string formed by concatenating or appending the specified string t concatenation is more commonly done, however, with the + operator.

Note that String objects are immutable; there is no setCharAt( ) method to change the contents. The a String do not modify the string they are invoked on but instead return a new String object that holds the text of the original. Use a StringBuffer if you want to manipulate the contents of a string or call toC getChars( ) to convert a string to an array of char values.

Java 1.4 introduced support for pattern matching with regular expressions. matches( ) returns true if th matches the pattern specified by the regular expression argument. replaceAll( ) and replaceFirst(in which all occurrences or the first occurrence of a substring that matches the specified regular express specified replacement string. The split( ) methods return an array of substrings of this string, formed at positions that match the specified regular expression. These regular expression methods are all conve simply call methods of the same name in the java.util.regex package. See the Pattern and Matcher package for further details.

Many programs use strings as commonly as they use Java primitive values. Because the String type is a a primitive value, however, you cannot in general use the == operator to compare two strings for equali though strings are immutable, you must use the more expensive equals( ) method. For programs that comparison, the intern( ) provides a way to speed up those comparisons. The String class maintains a objects that includes all double-quoted string literals and all compile-time constant strings defined in a J is guaranteed not to contain duplicates, and the set is used to ensure that duplicate String objects are n unnecessarily. The intern( ) method looks up a string in or adds a new string to this set of unique strin for a string that contains exactly the same characters as the string you invoked the method on. If such a intern( ) returns it. If no matching string is found, the string you invoked intern( ) on is itself stored ("interned") and becomes the return value of the method. What this means is that you can safely compa returned by the intern( ) method using the == and != operators instead of equals( ) . You can also any string returned by intern( ) to any string constant with == and != .

In Java 5.0, Unicode supplementary characters may be represented as a single int codepoint value or as char values known as a "surrogate pair." See Character for more on supplementary characters and me them. String methods for working with supplementary characters, such as codePointAt( ) , codePoin offsetByCodePoints( ) , are similar to those defined by Character .

Figure 10-58. java.lang.String


```
public final class String implements Serializable, Comparable<String>, CharSequence {
// Public Constructors
     public String( );
5.0  public String(StringBuilder builder);
     public String(StringBuffer buffer);
     public String(char[ ] value);
     public String(String original);
1.1  public String(byte[ ] bytes);
1.1  public String(byte[ ] bytes, String charsetName)
     throws java.io.UnsupportedEncodingException;
#    public String(byte[ ] ascii, int hibyte);
     public String(char[ ] value, int offset, int count);
1.1  public String(byte[ ] bytes, int offset, int length);
5.0  public String(int[ ] codePoints, int offset, int count);
#    public String(byte[ ] ascii, int hibyte, int offset, int count);
1.1  public String(byte[ ] bytes, int offset, int length, String charsetName)
     throws java.io.UnsupportedEncodingException;
// Public Constants
1.2  public static final java.util.Comparator<String> CASE_INSENSITIVE_ORDER;
// Public Class Methods
     public static String copyValueOf(char[ ] data);
     public static String copyValueOf(char[ ] data, int offset, int count);
5.0  public static String format(String format, Object... args);
5.0  public static String format(java.util.Locale l, String format, Object... args);
     public static String valueOf(float f);
     public static String valueOf(long l);
     public static String valueOf(Object obj);
     public static String valueOf(double d);
     public static String valueOf(boolean b);
     public static String valueOf(char[ ] data);
     public static String valueOf(int i);
     public static String valueOf(char c);
     public static String valueOf(char[ ] data, int offset, int count);
// Public Instance Methods
     public char charAt(int index);          Implements:CharSequence
5.0  public int codePointAt(int index);
5.0  public int codePointBefore(int index);
5.0  public int codePointCount(int beginIndex, int endIndex);
     public int compareTo(String anotherString);             Implements:Comparable
1.2  public int compareToIgnoreCase(String str);
     public String concat(String str);
5.0  public boolean contains(CharSequence s);
```

```
1.4  public boolean contentEquals(StringBuffer sb);
5.0  public boolean contentEquals(CharSequence cs);
     public boolean endsWith(String suffix);
     public boolean equalsIgnoreCase(String anotherString);
1.1  public byte[ ] getBytes( );
1.1  public byte[ ] getBytes(String charsetName) throws java.io.
     UnsupportedEncodingException;
     public void getChars(int srcBegin, int srcEnd, char[ ] dst, int dstBegin);
     public int indexOf(int ch);
     public int indexOf(String str);
     public int indexOf(int ch, int fromIndex);
     public int indexOf(String str, int fromIndex);
     public String intern( );                                           native
     public int lastIndexOf(String str);
     public int lastIndexOf(int ch);
     public int lastIndexOf(String str, int fromIndex);
     public int lastIndexOf(int ch, int fromIndex);
     public int length( );                     Implements:CharSequence
1.4  public boolean matches(String regex);
5.0  public int offsetByCodePoints(int index, int codePointOffset);
     public boolean regionMatches(int toffset, String other, int ooffset, int len);
     public boolean regionMatches(boolean ignoreCase, int toffset, String other, int oo
     public String replace(char oldChar, char newChar);
5.0  public String replace(CharSequence target, CharSequence replacement);
1.4  public String replaceAll(String regex, String replacement);
1.4  public String replaceFirst(String regex, String replacement);
1.4  public String[ ] split(String regex);
1.4  public String[ ] split(String regex, int limit);
     public boolean startsWith(String prefix);
     public boolean startsWith(String prefix, int toffset);
     public String substring(int beginIndex);
     public String substring(int beginIndex, int endIndex);
     public char[ ] toCharArray( );
     public String toLowerCase( );
1.1  public String toLowerCase(java.util.Locale locale);
     public String toString( );                Implements:CharSequence
     public String toUpperCase( );
1.1  public String toUpperCase(java.util.Locale locale);
     public String trim( );
// Methods Implementing CharSequence
     public char charAt(int index);
     public int length( );
1.4  public CharSequence subSequence(int beginIndex, int endIndex);
     public String toString( );
// Methods Implementing Comparable
     public int compareTo(String anotherString);
// Public Methods Overriding Object
     public boolean equals(Object anObject);
     public int hashCode( );
```

```
// Deprecated Public Methods
#    public void getBytes(int srcBegin, int srcEnd, byte[ ] dst, int dstBegin);
}
```

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

Too many fields to list.

Team LiB

Team LiB

StringBuffer java.lang

Java 1.0 *serializable appendable*

This class represents a mutable string of characters that can grow or shrink as necessary. Its mutability suitable for processing text in place, which is not possible with the immutable String class. Its resizabilit the various methods it implements make it easier to use than a char[ ] . Create a StringBuffer with tl StringBuffer( ) constructor. You may pass a String that contains the initial text for the buffer to this constructor, but if you do not, the buffer will start out empty. You may also specify the initial capacity fc buffer if you can estimate the number of characters the buffer will eventually hold.

The methods of this class are synchronized , which makes StringBuffer objects suitable for use by mu threads. In Java 5.0 and later, when working with a single thread, StringBuilder is preferred over this because it does not have the overhead of synchronized methods. StringBuilder implements the same as StringBuffer and can be used in the same way.

Query the character stored at a given index with charAt( ) and set or delete that character with setCha or deleteCharAt( ) . Use length( ) to return the length of the buffer, and use setLength( ) to set th of the buffer, truncating it or filling it with null characters ('\u0000') as necessary. capacity( ) returns t number of characters a StringBuffer can hold before its internal buffer needs to be reallocated. If you StringBuffer to grow substantially and can approximate its eventual size, you can use ensureCapacity preallocate sufficient internal storage.

Use the various append( ) methods to append text to the end of the buffer. Use insert( ) to insert tex specified position within the buffer. Note that in addition to strings, primitive values, character arrays, a arbitrary objects may be passed to append( ) and insert( ) . These values are converted to strings be they are appended or inserted. Use delete( ) to delete a range of characters from the buffer and use r) to replace a range of characters with a specified String .

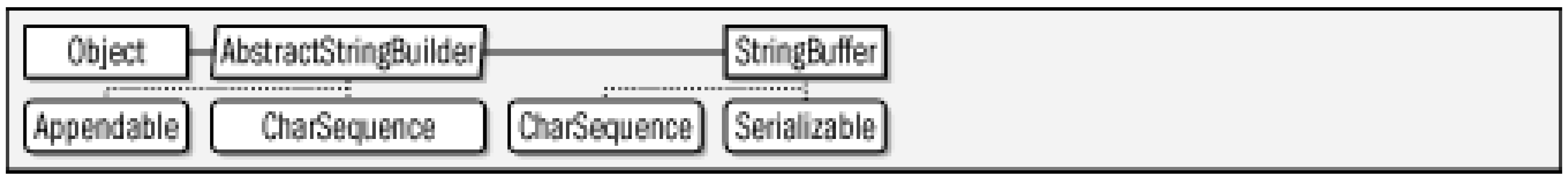
Use substring( ) to convert a portion of a StringBuffer to a String . The two versions of this methoc just like the same-named methods of String . Call toString( ) to obtain the contents of a StringBuff String object. Or use getChars( ) to extract the specified range of characters from the StringBuffer them into the specified character array starting at the specified index of that array.

As of Java 1.4, StringBuffer implements CharSequence and so also defines a subSequence( ) method like substring( ) but returns its value as a CharSequence . Java 1.4 also added indexOf( ) and lastI) methods that search forward or backward (from the optionally specified index) in a StringBuffer for sequence of characters that matches the specified String . These methods return the index of the matcl string or -1 if no match was found. See also the similarly named methods of String after which these m are modeled.

In Java 5.0, this class has a new constructor and new methods for working with CharSequence objects. I implements the Appendable interface for use with java.util.Formatter and includes new methods for with 21-bit Unicode characters as int codepoints.

String concatenation in Java is performed with the + operator and is implemented, prior to Java 5.0, usir append( ) method of a StringBuffer . In Java 5.0 and later, StringBuilder is used instead. After a st processed in a `StringBuffer` object, it can be efficiently converted to a `String` object for subsequent us `StringBuffer.toString( )` method is typically implemented so that it does not copy the internal array characters. Instead, it shares that array with the new `String` object, making a new copy for itself only if when further modifications are made to the `StringBuffer` object.

Figure 10-59. java.lang.StringBuffer




```
public final class StringBuffer extends AbstractStringBuilder implements CharSequence,
Serializable {
// Public Constructors
     public StringBuffer( );
     public StringBuffer(String str);
     public StringBuffer(int capacity);
5.0  public StringBuffer(CharSequence seq);
// Public Instance Methods
     public StringBuffer append(String str);                      synchronized
1.4  public StringBuffer append(StringBuffer sb);                   synchronized
5.0  public StringBuffer append(CharSequence s);
     public StringBuffer append(Object obj);                      synchronized
     public StringBuffer append(char[ ] str);                    synchronized
     public StringBuffer append(long lng);                        synchronized
     public StringBuffer append(float f);                         synchronized
     public StringBuffer append(double d);                        synchronized
     public StringBuffer append(boolean b);                       synchronized
     public StringBuffer append(char c);                 synchronized
     public StringBuffer append(int i);                  synchronized
     public StringBuffer append(char[ ] str, int offset, int len);     synchronized
5.0  public StringBuffer append(CharSequence s, int start, int end);     synchronized
5.0  public StringBuffer appendCodePoint(int codePoint);            synchronized
     public char charAt(int index);      Implements:CharSequence synchronized
1.2  public StringBuffer delete(int start, int end);                synchronized
1.2  public StringBuffer deleteCharAt(int index);                   synchronized
     public StringBuffer insert(int offset, char c);                    synchronized
     public StringBuffer insert(int offset, boolean b);
     public StringBuffer insert(int offset, long l);
     public StringBuffer insert(int offset, int i);
     public StringBuffer insert(int offset, String str);                synchronized
     public StringBuffer insert(int offset, Object obj);                synchronized
5.0  public StringBuffer insert(int dstOffset, CharSequence s);
     public StringBuffer insert(int offset, char[ ] str);       synchronized
     public StringBuffer insert(int offset, double d);
     public StringBuffer insert(int offset, float f);
1.2  public StringBuffer insert(int index, char[ ] str, int offset, int len);     synch
5.0  public StringBuffer insert(int dstOffset, CharSequence s, int start,
```

```
     int end);     synchronized
     public int length( );                    Implements:CharSequence synchronized
1.2  public StringBuffer replace(int start, int end, String str);     synchronized
     public StringBuffer reverse( );                          synchronized
     public String toString( );            Implements:CharSequence synchronized
// Methods Implementing CharSequence
     public char charAt(int index);                         synchronized
     public int length( );                                    synchronized
1.4  public CharSequence subSequence(int start, int end);           synchronized
     public String toString( );                               synchronized
// Public Methods Overriding AbstractStringBuilder
     public int capacity( );                                  synchronized
5.0  public int codePointAt(int index);                          synchronized
5.0  public int codePointBefore(int index);                      synchronized
5.0  public int codePointCount(int beginIndex, int endIndex);       synchronized
     public void ensureCapacity(int minimumCapacity);                 synchronized
     public void getChars(int srcBegin,
     int srcEnd, char[ ] dst, int dstBegin);     synchronized
1.4  public int indexOf(String str);
1.4  public int indexOf(String str, int fromIndex);                synchronized
1.4  public int lastIndexOf(String str);
1.4  public int lastIndexOf(String str, int fromIndex);            synchronized
5.0  public int offsetByCodePoints(int index, int codePointOffset);     synchronized
     public void setCharAt(int index, char ch);                    synchronized
     public void setLength(int newLength);                         synchronized
1.2  public String substring(int start);                        synchronized
1.2  public String substring(int start, int end);                    synchronized
5.0  public void trimToSize( );                           synchronized
}
```

Passed To

Too many methods to list.

Returned By

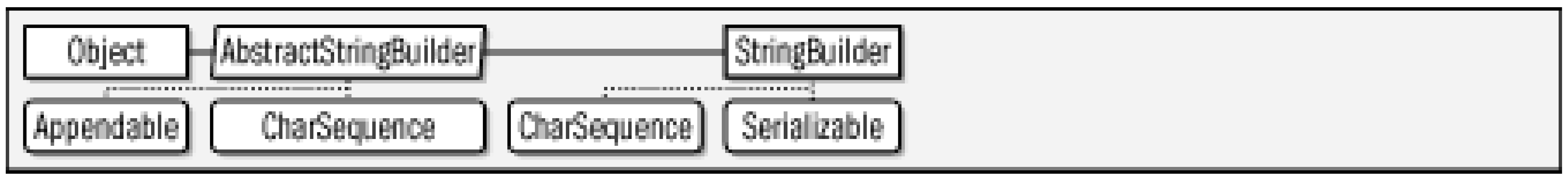
Too many methods to list.

StringBuilder java.lang

Java 5.0 *serializable appendable*

This class defines the same methods as `StringBuffer` but does not declare those methods `synchronized` , which can result in better performance in the common case in which only a single thread is using the object. `StringBuilder` is a drop-in replacement for `StringBuffer` and should be used in preference to `StringBuffer` except where thread safety is required. See `StringBuffer` for an overview of the methods shared by these two classes.

Figure 10-60. java.lang.StringBuilder




```
public final class StringBuilder extends AbstractStringBuilder implements CharSequence,
Serializable {
// Public Constructors
     public StringBuilder( );
     public StringBuilder(int capacity);
     public StringBuilder(String str);
     public StringBuilder(CharSequence seq);
// Public Instance Methods
     public StringBuilder append(long lng);
     public StringBuilder append(float f);
     public StringBuilder append(double d);
     public StringBuilder append(int i);
     public StringBuilder append(String str);
     public StringBuilder append(StringBuffer sb);
     public StringBuilder append(CharSequence s);
     public StringBuilder append(Object obj);
     public StringBuilder append(char c);
     public StringBuilder append(boolean b);
     public StringBuilder append(char[ ] str);
     public StringBuilder append(CharSequence s, int start, int end);
     public StringBuilder append(char[ ] str, int offset, int len);
     public StringBuilder appendCodePoint(int codePoint);
     public StringBuilder delete(int start, int end);
     public StringBuilder deleteCharAt(int index);
     public StringBuilder insert(int offset, boolean b);
     public StringBuilder insert(int offset, char c);
     public StringBuilder insert(int offset, int i);
```

```
    public StringBuilder insert(int dstOffset, CharSequence s);
    public StringBuilder insert(int offset, Object obj);
    public StringBuilder insert(int offset, String str);
    public StringBuilder insert(int offset, char[ ] str);
    public StringBuilder insert(int offset, double d);
    public StringBuilder insert(int offset, long l);
    public StringBuilder insert(int offset, float f);
    public StringBuilder insert(int index, char[ ] str, int offset, int len);
    public StringBuilder insert(int dstOffset, CharSequence s, int start, int end);
    public StringBuilder replace(int start, int end, String str);
    public StringBuilder reverse( );
// Methods Implementing CharSequence
    public String toString( );
// Public Methods Overriding AbstractStringBuilder
    public int indexOf(String str);
    public int indexOf(String str, int fromIndex);
    public int lastIndexOf(String str);
    public int lastIndexOf(String str, int fromIndex);
}
```

Passed To

String.String( )

StringIndexOutOfBoundsException java.lang

Java 1.0 *serializable unchecked*

Signals that the index used to access a character of a `String` or `StringBuffer` is less than zero or is too large.

Figure 10-61. java.lang.StringIndexOutOfBoundsException


```
public class StringIndexOutOfBoundsException extends IndexOutOfBoundsException {
// Public Constructors
     public StringIndexOutOfBoundsException( );
     public StringIndexOutOfBoundsException(int index);
     public StringIndexOutOfBoundsException(String s);
}
```

SuppressWarnings java.lang

Java 5.0 *@Target({TYPE, FIELD, METHOD, PARAMETER, CONSTRUCTOR, LOCAL_VARIABLE}) @Retention(SOURCE) annotation*

An annotation of this type tells the Java compiler not to generate specified kinds ofwarning messages for code within the annotated program element. Annotations of this type have source retention and may be applied to any program element except packages and other annotation types. An `@SuppressWarnings` annotation has an array of `String` objects as its `value`. These strings specify the names of the warnings to be suppressed. The available warnings (and their names) depend on the compiler implementation, and compilers will ignore warning names they do not support. Compiler vendors are expected to cooperate in defining at least a core set of common warning names. In Java 5.0, the `@SuppressWarnings` warning names supported by the *javac* compiler are the same as the warning flags that can be specfied with the `-Xlint` compiler flag.

Figure 10-62. java.lang.SuppressWarnings

```
public @interface SuppressWarnings {
// Public Instance Methods
     String[ ] value( );
}
```

Team LiB

System java.lang

Java 1.0

This class defines a platform-independent interface to system facilities, including system properties and input and output streams. All methods and variables of this class are static, and the class cannot be inst Because the methods defined by this class are low-level system methods, most require special permissi cannot be executed by untrusted code.

getProperty( ) looks up a named property on the system properties list, returning the optionally speci default value if no property definition is found. getProperties( ) returns the entire properties list. setProperties( ) sets a Properties object on the properties list. In Java 1.2 and later, setProperty(the value of a system property. In Java 5.0, you can clear a property setting with clearProperty( ) . Tl following table lists system properties that are always defined. Untrusted code may be unable to read sc of these properties. Additional properties can be defined using the -D option when invoking the Java inte

Property name	Description
file.separator	Platform directory separator character
path.separator	Platform path separator character
line.separator	Platform line separator character(s)
user.name	Current user s account name
user.home	Home directory of current user
user.dir	The current working directory
java.class.path	Where classes are loaded from
java.class.version	Version of the Java class file format
java.compiler	The name of the just-in-time compiler
java.ext.dirs	Path to directories that hold extensions
java.home	The directory Java is installed in
java.io.tmpdir	The directory that temporary files are written to
java.library.path	Directories to search for native libraries
java.specification.version	Version of the Java API specification
java.specification.vendor	Vendor of the Java API specification
java.specification.name	Name of the Java API specification
java.version	Version of the Java API implementation

Property name	Description
java.vendor	Vendor of this Java API implementation
java.vendor.url	URL of the vendor of this Java API implementation
java.vm.specification.version	Version of the Java VM specification
java.vm.specification.vendor	Vendor of the Java VM specification
java.vm.specification.name	Name of the Java VM specification
java.vm.version	Version of the Java VM implementation
java.vm.vendor	Vendor of the Java VM implementation
java.vm.name	Name of the Java VM implementation
os.name	Name of the host operating system
os.arch	Host operating system architecture
os.version	Version of the host operating system

The in , out , and err fields hold the standard input, output, and error streams for the system. These fi frequently used in calls such as System.out.println( ) . In Java 1.1, setIn( ) , setOut( ) , and setE allow these streams to be redirected.

System also defines various other useful static methods. exit( ) causes the Java VM to exit. arraycopy efficiently copies an array or a portion of an array into a destination array. currentTimeMillis( ) retur current time in milliseconds since midnight GMT, January 1, 1970 GMT. InJava 5.0, nanoTime( ) returns in nanoseconds. Unlike currentTimeMillis( ) this time is not relative to any fixed point and so is usefu for elapsed time computations.

getenv( ) returns the value of a platform-dependent environment variable, or (in Java 5.0) returns a Ma environment variables. The one-argument version of getenv( ) was previously deprecated but has been restored in Java 5.0.

identityHashCode( ) computes the hashcode for an object in the same way that the default Object.hashCode( ) method does. It does this regardless of whether or how the hashCode( ) method h been overridden.

In Java 5.0, inheritedChannel( ) returns a java.nio.channels.Channel object that represents a netw connection passed to the Java process by the invoking process. This allows Java programs to be used wi Unix *inetd* daemon, for example.

load( ) and loadLibrary( ) can read libraries of native code into the system. mapLibraryName( ) con system-independent library name into a system-dependent library filename. Finally, getSecurityManage and setSecurityManager( ) get and set the system SecurityManager object responsible for the system security policy.

See also Runtime , which defines several other methods that provide low-level access to system facilities

```
public final class System {
// No Constructor
```

```
// Public Constants
     public static final java.io.PrintStream err;
     public static final java.io.InputStream in;
     public static final java.io.PrintStream out;
// Public Class Methods
     public static void arraycopy(Object src, int srcPos, Object dest, int destPos,
     int length);     native
5.0  public static String clearProperty(String key);
     public static long currentTimeMillis( );                             native
     public static void exit(int status);
     public static void gc( );
5.0  public static java.util.Map<String,String> getenv( );
     public static String getenv(String name);
     public static java.util.Properties getProperties( );
     public static String getProperty(String key);
     public static String getProperty(String key, String def);
     public static SecurityManager getSecurityManager( );
1.1  public static int identityHashCode(Object x);                  native
5.0  public static java.nio.channels.Channel inheritedChannel( ) throws java.io.IOExcep
     public static void load(String filename);
     public static void loadLibrary(String libname);
1.2  public static String mapLibraryName(String libname);           native
5.0  public static long nanoTime( );                                    native
     public static void runFinalization( );
1.1  public static void setErr(java.io.PrintStream err);
1.1  public static void setIn(java.io.InputStream in);
1.1  public static void setOut(java.io.PrintStream out);
     public static void setProperties(java.util.Properties props);
1.2  public static String setProperty(String key, String value);
     public static void setSecurityManager(SecurityManager s);
// Deprecated Public Methods
1.1#  public static void runFinalizersOnExit(boolean value);
}
```

Thread java.lang

Java 1.0 *runnable*

This class encapsulates all information about a single thread of control running on the Java interpreter. T thread, you must either pass a Runnable object (i.e., an object that implements the Runnable interface a run( ) method) to the Thread constructor or subclass THRead so that it defines its own run( ) methoc) method of the Thread or of the specified Runnable object is the body of the thread. It begins executin start( ) method of the Thread object is called. The thread runs until the run( ) method returns. isAl returns TRue if a thread has been started, and the run( ) method has not yet exited.

The static methods of this class operate on the currently running thread. currentThread( ) returns the object of the currently running code. sleep( ) makes the current thread stop for a specified amount of yield( ) makes the current thread give up control to any other threads of equal priority that are waitin holdsLock( ) tests whether the current thread holds a lock (through a synchronized method or statem specified object; this Java 1.4 method is often useful with an assert statement.

The instance methods may be called by one thread to operate on a different thread. checkAccess( ) ch whether the running thread has permission to modify a THRead object and throws a SecurityException not. join( ) waits for a thread to die. interrupt( ) wakes up a waiting or sleeping thread (with an InterruptedException) or sets an interrupted flag on a nonsleeping thread. A thread can test its own flag with the static interrupted( ) method or can test the flag of another thread with isInterrupted(interrupted( ) implicitly clears the interrupted flag, but calling isInterrupted( ) does not. Methods r sleep( ) and interrupt( ) are the wait( ) and notify( ) methods defined by the Object class. Call causes the current thread to block until the object's notify( ) method is called by another thread.

setName( ) sets the name of a thread, which is purely optional. setPriority( ) sets the priority of the Higher priority threads run before lower priority threads. Java does not specify what happens to multiple equal priority; some systems perform time-slicing and share the CPU between such threads. On other sy compute-bound thread that does not call yield( ) may starve another thread of the same priority. setD sets a boolean flag that specifies whether this thread is a daemon or not. The Java VM keeps running as least one nondaemon thread is running. Call getThreadGroup( ) to obtain the ThreadGroup of which a t part. In Java 1.2 and later, use setContextClassLoader( ) to specify the ClassLoader to be used to lo classes required by the thread.

suspend( ) , resume( ) , and stop( ) suspend, resume, and stop a given thread, respectively, but all methods are deprecated because they are inherently unsafe and can cause deadlock. If a thread must b have it periodically check a flag and exit if the flag is set.

In Java 1.4 and later, the four-argument Thread( ) constructor allows you to specify the "stack size" pa the thread. Typically, larger stack sizes allow threads to recurse more deeply before running out of stack Smaller stack sizes reduce the fixed per-thread memory requirements and may allow more threads to e concurrently. The meaning of this argument is implementation dependent, and implementations may ev

Java 5.0 adds important new features to this class. getId( ) returns a unique long identifier for the thre getState( ) returns the state of the thread as an enumerated constant of type Thread.State . Thread.UncaughtExceptionHandler defines an API for handling exceptions that cause the run( ) meth thread to exit. Register a handler of this type with setUncaughtExceptionHandler( ) or register a defa with the static methods setDefaultUncaughtExceptionHandler( ) . Obtain a snapshot of a thread's cu trace with getStackTrace( ) . This returns an array of StackTraceElement objects: the first element o the most recent method invocation and the last element is the least recent. The static getAllStackTrace returns stack traces for all running threads (the traces may be obtained at different times for different tl

Figure 10-63. java.lang.Thread


```
public class Thread implements Runnable {
// Public Constructors
     public Thread( );
     public Thread(String name);
     public Thread(Runnable target);
     public Thread(Runnable target, String name);
     public Thread(ThreadGroup group, String name);
     public Thread(ThreadGroup group, Runnable target);
     public Thread(ThreadGroup group, Runnable target, String name);
1.4  public Thread(ThreadGroup group, Runnable target, String name, long stackSize);
// Public Constants
     public static final int MAX_PRIORITY; =10
     public static final int MIN_PRIORITY; =1
     public static final int NORM_PRIORITY;                              =5
// Nested Types
5.0  public enum State;
5.0  public interface UncaughtExceptionHandler;
// Public Class Methods
     public static int activeCount( );
     public static Thread currentThread( );                               native
     public static void dumpStack( );
     public static int enumerate(Thread[ ] tarray);
5.0  public static java.util.Map<Thread,StackTraceElement[ ]> getAllStackTraces( );
5.0  public static Thread.UncaughtExceptionHandler getDefaultUncaughtExceptionHandler(
1.4  public static boolean holdsLock(Object obj);                    native
     public static boolean interrupted( );
5.0  public static void setDefaultUncaughtExceptionHandler(Thread.UncaughtExceptionHand
     public static void sleep(long millis) throws InterruptedException;     native
     public static void sleep(long millis, int nanos) throws InterruptedException;
     public static void yield( );                                         native
// Public Instance Methods
     public final void checkAccess( );
1.2  public ClassLoader getContextClassLoader( );
5.0  public long getId( );                          default:7
     public final String getName( );                                      default:"Thre
     public final int getPriority( );                                     default:5
5.0  public StackTraceElement[ ] getStackTrace( );
5.0  public Thread.State getState( );
```

```
     public final ThreadGroup getThreadGroup( );
5.0  public Thread.UncaughtExceptionHandler getUncaughtExceptionHandler( ); default:Thr
     public void interrupt( );
     public final boolean isAlive( );                                    native defaul
     public final boolean isDaemon( );                                   default:false
     public boolean isInterrupted( );                                    default:false
     public final void join( ) throws InterruptedException;
     public final void join(long millis) throws InterruptedException;     synchronized
     public final void join(long millis, int nanos) throws InterruptedException;     sy
1.2  public void setContextClassLoader(ClassLoader cl);
     public final void setDaemon(boolean on);
     public final void setName(String name);
     public final void setPriority(int newPriority);
5.0  public void setUncaughtExceptionHandler(Thread.UncaughtExceptionHandler eh);
     public void start( );                                   synchronized
// Methods Implementing Runnable
     public void run( );
// Public Methods Overriding Object
     public String toString( );
// Deprecated Public Methods
#    public int countStackFrames( );                                   native
#    public void destroy( );
#    public final void resume( );
#    public final void stop( );
#    public final void stop(Throwable obj);                     synchronized
#    public final void suspend( );
}
```

Passed To

Runtime.{addShutdownHook( ) , removeShutdownHook( )} , SecurityManager.checkAccess( ) , Thread.UncaughtExceptionHandler.uncaughtException( ) , THReadGroup.{enumerate( ) , uncaughtException( )} , java.util.concurrent.ThreadPoolExecutor.beforeExecute( ) , java.util.concurrent.TimeUnit.timedJoin( ) , java.util.concurrent.locks.AbstractQueuedSynchronizer.isQueued( ) , java.util.concurrent.locks.LockSupport.unpark( ) , java.util.concurrent.locks.ReentrantLock.hasQueuedThread( ) , java.util.concurrent.locks.ReentrantReadWriteLock.hasQueuedThread( )

Returned By

java.util.concurrent.ThreadFactory.newThread( ) , java.util.concurrent.locks.AbstractQueuedSynchronizer.getFirstQueuedThread( ) , java.util.concurrent.locks.ReentrantLock.getOwner( ) , java.util.concurrent.locks.ReentrantReadWriteLock.getOwner( )

Thread.State java.lang

Java 5.0 *serializable comparable enum*

This enumerated type defines the possible states of a thread. Call the `getState( )` method of a `Thread` object to obtain one of the enumerated constants defined here. A `NEW` thread has not been started yet, and a `TERMINATED` tHRead has exited. A `BLOCKED` thread is waiting to enter a `synchronized` method or block. A `WAITING` thread is waiting in `Object.wait( )`, `Thread.join( )`, or a similar method. A `TIMED_WAITING` thread is waiting but is subject to a timeout, such as in `THRead.sleep( )` or the timed versions of `Object.wait( )` and `Thread.join( )`. Finally, a thread that has been started and has not yet exited and is not blocked or waiting is `RUNNABLE`. This does not mean that the operating system is currently running it or that it is even making any forward progress, but that it is at least available to run when the operating system gives it the CPU.

```
public enum Thread.State {
// Enumerated Constants
     NEW,
     RUNNABLE,
     BLOCKED,
     WAITING,
     TIMED_WAITING,
     TERMINATED;
// Public Class Methods
     public static Thread.State valueOf(String name);
     public static final Thread.State[ ] values( );
}
```

Returned By

`Thread.getState( )`, `java.lang.management.ThreadInfo.getThreadState( )`

Thread.UncaughtExceptionHandler java.lang

Java 5.0

This interface defines a handler to be invoked when a thread throws an exception that remains uncaught. When this happens, the `uncaughtException( )` method of the registered handler is invoked with the `Thread` object that threw the exception and the `THRowable` exception object as arguments. The handler is run by the thread that received the exception, and that thread will exit as soon as the handler exits. If `uncaughtException( )` itself throws an exception, that exception will be ignored.

An object that implements this interface may be registered for a `Thread` with the `setUncaughtExceptionHandler( )` method. A default `UncaughtExceptionHandler` may be registered with the static method `THRead.setDefaultUncaughtExceptionHandler( )`. If no handler or default handler is registered, the `uncaughtException( )` method of the containing `ThreadGroup` is used instead.

```
public interface Thread.UncaughtExceptionHandler {
// Public Instance Methods
     void uncaughtException(Thread t, Throwable e);
}
```

Implementations

`ThreadGroup`

Passed To

`Thread.{setDefaultUncaughtExceptionHandler( ), setUncaughtExceptionHandler( )}`

Returned By

`Thread.{getDefaultUncaughtExceptionHandler( ), getUncaughtExceptionHandler( )}`

ThreadDeath java.lang

Java 1.0 *serializable error*

Signals that a thread should terminate. This error is thrown in a thread when the `Thread.stop( )` method is called for that thread. This is an unusual `Error` type that simply causes a thread to be terminated, but does not print an error message or cause the interpreter to exit. You can catch `THReadDeath` errors to do any necessary cleanup for a thread, but if you do, you must rethrow the error so that the thread actually terminates.

Figure 10-64. java.lang.ThreadDeath


```
public class ThreadDeath extends Error {
// Public Constructors
     public ThreadDeath( );
}
```

ThreadGroup java.lang

Java 1.0

This class represents a group of threads and allows that group to be manipulated as a whole. A ThreadGroup can contain THRead objects, as well as other child ThreadGroup objects. All ThreadGroup objects are created as children of some other THReadGroup, and thus there is a parent/child hierarchy of ThreadGroup objects. Use getParent( ) to obtain the parent ThreadGroup, and use activeCount( ) , activeGroupCount( ), and the various enumerate( ) methods to list the child Thread and THReadGroup objects. Most applications can simply rely on the default system thread group. System-level code and applications such as servers that need to create a large number of threads may find it convenient to create their own THReadGroup objects, however.

interrupt( ) interrupts all threads in the group at once. setMaxPriority( ) specifies the maximum priority any thread in the group can have. checkAccess( ) checks whether the calling thread has permission to modify the given thread group. The method throws a SecurityException if the current thread does not have access. uncaughtException( ) contains the code that is run when a thread terminates because of an uncaught exception or error. You can customize this method by subclassing ThreadGroup.

Figure 10-65. java.lang.ThreadGroup

```
public class ThreadGroup implements Thread.UncaughtExceptionHandler {
// Public Constructors
     public ThreadGroup(String name);
     public ThreadGroup(ThreadGroup parent, String name);
// Public Instance Methods
     public int activeCount( );
     public int activeGroupCount( );
     public final void checkAccess( );
     public final void destroy( );
     public int enumerate(ThreadGroup[ ] list);
     public int enumerate(Thread[ ] list);
     public int enumerate(Thread[ ] list, boolean recurse);
     public int enumerate(ThreadGroup[ ] list, boolean recurse);
     public final int getMaxPriority( );
     public final String getName( );
     public final ThreadGroup getParent( );
1.2  public final void interrupt( );
     public final boolean isDaemon( );
```

```
1.1  public boolean isDestroyed( );                 synchronized
     public void list( );
     public final boolean parentOf(ThreadGroup g);
     public final void setDaemon(boolean daemon);
     public final void setMaxPriority(int pri);
     public void uncaughtException(Thread t, Throwable e);
Implements:Thread.UncaughtExceptionHandler
// Methods Implementing Thread.UncaughtExceptionHandler
     public void uncaughtException(Thread t, Throwable e);
// Public Methods Overriding Object
     public String toString( );
// Deprecated Public Methods
1.1#  public boolean allowThreadSuspension(boolean b);
#    public final void resume( );
#    public final void stop( );
#    public final void suspend( );
}
```

Passed To

SecurityManager.checkAccess( ), THRead.Thread( )

Returned By

SecurityManager.getThreadGroup( ), THRead.getThreadGroup( )

ThreadLocal<T> java.lang

Java 1.2

This class provides a convenient way to create thread-localvariables. When you declare a static field in a class, there is only one value for that field, shared by all objects of the class. When you declare a nonstatic instance field in a class, every object of the class has its own separate copy of that variable. ThreadLocal provides an option between these two extremes. If you declare a static field to hold a THReadLocal object, that ThreadLocal holds a different value for each thread. Objects running in the same thread see the same value when they call the get( ) method of the ThreadLocal object. Objects running in different threads obtain different values from get( ), however.

In Java 5.0, this class has been made generic and the type variable *T* represents the type of the object referenced by this ThreadLocal.

The set( ) method sets the value held by the THReadLocal object for the currently running thread. get( ) returns the value held for the currently running thread. Note that there is no way to obtain the value of the ThreadLocal object for any thread other than the one that calls get( ). To understand the ThreadLocal class, you may find it helpful to think of a ThreadLocal object as a hashtable or java.util.Map that maps from Thread objects to arbitrary values. Calling set( ) creates an association between the current Thread (Thread.currentThread( )) and the specified value. Calling get( ) first looks up the current thread, then uses the hashtable to look up the value associated with that current thread.

If a thread calls get( ) for the first time without having first called set( ) to establish a thread-local value, get( ) calls the protected initialValue( ) method to obtain the initial value to return. The default implementation of initialValue( ) simply returns null, but subclasses can override this if they desire.

See also InheritableThreadLocal, which allows thread-local values to be inherited from parent threads by child threads.

```
public class ThreadLocal<T> {
// Public Constructors
     public ThreadLocal( );
// Public Instance Methods
     public T get( );
5.0  public void remove( );
     public void set(T value);
// Protected Instance Methods
     protected T initialValue( );                                    constant
}
```

Subclasses

`InheritableThreadLocal`

Team LiB

Throwable java.lang

Java 1.0 *serializable*

This is the root class of the Java exception and error hierarchy. All exceptions and errors are subclasses Throwable . The getMessage( ) method retrieves any error message associated with the exception or e The default implemenation of getLocalizedMessage( ) simply calls getMessage( ) , but subclasses ma override this method to return an error message that has been localized for the default locale.

It is often the case that an Exception or Error is generated as a direct result of some other exception o perhaps one thrown by a lower-level API. As of Java 1.4 and later, all Throwable objects may have a "ca which specifies the Throwable that caused this one. If there is a cause, pass it to the THRowable( ) constructor, or to the initCause( ) method. When you catch a Throwable object, you can obtain the Throwable that caused it, if any, with getCause( ) .

Every THRowable object has information about the execution stack associated with it. This information is initialized when the THRowable object is created. If the object will be thrown somewhere other than whe was created, or if it caught and will be re-thrown, you can use fillInStackTrace( ) to capture the curr execution stack before throwing it. printStackTrace( ) prints a textual representation of the stack to t specified PrintWriter , PrintStream , or to the System.err stream. In Java 1.4, you can also obtain th information with getStackTrace( ) which returns an array of StackTraceElement objects describing th execution stack.

Figure 10-66. java.lang.Throwable

```
public class Throwable implements Serializable {
// Public Constructors
     public Throwable( );
     public Throwable(String message);
1.4  public Throwable(Throwable cause);
1.4  public Throwable(String message, Throwable cause);
// Public Instance Methods
     public Throwable fillInStackTrace( );                          native synchr
1.4  public Throwable getCause( );                                default:null
1.1  public String getLocalizedMessage( );                        default:null
     public String getMessage( );                                     default:null
1.4  public StackTraceElement[ ] getStackTrace( );
1.4  public Throwable initCause(Throwable cause);               synchronized
     public void printStackTrace( );
     public void printStackTrace(java.io.PrintStream s);
1.1  public void printStackTrace(java.io.PrintWriter s);
```

```
1.4  public void setStackTrace(StackTraceElement[ ] stackTrace);
// Public Methods Overriding Object
     public String toString( );
}
```

Subclasses

Error , Exception

Passed To

Too many methods to list.

Returned By

java.io.WriteAbortedException.getCause( ) , ClassNotFoundException.{getCause( ) , getExcep
)} , ExceptionInInitializerError.{getCause( ) , getException( )} ,
java.lang.reflect.InvocationTargetException.{getCause( ) , getTargetException( )} ,
java.lang.reflect.UndeclaredThrowableException.{getCause( ) , getUndeclaredThrowable( )}
java.security.PrivilegedActionException.getCause( ) , java.util.logging.LogRecord.getThro
, javax.xml.transform.TransformerException.{getCause( ) , getException( ) , initCause( )} ,
javax.xml.xpath.XPathException.getCause( )

Thrown By

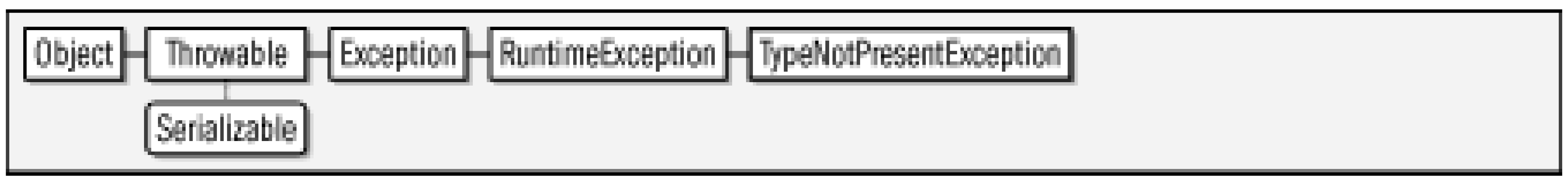
Object.finalize( ) , java.lang.reflect.InvocationHandler.invoke( )

TypeNotPresentExceptionjava.lang

Java 5.0 *serializable unchecked*

This unchecked exception signals that a class file associated with a `java.lang.reflect.Type` could not be found. It typically results when a class depends on a type that has changed or been removed and indicates version skew that requires recompilation or code refactoring. This is essentially the generic type version of `ClassNotFoundException`.

Figure 10-67. java.lang.TypeNotPresentException



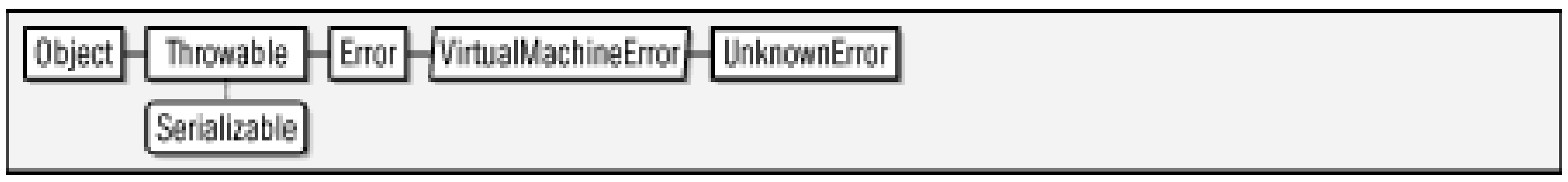

```
public class TypeNotPresentException extends RuntimeException {
// Public Constructors
     public TypeNotPresentException(String typeName, Throwable cause);
// Public Instance Methods
     public String typeName( );
}
```

UnknownError java.lang

Java 1.0 *serializable error*

Signals that an unknown error has occurred at the level of the Java Virtual Machine.

Figure 10-68. java.lang.UnknownError




```
public class UnknownError extends VirtualMachineError {
// Public Constructors
     public UnknownError( );
     public UnknownError(String s);
}
```

UnsatisfiedLinkError java.lang

Java 1.0 *serializable error*

Signals that Java cannot satisfy all the links in a class that it has loaded.

Figure 10-69. java.lang.UnsatisfiedLinkError


```
public class UnsatisfiedLinkError extends LinkageError {
// Public Constructors
     public UnsatisfiedLinkError( );
     public UnsatisfiedLinkError(String s);
}
```

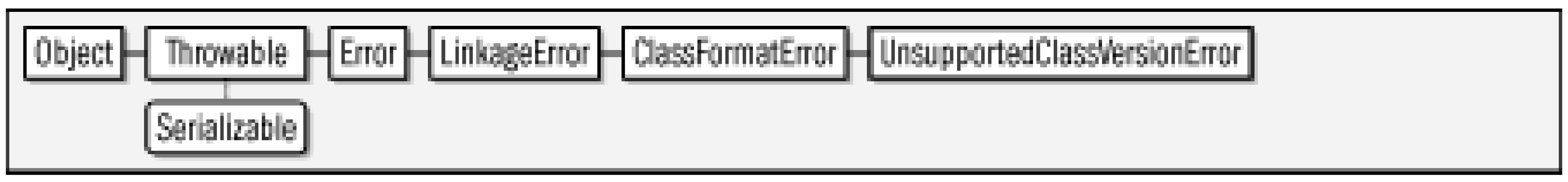
Team LiB

UnsupportedClassVersionError java.lang

Java 1.2 *serializable error*

Every Java class file contains a version number that specifies the version of the class file format. This error is thrown when the Java Virtual Machine attempts to read a class file with a version number it does not support.

Figure 10-70. java.lang.UnsupportedClassVersionError



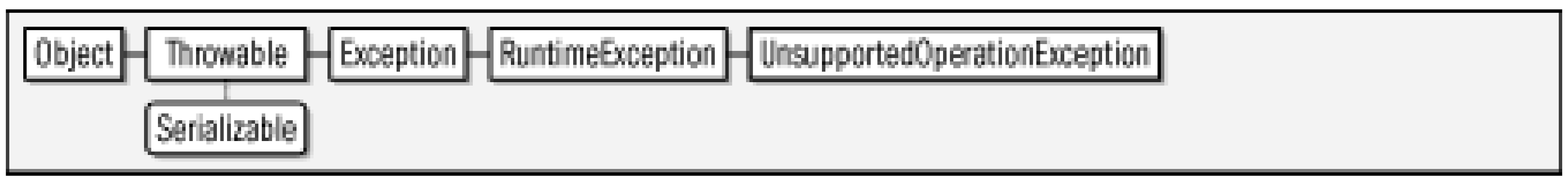

```
public class UnsupportedClassVersionError extends ClassFormatError {
// Public Constructors
     public UnsupportedClassVersionError( );
     public UnsupportedClassVersionError(String s);
}
```

UnsupportedOperationException java.lang

Java 1.2 *serializable unchecked*

Signals that a method you have called is not supported, and its implementation does not do anything (except throw this exception). This exception is used most often by the Java collection framework of `java.util`. Immutable or unmodifiable collections throw this exception when a modification method, such as `add( )` or `delete( )`, is called.

Figure 10-71. java.lang.UnsupportedOperationException




```
public class UnsupportedOperationException extends RuntimeException {
// Public Constructors
     public UnsupportedOperationException( );
5.0  public UnsupportedOperationException(Throwable cause);
     public UnsupportedOperationException(String message);
5.0  public UnsupportedOperationException(String message, Throwable cause);
}
```

Subclasses

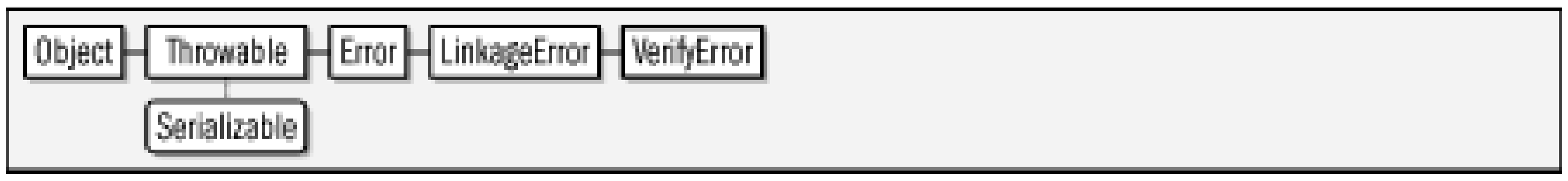
`java.nio.ReadOnlyBufferException`

VerifyError java.lang

Java 1.0 *serializable error*

Signals that a class has not passed the byte-code verification procedures.

Figure 10-72. java.lang.VerifyError




```
public class VerifyError extends LinkageError {
// Public Constructors
     public VerifyError( );
     public VerifyError(String s);
}
```

VirtualMachineError java.lang

Java 1.0 *serializable error*

An abstract error type that serves as superclass for a group of errors related to the Java Virtual Machine. See `InternalError`, `UnknownError`, `OutOfMemoryError`, and `StackOverflowError`.

Figure 10-73. java.lang.VirtualMachineError


```
public abstract class VirtualMachineError extends Error {
// Public Constructors
     public VirtualMachineError( );
     public VirtualMachineError(String s);
}
```

Subclasses

`InternalError`, `OutOfMemoryError`, `StackOverflowError`, `UnknownError`

Void java.lang

Java 1.1

The `Void` class cannot be instantiated and serves merely as a placeholder for its static `TYPE` field, which is a `Class` object constant that represents the `void` type.

```
public final class Void {
// No Constructor
// Public Constants
     public static final Class<Void> TYPE;
}
```

Team LiB

Package java.lang.annotation

Java 5.0

This package defines the framework for annotations. It includes the base`Annotation` interface that all annotation types extend, meta-annotation types, their associatedenumerated types, and exception and error classes related to annotations. The most important members of this package are the meta-annotation types: `Documented`, `Inherited`, `Retention`, and `Target`.

Interfaces

```
public interface Annotation;
```

Enumerated Types

```
public enum ElementType;
public enum RetentionPolicy;
```

Annotation Types

```
public @interface Documented;
public @interface Inherited;
public @interface Retention;
public @interface Target;
```

Exceptions

```
public class AnnotationTypeMismatchException extends RuntimeException;
public class IncompleteAnnotationException extends RuntimeException;
```

Errors

```
public class AnnotationFormatError extends Error;
```

Annotation java.lang.annotation

Java 5.0

A type declared with the `@interface` syntax is an annotation type that implicitly extends this interface. Note that the `Annotation` interface is not itself an annotation type. Furthermore, if you define an `interface` (rather than an `@interface`) that explicitly extends `Annotation`, the result is not an annotation type either. The only way to define an annotation type is with an `@interface` definition. When an annotation is queried with the `java.lang.reflect.AnnotatedElement` API, the object returned implements this interface as well as the interface defined by the specific annotation type.

This interface defines the `annotationType( )` method, which returns the `Class` of the annotation type for any annotation object. It also includes the `equals( )` and `hashCode( )` methods of `Object` to require an implementation to compare annotations by the values of their members rather than simply by using `= =`. Finally, `Annotation` also overrides the `toString( )` method to require implementations to provide some meaningful string representation of an annotation. The format of the returned string is not specified, but you can expect implementations to produce a string using a syntax similar to that used to encode annotations in Java source code.

```
public interface Annotation {
// Public Instance Methods
     Class<? extends java.lang.annotation.Annotation> annotationType( );
     boolean equals(Object obj);
     int hashCode( );
     String toString( );
}
```

Implementations

`Deprecated`, `Override`, `SuppressWarnings`, `Documented`, `Inherited`, `Retention`, `Target`

Returned By

Too many methods to list.

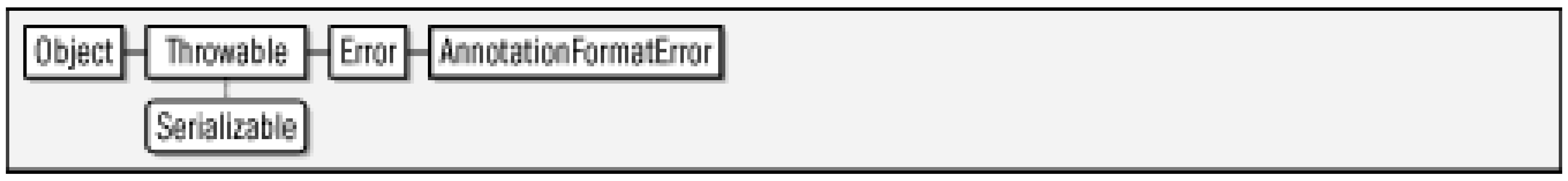
Team LiB

AnnotationFormatError java.lang.annotation

Java 5.0 *serializable error*

An error of this type indicates that a class file includes a malformed annotation.

Figure 10-74. java.lang.annotation.AnnotationFormatError




```
public class AnnotationFormatError extends Error {
// Public Constructors
     public AnnotationFormatError(Throwable cause);
     public AnnotationFormatError(String message);
     public AnnotationFormatError(String message, Throwable cause);
}
```

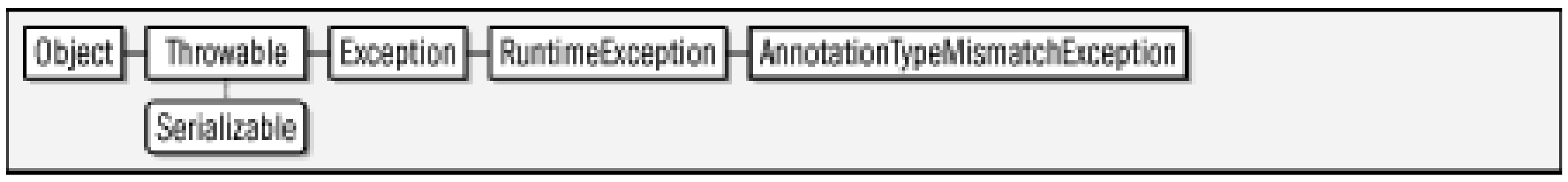
Team LiB

AnnotationTypeMismatchException java.lang.annotation

Java 5.0 *serializable unchecked*

An exception of this type indicates version skew in an annotation type. It occurs when the Java VM atter
an annotation from a class file and discovers that the type of an annotation member has changed since
(and the annotation it contains) was compiled.

Figure 10-75. java.lang.annotation.AnnotationTypeMismatchExcepti




```
public class AnnotationTypeMismatchException extends RuntimeException {
// Public Constructors
     public AnnotationTypeMismatchException(java.lang.reflect.Method element, String fo
// Public Instance Methods
     public java.lang.reflect.Method element( );
     public String foundType( );
}
```

Documented java.lang.annotation

Java 5.0 *@Documented @Retention(RUNTIME) @Target(ANNOTATION_TYPE) annotation*

A meta-annotation of this type indicates that the annotated type should be documented by Javadoc and similar documentation tools. If an annotation type is an `@Documented` annotation, then the presence of an annotation of that type is part of the public API of the annotated program element. `java.lang.Deprecated` is an `@Documented` annotation type, for example, and so are each of the meta-annotation types in this package.

It is recommended that any annotation type that is `@Documented` should also have runtime `@Retention` so that the presence of the annotation can be queried via reflection.

Figure 10-76. java.lang.annotation.Documented

```
public @interface Documented {
}
```

ElementType java.lang.annotation

Java 5.0 *serializable comparable enum*

The constants declared by this enumerated type represent the types of program elements that can be annotated. The `value` of an `@Target` annotation is an array of `ElementType` constants. Most of the constants have obvious meanings, but some require additional explanation. `TYPE` represents a class, interface, enumerated type, or annotation type. `ANNOTATION_TYPE` represents only annotation types and is used for meta-annotations. `FIELD` includes enumerated constants, and `PARAMETER` includes both method parameters and `catch` clause parameters. Note that the `METHOD` and `CONSTRUCTOR` are distinct constants.

Figure 10-77. java.lang.annotation.ElementType

```
public enum ElementType {
// Enumerated Constants
     TYPE,
     FIELD,
     METHOD,
     PARAMETER,
     CONSTRUCTOR,
     LOCAL_VARIABLE,
     ANNOTATION_TYPE,
     PACKAGE;
// Public Class Methods
     public static ElementType valueOf(String name);
     public static final ElementType[ ] values( );
}
```

Returned By

`Target.value( )`

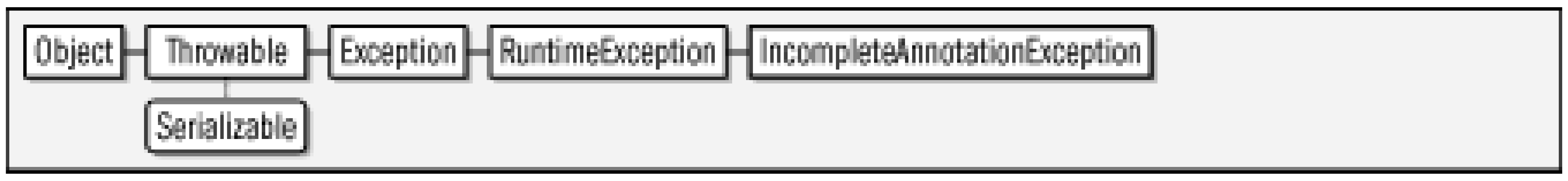
Team LiB

IncompleteAnnotationException java.lang.annotation

Java 5.0 *serializable unchecked*

An exception of this type indicates version skew in an annotation type. It occurs when the Java VM atter
annotation from a class file and discovers that the annotation type has added a new member since the c
This means that the annotation compiled into the class file is incomplete since it does not define a value
annotation type. Note that this exception does not occur if a new member with a `default` clause is adde
type.

Figure 10-78. java.lang.annotation.IncompleteAnnotationExcep




```
public class IncompleteAnnotationException extends RuntimeException {
// Public Constructors
     public IncompleteAnnotationException(Class<? extends java.lang.annotation.Annotatio
     String elementName);
// Public Instance Methods
     public Class<? extends java.lang.annotation.Annotation> annotationType( );
     public String elementName( );
}
```

Inherited java.lang.annotation

Java 5.0 *@Documented @Retention(RUNTIME) @Target(ANNOTATION_TYPE) annotation*

When an annotation type that has an `@Inherited` meta-annotation is applied to a class, that annotation should be inherited by subclasses and descendants of the annotated class. The inheritance is only for classes and their subclasses. If an `@Inherited` annotation type is applied to a method or program element other than a class, no inheritance applies. If the `@Inherited` annotation type also has runtime `Retention`, reflective access to the annotation through `java.lang.reflect.AnnotatedElement` manages the inheritance of the annotation.

Figure 10-79. java.lang.annotation.Inherited

```
public @interface Inherited {
}
```

Retention java.lang.annotation

Java 5.0 *@Documented @Retention(RUNTIME) @Target(ANNOTATION_TYPE) annotation*

A meta-annotation of this type specifies how long the annotated annotation type should be retained. The `value( )` of this annotation type is one of the three `RetentionPolicy` enumerated constants. See `RetentionPolicy` for details. If an annotation type does not have an `@Retention` meta-annotation, its default retention is `RetentionPolicy.CLASS`.

Figure 10-80. java.lang.annotation.Retention

```
public @interface Retention {
// Public Instance Methods
     RetentionPolicy value( );
}
```

RetentionPolicy java.lang.annotation

Java 5.0 *serializable comparable enum*

The constants declared by the enumerated type specify the possible retention values for an `@Retention` meta-annotation. Annotations with `SOURCE` retention appear in Java source code only and are discarded by the compiler. Annotations with `CLASS` retention are compiled into the class file and are visible to tools that read class files but are not loaded by the Java VM at runtime. (This is the default retention for annotation types that do not have an `@Retention` meta-annotation.) Finally, annotations with `RUNTIME` retention are stored in the class file and loaded by the Java interpreter at runtime. These annotations are available for reflective access through `java.lang.reflect.AnnotatedElement`.

Figure 10-81. java.lang.annotation.RetentionPolicy

```
public enum RetentionPolicy {
// Enumerated Constants
     SOURCE,
     CLASS,
     RUNTIME;
// Public Class Methods
     public static RetentionPolicy valueOf(String name);
     public static final RetentionPolicy[ ] values( );
}
```

Returned By

`Retention.value( )`

Team LiB

Target java.lang.annotation

Java 5.0 *@Documented @Retention(RUNTIME) @Target(ANNOTATION_TYPE) annotation*

A meta-annotation of this type specifies what program elements the annotated annotation type can be applied to. The `value( )` of a `Target` annotation is an array of `ElementType` enumerated constants. See `ElementType` for details on the allowed values. If an annotation type does not have ar `@Target` meta-annotation, it can be applied to any program element.

Figure 10-82. java.lang.annotation.Target

```
public @interface Target {
// Public Instance Methods
     ElementType[ ] value( );
}
```

Team LiB

Package java.lang.instrument

Java 5.0

This package defines the API for instrumenting a Java VM by transforming class files to add profiling support, code coverage testing, or other features.

The `-javaagent` command-line option to the Java interpreter provides a hook for running the `premain( )` method of a Java instrumentation *agent*. An `Instrumentation` object passed to the `premain( )` method provides an entry point into this package, and methods of `Instrumentation` allow loaded classes to be redefined and `ClassFileTransformer` objects to be registered for classes not yet loaded.

Interfaces

```
public interface ClassFileTransformer;
public interface Instrumentation;
```

Classes

```
public final class ClassDefinition;
```

Exceptions

```
public class IllegalClassFormatException extends Exception;
public class UnmodifiableClassException extends Exception;
```

Team LiB

ClassDefinition java.lang.instrument

Java 5.0

This class is a simple wrapper around a Class object and an array of bytes that represents a class file for that class. An array of ClassDefinition objects is passed to the redefineClasses( ) method of the Instrumentation class. Class redefinitions are allowed to change method implementations, but not the members or inheritance of a class or the signature of the methods.

```
public final class ClassDefinition {
// Public Constructors
     public ClassDefinition(Class<?> theClass, byte[ ] theClassFile);
// Public Instance Methods
     public Class<?> getDefinitionClass( );
     public byte[ ] getDefinitionClassFile( );
}
```

Passed To

Instrumentation.redefineClasses( )

Team LiB

ClassFileTransformer java.lang.instrument

Java 5.0

A ClassFileTransformer registered through an Instrumentation object is offered a chance to transfor every class that is subsequently loaded or redefined. The final argument totransform( ) is a byte array contains the raw bytes of the class file (or bytes returned by a previously invokedClassFileTransforme If the TRansform( ) method wishes to transform the class, it should return the transformed bytes in a r allocated array. The array passed to transform( ) should not be modified. If the transform( ) method not wish to transform a given class, it should return null .

```
public interface ClassFileTransformer {
// Public Instance Methods
     byte[ ] transform(ClassLoader loader, String className, Class<?> classBeingRedefin
java.security.ProtectionDomain protectionDomain, byte[ ] classfileBuffer)
throws IllegalClassFormatException;
}
```

Passed To

Instrumentation.{addTransformer( ) , removeTransformer( )}

IllegalClassFormatException java.lang.instrument

Java 5.0 *serializable checked*

A `ClassFileTransformer` should throw an exception of this type from its `transform( )` method if it believes that the class file bytes it has been passed are malformed (this could happen, for example, i a defective `ClassFileTransformer` had previously transformed a valid class file).

Figure 10-83. java.lang.instrument.IllegalClassFormatException


```
public class IllegalClassFormatException extends Exception {
// Public Constructors
     public IllegalClassFormatException( );
     public IllegalClassFormatException(String s);
}
```

Thrown By

`ClassFileTransformer.transform( )`

Team LiB

Instrumentation java.lang.instrument

Java 5.0

This interface is the main entry point to the `java.lang.instrument` API. A Java instrumentation agent specified on the Java interpreter command line with the `-javaagent` argument must be a class that defir the following method:

```
public static void premain(String args, Instrumentation instr)
```

The Java interpreter invokes the `premain( )` method during startup before calling the `main( )` method o the program. Any arguments specified with the `-javaagent` command line are passed in the first `premai )` argument, and an `Instrumentation` object is passed as the second argument.

The most powerful feature of the `Instrumentation` object is the ability to register `ClassFileTransform` objects to augment or rewrite the byte code of Java class files as they are loaded into the interpreter. If `isRedefineClassesSupported( )` returns `true` , you can also redefine already-loaded classes on the fly with `redefineClasses( )` .

`getAllLoadedClasses( )` returns an array of all classes loaded into the VM, and `getInitiatedClasses )` returns an array of classes loaded by a specified `ClassLoader` . `getObjectSize( )` returns an implementation-specific approximation of the amount of memory required by a specified object.

```
public interface Instrumentation {
// Public Instance Methods
     void addTransformer(ClassFileTransformer transformer);
     Class[ ] getAllLoadedClasses( );
     Class[ ] getInitiatedClasses(ClassLoader loader);
     long getObjectSize(Object objectToSize);
     boolean isRedefineClassesSupported( );
     void redefineClasses(ClassDefinition[ ] definitions) throws ClassNotFoundException,
     UnmodifiableClassException;
     boolean removeTransformer(ClassFileTransformer transformer);
}
```

Team LiB

UnmodifiableClassException java.lang.instrument

Java 5.0 *serializable checked*

An exception of this type is thrown from `Instrumentation.redefineClasses( )` if a requested redefinition cannot be performed. This might occur, for example, if the redefinition attempts to add o remove members from the class.

Figure 10-84. java.lang.instrument.UnmodifiableClassException


```
public class UnmodifiableClassException extends Exception {
// Public Constructors
     public UnmodifiableClassException( );
     public UnmodifiableClassException(String s);
}
```

Thrown By

`Instrumentation.redefineClasses( )`

Team LiB

Package java.lang.management

Java 5.0

This package defines "management bean" or "MXBean" interfaces for managing and monitoring a running Java virtual machine. It relies on the JMX API of the `javax.management` package, which is not covered in this book. `ManagementFactory` is the main entry point to this API; it defines static factory methods for obtaining instances of the various management bean interfaces. These instances can then be queried for specific information about the Java VM. The *jconsole* tool shipped with the Java 5.0 JDK demonstrates the capabilites of this package.

Interfaces

```
public interface ClassLoadingMXBean;
public interface CompilationMXBean;
public interface GarbageCollectorMXBean extends MemoryManagerMXBean;
public interface MemoryManagerMXBean;
public interface MemoryMXBean;
public interface MemoryPoolMXBean;
public interface OperatingSystemMXBean;
public interface RuntimeMXBean;
public interface ThreadMXBean;
```

Enumerated Types

```
public enum MemoryType;
```

Classes

```
public class ManagementFactory;
public final class ManagementPermission extends java.security.BasicPermission;
public class MemoryNotificationInfo;
public class MemoryUsage;
public class ThreadInfo;
```

ClassLoadingMXBean java.lang.management

Java 5.0

This MXBean interface defines methods for determining how many classes are currently loaded in the Java VM, how many have ever been loaded, and how many have ever been unloaded. The `setVerbose( )` method turns verbose class loading output from the VM on or off.

```
public interface ClassLoadingMXBean {
// Public Instance Methods
     int getLoadedClassCount( );
     long getTotalLoadedClassCount( );
     long getUnloadedClassCount( );
     boolean isVerbose( );
     void setVerbose(boolean value);
}
```

Returned By

`ManagementFactory.getClassLoadingMXBean( )`

CompilationMXBean java.lang.management

Java 5.0

This MXBean interface defines methods for querying the just-in-time compiler of the Java virtual machine. `getName( )` returns an identifying name for the compiler. If the implementation tracks compilation time, `getTotalCompilationTime( )` returns the approximate total compilation time in milliseconds.

```
public interface CompilationMXBean {
// Public Instance Methods
     String getName( );
     long getTotalCompilationTime( );
     boolean isCompilationTimeMonitoringSupported( );
}
```

Returned By

`ManagementFactory.getCompilationMXBean( )`

GarbageCollectorMXBean java.lang.management

Java 5.0

This MXBean interface allows monitoring of the number of garbage collections that have occurred and the approximate time they consumed in milliseconds. The methods return -1 to indicate that the garbage collector does not maintain those statistics. Note that VM implementations commonly have more than one garbage collector and use different collection strategies for new objects and old objects. Note also that this is a subinterface of `MemoryManagerMXBean`.

Figure 10-85. java.lang.management.GarbageCollectorMXBean


```
public interface GarbageCollectorMXBean extends MemoryManagerMXBean {
// Public Instance Methods
     long getCollectionCount( );
     long getCollectionTime( );
}
```

Team LiB

ManagementFactory java.lang.management

Java 5.0

This class provides the main entry point into the java.lang.management API. The static factory methods convenient way to obtain instances of the various MXBean interfaces for the currently running Java virtua returned instances can then be queried to monitor memory usage, class loading, and other details of vir performance.

To obtain an MXBean for a Java virtual machine running in another process, use the newPlatformMXBean specifying a javax.management.MBeanServerConnection as well as the name and type of the desired M constant fields of this class define the names of the available beans. Note that the javax.management pa scope of this quick reference.

```
public class ManagementFactory {
// No Constructor
// Public Constants
     public static final String CLASS_LOADING_MXBEAN_NAME;         ="java.lang:type=Cla
     public static final String COMPILATION_MXBEAN_NAME;           ="java.lang:type=Com
     public static final String GARBAGE_COLLECTOR_MXBEAN_DOMAIN_TYPE; ="java.lang:type=
     public static final String MEMORY_MANAGER_MXBEAN_DOMAIN_TYPE; ="java.lang:type=Mem
     public static final String MEMORY_MXBEAN_NAME;                ="java.lang:type=Mem
     public static final String MEMORY_POOL_MXBEAN_DOMAIN_TYPE;    ="java.lang:type=Mem
     public static final String OPERATING_SYSTEM_MXBEAN_NAME;      ="java.lang:type=Ope
     public static final String RUNTIME_MXBEAN_NAME;               ="java.lang:type=Run
     public static final String THREAD_MXBEAN_NAME;                ="java.lang:type=Thr
// Public Class Methods
     public static ClassLoadingMXBean getClassLoadingMXBean( );
     public static CompilationMXBean getCompilationMXBean( );
     public static java.util.List<GarbageCollectorMXBean> getGarbageCollectorMXBeans( )
     public static java.util.List<MemoryManagerMXBean> getMemoryManagerMXBeans( );
     public static MemoryMXBean getMemoryMXBean( );
     public static java.util.List<MemoryPoolMXBean> getMemoryPoolMXBeans( );
     public static OperatingSystemMXBean getOperatingSystemMXBean( );
     public static javax.management.MBeanServer getPlatformMBeanServer( );     synchron
     public static RuntimeMXBean getRuntimeMXBean( );
     public static ThreadMXBean getThreadMXBean( );
     public static <T> T newPlatformMXBeanProxy(javax.management.
MBeanServerConnection connection, String mxbeanName, Class<T> mxbeanInterface)
throws java.io.IOException;
}
```

ManagementPermission java.lang.management

Java 5.0 *serializable permission*

This `java.security.Permission` subclass governs access to the Java VM monitoring and management of this package. The two defined targets for this permission are `control` , which grants permission to ma VM, and `monitor` , which grants permission to monitor VM state. Fine-grained control over individual MX not supported.

Figure 10-86. java.lang.management.ManagementPermission


```
public final class ManagementPermission extends java.security.BasicPermission {
// Public Constructors
     public ManagementPermission(String name);
     public ManagementPermission(String name, String actions) throws IllegalArgumentExc
}
```

Team LiB

MemoryManagerMXBean java.lang.management

Java 5.0

This MXBean interface allows monitoring of a single memory manager (such as a garbage collector) in a Java VM. A VM implementation typically has more than one memory manager, and the `ManagementFactory` method `getMemoryManagerMXBeans( )` returns a `List` of objects of this type. Some or all of the objects in the returned list will also implement the `GarbageCollectorMXBean` subinterface.

Each memory manager may manage one or more memory pools, and `getMemoryPoolNames( )` returns the names of these pools. See also `ManagementFactory.getMemoryPoolMXBeans( )` and `MemoryPoolMXBean`.

```
public interface MemoryManagerMXBean {
// Public Instance Methods
     String[ ] getMemoryPoolNames( );
     String getName( );
     boolean isValid( );
}
```

Implementations

`GarbageCollectorMXBean`

MemoryMXBean java.lang.management

Java 5.0

This MXBean interface allows monitoring of current memory usage information forheap memory (allocated objects) and nonheap memory (loaded classes and libraries). It also allows the garbage collector to be explicitly invoked and verbose garbage-collection related output to be turned on or off

See MemoryUsage for details on how memory usage information is returned. See also MemoryPoolMXBean for a way to obtain both current and peak memory usage for individual memory pools.

```
public interface MemoryMXBean {
// Public Instance Methods
     void gc( );
     MemoryUsage getHeapMemoryUsage( );
     MemoryUsage getNonHeapMemoryUsage( );
     int getObjectPendingFinalizationCount( );
     boolean isVerbose( );
     void setVerbose(boolean value);
}
```

Returned By

ManagementFactory.getMemoryMXBean( )

Team LiB

MemoryNotificationInfo java.lang.management

Java 5.0

This class holds information about memory usage in a given memory pool and is generated when that u: crosses a threshold specified by a `MemoryPoolMXBean` . Use the `from( )` method to construct a `MemoryNotificationInfo` object from the user data of a `javax.management.Notification` object. Noti and the `javax.management` package are beyond the scope of this book.

```
public class MemoryNotificationInfo {
// Public Constructors
     public MemoryNotificationInfo(String poolName, MemoryUsage usage, long count);
// Public Constants
     public static final String MEMORY_COLLECTION_THRESHOLD_EXCEEDED;
     ="java.management.memory.collection.threshold.exceeded"
     public static final String MEMORY_THRESHOLD_EXCEEDED;
     ="java.management.memory.threshold.exceeded"
// Public Class Methods
     public static MemoryNotificationInfo from(javax.management.openmbean.CompositeData
// Public Instance Methods
     public long getCount( );
     public String getPoolName( );
     public MemoryUsage getUsage( );
}
```

MemoryPoolMXBean java.lang.management

Java 5.0

This MXBean interface allows monitoring of the current and peak memory usage for a single memory pool. Typical Java VM implementations segregate garbage-collected heap memory into two or more memory pools based on the age of the objects. Obtain a `List` of `MemoryPoolMXBean` instances with `ManagementFactory.getMemoryPoolMXBeans( )`. `getName( )` and `getType( )` return the name and type of each pool. `getUsage( )` and `getPeakUsage( )` return the current and peak memory usage for the pool in the form of a `MemoryUsage` object.

If `isUsageThresholdSupported( )` returns `TRue`, you can use `setUsageThreshold( )` to define a memory usage threshold. The `MemoryPoolMXBean` then keeps track of threshold crossings and issues notifications through the `javax.management.NotificationEmitter` API. You can register a `javax.management.NotificationListener` to receive these notifications. (Note that the `javax.management` package is not covered in this book.) Use `setCollectionUsageThreshold( )` instead to receive notifications when memory usage exceeds a specified threshold after a garbage collection pass.

```
public interface MemoryPoolMXBean {
// Public Instance Methods
     MemoryUsage getCollectionUsage( );
     long getCollectionUsageThreshold( );
     long getCollectionUsageThresholdCount( );
     String[ ] getMemoryManagerNames( );
     String getName( );
     MemoryUsage getPeakUsage( );
     MemoryType getType( );
     MemoryUsage getUsage( );
     long getUsageThreshold( );
     long getUsageThresholdCount( );
     boolean isCollectionUsageThresholdExceeded( );
     boolean isCollectionUsageThresholdSupported( );
     boolean isUsageThresholdExceeded( );
     boolean isUsageThresholdSupported( );
     boolean isValid( );
     void resetPeakUsage( );
     void setCollectionUsageThreshold(long threhsold);
     void setUsageThreshold(long threshold);
}
```

MemoryType java.lang.management

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type define the type of a memory pool as either heap or nonheap memory. See `MemoryPoolMXBean.getType( )`.

Figure 10-87. java.lang.management.MemoryType


```
public enum MemoryType {
// Enumerated Constants
     HEAP,
     NON_HEAP;
// Public Class Methods
     public static MemoryType valueOf(String name);
     public static final MemoryType[ ] values( );
// Public Methods Overriding Enum
     public String toString( );
}
```

Returned By

`MemoryPoolMXBean.getType( )`

Team LiB

MemoryUsage java.lang.management

Java 5.0

A MemoryUsage object represents a snapshot of memory usage for a specified type or pool of memory. Memory usage is measured as four long values, each of which represents a number of bytes. getInit( ) returns the initial amount of memory that the Java VM requests from the operating system. getUsed( ) returns the actual number of bytes used. getCommitted( ) returns the number of bytes that the operating system has committed to the Java VM for this pool. These bytes may not all be in use, but they are not available to other processes running on the system. getMax( ) returns the maximum amount of memory that the Java VM requests for this pool. getMax( ) returns -1 if there is no defined maximum value.

```
public class MemoryUsage {
// Public Constructors
     public MemoryUsage(long init, long used, long committed, long max);
// Public Class Methods
     public static MemoryUsage from(javax.management.openmbean.CompositeData cd);
// Public Instance Methods
     public long getCommitted( );
     public long getInit( );
     public long getMax( );
     public long getUsed( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

MemoryNotificationInfo.MemoryNotificationInfo( )

Returned By

MemoryMXBean.{getHeapMemoryUsage( ), getNonHeapMemoryUsage( )}, MemoryNotificationInfo.getUsage( ), MemoryPoolMXBean.{getCollectionUsage( ), getPeakUsage( ), getUsage( )}

Team LiB

OperatingSystemMXBean java.lang.management

Java 5.0

This MXBean interface allows queries of the operating system name, version, and CPU architecture as well as the number of available CPUs.

```
public interface OperatingSystemMXBean {
// Public Instance Methods
     String getArch( );
     int getAvailableProcessors( );
     String getName( );
     String getVersion( );
}
```

Returned By

`ManagementFactory.getOperatingSystemMXBean( )`

Team LiB

RuntimeMXBean java.lang.management

Java 5.0

This MXBean interface provides access to the runtime configuration of the Java virtual machine, including system properties, command-line arguments, class path, virtual machine vendor and version, and so on. `getUptime( )` returns the uptime of the virtual machine in milliseconds.

```
public interface RuntimeMXBean {
// Public Instance Methods
     String getBootClassPath( );
     String getClassPath( );
     java.util.List<String> getInputArguments( );
     String getLibraryPath( );
     String getManagementSpecVersion( );
     String getName( );
     String getSpecName( );
     String getSpecVendor( );
     String getSpecVersion( );
     long getStartTime( );
     java.util.Map<String,String> getSystemProperties( );
     long getUptime( );
     String getVmName( );
     String getVmVendor( );
     String getVmVersion( );
     boolean isBootClassPathSupported( );
}
```

Returned By

`ManagementFactory.getRuntimeMXBean( )`

ThreadInfo java.lang.management

Java 5.0

This class represents information about a thread from a `ThreadMXBean`. Some information, such as thread name, id, state, and stack trace are also available through the `java.lang.Thread` object. Other more useful information includes the object upon which a thread is waiting and the owner of the lock that the thread is trying to acquire. If `THReadMXBean` indicates that thread contention monitoring is supported and enabled, the `ThreadInfo` methods `getBlockedCount( )` and `getBlockedTime( )` return the number of times the thread has blocked or waited and the amount of time it has spent in the blocked and waiting states.

```
public class ThreadInfo {
// No Constructor
// Public Class Methods
     public static ThreadInfo from(javax.management.openmbean.CompositeData cd);
// Public Instance Methods
     public long getBlockedCount( );
     public long getBlockedTime( );
     public String getLockName( );
     public long getLockOwnerId( );
     public String getLockOwnerName( );
     public StackTraceElement[ ] getStackTrace( );
     public long getThreadId( );
     public String getThreadName( );
     public Thread.State getThreadState( );
     public long getWaitedCount( );
     public long getWaitedTime( );
     public boolean isInNative( );
     public boolean isSuspended( );
// Public Methods Overriding Object
     public String toString( );
}
```

Returned By

`ThreadMXBean.getThreadInfo( )`

Team LiB

ThreadMXBean java.lang.management

Java 5.0

This MXBean interface allows monitoring of thread usage in a Java VM. A number of methods, such as getThreadCount( ) and getPeakThreadCount( ), return information about all running threads. Other methods return information about individual threads. Threads are identified by their thread id, which is a long integer. getAllThreadIds( ) returns all ids as an array of long. Complete information, including stack trace, about a thread or set of threads can be obtained with the getTHReadInfo( ) methods, which return ThreadInfo objects.

If isThreadCpuTimeSupported( ) returns TRue, you can enable thread timing with setThreadCpuTimeEnabled( ) and query the runtime of a specific thread with getThreadCpuTime( ) and getThreadUserTime( ). The values returned by these methods are measured in nanoseconds.

One of the potentially most useful methods of this interface is findMonitorDeadlockedThreads( ) . It looks for cycles of threads that are deadlocked waiting to lock objects whose locks are held by other threads in the cycle.

```
public interface ThreadMXBean {
// Public Instance Methods
     long[ ] findMonitorDeadlockedThreads( );
     long[ ] getAllThreadIds( );
     long getCurrentThreadCpuTime( );
     long getCurrentThreadUserTime( );
     int getDaemonThreadCount( );
     int getPeakThreadCount( );
     int getThreadCount( );
     long getThreadCpuTime(long id);
     ThreadInfo getThreadInfo(long id);
     ThreadInfo[ ] getThreadInfo(long[ ] ids);
     ThreadInfo[ ] getThreadInfo(long[ ] ids, int maxDepth);
     ThreadInfo getThreadInfo(long id, int maxDepth);
     long getThreadUserTime(long id);
     long getTotalStartedThreadCount( );
     boolean isCurrentThreadCpuTimeSupported( );
     boolean isThreadContentionMonitoringEnabled( );
     boolean isThreadContentionMonitoringSupported( );
     boolean isThreadCpuTimeEnabled( );
     boolean isThreadCpuTimeSupported( );
     void resetPeakThreadCount( );
     void setThreadContentionMonitoringEnabled(boolean enable);
     void setThreadCpuTimeEnabled(boolean enable);
}
```

Returned By

`ManagementFactory.getThreadMXBean( )`

Package java.lang.ref

Java 1.2

The `java.lang.ref` package defines classes that allow Java programs to interact with the Java garbage collector. A `Reference` represents an indirect reference to an arbitrary object, known as the *referent*. `SoftReference`, `WeakReference`, and `PhantomReference` are three concrete subclasses of `Reference` that interact with the garbage collector in different ways, as explained in the individual class descriptions that follow. `ReferenceQueue` represents a linked list of `Reference` objects. Any `Reference` object may have a `ReferenceQueue` associated with it. A `Reference` object is *enqueued* on its `ReferenceQueue` at some point after the garbage collector determines that the referent object has become appropriately unreachable. (The exact level of unreachability depends on the type of `Reference` being used.) An application can monitor a `ReferenceQueue` to determine when referent objects enter a new reachability status.

Using the mechanisms defined in this package, you can implement a cache that grows and shrinks in size according to the amount of available system memory. Or, you can implement a hashtable that associates auxiliary information with arbitrary objects, but does not prevent those objects from being garbage-collected if they are otherwise unused. The mechanisms provided by this package are low-level ones, however, and typical applications do not use `java.lang.ref` directly. Instead, they rely on higher-level utilities built on top of the package. See `java.util.WeakHashMap` for one example.

In Java 5.0, the classes in this package have all been made into generic types. The type variable *T* represents the type of the object that is referred to.

Classes

```
public abstract class Reference<T>;
   public class PhantomReference<T> extends Reference<T>;
   public class SoftReference<T> extends Reference<T>;
   public class WeakReference<T> extends Reference<T>;
public class ReferenceQueue<T>;
```

PhantomReference<T> java.lang.ref

Java 1.2

This class represents a reference to an object that does not prevent the referent object from being finalized by the garbage collector. When (or at some point after) the garbage collector determines that there are no more hard (direct) references to the referent object, that there are no `SoftReference` or `WeakReference` objects that refer to the referent, and that the referent has been finalized, it enqueues the `PhantomReference` object on the `ReferenceQueue` specified when the `PhantomReference` was created. This serves as notification that the object has been finalized and provides one last opportunity for any required cleanup code to be run.

To prevent a `PhantomReference` object from resurrecting its referent object, its `get( )` method always returns `null`, both before and after the `PhantomReference` is enqueued. Nevertheless, a `PhantomReference` is not automatically cleared when it is enqueued, so when you remove a `PhantomReference` from a `ReferenceQueue`, you must call its `clear( )` method or allow the `PhantomReference` object itself to be garbage-collected.

This class provides a more flexible mechanism for object cleanup than the `finalize( )` method does. Note that in order to take advantage of it, it is necessary to subclass `PhantomReference` and define a method to perform the desired cleanup. Furthermore, since the `get( )` method of a `PhantomReference` always returns `null`, such a subclass must also store whatever data is required for the cleanup operation.

Figure 10-88. java.lang.ref.PhantomReference<T>

```
public class PhantomReference<T> extends Reference<T> {
// Public Constructors
     public PhantomReference(T referent, ReferenceQueue<? super T> q);
// Public Methods Overriding Reference
     public T get( );                                                   constant
}
```

Reference<T> java.lang.ref

Java 1.2

This abstract class represents some type of indirect reference to a referent. `get( )` returns the referent if the reference has not been explicitly cleared by the `clear( )` method or implicitly cleared by the garbage collector. There are three concrete subclasses of `Reference`. The garbage collector handles these subclasses differently and clears their references under different circumstances.

Each of the subclasses of `Reference` defines a constructor that allows a `ReferenceQueue` to be associated with the `Reference` object. The garbage collector places `Reference` objects onto their associated `ReferenceQueue` objects to provide notification about the state of the referent object. `isEnqueued( )` tests whether a `Reference` has been placed on the associated queue, and `enqueue( )` explicitly places it on the queue. `enqueue( )` returns `false` if the `Reference` object does not have an associated `ReferenceQueue`, or if it has already been enqueued.

```
public abstract class Reference<T> {
// No Constructor
// Public Instance Methods
     public void clear( );
     public boolean enqueue( );
     public T get( );
     public boolean isEnqueued( );
}
```

Subclasses

`PhantomReference`, `SoftReference`, `WeakReference`

Returned By

`ReferenceQueue.{poll( ), remove( )}`

Team LiB

ReferenceQueue<T> java.lang.ref

Java 1.2

This class represents a queue (or linked list) of Reference objects that have been enqueued because the garbage collector has determined that the referent objects to which they refer are no longer adequately reachable. It serves as a notification system for object-reachability changes. Use poll( ) to return the first Reference object on the queue; the method returns null if the queue is empty. Use remove( ) to return the first element on the queue, or, if the queue is empty, to wait for a Reference object to be enqueued. You can create as many ReferenceQueue objects as needed. Specify a ReferenceQueue for a Reference object by passing it to the SoftReference( ) , WeakReference( ) , or PhantomReference(constructor.

A ReferenceQueue is required to use PhantomReference objects. It is optional with SoftReference and WeakReference objects; for these classes, the get( ) method returns null if the referent object is no longer adequately reachable.

```
public class ReferenceQueue<T> {
// Public Constructors
     public ReferenceQueue( );
// Public Instance Methods
     public Reference<? extends T> poll( );
     public Reference<? extends T> remove( ) throws InterruptedException;
     public Reference<? extends T> remove(long timeout) throws IllegalArgumentException,
InterruptedException;
}
```

Passed To

PhantomReference.PhantomReference( ) , SoftReference.SoftReference( ) , WeakReference.WeakReference( )

SoftReference<T> java.lang.ref

Java 1.2

This class represents a soft reference to an object. A SoftReference is not cleared while there are any remaining hard (direct) references to the referent. Once the referent is no longer in use (i.e., there are no remaining hard references to it), the garbage collector may clear the SoftReference to the referent at any time. However, the garbage collector does not clear a SoftReference until it determines that system memory is running low. In particular, the Java VM never throws an OutOfMemoryError without first clearing all soft references and reclaiming the memory of the referents. The VM may (but is not required to) clear soft references according to a least-recently-used ordering.

If a SoftReference has an associated ReferenceQueue, the garbage collector enqueues the SoftReference at some time after it clears the reference.

SoftReference is particularly useful for implementing object-caching systems that do not have a fixed size, but grow and shrink as available memory allows.

Figure 10-89. java.lang.ref.SoftReference<T>

```
public class SoftReference<T> extends Reference<T> {
// Public Constructors
     public SoftReference(T referent);
     public SoftReference(T referent, ReferenceQueue<? super T> q);
// Public Methods Overriding Reference
     public T get( );
}
```

WeakReference<T> java.lang.ref

Java 1.2

This class refers to an object in a way that does not prevent that referent object from being finalized and reclaimed by the garbage collector. When the garbage collector determines that there are no more hard (direct) references to the object, and that there are no `SoftReference` objects that refer to the object, it clears the `WeakReference` and marks the referent object for finalization. At some point after this, it also enqueues the `WeakReference` on its associated `ReferenceQueue`, if there is one, in order to provide notification that the referent has been reclaimed.

`WeakReference` is used by `java.util.WeakHashMap` to implement a hashtable that does not prevent the hashtable key object from being garbage-collected. `WeakHashMap` is useful when you want to associate auxiliary information with an object but do not want to prevent the object from being reclaimed.

Figure 10-90. java.lang.ref.WeakReference<T>

```
public class WeakReference<T> extends Reference<T> {
// Public Constructors
     public WeakReference(T referent);
     public WeakReference(T referent, ReferenceQueue<? super T> q);

}
```

Package java.lang.reflect

Java 1.1

The java.lang.reflect package contains the classes and interfaces that, along with java.lang.Class, comprise the Java Reflection API.

The Constructor, Field, and Method classes represent the constructors, fields, and methods of a class. Because these types all represent members of a class, they each implement the Member interface, which defines a simple set of methods that can be invoked for any class member. These classes allow information about the class members to be obtained, methods and constructors to be invoked, and fields to be queried and set.

Class member modifiers are represented as integers that specify a number of bit flags. The Modifier class defines static methods that help interpret the meanings of these flags. The Array class defines static methods for creating arrays and reading and writing array elements.

As of Java 1.3, the Proxy class allows the dynamic creation of new Java classes that implement a specified set of interfaces. When an interface method is invoked on an instance of such a proxy class the invocation is delegated to an InvocationHandler object.

There have been a number of changes to this package to support the new language features of Java 5.0. The most important changes are support for querying the generic signature of classes, methods, constructors, and fields. Class, Method and Constructor implement the new GenericDeclaration interface, which provides access to the TypeVariable declarations of generic classes, methods, and constructors. In general, the package has been modified to add new generic versions of methods like Field.getType( ) and Method.getParameterTypes( ). Instead of returning Class objects, the new generic methods, like Field.getGenericType( ) and Method.getGenericParameterTypes( ), return Type objects. The Type interface is new in Java 5.0, and represents any kind of generic or nongeneric type. Class implements Type, so a Type object may simply be an ordinary Class. Type is also the super-interface for four other new interfaces: ParameterizedType, TypeVariable, WildcardType and GenericArrayType. A Type object that is not a Class should be an instance of one of these other interfaces, representing a generic type of some sort.

Support for reflection on annotations is provided by the AnnotatedElement interface which is implemented by Class, Package, Method, Constructor and Field. Method and Constructor also have new getParameterAnnotations( ) for querying annotations on method parameters. Other, more minor changes in Java 5.0 include the isEnumConstant( ) method of Field and the isVarArgs( ) method of Method and Constructor.

Interfaces

```
public interface AnnotatedElement;
public interface GenericArrayType extends Type;
public interface GenericDeclaration;
```

```
public interface InvocationHandler;
public interface Member;
public interface ParameterizedType extends Type;
public interface Type;
public interface TypeVariable<D extends GenericDeclaration> extends Type;
public interface WildcardType extends Type;
```

Classes

```
public class AccessibleObject implements AnnotatedElement;
   public final class Constructor<T> extends AccessibleObject implements
GenericDeclaration, Member;
   public final class Field extends AccessibleObject implements Member;
   public final class Method extends AccessibleObject implements
GenericDeclaration, Member;
public final class Array;
public class Modifier;
public class Proxy implements Serializable;
public final class ReflectPermission extends java.security.BasicPermission;
```

Exceptions

```
public class InvocationTargetException extends Exception;
public class MalformedParameterizedTypeException extends RuntimeException;
public class UndeclaredThrowableException extends RuntimeException;
```

Errors

```
public class GenericSignatureFormatError extends ClassFormatError;
```

Team LiB

AccessibleObject java.lang.reflect

Java 1.2

This class is the superclass of the Method, Constructor, and Field classes; its methods provide a mechanism for trusted applications to work with private, protected, and default visibility members that would otherwise not be accessible through the Reflection API. This class is new as of Java 1.2; ir Java 1.1, the Method, Constructor, and Field classes extended Object directly.

To use the java.lang.reflect package to access a member to which your code would not normally have access, pass TRue to the setAccessible( ) method. If your code has an appropriate ReflectPermission (such as "suppressAccessChecks"), this allows access to the member as if it were declared public. The static version of setAccessible( ) is a convenience method that sets the accessible flag for an array of members but performs only a single security check.

Figure 10-91. java.lang.reflect.AccessibleObject

```
public class AccessibleObject implements AnnotatedElement {
// Protected Constructors
     protected AccessibleObject( );
// Public Class Methods
     public static void setAccessible(AccessibleObject[ ] array, boolean flag)
     throws SecurityException;
// Public Instance Methods
     public boolean isAccessible( );
     public void setAccessible(boolean flag) throws SecurityException;
// Methods Implementing AnnotatedElement
5.0  public <T extends java.lang.annotation.Annotation> T getAnnotation(Class<T>
annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getAnnotations( );
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
5.0  public boolean isAnnotationPresent(Class<? extends java.lang.annotation.
Annotation> annotationClass);
}
```

Subclasses

Constructor, Field, Method

Team LiB

AnnotatedElement java.lang.reflect

Java 5.0

This interface is implemented by the classes representing program elements that can be annotated in Jav 5.0: `java.lang.Class` , `java.lang.Package` , `Method` , `Constructor` , and `Field` . The methods of this interface allow you to test for the presence of a specific annotation, query an annotation object of a spe type, or query all annotations present on an annotated element. `getdeclaredAnnotations( )` differs fro `getAnnotations( )` in that it does not include inherited annotations. (See the `java.lang.annotation.Inherited` meta-annotation.) If no annotations are present, `getAnnotations(` and `geTDeclaredAnnotations( )` return an array of length zero rather than `null` . It is safe to modify t arrays returned by these methods.

See also the `getParameterAnnotations( )` methods of `Method` and `Constructor` , which provide acces annotations on method parameters.

```
public interface AnnotatedElement {
// Public Instance Methods
     <T extends java.lang.annotation.Annotation> T getAnnotation(Class<T> annotationTyp
     java.lang.annotation.Annotation[ ] getAnnotations( );
     java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
     boolean isAnnotationPresent(Class<? extends java.lang.annotation.Annotation>
     annotationType);
}
```

Implementations

`Class` , `Package` , `AccessibleObject`

Team LiB

Array java.lang.reflect

Java 1.1

This class contains methods that allow you to set and query the values of array elements, to determine the length of an array, and to create new instances of arrays. Note that the Array class can manipulate only array values, not array types; Java data types, including array types, are represented by java.lang.Class. Since the Array class represents a Java value, unlike the Field, Method, and Constructor classes, which represent class members, the Array class is significantly different (despite some surface similarities) from those other classes in this package. Most notably, all the methods of Array are static and apply to all array values, not just a specific field, method, or constructor.

The get( ) method returns the value of the specified element of the specified array as an Object. If the array elements are of a primitive type, the value is converted to a wrapper object before being returned. You can also use getInt( ) and related methods to query array elements and return them as specific primitive types. The set( ) method and its primitive type variants perform the opposite operation. Also, the getLength( ) method returns the length of the array.

The newInstance( ) methods create new arrays. One version of this method is passed the number of elements in the array and the type of those elements. The other version of this method creates multidimensional arrays. Besides specifying the component type of the array, it is passed an array of numbers. The length of this array specifies the number of dimensions for the array to be created, and the values of each of the array elements specify the size of each dimension of the created array.

```
public final class Array {
// No Constructor
// Public Class Methods
     public static Object get(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static boolean getBoolean(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static byte getByte(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static char getChar(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static double getDouble(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static float getFloat(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static int getInt(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static int getLength(Object array)
throws IllegalArgumentException;     native
     public static long getLong(Object array, int index)
```

```
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static short getShort(Object array, int index)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static Object newInstance(Class<?> componentType, int length)
throws NegativeArraySizeException;
     public static Object newInstance(Class<?> componentType, int[ ] dimensions)
throws IllegalArgumentException, NegativeArraySizeException;
     public static void set(Object array, int index, Object value)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setBoolean(Object array, int index, boolean z)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setByte(Object array, int index, byte b)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setChar(Object array, int index, char c)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setDouble(Object array, int index, double d)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setFloat(Object array, int index, float f)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setInt(Object array, int index, int i)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setLong(Object array, int index, long l)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
     public static void setShort(Object array, int index, short s)
throws IllegalArgumentException, ArrayIndexOutOfBoundsException;     native
}
```

Team LiB

Constructor<T> java.lang.reflect

Java 1.1

This class represents a constructor method of a class. Instances of `Constructor` are obtained by calling `getConstructor( )` and related methods of `java.lang.Class`. `Constructor` implements the `Member` interface, so you can use the methods of that interface to obtain the constructor name, modifiers, and declaring class. In addition, `getParameterTypes( )` and `getExceptionTypes( )` also return important information about the represented constructor.

In addition to these methods that return information about the constructor, the `newInstance( )` method allows the constructor to be invoked with an array of arguments in order to create a new instance of the class that declares the constructor. If any of the arguments to the constructor are of primitive types, they must be converted to their corresponding wrapper object types to be passed to `newInstance( )`. If the constructor causes an exception, the `THRowable` object it throws is wrapped within the `InvocationTargetException` that is thrown by `newInstance( )`. Note that `newInstance( )` is much more useful than the `newInstance( )` method of `java.lang.Class` because it can pass arguments to the constructor.

`Constructor` has been modified in Java 5.0 to support generics, annotations, and varargs. The changes are the same as the Java 5.0 changes to the `Method` class. Additionally, `Constructor` has been made a generic type in Java 5.0. The type variable *T* represents the type that the constructor constructs, and is used as the return type of the `newInstance( )` method.

Figure 10-92. java.lang.reflect.Constructor<T>

```
public final class Constructor<T> extends AccessibleObject implements
GenericDeclaration, Member {
// No Constructor
// Public Instance Methods
     public Class<?>[ ] getExceptionTypes( );
5.0  public Type[ ] getGenericExceptionTypes( );
5.0  public Type[ ] getGenericParameterTypes( );
5.0  public java.lang.annotation.Annotation[ ][ ] getParameterAnnotations( );
     public Class<?>[ ] getParameterTypes( );
5.0  public boolean isVarArgs( );
     public T newInstance(Object ... initargs)
throws InstantiationException, IllegalAccessException, IllegalArgumentException,
InvocationTargetException;
```

```
5.0  public String toGenericString( );
// Methods Implementing GenericDeclaration
5.0  public TypeVariable<Constructor<T>>[ ] getTypeParameters( );
// Methods Implementing Member
     public Class<T> getDeclaringClass( );
     public int getModifiers( );
     public String getName( );
5.0  public boolean isSynthetic( );
// Public Methods Overriding AccessibleObject
5.0  public <T extends java.lang.annotation.Annotation> T getAnnotation
(Class<T> annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Returned By

`Class.{getConstructor( )`, `getConstructors( )`, `getdeclaredConstructor( )`, `geTDeclaredConstructors( )`, `getEnclosingConstructor( )}`

Team LiB

Field java.lang.reflect

Java 1.1

This class represents a field of a class. Instances of Field are obtained by calling the getField( ) and related methods of java.lang.Class. Field implements the Member interface, so once you have obtained a Field object, you can use getName( ), getModifiers( ), and getdeclaringClass( ) to determine the name, modifiers, and class of the field. Additionally, getType( ) returns the type of the field.

The set( ) method sets the value of the represented field for a specified object. (If the represented field is static, no object need be specified, of course.) If the field is of a primitive type, its value can be specified using a wrapper object of type Boolean, Integer, and so on, or it can be set using the setBoolean( ), setInt( ), and related methods. Similarly, the get( ) method queries the value of the represented field for a specified object and returns the field value as an Object. Various other methods query the field value and return it as various primitive types.

In Java 5.0, Field implements AnnotatedElement to support reflection on field annotations. The new getGenericType( ) method supports reflection on the generic type of fields, and isEnumConstant( ) supports fields of enum types.

Figure 10-93. java.lang.reflect.Field

```
public final class Field extends AccessibleObject implements Member {
// No Constructor
// Public Instance Methods
     public Object get(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public boolean getBoolean(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public byte getByte(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public char getChar(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public double getDouble(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public float getFloat(Object obj)
throws IllegalArgumentException, IllegalAccessException;
5.0  public Type getGenericType( );
```

```
     public int getInt(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public long getLong(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public short getShort(Object obj)
throws IllegalArgumentException, IllegalAccessException;
     public Class<?> getType( );
5.0  public boolean isEnumConstant( );
     public void set(Object obj, Object value)
throws IllegalArgumentException, IllegalAccessException;
     public void setBoolean(Object obj, boolean z)
throws IllegalArgumentException, IllegalAccessException;
     public void setByte(Object obj, byte b)
throws IllegalArgumentException, IllegalAccessException;
     public void setChar(Object obj, char c)
throws IllegalArgumentException, IllegalAccessException;
     public void setDouble(Object obj, double d)
throws IllegalArgumentException, IllegalAccessException;
     public void setFloat(Object obj, float f)
throws IllegalArgumentException, IllegalAccessException;
     public void setInt(Object obj, int i)
throws IllegalArgumentException, IllegalAccessException;
     public void setLong(Object obj, long l)
throws IllegalArgumentException, IllegalAccessException;
     public void setShort(Object obj, short s)
throws IllegalArgumentException, IllegalAccessException;
5.0  public String toGenericString( );
// Methods Implementing Member
     public Class<?> getDeclaringClass( );
     public int getModifiers( );
     public String getName( );
5.0  public boolean isSynthetic( );
// Public Methods Overriding AccessibleObject
5.0  public <T extends java.lang.annotation.Annotation> T getAnnotation
(Class<T> annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Returned By

`Class.{getDeclaredField( )`, `getdeclaredFields( )`, `getField( )`, `getFields( )}`

GenericArrayType java.lang.reflect

Java 5.0

This interface extends `Type` and represents a one-dimensional array of some element `Type`. Note that in the case of multidimensional arrays, the `Type` returned by `getGenericComponentType( )` is itself a `GenericArrayType`.

Figure 10-94. java.lang.reflect.GenericArrayType


```
public interface GenericArrayType extends Type {
// Public Instance Methods
     Type getGenericComponentType( );
}
```

GenericDeclaration java.lang.reflect

Java 5.0

This interface is implemented by the classes that represent program elements that can be made generic: `java.lang.Class` as well as `Method` and `Constructor`. It provides access to the type variables declared by the generic type, method, or constructor.`getTypeParameters( )` never returns `null`: if there are no declared type variables, it returns a zero-length array.

```
public interface GenericDeclaration {
// Public Instance Methods
     TypeVariable<?>[ ] getTypeParameters( );
}
```

Implementations

`Class`, `Constructor`, `Method`

Returned By

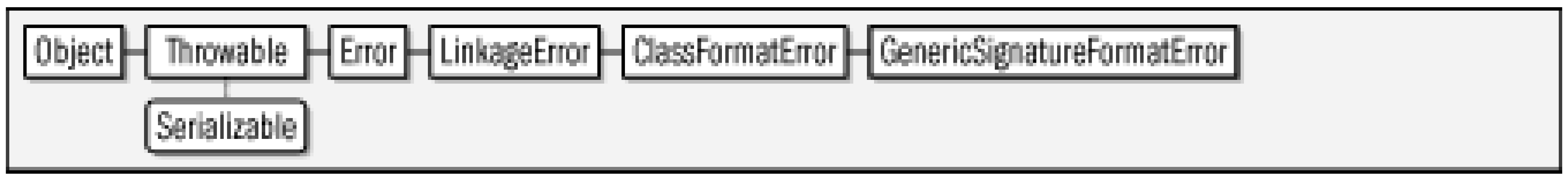
`TypeVariable.getGenericDeclaration( )`

GenericSignatureFormatError java.lang.reflect

Java 5.0 *serializable error*

An error of this type is thrown if the Java interpreter tries to load a class file that contains malformed generic signature information.

Figure 10-95. java.lang.reflect.GenericSignatureFormatError




```
public class GenericSignatureFormatError extends ClassFormatError {
// Public Constructors
     public GenericSignatureFormatError( );
}
```

InvocationHandler java.lang.reflect

Java 1.3

This interface defines a single invoke( ) method that is called whenever a method is invoked on a dynamically created Proxy object. Every Proxy object has an associated InvocationHandler object that is specified when the Proxy is instantiated. All method invocations on the proxy object are translated into calls to the invoke( ) method of the InvocationHandler.

The first argument to invoke( ) is the Proxy object through which the method was invoked. The second argument is a Method object that represents the method that was invoked. Call the geTDeclaringClass( ) method of this Method object to determine the interface in which the method was declared. This may be a superinterface of one of the specified interfaces or even java.lang.Object when the method invoked is toString( ), hashCode( ), or one of the other Object methods. The third argument to invoke( ) is the array of method arguments. Any primitive type arguments are wrapped in their corresponding object wrappers (e.g., Boolean, Integer, Double).

The value returned by invoke( ) becomes the return value of the proxy object method invocation and must be of an appropriate type. If the proxy object method returns a primitive type, invoke( ) should return an instance of the corresponding wrapper class. invoke( ) can throw any unchecked (i.e., runtime) exceptions or any checked exceptions declared by the proxy object method. If invoke( ) throws a checked exception that is not declared by the proxy object, that exception is wrapped within an unchecked UndeclaredThrowableException that is thrown in its place.

```
public interface InvocationHandler {
// Public Instance Methods
     Object invoke(Object proxy, Method method, Object[ ] args) throws Throwable;
}
```

Passed To

java.lang.reflect.Proxy.{newProxyInstance( ), Proxy( )}

Returned By

java.lang.reflect.Proxy.getInvocationHandler( )

Type Of

java.lang.reflect.Proxy.h

InvocationTargetException java.lang.reflect

Java 1.1 *serializable checked*

An object of this class is thrown by `Method.invoke( )` and `Constructor.newInstance( )` when an exception is thrown by the method or constructor invoked through those methods. The `InvocationTargetException` class serves as a wrapper around the object that was thrown; that object can be retrieved with the `getTargetException( )` method. In Java 1.4 and later, all exceptions can be "chained" in this way, and `getTargetException( )` is superseded by the more general `getCause( )` method.

Figure 10-96. java.lang.reflect.InvocationTargetException


```
public class InvocationTargetException extends Exception {
// Public Constructors
     public InvocationTargetException(Throwable target);
     public InvocationTargetException(Throwable target, String s);
// Protected Constructors
     protected InvocationTargetException( );
// Public Instance Methods
     public Throwable getTargetException( );
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );
}
```

Thrown By

`Constructor.newInstance( )`, `Method.invoke( )`

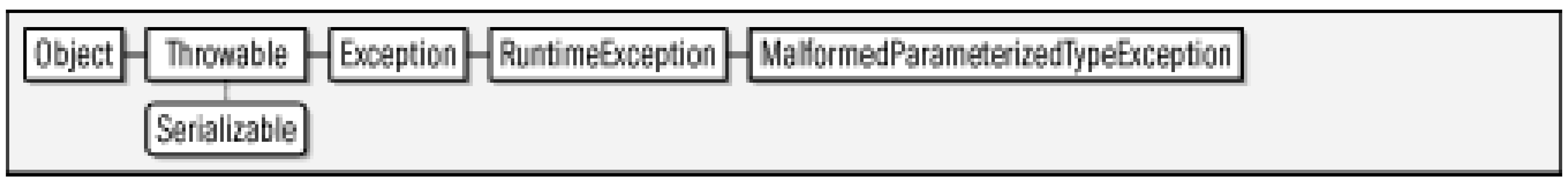
Team LiB

MalformedParameterizedTypeException java.lang.reflect

Java 5.0 *serializable unchecked*

An exception of this type is thrown during reflection if the generic type information contained in a class file is syntactically correct but semantically wrong. An example would be if the number of type parameters in a `ParameterizedType` differs from the number of type variables declared by the generic type. See also `GenericSignatureFormatError`. Although this type is not an `Error`, it does indicate a malformed class file and should not arise in common practice.

Figure 10-97. java.lang.reflect.MalformedParameterizedTypeException




```
public class MalformedParameterizedTypeException extends RuntimeException {
// Public Constructors
     public MalformedParameterizedTypeException( );
}
```

Member java.lang.reflect

Java 1.1

This interface defines the methods shared by all members (fields, methods, and constructors) of a class. `getName( )` returns the name of the member, `getModifiers( )` returns its modifiers, and `getdeclaringClass( )` returns the `Class` object that represents the class of which the member is a part. `isSynthetic( )` returns `TRue` if the member is one that does not appear in the source code but was introduced by the compiler.

```
public interface Member {
// Public Constants
     public static final int DECLARED;      =1
     public static final int PUBLIC;        =0
// Public Instance Methods
     Class getDeclaringClass( );
     int getModifiers( );
     String getName( );
5.0  boolean isSynthetic( );
}
```

Implementations

`Constructor`, `Field`, `Method`

Team LiB

Method java.lang.reflect

Java 1.1

This class represents a method. Instances of Method are obtained by calling the getMethod( ) and relate methods of java.lang.Class . Method implements the Member interface, so you can use the methods of that interface to obtain the method name, modifiers, and declaring class. In addition, getreturnType( ) getParameterTypes( ) , and getExceptionTypes( ) also return important information about the represented method.

Perhaps most importantly, the invoke( ) method allows the method represented by the Method object t be invoked with a specified array of argument values. If any of the arguments are of primitive types, the must be converted to their corresponding wrapper object types in order to be passed to invoke( ) . If th represented method is an instance method (i.e., if it is not static), the instance on which it should be invoked must also be passed to invoke( ) . The return value of the represented method is returned by invoke( ) . If the return value is a primitive value, it is first converted to the corresponding wrapper ty If the invoked method causes an exception, the Throwable object it throws is wrapped within the InvocationTargetException that is thrown by invoke( ) .

In Java 5.0, Method implements GenericDeclaration to support reflection on the type variables defined generic methods and AnnotatedElement to support reflection on method annotations. Additionally, getParameterAnnotations( ) supports reflection on method parameter annotations. The new methods getGenericReturnType( ) , getGenericParameterTypes( ) , and getGenericExceptionTypes( ) support reflection on generic method signatures. Finally, the new isVarArgs( ) method returns true if th method was declared using Java 5.0 varargs syntax.

Figure 10-98. java.lang.reflect.Method

```
public final class Method extends AccessibleObject implements GenericDeclaration, Membe
// No Constructor
// Public Instance Methods
5.0  public Object getDefaultValue( );
     public Class<?>[ ] getExceptionTypes( );
5.0  public Type[ ] getGenericExceptionTypes( );
5.0  public Type[ ] getGenericParameterTypes( );
5.0  public Type getGenericReturnType( );
5.0  public java.lang.annotation.Annotation[ ][ ] getParameterAnnotations( );
     public Class<?>[ ] getParameterTypes( );
     public Class<?> getReturnType( );
     public Object invoke(Object obj, Object... args)
```

```
throws IllegalAccessException, IllegalArgumentException, InvocationTargetException;
5.0  public boolean isBridge( );
5.0  public boolean isVarArgs( );
5.0  public String toGenericString( );
// Methods Implementing GenericDeclaration
5.0  public TypeVariable<Method>[ ] getTypeParameters( );
// Methods Implementing Member
     public Class<?> getDeclaringClass( );
     public int getModifiers( );
     public String getName( );
5.0  public boolean isSynthetic( );
// Public Methods Overriding AccessibleObject
5.0  public <T extends java.lang.annotation.Annotation> T getAnnotation
(Class<T> annotationClass);
5.0  public java.lang.annotation.Annotation[ ] getDeclaredAnnotations( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

java.lang.annotation.AnnotationTypeMismatchException.AnnotationTypeMismatchException( )
InvocationHandler.invoke( )

Returned By

Class.{getDeclaredMethod( ) , geTDeclaredMethods( ) , getEnclosingMethod( ) , getMethod( )
getMethods( )} , java.lang.annotation.AnnotationTypeMismatchException.element( )

Modifier java.lang.reflect

Java 1.1

This class defines a number of constants and static methods that can interpret the integer values returned by the `getModifiers( )` methods of the `Field`, `Method`, and `Constructor` classes. The `isPublic( )` , `isAbstract( )`, and related methods return `true` if the modifier value includes the specified modifier; otherwise, they return `false`. The constants defined by this class specify the various bit flags used in the modifiers value. You can use these constants to test for modifiers if you want to perform your own boolean algebra.

```
public class Modifier {
// Public Constructors
     public Modifier( );
// Public Constants
     public static final int ABSTRACT;     =1024
     public static final int FINAL;        =16
     public static final int INTERFACE;    =512
     public static final int NATIVE;       =256
     public static final int PRIVATE;      =2
     public static final int PROTECTED;    =4
     public static final int PUBLIC;       =1
     public static final int STATIC;       =8
1.2  public static final int STRICT;   =2048
     public static final int SYNCHRONIZED; =32
     public static final int TRANSIENT;    =128
     public static final int VOLATILE;     =64
// Public Class Methods
     public static boolean isAbstract(int mod);
     public static boolean isFinal(int mod);
     public static boolean isInterface(int mod);
     public static boolean isNative(int mod);
     public static boolean isPrivate(int mod);
     public static boolean isProtected(int mod);
     public static boolean isPublic(int mod);
     public static boolean isStatic(int mod);
1.2  public static boolean isStrict(int mod);
     public static boolean isSynchronized(int mod);
     public static boolean isTransient(int mod);
     public static boolean isVolatile(int mod);
     public static String toString(int mod);
}
```

ParameterizedType java.lang.reflect

Java 5.0

This subinterface of `Type` represents a parameterized type. `getrawType( )` returns the base type that has been parameterized. `getActualTypeArguments( )` returns the type parameters as a `Type[ ]`. Note that these parameters may themselves be `ParameterizedType` objects. `getOwnerType( )` is used with parameterized types that are also nested types: it returns the generic type of the containing type.

Figure 10-99. java.lang.reflect.ParameterizedType


```
public interface ParameterizedType extends Type {
// Public Instance Methods
     Type[ ] getActualTypeArguments( );
     Type getOwnerType( );
     Type getRawType( );
}
```

Proxy java.lang.reflect

Java 1.3 *serializable*

This class defines a simple but powerful API for dynamically generating a *proxy class*. A proxy class implements a specified list of interfaces and delegates invocations of the methods defined by those interfaces to a separate invocation handler object.

The static `getProxyClass( )` method dynamically creates a new `Class` object that implements each of the interfaces specified in the supplied `Class[ ]` array. The newly created class is defined in the context of the specified `ClassLoader`. The `Class` returned by `getProxyClass( )` is a subclass of `Proxy`. Every class that is dynamically generated by `getProxyClass( )` has a single public constructor, which expects a single argument of type `InvocationHandler`. You can create an instance of the dynamic proxy class by using the `Constructor` class to invoke this constructor. Or, more simply, you can combine the call to `getProxyClass( )` with the constructor call by calling the static `newProxyInstance( )` method, which both defines and instantiates a proxy class.

Every instance of a dynamic proxy class has an associated `InvocationHandler` object. All method calls made on a proxy class are translated into calls to the `invoke( )` method of this `InvocationHandler` object, which can handle the call in any way it sees fit. The static `getInvocationHandler( )` method returns the `InvocationHandler` object for a given proxy object. The static `isProxyClass( )` method returns `true` if a specified `Class` object is a dynamically generated proxy class.

Figure 10-100. java.lang.reflect.Proxy

```
public class Proxy implements Serializable {
// Protected Constructors
     protected Proxy(InvocationHandler h);
// Public Class Methods
     public static InvocationHandler getInvocationHandler(Object proxy)
throws IllegalArgumentException;
     public static Class<?> getProxyClass(ClassLoader loader, Class<?>
... interfaces) throws IllegalArgumentException;
     public static boolean isProxyClass(Class<?> cl);
     public static Object newProxyInstance(ClassLoader loader, Class<?>[ ]
interfaces, InvocationHandler h) throws IllegalArgumentException;
// Protected Instance Fields
     protected InvocationHandler h;
}
```

ReflectPermission java.lang.reflect

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that governs access to `private`, `protected`, and default-visibility methods, constructors, and fields through the Java Reflection API. In Java 1.2, the only defined name, or target, for `ReflectPermission` is "suppressAccessChecks". This permission is required to call the `setAccessible( )` method of `AccessibleObject`. Unlike some `Permission` subclasses, `ReflectPermission` does not use a list of actions. See also `AccessibleObject`.

System administrators configuring security policies should be familiar with this class, but application programmers should never need to use it directly.

Figure 10-101. java.lang.reflect.ReflectPermission

```
public final class ReflectPermission extends java.security.BasicPermission {
// Public Constructors
     public ReflectPermission(String name);
     public ReflectPermission(String name, String actions);
}
```

Team LiB

Type java.lang.reflect

Java 5.0

This interface has no members but is implemented or extended by any type that represents a generic or nongeneric type. `java.lang.Class` implements this interface. `Type` is also extended by four interfaces that represent four specific kinds of generic types: `ParameterizedType`, `TypeVariable`, `WildcardType`, and `GenericArrayType`.

```
public interface Type {
}
```

Implementations

`Class`, `GenericArrayType`, `ParameterizedType`, `TypeVariable`, `WildcardType`

Returned By

`Class.{getGenericInterfaces( ), getGenericSuperclass( )}`, `Constructor.{getGenericExceptionTypes( ), getGenericParameterTypes( )}`, `Field.getGenericType( )`, `GenericArrayType.getGenericComponentType( )`, `Method.{getGenericExceptionTypes( ), getGenericParameterTypes( ), getGenericReturnType( )}`, `ParameterizedType.{getActualTypeArguments( ), getOwnerType( ), getrawType( )}`, `TypeVariable.getBounds( )`, `WildcardType.{getLowerBounds( ), getUpperBounds( )}`

TypeVariable<D extends GenericDeclaration> java.lang.reflect

Java 5.0

This interface extends Type and represents the generic type represented by a type variable. getName( ) returns the name of the type variable, as it was declared in Java source code. getBounds( ) returns an array of Type objects that serve as the upper bounds for the variable. The returned array is never empty: if the type variable has no bounds declared, the single element of the array is Object.class. The getGenericDeclaration( ) method returns the Class, Method, or Constructor that declared this type variable (each of these classes implements the GenericDeclaration interface). Note that TypeVariable is itself a generic type and is parameterized with the kind of GenericDeclaration that declared the variable.

Figure 10-102. java.lang.reflect.TypeVariable<D extends GenericDeclaration>

```
public interface TypeVariable<D extends GenericDeclaration> extends Type {
// Public Instance Methods
     Type[ ] getBounds( );
     D getGenericDeclaration( );
     String getName( );
}
```

Returned By

Class.getTypeParameters( ), Constructor.getTypeParameters( ), GenericDeclaration.getTypeParameters( ), Method.getTypeParameters( )

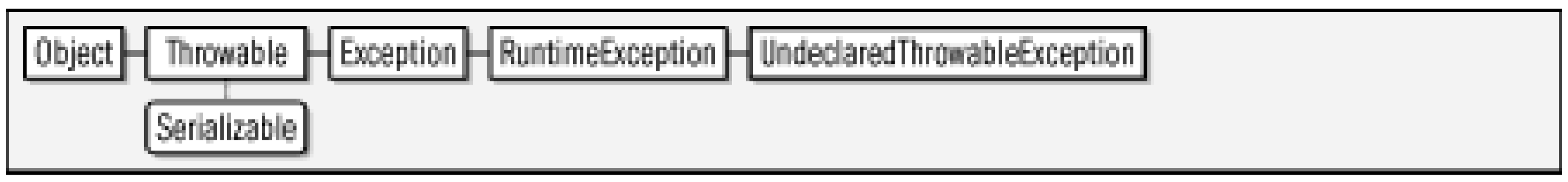
Team LiB

UndeclaredThrowableException java.lang.reflect

Java 1.3 *serializable unchecked*

Thrown by a method of a `Proxy` object if the `invoke( )` method of the proxy's `InvocationHandler` throws a checked exception not declared by the original method. This class serves as an unchecked exception wrapper around the checked exception. Use `getUndeclaredThrowable( )` to obtain the checked exception thrown by `invoke( )`. In Java 1.4 and later, all exceptions can be "chained" in this way, and `getUndeclaredThrowable( )` is superseded by the more general `getCause( )` method.

Figure 10-103. java.lang.reflect.UndeclaredThrowableException




```
public class UndeclaredThrowableException extends RuntimeException {
// Public Constructors
     public UndeclaredThrowableException(Throwable undeclaredThrowable);
     public UndeclaredThrowableException(Throwable undeclaredThrowable, String s);
// Public Instance Methods
     public Throwable getUndeclaredThrowable( );
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );
}
```

WildcardType java.lang.reflect

Java 5.0

This interface extends `Type` and represents a generic type declared with a bounded or unbounded wildcard. `getUpperBounds( )` returns the upper bounds of the wildcard. The returned array always includes at least one element. If no upper bound is declared, `Object.class` is the implicit upper bound. `getLowerBounds( )` returns the lower bounds of the wildcard. If no lower bound is declared, this method returns an empty array .

Figure 10-104. java.lang.reflect.WildcardType


```
public interface WildcardType extends Type {
// Public Instance Methods
     Type[ ] getLowerBounds( );
     Type[ ] getUpperBounds( );
}
```

Chapter 11. java.math

Package java.math

BigDecimal

BigInteger

MathContext

RoundingMode

Package java.math

Java 1.1

The `java.math` package contains the `BigInteger` class for arbitrary-precision integer arithmetic, which is useful for cryptography. It also contains the `BigDecimal` class for arbitrary precision decimal floating-point arithmetic, which is useful for financial applications that need to be careful about rounding errors. The `BigDecimal` class is greatly enhanced in Java 5.0 and is accompanied by the new types `MathContext` and `RoundingMode`.

Enumerated Types

```
public enum RoundingMode;
```

Classes

```
public class BigDecimal extends Number implements Comparable<BigDecimal>;
public class BigInteger extends Number implements Comparable<BigInteger>;
public final class MathContext implements Serializable;
```

BigDecimal java.math

Java 1.1 *serializable comparable*

This subclass of java.lang.Number represents a floating-point number of arbitrary size and precision. Because it uses a decimal rather than binary floating-point representation, it is not subject to theroundir errors that the float and double types are. This makes BigDecimal well-suited to financial and similar applications.

BigDecimal provides add( ) , subtract( ) , multiply( ) , and divide( ) methods to support basic arithmetic. In Java 5.0, this class has been expanded to define many more methods, includingpow( ) fo exponentiation. Many of the new methods use aMathContext to specify the desired precision of the resu and the RoundingMode to be used to achieve that precision.

BigDecimal extends Number and implements the Comparable interface. The compareTo( ) method compares the value of two BigDecimal objects and returns -1, 0, or 1 to indicate the result of the comparison. Use this method in place of the< , <= , > , and >= operators that you'd use with float and double values.

A BigDecimal object is represented as an integer of arbitrary size and an integer scale that specifies the number of decimal places in the value. When working withBigDecimal values, you can explicitly specify precision (i.e., the number of decimal places) you are interested in. Also, whenever aBigDecimal metho can discard precision (e.g., in a division operation), you are required to specify what sort of rounding sh be performed on the digit to the left of the discarded digit or digits. The eight constants defined by this c specify the available rounding modes. In Java 5.0, however, the preferred way to specify a rounding mo with the enumerated type RoundingMode .

Figure 11-1. java.math.BigDecimal

```
public class BigDecimal extends Number implements Comparable<BigDecimal> {
// Public Constructors
     public BigDecimal(BigInteger val);
5.0  public BigDecimal(int val);
5.0  public BigDecimal(long val);
     public BigDecimal(String val);
5.0  public BigDecimal(char[ ] in);
     public BigDecimal(double val);
5.0  public BigDecimal(long val, MathContext mc);
5.0  public BigDecimal(int val, MathContext mc);
5.0  public BigDecimal(double val, MathContext mc);
```

```
5.0  public BigDecimal(String val, MathContext mc);
5.0  public BigDecimal(char[ ] in, MathContext mc);
     public BigDecimal(BigInteger unscaledVal, int scale);
5.0  public BigDecimal(BigInteger val, MathContext mc);
5.0  public BigDecimal(BigInteger unscaledVal, int scale, MathContext mc);
5.0  public BigDecimal(char[ ] in, int offset, int len);
5.0  public BigDecimal(char[ ] in, int offset, int len, MathContext mc);
// Public Constants
5.0  public static final BigDecimal ONE;
     public static final int ROUND_CEILING;                              =2
     public static final int ROUND_DOWN;   =1
     public static final int ROUND_FLOOR;  =3
     public static final int ROUND_HALF_DOWN;                            =5
     public static final int ROUND_HALF_EVEN;                            =6
     public static final int ROUND_HALF_UP;                              =4
     public static final int ROUND_UNNECESSARY;                          =7
     public static final int ROUND_UP;     =0
5.0  public static final BigDecimal TEN;
5.0  public static final BigDecimal ZERO;
// Public Class Methods
     public static BigDecimal valueOf(long val);
5.0  public static BigDecimal valueOf(double val);
     public static BigDecimal valueOf(long unscaledVal, int scale);
// Public Instance Methods
     public BigDecimal abs( );
5.0  public BigDecimal abs(MathContext mc);
     public BigDecimal add(BigDecimal augend);
5.0  public BigDecimal add(BigDecimal augend, MathContext mc);
5.0  public byte byteValueExact( );
     public int compareTo(BigDecimal val);                 Implements:Comparable
5.0  public BigDecimal divide(BigDecimal divisor);
     public BigDecimal divide(BigDecimal divisor, int roundingMode);
5.0  public BigDecimal divide(BigDecimal divisor, RoundingMode roundingMode);
5.0  public BigDecimal divide(BigDecimal divisor, MathContext mc);
     public BigDecimal divide(BigDecimal divisor, int scale, int roundingMode);
5.0  public BigDecimal divide(BigDecimal divisor, int scale, RoundingMode roundingMode)
5.0  public BigDecimal[ ] divideAndRemainder(BigDecimal divisor);
5.0  public BigDecimal[ ] divideAndRemainder(BigDecimal divisor, MathContext mc);
5.0  public BigDecimal divideToIntegralValue(BigDecimal divisor);
5.0  public BigDecimal divideToIntegralValue(BigDecimal divisor, MathContext mc);
5.0  public int intValueExact( );
5.0  public long longValueExact( );
     public BigDecimal max(BigDecimal val);
     public BigDecimal min(BigDecimal val);
     public BigDecimal movePointLeft(int n);
     public BigDecimal movePointRight(int n);
     public BigDecimal multiply(BigDecimal multiplicand);
5.0  public BigDecimal multiply(BigDecimal multiplicand, MathContext mc);
     public BigDecimal negate( );
```

```
5.0  public BigDecimal negate(MathContext mc);
5.0  public BigDecimal plus( );
5.0  public BigDecimal plus(MathContext mc);
5.0  public BigDecimal pow(int n);
5.0  public BigDecimal pow(int n, MathContext mc);
5.0  public int precision( );
5.0  public BigDecimal remainder(BigDecimal divisor);
5.0  public BigDecimal remainder(BigDecimal divisor, MathContext mc);
5.0  public BigDecimal round(MathContext mc);
     public int scale( );
5.0  public BigDecimal scaleByPowerOfTen(int n);
     public BigDecimal setScale(int newScale);
     public BigDecimal setScale(int newScale, int roundingMode);
5.0  public BigDecimal setScale(int newScale, RoundingMode roundingMode);
5.0  public short shortValueExact( );
     public int signum( );
5.0  public BigDecimal stripTrailingZeros( );
     public BigDecimal subtract(BigDecimal subtrahend);
5.0  public BigDecimal subtract(BigDecimal subtrahend, MathContext mc);
     public BigInteger toBigInteger( );
5.0  public BigInteger toBigIntegerExact( );
5.0  public String toEngineeringString( );
5.0  public String toPlainString( );
5.0  public BigDecimal ulp( );
1.2  public BigInteger unscaledValue( );
// Methods Implementing Comparable
     public int compareTo(BigDecimal val);
// Public Methods Overriding Number
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
// Public Methods Overriding Object
     public boolean equals(Object x);
     public int hashCode( );
     public String toString( );
}
```

Passed To

javax.xml.datatype.DatatypeFactory.{newDuration( ) , newXMLGregorianCalendar( ) , newXMLGregorianCalendarTime( )} , javax.xml.datatype.Duration.multiply( ) , javax.xml.datatype.XMLGregorianCalendar.{setFractionalSecond( ) , setTime( )}

Returned By

java.util.Scanner.nextBigDecimal( ) , javax.xml.datatype.XMLGregorianCalendar.getFractionalSecond( )

BigInteger java.math

Java 1.1 *serializable comparable*

This subclass of `java.lang.Number` represents integers that can be arbitrarily large (i.e., integers that are not limited to the 64 bits available with the `long` data type). `BigInteger` defines methods that duplicate the functionality of the standard Java arithmetic and bit-manipulation operators. The `compareTo( )` method compares two `BigInteger` objects and returns -1, 0, or 1 to indicate the result of the comparison. The `gcd( )` , `modPow( )`, `modInverse( )`, and `isProbablePrime( )` methods perform advanced operations and are used primarily incryptographic and related algorithms.

Figure 11-2. java.math.BigInteger

```
public class BigInteger extends Number implements Comparable<BigInteger> {
// Public Constructors
     public BigInteger(byte[ ] val);
     public BigInteger(String val);
     public BigInteger(String val, int radix);
     public BigInteger(int signum, byte[ ] magnitude);
     public BigInteger(int numBits, java.util.Random rnd);
     public BigInteger(int bitLength, int certainty, java.util.Random rnd);
// Public Constants
1.2  public static final BigInteger ONE;
5.0  public static final BigInteger TEN;
1.2  public static final BigInteger ZERO;
// Public Class Methods
1.4  public static BigInteger probablePrime(int bitLength, java.util.Random rnd);
     public static BigInteger valueOf(long val);
// Public Instance Methods
     public BigInteger abs( );
     public BigInteger add(BigInteger val);
     public BigInteger and(BigInteger val);
     public BigInteger andNot(BigInteger val);
     public int bitCount( );
     public int bitLength( );
     public BigInteger clearBit(int n);
     public int compareTo(BigInteger val);              Implements:Comparable
```

```
     public BigInteger divide(BigInteger val);
     public BigInteger[ ] divideAndRemainder(BigInteger val);
     public BigInteger flipBit(int n);
     public BigInteger gcd(BigInteger val);
     public int getLowestSetBit( );
     public boolean isProbablePrime(int certainty);
     public BigInteger max(BigInteger val);
     public BigInteger min(BigInteger val);
     public BigInteger mod(BigInteger m);
     public BigInteger modInverse(BigInteger m);
     public BigInteger modPow(BigInteger exponent, BigInteger m);
     public BigInteger multiply(BigInteger val);
     public BigInteger negate( );
5.0  public BigInteger nextProbablePrime( );
     public BigInteger not( );
     public BigInteger or(BigInteger val);
     public BigInteger pow(int exponent);
     public BigInteger remainder(BigInteger val);
     public BigInteger setBit(int n);
     public BigInteger shiftLeft(int n);
     public BigInteger shiftRight(int n);
     public int signum( );
     public BigInteger subtract(BigInteger val);
     public boolean testBit(int n);
     public byte[ ] toByteArray( );
     public String toString(int radix);
     public BigInteger xor(BigInteger val);
// Methods Implementing Comparable
     public int compareTo(BigInteger val);
// Public Methods Overriding Number
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
// Public Methods Overriding Object
     public boolean equals(Object x);
     public int hashCode( );
     public String toString( );
}
```

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

`java.security.spec.RSAKeyGenParameterSpec.{F0, F4}`

MathContext java.math

Java 5.0 *serializable*

This simple class represents a precision (number of significant digits) and a `RoundingMode` to be used in `BigDecimal` arithmetic. The constants are predefined `MathContext` objects that can be used to select unlimited precision arithmetic or to select specific operating modes that matchdecimal floating-point modes defined by the IEEE 754R standard.

Figure 11-3. java.math.MathContext


```
public final class MathContext implements Serializable {
// Public Constructors
     public MathContext(int setPrecision);
     public MathContext(String val);
     public MathContext(int setPrecision, RoundingMode setRoundingMode);
// Public Constants
     public static final MathContext DECIMAL128;
     public static final MathContext DECIMAL32;
     public static final MathContext DECIMAL64;
     public static final MathContext UNLIMITED;
// Public Instance Methods
     public int getPrecision( );
     public RoundingMode getRoundingMode( );
// Public Methods Overriding Object
     public boolean equals(Object x);
     public int hashCode( );
     public String toString( );
}
```

Passed To

Too many methods to list.

Team LiB

RoundingMode java.math

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type represent possible ways of rounding numbers. UP and DOWN specify rounding away from zero or toward zero. CEILING and FLOOR represent rounding toward positive infinity and negative infinity. HALF_UP, HALF_DOWN, and HALF_EVEN all round toward the nearest value and differ only in what they do when two values are equidistant. In this case, they round up, down, or to the "even" neighbor. UNNECESSARY is a special rounding mode that serves as an assertion that an arithmetic operation will have an exact result and that rounding is not needed. If this assertion failsthat is, if the operation does require roundingan ArithmeticException is thrown.

Figure 11-4. java.math.RoundingMode

```
public enum RoundingMode {
// Enumerated Constants
     UP,
     DOWN,
     CEILING,
     FLOOR,
     HALF_UP,
     HALF_DOWN,
     HALF_EVEN,
     UNNECESSARY;
// Public Class Methods
     public static RoundingMode valueOf(int rm);
     public static RoundingMode valueOf(String name);
     public static final RoundingMode[ ] values( );
}
```

Passed To

BigDecimal.{divide( ), setScale( )}, MathContext.MathContext( )

Returned By

MathContext.getRoundingMode( )

Chapter 12. java.net

Package java.net

Authenticator

Authenticator.RequestorType

BindException

CacheRequest

CacheResponse

ConnectException

ContentHandler

ContentHandlerFactory

CookieHandler

DatagramPacket

DatagramSocket

DatagramSocketImpl

DatagramSocketImplFactory

FileNameMap

HttpRetryException

HttpURLConnection

Inet4Address

Inet6Address

InetAddress

InetSocketAddress

JarURLConnection

MalformedURLException

MulticastSocket

NetPermission

NetworkInterface

NoRouteToHostException

PasswordAuthentication

PortUnreachableException

ProtocolException

Proxy

Proxy.Type

ProxySelector

ResponseCache

SecureCacheResponse

ServerSocket

Socket

SocketAddress

SocketException

SocketImpl

SocketImplFactory

SocketOptions

SocketPermission

SocketTimeoutException

UnknownHostException

UnknownServiceException

URI

URISyntaxException

URL

URLClassLoader

URLConnection

URLDecoder

URLEncoder

Team LiB

Package java.net

Java 1.0

The java.net package provides a powerful and flexible infrastructure for networking. This introduction describes the most commonly used classes in brief. Note that as of Java 1.4, the New I/O API of java.ni java.nio.channels can be used for high-performance nonblocking networking. See also the javax.net package for classes for secure networking using SSL.

The URL class represents an Internet uniform resource locator (URL). It provides a very simple interface networking: the object referred to by the URL can be downloaded with a single call, or streams may be to read from or write to the object. At a slightly more complex level, a URLConnection object can be obta from a given URL object. The URLConnection class provides additional methods that allow you to work w URLs in more sophisticated ways. Java 1.4 introduced the URI class; it provides a powerful API for manip URI and URL strings but does not have any networking capabilities itself. Java 5.0 defines APIs for defin registering cache, cookie, and proxy handlers to be used by built-in protocol handlers when network res are requested through the URL class. See RequestCache , CookieHandler , ProxySelector , and Proxy

If you want to do more than simply download an object referenced by a URL, you can do your own netw with the Socket class. This class allows you to connect to a specified port on a specified Internet host ar and write data using the InputStream and OutputStream classes of the java.io package. If you want to implement a server to accept connections from clients, you can use the related ServerSocket class. Both Socket and ServerSocket use the InetAddress address class, which represents an Internet address. A Java 1.4, Inet4Address and Inet6Address are subclasses that represent the addresses used by version version 6 of the IP protocol. Java 1.4 also introduced the SocketAddress class as a high-level representa a network address that is not tied to a specific networking protocol. An IP-specific InetSocketAddress su encapsulates an InetAddress and a port number.

The java.net package allows you to do low-level networking with DatagramPacket objects, which may b and received over the network through a DatagramSocket object. MulticastSocket extends DatagramS to support multicast networking.

Interfaces

```
public interface ContentHandlerFactory;
public interface DatagramSocketImplFactory;
public interface FileNameMap;
public interface SocketImplFactory;
public interface SocketOptions;
public interface URLStreamHandlerFactory;
```

Enumerated Types

```
public enum Authenticator.RequestorType;
public enum Proxy.Type;
```

Classes

```
public abstract class Authenticator;
public abstract class CacheRequest;
public abstract class CacheResponse;
   public abstract class SecureCacheResponse extends CacheResponse;
public abstract class ContentHandler;
public abstract class CookieHandler;
public final class DatagramPacket;
public class DatagramSocket;
   public class MulticastSocket extends DatagramSocket;
public abstract class DatagramSocketImpl implements SocketOptions;
public class InetAddress implements Serializable;
   public final class Inet4Address extends InetAddress;
   public final class Inet6Address extends InetAddress;
public final class NetPermission extends java.security.BasicPermission;
public final class NetworkInterface;
public final class PasswordAuthentication;
public class Proxy;
public abstract class ProxySelector;
public abstract class ResponseCache;
public class ServerSocket;
public class Socket;
public abstract class SocketAddress implements Serializable;
   public class InetSocketAddress extends SocketAddress;
public abstract class SocketImpl implements SocketOptions;
public final class SocketPermission extends java.security.Permission implements Serializ
public final class URI implements Comparable<URI>, Serializable;
public final class URL implements Serializable;
public class URLClassLoader extends java.security.SecureClassLoader;
public abstract class URLConnection;
   public abstract class HttpURLConnection extends URLConnection;
   public abstract class JarURLConnection extends URLConnection;
public class URLDecoder;
public class URLEncoder;
public abstract class URLStreamHandler;
```

Exceptions

```
public class HttpRetryException extends java.io.IOException;
public class MalformedURLException extends java.io.IOException;
public class ProtocolException extends java.io.IOException;
public class SocketException extends java.io.IOException;
   public class BindException extends SocketException;
   public class ConnectException extends SocketException;
```

```
   public class NoRouteToHostException extends SocketException;
   public class PortUnreachableException extends SocketException;
public class SocketTimeoutException extends java.io.InterruptedIOException;
public class UnknownHostException extends java.io.IOException;
public class UnknownServiceException extends java.io.IOException;
public class URISyntaxException extends Exception;
```

Authenticator java.net

Java 1.2

This abstract class defines a customizable mechanism for requesting and performingpassword authentication when required in URL-based networking. The static setDefault( ) method establishes the systemwide Authenticator. An Authenticator implementation can obtain the required authentication information from the user however it wants (e.g., through a text- or a GUI-based interface). setDefault( ) can be called only once; subsequent calls are ignored. Calling setDefault( ) requires an appropriate NetPermission.

When an application or the Java runtime system requires password authentication (to read the contents of a specified URL, for example), it calls the static requestPasswordAuthentication( ) method, passing arguments that specify the host and port for which the password is required and a prompt that may be displayed to the user. This method looks up the defaultAuthenticator for the system and calls its getPasswordAuthentication( ) method. Calling requestPasswordAuthentication( ) requires an appropriate NetPermission.

Authenticator is an abstract class; its default implementation of getPasswordAuthentication( ) always returns null. To create an Authenticator, you must override this method so that it prompts the user to enter a username and password and returns that information in the form of a PasswordAuthentication object. Your implementation of getPasswordAuthentication( ) may call the various getrequesting( ) methods to find out who is requesting the password and what the recommended user prompt is. Java 1.4 added a version of the static requestPasswordAuthentication( ) method that allows specification of the requesting hostname. A corresponding getrequestingHost( ) instance method was also added.

Java 5.0 adds yet another version of requestPasswordAuthentication( ), and corresponding methods to query the URL that requires the password and the RequestorType of the request. RequestorType is a nested enum type that specifies whether the request comes from an HTTP server or a proxy server.

```
public abstract class Authenticator {
// Public Constructors
     public Authenticator( );
// Nested Types
5.0  public enum RequestorType;
// Public Class Methods
     public static PasswordAuthentication requestPasswordAuthentication
(InetAddress addr, int port, String protocol,
String prompt, String scheme);
1.4  public static PasswordAuthentication requestPasswordAuthentication
(String host, InetAddress addr, int port, String protocol,
String prompt, String scheme);
5.0  public static PasswordAuthentication
        requestPasswordAuthentication(String host,
```

```
        InetAddress addr, int port, String protocol, String prompt,
        String scheme, URL url, Authenticator.RequestorType reqType);
     public static void setDefault(Authenticator a);       synchronized
// Protected Instance Methods
     protected PasswordAuthentication getPasswordAuthentication( );     constant
1.4  protected final String getRequestingHost( );
     protected final int getRequestingPort( );
     protected final String getRequestingPrompt( );
     protected final String getRequestingProtocol( );
     protected final String getRequestingScheme( );
     protected final InetAddress getRequestingSite( );
5.0  protected URL getRequestingURL( );
5.0  protected Authenticator.RequestorType getRequestorType( );
}
```

Team LiB

Team LiB

Authenticator.RequestorType java.net

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type specify whether an authentication request comes from an HTTP origin server or a proxy server.

```
public enum Authenticator.RequestorType {
// Enumerated Constants
     PROXY,
     SERVER;
// Public Class Methods
     public static Authenticator.RequestorType valueOf(String name);
     public static final Authenticator.RequestorType[ ] values( );
}
```

Passed To

`Authenticator.requestPasswordAuthentication( )`

Returned By

`Authenticator.getRequestorType( )`

BindException java.net

Java 1.1 *serializable checked*

Signals that a socket cannot be bound to a local address and port. This often means that the port is already in use.

Figure 12-1. java.net.BindException


```
public class BindException extends SocketException {
// Public Constructors
     public BindException( );
     public BindException(String msg);
}
```

CacheRequest java.net

Java 5.0

When a URLStreamHandler reads a network resource, it should call the put( ) method of the currently installed ResponseCache, if there is one. If the cache wants to save a local copy of the resource, it will return a CacheRequest object to the URLStreamHandler. The handler should then write the resource to the OutputStream returned by the getBody( ) method.

See also CacheResponse. This class is used by the implementors of URLStreamHandler, not by casual users of the java.net package.

```
public abstract class CacheRequest {
// Public Constructors
     public CacheRequest( );
// Public Instance Methods
     public abstract void abort( );
     public abstract java.io.OutputStream getBody( ) throws java.io.IOException;
}
```

Returned By

ResponseCache.put( )

CacheResponse java.net

Java 5.0

If a ResponseCache holds a local copy of a network resource, it returns a CacheResponse object from the ResponseCache.get( ) method. The resource can then be read from the java.io.InputStream returned by getBody( ). The protocol response headers are available in the form of java.util.Map from getHeaders( ).

See also SecureCacheResponse and CacheRequest. Note that this class is intended for use in URLStreamHandler implementations, not by casual users of the java.net package.

```
public abstract class CacheResponse {
// Public Constructors
     public CacheResponse( );
// Public Instance Methods
     public abstract java.io.InputStream getBody( ) throws java.io.IOException;
     public abstract java.util.Map<String,java.util.List<String>> getHeaders( )
     throws java.io.IOException;
}
```

Subclasses

SecureCacheResponse

Returned By

ResponseCache.get( )

ConnectException java.net

Java 1.1 *serializable checked*

Signals that a socket cannot be connected to a remote address and port. This means that the remote host can be reached, but is not responding, perhaps because there is no process on that host that is listening on the specified port.

Figure 12-2. java.net.ConnectException


```
public class ConnectException extends SocketException {
// Public Constructors
     public ConnectException( );
     public ConnectException(String msg);
}
```

ContentHandler java.net

Java 1.0

This abstract class defines a method that reads data from a `URLConnection` and returns an object that represents that data. Each subclass that implements this method is responsible for handling a different type of content (i.e., a different MIME type). Applications never create `ContentHandler` objects directly; they are created, when necessary, by the registered `ContentHandlerFactory` object. Applications should also never call `ContentHandler` methods directly; they should call `URL.getContent( )` or `URLConnection.getContent( )` instead. You need to subclass `ContentHandler` only if you are writing a web browser or similar application that needs to parse and understand some new content type.

```
public abstract class ContentHandler {
// Public Constructors
     public ContentHandler( );
// Public Instance Methods
     public abstract Object getContent(URLConnection urlc)
throws java.io.IOException;
1.3  public Object getContent(URLConnection urlc, Class[ ] classes)
throws java.io.IOException;
}
```

Returned By

`ContentHandlerFactory.createContentHandler( )`

ContentHandlerFactory java.net

Java 1.0

This interface defines a method that creates and returns an appropriate `ContentHandler` object for a specified MIME type. A systemwide `ContentHandlerFactory` interface may be specified using the `URLConnection.setContentHandlerFactory( )` method. Normal applications never need to use or implement this interface.

```
public interface ContentHandlerFactory {
// Public Instance Methods
     java.net.ContentHandler createContentHandler(String mimetype);
}
```

Passed To

`URLConnection.setContentHandlerFactory( )`

Team LiB

CookieHandler java.net

Java 5.0

This abstract class defines an API to be implemented by an application that wants to manage HTTP cookies for networking done via the `URL` class. Install an implementation of this class with the `setDefault( )` method. The default HTTP protocol handler uses `getdefault( )` to obtain the `CookieHandler` implementation. The protocol handler then calls `get( )` when it wants the `CookieHandler` to copy cookie values into HTTP request headers and calls `put( )` when it wants the `CookieHandler` to read a set of response headers and store the cookies they contain.

This class is intended to be subclassed by advanced users of the package; it is not intended for casua users.

```
public abstract class CookieHandler {
// Public Constructors
     public CookieHandler( );
// Public Class Methods
     public static CookieHandler getDefault( );      synchronized
     public static void setDefault(CookieHandler cHandler);       synchronized
// Public Instance Methods
     public abstract java.util.Map<String,java.util.List<String>>
get(URI uri, java.util.Map<String,java.util.List<String>> requestHeaders)
throws java.io.IOException;
     public abstract void put(URI uri, java.util.Map<String,
java.util.List<String>> responseHeaders)
throws java.io.IOException;
}
```

Team LiB

DatagramPacket java.net

Java 1.0

This class implements a packet of data that may be sent or received over the network through a DatagramSocket. Create a DatagramPacket to be sent over the network with one of the consructor methods that includes a network address. Create a DatagramPacket into which data can be received using one of the constructors that does not include a network address argument. The receive( ) method of DatagramSocket waits for data and stores it in a DatagramPacket created in this way. The contents and sender of a received packet can be queried with the DatagramPacket instance methods.

New constructors and methods were added to this class in Java 1.4 to support the SocketAddress abstraction of a network address.

```
public final class DatagramPacket {
// Public Constructors
     public DatagramPacket(byte[ ] buf, int length);
1.4  public DatagramPacket(byte[ ] buf, int length, SocketAddress address)
throws SocketException;
1.2  public DatagramPacket(byte[ ] buf, int offset, int length);
     public DatagramPacket(byte[ ] buf, int length, InetAddress address,
     int port);
1.4  public DatagramPacket(byte[ ] buf, int offset, int length,
SocketAddress address) throws SocketException;
1.2  public DatagramPacket(byte[ ] buf, int offset, int length,
InetAddress address, int port);
// Public Instance Methods
     public InetAddress getAddress( );               synchronized
     public byte[ ] getData( );               synchronized
     public int getLength( );                 synchronized
1.2  public int getOffset( );                   synchronized
     public int getPort( );                   synchronized
1.4  public SocketAddress getSocketAddress( );   synchronized
1.1  public void setAddress(InetAddress iaddr);        synchronized
1.1  public void setData(byte[ ] buf);  synchronized
1.2  public void setData(byte[ ] buf, int offset, int length);     synchronized
1.1  public void setLength(int length);        synchronized
1.1  public void setPort(int iport);          synchronized
1.4  public void setSocketAddress(SocketAddress address);     synchronized
}
```

Passed To

`DatagramSocket.{receive( ), send( )}`, `DatagramSocketImpl.{peekData( ), receive( ), send( )}`, `MulticastSocket.send( )`

Team LiB

Team LiB

DatagramSocket java.net

Java 1.0

This class defines a socket that can receive and send unreliable datagram packets over the network usin the UDP protocol. A *datagram* is a very low-level networking interface: it is simply an array of bytes sen over the network. A datagram does not implement any kind of stream-based communication protocol, and there is no connection established between the sender and the receiver. Datagram packets are calle unreliable because the protocol does not make any attempt to ensure they arrive or to resend them if they don't. Thus, packets sent through a `DatagramSocket` are not guaranteed to arrive in the order sent or even to arrive at all. On the other hand, this low-overhead protocol makes datagram transmission ve fast. See `Socket` and `URL` for higher-level interfaces to networking. This class was introduced in Java 1.0 and was enhanced in Java 1.4 to allow local and remote addresses to be specified using the protocol-independent `SocketAddress` class.

`send( )` sends a `DatagramPacket` tHRough the socket. The packet must contain the destination address to which it should be sent. `receive( )` waits for data to arrive at the socket and stores it, along with the address of the sender, in the specified `DatagramPacket`. `close( )` closes the socket and frees the local port for reuse. Once `close( )` has been called, the `DatagramSocket` should not be used again, except to call the `isClosed( )` method which returns `true` if the socket has been closed.

Each time a packet is sent or received, the system must perform a security check to ensure that the calling code has permission to send data to or receive data from the specified host. In Java 1.2 and later if you are sending multiple packets to or receiving multiple packets from a single host, use `connect( )` to specify the host with which you are communicating. This causes the security check to be done a single time, but does not allow the socket to communicate with any other host until `disconnect( )` is called. Use `geTRemoteSocketAddress( )` or `getInetAddress( )` and `getPort( )` to obtain the network address, if any, that the socket is connected to. Use `isConnected( )` to determine if the socket is currently connected in this way.

By default, a `DatagramSocket` sends data through a local address assigned by the system. If desired, however, you can *bind* the socket to a specified local address. Do this by using one of the constructors other than the no-arg constructor. Or, bind the `DatagramSocket` to a local `SocketAddress` with the `bind( )` method. You can determine whether a DatagramSocket is bound with `isBound( )`, and you can obtain the local address of the socket with `getLocalSocketAddress( )` or with `getLocalAddress( )` and `getLocalPort( )`.

This class defines a number of get/set method pairs for setting and querying a variety of "socket options for datagram transmission. `setSoTimeout( )` specifies the number of milliseconds that `receive( )` waits for a packet to arrive before throwing an `InterruptedIOException`. Specify `0` milliseconds to wait forever. `setSendBufferSize( )` and `setReceiveBufferSize( )` set hints as to the underlying size of th networking buffers. `setBroadcast( )`, `setReuseAddress( )`, and `setTrafficClass( )` set more complex socket options; use of these options requires a sophisticated understanding of low-level networ protocols, and an explaination of them is beyond the scope of this reference.

In Java 1.4 and later, `getChannel( )` returns a `java.nio.channels.DatagramChannel` associated with this DatagramSocket . Sockets created with one of the DatagramSocket( ) constructors always return null from this method. getChannel( ) only returns a useful value for sockets that were created by and belong to a DatagramChannel .

```
public class DatagramSocket {
// Public Constructors
     public DatagramSocket( ) throws SocketException;
1.4  public DatagramSocket(SocketAddress bindaddr) throws SocketException;
     public DatagramSocket(int port) throws SocketException;
1.1  public DatagramSocket(int port, InetAddress laddr) throws SocketException;
// Protected Constructors
1.4  publicprotected DatagramSocket(DatagramSocketImpl impl);
// Public Class Methods
1.3  public static void setDatagramSocketImplFactory(DatagramSocketImplFactory
fac) throws java.io.IOException;  synchronized
// Public Instance Methods
1.4  public void bind(SocketAddress addr) throws SocketException;  synchronized
     public void close( );
1.4  public void connect(SocketAddress addr) throws SocketException;
1.2  public void connect(InetAddress address, int port);
1.2  public void disconnect( );
1.4  public boolean getBroadcast( )
throws SocketException;  synchronized default:true
1.4  public java.nio.channels.DatagramChannel getChannel( );
 constant default:null
1.2  public InetAddress getInetAddress( );  default:null
1.1  public InetAddress getLocalAddress( );  default:Inet4Address
     public int getLocalPort( );  default:32777
1.4  public SocketAddress getLocalSocketAddress( );   default:InetSocketAddress
1.2  public int getPort( );       default:-1
1.2  public int getReceiveBufferSize( )
throws SocketException;      synchronized default:32767
1.4  public SocketAddress getRemoteSocketAddress( );     default:null
1.4  public boolean getReuseAddress( )
throws SocketException;    synchronized default:false
1.2  public int getSendBufferSize( )
throws SocketException;     synchronized default:32767
1.1  public int getSoTimeout( ) throws SocketException;  synchronized default:0
1.4  public int getTrafficClass( ) throws SocketException;     synchronized default:0
1.4  public boolean isBound( );                  default:true
1.4  public boolean isClosed( );                 default:false
1.4  public boolean isConnected( );              default:false
     public void receive(DatagramPacket p) throws java.io.IOException;     synchronized
     public void send(DatagramPacket p) throws java.io.IOException;
1.4  public void setBroadcast(boolean on) throws SocketException;     synchronized
1.2  public void setReceiveBufferSize(int size) throws SocketException;     synchronize
1.4  public void setReuseAddress(boolean on) throws SocketException;     synchronized
1.2  public void setSendBufferSize(int size) throws SocketException;     synchronized
1.1  public void setSoTimeout(int timeout) throws SocketException;     synchronized
```

```
1.4  public void setTrafficClass(int tc) throws SocketException;     synchronized
}
```

Subclasses

MulticastSocket

Returned By

java.nio.channels.DatagramChannel.socket( )

Team LiB

Team LiB

DatagramSocketImpl java.net

Java 1.1

This abstract class defines the methods necessary to implement communication through datagram and multicast sockets. System programmers may create subclasses of this class when they need to implement datagram or multicast sockets in a nonstandard network environment, such as behind a firewall or on a network that uses a nonstandard transport protocol. Normal applications never need to use or subclass this class.

Figure 12-3. java.net.DatagramSocketImpl


```
public abstract class DatagramSocketImpl implements SocketOptions {
// Public Constructors
     public DatagramSocketImpl( );
// Protected Instance Methods
     protected abstract void bind(int lport, InetAddress laddr)
throws SocketException;
     protected abstract void close( );
1.4  protected void connect(InetAddress address, int port)
throws SocketException;     empty
     protected abstract void create( ) throws SocketException;
1.4  protected void disconnect( );               empty
     protected java.io.FileDescriptor getFileDescriptor( );
     protected int getLocalPort( );
1.2  protected abstract int getTimeToLive( ) throws java.io.IOException;
     protected abstract void join(InetAddress inetaddr)
throws java.io.IOException;
1.4  protected abstract void joinGroup(SocketAddress mcastaddr, NetworkInterface
netIf) throws java.io.IOException;
     protected abstract void leave(InetAddress inetaddr)
throws java.io.IOException;
1.4  protected abstract void leaveGroup(SocketAddress mcastaddr, NetworkInterface
netIf) throws java.io.IOException;
     protected abstract int peek(InetAddress i) throws java.io.IOException;
1.4  protected abstract int peekData(DatagramPacket p) throws java.io.IOException;
     protected abstract void receive(DatagramPacket p) throws java.io.IOException;
     protected abstract void send(DatagramPacket p) throws java.io.IOException;
1.2  protected abstract void setTimeToLive(int ttl) throws java.io.IOException;
// Protected Instance Fields
```

```
     protected java.io.FileDescriptor fd;
     protected int localPort;
// Deprecated Protected Methods
#    protected abstract byte getTTL( ) throws java.io.IOException;
#    protected abstract void setTTL(byte ttl) throws java.io.IOException;
}
```

Passed To

DatagramSocket.DatagramSocket( )

Returned By

DatagramSocketImplFactory.createDatagramSocketImpl( )

Team LiB

DatagramSocketImplFactory java.net

Java 1.3

This interface defines a method that creates `DatagramSocketImpl` objects. You can register an instance of this factory interface with the static `setDatagramSocketImplFactory( )` method of `DatagramSocket`. Application-level code never needs to use or implement this interface.

```
public interface DatagramSocketImplFactory {
// Public Instance Methods
     DatagramSocketImpl createDatagramSocketImpl( );
}
```

Passed To

`DatagramSocket.setDatagramSocketImplFactory( )`

FileNameMap java.net

Java 1.1

This interface defines a single method that is called to obtain theMIME type of a file based on the name of the file. The `fileNameMap` field of the `URLConnection` class refers to an object that implements this interface. The filename-to-file-type map it implements is used by the static `URLConnection.guessContentTypeFromName( )` method.

```
public interface FileNameMap {
// Public Instance Methods
     String getContentTypeFor(String fileName);
}
```

Passed To

`URLConnection.setFileNameMap( )`

Returned By

`URLConnection.getFileNameMap( )`

HttpRetryException java.net

Java 5.0 *serializable checked*

An exception of this type is thrown when an HTTP request needs to be retried (due to a server redirect or authentication request, for example) but the protocol handler cannot automatically retry it because the `HttpURLConnection` has been placed in streaming mode. (See the `setFixedLengthStreamingMode( )` and `setChunkedStreamingMode( )` methods of `HttpURLConnection`.) The methods of the exception provide details about how the request should be retried.

Figure 12-4. java.net.HttpRetryException


```
public class HttpRetryException extends java.io.IOException {
// Public Constructors
     public HttpRetryException(String detail, int code);
     public HttpRetryException(String detail, int code, String location);
// Public Instance Methods
     public String getLocation( );
     public String getReason( );
     public int responseCode( );
}
```

Team LiB

HttpURLConnection java.net

Java 1.1

This class is a specialization of URLConnection. An instance of this class is returned when the openConnection( ) method is called for a URL object that uses the HTTP protocol. The many constants defined by this class are the status codes returned by HTTP servers. setRequestMethod( ) specifies what kind of HTTP request is made. The contents of this request must be sent through the OutputStream returned by the getOutputStream( ) method of the superclass. Once an HTTP request has been sent, getresponseCode( ) returns the HTTP server's response code as an integer, and geTResponseMessage( ) returns the server's response message. The disconnect( ) method closes the connection. The static setFollowRedirects( ) specifies whether URL connections that use the HTTP protocol should automatically follow redirect responses sent by HTTP servers. In order to successfully use this class, you need to understand the details of the HTTP protocol.

Figure 12-5. java.net.HttpURLConnection

```
public abstract class HttpURLConnection extends URLConnection {
// Protected Constructors
     protected HttpURLConnection(URL u);
// Public Constants
     public static final int HTTP_ACCEPTED;         =202
     public static final int HTTP_BAD_GATEWAY;      =502
     public static final int HTTP_BAD_METHOD;       =405
     public static final int HTTP_BAD_REQUEST;      =400
     public static final int HTTP_CLIENT_TIMEOUT;   =408
     public static final int HTTP_CONFLICT;         =409
     public static final int HTTP_CREATED;          =201
     public static final int HTTP_ENTITY_TOO_LARGE; =413
     public static final int HTTP_FORBIDDEN;        =403
     public static final int HTTP_GATEWAY_TIMEOUT;  =504
     public static final int HTTP_GONE;             =410
     public static final int HTTP_INTERNAL_ERROR;   =500
     public static final int HTTP_LENGTH_REQUIRED;  =411
     public static final int HTTP_MOVED_PERM;       =301
     public static final int HTTP_MOVED_TEMP;       =302
     public static final int HTTP_MULT_CHOICE;      =300
     public static final int HTTP_NO_CONTENT;       =204
     public static final int HTTP_NOT_ACCEPTABLE;   =406
```

```
     public static final int HTTP_NOT_AUTHORITATIVE;        =203
     public static final int HTTP_NOT_FOUND;        =404
1.3  public static final int HTTP_NOT_IMPLEMENTED;      =501
     public static final int HTTP_NOT_MODIFIED;     =304
     public static final int HTTP_OK;               =200
     public static final int HTTP_PARTIAL;          =206
     public static final int HTTP_PAYMENT_REQUIRED; =402
     public static final int HTTP_PRECON_FAILED;    =412
     public static final int HTTP_PROXY_AUTH;       =407
     public static final int HTTP_REQ_TOO_LONG;     =414
     public static final int HTTP_RESET;            =205
     public static final int HTTP_SEE_OTHER;        =303
     public static final int HTTP_UNAUTHORIZED;     =401
     public static final int HTTP_UNAVAILABLE;      =503
     public static final int HTTP_UNSUPPORTED_TYPE; =415
     public static final int HTTP_USE_PROXY;        =305
     public static final int HTTP_VERSION;          =505
// Public Class Methods
     public static boolean getFollowRedirects( );
     public static void setFollowRedirects(boolean set);
// Public Instance Methods
     public abstract void disconnect( );
1.2  public java.io.InputStream getErrorStream( );       constant
1.3  public boolean getInstanceFollowRedirects( );
     public String getRequestMethod( );
     public int getResponseCode( ) throws java.io.IOException;
     public String getResponseMessage( ) throws java.io.IOException;
5.0  public void setChunkedStreamingMode(int chunklen);
5.0  public void setFixedLengthStreamingMode(int contentLength);
1.3  public void setInstanceFollowRedirects(boolean followRedirects);
     public void setRequestMethod(String method) throws ProtocolException;
     public abstract boolean usingProxy( );
// Public Methods Overriding URLConnection
1.4  public String getHeaderField(int n);      constant
1.3  public long getHeaderFieldDate(String name, long Default);
1.4  public String getHeaderFieldKey(int n);   constant
1.2  public java.security.Permission getPermission( )
throws java.io.IOException;
// Protected Instance Fields
5.0  protected int chunkLength;
5.0  protected int fixedContentLength;
1.3  protected boolean instanceFollowRedirects;
     protected String method;
     protected int responseCode;
     protected String responseMessage;
// Deprecated Public Fields
#    public static final int HTTP_SERVER_ERROR;   =500
}
```

Subclasses

`javax.net.ssl.HttpsURLConnection`

Team LiB

Inet4Address java.net

Java 1.4 *serializable*

`Inet4Address` implements methods defined by its superclass to make them specific toIPv4 (Internet Protocol version 4) internet addresses. `Inet4Address` does not have a constructor. Create instances with the static methods of `InetAddress`, which return instances of `Inet4Address` or `Inet6Address` as appropriate.

Figure 12-6. java.net.Inet4Address


```
public final class Inet4Address extends InetAddress {
// No Constructor
// Public Methods Overriding InetAddress
     public boolean equals(Object obj);
     public byte[ ] getAddress( );
     public String getHostAddress( );
     public int hashCode( );
     public boolean isAnyLocalAddress( );
     public boolean isLinkLocalAddress( );
     public boolean isLoopbackAddress( );
     public boolean isMCGlobal( );
     public boolean isMCLinkLocal( );
     public boolean isMCNodeLocal( );                constant
     public boolean isMCOrgLocal( );
     public boolean isMCSiteLocal( );
     public boolean isMulticastAddress( );
     public boolean isSiteLocalAddress( );
}
```

Team LiB

Inet6Address java.net

Java 1.4 *serializable*

Inet6Address implements methods defined by its superclass to make them specific toIPv6 (Internet Protocol version 6) internet addresses. See RFC 2373 for complete details about internet addresses of this type. Inet6Address does not have a constructor. Create instances with the static methods of InetAddress, which return instances of Inet4Address or Inet6Address as appropriate. In Java 5.0, you can also use the getByAddress( ) factory methods of this class directly.

Figure 12-7. java.net.Inet6Address


```
public final class Inet6Address extends InetAddress {
// No Constructor
// Public Class Methods
5.0  public static Inet6Address getByAddress(String host,
byte[ ] addr, NetworkInterface nif) throws UnknownHostException;
5.0  public static Inet6Address getByAddress(String host,
byte[ ] addr, int scope_id) throws UnknownHostException;
// Public Instance Methods
5.0  public NetworkInterface getScopedInterface( );
5.0  public int getScopeId( );
     public boolean isIPv4CompatibleAddress( );
// Public Methods Overriding InetAddress
     public boolean equals(Object obj);
     public byte[ ] getAddress( );
     public String getHostAddress( );
     public int hashCode( );
     public boolean isAnyLocalAddress( );
     public boolean isLinkLocalAddress( );
     public boolean isLoopbackAddress( );
     public boolean isMCGlobal( );
     public boolean isMCLinkLocal( );
     public boolean isMCNodeLocal( );
     public boolean isMCOrgLocal( );
     public boolean isMCSiteLocal( );
     public boolean isMulticastAddress( );
     public boolean isSiteLocalAddress( );
}
```

downloaded from: lib.ommolketab.ir

Team LiB

InetAddress java.net

Java 1.0 *serializable*

This class represents an Internet Protocol (IP) address. The class does not have a public constructor but static factory methods for obtaining InetAddress objects. getLocalHost( ) returns the InetAddress of computer. getByName( ) returns the InetAddress of a host specified by name. getAllByName( ) return InetAddress objects that represents all the available addresses for a host specified by name.getByAddr an InetAddress that represents the IP address defined by the specified array of bytes.

Once you have obtained an InetAddress object, its instance methods provide various sorts of informatio of the most important are getHostName( ) , which returns the hostname, and getAddress( ) , which re address as an array of bytes, with the highest-order byte as the first element of the array.getHostAddre the IP address formatted as a string rather than as an array of bytes. The various methods whose name determine whether the address falls into any of the named categories. The "isMC" methods are all relate addresses.

This class was originally defined in Java 1.0, but many of its methods were added in Java 1.4. Java 1.4 subclasses, Inet4Address and Inet6Address representing IPv4 and IPv6 (version 4 and version 6) addr adds isReachable( ) for testing whether the address describes a reachable (and responsive) host.

Figure 12-8. java.net.InetAddress

```
public class InetAddress implements Serializable {
// No Constructor
// Public Class Methods
     public static InetAddress[ ] getAllByName(String host) throws UnknownHostException
1.4  public static InetAddress getByAddress(byte[ ] addr)
throws UnknownHostException;
1.4  public static InetAddress getByAddress(String host, byte[ ] addr) throws UnknownHos
     public static InetAddress getByName(String host) throws UnknownHostException;
     public static InetAddress getLocalHost( ) throws UnknownHostException;
// Public Instance Methods
     public byte[ ] getAddress( );            constant
1.4  public String getCanonicalHostName( );
     public String getHostAddress( );                constant
     public String getHostName( );
1.4  public boolean isAnyLocalAddress( );        constant
1.4  public boolean isLinkLocalAddress( );       constant
1.4  public boolean isLoopbackAddress( );        constant
1.4  public boolean isMCGlobal( );               constant
```

```
1.4  public boolean isMCLinkLocal( );             constant
1.4  public boolean isMCNodeLocal( );             constant
1.4  public boolean isMCOrgLocal( );              constant
1.4  public boolean isMCSiteLocal( );             constant
1.1  public boolean isMulticastAddress( );        constant
5.0  public boolean isReachable(int timeout) throws java.io.IOException;
5.0  public boolean isReachable(NetworkInterface netif, int ttl, int timeout)
throws java.io.IOException;
1.4  public boolean isSiteLocalAddress( );        constant
// Public Methods Overriding Object
     public boolean equals(Object obj);             constant
     public int hashCode( );                          constant
     public String toString( );
}
```

Subclasses

Inet4Address , Inet6Address

Passed To

Too many methods to list.

Returned By

Authenticator.getRequestingSite( ) , DatagramPacket.getAddress( ) , DatagramSocket.{getIne
getLocalAddress( )} , InetSocketAddress.getAddress( ) , MulticastSocket.getInterface( ) ,
ServerSocket.getInetAddress( ) , Socket.{getInetAddress( ) , getLocalAddress( )} ,
SocketImpl.getInetAddress( ) , URLStreamHandler.getHostAddress( ) ,
javax.security.auth.kerberos.KerberosTicket.getClientAddresses( )

Type Of

SocketImpl.address

InetSocketAddress java.net

Java 1.4 *serializable*

InetSocketAddress represents an the combination of an IP (Internet Protocol) address and a port number. The constructors allow you to specify the IP address as an InetAddress or as a hostname, and they also allow you to omit the IP address, in which case the wildcard address is used (this is useful for server sockets).

Figure 12-9. java.net.InetSocketAddress


```
public class InetSocketAddress extends SocketAddress {
// Public Constructors
     public InetSocketAddress(int port);
     public InetSocketAddress(InetAddress addr, int port);
     public InetSocketAddress(String hostname, int port);
// Public Class Methods
5.0  public static InetSocketAddress createUnresolved(String host, int port);
// Public Instance Methods
     public final InetAddress getAddress( );
     public final String getHostName( );
     public final int getPort( );
     public final boolean isUnresolved( );
// Public Methods Overriding Object
     public final boolean equals(Object obj);
     public final int hashCode( );
     public String toString( );
}
```

JarURLConnection java.net

Java 1.2

This class is a specialized URLConnection that represents a connection to a jar: URL. A jar: URL is a compound URL that includes the URL of a JAR archive and, optionally, a reference to a file or directory within the JAR archive. The jar: URL syntax uses the ! character to separate the pathname of the JAR archive from the filename within the JAR archive. Note that a jar: URL contains a subprotocol that specifies the protocol that retrieves the JAR file itself. For example:

```
jar:http://my.jar.com/my.jar!/       // The whole archive
jar:file:/usr/java/lib/my.jar!/com/jar/          // A directory of the archive
jar:ftp://ftp.jar.com/pub/my.jar!/com/jar/Jar.class // A file in the archive
```

To obtain a JarURLConnection, define a URL object for a jar: URL, open a connection to it with openConnection( ), and cast the returned URLConnection object to a JarURLConnection. The various methods defined by JarURLConnection allow you to read the manifest file of the JAR archive and look up attributes from that manifest for the archive as a whole or for individual entries in the archive. These methods make use of various classes from the java.util.jar package.

Figure 12-10. java.net.JarURLConnection

```
public abstract class JarURLConnection extends URLConnection {
// Protected Constructors
     protected JarURLConnection(URL url) throws MalformedURLException;
// Public Instance Methods
     public java.util.jar.Attributes getAttributes( ) throws java.io.IOException;
     public java.security.cert.Certificate[ ] getCertificates( )
throws java.io.IOException;
     public String getEntryName( );
     public java.util.jar.JarEntry getJarEntry( ) throws java.io.IOException;
     public abstract java.util.jar.JarFile getJarFile( )
throws java.io.IOException;
     public URL getJarFileURL( );
     public java.util.jar.Attributes getMainAttributes( )
throws java.io.IOException;
     public java.util.jar.Manifest getManifest( ) throws java.io.IOException;
// Protected Instance Fields
     protected URLConnection jarFileURLConnection;
}
```

MalformedURLException java.net

Java 1.0 *serializable checked*

Signals that an unparseable URL specification has been passed to a method.

Figure 12-11. java.net.MalformedURLException


```
public class MalformedURLException extends java.io.IOException {
// Public Constructors
     public MalformedURLException( );
     public MalformedURLException(String msg);
}
```

Thrown By

java.io.File.toURL( ), JarURLConnection.JarURLConnection( ), URI.toURL( ), URL.URL( )

Team LiB

MulticastSocket java.net

Java 1.1

This subclass of `DatagramSocket` can send and receive multicast UDP packets. It extends `DatagramSock` `joinGroup( )` and `leaveGroup( )` methods to join and leave multicast groups. You do not have to join a packet to a multicast address, but you must join the group to receive packets sent to that address. Note `MulticastSocket` is governed by a security manager.

Use `setTimeToLive( )` to set a time-to-live value for any packets sent through a `MulticastSocket` . Th number of network hops a packet can take and controls the scope of a multicast. Use `setInterface( )` `setNetworkInterface( )` to specify the `InetAddress` or the `NetworkInterface` that outgoing multicast this is useful for servers or other computers that have more than one internet address or network interf `)` specifies whether a multicast packets sent through this socket should be send back to this socket or n really be named "setLoopbackModeDisabled( )": passing an argument of `TRue` requests (but does not rec disable loopback packets.

Figure 12-12. java.net.MulticastSocket

```
public class MulticastSocket extends DatagramSocket {
// Public Constructors
     public MulticastSocket( ) throws java.io.IOException;
1.4  public MulticastSocket(SocketAddress bindaddr) throws java.io.IOException;
     public MulticastSocket(int port) throws java.io.IOException;
// Public Instance Methods
     public InetAddress getInterface( )
throws SocketException;      default:Inet4Address
1.4  public boolean getLoopbackMode( ) throws SocketException;     default:false
1.4  public NetworkInterface getNetworkInterface( ) throws SocketException;
1.2  public int getTimeToLive( ) throws java.io.IOException;     default:1
     public void joinGroup(InetAddress mcastaddr) throws java.io.IOException;
1.4  public void joinGroup(SocketAddress mcastaddr, NetworkInterface netIf)
throws java.io.IOException;
     public void leaveGroup(InetAddress mcastaddr)
throws java.io.IOException;
1.4  public void leaveGroup(SocketAddress mcastaddr, NetworkInterface netIf) throws jav
     public void setInterface(InetAddress inf) throws SocketException;
1.4  public void setLoopbackMode(boolean disable) throws SocketException;
1.4  public void setNetworkInterface(NetworkInterface netIf)
throws SocketException;
1.2  public void setTimeToLive(int ttl) throws java.io.IOException;
```

```
// Deprecated Public Methods
#    public byte getTTL( ) throws java.io.IOException;     default:1
#    public void send(DatagramPacket p, byte ttl) throws java.io.IOException;
#    public void setTTL(byte ttl) throws java.io.IOException;
}
```

Team LiB

Team LiB

NetPermission java.net

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that represents various permissions required for Java's URL-based networking system. See also `SocketPermission`, which represents permissions to perform lower-level networking operations. A `NetPermission` is defined solely by its name; no actions list is required or supported. As of Java 1.2, there are three `NetPermission` targets defined: "setDefaultAuthenticator" is required to call `Authenticator.setDefault( )`; "requestPasswordAuthentication" to call `Authenticator.requestPasswordAuthentication( )`; and "specifyStreamHandler" to explicitly pass a `URLStreamHandler` object to the `URL( )` constructor. The target "*" is a wildcard that represents all defined `NetPermission` targets.

System administrators configuring security policies must be familiar with this class and the permissions it represents. System programmers may use this class, but application programmers never need to use it explicitly.

Figure 12-13. java.net.NetPermission

```
public final class NetPermission extends java.security.BasicPermission {
// Public Constructors
     public NetPermission(String name);
     public NetPermission(String name, String actions);
}
```

Team LiB

NetworkInterface java.net

Java 1.4

Instances of this class represent a network interface on the local machine. getName( ) and getdisplayName( ) return the name of the interface, and getInetAddresses( ) returns a java.util.Enumeration of the internet addresses for the interface. Obtain a NetworkInterface object with one of the static methods defined by this class. getNetworkInterfaces( ) returns an enumeration of all interfaces for the local host. This class is typically only used in advanced networking applications.

```
public final class NetworkInterface {
// No Constructor
// Public Class Methods
     public static NetworkInterface getByInetAddress(InetAddress addr)
throws SocketException;
     public static NetworkInterface getByName(String name) throws SocketException;
     public static java.util.Enumeration<NetworkInterface> getNetworkInterfaces( )
throws SocketException;
// Public Instance Methods
     public String getDisplayName( );
     public java.util.Enumeration<InetAddress> getInetAddresses( );
     public String getName( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

DatagramSocketImpl.{joinGroup( ), leaveGroup( )}, Inet6Address.getByAddress( ), InetAddress.isReachable( ), MulticastSocket.{joinGroup( ), leaveGroup( ), setNetworkInterface( )}

Returned By

Inet6Address.getScopedInterface( ), MulticastSocket.getNetworkInterface( )

NoRouteToHostException java.net

Java 1.1 *serializable checked*

This exception signals that a socket cannot be connected to a remote host because the host cannot be contacted. Typically, this means that some link in the network between the local machine and the remote host is down or that the host is behind a firewall.

Figure 12-14. java.net.NoRouteToHostException


```
public class NoRouteToHostException extends SocketException {
// Public Constructors
     public NoRouteToHostException( );
     public NoRouteToHostException(String msg);
}
```

PasswordAuthentication java.net

Java 1.2

This simple immutable class encapsulates a username and a password. The password is stored as a character array rather than as a `String` object so that the caller can erase the contents of the array after use for increased security. Note that the `PasswordAuthentication( )` constructor clones the specified password character array, but `getPassword( )` returns a reference to the object's internal array.

Application programmers defining an `Authenticator` object for their application need to create and return a `PasswordAuthentication` object from the `getPasswordAuthentication( )` method of that object. System programmers writing `URLStreamHandler` implementations or otherwise interacting with a network server that requests password authentication may obtain a `PasswordAutentication` object representing the user's name and password by calling the static `Authenticator.requestPasswordAuthentication( )` method.

```
public final class PasswordAuthentication {
// Public Constructors
     public PasswordAuthentication(String userName, char[ ] password);
// Public Instance Methods
     public char[ ] getPassword( );
     public String getUserName( );
}
```

Returned By

`Authenticator.{getPasswordAuthentication( ), requestPasswordAuthentication( )}`

PortUnreachableException java.net

Java 1.4 *serializable checked*

An exception of this type may be thrown by a `send( )` or `receive( )` call on a `DatagramSocket` if the `connect( )` method of that socket has been called, and if the connection attempt resulted in an ICMP "port unreachable" message.

Figure 12-15. java.net.PortUnreachableException


```
public class PortUnreachableException extends SocketException {
// Public Constructors
     public PortUnreachableException( );
     public PortUnreachableException(String msg);
}
```

ProtocolException java.net

Java 1.0 *serializable checked*

Signals a protocol error in the `Socket` class.

Figure 12-16. java.net.ProtocolException


```
public class ProtocolException extends java.io.IOException {
// Public Constructors
     public ProtocolException( );
     public ProtocolException(String host);
}
```

Thrown By

`HttpURLConnection.setRequestMethod( )`

Team LiB

Proxy java.net

Java 5.0

An instance of this class represents a set of proxy server settings: a network address and a proxy server type. The `NO_PROXY` constant represents a `Proxy.Type.DIRECT` connection. `Proxy` objects may be passed to the `Socket( )` constructor or to the `URL.openConnection( )` method to connect through a specific proxy server. The `ProxySelector` class provides a way to automate the selection of proxy servers based on requested URLs.

```
public class Proxy {
// Public Constructors
     public Proxy(Proxy.Type type, SocketAddress sa);
// Public Constants
     public static final java.net.Proxy NO_PROXY;
// Nested Types
     public enum Type;
// Public Instance Methods
     public SocketAddress address( );
     public Proxy.Type type( );
// Public Methods Overriding Object
     public final boolean equals(Object obj);
     public final int hashCode( );
     public String toString( );
}
```

Passed To

`Socket.Socket( )`, `URL.openConnection( )`, `URLStreamHandler.openConnection( )`

Proxy.Type java.net

Java 5.0 *serializable comparable enum*

The constants of this enumerated type represent a type of proxy server. `DIRECT` indicates a direct, nonproxied connection. `HTTP` represents a proxy server that understands high-level protocols such as HTTP or FTP. And `SOCKS` represents a low-level SOCKS proxy server.

```
public enum Proxy.Type {
// Enumerated Constants
     DIRECT,
     HTTP,
     SOCKS;
// Public Class Methods
     public static Proxy.Type valueOf(String name);
     public static final Proxy.Type[ ] values( );
}
```

Passed To

`java.net.Proxy.Proxy( )`

Returned By

`java.net.Proxy.type( )`

ProxySelector java.net

Java 5.0

An implementation of this abstract class can be used to automatically select one or more `Proxy` objects to use to connect to a specified `URL`. Install an implementation of this class with the `setDefault( )` method. `URLConnection` implementations use the installed `ProxySelector`, if there is one, and call `select( )` to obtain a list of suitable `Proxy` objects for the connection. If a `URLConnection` cannot contact the proxy server specified in a `Proxy` object, it calls the `connectFailed( )` method to notify the `ProxySelector` object of the failure.

This class is intended to be implemented by advanced users of `java.net` and is not for casual use.

```
public abstract class ProxySelector {
// Public Constructors
     public ProxySelector( );
// Public Class Methods
     public static ProxySelector getDefault( );
     public static void setDefault(ProxySelector ps);
// Public Instance Methods
     public abstract void connectFailed(URI uri, SocketAddress sa,
java.io.IOException ioe);
     public abstract java.util.List<java.net.Proxy> select(URI uri);
}
```

ResponseCache java.net

Java 5.0

This abstract class defines an API for low-level caching of network resources retrieved through the URL and URLConnection classes. This class is intended for use by URLStreamHandler implementations, not by casual users of the java.net package. Clients that wish to enable local caching should register a ResponseCache implementation with setDefault( ) and enable caching with URLConnection.setDefaultUseCaches( ).

The static geTDefault( ) and setDefault( ) methods query and set a ResponseCache for the system. If there is a ResponseCache installed, protocol handlers should call put( ) to offer a network resource to the cache. If the cache is interested, it returns a CacheRequest object into which the URLStreamHandler can write its data. A URLStreamHandler that wants to query the cache should call get( ). If the ResponseCache holds a cached copy of the requested resource, it returns a CacheResponse from which the URLStreamHandler can read the resource.

```
public abstract class ResponseCache {
// Public Constructors
     public ResponseCache( );
// Public Class Methods
     public static ResponseCache getDefault( );      synchronized
     public static void setDefault(ResponseCache responseCache);    synchronized
// Public Instance Methods
     public abstract CacheResponse get(URI uri, String rqstMethod,
java.util.Map<String,java.util.List<String>> rqstHeaders)
        throws java.io.IOException;
     public abstract CacheRequest put(URI uri, URLConnection conn)
        throws java.io.IOException;
}
```

Team LiB

SecureCacheResponse java.net

Java 5.0

This subclass of CacheResponse represents a cached network resource that was retreived through a secure protocol such as HTTPS. Its methods return certificates and other details about the secure transfer. See also ResponseCache. This class is not intended for casual users of the java.net package.

Figure 12-17. java.net.SecureCacheResponse


```
public abstract class SecureCacheResponse extends CacheResponse {
// Public Constructors
     public SecureCacheResponse( );
// Public Instance Methods
     public abstract String getCipherSuite( );
     public abstract java.util.List<java.security.cert.Certificate>
     getLocalCertificateChain( );
     public abstract java.security.Principal getLocalPrincipal( );
     public abstract java.security.Principal getPeerPrincipal( )
     throws javax.net.ssl.SSLPeerUnverifiedException;
     public abstract java.util.List<java.security.cert.Certificate>
     getServerCertificateChain( )
     throws javax.net.ssl.SSLPeerUnverifiedException;
}
```

Team LiB

ServerSocket java.net

Java 1.0

This class is used by servers to listen for connection requests from clients. Before you can use a ServerS be *bound* to the local network address that it is to listen on. All of the ServerSocket( ) constructors exc argument constructor create a server socket and bind it to the specified local port, optionally specifying backlog" value: this is the number of client connection attempts that may be queued up before subsequ attempts are rejected.

In Java 1.4 and later, the no-argument ServerSocket( ) constructor allows you to create an unbound s this allows you to bind the socket using the bind( ) method which uses a SocketAddress object rather number. It also allows you to call setReuseAddress( ), which is only useful when done before the sock Call isBound( ) to determine whether a server socket has been bound. If it has, use getLocalSocketAd getLocalPort( ) and getInetAddress( ) to obtain the local address it is bound to.

Once a ServerSocket has been bound, you can call the accept( ) method to listen on the specified por until the client requests a connection on the port. When this happens, accept( ) accepts the connection returning a Socket the server can use to communicate with the client. A typical server starts a new thre the communication with the client and calls accept( ) again to listen for another connection.

ServerSocket defines several methods for setting socket options that affect the socket's behavior. setSo specifies the number of milliseconds that accept( ) should block before throwing an InterruptedIOExc value of 0 means that it should block forever. setReceiveBufferSize( ) is an advanced option that sug desired size for the internal receive buffer of the Socket objects returned by accept( ). This is only a h be ignored by the system. setReuseAddress( ) is another advanced option; it specifies that a bind( ) should succeed even if the local bind address is still nominally in use by a socket that is in the process o

Like all sockets, a ServerSocket should be closed with the close( ) method when it is no longer neede a ServerSocket should not be used, except to call the isClosed( ) method which returns TRue if it has

The getChannel( ) method is a link between this ServerSocket class and the New I/O java.nio.channels.ServerSocketChannel class. It returns the ServerSocketChannel associated with ServerSocket if there is one. Note, however, that this method always returns null for sockets created w ServerSocket( ) constructors. If you create a ServerSocketChannel object, and obtain a ServerSocke however, then the getChannel( ) method provides a way to link back to the parent channel.

```
public class ServerSocket {
// Public Constructors
1.4  public ServerSocket( ) throws java.io.IOException;
     public ServerSocket(int port) throws java.io.IOException;
     public ServerSocket(int port, int backlog)
throws java.io.IOException;
1.1  public ServerSocket(int port, int backlog, InetAddress bindAddr) throws java.io.IO
// Public Class Methods
     public static void setSocketFactory(SocketImplFactory fac)
```

```
throws java.io.IOException;     synchronized
// Public Instance Methods
     public Socket accept( ) throws java.io.IOException;
1.4  public void bind(SocketAddress endpoint) throws java.io.IOException;
1.4  public void bind(SocketAddress endpoint, int backlog) throws java.io.IOException;
     public void close( ) throws java.io.IOException;
1.4  public java.nio.channels.ServerSocketChannel getChannel( );
 constant default:null
     public InetAddress getInetAddress( );           default:null
     public int getLocalPort( );                     default:-1
1.4  public SocketAddress getLocalSocketAddress( );      default:null
1.4  public int getReceiveBufferSize( ) throws SocketException;     synchronized defaul
1.4  public boolean getReuseAddress( ) throws SocketException;    default:true
1.1  public int getSoTimeout( )
throws java.io.IOException;     synchronized default:0
1.4  public boolean isBound( );                  default:false
1.4  public boolean isClosed( );                 default:false
5.0  public void setPerformancePreferences(int connectionTime, int latency,
int bandwidth);     empty
1.4  public void setReceiveBufferSize(int size)
throws SocketException;     synchronized
1.4  public void setReuseAddress(boolean on) throws SocketException;
1.1  public void setSoTimeout(int timeout) throws SocketException;     synchronized
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Methods
1.1  protected final void implAccept(Socket s) throws java.io.IOException;
}
```

Subclasses

javax.net.ssl.SSLServerSocket

Returned By

java.nio.channels.ServerSocketChannel.socket( ) , javax.net.ServerSocketFactory.createSe
)

Team LiB

Socket java.net

Java 1.0

This class implements a socket for stream-based communication over the network. See URL for a higher-level interface to networking and DatagramSocket for a lower-level interface.

Before you can use a socket for communication, it must be *bound* to a local address and *connected* to a remote address. Binding and connection are done automatically for you when you call any of the Socket( ) constructors except the no-argument constructor. These constructors allow you to specify either the name or the InetAddress of the computer to connect to, and also require you to specify the port number to connect to. Two of these constructors also allow you to specify the local InetAddress and port number to bind the socket to. Most applications do not need to specify a local address, and can simply use one of the two-argument versions of Socket( ) and can allow the constructor to choose an ephemeral local port to bind the socket to.

The no-argument Socket( ) constructor is different from the others: it creates an unbound and unconnected socket. In Java 1.4 and later, you can explicitly call bind( ) and connect( ) to bind and connect the socket. It can be useful to do this when you want to set a socket option (described below) that must be set before binding or connection. bind( ) uses a SocketAddress object to describe the local address to bind to, and connect( ) uses a SocketAddress to specify the remote address to connect to. There is also a version of connect( ) that takes a timeout value in milliseconds: if the connection attempt takes longer than the specified amount of time, connect( ) throws an IOException. (See ServerSocket for a description of how to write server code that accepts socket connection requests from client code.) Java 5.0 includes a constructor that takes a Proxy object as its sole argument. Like the no-argument constructor, this creates an unbound and unconnected socket. When you attempt to connect it, the connection will be made through the specified Proxy.

Use isBound( ) and isConnected( ) to determine whether a Socket is bound and connected. Use getInetAddress( ) and getPort( ) to determine the IP address and port number that the socket is connected to. Or, in Java 1.4 and later, use geTRemoteSocketAddress( ) to obtain the remote address as a SocketAddress object. Similarly, use getLocalAddress( ) and getLocalPort( ) or use getLocalSocketAddress( ) to find out what address a socket is bound to.

Once you have a Socket object that is bound and connected, use getInputStream( ) and getOutputStream( ) to obtain InputStream and OutputStream objects you can use to communicate with the remote host. You can use these streams just as you would use similar streams for file input and output. When you are done with a Socket, use close( ) to close it. Once a socket has been closed, it is not possible to call connect( ) again to reuse it, and you should not call any of its methods except isClosed( ). Because networking code can throw many exceptions, it is common practice to close( ) a socket in the finally clause of a try/catch statement to ensure that the socket always gets closed. Note, however, that the close( ) method itself can throw an IOException, and you may need to put it in its own try block. In Java 1.3 and later shutdownInput( ) and shutdownOutput( ) allow you to close the input and output communication channels individually without closing the entire socket. In Java 1.4 and later, isInputShutdown( )

and isOutputShutdown( ) allow you to test for this.

The Socket class defines a number of methods that allow you to set (and query) "socket options" that affect the low-level networking behavior of the socket. setSendBufferSize( ) and setReceiveBufferSize( ) provide hints to the underlying networking system about what buffer size is best to use with this socket. setSoTimeout( ) specifies the number of milliseconds a read( ) call on the input stream returned by getInputStream( ) waits for data before throwing an InterruptedIOException. The default value of 0 specifies that the stream blocks indefinitely. setSoLinger( ) specifies what to do when a socket is closed while there is still data waiting to be transmitted. If lingering is turned on, the close( ) call blocks for up to the specified number of seconds while attempting to transmit the remaining data. Calling setTcpNoDelay( ) with an argument of TRue causes data to be sent through the socket as soon as it is available, instead of waiting for the TCP packet to become more full before sending it. In Java 1.3, use setKeepAlive( ) to enable or disable the periodic exchange of control messages across an idle socket connection. The keepalive protocol enables a client to determine if its server has crashed without closing the socket and vice versa. In Java 1.4, pass true to setOOBInline( ) if you want to receive "out of band" data sent to this socket "inline" on the input stream of the socket (by default such data is simply discarded). This can be used to receive bytes sent with sendUrgentData( ). Java 1.4 also adds setReuseAddress( ) which you can use before binding the socket to specify that the socket should be allowed to bind to a port that is still nominally in use by another socket that is in the process of shutting down. setTrafficClass( ) is also new in Java 1.4; it sets the "traffic class" field for the socket, and requires an understanding of the low-level details of the IP protocol.

The getChannel( ) method is a link between this Socket class and the New I/O java.nio.channels.SocketChannel class. It returns the SocketChannel associated with this Socket if there is one. Note, however, that this method always returns null for sockets created with any of the Socket( ) constructors. If you create a SocketChannel object, and obtain a Socket from it, then the getChannel( ) method provides a way to link back to the parent channel.

```
public class Socket {
// Public Constructors
1.1  public Socket( );
5.0  public Socket(java.net.Proxy proxy);
     public Socket(String host, int port)
throws UnknownHostException, java.io.IOException;
     public Socket(InetAddress address, int port) throws java.io.IOException;
#    public Socket(String host, int port, boolean stream)
throws java.io.IOException;
#    public Socket(InetAddress host, int port, boolean stream)
throws java.io.IOException;
1.1  public Socket(String host, int port, InetAddress localAddr, int localPort)
throws java.io.IOException;
1.1  public Socket(InetAddress address, int port, InetAddress localAddr,
int localPort) throws java.io.IOException;
// Protected Constructors
1.1  protected Socket(SocketImpl impl) throws SocketException;
// Public Class Methods
     public static void setSocketImplFactory(SocketImplFactory fac)
throws java.io.IOException;     synchronized
// Public Instance Methods
1.4  public void bind(SocketAddress bindpoint) throws java.io.IOException;
```

```
     public void close( ) throws java.io.IOException;        synchronized
1.4  public void connect(SocketAddress endpoint) throws java.io.IOException;
1.4  public void connect(SocketAddress endpoint, int timeout)
throws java.io.IOException;
1.4  public java.nio.channels.SocketChannel getChannel( ); constant default:null
     public InetAddress getInetAddress( );           default:null
     public java.io.InputStream getInputStream( ) throws java.io.IOException;
1.3  public boolean getKeepAlive( ) throws SocketException;     default:false
1.1  public InetAddress getLocalAddress( );      default:Inet4Address
     public int getLocalPort( );                         default:-1
1.4  public SocketAddress getLocalSocketAddress( );      default:null
1.4  public boolean getOOBInline( ) throws SocketException;     default:false
     public java.io.OutputStream getOutputStream( ) throws java.io.IOException;
     public int getPort( );                              default:0
1.2  public int getReceiveBufferSize( )
        throws SocketException;     synchronized default:43690
1.4  public SocketAddress getRemoteSocketAddress( );     default:null
1.4  public boolean getReuseAddress( ) throws SocketException;    default:false
1.2  public int getSendBufferSize( ) throws SocketException;
 synchronized default:8192
1.1  public int getSoLinger( ) throws SocketException;   default:-1
1.1  public int getSoTimeout( ) throws SocketException;  synchronized default:0
1.1  public boolean getTcpNoDelay( ) throws SocketException;     default:false
1.4  public int getTrafficClass( ) throws SocketException;      default:0
1.4  public boolean isBound( );                     default:false
1.4  public boolean isClosed( );                    default:false
1.4  public boolean isConnected( );                 default:false
1.4  public boolean isInputShutdown( );             default:false
1.4  public boolean isOutputShutdown( );            default:false
1.4  public void sendUrgentData(int data) throws java.io.IOException;
1.3  public void setKeepAlive(boolean on) throws SocketException;
1.4  public void setOOBInline(boolean on) throws SocketException;
5.0  public void setPerformancePreferences(int connectionTime, int latency,
int bandwidth);     empty
1.2  public void setReceiveBufferSize(int size)
throws SocketException;     synchronized
1.4  public void setReuseAddress(boolean on) throws SocketException;
1.2  public void setSendBufferSize(int size)
        throws SocketException;     synchronized
1.1  public void setSoLinger(boolean on, int linger) throws SocketException;
1.1  public void setSoTimeout(int timeout)
throws SocketException;     synchronized
1.1  public void setTcpNoDelay(boolean on) throws SocketException;
1.4  public void setTrafficClass(int tc) throws SocketException;
1.3  public void shutdownInput( ) throws java.io.IOException;
1.3  public void shutdownOutput( ) throws java.io.IOException;
// Public Methods Overriding Object
     public String toString( );
}
```

Subclasses

javax.net.ssl.SSLSocket

Passed To

ServerSocket.implAccept( ), javax.net.ssl.SSLSocketFactory.createSocket( ), javax.net.ssl.X509KeyManager.{chooseClientAlias( ), chooseServerAlias( )}

Returned By

ServerSocket.accept( ), java.nio.channels.SocketChannel.socket( ), javax.net.SocketFactory.createSocket( ), javax.net.ssl.SSLSocketFactory.createSocket( )

SocketAddress java.net

Java 1.4 *serializable*

Instances of this abstract class are opaque representations of network socket addresses. The only concrete subclass in the core Java platform is `InetSocketAddress` which represents an internet address and port number. See `InetSocketAddress`.

Figure 12-18. java.net.SocketAddress


```
public abstract class SocketAddress implements Serializable {
// Public Constructors
     public SocketAddress( );
}
```

Subclasses

`InetSocketAddress`

Passed To

Too many methods to list.

Returned By

`DatagramPacket.getSocketAddress( )`, `DatagramSocket.{getLocalSocketAddress( ), getremoteSocketAddress( )}`, `java.net.Proxy.address( )`, `ServerSocket.getLocalSocketAddress( )`, `Socket.{getLocalSocketAddress( ), getremoteSocketAddress( )}`, `java.nio.channels.DatagramChannel.receive( )`

SocketException java.net

Java 1.0 *serializable checked*

Signals an exceptional condition while using a socket.

Figure 12-19. java.net.SocketException


```
public class SocketException extends java.io.IOException {
// Public Constructors
     public SocketException( );
     public SocketException(String msg);
}
```

Subclasses

BindException, ConnectException, NoRouteToHostException, PortUnreachableException

Thrown By

Too many methods to list.

SocketImpl java.net

Java 1.0

This abstract class defines the methods necessary to implement communication through sockets. Different subclasses of this class may provide different implementations suitable in different environments (such as behind firewalls). These socket implementations are used by the`Socket` and `ServerSocket` classes. Normal applications never need to use or subclass this class.

Figure 12-20. java.net.SocketImpl


```
public abstract class SocketImpl implements SocketOptions {
// Public Constructors
     public SocketImpl( );
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Methods
     protected abstract void accept(SocketImpl s) throws java.io.IOException;
     protected abstract int available( ) throws java.io.IOException;
     protected abstract void bind(InetAddress host, int port)
     throws java.io.IOException;
     protected abstract void close( ) throws java.io.IOException;
     protected abstract void connect(String host, int port)
throws java.io.IOException;
     protected abstract void connect(InetAddress address, int port)
throws java.io.IOException;
1.4  protected abstract void connect(SocketAddress address, int timeout)
throws java.io.IOException;
     protected abstract void create(boolean stream) throws java.io.IOException;
     protected java.io.FileDescriptor getFileDescriptor( );
     protected InetAddress getInetAddress( );
     protected abstract java.io.InputStream getInputStream( )
     throws java.io.IOException;
     protected int getLocalPort( );
     protected abstract java.io.OutputStream getOutputStream( )
     throws java.io.IOException;
     protected int getPort( );
     protected abstract void listen(int backlog) throws java.io.IOException;
1.4  protected abstract void sendUrgentData(int data) throws java.io.IOException;
5.0  protected void setPerformancePreferences(int connectionTime, int latency,
```

```
int bandwidth);     empty
1.3  protected void shutdownInput( ) throws java.io.IOException;
1.3  protected void shutdownOutput( ) throws java.io.IOException;
1.4  protected boolean supportsUrgentData( );    constant
// Protected Instance Fields
     protected InetAddress address;
     protected java.io.FileDescriptor fd;
     protected int localport;
     protected int port;
}
```

Passed To

`Socket.Socket( )`

Returned By

`SocketImplFactory.createSocketImpl( )`

SocketImplFactory java.net

Java 1.0

This interface defines a method that creates `SocketImpl` objects. `SocketImplFactory` objects may be registered to create `SocketImpl` objects for the `Socket` and `ServerSocket` classes. Normal applications never need to use or implement this interface.

```
public interface SocketImplFactory {
// Public Instance Methods
     SocketImpl createSocketImpl( );
}
```

Passed To

`ServerSocket.setSocketFactory( )`, `Socket.setSocketImplFactory( )`

Team LiB

SocketOptions java.net

Java 1.2

This interface defines constants that represent low-level BSD Unix-style socket options and methods that set and query the value of those options. In Java 1.2, SocketImpl and DatagramSocketImpl implement this interface. Any custom socket implementations you define should also provide meaningful implementations for the getOption( ) and setOption( ) methods. Your implementation may support options other than those defined here. Only custom socket implementations need to use this interface. All other code can use methods defined by Socket, ServerSocket, DatagramSocket, and MulticastSocket to set specific socket options for those socket types.

```
public interface SocketOptions {
// Public Constants
     public static final int IP_MULTICAST_IF;       =16
1.4  public static final int IP_MULTICAST_IF2;  =31
1.4  public static final int IP_MULTICAST_LOOP; =18
1.4  public static final int IP_TOS;            =3
     public static final int SO_BINDADDR;           =15
1.4  public static final int SO_BROADCAST;      =32
1.3  public static final int SO_KEEPALIVE;      =8
     public static final int SO_LINGER;             =128
1.4  public static final int SO_OOBINLINE;      =4099
     public static final int SO_RCVBUF;             =4098
     public static final int SO_REUSEADDR;          =4
     public static final int SO_SNDBUF;             =4097
     public static final int SO_TIMEOUT;            =4102
     public static final int TCP_NODELAY;           =1
// Public Instance Methods
     Object getOption(int optID) throws SocketException;
     void setOption(int optID, Object value) throws SocketException;
}
```

Implementations

DatagramSocketImpl, SocketImpl

SocketPermission java.net

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that governs all networking operations performed with sockets. Like all permissions, a `SocketPermission` consists of a name, or target, and a list of actions that may be performed on that target. The target of a `SocketPermission` is the host and, optionally, the port or ports for which permission is being granted or requested. The target consists of a hostname optionally followed by a colon and a port specification. The host may be a DNS domain name, a numerical IP address, or the string "localhost". If you specify a host domain name, you may use `*` as a wildcard as the leftmost portion of the hostname. The port specification, if present, must be a single port number or a range of port numbers in the form `n1-n2`. If `n1` is omitted, it is taken to be `0`, and if `n2` is omitted, it is taken to be `65535`. If no port is specified, the socket permission applies to all ports of the specified host. Here are some legal `SocketPermission` targets:

```
java.sun.com:80
*.sun.com:1024-2000
*:1024-
localhost:-1023
```

In addition to a target, each `SocketPermission` must have a comma-separated list of actions, which specify the operations that may be performed on the specified host(s) and port(s). The available actions are "connect", "accept", "listen", and "resolve". "connect" represents permission to connect to the specified target. "accept" indicates permission to accept connections from the specified target. "listen" represents permission to listen on the specified ports for connection requests. This action is only valid when used for ports on "localhost". Finally, the "resolve" action indicates permission to use the DNS name service to resolve domain names into IP addresses. This action is required for and implied by all other actions.

System administrators configuring security policies must be familiar with this class and understand the risks of granting the various permissions it represents. System programmers writing new low-level networking libraries or connecting to native code that performs networking may need to use this class. Application programmers, however, should never need to use it directly.

Figure 12-21. java.net.SocketPermission

```
public final class SocketPermission extends java.security.Permission
implements Serializable {
// Public Constructors
```

```
    public SocketPermission(String host, String action);
// Public Methods Overriding Permission
    public boolean equals(Object obj);
    public String getActions( );
    public int hashCode( );
    public boolean implies(java.security.Permission p);
    public java.security.PermissionCollection newPermissionCollection( );
}
```

SocketTimeoutException java.net

Java 1.4 *serializable checked*

Signals that a timeout value was exceeded for a socket read or accept operation. See the `setSoTimeout( )` method of `Socket`.

Figure 12-22. java.net.SocketTimeoutException


```
public class SocketTimeoutException extends java.io.InterruptedIOException {
// Public Constructors
     public SocketTimeoutException( );
     public SocketTimeoutException(String msg);
}
```

UnknownHostException java.net

Java 1.0 *serializable checked*

Signals that the name of a specified host could not be resolved.

Figure 12-23. java.net.UnknownHostException


```
public class UnknownHostException extends java.io.IOException {
// Public Constructors
     public UnknownHostException( );
     public UnknownHostException(String host);
}
```

Thrown By

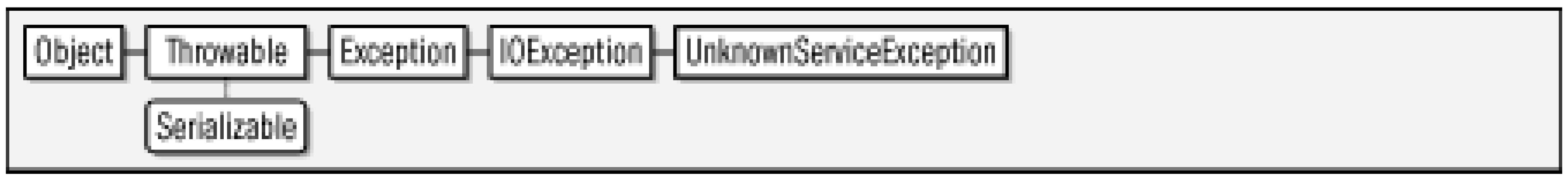
Inet6Address.getByAddress( ), InetAddress.{getAllByName( ), getByAddress( ), getByName( ), getLocalHost( )}, Socket.Socket( ), javax.net.SocketFactory.createSocket( ), javax.net.ssl.SSLSocket.SSLSocket( )

UnknownServiceException java.net

Java 1.0 *serializable checked*

Signals an attempt to use an unsupported service of a network connection.

Figure 12-24. java.net.UnknownServiceException




```
public class UnknownServiceException extends java.io.IOException {
// Public Constructors
     public UnknownServiceException( );
     public UnknownServiceException(String msg);
}
```

URI java.net

Java 1.4 *serializable comparable*

The URI class is an immutable representation of a Uniform Resource Identifier or URI. A URI is a generalization of the URLs or Uniform Resource Locators used on the world wide web. The URI supports parsing and textual manipulation of URI strings, but does not have any direct networking capabilities the way that the URL class does. The advantages of the URI class over the URL class are that it provides more general facilities for parsing and manipulating URLs than the URL class, that it can can represent relative URIs which do not include a scheme (or protocol), and that it can manipulate URIs that include unsupported or even unknown schemes.

Obtain a URI with one of the constructors, which allow a URI to be parsed from a single string, or allow the specification of the individual components of a URI. These constructors can throw URISyntaxException, which is a checked exception. When using hard-coded URIs (rather than URIs based on user input) you may prefer to use the static create( ) method which does not throw any checked exceptions.

Once you have created a URI, object you can use the various get methods to query the various portions of the URI. The getraw( ) methods are like the get( ) methods except that they do not decode hexadecimal escape sequences of the form %xx that appear in the URI. normalize( ) returns a new URI object that has "." and unnecessary ".." sequences removed from its path component. resolve( ) interprets its URI (or string) argument relative to this URI and returns the result. relativize( ) performs the reverse operation. It returns a new URI which represents the same resource as the specified URI argument, but which is relative to this URI. Finally, the toURL( ) method converts an absolute URI object to the equivalent URL. Since the URI class provides superior textual manipulation capabilities for URLs, it can be useful to use the URI class to resolve relative URLs (for example) and then convert those URI objects to URL objects when they are ready for networking.

Figure 12-25. java.net.URI

```
public final class URI implements Comparable<URI>, Serializable {
// Public Constructors
     public URI(String str) throws URISyntaxException;
     public URI(String scheme, String ssp, String fragment)
     throws URISyntaxException;
     public URI(String scheme, String host, String path, String fragment)
     throws URISyntaxException;
```

```
    public URI(String scheme, String authority, String path, String query,
    String fragment) throws URISyntaxException;
    public URI(String scheme, String userInfo, String host, int port,
    String path, String query, String fragment)
throws URISyntaxException;
// Public Class Methods
    public static URI create(String str);
// Public Instance Methods
    public String getAuthority( );
    public String getFragment( );
    public String getHost( );
    public String getPath( );
    public int getPort( );
    public String getQuery( );
    public String getRawAuthority( );
    public String getRawFragment( );
    public String getRawPath( );
    public String getRawQuery( );
    public String getRawSchemeSpecificPart( );
    public String getRawUserInfo( );
    public String getScheme( );
    public String getSchemeSpecificPart( );
    public String getUserInfo( );
    public boolean isAbsolute( );
    public boolean isOpaque( );
    public URI normalize( );
    public URI parseServerAuthority( ) throws URISyntaxException;
    public URI relativize(URI uri);
    public URI resolve(URI uri);
    public URI resolve(String str);
    public String toASCIIString( );
    public URL toURL( ) throws MalformedURLException;
// Methods Implementing Comparable
5.0 public int compareTo(URI that);
// Public Methods Overriding Object
    public boolean equals(Object ob);
    public int hashCode( );
    public String toString( );
}
```

Passed To

`java.io.File.File( )`, `CookieHandler.{get( ), put( )}`, `ProxySelector.{connectFailed( ), select( )}`, `ResponseCache.{get( ), put( )}`

Returned By

`java.io.File.toURI( )`, `URL.toURI( )`

URISyntaxException java.net

Java 1.4 *serializable checked*

Signals that a string could not be parsed as a valid URI. `getInput( )` returns the string that could not be parsed. `getreason( )` returns an error message. `getIndex( )` returns the character position at which the syntax error occurred, if that information is available. `getMessage( )` returns a human-readable string that includes the information from each of the other three methods.

This is a checked exception thrown by all the `URI( )` constructors. If you are parsing a hard-coded URI that you do not believe to contain any syntax errors, and wish to avoid the checked exception, you can use the `URI.create( )` factory method instead of the one-argument version of the `URI( ) constructor`.

Figure 12-26. java.net.URISyntaxException

```
public class URISyntaxException extends Exception {
// Public Constructors
     public URISyntaxException(String input, String reason);
     public URISyntaxException(String input, String reason, int index);
// Public Instance Methods
     public int getIndex( );
     public String getInput( );
     public String getReason( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

Thrown By

`URI.{parseServerAuthority( )`, `URI( )}`, `URL.toURI( )`

Team LiB

URL java.net

Java 1.0 *serializable*

This class represents a uniform resource locator and allows the data referred to by the URL to be downloaded. A URL can be specified as a single string or with separate protocol, host, port, and file specifications. Relative URLs can also be specified with a `String` and the `URL` object to which it is relative. `getFile( )`, `getHost( )`, `getProtocol( )` and related methods return the various portions of the URL specified by a `URL` object. `sameFile( )` determines whether a `URL` object refers to the same file as this one. `getdefaultPort( )` returns the default port number for the protocol of the `URL` object; it may differ from the number returned by `getPort( )`. Use `openConnection( )` to obtain a `URLConnection` object with which you can download the content of the URL. In Java 5.0, you can explicitly specify a `Proxy` object through which the connection should be opened. For simple cases, however, the `URL` class defines shortcut methods that create and invoke methods on a `URLConnection` internally. `getContent( )` downloads the URL data and parses it into an appropriate Java object (such as a string or image) if an appropriate `ContentHandler` can be found. In Java 1.3 and later, you can pass an array of `Class` objects that specify the type of objects that you are willing to accept as the return value of this method. If you wish to parse the URL content yourself, call `openStream( )` to obtain an `InputStream` from which you can read the data.

Figure 12-27. java.net.URL

```
public final class URL implements Serializable {
// Public Constructors
     public URL(String spec) throws MalformedURLException;
     public URL(URL context, String spec) throws MalformedURLException;
1.2  public URL(URL context, String spec, URLStreamHandler handler)
        throws MalformedURLException;
     public URL(String protocol, String host, String file)
        throws MalformedURLException;
     public URL(String protocol, String host, int port, String file)
        throws MalformedURLException;
1.2  public URL(String protocol, String host, int port, String file,
        URLStreamHandler handler) throws MalformedURLException;
// Public Class Methods
     public static void setURLStreamHandlerFactory(URLStreamHandlerFactory fac);
// Public Instance Methods
1.3  public String getAuthority( );
     public final Object getContent( ) throws java.io.IOException;
1.3  public final Object getContent(Class[ ] classes)
```

```
        throws java.io.IOException;
1.4  public int getDefaultPort( );
     public String getFile( );
     public String getHost( );
1.3  public String getPath( );
     public int getPort( );
     public String getProtocol( );
1.3  public String getQuery( );
     public String getRef( );
1.3  public String getUserInfo( );
     public URLConnection openConnection( ) throws java.io.IOException;
5.0  public URLConnection openConnection(java.net.Proxy proxy)
     throws java.io.IOException;
     public final java.io.InputStream openStream( ) throws java.io.IOException;
     public boolean sameFile(URL other);
     public String toExternalForm( );
5.0  public URI toURI( ) throws URISyntaxException;
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );                    synchronized
     public String toString( );
// Protected Instance Methods
     protected void set(String protocol, String host, int port, String file,
String ref);
1.3  protected void set(String protocol, String host, int port, String authority,
String userInfo, String path, String query,
String ref);
}
```

Passed To

Too many methods to list.

Returned By

`java.io.File.toURL( )`, `Class.getResource( )`, `ClassLoader.{findResource( )`, `getresource( )`, `getSystemResource( )}`, `Authenticator.getRequestingURL( )`, `JarURLConnection.getJarFileURL( )`, `URI.toURL( )`, `URLClassLoader.{findResource( )`, `getURLs( )}`, `URLConnection.getURL( )`, `java.security.CodeSource.getLocation( )`

Type Of

`URLConnection.url`

Team LiB

URLClassLoader java.net

Java 1.2

This ClassLoader provides a useful way to load untrusted Java code from a search path of arbitrary URLs, where each URL represents a directory or JAR file to search. Use the inherited loadClass( ) method to load a named class with a URLClassLoader. Classes loaded by a URLClassLoader have whatever permissions are granted to their java.security.CodeSource by the system java.security.Policy, plus they have one additional permission that allows the class loader to read any resource files associated with the class. If the class is loaded from a local file: URL that represents a directory, the class is given permission to read all files and directories below that directory. If the class is loaded from a local file: URL that represents a JAR file, the class is given permission to read that JAR file. If the class is loaded from a URL that represents a resource on another host, that class is given permission to connect to and accept network connections from that host. Note, however, that loaded classes are not granted this additional permission if the code that created the URLClassLoader in the first place would not have had that permission.

You can obtain a URLClassLoader by calling one of the URLClassLoader( ) constructors or one of the static newInstance( ) methods. If you call newInstance( ), the loadClass( ) method of the returned URLClassLoader performs an additional check to ensure that the caller has permission to access the specified package.

Figure 12-28. java.net.URLClassLoader

```
public class URLClassLoader extends java.security.SecureClassLoader {
// Public Constructors
     public URLClassLoader(URL[ ] urls);
     public URLClassLoader(URL[ ] urls, ClassLoader parent);
     public URLClassLoader(URL[ ] urls, ClassLoader parent,
     URLStreamHandlerFactory factory);
// Public Class Methods
     public static URLClassLoader newInstance(URL[ ] urls);
     public static URLClassLoader newInstance(URL[ ] urls, ClassLoader parent);
// Public Instance Methods
     public URL[ ] getURLs( );
// Protected Methods Overriding SecureClassLoader
     protected java.security.PermissionCollection getPermissions(java.security.
     CodeSource codesource);
// Public Methods Overriding ClassLoader
     public URL findResource(String name);
```

```
    public java.util.Enumeration<URL> findResources(String name)
    throws java.io.IOException;
// Protected Methods Overriding ClassLoader
    protected Class<?> findClass(String name) throws ClassNotFoundException;
// Protected Instance Methods
    protected void addURL(URL url);
    protected Package definePackage(String name, java.util.jar.Manifest man,
    URL url) throws IllegalArgumentException;
}
```

Team LiB

URLConnection java.net

Java 1.0

This abstract class defines a network connection to an object specified by a URL. URL.openConnection( ) returns a URLConnection instance. You should use a URLConnection object when you want more control over the downloading of data than is available through the simpler URL methods. connect( ) actually establishes the network connection. Some methods must be called before the connection is made, and others depend on being connected. The methods that depend on being connected call connect( ) themselves if no connection exists yet, so you never need to call this method explicitly. The getContent( ) methods are just like the same-named methods of the URL class: they download the data referred to by the URL and parse it into an appropriate type of object (such as a string or an image). In Java 1.3 and later, there is a version of getContent( ) that allows you to specify the types of parsed objects that you are willing to accept by passing an array of Class objects. If you prefer to parse the URL content yourself instead of calling getContent( ), you can call getInputStream( ) (and getOutputStream( ) if the URL protocol supports writing) to obtain a stream through which you can read (or write) data from (or to) the resource identified by the URL.

Before a connection is established, you may want to set request fields (such as HTTP request headers) to refine the URL request. Use setRequestProperty( ) to set a new value for a named header. In Java 1.4 and later, you can use addRequestProperty( ) to add a new comma-separated item to an existing header. Java 1.4 also added geTRequestProperties( ), a method that returns the current set of request properties in the form of an unmodifiable Map object that maps request header names to List objects that contain the string value or values for the named header.

Once a connection has been established, there are a number of methods you can call to obtain information from the "response headers" of the URL. getContentLength( ), getContentType( ), getContentEncoding( ), getExpiration( ), getdate( ), and getLastModified( ) return the appropriate information about the object referred to by the URL, if that information can be determined (e.g., from HTTP header fields). getHeaderField( ) returns an HTTP header field specified by name or by number. getHeaderFieldInt( ) and getHeaderFieldDate( ) return the value of a named header field parsed as an integer or a date. In Java 1.4 and later, getHeaderFields( ) returns an unmodifiable Map object that maps response header names to an unmodifiable List that contains the string value or values for the named header.

There are a number of options you can specify to control how the URLConnection behaves. These options are set with the various set( ) methods and may be queried with corresponding get( ) methods. The options must be set before the connect( ) method is called. setDoInput( ) and setDoOutput( ) allow you to specify whether you are using the URLConnection for input and/or output (input-only by default). setAllowUserInteraction( ) specifies whether user interaction (such as typing a password) is allowed during the data transfer (false by default). setDefaultAllowUserInteraction( ) is a class method that allows you to change the default value for user interaction. setUseCaches( ) allows you to specify whether a cached version of the URL can be used. You can set this to false to force a URL to be reloaded. setDefaultUseCaches( ) sets the default value for setUseCaches( ). setIfModifiedSince( ) allows you to specify that a URL should not be fetched unless it has been modified since a specified time (if it is possible to determine its modification date). In Java 5.0 and later, you can specify how long a `URLConnection` should wait while connecting or reading data with `setConnectTimeout( )` and `setReadTimeout( )`.

```
public abstract class URLConnection {
// Protected Constructors
     protected URLConnection(URL url);
// Public Class Methods
     public static boolean getDefaultAllowUserInteraction( );
1.1  public static FileNameMap getFileNameMap( );        synchronized
     public static String guessContentTypeFromName(String fname);
     public static String guessContentTypeFromStream(java.io.InputStream is)
     throws java.io.IOException;
     public static void setContentHandlerFactory(ContentHandlerFactory
     fac);     synchronized
     public static void setDefaultAllowUserInteraction(boolean
     defaultallowuserinteraction);
1.1  public static void setFileNameMap(FileNameMap map);
// Public Instance Methods
1.4  public void addRequestProperty(String key, String value);
     public abstract void connect( ) throws java.io.IOException;
     public boolean getAllowUserInteraction( );
5.0  public int getConnectTimeout( );
     public Object getContent( ) throws java.io.IOException;
1.3  public Object getContent(Class[ ] classes) throws java.io.IOException;
     public String getContentEncoding( );
     public int getContentLength( );
     public String getContentType( );
     public long getDate( );
     public boolean getDefaultUseCaches( );
     public boolean getDoInput( );
     public boolean getDoOutput( );
     public long getExpiration( );
     public String getHeaderField(int n);          constant
     public String getHeaderField(String name);    constant
     public long getHeaderFieldDate(String name, long Default);
     public int getHeaderFieldInt(String name, int Default);
     public String getHeaderFieldKey(int n);       constant
1.4  public java.util.Map<String,java.util.List<String>> getHeaderFields( );
     public long getIfModifiedSince( );
     public java.io.InputStream getInputStream( ) throws java.io.IOException;
     public long getLastModified( );
     public java.io.OutputStream getOutputStream( ) throws java.io.IOException;
1.2  public java.security.Permission getPermission( )
        throws java.io.IOException;
5.0  public int getReadTimeout( );
1.4  public java.util.Map<String,java.util.List<String>> getRequestProperties( );
     public String getRequestProperty(String key);
     public URL getURL( );
     public boolean getUseCaches( );
```

```
     public void setAllowUserInteraction(boolean allowuserinteraction);
5.0  public void setConnectTimeout(int timeout);
     public void setDefaultUseCaches(boolean defaultusecaches);
     public void setDoInput(boolean doinput);
     public void setDoOutput(boolean dooutput);
     public void setIfModifiedSince(long ifmodifiedsince);
5.0  public void setReadTimeout(int timeout);
     public void setRequestProperty(String key, String value);
     public void setUseCaches(boolean usecaches);
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected boolean allowUserInteraction;
     protected boolean connected;
     protected boolean doInput;
     protected boolean doOutput;
     protected long ifModifiedSince;
     protected URL url;
     protected boolean useCaches;
// Deprecated Public Methods
#    public static String getDefaultRequestProperty(String key);      constant
#    public static void setDefaultRequestProperty(String key,
     String value);     empty
}
```

Subclasses

HttpURLConnection, JarURLConnection

Passed To

java.net.ContentHandler.getContent( ), ResponseCache.put( )

Returned By

URL.openConnection( ), URLStreamHandler.openConnection( )

Type Of

JarURLConnection.jarFileURLConnection

URLDecoder java.net

Java 1.2

This class defines a static decode( ) method that reverses the encoding performed by URLEncoder.encode( ). It decodes 8-bit text with the MIME type "x-www-form-urlencoded", which is a standard encoding used by web browsers to submit form contents to CGI scripts and other server-side programs.

```
public class URLDecoder {
// Public Constructors
     public URLDecoder( );
// Public Class Methods
1.4  public static String decode(String s, String enc)
throws java.io.UnsupportedEncodingException;
// Deprecated Public Methods
#    public static String decode(String s);
}
```

URLEncoder java.net

Java 1.0

This class defines a single static method that converts a string to its URL-encoded form. That is, spaces are converted to +, and nonalphanumeric characters other than underscore are output as two hexadecimal digits following a percent sign. Note that this technique works only for 8-bit characters. This method canonicalizes a URL specification so that it uses only characters from an extremely portable subset of ASCII that can be correctly handled by computers around the world.

```
public class URLEncoder {
// No Constructor
// Public Class Methods
1.4  public static String encode(String s, String enc)
throws java.io.UnsupportedEncodingException;
// Deprecated Public Methods
#    public static String encode(String s);
}
```

Team LiB

Chapter 13. java.nio and Subpackages

This chapter documents the New I/O API defined by the `java.nio` package and its subpackages. It covers:

`java.nio`

Defines the `Buffer` class and type-specific subclasses, most notably the `ByteBuffer` class that is heavily used for I/O in the `java.nio.channels` class.

`java.nio.channels`

Defines the `Channel` abstraction for high-performance I/O, and implements channels for file and network I/O. Also allows nonblocking I/O with the `Selector` class.

`java.nio.channels.spi`

The service provider interface for channel and selector implementations.

`java.nio.charset`

Defines classes for encoding sequences of characters into bytes and decoding sequences of bytes into characters, according to the encoding rules of a named charset.

`java.nio.charset.spi`

The service provider interface for charset implementations.

Team LiB

Package java.nio

Java 1.4

This package defines buffer classes that are fundamental to the `java.nio` API. See `Buffer` for an overview of buffers, and see `ByteBuffer` (the most important of the buffer classes) for full documentation of byte buffers. The other type-specific buffer classes are close analogs to `ByteBuffer` and are documented in terms of that class. See the `java.nio.channels` package for classes that perform I/O operations on buffers.

Classes

```
public abstract class Buffer;
   public abstract class ByteBuffer extends Buffer
   implements Comparable<ByteBuffer>;
      public abstract class MappedByteBuffer extends ByteBuffer;
   public abstract class CharBuffer extends Buffer
      implements Comparable<CharBuffer>, Appendable, CharSequence,
      Readable;
   public abstract class DoubleBuffer extends Buffer
   implements Comparable<DoubleBuffer>;
   public abstract class FloatBuffer extends Buffer
   implements Comparable<FloatBuffer>;
   public abstract class IntBuffer extends Buffer
   implements Comparable<IntBuffer>;
   public abstract class LongBuffer extends Buffer
   implements Comparable<LongBuffer>;
   public abstract class ShortBuffer extends Buffer
   implements Comparable<ShortBuffer>;
public final class ByteOrder;
```

Exceptions

```
public class BufferOverflowException extends RuntimeException;
public class BufferUnderflowException extends RuntimeException;
public class InvalidMarkException extends IllegalStateException;
public class ReadOnlyBufferException extends UnsupportedOperationException;
```

Buffer java.nio

Java 1.4

This class is the abstract superclass of all buffer classes in the `java.nio` API. A *`buffer`* is a linear (finite) sequence of prmitive values. The `java.nio` package defines a `Buffer` subclass for each primitive type in Java except for `boolean`. `Buffer` itself defines the common, type-independent features of all buffers. `Buffer` and its subclasses are intended for use by a single thread at a time, and contain no synchronization code to make them thread-safe.

The purpose of a buffer is to store data, and buffer classes must define methods for reading data from a buffer and writing data into a buffer. Because each `Buffer` subclass stores data of a different primitive type, however, the `get( )` and `put( )` methods that read and write data must be defined by each of the individual subclasses. See `ByteBuffer` (the most important subclass) for documentation of these methods; all the other subclasses define similar methods which differ only in the datatype of the values being read or written.

Each buffer has four numbers associated with it:

capacity

A buffer's capacity is its maximum size; it can hold this many values. The capacity is specified when a buffer is created, and may not be changed; it can be queried with the `capacity( )` method.

limit

A buffer's limit is its current size, or the index of the first element that does not contain valid data. Data cannot be read from or written into a buffer beyond the limit. When data is being written into a buffer, the limit is usually the same as the capacity. When data is being read from a buffer, the limit may be less than the capacity, and indicates the amount of valid data contained in the buffer. Two `limit( )` methods exist: one to query a buffer's limit, and one to set it.

position

A buffer's position is the index of the element in the buffer at which data is being read or written. It is used and updated by the relative `get( )` and `put( )` methods defined by `ByteBuffer` and the other `Buffer` subclasses. Two `position( )` methods exist to query and set the current position of the buffer. A buffer's position is always greater than or equal to zero and always less than or equal to the buffer's limit. The remaining( ) method returns the number of elements between the position and the limit and hasRemaining( ) returns true if this number is greater than zero.

mark

A buffer's mark is a temporarily saved position. Call mark( ) to set the mark to the current position. Call reset( ) to restore the buffer's position to the marked position.

Buffer defines several methods that perform important operations on a buffer:

clear( )

This method does not actually clear the contents of the buffer, but it sets the position to zero, sets the limit to the capacity, and discards any saved mark. This prepares the buffer to have new data written into it.

flip( )

This method sets the limit to the position, sets the position to zero, and discards any saved mark. After data has been written into a buffer, this method "flips" the purpose of the buffer and prepares it for reading.

rewind( )

This method sets the position to zero and discards any saved mark. It does not alter the limit, and can be used to restart a read operation at the beginning of the buffer.

Buffer objects may be read-only, in which case any attempt to store data in the buffer results in a ReadonlyBufferException. The isReadOnly( ) method returns TRue if a buffer is read-only.

```
public abstract class Buffer {
// No Constructor
// Public Instance Methods
     public final int capacity( );
     public final Buffer clear( );  omu
     public final Buffer flip( );
     public final boolean hasRemaining( );
     public abstract boolean isReadOnly( );
     public final int limit( );
     public final Buffer limit(int newLimit);
     public final Buffer mark( );
     public final int position( );
     public final Buffer position(int newPosition);
     public final int remaining( );
```

```
    public final Buffer reset( );
    public final Buffer rewind( );
}
```

Subclasses

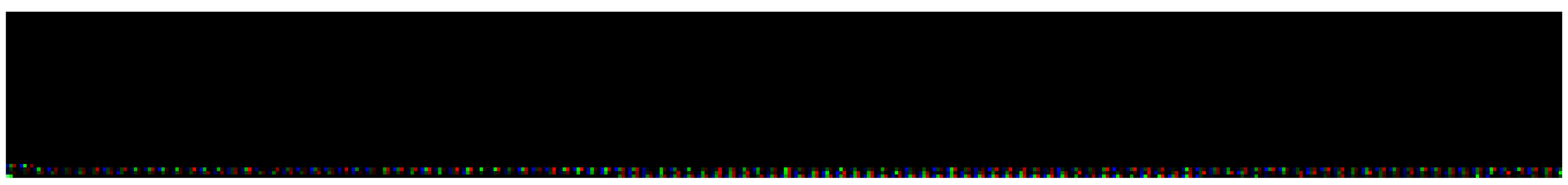
ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

BufferOverflowException java.nio

Java 1.4 *serializable unchecked*

Signals that a relative `put( )` operation on a buffer could not complete because the number of elements to write exceeds the number of remaining elements between the buffer's position and its limit.

Figure 13-1. java.nio.BufferOverflowException



```
public class BufferOverflowException extends RuntimeException {
// Public Constructors
     public BufferOverflowException( );
}
```

BufferUnderflowException java.nio

Java 1.4 *serializable unchecked*

Signals that a relative `get( )` operation on a buffer could not complete because the number of elements to read exceeds the number of remaining elements between the buffer's position and its limit.

Figure 13-2. java.nio.BufferUnderflowException

```
public class BufferUnderflowException extends RuntimeException {
// Public Constructors
     public BufferUnderflowException( );
}
```

Team LiB

ByteBuffer java.nio

Java 1.4 *comparable*

ByteBuffer holds a sequence of bytes for use in an I/O operation. ByteBuffer is an abstract class, so you cannot instantiate one by calling a constructor. Instead, you must use allocate( ) , allocateDirect( ), or wrap( ).

allocate( ) returns a ByteBuffer with the specified capacity. The position of this new buffer is zero, and its limit is set to its capacity. allocateDirect( ) is like allocate( ) except that it attempts to allocate a buffer that the underlying operating system can use "directly." Suchdirect buffers" may be substantially more efficient for low-level I/O operations than normal buffers, but may also have significantly larger allocation costs.

If you have already allocated an array of bytes, you can use the wrap( ) method to create a ByteBuffer that uses the byte array as its storage. In the one-argument version of wrap( ) you specify only the array; the buffer capacity and limit are set to the array length, and the position is set to zero. In the other form of wrap( ) you specify the array, as well as an offset and length that specify a portion of that array. The capacity of the resulting ByteBuffer is again set to the total array length, but its position is set to the specified offset, and its limit is set to the offset plus length.

Once you have obtained a ByteBuffer, you can use the various get( ) and put( ) methods to read data from it or write data into it. Several versions of these methods exist to read and write single bytes or arrays of bytes. The single-byte methods come in two forms. Relative get( ) and put( ) methods query or set the byte at the current position and then increment the position. The absolute forms of the methods take an additional arguement that specifies the buffer element that is to be read or written and do not affect the buffer position. Two other relative forms of the get( ) method exist to read as sequence of bytes (starting at and incrementing the buffer's position) into a specified byte array or a specified sub-array. These methods throw a BufferUnderflowException if there are not enough bytes left in the buffer. Two relative forms of the put( ) method copy bytes from a specified array or sub-array into the buffer (starting at and incrementing the buffer's position). They throw a BufferOverflowException if there is not enough room left in the buffer to hold the bytes. One final form of the put( ) method transfers all the remaining bytes from one ByteBuffer into this buffer, incrementing the positions of both buffers.

In addition to the get( ) and put( ) methods, ByteBuffer also defines another operation that affect the buffer's content. compact( ) discards any bytes before the buffer position, and copies all bytes between the position and limit to the beginning of the buffer. The position is then set to the new limit, and the limit is set to the capacity. This method compacts a buffer by discarding elements that have already been read, and then prepares the buffer for appending new elements to those that remain.

All Buffer subclasses, such as CharBuffer, IntBuffer and FloatBuffer have analogous methods which are just like these get( ) and put( ) methods except that they operate on different data types. ByteBuffer is unique among Buffer subclasses in that it has additional methods for reading and writing values of other primitive types from and into the byte buffer. These methods have names like getInt( ) and putChar( ), and there are methods for all primitive types except byte and boolean. Each method reads or writes a single primitive value. Like the get( ) and put( ) methods, they come in relative and absolute variations: the relative methods start with the byte at the buffer's position, and increment the position by the appropriate number of bytes (two bytes for a char, four bytes for an int, eight bytes for a double, etc.). The absolute methods take an buffer index (it is a byte index and is not multiplied by the size of the primitive value) as an argument and do not modify the buffer position. The encoding of multi-byte primitive values into a byte buffer can be done most-significant byte to least-significant byte ("big-endian byte order") or the reverse ("little-endian byte order"). The byte order used by these primitive-type get and put methods is specified by a ByteOrder object. The byte order for a ByteBuffer can be queried and set with the two forms of the order( ) method. The default byte order for all newly-created ByteBuffer objects is ByteOrder.BIG_ENDIAN.

Other methods that are unique to ByteBuffer( ) are a set of methods that allow a buffer of bytes to be viewed as a buffer of other primitive types. asCharBuffer( ), asIntBuffer( ) and related methods return "view buffers" that allow the bytes between the position and the limit of the underlying ByteBuffer to be viewed as a sequence of characters, integers, or other primitive values. The returned buffers have position, limit, and mark values that are independent of those of the underlying buffer. The initial position of the returned buffer is zero, and the limit and capacity are the number of bytes between the position and limit of the original buffer divided by the size in bytes of the relevant primitive type (two for char and short, four for int and float, and eight for long and double). Note that the returned view buffer is a view of the bytes between the position and limit of the byte buffer. Subsequent changes to the position and limit of the byte buffer do not change the size of the view buffer, but changes to the bytes themselves to change the values that are viewed through the view buffer. View buffers use the byte ordering that was current in the byte buffer when they were created; subsequent changes to the byte order of the byte buffer do not affect the view buffer. If the underlying byte buffer is direct, then the returned buffer is also direct; this is important because ByteBuffer is the only buffer class with an allocateDirect( ) method.

ByteBuffer defines some additional methods, which, like the get( ) and put( ) methods have analogs in all Buffer subclasses. duplicate( ) returns a new buffer that shares the content with this one. The two buffers have independent position, limit, and mark values, although the duplicate buffer starts off with the same values as the original buffer. The duplicate buffer is direct if the original is direct and is read-only if the original is read-only. The buffers share content, and content changes made to either buffer are visible through the other. asReadOnlyBuffer( ) is like duplicate( ) except that the returned buffer is read-only, and all of its put( ) and related methods throw a ReadOnlyBufferException. slice( ) is also somewhat like duplicate( ) except the returned buffer represents only the content between the current position and limit. The returned buffer has a position of zero, a limit and capacity equal to the number of remaining elements in this buffer, and an undefined mark. isDirect( ) is a simple method that returns true if a buffer is a direct buffer and false otherwise. If this buffer has a backing array and is not a read-only buffer (e.g., if it was created with the allocate( ) or wrap( ) methods) then hasArray( ) returns TRue, array( ) returns the backing array, and arrayOffset( ) returns the offset within that array of the first element of the buffer. If hasArray( ) returns false, then array( ) and arrayOffset( ) may throw an UnsupportedOperationException or a ReadOnlyBufferException.

Finally, ByteBuffer and other Buffer subclasses override several standard object methods. The equals( ) methods compares the elements between the position and limit of two buffers and returns true only if there are the same number and have the same value. Note that elements before the position of the buffer are not considered. The hashCode( ) method is implemented to match the equals( ) method: the hashcode is based only upon the elements between the position and limit of the buffer. This means that the hashcode changes if either the contents or position of the buffer changes. This means that instances of ByteBuffer and other Buffer subclasses are not usually useful as keys for hashtables or java.util.Map objects. toString( ) returns a string summary of the buffer, but the precise contents of the string are unspecified. ByteBuffer and each of the other Buffer subclasses also implement the Comparable interface and define a compareTo( ) method that performs an element-by-element comparison operation on the buffer elements between the position and the limit of the buffer.

Figure 13-3. java.nio.ByteBuffer


```
public abstract class ByteBuffer extends Buffer
implements Comparable<ByteBuffer> {
// No Constructor
// Public Class Methods
     public static ByteBuffer allocate(int capacity);
     public static ByteBuffer allocateDirect(int capacity);
     public static ByteBuffer wrap(byte[ ] array);
     public static ByteBuffer wrap(byte[ ] array, int offset, int length);
// Public Instance Methods
     public final byte[ ] array( );
     public final int arrayOffset( );
     public abstract CharBuffer asCharBuffer( );
     public abstract DoubleBuffer asDoubleBuffer( );
     public abstract FloatBuffer asFloatBuffer( );
     public abstract IntBuffer asIntBuffer( );
     public abstract LongBuffer asLongBuffer( );
     public abstract ByteBuffer asReadOnlyBuffer( );
     public abstract ShortBuffer asShortBuffer( );
     public abstract ByteBuffer compact( );
     public abstract ByteBuffer duplicate( );
     public abstract byte get( );
     public abstract byte get(int index);
     public ByteBuffer get(byte[ ] dst);
     public ByteBuffer get(byte[ ] dst, int offset, int length);
     public abstract char getChar( );
     public abstract char getChar(int index);
     public abstract double getDouble( );
     public abstract double getDouble(int index);
     public abstract float getFloat( );
     public abstract float getFloat(int index);
     public abstract int getInt( );
     public abstract int getInt(int index);
     public abstract long getLong( );
     public abstract long getLong(int index);
     public abstract short getShort( );
```

```
     public abstract short getShort(int index);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public final ByteOrder order( );
     public final ByteBuffer order(ByteOrder bo);
     public ByteBuffer put(ByteBuffer src);
     public abstract ByteBuffer put(byte b);
     public final ByteBuffer put(byte[ ] src);
     public abstract ByteBuffer put(int index, byte b);
     public ByteBuffer put(byte[ ] src, int offset, int length);
     public abstract ByteBuffer putChar(char value);
     public abstract ByteBuffer putChar(int index, char value);
     public abstract ByteBuffer putDouble(double value);
     public abstract ByteBuffer putDouble(int index, double value);
     public abstract ByteBuffer putFloat(float value);
     public abstract ByteBuffer putFloat(int index, float value);
     public abstract ByteBuffer putInt(int value);
     public abstract ByteBuffer putInt(int index, int value);
     public abstract ByteBuffer putLong(long value);
     public abstract ByteBuffer putLong(int index, long value);
     public abstract ByteBuffer putShort(short value);
     public abstract ByteBuffer putShort(int index, short value);
     public abstract ByteBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(ByteBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```

Subclasses

`MappedByteBuffer`

Passed To

Too many methods to list.

Returned By

`java.nio.charset.Charset.encode( )`, `java.nio.charset.CharsetEncoder.encode( )`

ByteOrder java.nio

Java 1.4

This class is a type-safe enumeration of byte orders, and is used by the ByteBuffer class. The two constant fields define the two legal byte order values: BIG_ENDIAN byte order means most-significant-byte first. LITTLE_ENDIAN means least-significant-byte first. The static nativeOrder( ) method returns whichever of these two constants represents the native byte order of the underlying operating system and hardware. Finally, the toString( ) method returns the string "BIG_ENDIAN" or "LITTLE_ENDIAN".

```
public final class ByteOrder {
// No Constructor
// Public Constants
     public static final ByteOrder BIG_ENDIAN;
     public static final ByteOrder LITTLE_ENDIAN;
// Public Class Methods
     public static ByteOrder nativeOrder( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

ByteBuffer.order( )

Returned By

ByteBuffer.order( ), CharBuffer.order( ), DoubleBuffer.order( ), FloatBuffer.order( ), IntBuffer.order( ), LongBuffer.order( ), ShortBuffer.order( )

CharBuffer java.nio

Java 1.4 *comparable appendable readable*

CharBuffer holds a sequence of Unicode character values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by ByteBuffer except that they use char and char[ ] argument and return values instead of byte and byte[ ] values. See ByteBuffer for details.

In addition to the ByteBuffer analogs, this class also implements the java.lang.CharSequence interface so that it can be used with java.util.regex regular expression operations or anywhere else a CharSequence is expected. In Java 5.0, CharBuffer adds the append( ) and read( ) methods of the java.lang.Appendable and java.lang.Readable interfaces, making CharBuffer objects suitable for use with the Formatter and Scanner classes of java.util.

Note that CharBuffer is an abstract class and does not defined a constructor. There are three ways to obtain a CharBuffer:

- By calling the static allocate( ) method. Note that there is no allocateDirect( ) method as there is for ByteBuffer.
- By calling one of the static wrap( ) methods to create a CharBuffer that uses the specified char array or CharSequence for its content. Note that wrapping a CharSequence results in a read-only CharBuffer.
- By calling the asCharBuffer( ) method of a ByteBuffer to obtain a CharBuffer "view" of the underlying bytes. If the underlying ByteBuffer is direct, then the CharBuffer view will also be direct.

Note that this class holds a sequence of 16-bit Unicode characters, and does not represent text in any other encoding. Classes in the java.nio.charset package can be used to encode a CharBuffer of Unicode characters into a ByteBuffer, or decode the bytes in a ByteBuffer into a CharBuffer of Unicode text. Java 5.0 supports Unicode supplementary characters that do not fit in 16 bits. See java.lang.Character for details. Note that CharBuffer does not include any utility methods for working with int codepoints or surrogate pairs.

Figure 13-4. java.nio.CharBuffer

```
public abstract class CharBuffer extends Buffer
```

```
implements Comparable<CharBuffer>, Appendable, CharSequence, Readable {
// No Constructor
// Public Class Methods
     public static CharBuffer allocate(int capacity);
     public static CharBuffer wrap(char[ ] array);
     public static CharBuffer wrap(CharSequence csq);
     public static CharBuffer wrap(char[ ] array, int offset, int length);
     public static CharBuffer wrap(CharSequence csq, int start, int end);
// Public Instance Methods
5.0  public CharBuffer append(char c);
5.0  public CharBuffer append(CharSequence csq);
5.0  public CharBuffer append(CharSequence csq, int start, int end);
     public final char[ ] array( );
     public final int arrayOffset( );
     public abstract CharBuffer asReadOnlyBuffer( );
     public abstract CharBuffer compact( );
     public abstract CharBuffer duplicate( );
     public abstract char get( );
     public abstract char get(int index);
     public CharBuffer get(char[ ] dst);
     public CharBuffer get(char[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public final CharBuffer put(char[ ] src);
     public CharBuffer put(CharBuffer src);
     public final CharBuffer put(String src);
     public abstract CharBuffer put(char c);
     public abstract CharBuffer put(int index, char c);
     public CharBuffer put(String src, int start, int end);
     public CharBuffer put(char[ ] src, int offset, int length);
     public abstract CharBuffer slice( );
// Methods Implementing CharSequence
     public final char charAt(int index);
     public final int length( );
     public abstract CharSequence subSequence(int start, int end);
     public String toString( );
// Methods Implementing Comparable
5.0  public int compareTo(CharBuffer that);
// Methods Implementing Readable
5.0  public int read(CharBuffer target) throws java.io.IOException;
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
}
```

Passed To

`java.io.Reader.read( )`, `Readable.read( )`, `java.nio.charset.Charset.encode( )`, `java.nio.charset.CharsetDecoder.{decode( )`, `decodeLoop( )`, `flush( )`, `implFlush( )}`, `java.nio.charset.CharsetEncoder.{encode( )`, `encodeLoop( )}`

Returned By

`ByteBuffer.asCharBuffer( )`, `java.nio.charset.Charset.decode( )`, `java.nio.charset.CharsetDecoder.decode( )`

DoubleBuffer java.nio

Java 1.4 *comparable*

DoubleBuffer holds a sequence of double values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by ByteBuffer except that they use double and double[ ] argument and return values instead of byte and byte[ ] values. See ByteBuffer for details.

DoubleBuffer is abstract and has no constructor. Create one by calling the static allocate( ) or wrap( ) methods, which are also analogs of ByteBuffer methods. Or, create a "view" DoubleBuffer by calling the asDoubleBuffer( ) method of an underlying ByteBuffer.

Figure 13-5. java.nio.DoubleBuffer

```
public abstract class DoubleBuffer extends Buffer
implements Comparable<DoubleBuffer> {
// No Constructor
// Public Class Methods
     public static DoubleBuffer allocate(int capacity);
     public static DoubleBuffer wrap(double[ ] array);
     public static DoubleBuffer wrap(double[ ] array, int offset, int length);
// Public Instance Methods
     public final double[ ] array( );
     public final int arrayOffset( );
     public abstract DoubleBuffer asReadOnlyBuffer( );
     public abstract DoubleBuffer compact( );
     public abstract DoubleBuffer duplicate( );
     public abstract double get( );
     public abstract double get(int index);
     public DoubleBuffer get(double[ ] dst);
     public DoubleBuffer get(double[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public DoubleBuffer put(DoubleBuffer src);
     public abstract DoubleBuffer put(double d);
     public final DoubleBuffer put(double[ ] src);
     public abstract DoubleBuffer put(int index, double d);
```

```
    public DoubleBuffer put(double[ ] src, int offset, int length);
    public abstract DoubleBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(DoubleBuffer that);
// Public Methods Overriding Object
    public boolean equals(Object ob);
    public int hashCode( );
    public String toString( );
}
```

Returned By

ByteBuffer.asDoubleBuffer( )

FloatBuffer java.nio

Java 1.4 *comparable*

`FloatBuffer` holds a sequence of `float` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `float` and `float[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`FloatBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `FloatBuffer` by calling the `asFloatBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-6. java.nio.FloatBuffer

```
public abstract class FloatBuffer extends Buffer
implements Comparable<FloatBuffer> {
// No Constructor
// Public Class Methods
     public static FloatBuffer allocate(int capacity);
     public static FloatBuffer wrap(float[ ] array);
     public static FloatBuffer wrap(float[ ] array, int offset, int length);
// Public Instance Methods
     public final float[ ] array( );
     public final int arrayOffset( );
     public abstract FloatBuffer asReadOnlyBuffer( );
     public abstract FloatBuffer compact( );
     public abstract FloatBuffer duplicate( );
     public abstract float get( );
     public abstract float get(int index);
     public FloatBuffer get(float[ ] dst);
     public FloatBuffer get(float[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public FloatBuffer put(FloatBuffer src);
     public abstract FloatBuffer put(float f);
     public final FloatBuffer put(float[ ] src);
     public abstract FloatBuffer put(int index, float f);
```

```
     public FloatBuffer put(float[ ] src, int offset, int length);
     public abstract FloatBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(FloatBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```

Returned By

ByteBuffer.asFloatBuffer( )

IntBuffer java.nio

Java 1.4 *comparable*

IntBuffer holds a sequence of int values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by ByteBuffer except that they use int and int[ ] argument and return values instead of byte and byte[ ] values. See ByteBuffer for details.

IntBuffer is abstract and has no constructor. Create one by calling the static allocate( ) or wrap( ) methods, which are also analogs of ByteBuffer methods. Or, create a "view" IntBuffer by calling the asIntBuffer( ) method of an underlying ByteBuffer.

Figure 13-7. java.nio.IntBuffer

```
public abstract class IntBuffer extends Buffer implements Comparable<IntBuffer> {
// No Constructor
// Public Class Methods
     public static IntBuffer allocate(int capacity);
     public static IntBuffer wrap(int[ ] array);
     public static IntBuffer wrap(int[ ] array, int offset, int length);
// Public Instance Methods
     public final int[ ] array( );
     public final int arrayOffset( );
     public abstract IntBuffer asReadOnlyBuffer( );
     public abstract IntBuffer compact( );
     public abstract IntBuffer duplicate( );
     public abstract int get( );
     public abstract int get(int index);
     public IntBuffer get(int[ ] dst);
     public IntBuffer get(int[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public IntBuffer put(IntBuffer src);
     public abstract IntBuffer put(int i);
     public final IntBuffer put(int[ ] src);
     public abstract IntBuffer put(int index, int i);
     public IntBuffer put(int[ ] src, int offset, int length);
     public abstract IntBuffer slice( );
```

```
// Methods Implementing Comparable
5.0  public int compareTo(IntBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```

Returned By

`ByteBuffer.asIntBuffer( )`

Team LiB

InvalidMarkException java.nio

Java 1.4 *serializable unchecked*

Signals that a buffer's position cannot be `reset( )` because there is no mark defined.

Figure 13-8. java.nio.InvalidMarkException


```
public class InvalidMarkException extends IllegalStateException {
// Public Constructors
     public InvalidMarkException( );
}
```

Team LiB

LongBuffer java.nio

Java 1.4 *comparable*

LongBuffer holds a sequence of long values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by ByteBuffer except that they use long and long[ ] argument and return values instead of byte and byte[ ] values. See ByteBuffer for details.

LongBuffer is abstract and has no constructor. Create one by calling the static allocate( ) or wrap( ) methods, which are also analogs of ByteBuffer methods. Or, create a "view" LongBuffer by calling the asLongBuffer( ) method of an underlying ByteBuffer.

Figure 13-9. java.nio.LongBuffer

```
public abstract class LongBuffer extends Buffer
implements Comparable<LongBuffer> {
// No Constructor
// Public Class Methods
     public static LongBuffer allocate(int capacity);
     public static LongBuffer wrap(long[ ] array);
     public static LongBuffer wrap(long[ ] array, int offset, int length);
// Public Instance Methods
     public final long[ ] array( );
     public final int arrayOffset( );
     public abstract LongBuffer asReadOnlyBuffer( );
     public abstract LongBuffer compact( );
     public abstract LongBuffer duplicate( );
     public abstract long get( );
     public abstract long get(int index);
     public LongBuffer get(long[ ] dst);
     public LongBuffer get(long[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public LongBuffer put(LongBuffer src);
     public abstract LongBuffer put(long l);
     public final LongBuffer put(long[ ] src);
     public abstract LongBuffer put(int index, long l);
     public LongBuffer put(long[ ] src, int offset, int length);
```

```
    public abstract LongBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(LongBuffer that);
// Public Methods Overriding Object
    public boolean equals(Object ob);
    public int hashCode( );
    public String toString( );
}
```

Returned By

ByteBuffer.asLongBuffer( )

Team LiB

Team LiB

MappedByteBuffer java.nio

Java 1.4 *comparable*

This class is a ByteBuffer that represents a memory-mapped portion of a file. Create a MappedByteBuffer by calling the map( ) method of a java.nio.channels.FileChannel. All MappedByteBuffer buffers are direct buffers.

isLoaded( ) returns a hint as to whether the contents of the buffer are currently in primary memory (as opposed to resident on disk). If it returns TRue, then operations on the buffer will probably execute very quickly. The load( ) method requests (but does not require) that the operating system load the buffer contents into primary memory. It is not guaranteed to succeed. For buffers that are mapped in read/write mode, the force( ) method outputs any changes that have been made to the buffer contents to the underlying file. If the file is on a local device, then it is guaranteed to be updated before force( ) returns. No such guarantees can be made for mapped network files.

Note that the underlying file of a MappedByteBuffer may be shared, which means that the contents of such a buffer can change asynchronously if the contents of the file are modified by another thread or another process (such asynchronous changes to the underlying file may or may not be visible through the buffer; this is a platform-dependent, and should not be relied on). Furthermore, if another thread or process truncates the file, some or all of the elements of the buffer may no longer map to any content of the file. An attempt to read or write such an inaccesible element of the buffer will cause an implementation-defined exception, either immediately or at some later time.

Figure 13-10. java.nio.MappedByteBuffer

```
public abstract class MappedByteBuffer extends ByteBuffer {
// No Constructor
// Public Instance Methods
     public final MappedByteBuffer force( );
     public final boolean isLoaded( );
     public final MappedByteBuffer load( );
}
```

Returned By

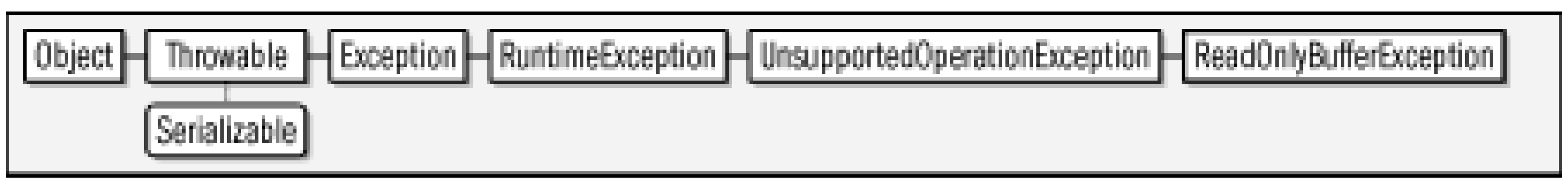
java.nio.channels.FileChannel.map( )

ReadOnlyBufferException java.nio

Java 1.4 *serializable unchecked*

Signals that a buffer is read-only and that its `put( )` or `compact( )` methods are not allowed to modify the buffer contents.

Figure 13-11. java.nio.ReadOnlyBufferException




```
public class ReadOnlyBufferException extends UnsupportedOperationException {
// Public Constructors
     public ReadOnlyBufferException( );
}
```

Team LiB

ShortBuffer java.nio

Java 1.4 *comparable*

ShortBuffer holds a sequence of short values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by ByteBuffer except that they use short and short[ ] argument and return values instead of byte and byte[ ] values. See ByteBuffer for details.

ShortBuffer is abstract and has no constructor. Create one by calling the static allocate( ) or wrap( ) methods, which are also analogs of ByteBuffer methods. Or, create a "view" ShortBuffer by calling the asShortBuffer( ) method of an underlying ByteBuffer.

Figure 13-12. java.nio.ShortBuffer

```
public abstract class ShortBuffer extends Buffer
implements Comparable<ShortBuffer> {
// No Constructor
// Public Class Methods
     public static ShortBuffer allocate(int capacity);
     public static ShortBuffer wrap(short[ ] array);
     public static ShortBuffer wrap(short[ ] array, int offset, int length);
// Public Instance Methods
     public final short[ ] array( );
     public final int arrayOffset( );
     public abstract ShortBuffer asReadOnlyBuffer( );
     public abstract ShortBuffer compact( );
     public abstract ShortBuffer duplicate( );
     public abstract short get( );
     public abstract short get(int index);
     public ShortBuffer get(short[ ] dst);
     public ShortBuffer get(short[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public ShortBuffer put(ShortBuffer src);
     public abstract ShortBuffer put(short s);
     public final ShortBuffer put(short[ ] src);
     public abstract ShortBuffer put(int index, short s);
```

```
    public ShortBuffer put(short[ ] src, int offset, int length);
    public abstract ShortBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(ShortBuffer that);
// Public Methods Overriding Object
    public boolean equals(Object ob);
    public int hashCode( );
    public String toString( );
}
```

Returned By

`ByteBuffer.asShortBuffer( )`

Team LiB

Package java.nio.channels

Java 1.4

This package is at the heart of the NIO API. A *channel* is a communication channel for transferring bytes from or to a `java.nio.ByteBuffer`. Channels serve a similar purpose to the `InputStream` and `OutputStream` classes of the `java.io` package, but are completely unrelated to those classes, and provide important features not available with the `java.io` API. The `Channels` class defines methods that bridge the `java.io` and `java.nio.channels` APIs, by returning channels based on streams and streams based on channels.

The `Channel` interface simply defines methods for testing whether a channel is open and for closing a channel. The other interfaces in the package extend `Channel` and define `read( )` and `write( )` methods for reading bytes from the channel into one or more byte buffers and for writing bytes from one or more byte buffers to the channel.

The `FileChannel` class defines an channel-based API for reading and writing from files (and also provides other important file functionality such as file locking and memory mapping that is not available through the `java.io` package). `SocketChannel`, `ServerSocketChannel`, and `DatagramChannel` are channels for communication over a network, and `Pipe` defines two inner classes that use the channel abstraction for communication between threads.

The network and pipe channels are all subclasses of the `SelectableChannel` class, and may be put into nonblocking mode, in which calls to `read( )` and `write( )` return immediately, even if the channel is not ready for reading or writing. nonblocking IO and networking is not possible using the stream abstraction of the `java.io` and `java.net` packages, and is perhaps the most important new feature of the `java.nio` API. The `Selector` class is crucial to the efficient use of nonblocking channels: it allows a program to register interested in I/O operations on several different channels at once. A call to the `select( )` method of a `Selector` will block until one of those channels becomes ready for I/O, and will then wake up. This technique is important for writing scalable high-performance network servers. See `Selector` and `SelectionKey` for details.

Finally, this package allows for very fine-grained error handling by defining a large number of exception classes, several of which may be thrown by only a single method within the `java.nio` API.

Interfaces

```
public interface ByteChannel extends ReadableByteChannel, WritableByteChannel;
public interface Channel extends java.io.Closeable;
public interface GatheringByteChannel extends WritableByteChannel;
public interface InterruptibleChannel extends Channel;
public interface ReadableByteChannel extends Channel;
public interface ScatteringByteChannel extends ReadableByteChannel;
public interface WritableByteChannel extends Channel;
```

Classes

```
public final class Channels;
public abstract class DatagramChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
public abstract class FileChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
public static class FileChannel.MapMode;
public abstract class FileLock;
public abstract class Pipe;
public abstract static class Pipe.SinkChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements GatheringByteChannel, WritableByteChannel;
public abstract static class Pipe.SourceChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ReadableByteChannel, ScatteringByteChannel;
public abstract class SelectableChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
      implements Channel;
public abstract class SelectionKey;
public abstract class Selector;
public abstract class ServerSocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel;
public abstract class SocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
```

Exceptions

```
public class AlreadyConnectedException extends IllegalStateException;
public class CancelledKeyException extends IllegalStateException;
public class ClosedChannelException extends java.io.IOException;
   public class AsynchronousCloseException extends ClosedChannelException;
      public class ClosedByInterruptException extends AsynchronousCloseException;
public class ClosedSelectorException extends IllegalStateException;
public class ConnectionPendingException extends IllegalStateException;
public class FileLockInterruptionException extends java.io.IOException;
public class IllegalBlockingModeException extends IllegalStateException;
public class IllegalSelectorException extends IllegalArgumentException;
public class NoConnectionPendingException extends IllegalStateException;
public class NonReadableChannelException extends IllegalStateException;
public class NonWritableChannelException extends IllegalStateException;
public class NotYetBoundException extends IllegalStateException;
public class NotYetConnectedException extends IllegalStateException;
public class OverlappingFileLockException extends IllegalStateException;
public class UnresolvedAddressException extends IllegalArgumentException;
public class UnsupportedAddressTypeException extends IllegalArgumentException;
```

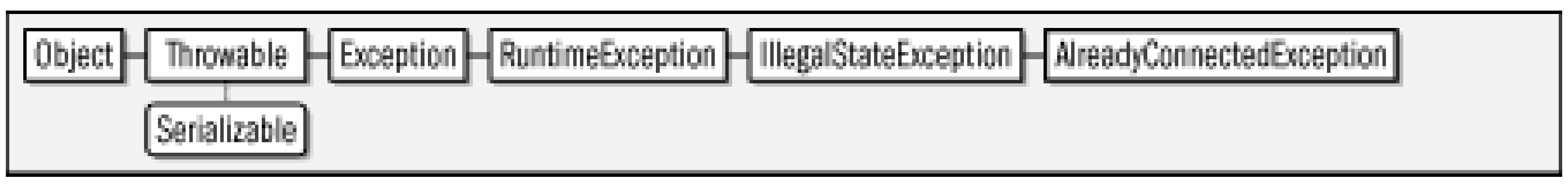
downloaded from: lib.ommolketab.ir

AlreadyConnectedException java.nio.channels

Java 1.4 *serializable unchecked*

Thrown by a call to `connect( )` on a `SocketChannel` that is already connected.

Figure 13-13. java.nio.channels.AlreadyConnectedException




```
public class AlreadyConnectedException extends IllegalStateException {
// Public Constructors
     public AlreadyConnectedException( );
}
```

AsynchronousCloseException java.nio.channels

Java 1.4 *serializable checked*

Signals the termination of a blocked I/O operation because another thread closed the channel asynchronously. See also `ClosedByInterruptException`.

Figure 13-14. java.nio.channels.AsynchronousCloseException


```
public class AsynchronousCloseException extends ClosedChannelException {
// Public Constructors
     public AsynchronousCloseException( );
}
```

Subclasses

`ClosedByInterruptException`

Thrown By

`java.nio.channels.spi.AbstractInterruptibleChannel.end( )`

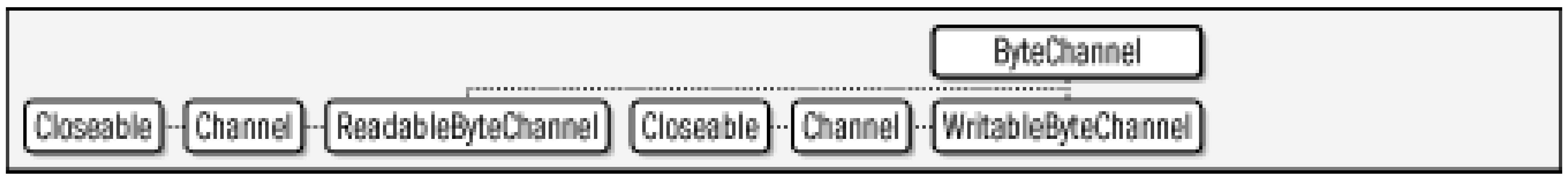
Team LiB

ByteChannel java.nio.channels

Java 1.4 *closeable*

This interface extends ReadableByteChannel and WritableByteChannel but adds no methods or constants of its own. It exists simply as a convience that to unify the two interfaces.

Figure 13-15. java.nio.channels.ByteChannel




```
public interface ByteChannel extends ReadableByteChannelWritableByteChannel {
}
```

Implementations

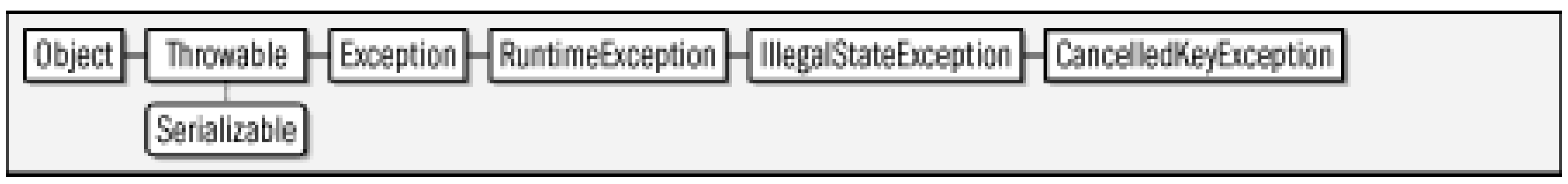
DatagramChannel, FileChannel, SocketChannel

CancelledKeyException java.nio.channels

Java 1.4 *serializable unchecked*

Signals an attempt to use a `SelectionKey` whose `cancel( )` method has previously been called.

Figure 13-16. java.nio.channels.CancelledKeyException




```
public class CancelledKeyException extends IllegalStateException {
// Public Constructors
     public CancelledKeyException( );
}
```

Channel java.nio.channels

Java 1.4 *closeable*

This interface defines a communication channel for input and output. The `Channel` interface is a high-level generic interface which is extended by more specific interfaces, such as `ReadableByteChannel` and `WritableByteChannel`. `Channel` defines only two methods: `isOpen( )` determines whether a channel is open, and `close( )` closes a channel. Channels are open when they are first created. Once closed, a channel remains closed forever, and no further I/O operations may take place through it.

Many channel implementations are interruptible and asynchonously closeable, and implement the `InterruptibleChannel` interface to advertise this fact. See `InterruptibleChannel` for details.

Figure 13-17. java.nio.channels.Channel

```
public interface Channel extends java.io.Closeable {
// Public Instance Methods
     void close( ) throws java.io.IOException;
     boolean isOpen( );
}
```

Implementations

`InterruptibleChannel`, `ReadableByteChannel`, `SelectableChannel`, `WritableByteChannel`, `java.nio.channels.spi.AbstractInterruptibleChannel`

Returned By

`System.inheritedChannel( )`, `java.nio.channels.spi.SelectorProvider.inheritedChannel( )`

Channels java.nio.channels

Java 1.4

This class defines static methods that provide a bridge between the byte stream and character stream classes of the `java.io` package and the channel classes of `java.nio.channels`. `Channels` is never intended to be instantiated: it serves solely as a placeholder for static methods. These method create byte channels based on `java.io` byte streams, and create `java.io` byte streams based on byte channels. Note that the channel objects returned by the `newChannel( )` methods may not implement `InterruptibleChannel`, and so may not be asynchonously closeable and interruptible like other channel classes in this package. `Channels` also defines methods to create character streams (`java.io.Reader` and `java.io.Writer`) based on the combination of a byte channel and a character encoding. The encoding may be specified by charset name, or with a `CharsetDecoder` or `CharsetEncoder` (see `java.nio.charset`).

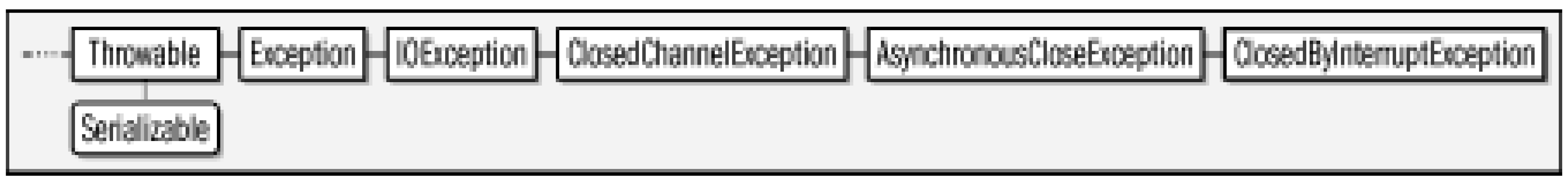
```
public final class Channels {
// No Constructor
// Public Class Methods
     public static ReadableByteChannel newChannel(java.io.InputStream in);
     public static WritableByteChannel newChannel(java.io.OutputStream out);
     public static java.io.InputStream newInputStream(ReadableByteChannel ch);
     public static java.io.OutputStream newOutputStream(WritableByteChannel ch);
     public static java.io.Reader newReader(ReadableByteChannel ch,
String csName);
     public static java.io.Reader newReader(ReadableByteChannel ch,
java.nio.charset.CharsetDecoder dec, int minBufferCap);
     public static java.io.Writer newWriter(WritableByteChannel ch,
String csName);
     public static java.io.Writer newWriter(WritableByteChannel ch,
java.nio.charset.CharsetEncoder enc, int minBufferCap);
}
```

ClosedByInterruptException java.nio.channels

Java 1.4 *serializable checked*

An exception of this type is thrown by a thread blocked in an I/O operation on a channel when another thread calls its `interrupt( )` method. This exception is a subclass of `AsynchronousCloseException` and the channel will be closed as a side-effect of the thread interruption.

Figure 13-18. java.nio.channels.ClosedByInterruptException




```
public class ClosedByInterruptException extends AsynchronousCloseException {
// Public Constructors
     public ClosedByInterruptException( );
}
```

ClosedChannelException java.nio.channels

Java 1.4 *serializable checked*

Signals an attempt to perform I/O on a channel that has been closed with the `close( )` method, or that is closed for a particular type of I/O operation (a `SocketChannel`, for example, may have its read and write halves shut down independently.) Channels may be closed asynchronously, and threads blocking to complete an I/O operation will throw a subclass of this exception type. See `AsynchronousCloseException` and `ClosedByInterruptException`.

Figure 13-19. java.nio.channels.ClosedChannelException


```
public class ClosedChannelException extends java.io.IOException {
// Public Constructors
     public ClosedChannelException( );
}
```

Subclasses

`AsynchronousCloseException`

Thrown By

`SelectableChannel.register( )`, `java.nio.channels.spi.AbstractSelectableChannel.register( )`

ClosedSelectorException java.nio.channels

Java 1.4 *serializable unchecked*

Signals an attempt to use a `Selector` object whose `close( )` method has been called.

Figure 13-20. java.nio.channels.ClosedSelectorException


```
public class ClosedSelectorException extends IllegalStateException {
// Public Constructors
     public ClosedSelectorException( );
}
```

ConnectionPendingException java.nio.channels

Java 1.4 *serializable unchecked*

Signals a call to the `connect( )` method of a `SocketChannel` when there is already a connection pending for that channel. See `SocketChannel.isConnectionPending( )`.

Figure 13-21. java.nio.channels.ConnectionPendingException


```
public class ConnectionPendingException extends IllegalStateException {
// Public Constructors
     public ConnectionPendingException( );
}
```

DatagramChannel java.nio.channels

Java 1.4 *closeable*

This class implements a communication channel based on network datagrams. Obtain a `DatagramChannel` by calling the static `open( )` method. Call `socket( )` to obtain the `java.net.DatagramSocket` object on which the channel is based if you need to set any socket options to control low-level networking details.

The `send( )` method sends the remaining bytes of the specified `ByteBuffer` to the host and port specified in the `java.net.SocketAddress` in the form of a datagram. `receive( )` does the opposite: it receives a datagram, stores its content into the specified buffer (discarding any bytes that do not fit) and then returns a `SocketAddress` that specifies the sender of the datagram (or returns `null` if the channel was in nonblocking mode and no datagram was waiting).

The `send( )` and `receive( )` methods typically perform security checks on each invocation to see if the application has permissions to communicate with the remote host. If your application will use a `DatagramChannel` to exchange datagrams with a single remote host and port, use the `connect( )` method to connect to a specified `SocketAddress`. The `connect( )` method performs the required security checks once and allows future communication with the specified address without the overhead. Once a `DatagramChannel` is connected, you can use the standard `read( )` and `write( )` methods defined by the `ReadableByteChannel`, `WritableByteChannel`, `GatheringByteChannel` and `ScatteringByteChannel` interfaces. Like the `receive( )` method, the `read( )` methods silently discard any received bytes that do not fit in the specified `ByteBuffer`. The `read( )` and `write( )` methods throw a `NotYetConnected` exception if `connect( )` has not been called.

`DatagramChannel` is a `SelectableChannel`; its `validOps( )` method specifies that read and write operations may be selected. `DatagramChannel` objects are thread-safe. Read and write operations may proceed concurrently, but the class ensures that only one thread may read and one thread write at a time.

Figure 13-2. java.nio.channels.DatagramChannel

```
public abstract class DatagramChannel extends java.nio.channels.spi.
AbstractSelectableChannel
implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
```

```
// Protected Constructors
     protected DatagramChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Class Methods
     public static DatagramChannel open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract DatagramChannel connect(java.net.SocketAddress remote)
throws java.io.IOException;
     public abstract DatagramChannel disconnect( ) throws java.io.IOException;
     public abstract boolean isConnected( );
     public abstract java.net.SocketAddress receive(java.nio.ByteBuffer dst)
throws java.io.IOException;
     public abstract int send(java.nio.ByteBuffer src, java.net.SocketAddress
target) throws java.io.IOException;
     public abstract java.net.DatagramSocket socket( );
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
throws java.io.IOException;
// Public Methods Overriding SelectableChannel
     public final int validOps( );          constant
}
```

Returned By

java.net.DatagramSocket.getChannel( ), java.nio.channels.spi.SelectorProvider.openDatagramChannel( )

FileChannel java.nio.channels

Java 1.4 *closeable*

This class implements a communication channel for efficiently reading and and writing files. It implements the standard `read( )` and `write( )` methods of the `ReadableByteChannel`, `WritableByteChannel`, `GatheringByteChannel` and `ScatteringByteChannel` methods. In addition, however, `FileChannel` provides methods for: random-access to the file, efficient transfer of bytes between the file and another channel, file locking, memory mapping, querying and setting the file size and forcing buffered updates to be written to disk. These important features are described in further detail below. Note that since file operations do not typically block for extended periods the way network operations can, `FileChannel` does not subclass `SelectableChannel` (it is the only channel class that does not) and cannot be used with `Selector` objects.

`FileChannel` has no public constructor and no static factory methods. To obtain a `FileChannel`, first create a `FileInputStream`, `FileOutputStream`, or `RandomAccessFile` object (see the `java.io` package) and then call the `getChannel( )` method of that object. If you use a `FileInputStream`, the resulting channel will allow reading but not writing, and if you use a `FileOutputStream`, the channel will allow writing but not reading. If you obtain a `FileChannel` from a `RandomAccessFile`, then the channel will allow reading, or both reading and writing, depending on the *mode* argument to the `RandomAccessFile` constructor.

A `FileChannel` has a *position* or file pointer that specifies the current point in the file. You can set or query the file position with two methods, both of which share the name `position( )`. The position of a `FileChannel` and of the stream or `RandomAccessFile` from which it is derived are always the same: changing the position of the channel changes the position of the stream, and vice versa. The initial position of a `FileChannel` is the position of the stream or `RandomAccessFile` when the `getChannel( )` method was called. If you create a `FileChannel` from a `FileOutputStream` that was opened in append mode, then any output to the channel always occurs at the end of the file, and sets the file position to the end end of the file.

Once you have a `FileChannel` object, you can use the standard `read( )` and `write( )` methods defined by the various channel interfaces. In addition to updating the buffer position as they read and write bytes, these methods also update the file position to or from which those bytes are written or read. These standard `read( )` methods return the number of bytes actually read, and return -1 if there are no bytes left in the file to read. The `write( )` methods enlarge the file if they write past the current end-of-file.

`FileChannel` also defines position-independent `read( )` and `write( )` methods that take a file position as an explicit argument: they read or write starting at that position of the file, and although they update the position of the `ByteBuffer`, they do not update the file position of the `FileChannel`. If the specified position is past the end-of-file, the read( ) method does not read any bytes and returns -1, and the `write( )` method enlarges the file, leaving any bytes between the old end-of-file and the specified position undefined.

It is common to read bytes from a `FileChannel` and then immediately write them out to some other channel (such as a SocketChannel: think of a web server, for example), or to read bytes from a channel and immediately write them to a FileChannel (consider an FTP client). FileChannel provides two methods, transferTo( ) and TRansferFrom( ) that do this very efficiently, without the need for a temporary ByteBuffer. TRansferTo( ) reads up to the specified number of bytes starting at the specified location from this FileChannel and writes them to the specified channel. It does not alter the file position of the FileChannel, and it returns the number of bytes actually transferred. transferFrom( ) does the reverse: it reads up to the specified number of available bytes from the specified channel, and writes them to this FileChannel at the specified location, without altering the file position of this channel, and returns the actual number of bytes transferred. For both methods, if the destination or source channel is a FileChannel itself, then the file position of that channel is updated.

The size( ) method returns the size (in bytes) of the underlying file. truncate( ) reduces the file size to the specified value, discarding any file content that exceeds that size. If the specified size is greater than or equal to the current file size, the file is unchanged. If the file position is greater than the new size of the file, it the position is changed to the new size.

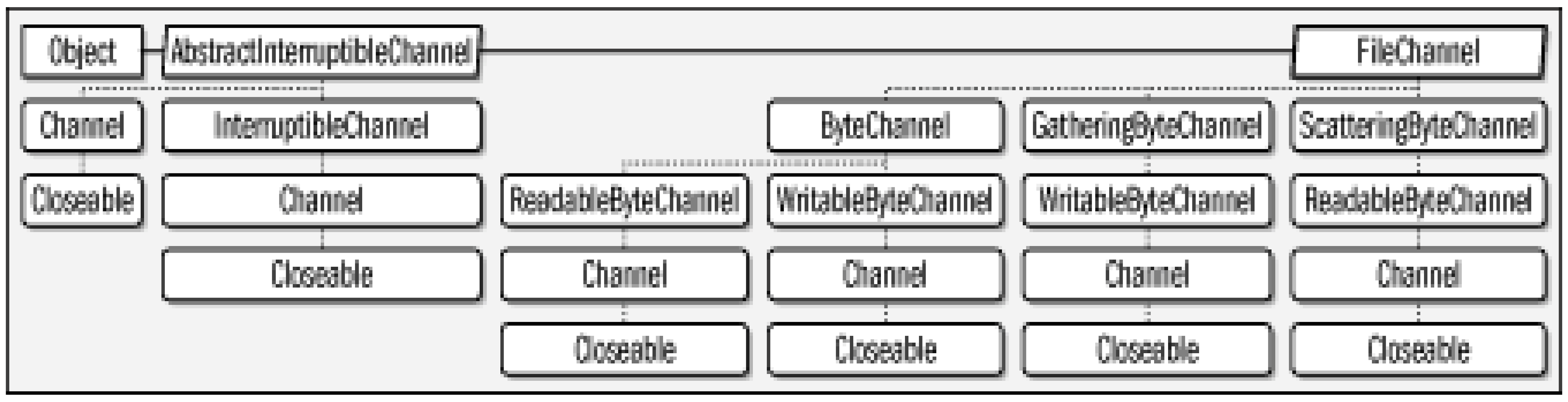
Use the force( ) method to force any buffered modifications to the file to be written to the underlying storage device. If the file resides on a local device, (as opposed to a network filesystem, for example) then force( ) guarantees that any changes to the file made since the channel was opened or since a previous call to force( ) will have been written to the device. The argument to this method is a hint as to whether file meta-data (such as last modification time) is to be forced out in addition to file content. If this argument is true, the system will force content and meta-data. If false, the system may omit updates to meta-data. Note that force( ) is only required to output change made directly through the FileChannel. File updates made through a MappedByteBuffer returned by the map( ) method (described below)y should be forced out with the force( ) method of MappedByteBuffer.

FileChannel defines two blocking lock( ) and two nonblocking tryLock( ) methods for locking a file or a region of a file against concurrent access by another program. (These methods are not suitable for preventing concurrent access to a file by two threads within the same Java virtual machine.) The no-argument versions of these methods attempt to acquire an exclusive lock on the entire file. The three-argument versions of the methods attempt to lock a specified region of the file, and may acquire shared locks in addition to exclusive locks. (A shared lock prevents any other process from acquiring an exclusive lock, but does not prevent other shared locks: typically, you acquire a shared lock when reading a file that should not be concurrently updated, and acquire an exclusive lock before writing file content to ensure that no one else is trying to read it at the same time.) The tryLock( ) methods return a FileLock object, or null if there was already a conflicting lock on the file. The lock( ) methods block if there is already a conflicting lock and never return null. See FileLock for more information about locks. The FileChannel file locking mechanism uses whatever locking capability is provided by the underlying platform. Some operating systems enforce file locking: if one process holds a lock, other processes are prevented by the operating system from accessing the file. Other operating systems merely prevent other processes from acquiring a conflicting lock: in this case, successful file locking requires the cooperation of all processes. Some operating systems do not support shared locks: on these systems an exclusive lock is returned even when a shared lock is requested.

The map( ) method returns a MappedByteBuffer that represents the specified region of the file. File contents can be read directly from the buffer, and (if the mapping is done in read/write mode) bytes placed in the buffer will be written to the file. The mapping represented by a MappedByteBuffer remains valid until the buffer is garbage collected; the buffer continues to function even if the FileChannel from which it was created is closed. File mappings can be done in three different modes which specify whether bytes can be written into the buffer and what happens when this is done. See `FileChannel.MapMode` for a description of the three modes.

The `map( )` method relies on the memory-mapping facilities provided by the underlying operating system. This means that a number of details may vary from implementation to implementation. In particular, it is not specified whether changes to the underlying file made after the call to `map( )` are visible through the `MappedByteBuffer`. Using a mapped file is typically more efficient that an unmapped file only when the file is a large one.

Figure 13-23. java.nio.channels.FileChannel




```
public abstract class FileChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
 implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected FileChannel( );
// Nested Types
     public static class MapMode;
// Public Instance Methods
     public abstract void force(boolean metaData) throws java.io.IOException;
     public final FileLock lock( ) throws java.io.IOException;
     public abstract FileLock lock(long position, long size, boolean shared)
        throws java.io.IOException;
     public abstract java.nio.MappedByteBuffer map(FileChannel.MapMode mode,
        long position, long size) throws java.io.IOException;
     public abstract long position( ) throws java.io.IOException;
     public abstract FileChannel position(long newPosition)
        throws java.io.IOException;
     public abstract int read(java.nio.ByteBuffer dst, long position)
        throws java.io.IOException;
     public abstract long size( ) throws java.io.IOException;
     public abstract long transferFrom(ReadableByteChannel src, long position,
        long count) throws java.io.IOException;
     public abstract long transferTo(long position, long count,
        WritableByteChannel target) throws java.io.IOException;
     public abstract FileChannel truncate(long size) throws java.io.IOException;
     public final FileLock tryLock( ) throws java.io.IOException;
     public abstract FileLock tryLock(long position, long size, boolean shared)
        throws java.io.IOException;
     public abstract int write(java.nio.ByteBuffer src, long position)
        throws java.io.IOException;
```

```
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
        throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
        int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
        throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
        throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
        int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
        throws java.io.IOException;
}
```

Passed To

FileLock.FileLock( )

Returned By

java.io.FileInputStream.getChannel( ), java.io.FileOutputStream.getChannel( ), java.io.RandomAccessFile.getChannel( ), FileLock.channel( )

FileChannel.MapMode java.nio.channels

Java 1.4

This class defines three constants that define the legal values of the *mode* argument to the `map( )` method of the `FileChannel` class. The constants and their meanings are the following:

`READ_ONLY`

The memory mapping is read-only. The contents of the `MappedByteBuffer` returned by the `map( )` method may be read but may not be modified.

`READ_WRITE`

The memory mapping is bidirectional: The contents of the returned buffer can be modified, and any modifications will (eventually) be written to the underlying file. The `FileChannel` must have been created from a `java.io.RandomAccessFile` opened in read/write mode.

`PRIVATE`

The returned buffer may be modified, but any such changes are private to the buffer, and are never written to the underlying file. This mapping mode is also known as "copy-on-write."

```
public static class FileChannel.MapMode {
// No Constructor
// Public Constants
     public static final FileChannel.MapMode PRIVATE;
     public static final FileChannel.MapMode READ_ONLY;
     public static final FileChannel.MapMode READ_WRITE;
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`FileChannel.map( )`

Team LiB

FileLock java.nio.channels

Java 1.4

A FileLock object is returned by the lock( ) and tryLock( ) methods of FileChannel and represents a lock on a file or a region of a file. See FileChannel for more information on file locking with those methods. When a lock is no longer required, it should be released with the release( ) method. A lock will also be released if the channel is closed, or when the virtual machine terminates. isValid( ) returns TRue if the lock has not yet been released, and returns false if it has been released.

The channel( ) , position( ), size( ) and isShared( ) methods return basic information about the lock: the FileChannel that was locked, the region of the file that was locked, and whether the lock is shared or exclusive. If the entire file is locked, then the size( ) method returns a value (Long.MAX_VALUE) that is much greater than the actual file size. If the underlying operating system does not support shared locks, then isShared( ) may return false even if a shared lock was requested. overlaps( ) is a convenience method that returns true if the position and size of this lock overlap the specified position and size.

```
public abstract class FileLock {
// Protected Constructors
     protected FileLock(FileChannel channel, long position, long size,
        boolean shared);
// Public Instance Methods
     public final FileChannel channel( );
     public final boolean isShared( );
     public abstract boolean isValid( );
     public final boolean overlaps(long position, long size);
     public final long position( );
     public abstract void release( ) throws java.io.IOException;
     public final long size( );
// Public Methods Overriding Object
     public final String toString( );
}
```

Returned By

FileChannel.{lock( ), tryLock( )}

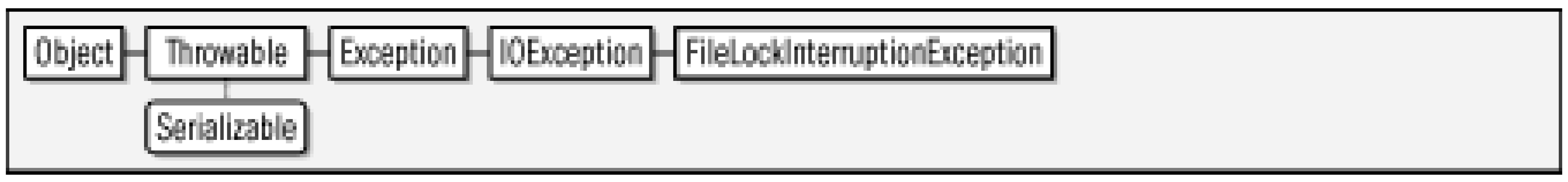
Team LiB

FileLockInterruptionException java.nio.channels

Java 1.4 *serializable checked*

Signals that the `interrupt( )` method of a thread blocked waiting to acquire a file lock was called. See `FileChannel.lock( )`.

Figure 13-24. java.nio.channels.FileLockInterruptionException




```
public class FileLockInterruptionException extends java.io.IOException {
// Public Constructors
     public FileLockInterruptionException( );
}
```

GatheringByteChannel java.nio.channels

Java 1.4 *closeable*

This interface extends WritableByteChannel and adds two additional write( ) methods that can "gather" bytes from one or more buffers and write them out to the channel. These methods are passed an array of ByteBuffer objects, and, optionally, an offset and length that define the relevant sub-array to be used. The write( ) method attempts to write all the remaining bytes from all the specified buffers (in the order in which they appear in the buffer array) to the channel. The return value of the method is the number of bytes actually written. See WritableByteChannel for a discussion of exceptions and thread-safety that apply to these write( ) methods as well.

Figure 13-25. java.nio.channels.GatheringByteChannel

```
public interface GatheringByteChannel extends WritableByteChannel {
// Public Instance Methods
     long write(java.nio.ByteBuffer[ ] srcs) throws java.io.IOException;
     long write(java.nio.ByteBuffer[ ] srcs, int offset, int length)
        throws java.io.IOException;
}
```

Implementations

DatagramChannel, FileChannel, Pipe.SinkChannel, SocketChannel

IllegalBlockingModeException java.nio.channels

Java 1.4 *serializable unchecked*

Signals an attempt to use a channel in the wrong blocking mode. An exception of this type is thrown by `SelectableChannel.register( )` if the channel is not in nonblocking mode.

Figure 13-26. java.nio.channels.IllegalBlockingModeException

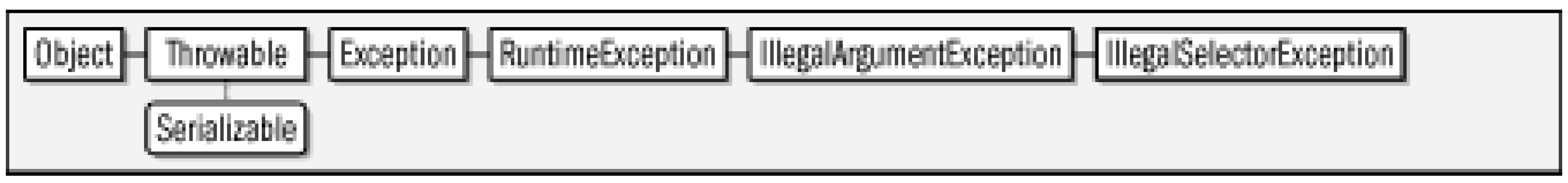

```
public class IllegalBlockingModeException extends IllegalStateException {
// Public Constructors
     public IllegalBlockingModeException( );
}
```

IllegalSelectorException java.nio.channels

Java 1.4 *serializable unchecked*

Signals an attempt to register a `SelectableChannel` with a `Selector` when the channel and the selector were not created by the same `java.nio.channels.spi.SelectorProvider`.

Figure 13-27. java.nio.channels.IllegalSelectorException




```
public class IllegalSelectorException extends IllegalArgumentException {
// Public Constructors
     public IllegalSelectorException( );
}
```

InterruptibleChannel java.nio.channels

Java 1.4 *closeable*

Channels that implement this marker interface have two important properties that are relevant to multithreaded programs: they are *asynchonously closeable* and *interruptible*. When the `close( )` method of an `InterruptibleChannel` is called, any other thread that is blocked waiting for an I/O operation to complete on that channel will stop blocking and receive an `AsynchronousCloseException`. Furthermore, if a thread is blocked waiting for an I/O operation to complete on an `InterruptibleChannel`, then another thread may call the `interrupt( )` method of the blocked thread. This causes the interrupt status of the blocked thread to be set and causes the thread to wake up and receive an `ClosedByInterruptException` (a subclass of `AsynchronousCloseException`). As the name of this interrupt implies, the channel that the thread was blocked on is closed as a side-effect of the thread interruption. There is no way to interrupt a blocked thread without closing the channel upon which it is blocked. This ability to interrupt a blocked thread is particularly noteworthy because it has never worked reliably with the older `java.io` API.

All the concrete channel implementations that are part of this package implement `InterruptibleChannel`. Note, however, that methods such as `Channels.newChannel( )` may return channel objects that are not interruptible. You can use the `instanceof` to determine whether an unknown channel object implements this interface.

Figure 13-28. java.nio.channels.InterruptibleChannel

```
public interface InterruptibleChannel extends Channel {
// Public Instance Methods
     void close( ) throws java.io.IOException;
}
```

Implementations

`java.nio.channels.spi.AbstractInterruptibleChannel`

Team LiB

NoConnectionPendingException java.nio.channels

Java 1.4 *serializable unchecked*

Signals that `SocketChannel.finishConnect( )` was called without a previous call to `SocketChannel.connect( )`.

Figure 13-29. java.nio.channels.NoConnectionPendingException


```
public class NoConnectionPendingException extends IllegalStateException {
// Public Constructors
     public NoConnectionPendingException( );
}
```

Team LiB

NonReadableChannelException java.nio.channels

Java 1.4 *serializable unchecked*

Signals a call to the `read( )` method of a readable channel that is not open for reading, such as a `FileChannel` created from a `FileOutputStream`.

Figure 13-30. java.nio.channels.NonReadableChannelException


```
public class NonReadableChannelException extends IllegalStateException {
// Public Constructors
     public NonReadableChannelException( );
}
```

NonWritableChannelException java.nio.channels

Java 1.4 *serializable unchecked*

Signal a call to a `write( )` method of a writable channel that is not open for writing, such as a `FileChannel` created from a `FileInputStream`.

Figure 13-31. java.nio.channels.NonWritableChannelException


```
public class NonWritableChannelException extends IllegalStateException {
// Public Constructors
     public NonWritableChannelException( );
}
```

Team LiB

NotYetBoundException java.nio.channels

Java 1.4 *serializable unchecked*

Signals a call to `ServerSocketChannel.accept( )` before the underlying server socket has been bound to a local port. Call `socket( ).bind( )` to bind the `java.net.ServerSocket` that underlies the `ServerSocketChannel`.

Figure 13-32. java.nio.channels.NotYetBoundException


```
public class NotYetBoundException extends IllegalStateException {
// Public Constructors
     public NotYetBoundException( );
}
```

NotYetConnectedException java.nio.channels

Java 1.4 *serializable unchecked*

Signals an attempt to `read( )` or `write( )` on a `SocketChannel` that is not yet connected to a remote host. See `SocketChannel.connect( )`.

Figure 13-33. java.nio.channels.NotYetConnectedException


```
public class NotYetConnectedException extends IllegalStateException {
// Public Constructors
     public NotYetConnectedException( );
}
```

Team LiB

OverlappingFileLockException java.nio.channels

Java 1.4 *serializable unchecked*

This exception is thrown by the `lock( )` and `tryLock( )` methods of `FileChannel` if the requested lock region overlaps a file lock that is already held by some thread in this JVM, or if there is already a thread in this JVM waiting to lock an overlapping region of the same file. The`FileChannel` file locking mechanism is designed to lock files against concurrent access by two separate processes. Two threads within the same JVM should not attempt to acquire a lock on overlapping regions of the same file, and any attempt to do so causes an exception of this type to be thrown.

Figure 13-34. java.nio.channels.OverlappingFileLockException


```
public class OverlappingFileLockException extends IllegalStateException {
// Public Constructors
     public OverlappingFileLockException( );
}
```

Pipe java.nio.channels

Java 1.4

A pipe is an abstraction that allows the one-way transfer of bytes from onethread to another. A pipe has a "read end" and a "write end" which are represented by objects that implement the ReadableByteChannel and WritableByteChannel interfaces. Create a new pipe with the static Pipe.open( ) method. Call the sink( ) method to obtain the Pipe.SinkChannel object that represents the write end of the pipe, and call the source( ) method to obtain the Pipe.SourceChannel object that represents the read end of the pipe.

Programmers familiar with Unix-style pipes may find the names and return values of the sink( ) and source( ) methods confusing. A Unix pipe is an interprocess communication mechanism that is tied to two specific processes, one of which is a source of bytes and one of which is a destination, or sink, for those bytes. With this conceptual model of a pipe, you would expect the source to obtain the channel it writes to with the source( ) method and the sink to obtain the channel it reads from with the sink( ) method.

This Pipe class is not a Unix-style pipe, however. While it can be used for communication between two threads, the ends of the pipe are not tied to those threads, and there need not be a single source thread and a single sink thread. Therefore, in the Pipe API it is the pipe itself that serves as the source and the sink of bytes: bytes are read from the source end of the pipe, and are written to the sink end.

```
public abstract class Pipe {
// Protected Constructors
     protected Pipe( );
// Nested Types
     public abstract static class SinkChannel extends java.nio.channels.spi.
        AbstractSelectableChannel implements GatheringByteChannel,
        WritableByteChannel;
     public abstract static class SourceChannel extends java.nio.channels.spi.
        AbstractSelectableChannel implements ReadableByteChannel,
        ScatteringByteChannel;
// Public Class Methods
     public static Pipe open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract Pipe.SinkChannel sink( );
     public abstract Pipe.SourceChannel source( );
}
```

Returned By

java.nio.channels.spi.SelectorProvider.openPipe( )

Team LiB

Team LiB

Pipe.SinkChannel java.nio.channels

Java 1.4 *closeable*

This public inner class is represents the write end of a pipe. Bytes written to a `Pipe.SinkChannel` become available on the corresponding `Pipe.SourceChannel` of the pipe. Obtain a `Pipe.SinkChannel` by creating a `Pipe` object with `Pipe.open( )` and then calling the `sink( )` method of that object. See also the containing `Pipe` class.

`Pipe.SinkChannel` implements `WritableByteChannel` and `GatheringByteChannel` and defines the `write( )` methods of those interfaces. This class subclasses `SelectableChannel`, so that it can be used with a `Selector`. It overrides the abstract `validOps( )` method of `SelectableChannel` to return `SelectionKey.OP_WRITE`, but defines no new methods of its own.

```
public abstract static class Pipe.SinkChannel extends java.nio.channels.spi.
AbstractSelectableChannel implements GatheringByteChannel, WritableByteChannel {
// Protected Constructors
     protected SinkChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Methods Overriding SelectableChannel
     public final int validOps( );        constant
}
```

Returned By

`Pipe.sink( )`

Team LiB

Pipe.SourceChannel java.nio.channels

Java 1.4 *closeable*

This public inner class is represents the read end of a pipe. Bytes that are written to the corresponding write end of the pipe (see Pipe.SinkChannel) become available for reading through this channel. Obtain a Pipe.SourceChannel by creating a Pipe object with Pipe.open( ) and then calling the source( ) method of that object. See also the containing Pipe class.

Pipe.SourceChannel implements ReadableByteChannel and ScatteringByteChannel and defines the read( ) methods of those interfaces. This class subclasses SelectableChannel, so that it can be used with a Selector. It overrides the abstract validOps( ) method of SelectableChannel to return SelectionKey.OP_READ, but defines no new methods of its own.

```
public abstract static class Pipe.SourceChannel extends java.nio.channels.spi.
AbstractSelectableChannel implements ReadableByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected SourceChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Methods Overriding SelectableChannel
     public final int validOps( );          constant
}
```

Returned By

Pipe.source( )

ReadableByteChannel java.nio.channels

Java 1.4 *closeable*

This subinterface of `Channel` defines a single key `read( )` method which reads bytes from the channel and stores them in the specified `ByteBuffer`, updating the buffer position as it does so. `read( )` attempts to read as many bytes as will fit in the specified buffer, (see `Buffer.remaining( )`) but may read fewer than this. If the channel is a nonblocking channel, for example, the `read( )` will return immediately, even if there are no bytes available to be read. `read( )` returns the number of bytes actually read (which may be zero in the nonblocking case), or returns -1 if there are no more bytes to be read in the channel (if, for example, the end of a file has been reached, or the othe end of a socket has been closed.)

`read( )` is declared to throw an `IOException`. More specifically, it may throw a `ClosedChannelException` if the channel is closed. If the channel is closed asynchronously, or if a blocked thread is interrupted, the `read( )` method may terminate with an `AsynchronousCloseException` or a `ClosedByInterruptException`. `read( )` may also throw an unchecked `NonReadableChannelException` if it is called on a channel that was not opened or configured to allow reading.

`ReadableByteChannel` implementations are required to be thread-safe: only one thread may perform a read operation on a channel at a time. If a read operation is in progress, then any call to `read( )` will block until the in-progress operation completes. Some channel implementations may allow read and write operations to proceed concurrently, but none will allow two read operations to proceed at the same time.

Figure 13-35. java.nio.channels.ReadableByteChannel

```
public interface ReadableByteChannel extends Channel {
// Public Instance Methods
     int read(java.nio.ByteBuffer dst) throws java.io.IOException;
}
```

Implementations

`ByteChannel`, `Pipe.SourceChannel`, `ScatteringByteChannel`

Passed To

`Channels.{newInputStream( ), newReader( )}`, `FileChannel.transferFrom( )`, `java.util.Scanner.Scanner( )`

Returned By

`Channels.newChannel( )`

ScatteringByteChannel java.nio.channels

Java 1.4 *closeable*

This interface extends ReadableByteChannel and adds two additional read( ) methods that read bytes for a channel and "scatter" them to an array (or subarray) of buffers. These methods are passed an array of ByteBuffer objects, and, optionally, an offset and length that define the region of the array to be used. The read( ) method attempts to read enough bytes from the channel to fill each of the specified buffers in the order in which they appear in the buffer array (the "scattering" process is actually much more orderly and linear than the name implies). The return value of the method is the number of bytes actually read, which may be different than the sum of the remaining bytes in the buffers. See ReadableByteChannel for a discussion of exceptions and thread-safety that apply to these read( ) methods as well.

Figure 13-36. java.nio.channels.ScatteringByteChannel

```
public interface ScatteringByteChannel extends ReadableByteChannel {
// Public Instance Methods
     long read(java.nio.ByteBuffer[ ] dsts) throws java.io.IOException;
     long read(java.nio.ByteBuffer[ ] dsts, int offset, int length)
throws java.io.IOException;
}
```

Implementations

DatagramChannel, FileChannel, Pipe.SourceChannel, SocketChannel

Team LiB

SelectableChannel java.nio.channels

Java 1.4 *closeable*

This abstract class defines the API for channels that can be used with a`Selector` object to allow a thread to block while waiting for activity on any of a group of channels. All channel classes in the `java.nio.channels` package except for `FileChannel` are subclasses of `SelectableChannel`.

A selectable channel may only be registered with a`Selector` if it is nonblocking, so this class defines the `configureBlocking( )` method. Pass `false` to this method to put a channel into nonblocking mode, or pass `TRue` to make calls to its `read( )` and/or `write( )` methods block. Use `isBlocking( )` to determine the current blocking mode of a selectable channel.

Register a `SelectableChannel` with a `Selector` by calling the `register( )` method of the channel (not of the selector). There are two versions of this method: both take a`Selector` object and a bitmask that specifies the set of channel operations that are to be "selected" on that channel. (see `SelectionKey` for the constants that can be OR-ed together to form this bitmask). Both methods return a `SelectionKey` object that represents the registration of the channel with the selector. One version of the `register( )` method also takes an arbitrary object argument which serves as an "attachment" to the `SelectionKey` and allows you to associate arbitrary data with it. The`validOps( )` method returns a bitmask that specifies the set of operations that a particular`channel` object allows to be selected. The bitmask passed to`register( )` may only contain bits that are set in this `validOps( )` value.

Note that `SelectableChannel` does not define a `deregister( )` method. Instead, to remove a channel from the set of channels being monitored by a`Selector`, you must call the `cancel( )` method of the `SelectionKey` returned by `register( )`.

Call `isRegistered( )` to determine whether a `SelectableChannel` is registered with any `Selector`. (Note that a single channel may be registered with more than one`Selector`.) If you did not keep track of the `SelectionKey` returned by a call to `register( )`, you can query it with the `keyFor( )` method.

See `Selector` and `SelectionKey` for further details on multiplexing selectable channels.

Figure 13-37. java.nio.channels.SelectableChannel

```
public abstract class SelectableChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel implements Channel {
// Protected Constructors
```

```
    protected SelectableChannel( );
// Public Instance Methods
    public abstract Object blockingLock( );
    public abstract SelectableChannel configureBlocking(boolean block)
       throws java.io.IOException;
    public abstract boolean isBlocking( );
    public abstract boolean isRegistered( );
    public abstract SelectionKey keyFor(Selector sel);
    public abstract java.nio.channels.spi.SelectorProvider provider( );
    public final SelectionKey register(Selector sel, int ops)
       throws ClosedChannelException;
    public abstract SelectionKey register(Selector sel, int ops, Object att)
       throws ClosedChannelException;
    public abstract int validOps( );
}
```

Subclasses

java.nio.channels.spi.AbstractSelectableChannel

Returned By

SelectionKey.channel( ), java.nio.channels.spi.AbstractSelectableChannel.configureBlocking( )

Team LiB

SelectionKey java.nio.channels

Java 1.4

A SelectionKey represents the registration of a SelectableChannel with a Selector, and serves to identify a selected channel and the operations that are ready to be performed on that channel. After a call to the select( ) method of a selector, the selectedKeys( ) method of the selector returns a Set of SelectionKey objects to identify the channel or channels that are ready for reading, for writing, or for another operation.

Create a SelectionKey by passing a Selector object to the register( ) method of a SelectableChannel. The channel( ) and selector( ) methods of the returned SelectionKey return the SelectableChannel and Selector objects associated with that key.

When you no longer wish the channel to be registered with the selector, call the cancel( ) method of the SelectionKey. isValid( ) determines whether a SelectionKey is still "valid"it returns true unless the cancel( ) method has been called, the channel has been closed or the selector has been closed.

The main purpose of a SelectionKey is to hold the "interest set" of channel operations that the selector should monitor for the channel, and also the "ready set" of operations that the selector has determined are ready to proceed on the channel. Both sets are represented as integer bitmasks (not java.util.Set objects) formed by OR-ing together any of the OP_ constants defined by this class. Those constants are the following:

OP_READ

In the interest set, this bit specifies an interest in read operations. In the ready set, this bit specifies that the channel has bytes available for reading, has reached the end-of-stream, has been remotely closed, or that an error has occurred.

OP_WRITE

In the interest set, this bit specifies an interest in write operations. In the ready set, this bit specifies that the channel is ready to have bytes written, or has been closed, or that an error has occurred.

OP_CONNECT

In the interest set, this bit specifies an interest in socket connection operations. In the ready set, it indicates that a socket channel is ready to connect, or that an error has occurred.

OP_ACCEPT

In the interest set, this bit specifies an interest in server socket accept operations. In the ready set, it indicates that a server socket channel is ready to accept a connection or that an error has occurred.

The no-argument version of the interestOps( ) method allows you to query the interest set. The inital value of the interest set the bitmask that was passed to theregister( ) method of the channel. It can be changed, however, by passing a new bitmask to the one-argument version of interestOps( ). (Note that the same method name is used to both query and set the interest set.) The current state of the ready set can be queried with readyOps( ). You can also use the convenience methods isReadable( ), isWritable( ) isConnectable( ) and isAcceptable( ) to test whether individual operation bits are set in the ready set bitmask. There is no way to explicitly set the state of the ready seteach call to select( ) method updates the ready set for you. Note, however, that you must remove a SelectionKey object from the Set returned by Selector.selectedKeys( ) for the bits of the ready set to be cleared at the start of the next selection operation. If you never remove the SelectionKey from the set of selected keys, the Selector assumes that none of the I/O readyness conditions represented by the ready set have been handled yet, and leaves their bits set.

Use attach( ) to associate an arbitrary object with a SelectionKey, and call attachment( ) to query that object. This ability to associate data with a selection key is often useful when using a Selector with multiple channels: it can provide the context necessary to process aSelectionKey that has been selected.

```
public abstract class SelectionKey {
// Protected Constructors
     protected SelectionKey( );
// Public Constants
     public static final int OP_ACCEPT;    =16
     public static final int OP_CONNECT;   =8
     public static final int OP_READ;      =1
     public static final int OP_WRITE;     =4
// Public Instance Methods
     public final Object attach(Object ob);
     public final Object attachment( );
     public abstract void cancel( );
     public abstract SelectableChannel channel( );
     public abstract int interestOps( );
     public abstract SelectionKey interestOps(int ops);
     public final boolean isAcceptable( );
     public final boolean isConnectable( );
     public final boolean isReadable( );
     public abstract boolean isValid( );
     public final boolean isWritable( );
     public abstract int readyOps( );
     public abstract Selector selector( );
}
```

Subclasses

java.nio.channels.spi.AbstractSelectionKey

Returned By

SelectableChannel.{keyFor( ), register( )}, java.nio.channels.spi.AbstractSelectableChannel.{keyFor( ), register( )}, java.nio.channels.spi.AbstractSelector.register( )

Team LiB

Selector java.nio.channels

Java 1.4

A Selector is an object that monitors multiple nonblocking SelectableChannel objects and (after blocking if necessary) "selects" the channel that is (or the channels that are) ready for I/O. Create a new Selector with the static open( ) method. Next register the channels that it is to monitor: a channel is registered by passing the Selector to the register( ) method of the channel (register( ) is defined by the abstract SelectableChannel class). In addition to the Selector you must also pass a bitmask that specifies which I/O operations (reading, writing, connecting, and accepting) that the Selector is to monitor for that channel. Each call to this register( ) method returns a SelectionKey object. (The SelectionKey class also defines the constants that are used to form the bitmask of I/O operations.) Note that before a SelectableChannel can be registered, it must be in nonblocking mode, which can be accomplished with the configureBlocking( ) method of SelectableChannel.

Once the channels are registered with the Selector, call select( ) to block until one or more of the channels is ready for I/O. One version of select( ) takes a timeout value and returns if the specified number of milliseconds elapses without any channels becoming ready for I/O. These methods also return if any of the channels is closed, if an error occurs on any channel, if the wakeup( ) method of the Selector is called, or if the interrupt( ) method of the blocked thread is called. There is also a selectNow( ) method which is like select( ) except that it does not block: it simply polls each of the channels and determines which have become ready for I/O. The return value of selectNow( ) and of both select( ) methods is the number of channels ready for I/O. It is possible for this return value to be zero.

The select( ) and selectNow( ) methods returns the number of channels that are ready for I/O; they do not return the channels themselves. To obtain this information, you must call the selectedKeys( ) method, which returns a java.util.Set containing SelectionKey objects. After calling select( ) and selectedKeys( ), applications typically obtain a java.util.Iterator for the Set and use it to loop through the SelectionKey objects that represent the channels that are ready for I/O. Use the channel( ) method of the SelectionKey to determine which channel is ready, and call readyOps( ), isReadable( ), isWritable( ) or related methods of the SelectionKey to determine what kind of I/O operation is ready on the channel. SelectionKey objects remain in the selectedKeys( ) set until explicitly removed, so after performing the I/O operation for a given SelectionKey, you should remove that key from the Set returned by selectedKeys( ) (use the remove( ) method of the Set of its Iterator).

In addition to the selectedKeys( ) method, Selector also defines a keys( ) method, which also returns a Set of SelectionKey objects. This set represents the complete set of channels that are being monitored by the Selector and may not be modified, except by closing the channel or deregistring the channel by calling the cancel( ) method of the associated SelectionKey. Cancelled keys are removed from the keys( ) set on the next call to select( ) or selectNow( ).

Call wakeup( ) to cause another thread blocked in a call to select( ) to wake up and return immediately. If wakeup( ) is called but no thread is currently blocked in a select( ) call, then the next call to select( ) or selectNow( ) will return immediately.

When a Selector object is no longer needed, close it by calling close( ). If any thread is blocked in a select( ) call, it will return immediately as if wakeup( ) had been called. After calling close( ), you should not call any other methods of a Selector. isOpen( ) returns true if a Selector is still open, and returns false if it has been closed.

The Selector class is thread-safe. Note, however, that the Set object returnd by selectedKeys( ) is not: it should be used by only one thread at a time.

```
public abstract class Selector {
// Protected Constructors
     protected Selector( );
// Public Class Methods
     public static Selector open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract void close( ) throws java.io.IOException;
     public abstract boolean isOpen( );
     public abstract java.util.Set<SelectionKey> keys( );
     public abstract java.nio.channels.spi.SelectorProvider provider( );
     public abstract int select( ) throws java.io.IOException;
     public abstract int select(long timeout) throws java.io.IOException;
     public abstract java.util.Set<SelectionKey> selectedKeys( );
     public abstract int selectNow( ) throws java.io.IOException;
     public abstract Selector wakeup( );
}
```

Subclasses

java.nio.channels.spi.AbstractSelector

Passed To

SelectableChannel.{keyFor( ), register( )}, java.nio.channels.spi.AbstractSelectableChannel.{keyFor( ), register( )}

Returned By

SelectionKey.selector( )

ServerSocketChannel java.nio.channels

Java 1.4 *closeable*

This class is the `java.nio` version of `java.net.ServerSocket`. It is a selectable channel that can be used by servers to accept connections from clients. Unlike other channel classes in this package, this class cannot be used for reading or writing bytes: it does not implement any of the `ByteChannel` interfaces, and exists only to accept and establish connections with clients, not to communicate with those clients. `ServerSocketChannel` differs from `java.net.ServerSocket` in two important ways: it can put into nonblocking mode and used with a `Selector`, and its `accept( )` method returns a `SocketChannel` rather than a `Socket`, so that communication with the client whose connection was just accepted can be done using the `java.nio` APIs.

Create a new `ServerSocketChannel` with the static `open( )` method. Next, call `socket( )` to obtain the associated `ServerSocket` object, and use its `bind( )` method to bind the server socket to a specific port on the local host. You can also call any other `ServerSocket` methods to configure other socket options at this point.

To accept a new connection through this `ServerSocketChannel`, simply call `accept( )`. If the channel is in blocking mode, this method will block until a client connects, and will then return a `SocketChannel` that is connected to the client. In nonblocking mode, (see the inherited `configureBlocking( )` method) `accept( )` returns a `SocketChannel` only if there is a client currently waiting to connect, and otherwise immediately returns `null`. To be notified when a client is waiting to connect, use the inherited `register( )` method to register nonblocking a `ServerSocketChannel` with a `Selector` and specify an interest in accept operations with the `SelectionKey.OP_ACCEPT` constant. See `Selector` and `SelectionKey` for further details.

Note that the `SocketChannel` object returned by the `accept( )` method is always in nonblocking mode, regardless of the blocking mode of the `ServerSocketChannel`.

`ServerSocketChannel` is thread-safe; only one thread may call the `accept( )` method at a time. When a `ServerSocketChannel` is no longer required, close it with the inherited `close( )` method.

Figure 13-38. java.nio.channels.ServerSocketChannel

```
public abstract class ServerSocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel {
```

```
// Protected Constructors
     protected ServerSocketChannel(java.nio.channels.spi.SelectorProvider
        provider);
// Public Class Methods
     public static ServerSocketChannel open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract SocketChannel accept( ) throws java.io.IOException;
     public abstract java.net.ServerSocket socket( );
// Public Methods Overriding SelectableChannel
     public final int validOps( );
}
```

Returned By

java.net.ServerSocket.getChannel( ), java.nio.channels.spi.SelectorProvider.openServerSocketChannel( )

Team LiB

SocketChannel java.nio.channels

Java 1.4 *closeable*

This class is a channel for communicating over a java.net.Socket. It implements ReadableByteChannel and WriteableByteChannel as well as GatheringByteChannel and ScatteringByteChannel. It is a subclass of SelectableChannel and can be used with a Selector.

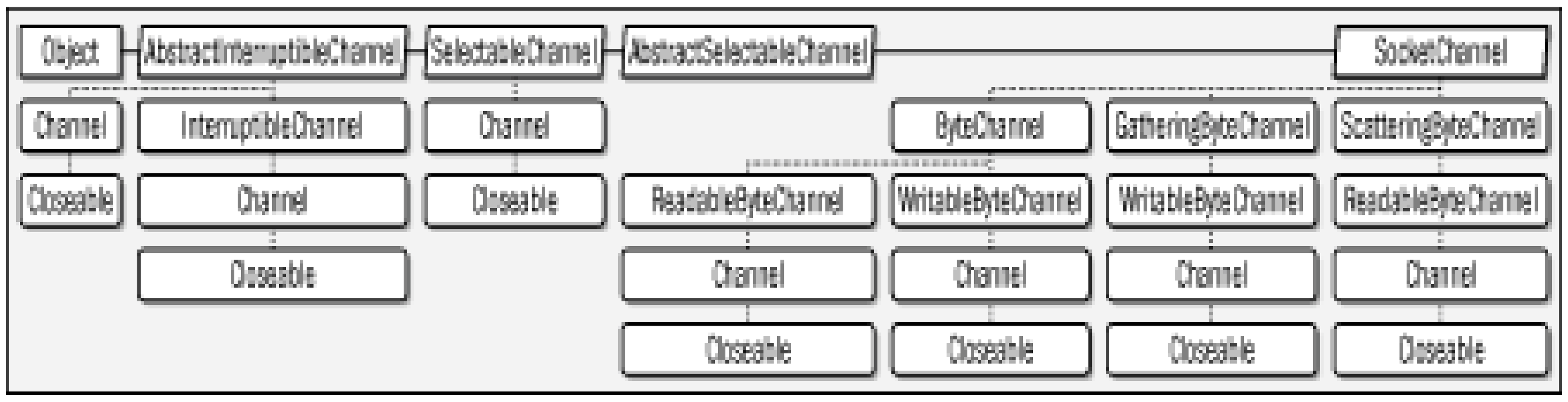
Create a new SocketChannel with one of the static open( ) methods. The no-argument version of open( ) creates a new SocketChannel but does not connect it to a remote host. The other version of open( ) opens a new channel and connects it to the specified java.net.SocketAddress. If you create an unconnected socket, you can explictly connect it with the connect( ) method. The main reason to open the channel and connect to the remote host in separate steps is if you want to do a nonblocking connect. To do this, first put the channel into nonblocking mode with the inherited configureBlocking( ) method. Then, call connect( ): it will return immediately, without waiting for the connection to be established. Then register the channel with a Selector specifying that you are interested in SelectionKey.OP_CONNECT operations. When you are notified that your channel is ready to connect (see Selector and SelectionKey for details) simply call the nonblocking finishConnect( ) method to complete the connection. isConnected( ) returns TRue once a connection is established, and false otherwise. isConnectionPending( ) returns true if connect( ) has been called in blocking mode and has not yet returned, or if connect( ) has been called in nonblocking mode, but finishConnect( ) has not been called yet.

Once you have opened and connected a SocketChannel, you can read and write bytes to it with the various read( ) and write( ) methods. SocketChannel is thread-safe: read and write operations may proceed concurrently, but SocketChannel will not allow more than one read operation and more than one write operation to proceed at the same time. If you place a SocketChannel into nonblocking mode, you can register it with a Selector using the SelectionKey constants OP_READ and OP_WRITE, to have the Selector tell you when the channel is ready for reading or writing.

The socket( ) method returns the java.net.Socket that is associated with the SocketChannel. You can use this Socket object to configure socket options, bind the socket to a specific local address, close the socket, or shutdown its input or output sides. See java.net.Socket. Note that although all SocketChannel objects have associated Socket objects, the reverse is not true: you cannot obtain a SocketChannel from a Socket unless the Socket was created along with the SocketChannel by a call to SocketChannel.open( ).

When you are done with a SocketChannel, close it with the close( ) method. You can also independently shut down the read and write portions of the channel with socket( ).shutdownInput( ) and socket( ).shutdownOutput( ). When the input is shut down, any future reads (and any blocked read operation) will return -1 to indicate that the end-of-stream has been reached. When the output is shut down, any future writes throw a ClosedChannelException, and any write operation that was blocked at the time of shut down throws a AsynchronousCloseException.

Figure 13-39. java.nio.channels.SocketChannel




```
public abstract class SocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel
implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected SocketChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Class Methods
     public static SocketChannel open( ) throws java.io.IOException;
     public static SocketChannel open(java.net.SocketAddress remote)
        throws java.io.IOException;
// Public Instance Methods
     public abstract boolean connect(java.net.SocketAddress remote)
        throws java.io.IOException;
     public abstract boolean finishConnect( ) throws java.io.IOException;
     public abstract boolean isConnected( );
     public abstract boolean isConnectionPending( );
     public abstract java.net.Socket socket( );
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
        throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
        int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
        throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
        throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
        int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
        throws java.io.IOException;
// Public Methods Overriding SelectableChannel
     public final int validOps( );
}
```

Returned By

`java.net.Socket.getChannel( )`, `ServerSocketChannel.accept( )`, `java.nio.channels.spi.SelectorProvider.openSocketChannel( )`

Team LiB

UnresolvedAddressException java.nio.channels

Java 1.4 *serializable unchecked*

Signals the use of a `java.net.SocketAddress` that could not be resolved: for example a `java.net.InetSocketAddress` that contains an unknown hostname.

Figure 13-40. java.nio.channels.UnresolvedAddressException


```
public class UnresolvedAddressException extends IllegalArgumentException {
// Public Constructors
     public UnresolvedAddressException( );
}
```

Team LiB

UnsupportedAddressTypeException java.nio.channels

Java 1.4 *serializable unchecked*

Signals the use of a `java.net.SocketAddress` subclass that is unknown to or not supported by the implementation. It is safe to assume that addresses of the type `java.net.InetSocketAddress` are universally supported.

Figure 13-41. java.nio.channels.UnsupportedAddressTypeException


```
public class UnsupportedAddressTypeException extends IllegalArgumentException {
// Public Constructors
     public UnsupportedAddressTypeException( );
}
```

WritableByteChannel java.nio.channels

Java 1.4 *closeable*

This subinterface of Channel defines a single key write( ) method which writes bytes from a specified ByteBuffer (updating the buffer position as it goes) to the channel. If possible, it writes all remaining bytes in the buffer (see Buffer.remaining( )). This is not always possible (with nonblocking channels, for example) so the write( ) method returns the number of bytes that it was actually able to write to the channel.

write( ) is declared to throw an IOException. More specifically, it may throw a ClosedChannelException if the channel is closed. If the channel is closed asynchronously, or if a blocked thread is interrupted, the write( ) method may terminate with an AsynchronousCloseException or a ClosedByInterruptException. write( ) may also throw an unchecked NonWritableChannelException if it is called on a channel (such as a FileChannel) that was not opened or configured to allow writing.

WritableByteChannel implementations are required to be thread-safe: only one thread may perform a write operation on a channel at a time. If a write operation is in progress, then any call to write( ) will block until the in-progress operation completes. Some channel implementations may allow read and write operations to proceed concurrently; some may not.

Figure 13-42. java.nio.channels.WritableByteChannel

```
public interface WritableByteChannel extends Channel {
// Public Instance Methods
     int write(java.nio.ByteBuffer src) throws java.io.IOException;
}
```

Implementations

ByteChannel, GatheringByteChannel, Pipe.SinkChannel

Passed To

Channels.{newOutputStream( ), newWriter( )}, FileChannel.transferTo( )

Returned By

`Channels.newChannel( )`

Package java.nio.channels.spi

Java 1.4

This package defines four classes that are used by implementors of channels and selector classes of `java.nio.channels`. It also defines the `SelectorProvider` class which allows a custom implementation of channels and selectors to be specified for use instead of the default implementation. Application programmers should never need to use this package, except in rare circumstances to explicitly install a `SelectionProvider` implementation with the `SelectionProvider.provider( )` method.

Classes

```
public abstract class AbstractInterruptibleChannel
    implements java.nio.channels.Channel, java.nio.channels.
    InterruptibleChannel;
public abstract class AbstractSelectableChannel extends java.nio.channels.
    SelectableChannel;
public abstract class AbstractSelectionKey extends java.nio.channels.
    SelectionKey;
public abstract class AbstractSelector extends java.nio.channels.Selector;
public abstract class SelectorProvider;
```

Team LiB

AbstractInterruptibleChannel java.nio.channels.spi

Java 1.4 *closeable*

This class exists as a convenience for implementors of new Channel classes. Application programmers should never need to subclass or use it.

Figure 13-43. java.nio.channels.spi.AbstractInterruptibleChannel


```
public abstract class AbstractInterruptibleChannel
implements java.nio.channels.Channel, java.nio.channels.InterruptibleChannel {
// Protected Constructors
     protected AbstractInterruptibleChannel( );
// Methods Implementing Channel
     public final void close( ) throws java.io.IOException;
     public final boolean isOpen( );
// Protected Instance Methods
     protected final void begin( );
     protected final void end(boolean completed)
         throws java.nio.channels.AsynchronousCloseException;
     protected abstract void implCloseChannel( ) throws java.io.IOException;
}
```

Subclasses

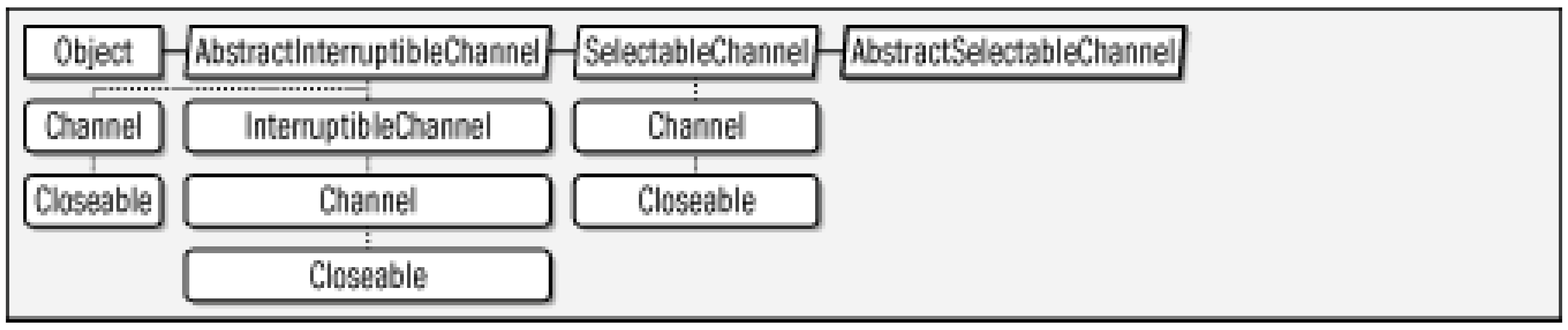
java.nio.channels.FileChannel, java.nio.channels.SelectableChannel

AbstractSelectableChannel java.nio.channels.spi

Java 1.4 *closeable*

This class exists as a convenience for implementors of new selectable channel classes: it defines common methods of `SelectableChannel` in terms of protected methods whose names begin with `impl`. Application programmers should never need to use or subclass this class.

Figure 13-44. java.nio.channels.spi.AbstractSelectableChannel




```
public abstract class AbstractSelectableChannel extends java.nio.channels.
SelectableChannel {
// Protected Constructors
     protected AbstractSelectableChannel(SelectorProvider provider);
// Public Methods Overriding SelectableChannel
     public final Object blockingLock( );
     public final java.nio.channels.SelectableChannel configureBlocking(boolean
       block) throws java.io.IOException;
     public final boolean isBlocking( );
     public final boolean isRegistered( );
     public final java.nio.channels.SelectionKey keyFor(java.nio.channels.
       Selector sel);
     public final SelectorProvider provider( );
     public final java.nio.channels.SelectionKey register(java.nio.channels.
Selector sel, int ops, Object att)
throws java.nio.channels.ClosedChannelException;
// Protected Methods Overriding AbstractInterruptibleChannel
     protected final void implCloseChannel( ) throws java.io.IOException;
// Protected Instance Methods
     protected abstract void implCloseSelectableChannel( )
       throws java.io.IOException;
     protected abstract void implConfigureBlocking(boolean block)
       throws java.io.IOException;
}
```

Subclasses

java.nio.channels.DatagramChannel, java.nio.channels.Pipe.SinkChannel, java.nio.channels.Pipe.SourceChannel, java.nio.channels.ServerSocketChannel, java.nio.channels.SocketChannel

Passed To

AbstractSelector.register( )

AbstractSelectionKey java.nio.channels.spi

Java 1.4

This class exists as a convenience for implementors of new `SelectionKey` classes. Application programmers should never need to use or subclass this class.

Figure 13-45. java.nio.channels.spi.AbstractSelectionKey


```
public abstract class AbstractSelectionKey extends java.nio.channels
.SelectionKey {
// Protected Constructors
     protected AbstractSelectionKey( );
// Public Methods Overriding SelectionKey
     public final void cancel( );
     public final boolean isValid( );
}
```

Passed To

`AbstractSelector.deregister( )`

AbstractSelector java.nio.channels.spi

Java 1.4

This class exists as a convenience for implementors of new `Selector` classes. Application programmers should never need to use or subclass this class.

Figure 13-46. java.nio.channels.spi.AbstractSelector


```
public abstract class AbstractSelector extends java.nio.channels.Selector {
// Protected Constructors
     protected AbstractSelector(SelectorProvider provider);
// Public Methods Overriding Selector
     public final void close( ) throws java.io.IOException;
     public final boolean isOpen( );
     public final SelectorProvider provider( );
// Protected Instance Methods
     protected final void begin( );
     protected final java.util.Set<java.nio.channels.SelectionKey>
       cancelledKeys( );
     protected final void deregister(AbstractSelectionKey key);
     protected final void end( );
     protected abstract void implCloseSelector( ) throws java.io.IOException;
     protected abstract java.nio.channels.SelectionKey register
      (AbstractSelectableChannel ch, int ops, Object att);
}
```

Returned By

`SelectorProvider.openSelector( )`

Team LiB

SelectorProvider java.nio.channels.spi

Java 1.4

This class is the central service-provider class for the channels and selectors of the `java.nio.channels` API. A concrete subclass of `SelectorProvider` implements factory methods that return open socket channels, server socket channels, datagram channels, pipes (with their two internal channels) and `Selector` objects. There is one default `SelectorProvider` object per JVM: this object can be obtained with the static `SelectorProvider.provider( )` method.

You can specify a custom `SelectorProvider` implementation by setting its class name as the value of the system property `java.nio.channels.spi.SelectorProvider`. Or, you can put the class name in a file named *META-INF/services/java.nio.channels.spi.SelectorProvider*, in your application's JAR file. The `provider( )` method first looks for the system property, then looks for the JAR file entry. If it finds neither, it instantiates the implementation's default `SelectorProvider`.

Applications are not required to use the default `SelectorProvider` exclusively. It is legal to instantiate other `SelectorProvider` objects and explictly invoke their `open( )` methods to create channels in that way.

```
public abstract class SelectorProvider {
// Protected Constructors
     protected SelectorProvider( );
// Public Class Methods
     public static SelectorProvider provider( );
// Public Instance Methods
5.0  public java.nio.channels.Channel inheritedChannel( ) throws java.io.
        IOException;     constant
     public abstract java.nio.channels.DatagramChannel openDatagramChannel( )
        throws java.io.IOException;
     public abstract java.nio.channels.Pipe openPipe( )
        throws java.io.IOException;
     public abstract AbstractSelector openSelector( )
        throws java.io.IOException;
     public abstract java.nio.channels.ServerSocketChannel
        openServerSocketChannel( ) throws java.io.IOException;
     public abstract java.nio.channels.SocketChannel openSocketChannel( )
        throws java.io.IOException;
}
```

Passed To

`java.nio.channels.DatagramChannel.DatagramChannel( )`,
`java.nio.channels.Pipe.SinkChannel.SinkChannel( )`,

java.nio.channels.Pipe.SourceChannel.SourceChannel( ), java.nio.channels.ServerSocketChannel.ServerSocketChannel( ), java.nio.channels.SocketChannel.SocketChannel( ), AbstractSelectableChannel.AbstractSelectableChannel( ), AbstractSelector.AbstractSelector( )

Returned By

java.nio.channels.SelectableChannel.provider( ), java.nio.channels.Selector.provider( ), AbstractSelectableChannel.provider( ), AbstractSelector.provider( )

Team LiB

Package java.nio.charset

Java 1.4

This package contains classes that represent character sets or encodings, and defines methods that encode characters into bytes and decode bytes into characters. The key class is `Charset`, and you can obtain a `Charset` object for a named character encoding with the static `forName( )` method. `Charset` defines `encode( )` and `decode( )` convenience methods, but for full control over the encoding and decoding process, you can also obtain a `CharsetEncoder` or `CharsetDecoder` object from the `Charset`.

The Java platform has had a character encoding and decoding facility since Java 1.1, and defines a number of classes and methods that perform character encoding or decoding. Some of these classes and methods are specified to use the default charset for the locale; others take the name of a charse as a method or constructor argument. See, for example, the `String( )`, `java.io.InputStreamReader( )` and `java.io.OutputStreamWriter( )` constructors. In Java 1.4, the `java.nio.charset` package defines a public API to the character encoding and decoding facility and allows applications to work with it explicitly. Most applications will not have to do this, however, and can simply continue to rely on the default charset, or can continue to supply charset names where needed. Even applications that use the `java.nio.channels` package can avoid explicit character encoding and decoding by passing the name of a desired charset to the `newReader( )` and `newWriter( )` methods of `java.nio.channels.Channels`.

Classes

```
public abstract class Charset implements Comparable<Charset>;
public abstract class CharsetDecoder;
public abstract class CharsetEncoder;
public class CoderResult;
public class CodingErrorAction;
```

Exceptions

```
public class CharacterCodingException extends java.io.IOException;
   public class MalformedInputException extends CharacterCodingException;
   public class UnmappableCharacterException extends CharacterCodingException;
public class IllegalCharsetNameException extends IllegalArgumentException;
public class UnsupportedCharsetException extends IllegalArgumentException;
```

Errors

```
public class CoderMalfunctionError extends Error;
```

Team LiB

CharacterCodingException java.nio.charset

Java 1.4 *serializable checked*

Signals a problem encoding or decoding characters or bytes. This is a generic superclass for more-specific exception types. Note that the one-argument versions of `CharsetEncoder.encode( )` and `CharsetDecoder.decode( )` may throw an exception of this type, but that the three-argument versions of the same method instead report encoding problems through their `CoderResult` return value. Note also that the `encode( )` and `decode( )` convenience methods of `Charset` do not throw this exception because they specify that malformed input and unmappable characters or bytes should be replaced. (See `CodingErrorAction`.)

Figure 13-47. java.nio.charset.CharacterCodingException

```
public class CharacterCodingException extends java.io.IOException {
// Public Constructors
     public CharacterCodingException( );
}
```

Subclasses

`MalformedInputException`, `UnmappableCharacterException`

Thrown By

`CharsetDecoder.decode( )`, `CharsetEncoder.encode( )`, `CoderResult.throwException( )`

Team LiB

Charset java.nio.charset

Java 1.4 *comparable*

A Charset represents a character set or encoding. Each Charset has a cannonical name, returned by name( ), and a set of aliases, returned by aliases( ). You can look up a Charset by name or alias with the static Charset.forName( ) method, which throws an UnsupportedCharsetException if the named charset is not installed on the system. In Java 5.0, you can obtain the defaultCharset used by the Java VM with the static defaultCharset( ) method. Check whether a charset specified by name or alias is supported with the static isSupported( ). Obtain the complete set of installed charsets with availableCharsets( ) which returns a sorted map from canonical names to Charset objects. Note that charset names are not case-sensitive, and you can use any capitialization for charset names you pass to isSupported( ) and forName( ). Note that there are a number of classes and methods in the Java platform that specify charsets by name rather than byCharset object. See, for example, java.io.InputStreamReader, java.io.OutputStreamWriter, String.getBytes( ), and java.nio.channels.Channels.newWriter( ). When working with classes and methods such as these, there is no need to use aCharset object.

All implementations of Java are required to support at least the following 6 charsets:

Canonical name	Description
US-ASCII	seven-bit ASCII
ISO-8859-1	The 8-bit superset of ASCII which includes the characters used in most Western-European languages. Also known as ISO-LATIN-1.
UTF-8	An 8-bit encoding of Unicode characters that is compatible with US-ASCII.
UTF-16BE	A 16-bit encoding of Unicode characters, using big-endian byte order.
UTF-16LE	A 16-bit encoding of Unicode characters, using little-endian byte order.
UTF-16	A 16-bit encoding of Unicode characters, with byte order specified by a byte order mark character. Assumes big-endian when decoding if there is no byte order mark. Encodes using big-endian byte order and outputs an appropriate byte order mark.

Once you have obtained a Charset with forName( ) or availableCharsets( ), you can use the encode( ) method to encode a String or CharBuffer of text into a ByteBuffer, or you can use the decode( ) method to convert the bytes in a ByteBuffer into characters in a CharBuffer. These convenience methods create a new CharsetEncoder or CharsetDecoder, specify that malformed input or unmappable characters or bytes should be replaced with the default replacement string or bytes, and then invoke the encode( ) or decode( ) method of the encoder or decoder. For full control over the encoding and decoding process, you may prefer to obtain your ownCharsetEncoder or CharsetDecoder object with newEncoder( ) or newDecoder( ). See CharsetDecoder for details.

Instead of using a Charset, CharsetEncoder, or CharsetDecoder directly, you may also pass an encoder or decoder to the static methods of java.nio.channels.Channels to obtain a java.io.Reader or java.io.Writer that you can use to read or write characters from or to a byte-oriented Channel.

Note that not all Charset objects support encoding ("auto-detect" charsets can determine the source charset when decoding, but have no way to encode). Use canEncode( ) to determine whether a given Charset can encode.

Charset also defines, implements, or overrides various other methods. displayName( ) returns a localized name for the charset, or returns the cannonical name if there is no localization. toString( ) returns an implementation-dependent textual representation of the charset. The equals( ) method compares two charsets by comparing their canonical names. Charset implements Comparable, and its compareTo( ) method orders charsets by their canonical name. contains( ) returns true if a specified charset is "contained in" this charset. That is, if every character that can be represented in the specified charset can also be represented in this charset. Note that those representations need not be the same, however. isRegistered( ) returns true if the charset is registered with the IANA charset registry (see http://www.iana.org/assignments/character-sets.)

Figure 13-48. java.nio.charset.Charset

```
public abstract class Charset implements Comparable<Charset> {
// Protected Constructors
     protected Charset(String canonicalName, String[ ] aliases);
// Public Class Methods
     public static java.util.SortedMap<String,Charset> availableCharsets( );
5.0  public static Charset defaultCharset( );
     public static Charset forName(String charsetName);
     public static boolean isSupported(String charsetName);
// Public Instance Methods
     public final java.util.Set<String> aliases( );
     public boolean canEncode( );        constant
     public abstract boolean contains(Charset cs);
     public final java.nio.CharBuffer decode(java.nio.ByteBuffer bb);
     public String displayName( );
     public String displayName(java.util.Locale locale);
     public final java.nio.ByteBuffer encode(java.nio.CharBuffer cb);
     public final java.nio.ByteBuffer encode(String str);
     public final boolean isRegistered( );
     public final String name( );
     public abstract CharsetDecoder newDecoder( );
     public abstract CharsetEncoder newEncoder( );
// Methods Implementing Comparable
5.0  public final int compareTo(Charset that);
// Public Methods Overriding Object
```

```
    public final boolean equals(Object ob);
    public final int hashCode( );
    public final String toString( );
}
```

Passed To

java.io.InputStreamReader.InputStreamReader( ), java.io.OutputStreamWriter.OutputStreamWriter( ), CharsetDecoder.CharsetDecoder( ), CharsetEncoder.CharsetEncoder( )

Returned By

CharsetDecoder.{charset( ), detectedCharset( )}, CharsetEncoder.charset( ), java.nio.charset.spi.CharsetProvider.charsetForName( )

CharsetDecoder java.nio.charset

Java 1.4

A CharsetDecoder is a "decoding engine" that converts a sequence of bytes into a sequence of characters based on the encoding of some charset. Obtain a CharsetDecoder from the Charset that represents the charset to be decoded. If you have a complete sequence of bytes to be decoded in a ByteBuffer you can pass that buffer to the one-argument version of decode( ). This convenience method decodes the bytes and stores the resulting characters into a newly allocated CharBuffer, resetting and flushing the decoder as necessary. It throws an exception if there are problems with the bytes to be decoded.

Typically, however, the three-argument version of decode( ) is used in a multistep decoding process:

1. Call the reset( ) method, unless this is the first time the CharsetDecoder has been used.
2. Call the three-argument version of decode( ) one or more times. The third argument should be true on, and only on, the last invocation of the method. The first argument to decode( ) is a ByteBuffer that contains bytes to be decoded. The second argument is a CharBuffer into which the resulting characters are stored. The return value of the method is a CoderResult object that specifies the state of the ongoing the decoding operation. The possible CoderResult return values are detailed below. In a typical case, however, decode( ) returns after it has decoded all of the bytes in the input buffer. In this case, you would then typically fill the input buffer with more bytes to be decoded, and read characters from the output buffer, calling its compact( ) method to make room for more. If an unexpected problem arises in the CharsetDecoder implementation, decode( ) throws a CoderMalfunctionError.
3. Pass the output CharBuffer to the flush( ) method to allow any remaining characters to be output.

The decode( ) method returns a CoderResult that indicates the state of the decoding operation. If the return value is CoderResult.UNDERFLOW, then it means that decode( ) returned because all bytes from the input buffer have been read, and more input is required. If the return value is CoderResult.OVERFLOW, then it means that decode( ) returned because the output CharBuffer is full, and no more characters can be decoded into it. Otherwise, the reurn value is a CoderResult whose isError( ) method returns true. There are two basic types of decoding errors. If isMalformed( ) returns true then the input included bytes that are not legal for the charset. These bytes start at the position of the input buffer, and continue for length( ) bytes. Otherwise, if isUnmappable( ) returns true, then the input bytes include a character for which there is no representation in Unicode. The relevant bytes start at the position of the input buffer and continue fo length( ) bytes.

By default a CharsetDecoder reports all malformed input and unmappable character errors by returning a CoderResult object as described above. This behavior can be altered, however, by passing a CodingErrorAction to onMalformedInput( ) and onUnmappableCharacter( ). (Query the current action for these types of errors with malformedInputAction( ) and unmappableCharacterAction( ).) CodingErrorAction defines three constants that represent the three possible actions. The default action is REPORT. The action IGNORE tells the CharsetDecoder to ignore (i.e. skip) malformed input and unmappable charaters. The REPLACE action tells the CharsetDecoder to replace malformed input and unmappable characters with the replacement string. This replacement string can be set with replaceWith( ), and can be queried with replacement( ).

averageCharsPerByte( ) and maxCharsPerByte( ) return the average and maximum number of characters that are produced by this decoder per decoded byte. These values can be used to help you choose the size of the CharBuffer to allocate for decoding.

CharsetDecoder is not a thread-safe class. Only one thread should use an instance at a time.

CharsetDecoder is an abstract class. Implementors defining new charsets will need to subclass CharsetDecoder and define the abstract decodeLoop( ) method, which is invoked by decode( ).

```
public abstract class CharsetDecoder {
// Protected Constructors
     protected CharsetDecoder(Charset cs,
     float averageCharsPerByte, float maxCharsPerByte);
// Public Instance Methods
     public final float averageCharsPerByte( );
     public final Charset charset( );
     public final java.nio.CharBuffer decode(java.nio.ByteBuffer in)
        throws CharacterCodingException;
     public final CoderResult decode(java.nio.ByteBuffer in, java.nio.
        CharBuffer out, boolean endOfInput);
     public Charset detectedCharset( );
     public final CoderResult flush(java.nio.CharBuffer out);
     public boolean isAutoDetecting( );          constant
     public boolean isCharsetDetected( );
     public CodingErrorAction malformedInputAction( );
     public final float maxCharsPerByte( );
     public final CharsetDecoder onMalformedInput(CodingErrorAction newAction);
     public final CharsetDecoder onUnmappableCharacter(CodingErrorAction
        newAction);
     public final String replacement( );
     public final CharsetDecoder replaceWith(String newReplacement);
     public final CharsetDecoder reset( );
     public CodingErrorAction unmappableCharacterAction( );
// Protected Instance Methods
     protected abstract CoderResult decodeLoop(java.
        nio.ByteBuffer in, java.nio.CharBuffer out);
     protected CoderResult implFlush(java.nio.CharBuffer out);
     protected void implOnMalformedInput(CodingErrorAction
        newAction);     empty
     protected void implOnUnmappableCharacter(CodingErrorAction
        newAction);     empty
     protected void implReplaceWith(String
```

```
        newReplacement);            empty
    protected void implReset( );                              empty
}
```

Passed To

java.io.InputStreamReader.InputStreamReader( ), java.nio.channels.Channels.newReader( )

Returned By

Charset.newDecoder( )

Team LiB

CharsetEncoder java.nio.charset

Java 1.4

A CharsetEncoder is an "encoding engine" that converts a sequence of characters into a sequence of bytes using some character encoding. Obtain a CharsetEncoder with the newEncoder( ) method of the Charset that represents the desired encoding.

A CharsetEncoder works like a CharsetDecoder in reverse. Use the encode( ) method to encode characters read from a CharBuffer into bytes stored in a ByteBuffer. Please see CharsetDecoder, which is documented in detail.

```
public abstract class CharsetEncoder {
// Protected Constructors
     protected CharsetEncoder(Charset cs,
        float averageBytesPerChar, float maxBytesPerChar);
     protected CharsetEncoder(Charset cs,
        float averageBytesPerChar, float maxBytesPerChar, byte[ ] replacement);
// Public Instance Methods
     public final float averageBytesPerChar( );
     public boolean canEncode(CharSequence cs);
     public boolean canEncode(char c);
     public final Charset charset( );
     public final java.nio.ByteBuffer encode(java.nio.CharBuffer in)
        throws CharacterCodingException;
     public final CoderResult encode(java.nio.CharBuffer in,
        java.nio.ByteBuffer out, boolean endOfInput);
     public final CoderResult flush(java.nio.ByteBuffer out);
     public boolean isLegalReplacement(byte[ ] repl);
     public CodingErrorAction malformedInputAction( );
     public final float maxBytesPerChar( );
     public final CharsetEncoder onMalformedInput(CodingErrorAction
        newAction);
     public final CharsetEncoder onUnmappableCharacter(CodingErrorAction
        newAction);
     public final byte[ ] replacement( );
     public final CharsetEncoder replaceWith(byte[ ] newReplacement);
     public final CharsetEncoder reset( );
     public CodingErrorAction unmappableCharacterAction( );
// Protected Instance Methods
     protected abstract CoderResult encodeLoop(java.nio.CharBuffer in,
        java.nio.ByteBuffer out);
     protected CoderResult implFlush(java.nio.ByteBuffer out);
     protected void implOnMalformedInput(CodingErrorAction
         newAction);     empty
```

```
    protected void implOnUnmappableCharacter(CodingErrorAction
        newAction);     empty
    protected void implReplaceWith(byte[ ] newReplacement);     empty
    protected void implReset( );                     empty
}
```

Passed To

java.io.OutputStreamWriter.OutputStreamWriter( ), java.nio.channels.Channels.newWriter( )

Returned By

Charset.newEncoder( )

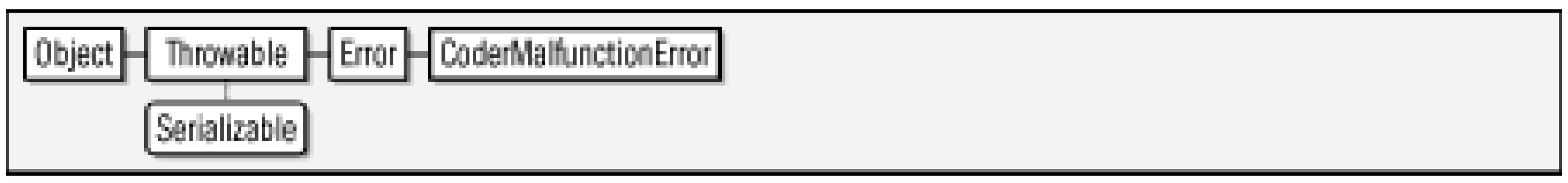
Team LiB

CoderMalfunctionError java.nio.charset

Java 1.4 *serializable error*

Signals a malfunctiontypically an unknown and unrecoverable errorin a `CharsetEncoder` or `CharsetDecoder`. An error of this type is thrown by the `encode( )` and `decode( )` methods when the protected `encodeLoop( )` or `decodeLoop( )` methods upon which they are implemented throws an exception of an unexpected type.

Figure 13-49. java.nio.charset.CoderMalfunctionError




```
public class CoderMalfunctionError extends Error {
// Public Constructors
     public CoderMalfunctionError(Exception cause);
}
```

Team LiB

CoderResult java.nio.charset

Java 1.4

A CoderResult object specifies the results of a call to CharsetDecoder.decode( ) or CharsetEncoder.encode( ). There are four possible reasons why a call to the decode( ) or encode( ) would return:

- If all the bytes have been decoded or all the characters have been encoded, and the input buffe is empty, then the return value is the constant object CoderResult.UNDERFLOW, indicating that coding stopped because there was no more data to code. Calling the isUnderflow( ) method on the returned object returns true and calling isError( ) returns false. This is a normal return value.
- If there is more data to be coded, but there is no more room in the output buffer to store the coded data, then the return value is the constant object CoderResult.OVERFLOW. Calling isOverflow( ) on the returned object returns true, and calling isError( ) returns false. This is a normal return value.
- If the input data was malformed, containing characters or bytes that are not legal for the charset, and the CharsetEncoder or CharsetDecoder has not specified that malformed input should be ignored or replaced, then the returned value is a CoderResult object whose isError( ) and isMalformed( ) methods both return true. The position of the input buffer is at the first malformed character or byte, and the length( ) method of the returned object specifies how many characters or bytes are malformed.
- If the input was well-formed, but contains characters or bytes that are "unmappable"that cannot be encoded or decoded in the specified charsetand if the CharsetEncoder or CharsetDecoder has not specified that unmappable characters should be ignored or replaced, then the returned value is a CoderResult object whose isError( ) and isUnmappable( ) methods both return true. The input buffer is positioned at the first unmappable character or byte, and the length( ) method of the CoderResult specifies the number of unmappable characters or bytes.

```
public class CoderResult {
// No Constructor
// Public Constants
     public static final CoderResult OVERFLOW;
     public static final CoderResult UNDERFLOW;
// Public Class Methods
     public static CoderResult malformedForLength(int length);
     public static CoderResult unmappableForLength(int length);
// Public Instance Methods
     public boolean isError( );
     public boolean isMalformed( );
```

```
    public boolean isOverflow( );
    public boolean isUnderflow( );
    public boolean isUnmappable( );
    public int length( );
    public void throwException( ) throws CharacterCodingException;
// Public Methods Overriding Object
    public String toString( );
}
```

Returned By

CharsetDecoder.{decode( ), decodeLoop( ), flush( ), implFlush( )}, CharsetEncoder.{encode( ), encodeLoop( ), flush( ), implFlush( )}

CodingErrorAction java.nio.charset

Java 1.4

This class is a typesafe enumeration that defines three constants that serve as the legal argument values to the onMalformedInput( ) and onUnmappableCharacter( ) methods of CharsetDecoder and CharsetEncoder. These constants specify how malformed input and unmappable error conditions should be handled. The values are:

CodingErrorAction.REPORT

> Specifies that the error should be reported. This is done by returning a CoderResult object from the three-argument version of decode( ) or encode( ) or by throwing a MalformedInputException or UnmappableCharacterException from the one-argument version of decode( ) or encode( ). This is the default action for both error types for both CharsetDecoder and CharsetEncoder.

CodingErrorAction.IGNORE

> Specifies that the malformed input or unmappable input character should simply be skipped, with no output.

CodingErrorAction.REPLACE

> Specifies that the malformed input or unmappable character should be skipped and the replacement string or replacement bytes should be appended to the output.

See CharsetDecoder for more information.

```
public class CodingErrorAction {
// No Constructor
// Public Constants
     public static final CodingErrorAction IGNORE;
     public static final CodingErrorAction REPLACE;
     public static final CodingErrorAction REPORT;
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

CharsetDecoder.{implOnMalformedInput( ), implOnUnmappableCharacter( ), onMalformedInput( ), onUnmappableCharacter( )}, CharsetEncoder.{implOnMalformedInput( ), implOnUnmappableCharacter( ), onMalformedInput( ), onUnmappableCharacter( )}

Returned By

CharsetDecoder.{malformedInputAction( ), unmappableCharacterAction( )}, CharsetEncoder.{malformedInputAction( ), unmappableCharacterAction( )}

IllegalCharsetNameException java.nio.charset

Java 1.4 *serializable unchecked*

Signals that a charset name (for example one passed to `Charset.forName( )` or `Charset.isSupported( )`) is not legal. Charset names may contain only the characters A-Z (in upper- and lowercase), the digits 0-9, and hyphens, underscores, colons, and periods. They must begin with a letter or a digit, not with a punctuation character.

Figure 13-50. java.nio.charset.IllegalCharsetNameException

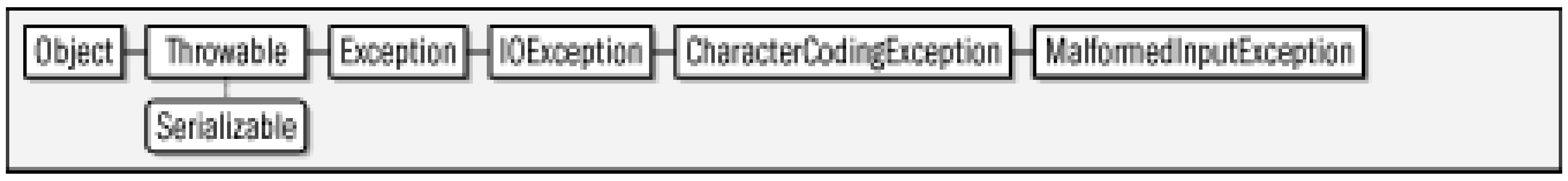

```
public class IllegalCharsetNameException extends IllegalArgumentException {
// Public Constructors
     public IllegalCharsetNameException(String charsetName);
// Public Instance Methods
     public String getCharsetName( );
}
```

MalformedInputException java.nio.charset

Java 1.4 *serializable checked*

Signals that input to the `CharsetDecoder.decode( )` or `CharsetEncoder.encode( )` method was malformed.

Figure 13-51. java.nio.charset.MalformedInputException




```
public class MalformedInputException extends CharacterCodingException {
// Public Constructors
     public MalformedInputException(int inputLength);
// Public Instance Methods
     public int getInputLength( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

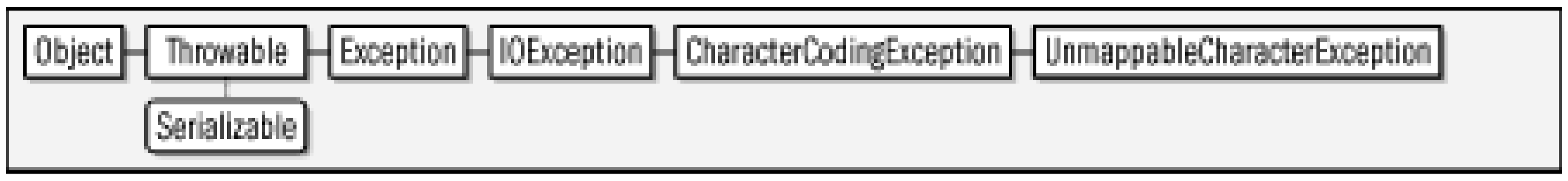
Team LiB

UnmappableCharacterException java.nio.charset

Java 1.4 *serializable checked*

Signals that input to the `CharsetDecoder.decode( )` or `CharsetEncoder.encode( )` method contained a character or byte sequence that is not mappable in the specified charset.

Figure 13-52. java.nio.charset.UnmappableCharacterException




```
public class UnmappableCharacterException extends CharacterCodingException {
// Public Constructors
     public UnmappableCharacterException(int inputLength);
// Public Instance Methods
     public int getInputLength( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

UnsupportedCharsetException java.nio.charset

Java 1.4 *serializable unchecked*

Signals that the requested charset is not supported on the current platform. This exception is thrown by `Charset.forName( )` when no `Charset` object can be obtained for the named charset. See also `Charset.isSupported( )`.

Figure 13-53. java.nio.charset.UnsupportedCharsetException


```
public class UnsupportedCharsetException extends IllegalArgumentException {
// Public Constructors
     public UnsupportedCharsetException(String charsetName);
// Public Instance Methods
     public String getCharsetName( );

}
```

Package java.nio.charset.spi

Java 1.4

This package defines a "provider" class for system developers who are defining new`Charset` implementations and want to make them available to the system. Application programmers never need to us this package or the class it defines.

Classes

```
public abstract class CharsetProvider;
```

CharsetProvider java.nio.charset.spi

Java 1.4

System programmers developing new Charset implementations should implement this class to make those charsets available to the system. charsetForName( ) should return a Charset instance for the given name. charsets( ) should return a java.util.Iterator that allows the caller to iterate through the set of Charset objects defined by the provider.

A CharsetProvider and its associated Charset implementations should be packaged in a JAR file and made available to the system in the *jre/lib/ext/* extensions directory (or some other extensions location.) The JAR file should contain a file named *META-INF/services/java.nio.charset.spi.CharsetProvider* which contains the class name of the CharsetProvider implementation.

```
public abstract class CharsetProvider {
// Protected Constructors
     protected CharsetProvider( );
// Public Instance Methods
     public abstract java.nio.charset.Charset charsetForName(String charsetName);
     public abstract java.util.Iterator<java.nio.charset.Charset> charsets( );
}
```

Team LiB

Chapter 14. java.security and Subpackages

This chapter documents the `java.security` package and its subpackages. Those packages are:

`java.security`

> This large packages contains much of Java's security infrastructure, including a group of classes that provide access control through policies and permissions, and another group that provides authentication-related services such as digital signatures.

`java.security.cert`

> This package defines classes and interfaces for working with public key certificates, certificate revocation lists (CRLs) and, in Java 1.4 and later, certificate chains (or certificate paths). It defines classes that should work with any type of certificate, and type-specific subclasses for X.509 certificates and CRLs.

`java.security.interfaces`

> This package defines interfaces for algorithm-specific types of cryptographic keys. Providers that support those algorithms must implement these interfaces.

`java.security.spec`

> This package defines classes that define a transparent, portable representation of algorithm-specific objects such as cryptographic keys. Instances of these classes can be used with any security provider.

The `java.security.acl` package is part of the Java platform, but has been superseded by access-control classes in `java.security`. It is not documented here.

Package java.security

Java 1.1

The java.security package contains the classes and interfaces that implement the Java security architecture. These classes can be divided into two broad categories. First, there are classes that implement access control and prevent untrusted code from performing sensitive operations. Second, there are authentication classes that implement message digests and digital signatures and can authenticate Java classes and other objects.

The central access control class is AccessController; it uses the currently installed Policy object to decide whether a given class has Permission to access a given system resource. The Permissions and ProtectionDomain classes are also important pieces of the Java access control architecture.

The key classes for authentication are MessageDigest and Signature; they compute and verify cryptographic message digests and digital signatures. These classes use public-key cryptography techniques and rely on the PublicKey and PrivateKey interfaces. They also rely on an infrastructure of related classes, such as SecureRandom for producing cryptographic-strength pseudorandom numbers, KeyPairGenerator for generating pairs of public and private keys, and KeyStore for managing a collection of keys and certificates. (This package defines a Certificate interface, but it is deprecated; see the java.security.cert package for the preferred Certificate class.)

The CodeSource class unites the authentication classes with the access control classes. It represents the source of a Java class as a URL and a set of java.security.cert.Certificate objects that contain the digital signatures of the code. The AccessController and Policy classes look at the CodeSource of a class when making access control decisions.

All the cryptographic-authentication features of this package are provider-based, which means they are implemented by security provider modules that can be plugged easily into any Java 1.2 (or later) installation. Thus, in addition to defining a security API, this package also defines a service provider interface (SPI). Various classes with names that end in Spi are part of this SPI. Security provider implementations must subclass these Spi classes, but applications never need to use them. Each security provider is represented by a Provider class, and the Security class allows new providers to be dynamically installed.

The java.security package contains several useful utility classes. For example, DigestInputStream and DigestOutputStream make it easy to compute message digests. GuardedObject provides customizable access control for an individual object. SignedObject protects the integrity of an arbitrary Java object by attaching a digital signature, making it easy to detect any tampering with the object. Although the java.security package contains cryptographic classes for authentication, it does not contain classes for encryption or decryption. Instead, this functionality is part of the Java Cryptography Extension or JCE which defines the javax.crypto package and its subpackages. The JCE is part of the core platform in Java 1.4 and later, and is available as a standard extension to Java 1.2 and Java 1.3.

Interfaces

```
public interface Certificate;
public interface DomainCombiner;
public interface Guard;
public interface Key extends Serializable;
public interface KeyStore.Entry;
public interface KeyStore.LoadStoreParameter;
public interface KeyStore.ProtectionParameter;
public interface Principal;
public interface PrivateKey extends Key;
public interface PrivilegedAction<T>;
public interface PrivilegedExceptionAction<T>;
public interface PublicKey extends Key;
```

Enumerated Types

```
public enum KeyRep.Type;
```

Collections

```
public abstract class Provider extends java.util.Properties;
   public abstract class AuthProvider extends Provider;
```

Other Classes

```
public final class AccessControlContext;
public final class AccessController;
public class AlgorithmParameterGenerator;
public abstract class AlgorithmParameterGeneratorSpi;
public class AlgorithmParameters;
public abstract class AlgorithmParametersSpi;
public final class CodeSigner implements Serializable;
public class CodeSource implements Serializable;
public class DigestInputStream extends java.io.FilterInputStream;
public class DigestOutputStream extends java.io.FilterOutputStream;
public class GuardedObject implements Serializable;
public abstract class Identity implements Principal, Serializable;
   public abstract class IdentityScope extends Identity;
   public abstract class Signer extends Identity;
public class KeyFactory;
public abstract class KeyFactorySpi;
public final class KeyPair implements Serializable;
public abstract class KeyPairGeneratorSpi;
   public abstract class KeyPairGenerator extends KeyPairGeneratorSpi;
public class KeyRep implements Serializable;
```

```
public class KeyStore;
public abstract static class KeyStore.Builder;
public static class KeyStore.CallbackHandlerProtection implements KeyStore.
   ProtectionParameter;
public static class KeyStore.PasswordProtection
   implements javax.security.auth.Destroyable, KeyStore.ProtectionParameter;
public static final class KeyStore.PrivateKeyEntry implements KeyStore.Entry;
public static final class KeyStore.SecretKeyEntry implements KeyStore.Entry;
public static final class KeyStore.TrustedCertificateEntry implements KeyStore.
   Entry;
public abstract class KeyStoreSpi;
public abstract class MessageDigestSpi;
   public abstract class MessageDigest extends MessageDigestSpi;
public abstract class Permission implements Guard, Serializable;
   public final class AllPermission extends Permission;
   public abstract class BasicPermission extends Permission implements
      Serializable;
      public final class SecurityPermission extends BasicPermission;
   public final class UnresolvedPermission extends Permission implements
      Serializable;
public abstract class PermissionCollection implements Serializable;
   public final class Permissions extends PermissionCollection implements
      Serializable;
public abstract class Policy;
public class ProtectionDomain;
public static class Provider.Service;
public class SecureClassLoader extends ClassLoader;
public class SecureRandom extends java.util.Random;
public abstract class SecureRandomSpi implements Serializable;
public final class Security;
public abstract class SignatureSpi;
   public abstract class Signature extends SignatureSpi;
public final class SignedObject implements Serializable;
public final class Timestamp implements Serializable;
```

Exceptions

```
public class AccessControlException extends SecurityException;
public class GeneralSecurityException extends Exception;
   public class DigestException extends GeneralSecurityException;
   public class InvalidAlgorithmParameterException extends
   GeneralSecurityException;
   public class KeyException extends GeneralSecurityException;
      public class InvalidKeyException extends KeyException;
      public class KeyManagementException extends KeyException;
   public class KeyStoreException extends GeneralSecurityException;
   public class NoSuchAlgorithmException extends GeneralSecurityException;
   public class NoSuchProviderException extends GeneralSecurityException;
   public class SignatureException extends GeneralSecurityException;
   public class UnrecoverableEntryException extends GeneralSecurityException;
```

```
public class UnrecoverableKeyException extends GeneralSecurityException;
public class InvalidParameterException extends IllegalArgumentException;
public class PrivilegedActionException extends Exception;
public class ProviderException extends RuntimeException;
```

AccessControlContext java.security

Java 1.2

This class encapsulates the state of a call stack. The checkPermission( ) method can make access-control decisions based on the saved state of the call stack. Access-control checks are usually performed by the AccessController.checkPermission( ) method, which checks that the current call stack has the required permissions. Sometimes, however, it is necessary to make access-control decisions based on a previous state of the call stack. Call AccessController.getContext( ) to create an AccessControlContext for a particular call stack. In Java 1.3, this class has constructors that specify a custom context in the form of an array of ProtectionDomain objects and that associate a DomainCombiner object with an existing AccessControlContext. This class is used only by system-level code; typical applications rarely need to use it.

```
public final class AccessControlContext {
// Public Constructors
     public AccessControlContext(ProtectionDomain[ ] context);
1.3  public AccessControlContext(AccessControlContext acc, DomainCombiner
        combiner);
// Public Instance Methods
     public void checkPermission(Permission perm) throws AccessControlException;
1.3  public DomainCombiner getDomainCombiner( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Passed To

AccessController.doPrivileged( ), javax.security.auth.Subject.{doAsPrivileged( ), getSubject( )}

Returned By

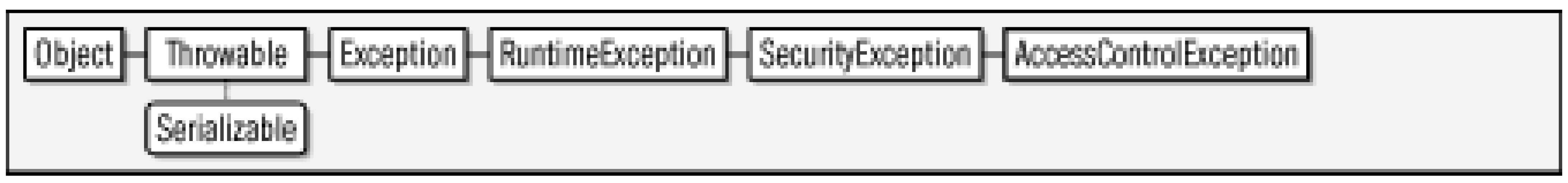
AccessController.getContext( )

AccessControlException java.security

Java 1.2 *serializable unchecked*

Thrown by `AccessController` to signal that an access request has been denied. `getPermission( )` returns the `Permission` object, if any, that was involved in the denied request.

Figure 14-1. java.security.AccessControlException




```
public class AccessControlException extends SecurityException {
// Public Constructors
     public AccessControlException(String s);
     public AccessControlException(String s, Permission p);
// Public Instance Methods
     public Permission getPermission( );
}
```

Thrown By

`AccessControlContext.checkPermission( )`, `AccessController.checkPermission( )`

Team LiB

AccessController java.security

Java 1.2

The static methods of this class implement the default access-control mechanism as of Java 1.2. `checkPermission( )` traverses the call stack of the current thread and checks whether all classes in the call stack have the requested permission. If so, `checkPermission( )` returns, and the operation can proceed. If not, `checkPermission( )` tHRows an `AccessControlException`. As of Java 1.2, the `checkPermission( )` method of the default `java.lang.SecurityManager` calls `AccessController.checkPermission( )`. System-level code that needs to perform an access check should invoke the `SecurityManager` method rather than calling the `AccessController` method directly. Unless you are writing system-level code that must control access to system resources, you never need to use this class or the `SecurityManager.checkPermission( )` method.

The various `doPrivileged( )` methods run blocks of privileged code encapsulated in a `PrivilegedAction` or `PrivilegedExceptionAction` object. When `checkPermission( )` is traversing the call stack of a thread, it stops if it reaches a privileged block that was executed with `doPrivileged( )`. This means that privileged code can run with a full set of privileges, even if it was invoked by untrusted or lower-privileged code. See `PrivilegedAction` for more details.

The `getContext( )` method returns an `AccessControlContext` that represents the current security context of the caller. Such a context might be saved and passed to a future call (perhaps a call made from a different thread). Use the two-argument version of `doPrivileged( )` to force permission checks to check the `AccessControlContext` as well.

```
public final class AccessController {
// No Constructor
// Public Class Methods
     public static void checkPermission(Permission perm)
        throws AccessControlException;
     public static <T> T doPrivileged(PrivilegedExceptionAction<T> action)
        throws PrivilegedActionException;    naopdtive
     public static <T> T doPrivileged(PrivilegedAction<T> action);     native
     public static <T> T doPrivileged(PrivilegedExceptionAction<T> action,
        AccessControlContext context)
        throws PrivilegedActionException;     native
     public static <T> T doPrivileged(PrivilegedAction<T> action,
       AccessControlContext context);     native
     public static AccessControlContext getContext( );
}
```

Team LiB

AlgorithmParameterGenerator java.security

Java 1.2

This class defines a generic API for generating parameters for a cryptographic algorithm, typically a `Signature` or a `javax.crypto.Cipher`. Create an `AlgorithmParameterGenerator` by calling one of the static `getInstance( )` factory methods and specifying the name of the algorithm and, optionally the name or `Provider` object of the desired provider. The default "SUN" provider supports the "DSA" algorithm. The "SunJCE" provider shipped with the JCE supports "DiffieHellman". Once you have obtained a generator, initialize it by calling the `init( )` method and specifying an algorithm-independent parameter size (in bits) or an algorithm-dependent `AlgorithmParameterSpec` object. You may also specify a `SecureRandom` source of randomness when you call `init( )`. Once you have created and initialized the `AlgorithmParameterGenerator`, call `generateParameters( )` to generate an `AlgorithmParameters` object.

```
public class AlgorithmParameterGenerator {
// Protected Constructors
     protected AlgorithmParameterGenerator(AlgorithmParameterGeneratorSpi
paramGenSpi, Provider provider, String algorithm);
// Public Class Methods
     public static AlgorithmParameterGenerator getInstance(String algorithm)
        throws NoSuchAlgorithmException;
1.4  public static AlgorithmParameterGenerator getInstance(String algorithm,
Provider provider) throws NoSuchAlgorithmException;
     public static AlgorithmParameterGenerator getInstance(String algorithm,
        String provider)
        throws NoSuchAlgorithmException, NoSuchProviderException;
// Public Instance Methods
     public final AlgorithmParameters generateParameters( );
     public final String getAlgorithm( );
     public final Provider getProvider( );
     public final void init(java.security.spec.AlgorithmParameterSpec
        genParamSpec) throws InvalidAlgorithmParameterException;
     public final void init(int size);
     public final void init(java.security.spec.AlgorithmParameterSpec
        genParamSpec, SecureRandom random)
        throws InvalidAlgorithmParameterException;
     public final void init(int size, SecureRandom random);
}
```

AlgorithmParameterGeneratorSpi java.security

Java 1.2

This abstract class defines the service-provider interface for algorithm-parameter generation. A security provider must implement a concrete subclass of this class for each algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class AlgorithmParameterGeneratorSpi {
// Public Constructors
     public AlgorithmParameterGeneratorSpi( );
// Protected Instance Methods
     protected abstract AlgorithmParameters engineGenerateParameters( );
     protected abstract void engineInit(java.security.spec.
AlgorithmParameterSpec genParamSpec, SecureRandom random)
throws InvalidAlgorithmParameterException;
     protected abstract void engineInit(int size, SecureRandom random);
}
```

Passed To

AlgorithmParameterGenerator.AlgorithmParameterGenerator( )

Team LiB

AlgorithmParameters java.security

Java 1.2

This class is a generic, opaque representation of the parameters used by some cryptographic algorithm. You can create an instance of the class with one of the static getInstance( ) factory methods, specifyir the desired algorithm and, optionally, the desired provider. The default "SUN" provider supports the "DS algorithm. The "SunJCE" provider shipped with the JCE supports "DES", "DESede", "PBE", "Blowfish", an "DiffieHellman". Once you have obtained an AlgorithmParameters object, initialize it by passing an algorithm-specific java.security.spec.AlgorithmParameterSpec object or the encoded parameter values as a byte array to the init( ) method. You can also create an AlgorithmParameters object witl an AlgorithmParameterGenerator . getEncoded( ) returns the initialized algorithm parameters as a byte array, using either the algorithm-specific default encoding or the named encoding format you specified.

```
public class AlgorithmParameters {
// Protected Constructors
     protected AlgorithmParameters(AlgorithmParametersSpi paramSpi, Provider
provider, String algorithm);
// Public Class Methods
     public static AlgorithmParameters getInstance(String algorithm)
throws NoSuchAlgorithmException;
     public static AlgorithmParameters getInstance(String algorithm,
String provider) throws NoSuchAlgorithmException, NoSuchProviderException;
1.4  public static AlgorithmParameters getInstance(String algorithm, Provider provider)
throws NoSuchAlgorithmException;
// Public Instance Methods
     public final String getAlgorithm( );
     public final byte[ ] getEncoded( ) throws java.io.IOException;
     public final byte[ ] getEncoded(String format) throws java.io.IOException;
     public final <T extends java.security.spec.AlgorithmParameterSpec>
T getParameterSpec(Class<T> paramSpec) throws java.security.spec.
InvalidParameterSpecException;
     public final Provider getProvider( );
     public final void init(java.security.spec.AlgorithmParameterSpec paramSpec)
throws java.security.spec.InvalidParameterSpecException;
     public final void init(byte[ ] params) throws java.io.IOException;
     public final void init(byte[ ] params, String format)
throws java.io.IOException;
// Public Methods Overriding Object
     public final String toString( );
}
```

Passed To

javax.crypto.Cipher.init( ) , javax.crypto.CipherSpi.engineInit( ) , javax.crypto.EncryptedPrivateKeyInfo.EncryptedPrivateKeyInfo( ) , javax.crypto.ExemptionMechanism.init( ) , javax.crypto.ExemptionMechanismSpi.engineInit( )

Returned By

AlgorithmParameterGenerator.generateParameters( ) , AlgorithmParameterGeneratorSpi.engineGenerateParameters( ) , Signature.getParameters( ) , SignatureSpi.engineGetParameters( ) , javax.crypto.Cipher.getParameters( ) , javax.crypto.CipherSpi.engineGetParameters( ) , javax.crypto.EncryptedPrivateKeyInfo.getAlgParameters( )

Team LiB

AlgorithmParametersSpi java.security

Java 1.2

This abstract class defines the service-provider interface for AlgorithmParameters. A security provider must implement a concrete subclass of this class for each cryptographic algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class AlgorithmParametersSpi {
// Public Constructors
     public AlgorithmParametersSpi( );
// Protected Instance Methods
     protected abstract byte[ ] engineGetEncoded( ) throws java.io.IOException;
     protected abstract byte[ ] engineGetEncoded(String format)
        throws java.io.IOException;
     protected abstract <T extends java.security.spec.AlgorithmParameterSpec>
        T engineGetParameterSpec(Class<T> paramSpec)
        throws java.security.spec.InvalidParameterSpecException;
     protected abstract void engineInit(java.security.spec.
        AlgorithmParameterSpec paramSpec)
        throws java.security.spec.InvalidParameterSpecException;
     protected abstract void engineInit(byte[ ] params)
        throws java.io.IOException;
     protected abstract void engineInit(byte[ ] params, String format)
        throws java.io.IOException;
     protected abstract String engineToString( );
}
```

Passed To

AlgorithmParameters.AlgorithmParameters( )

AllPermission java.security

Java 1.2 *serializable permission*

This class is a `Permission` subclass whose `implies( )` method always returns `true`. This means that code that has been granted `AllPermission` is granted all other possible permissions. This class exists to provide a convenient way to grant all permissions to completely trusted code. It should be used with care. Applications typically do not need to work directly with `Permission` objects.

Figure 14-2. java.security.AllPermission

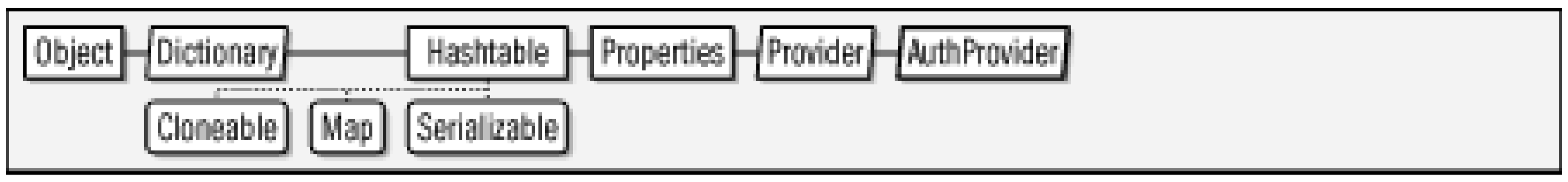

```
public final class AllPermission extends Permission {
// Public Constructors
     public AllPermission( );
     public AllPermission(String name, String actions);
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );      default:"<all actions>"
     public int hashCode( );           constant
     public boolean implies(Permission p);      constant
     public PermissionCollection newPermissionCollection( );
}
```

AuthProvider java.security

Java 5.0 *cloneable serializable collection*

This subclass of `Provider` defines methods that allow users to "log in" before using the provider's services. An implementation of the `login( )` method should use the supplied `javax.security.auth.callback.CallbackHandler` class to request the user's password or other authentication credentials. If no callback handler is passed to `login( )`, it should use the one registered with `setCallbackHandler( )` or a default.

Figure 14-3. java.security.AuthProvider




```
public abstract class AuthProvider extends Provider {
// Protected Constructors
     protected AuthProvider(String name, double version, String info);
// Public Instance Methods
     public abstract void login(javax.security.auth.Subject subject, javax.
        security.auth.callback.CallbackHandler handler)
        throws javax.security.auth.login.LoginException;
     public abstract void logout( ) throws javax.security.auth.login.LoginException;
     public abstract void setCallbackHandler(javax.security.auth.callback.
        CallbackHandler handler);
}
```

BasicPermission java.security

Java 1.2 *serializable permission*

This Permission class is the abstract superclass for a number of simple permission types. BasicPermission is typically subclassed to implement named permissions that have a name, or target, string, but do not support actions. The implies( ) method of BasicPermission defines a simple wildcarding capability. The target "*" implies permission for any target. The target "x.*" implies permission for any target that begins with "x.". Applications typically do not need to work directly with Permission objects.

Figure 14-4. java.security.BasicPermission


```
public abstract class BasicPermission extends Permission
        implements Serializable {
// Public Constructors
     public BasicPermission(String name);
     public BasicPermission(String name, String actions);
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(Permission p);
     public PermissionCollection newPermissionCollection( );
}
```

Subclasses

java.io.SerializablePermission, RuntimePermission, java.lang.management.ManagementPermission, java.lang.reflect.ReflectPermission, java.net.NetPermission, SecurityPermission, java.util.PropertyPermission, java.util.logging.LoggingPermission, javax.net.ssl.SSLPermission, javax.security.auth.AuthPermission, javax.security.auth.kerberos.DelegationPermission

Team LiB

Certificate java.security

Java 1.1; Deprecated in 1.2 *@Deprecated*

This interface was used in Java 1.1 to represent an identity certificate. It has been deprecated as of Java 1.2 in favor of the `java.security.cert` package (see Chapter 19). See also `java.security.cert.Certificate`.

```
public interface Certificate {
// Public Instance Methods
     void decode(java.io.InputStream stream)
        throws KeyException, java.io.IOException;
     void encode(java.io.OutputStream stream)
        throws KeyException, java.io.IOException;
     String getFormat( );
     Principal getGuarantor( );
     Principal getPrincipal( );
     PublicKey getPublicKey( );
     String toString(boolean detailed);
}
```

Passed To

`Identity.{addCertificate( ), removeCertificate( )}`

Returned By

`Identity.certificates( )`

CodeSigner java.security

Java 5.0 *serializable*

This class encapsulates the certificate path of a code signer and a signed timestamp. Instances are immutable. See `CodeSource` and `java.util.jar.JarEntry`.

Figure 14-5. java.security.CodeSigner


```
public final class CodeSigner implements Serializable {
// Public Constructors
     public CodeSigner(java.security.cert.CertPath signerCertPath,
        Timestamp timestamp);
// Public Instance Methods
     public java.security.cert.CertPath getSignerCertPath( );
     public Timestamp getTimestamp( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

`CodeSource.CodeSource( )`

Returned By

`CodeSource.getCodeSigners( )`, `java.util.jar.JarEntry.getCodeSigners( )`

CodeSource java.security

Java 1.2 *serializable*

This class represents the source of a Java class, as defined by the URL from which the class was loaded and the set of digital signatures attached to the class. A `CodeSource` object is created by specifying a `java.net.URL` and an array of `java.security.cert.Certificate` objects. In Java 5.0, the class has been generalized to accept an array of `CodeSigner` objects instead of `Certificate` objects. Only applications that create custom `ClassLoader` objects should ever need to use or subclass this class.

When a `CodeSource` represents a specific piece of Java code, it includes a fully qualified URL and the actual set of certificates used to sign the code. When a `CodeSource` object defines a `ProtectionDomain`, however, the URL may include wildcards, and the array of certificates is a minimum required set of signatures. The `implies( )` method of such a `CodeSource` tests whether a particular Java class comes from a matching URL and has the required set of signatures.

Figure 14-6. java.security.CodeSource

```
public class CodeSource implements Serializable {
// Public Constructors
5.0  public CodeSource(java.net.URL url, CodeSigner[ ] signers);
     public CodeSource(java.net.URL url, java.security.cert.
        Certificate[ ] certs);
// Public Instance Methods
     public final java.security.cert.Certificate[ ] getCertificates( );
5.0  public final CodeSigner[ ] getCodeSigners( );
     public final java.net.URL getLocation( );
     public boolean implies(CodeSource codesource);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

`java.net.URLClassLoader.getPermissions( )`, `java.security.Policy.getPermissions( )`, `ProtectionDomain.ProtectionDomain( )`, `SecureClassLoader.{defineClass( )`, `getPermissions( )}`, `javax.security.auth.Policy.getPermissions( )`

Returned By

`ProtectionDomain.getCodeSource( )`

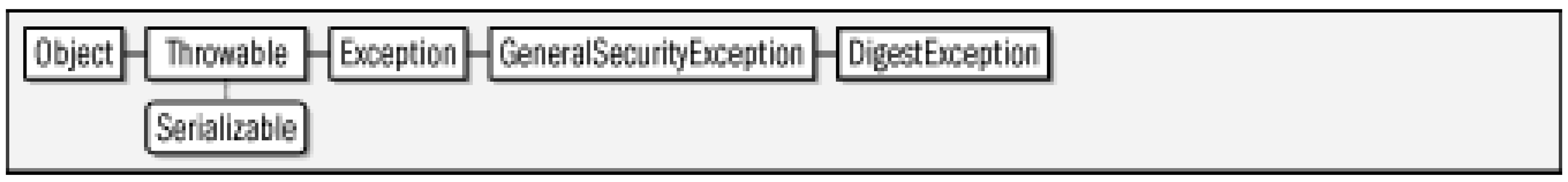
Team LiB

DigestException java.security

Java 1.1 *serializable checked*

Signals a problem creating a message digest.

Figure 14-7. java.security.DigestException




```
public class DigestException extends GeneralSecurityException {
// Public Constructors
     public DigestException( );
5.0  public DigestException(Throwable cause);
     public DigestException(String msg);
5.0  public DigestException(String message, Throwable cause);
}
```

Thrown By

MessageDigest.digest( ), MessageDigestSpi.engineDigest( )

DigestInputStream java.security

Java 1.1 *closeable*

This class is a byte input stream with an associated `MessageDigest` object. When bytes are read with any of the `read( )` methods, those bytes are automatically passed to the `update( )` method of the `MessageDigest`. When you have finished reading bytes, you can call the `digest( )` method of the `MessageDigest` to obtain a message digest. If you want to compute a digest just for some of the bytes read from the stream, use `on( )` to turn the digesting function on and off. Digesting is on by default; call `on(false)` to turn it off. See also `DigestOutputStream` and `MessageDigest`.

Figure 14-8. java.security.DigestInputStream


```
public class DigestInputStream extends java.io.FilterInputStream {
// Public Constructors
     public DigestInputStream(java.io.InputStream stream, MessageDigest digest);
// Public Instance Methods
     public MessageDigest getMessageDigest( );
     public void on(boolean on);
     public void setMessageDigest(MessageDigest digest);
// Public Methods Overriding FilterInputStream
     public int read( ) throws java.io.IOException;
     public int read(byte[ ] b, int off, int len) throws java.io.IOException;
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected MessageDigest digest;
}
```

DigestOutputStream java.security

Java 1.1 *closeable flushable*

This class is a byte output stream with an associated `MessageDigest` object. When bytes are written to the stream with any of the `write( )` methods, those bytes are automatically passed to the `update( )` method of the `MessageDigest`. When you have finished writing bytes, you can call the `digest( )` method of the `MessageDigest` to obtain a message digest. If you want to compute a digest just for some of the bytes written to the stream, use `on( )` to turn the digesting function on and off. Digesting is on by default; call `on(false)` to turn it off. See also `DigestInputStream` and `MessageDigest`.

Figure 14-9. java.security.DigestOutputStream

```
public class DigestOutputStream extends java.io.FilterOutputStream {
// Public Constructors
     public DigestOutputStream(java.io.OutputStream stream,
        MessageDigest digest);
// Public Instance Methods
     public MessageDigest getMessageDigest( );
     public void on(boolean on);
     public void setMessageDigest(MessageDigest digest);
// Public Methods Overriding FilterOutputStream
     public void write(int b) throws java.io.IOException;
     public void write(byte[ ] b, int off, int len) throws java.io.IOException;
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected MessageDigest digest;
}
```

DomainCombiner java.security

Java 1.3

This interface defines a single `combine( )` method that combines two arrays of `ProtectionDomain` objects into a single equivalent (and perhaps optimized) array. You can associate a `DomainCombiner` with an existing `AccessControlContext` by calling the two-argument `AccessControlContext( )` constructor. Then, when the `checkPermission( )` method of the `AccessControlContext` is called or when the `AccessControlContext` is passed to a `doPrivileged( )` method of `AccessController`, the specified `DomainCombiner` merges the protection domains of the current stack frame with the protection domains encapsulated in the `AccessControlContext`. This class is used only by system-level code; typical applications rarely need to use it.

```
public interface DomainCombiner {
// Public Instance Methods
     ProtectionDomain[ ] combine(ProtectionDomain[ ] currentDomains,
        ProtectionDomain[ ] assignedDomains);
}
```

Implementations

`javax.security.auth.SubjectDomainCombiner`

Passed To

`AccessControlContext.AccessControlContext( )`

Returned By

`AccessControlContext.getDomainCombiner( )`

Team LiB

GeneralSecurityException java.security

Java 1.2 *serializable checked*

This class is the superclass of most of the exceptions defined by the `java.security` package.

Figure 14-10. java.security.GeneralSecurityException


```
public class GeneralSecurityException extends Exception {
// Public Constructors
     public GeneralSecurityException( );
5.0  public GeneralSecurityException(Throwable cause);
     public GeneralSecurityException(String msg);
5.0  public GeneralSecurityException(String message, Throwable cause);
}
```

Subclasses

Too many classes to list.

Guard java.security

Java 1.2

This interface guards access to an object. The `checkGuard( )` method is passed an object to which access has been requested. If access should be granted, `checkGuard( )` should return silently. Otherwise, if access is denied, `checkGuard( )` should throw a `java.lang.SecurityException`. The `Guard` object is used primarily by the `GuardedObject` class. Note that all `Permission` objects implement the `Guard` interface.

```
public interface Guard {
// Public Instance Methods
     void checkGuard(Object object) throws SecurityException;
}
```

Implementations

`Permission`

Passed To

`GuardedObject.GuardedObject( )`

GuardedObject java.security

Java 1.2 *serializable*

This class uses a Guard object to guard against unauthorized access to an arbitrary encapsulated object. Create a GuardedObject by specifying an object and a Guard for it. The getObject( ) method calls the checkGuard( ) method of the Guard to determine whether access to the object should be allowed. If access is allowed, getObject( ) returns the encapsulated object. Otherwise, it throws a java.lang.SecurityException.

The Guard object used by a GuardedObject is often a Permission. In this case, access to the guarded object is granted only if the calling code is granted the specified permission by the current security policy.

Figure 14-11. java.security.GuardedObject

```
public class GuardedObject implements Serializable {
// Public Constructors
     public GuardedObject(Object object, Guard guard);
// Public Instance Methods
     public Object getObject( ) throws SecurityException;
}
```

Identity java.security

Java 1.1; Deprecated in 1.2 @Deprecated serializable

This deprecated class was used in Java 1.1 to represent an entity or `Principal` with an associated `PublicKey` object. In Java 1.1, the public key for a named entity could be retrieved from the system keystore with a line like the following:

```
IdentityScope.getSystemScope( ).getIdentity(name).getPublicKey( )
```

As of Java 1.2, the `Identity` class and the related `IdentityScope` and `Signer` classes have been deprecated in favor of `KeyStore` and `java.security.cert.Certificate`.

Figure 14-12. java.security.Identity

```
public abstract class Identity implements Principal, Serializable {
// Public Constructors
     public Identity(String name);
     public Identity(String name, IdentityScope scope)
        throws KeyManagementException;
// Protected Constructors
     protected Identity( );
// Public Instance Methods
     public void addCertificate(java.security.Certificate certificate)
        throws KeyManagementException;
     public java.security.Certificate[ ] certificates( );
     public String getInfo( );
     public PublicKey getPublicKey( );
     public final IdentityScope getScope( );
     public void removeCertificate(java.security.Certificate certificate)
        throws KeyManagementException;
     public void setInfo(String info);
     public void setPublicKey(PublicKey key) throws KeyManagementException;
     public String toString(boolean detailed);
// Methods Implementing Principal
     public final boolean equals(Object identity);
```

```
     public final String getName( );
     public int hashCode( );
     public String toString( );
// Protected Instance Methods
     protected boolean identityEquals(Identity identity);
}
```

Subclasses

IdentityScope, Signer

Passed To

IdentityScope.{addIdentity( ), removeIdentity( )}

Returned By

IdentityScope.getIdentity( )

IdentityScope java.security

Java 1.1; Deprecated in 1.2 @Deprecated serializable

This deprecated class was used in Java 1.1 to represent a group of Identity and Signer objects and their associated PublicKey and PrivateKey objects. As of Java 1.2, it has been replaced by the KeyStore class.

Figure 14-13. java.security.IdentityScope


```
public abstract class IdentityScope extends Identity {
// Public Constructors
     public IdentityScope(String name);
     public IdentityScope(String name, IdentityScope scope)
        throws KeyManagementException;
// Protected Constructors
     protected IdentityScope( );
// Public Class Methods
     public static IdentityScope getSystemScope( );
// Protected Class Methods
     protected static void setSystemScope(IdentityScope scope);
// Public Instance Methods
     public abstract void addIdentity(Identity identity)
        throws KeyManagementException;
     public abstract Identity getIdentity(String name);
     public Identity getIdentity(Principal principal);
     public abstract Identity getIdentity(PublicKey key);
     public abstract java.util.Enumeration<Identity> identities( );
     public abstract void removeIdentity(Identity identity)
        throws KeyManagementException;
     public abstract int size( );
// Public Methods Overriding Identity
     public String toString( );
}
```

Passed To

`Identity.Identity( )`, `Signer.Signer( )`

Returned By

`Identity.getScope( )`

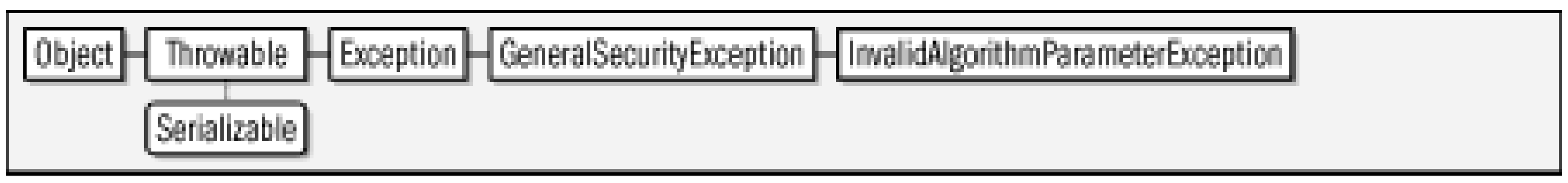
Team LiB

InvalidAlgorithmParameterException java.security

Java 1.2 *serializable checked*

Signals that one or more algorithm parameters (usually specified by a `java.security.spec.AlgorithmParameterSpec` object) are not valid.

Figure 14-14. java.security.InvalidAlgorithmParameterException




```
public class InvalidAlgorithmParameterException
        extends GeneralSecurityException {
// Public Constructors
     public InvalidAlgorithmParameterException( );
5.0  public InvalidAlgorithmParameterException(Throwable cause);
     public InvalidAlgorithmParameterException(String msg);
5.0  public InvalidAlgorithmParameterException(String message, Throwable cause);
}
```

Thrown By

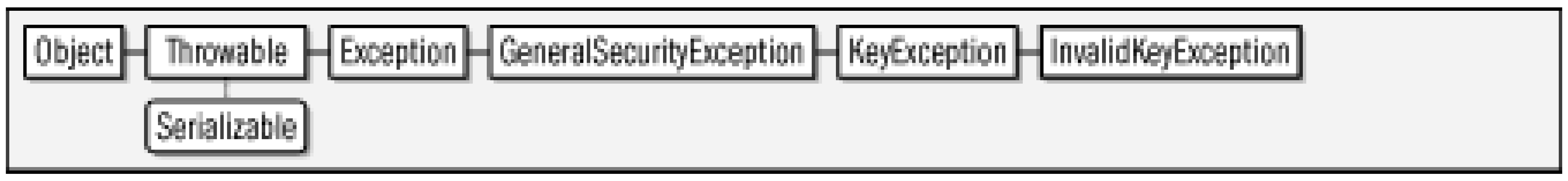
Too many methods to list.

InvalidKeyException java.security

Java 1.1 *serializable checked*

Signals that a `Key` is not valid.

Figure 14-15. java.security.InvalidKeyException




```
public class InvalidKeyException extends KeyException {
// Public Constructors
     public InvalidKeyException( );
5.0  public InvalidKeyException(Throwable cause);
     public InvalidKeyException(String msg);
5.0  public InvalidKeyException(String message, Throwable cause);
}
```

Thrown By

Too many methods to list.

InvalidParameterException java.security

Java 1.1 *serializable unchecked*

This subclass of `java.lang.IllegalArgumentException` signals that a parameter passed to a security method is not valid. This exception type is not widely used.

Figure 14-16. java.security.InvalidParameterException


```
public class InvalidParameterException extends IllegalArgumentException {
// Public Constructors
     public InvalidParameterException( );
     public InvalidParameterException(String msg);
}
```

Thrown By

`Signature.{getParameter( ), setParameter( )}`, `SignatureSpi.{engineGetParameter( ), engineSetParameter( )}`, `Signer.setKeyPair( )`, `java.security.interfaces.DSAKeyPairGenerator.initialize( )`

Key java.security

Java 1.1 *serializable*

This interface defines the high-level characteristics of all cryptographic keys.`getAlgorithm( )` returns the name of the cryptographic algorithm (such as RSA) used with the key.`getFormat( )` return the name of the external encoding (such as X.509) used with the key.`getEncoded( )` returns the key as an array of bytes, encoded using the format specified by`getFormat( )`.

Figure 14-17. java.security.Key


```
public interface Key extends Serializable {
// Public Constants
1.2  public static final long serialVersionUID;  =6603384152749567654
// Public Instance Methods
     String getAlgorithm( );
     byte[ ] getEncoded( );
     String getFormat( );
}
```

Implementations

`PrivateKey`, `PublicKey`, `javax.crypto.SecretKey`

Passed To

Too many methods to list.

Returned By

`KeyFactory.translateKey( )`, `KeyFactorySpi.engineTranslateKey( )`, `KeyStore.getKey( )`, `KeyStoreSpi.engineGetKey( )`, `javax.crypto.Cipher.unwrap( )`, `javax.crypto.CipherSpi.engineUnwrap( )`, `javax.crypto.KeyAgreement.doPhase( )`, `javax.crypto.KeyAgreementSpi.engineDoPhase( )`

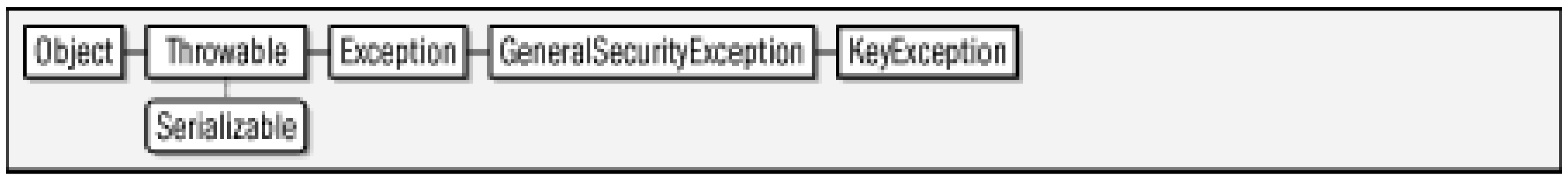
Team LiB

KeyException java.security

Java 1.1 *serializable checked*

Signals that something is wrong with a key. See also the subclasses `InvalidKeyException` and `KeyManagementException`.

Figure 14-18. java.security.KeyException




```
public class KeyException extends GeneralSecurityException {
// Public Constructors
     public KeyException( );
5.0  public KeyException(Throwable cause);
     public KeyException(String msg);
5.0  public KeyException(String message, Throwable cause);
}
```

Subclasses

`InvalidKeyException`, `KeyManagementException`

Thrown By

`java.security.Certificate.{decode( )`, `encode( )}`, `Signer.setKeyPair( )`

KeyFactory java.security

Java 1.2

This class translates asymmetric cryptographic keys between the two representations used by the Java Security API. java.security.Key is the opaque, algorithm-independent representation of a key used by most of the Security API. java.security.spec.KeySpec is a marker interface implemented by transparent, algorithm-specific representations of keys. KeyFactory is used with public and private keys; see javax.crypto.SecretKeyFactory if you are working with symmetric or secret keys.

To convert a Key to a KeySpec or vice versa, create a KeyFactory by calling one of the static getInstance( ) factory methods specifying the name of the key algorithm (e.g., DSA or RSA) and optionally specifying the name or Provider object for the desired provider. Then, use generatePublic( ) or generatePrivate( ) to create a PublicKey or PrivateKey object from a corresponding KeySpec. Or use getKeySpec( ) to obtain a KeySpec for a given Key. Because there can be more than one KeySpec implementation used by a particular cryptographic algorithm, you must also specify the Class of the KeySpec you desire.

If you do not need to transport keys portably between applications and/or systems, you can use a KeyStore to store and retrieve keys and certificates, avoiding KeySpec and KeyFactory altogether.

```
public class KeyFactory {
// Protected Constructors
     protected KeyFactory(KeyFactorySpi keyFacSpi, Provider provider,
        String algorithm);
// Public Class Methods
     public static KeyFactory getInstance(String algorithm)
        throws NoSuchAlgorithmException;
     public static KeyFactory getInstance(String algorithm, String provider)
        throws NoSuchAlgorithmException, NoSuchProviderException;
1.4  public static KeyFactory getInstance(String algorithm, Provider provider)
        throws NoSuchAlgorithmException;
// Public Instance Methods
     public final PrivateKey generatePrivate(java.security.spec.KeySpec keySpec)
        throws java.security.spec.InvalidKeySpecException;
     public final PublicKey generatePublic(java.security.spec.KeySpec keySpec)
        throws java.security.spec.InvalidKeySpecException;
     public final String getAlgorithm( );
     public final <T extends java.security.spec.KeySpec> T getKeySpec(Key key,
        Class<T> keySpec)
        throws java.security.spec.InvalidKeySpecException;
     public final Provider getProvider( );
     public final Key translateKey(Key key) throws InvalidKeyException;
}
```

Team LiB

KeyFactorySpi java.security

Java 1.2

This abstract class defines the service-provider interface forKeyFactory. A security provider must implement a concrete subclass of this class for each cryptographic algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class KeyFactorySpi {
// Public Constructors
     public KeyFactorySpi( );
// Protected Instance Methods
     protected abstract PrivateKey engineGeneratePrivate(java.security.spec.
        KeySpec keySpec) throws java.security.spec.InvalidKeySpecException;
     protected abstract PublicKey engineGeneratePublic(java.security.spec.
        KeySpec keySpec) throws java.security.spec.InvalidKeySpecException;
     protected abstract <T extends java.security.spec.KeySpec>
        T engineGetKeySpec(Key key, Class<T> keySpec)
        throws java.security.spec.InvalidKeySpecException;
     protected abstract Key engineTranslateKey(Key key)
        throws InvalidKeyException;
}
```

Passed To

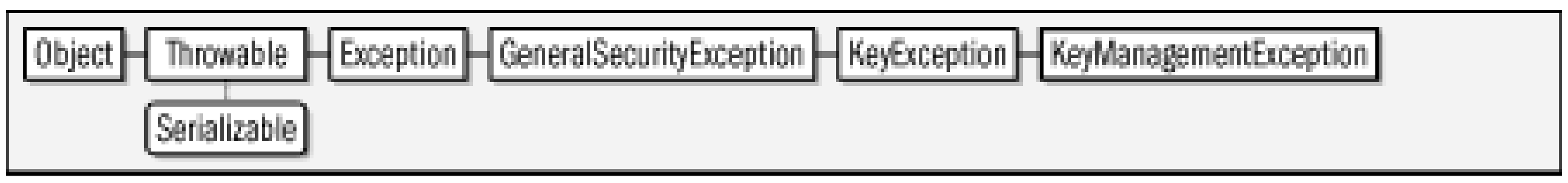
KeyFactory.KeyFactory( )

KeyManagementException java.security

Java 1.1 *serializable checked*

Signals an exception in a key management operation. In Java 1.2, this exception is only thrown by deprecated methods.

Figure 14-19. java.security.KeyManagementException




```
public class KeyManagementException extends KeyException {
// Public Constructors
     public KeyManagementException( );
5.0  public KeyManagementException(Throwable cause);
     public KeyManagementException(String msg);
5.0  public KeyManagementException(String message, Throwable cause);
}
```

Thrown By

`Identity.{addCertificate( )`, `Identity( )`, `removeCertificate( )`, `setPublicKey( )}`, `IdentityScope.{addIdentity( )`, `IdentityScope( )`, `removeIdentity( )}`, `Signer.Signer( )`, `javax.net.ssl.SSLContext.init( )`, `javax.net.ssl.SSLContextSpi.engineInit( )`

KeyPair java.security

Java 1.1 *serializable*

This class is a simple container for a `PublicKey` and a `PrivateKey` object. Because a `KeyPair` contains an unprotected private key, it must be used with as much caution as a `PrivateKey` object.

Figure 14-20. java.security.KeyPair


```
public final class KeyPair implements Serializable {
// Public Constructors
     public KeyPair(PublicKey publicKey, PrivateKey privateKey);
// Public Instance Methods
     public PrivateKey getPrivate( );
     public PublicKey getPublic( );
}
```

Passed To

`Signer.setKeyPair( )`

Returned By

`KeyPairGenerator.{generateKeyPair( ), genKeyPair( )}`, `KeyPairGeneratorSpi.generateKeyPair( )`

KeyPairGenerator java.security

Java 1.1

This class generates a public/private key pair for a specified cryptographic algorithm. To create a KeyPairGenerator, call one of the static getInstance( ) methods, specifying the name of the algorithm and, optionally, the name or Provider object of the security provider to use. The default "SUN" provider shipped with Java 1.2 supports only the "DSA" algorithm. The "SunJCE" provider of the Java Cryptography Extension (JCE) additionally supports the "DiffieHellman" algorithm.

Once you have created a KeyPairGenerator, initialize it by calling initialize( ). You can perform an algorithm-independent initialization by simply specifying the desired key size in bits. Alternatively, you can do an algorithm-dependent initialization by providing an appropriate AlgorithmParameterSpec object for the key-generation algorithm. In either case, you may optionally provide your own source of randomness in the guise of a SecureRandom object. Once you have created and initialized a KeyPairGenerator, call genKeyPair( ) to create a KeyPair object. Remember that the KeyPair contains a PrivateKey that *must* be kept private.

For historical reasons, KeyPairGenerator extends KeyPairGeneratorSpi. Applications should not use any methods inherited from that class.

Figure 14-21. java.security.KeyPairGenerator

```
public abstract class KeyPairGenerator extends KeyPairGeneratorSpi {
// Protected Constructors
     protected KeyPairGenerator(String algorithm);
// Public Class Methods
     public static KeyPairGenerator getInstance(String algorithm)
        throws NoSuchAlgorithmException;
1.4  public static KeyPairGenerator getInstance(String algorithm,
        Provider provider) throws NoSuchAlgorithmException;
     public static KeyPairGenerator getInstance(String algorithm,
        String provider)
throws NoSuchAlgorithmException, NoSuchProviderException;
// Public Instance Methods
1.2  public final KeyPair genKeyPair( );
     public String getAlgorithm( );
1.2  public final Provider getProvider( );
1.2  public void initialize(java.security.spec.AlgorithmParameterSpec params)
        throws InvalidAlgorithmParameterException;
```

```
     public void initialize(int keysize);
// Public Methods Overriding KeyPairGeneratorSpi
     public KeyPair generateKeyPair( );          constant
1.2  public void initialize(java.security.spec.AlgorithmParameterSpec params,
        SecureRandom random)
        throws InvalidAlgorithmParameterException;     empty
     public void initialize(int keysize, SecureRandom random);     empty
}
```

Team LiB

KeyPairGeneratorSpi java.security

Java 1.2

This abstract class defines the service-provider interface for KeyPairGenerator. A security provider must implement a concrete subclass of this class for each cryptographic algorithm for which it can generate key pairs. Applications never need to use or subclass this class.

```
public abstract class KeyPairGeneratorSpi {
// Public Constructors
     public KeyPairGeneratorSpi( );
// Public Instance Methods
     public abstract KeyPair generateKeyPair( );
     public void initialize(java.security.spec.AlgorithmParameterSpec params,
        SecureRandom random)
        throws InvalidAlgorithmParameterException;
     public abstract void initialize(int keysize, SecureRandom random);
}
```

Subclasses

KeyPairGenerator

KeyRep java.security

Java 5.0 *serializable*

This class defines a serialized representation for `Key` implementations and is typically used only by security providers, not users of the `java.security` package.

Figure 14-22. java.security.KeyRep


```
public class KeyRep implements Serializable {
// Public Constructors
     public KeyRep(KeyRep.Type type, String algorithm, String format,
        byte[ ] encoded);
// Nested Types
     public enum Type;
// Protected Instance Methods
     protected Object readResolve( ) throws java.io.ObjectStreamException;
}
```

KeyRep.Type java.security

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type represent the general types of cryptographic keys: public keys, private keys, and secret keys.

```
public enum KeyRep.Type {
// Enumerated Constants
     SECRET,
     PUBLIC,
     PRIVATE;
// Public Class Methods
     public static KeyRep.Type valueOf(String name);
     public static final KeyRep.Type[ ] values( );
}
```

Passed To

KeyRep.KeyRep( )

Team LiB

KeyStore java.security

Java 1.2

This class represents a mapping of names, or aliases, to Key and java.security.cert.Certificate objects. Obtain a KeyStore object by calling one of the static getInstance( ) methods, specifying the desired key store type and, optionally, the desired provider. Use "JKS" to specify the "Java Key Store" ty defined by Sun. Because of U.S. export regulations, this default KeyStore supports only weak encryption private keys. If you have the Java Cryptography Extension installed, use the type "JCEKS" and provider "SunJCE" to obtain a KeyStore implementation that offers much stronger password-based encryption of keys. Once you have created a KeyStore , use load( ) to read its contents from a stream, supplying ar optional password that verifies the integrity of the stream data. Keystores are typically read from a file named *.keystore* in the user's home directory.

The KeyStore API has been substantially enhanced in Java 5.0. We describe pre-5.0 methods first, and then cover Java 5.0 enhancements below. A KeyStore may contain both public and private key entries. A public key entry is represented by a Certificate object. Use getCertificate( ) to look up a named public key certificate and setCertificateEntry( ) to add a new public key certificate to the keystore. A private key entry in the keystore contains both a password-protected Key and an array of Certificate objects that represent the certificate chain for the public key that corresponds to the private key. Use getKey( ) and getCertificateChain( ) to look up the key and certificate chain. Use setKeyEntry( ) create a new private key entry. You must provide a password when reading or writing a private key fron the keystore; this password encrypts the key data, and each private key entry should have a different password. If you are using the JCE, you may also store javax.crypto.SecretKey objects in a KeyStore Secret keys are stored like private keys, except that they do not have a certificate chain associated with them. To delete an entry from a KeyStore , use deleteEntry( ) . If you modify the contents of a KeyStore , use store( ) to save the keystore to a specified stream. You may specify a password that is used to validate the integrity of the data, but it is not used to encrypt the keystore.

In Java 5.0 the KeyStore.Entry interface defines a keystore entry. Implementations include the nested types PrivateKeyEntry , SecretKeyEntry , and trustedCertificateEntry . You can get or set an ent of any type with the new methods getEntry( ) and setEntry( ) . These methods accept a KeyStore.ProtectionParameter object, such as a password represented as a KeyStore.PasswordProtection object. Java 5.0 also defines new load( ) and store( ) methods that specify a password indirectly through a KeyStore.LoadStoreParameter .

```
public class KeyStore {
// Protected Constructors
    protected KeyStore(KeyStoreSpi keyStoreSpi, Provider provider, String type);
// Nested Types
5.0  public abstract static class Builder;
5.0  public static class CallbackHandlerProtection
         implements KeyStore.ProtectionParameter;
5.0  public interface Entry;
5.0  public interface LoadStoreParameter;
5.0  public static class PasswordProtection
```

```
        implements javax.security.auth.Destroyable, KeyStore.ProtectionParameter;
5.0  public static final class PrivateKeyEntry
        implements KeyStore.Entry;
5.0  public interface ProtectionParameter;
5.0  public static final class SecretKeyEntry implements KeyStore.Entry;
5.0  public static final class TrustedCertificateEntry implements KeyStore.Entry;
// Public Class Methods
     public static final String getDefaultType( );
     public static KeyStore getInstance(String type) throws KeyStoreException;
     public static KeyStore getInstance(String type, String provider)
        throws KeyStoreException, NoSuchProviderException;
1.4  public static KeyStore getInstance(String type, Provider provider)
        throws KeyStoreException;
// Public Instance Methods
     public final java.util.Enumeration<String> aliases( )
        throws KeyStoreException;
     public final boolean containsAlias(String alias) throws KeyStoreException;
     public final void deleteEntry(String alias) throws KeyStoreException;
5.0  public final boolean entryInstanceOf(String alias,
        Class<? extends KeyStore.Entry> entryClass)
        throws KeyStoreException;
     public final java.security.cert.Certificate getCertificate(String alias)
        throws KeyStoreException;
     public final String getCertificateAlias(java.security.cert.Certificate cert)
        throws KeyStoreException;
     public final java.security.cert.Certificate[ ] getCertificateChain
        (String alias) throws KeyStoreException;
     public final java.util.Date getCreationDate(String alias)
        throws KeyStoreException;
5.0  public final KeyStore.Entry getEntry(String alias, KeyStore.
        ProtectionParameter protParam)
        throws NoSuchAlgorithmException, UnrecoverableEntryException, KeyStoreException;
     public final Key getKey(String alias, char[ ] password)
        throws KeyStoreException, NoSuchAlgorithmException, UnrecoverableKeyException;
     public final Provider getProvider( );
     public final String getType( );
     public final boolean isCertificateEntry(String alias)
        throws KeyStoreException;
     public final boolean isKeyEntry(String alias) throws KeyStoreException;
5.0  public final void load(KeyStore.LoadStoreParameter param)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
     public final void load(java.io.InputStream stream, char[ ] password)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
     public final void setCertificateEntry(String alias, java.security.cert.
        Certificate cert) throws KeyStoreException;
5.0  public final void setEntry(String alias, KeyStore.Entry entry,
        KeyStore.ProtectionParameter protParam)
        throws KeyStoreException;
```

```
    public final void setKeyEntry(String alias, byte[ ] key,
       java.security.cert.Certificate[ ] chain)
       throws KeyStoreException;
    public final void setKeyEntry(String alias, Key key, char[ ] password,
       java.security.cert.Certificate[ ] chain)
       throws KeyStoreException;
    public final int size( ) throws KeyStoreException;
5.0 public final void store(KeyStore.LoadStoreParameter param)
       throws KeyStoreException, java.io.IOException, NoSuchAlgorithmException,
       java.security.cert.CertificateException;
    public final void store(java.io.OutputStream stream, char[ ] password)
       throws KeyStoreException, java.io.IOException, NoSuchAlgorithmException,
       java.security.cert.CertificateException;
}
```

Passed To

KeyStore.Builder.newInstance( ) , java.security.cert.PKIXBuilderParameters.PKIXBuilderParameters( ) , java.security.cert.PKIXParameters.PKIXParameters( ) , javax.net.ssl.KeyManagerFactory.in:) , javax.net.ssl.KeyManagerFactorySpi.engineInit( ) , javax.net.ssl.TrustManagerFactory.init( ) , javax.net.ssl.TrustManagerFactorySpi.engineInit( )

Returned By

KeyStore.Builder.getKeyStore( )

Team LiB

KeyStore.Builder java.security

Java 5.0

An instance of this class encapsulates the parameters necessary to obtain a KeyStore object at some later time. This class is useful when you want to defer the initialization of a KeyStore (which may require the user to enter a password) until it is needed. See the javax.net.ssl.KeyStoreBuilderParameters class, for example.

```
public abstract static class KeyStore.Builder {
// Protected Constructors
     protected Builder( );
// Public Class Methods
     public static KeyStore.Builder newInstance(KeyStore keyStore,
        KeyStore.ProtectionParameter protectionParameter);
     public static KeyStore.Builder newInstance(String type, Provider provider,
        KeyStore.ProtectionParameter protection);
     public static KeyStore.Builder newInstance(String type, Provider provider,
        java.io.File file,
KeyStore.ProtectionParameter protection);
// Public Instance Methods
     public abstract KeyStore getKeyStore( ) throws KeyStoreException;
     public abstract KeyStore.ProtectionParameter getProtectionParameter
        (String alias) throws KeyStoreException;
}
```

Passed To

javax.net.ssl.KeyStoreBuilderParameters.KeyStoreBuilderParameters( )

KeyStore.CallbackHandlerProtection java.security

Java 5.0

This class is a KeyStore.ProtectionParameter implementation that wraps a javax.security.auth.callback.CallbackHandler for prompting the user for a password or other authentication credentials.

```
public static class KeyStore.CallbackHandlerProtection
        implements KeyStore.ProtectionParameter {
// Public Constructors
     public CallbackHandlerProtection(javax.security.auth.callback.
        CallbackHandler handler);
// Public Instance Methods
     public javax.security.auth.callback.CallbackHandler getCallbackHandler( );
}
```

KeyStore.Entry java.security

Java 5.0

This marker interface represents an entry in a KeyStore.

```
public interface KeyStore.Entry {
}
```

Implementations

KeyStore.PrivateKeyEntry, KeyStore.SecretKeyEntry, KeyStore.TrustedCertificateEntry

Passed To

KeyStore.setEntry( ), KeyStoreSpi.engineSetEntry( )

Returned By

KeyStore.getEntry( ), KeyStoreSpi.engineGetEntry( )

KeyStore.LoadStoreParameter java.security

Java 5.0

This interface represents an object passed to the `load( )` or `store( )` methods of `KeyStore`. An implementation must be able to return a `KeyStore.ProtectionParameter`.

```
public interface KeyStore.LoadStoreParameter {
// Public Instance Methods
     KeyStore.ProtectionParameter getProtectionParameter( );
}
```

Passed To

`KeyStore.{load( ), store( )}`, `KeyStoreSpi.{engineLoad( ), engineStore( )}`

Team LiB

KeyStore.PasswordProtection java.security

Java 5.0

This class is a KeyStore.ProtectionParameter implementation that wraps a password specified as a ch] . Note that getPassword( ) returns a reference to the internal array, not a clone of it. The destroy( ) method zeros out this array.

```
public static class KeyStore.PasswordProtection
        implements javax.security.auth.Destroyable, KeyStore.ProtectionParameter {
// Public Constructors
     public PasswordProtection(char[ ] password);
// Public Instance Methods
     public char[ ] getPassword( );           synchronized
// Methods Implementing Destroyable
     public void destroy( )
        throws javax.security.auth.DestroyFailedException;                     synchron
     public boolean isDestroyed( );           synchronized
}
```

KeyStore.PrivateKeyEntry java.security

Java 5.0

This KeyStore.Entry implementation represents a private key. getPrivateKey( ) returns the key. getCertificateChain( ) returns the certificate chain of the corresponding public key. The first element of the returned array is the certificate of the ultimate certificate authority (CA). This "end entity" certificate is also available through the getCertificate( ) method.

```
public static final class KeyStore.PrivateKeyEntry implements KeyStore.Entry {
// Public Constructors
     public PrivateKeyEntry(PrivateKey privateKey, java.security.cert.
        Certificate[ ] chain);
// Public Instance Methods
     public java.security.cert.Certificate getCertificate( );
     public java.security.cert.Certificate[ ] getCertificateChain( );
     public PrivateKey getPrivateKey( );
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

KeyStore.ProtectionParameter java.security

Java 5.0

This marker interface should be implemented by classes that provide some form of protection for the entries in a KeyStore.

```
public interface KeyStore.ProtectionParameter {
}
```

Implementations

KeyStore.CallbackHandlerProtection, KeyStore.PasswordProtection

Passed To

KeyStore.{getEntry( ), setEntry( )}, KeyStore.Builder.newInstance( ), KeyStoreSpi.{engineGetEntry( ), engineSetEntry( )}

Returned By

KeyStore.Builder.getProtectionParameter( ), KeyStore.LoadStoreParameter.getProtectionParameter( )

Team LiB

KeyStore.SecretKeyEntry java.security

Java 5.0

This `KeyStore.Entry` implementation represents a secret key. `getSecretKey( )` returns the key as a `javax.crypto.SecretKey`.

```
public static final class KeyStore.SecretKeyEntry implements KeyStore.Entry {
// Public Constructors
     public SecretKeyEntry(javax.crypto.SecretKey secretKey);
// Public Instance Methods
     public javax.crypto.SecretKey getSecretKey( );
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

KeyStore.TrustedCertificateEntry java.security

Java 5.0

This implementation of KeyStore.Entry represents a certificate that contains and certifies a public key. gettrustedCertificate( ) returns the certificate.

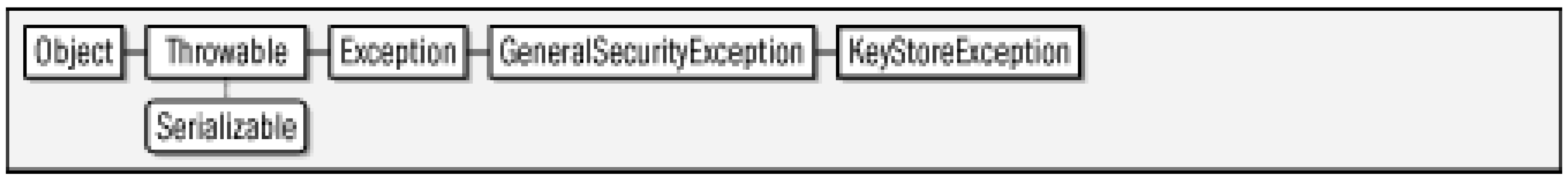
```
public static final class KeyStore.TrustedCertificateEntry
        implements KeyStore.Entry {
// Public Constructors
     public TrustedCertificateEntry(java.security.cert.Certificate trustedCert);
// Public Instance Methods
     public java.security.cert.Certificate getTrustedCertificate( );
// Public Methods Overriding Object
     public String toString( );
}
```

KeyStoreException java.security

Java 1.2 *serializable checked*

Signals a problem with a KeyStore.

Figure 14-23. java.security.KeyStoreException




```
public class KeyStoreException extends GeneralSecurityException {
// Public Constructors
     public KeyStoreException( );
5.0  public KeyStoreException(Throwable cause);
     public KeyStoreException(String msg);
5.0  public KeyStoreException(String message, Throwable cause);
}
```

Thrown By

Too many methods to list.

Team LiB

KeyStoreSpi java.security

Java 1.2

This abstract class defines the service-provider interface for KeyStore . A security provider must implem a concrete subclass of this class for each KeyStore type it supports. Applications never need to use or subclass this class.

```
public abstract class KeyStoreSpi {
// Public Constructors
     public KeyStoreSpi( );
// Public Instance Methods
     public abstract java.util.Enumeration<String> engineAliases( );
     public abstract boolean engineContainsAlias(String alias);
     public abstract void engineDeleteEntry(String alias)
        throws KeyStoreException;
5.0  public boolean engineEntryInstanceOf(String alias, Class<?
        extends KeyStore.Entry> entryClass);
     public abstract java.security.cert.Certificate engineGetCertificate
        (String alias);
     public abstract String engineGetCertificateAlias(java.security.cert.
        Certificate cert);
     public abstract java.security.cert.Certificate[ ] engineGetCertificateChain
        (String alias);
     public abstract java.util.Date engineGetCreationDate(String alias);
5.0  public KeyStore.Entry engineGetEntry(String alias,
        KeyStore.ProtectionParameter protParam)
        throws KeyStoreException, NoSuchAlgorithmException, UnrecoverableEntryException;
     public abstract Key engineGetKey(String alias, char[ ] password)
        throws NoSuchAlgorithmException, UnrecoverableKeyException;
     public abstract boolean engineIsCertificateEntry(String alias);
     public abstract boolean engineIsKeyEntry(String alias);
5.0  public void engineLoad(KeyStore.LoadStoreParameter param)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
     public abstract void engineLoad(java.io.InputStream stream, char[ ] password)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
     public abstract void engineSetCertificateEntry(String alias,
        java.security.cert.Certificate cert)
        throws KeyStoreException;
5.0  public void engineSetEntry(String alias, KeyStore.Entry entry,
        KeyStore.ProtectionParameter protParam)
        throws KeyStoreException;
     public abstract void engineSetKeyEntry(String alias, byte[ ] key,
```

```
        java.security.cert.Certificate[ ] chain)
        throws KeyStoreException;
    public abstract void engineSetKeyEntry(String alias, Key key,
        char[ ] password, java.security.cert.Certificate[ ] chain)
        throws KeyStoreException;
    public abstract int engineSize( );
5.0 public void engineStore(KeyStore.LoadStoreParameter param)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
    public abstract void engineStore(java.io.OutputStream stream,
        char[ ] password)
        throws java.io.IOException, NoSuchAlgorithmException,
        java.security.cert.CertificateException;
}
```

Passed To

`KeyStore.KeyStore( )`

MessageDigest java.security

Java 1.1

This class computes a message digest (also known as a cryptographic checksum) for an arbitrary sequence of bytes. Obtain a `MessageDigest` object by calling one of the static `getInstance( )` factory methods and specifying the desired algorithm (e.g., SHA or MD5) and, optionally, the desired provider. Next, specify the data to be digested by calling any of the `update( )` methods one or more times. Prior to Java 5.0, you must pass a `byte[ ]` to `update( )`. In Java 5.0 and later, however, you can also use a `java.nio.ByteBuffer`. This facilitates the computation of message digests when using the New I/O API.

After you pass data to `update( )`, call `digest( )`, which computes the message digest and returns it as an array of bytes. If you have only one array of bytes to be digested, you can pass it directly to `digest( )` and skip the `update( )` step. When you call `digest( )`, the `MessageDigest( )` object is reset and is then ready to compute a new digest. You can also explicitly reset a `MessageDigest` without computing the digest by calling `reset( )`. To compute a digest for part of a message without resetting the `MessageDigest`, clone the `MessageDigest` and call `digest( )` on the cloned copy. Note that not all implementations are cloneable, so the `clone( )` method may throw an exception.

The `MessageDigest` class is often used in conjunction with `DigestInputStream` and `DigestOutputStream`, which automate the `update( )` calls for you.

Figure 14-24. java.security.MessageDigest

```
public abstract class MessageDigest extends MessageDigestSpi {
// Protected Constructors
     protected MessageDigest(String algorithm);
// Public Class Methods
     public static MessageDigest getInstance(String algorithm)
        throws NoSuchAlgorithmException;
     public static MessageDigest getInstance(String algorithm,
        String provider)
        throws NoSuchAlgorithmException, NoSuchProviderException;
1.4  public static MessageDigest getInstance(String algorithm, Provider provider)
throws NoSuchAlgorithmException;
     public static boolean isEqual(byte[ ] digesta, byte[ ] digestb);
// Public Instance Methods
     public byte[ ] digest( );
     public byte[ ] digest(byte[ ] input);
```

```
1.2  public int digest(byte[ ] buf, int offset, int len)
        throws DigestException;
     public final String getAlgorithm( );
1.2  public final int getDigestLength( );
1.2  public final Provider getProvider( );
     public void reset( );
     public void update(byte input);
     public void update(byte[ ] input);
5.0  public final void update(java.nio.ByteBuffer input);
     public void update(byte[ ] input, int offset, int len);
// Public Methods Overriding MessageDigestSpi
     public Object clone( ) throws CloneNotSupportedException;
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

DigestInputStream.{DigestInputStream( ), setMessageDigest( )}, DigestOutputStream.{DigestOutputStream( ), setMessageDigest( )}

Returned By

DigestInputStream.getMessageDigest( ), DigestOutputStream.getMessageDigest( )

Type Of

DigestInputStream.digest, DigestOutputStream.digest

MessageDigestSpi java.security

Java 1.2

This abstract class defines the service-provider interface for MessageDigest. A security provider must implement a concrete subclass of this class for each message-digest algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class MessageDigestSpi {
// Public Constructors
     public MessageDigestSpi( );
// Public Methods Overriding Object
     public Object clone( ) throws CloneNotSupportedException;
// Protected Instance Methods
     protected abstract byte[ ] engineDigest( );
     protected int engineDigest(byte[ ] buf, int offset, int len)
         throws DigestException;
     protected int engineGetDigestLength( );               constant
     protected abstract void engineReset( );
     protected abstract void engineUpdate(byte input);
5.0  protected void engineUpdate(java.nio.ByteBuffer input);
     protected abstract void engineUpdate(byte[ ] input, int offset, int len);
}
```

Subclasses

MessageDigest

NoSuchAlgorithmException java.security

Java 1.1 *serializable checked*

Signals that a requested cryptographic algorithm is not available. Thrown by `getInstance( )` factory methods throughout the `java.security` package.

Figure 14-25. java.security.NoSuchAlgorithmException


```
public class NoSuchAlgorithmException extends GeneralSecurityException {
// Public Constructors
     public NoSuchAlgorithmException( );
5.0  public NoSuchAlgorithmException(Throwable cause);
     public NoSuchAlgorithmException(String msg);
5.0  public NoSuchAlgorithmException(String message, Throwable cause);
}
```

Thrown By

Too many methods to list.

Team LiB

NoSuchProviderException java.security

Java 1.1 *serializable checked*

Signals that a requested cryptographic service provider is not available. Thrown by `getInstance( )` factory methods throughout the `java.security` package.

Figure 14-26. java.security.NoSuchProviderException


```
public class NoSuchProviderException extends GeneralSecurityException {
// Public Constructors
     public NoSuchProviderException( );
     public NoSuchProviderException(String msg);
}
```

Thrown By

Too many methods to list.

Permission java.security

Java 1.2 *serializable permission*

This abstract class represents a system resource, such as a file in the filesystem, or a system capability, such as the ability to accept network connections. Concrete subclasses of `Permission`, such as `java.io.FilePermission` and `java.net.SocketPermission`, represent specific types of resources. `Permission` objects are used by system code that is requesting access to a resource. They are also used by `Policy` objects that grant access to resources. The `AccessController.checkPermission( )` method considers the source of the currently running Java code, determines the set of permissions that are granted to that code by the current `Policy`, and then checks to see whether a specified `Permission` object is included in that set. As of Java 1.2, this is the fundamental Java access-control mechanism.

Each permission has a name (sometimes called the *target*) and, optionally, a comma-separated list of actions. For example, the name of a `FilePermission` is the name of the file or directory for which permission is being granted. The actions associated with this permission might be "read"; "write"; or "read,write". The interpretation of the name and action strings is entirely up to the implementation of `Permission`. A number of implementations support the use of wildcards; for example, a `FilePermission` can have a name of "/tmp/*", which represents access to any files in a */tmp* directory. Permission objects must be immutable, so an implementation must never define a `setName( )` or `setActions( )` method.

One of the most important abstract methods defined by `Permission` is `implies( )`. This method must return `true` if this `Permission` implies another `Permission`. For example, if an application requests a `FilePermission` with name "/tmp/test" and action "read", and the current security `Policy` grants a `FilePermission` with name "/tmp/*" and actions "read,write", the request is granted because the requested permission is implied by the granted one.

In general, only system-level code needs to work directly with `Permission` and its concrete subclasses. System administrators who are configuring security policies need to understand the various `Permission` subclasses. Applications that want to extend the Java access-control mechanism to provide customized access control to their own resources should subclass `Permission` to define custom permission types.

Figure 14-27. java.security.Permission

```
public abstract class Permission implements Guard, Serializable {
// Public Constructors
     public Permission(String name);
```

```
// Public Instance Methods
     public abstract String getActions( );
     public final String getName( );
     public abstract boolean implies(Permission permission);
     public PermissionCollection newPermissionCollection( );  constant
// Methods Implementing Guard
     public void checkGuard(Object object) throws SecurityException;
// Public Methods Overriding Object
     public abstract boolean equals(Object obj);
     public abstract int hashCode( );
     public String toString( );
}
```

Subclasses

java.io.FilePermission, java.net.SocketPermission, AllPermission, BasicPermission, UnresolvedPermission, javax.security.auth.PrivateCredentialPermission, javax.security.auth.kerberos.ServicePermission

Passed To

Too many methods to list.

Returned By

java.net.HttpURLConnection.getPermission( ), java.net.URLConnection.getPermission( ), AccessControlException.getPermission( )

Team LiB

PermissionCollection java.security

Java 1.2 *serializable*

This class is used by Permissions to store a collection of Permission objects that are all the same type. Like the Permission class itself, PermissionCollection defines an implies( ) method that can determine whether a requested Permission is implied by any of the Permission objects in the collection. Some Permission types may require a custom PermissionCollection type in order to correctly implement the implies( ) method. In this case, the Permission subclass should override newPermissionCollection( ) to return a Permission of the appropriate type. PermissionCollection is used by system code that manages security policies. Applications rarely need to use it.

Figure 14-28. java.security.PermissionCollection

```
public abstract class PermissionCollection implements Serializable {
// Public Constructors
     public PermissionCollection( );
// Public Instance Methods
     public abstract void add(Permission permission);
     public abstract java.util.Enumeration<Permission> elements( );
     public abstract boolean implies(Permission permission);
     public boolean isReadOnly( );
     public void setReadOnly( );
// Public Methods Overriding Object
     public String toString( );
}
```

Subclasses

Permissions

Passed To

ProtectionDomain.ProtectionDomain( )

Returned By

Too many methods to list.

Permissions java.security

Java 1.2 *serializable*

This class stores an arbitrary collection of `Permission` objects. When `Permission` objects are added with the `add( )` method, they are grouped into an internal set of `PermissionCollection` objects that contain only a single type of `Permission`. Use the `elements( )` method to obtain an `Enumeration` of the `Permission` objects in the collection. Use `implies( )` to determine if a specified `Permission` is implied by any of the `Permission` objects in the collection. `Permissions` is used by system code that manages security policies. Applications rarely need to use it.

Figure 14-29. java.security.Permissions


```
public final class Permissions extends PermissionCollection
        implements Serializable {
// Public Constructors
     public Permissions( );
// Public Methods Overriding PermissionCollection
     public void add(Permission permission);
     public java.util.Enumeration<Permission> elements( );
     public boolean implies(Permission permission);
}
```

Policy java.security

Java 1.2

This class represents a security policy that determines the permissions granted to code based on its source and signers, and, in Java 1.4 and later, based on the user on whose behalf that code is running. There is only a single Policy in effect at any one time. Obtain the system policy by calling the static getPolicy( ) method. Code that has appropriate permissions can specify a new system policy by calling setPolicy( ). The refresh( ) method is a request to a Policy object to update its state (for example, by rereading its configuration file). The Policy class is used primarily by system-level code. Applications should not need to use this class unless they implement some kind of custom access-control mechanism.

Prior to Java 1.4, this class provides a mapping from CodeSource objects to PermissionCollection objects. getPermissions( ) is the central Policy method; it evaluates the Policy for a given CodeSource and returns an appropriate PermissionCollection representing the static set of permissions available to code from that source.

As of Java 1.4, you can use a ProtectionDomain object to encapsulate a CodeSource and a set of users on whose behalf the code is running. In this release, there is a new getPermissions( ) method that returns a PermissionsCollection appropriate for the specified ProtectionDomain. In addition, there is a new implies( ) method that dynamically queries the Policy to see if the specified permission is granted to the specific ProtectionDomain.

```
public abstract class Policy {
// Public Constructors
     public Policy( );
// Public Class Methods
     public static java.security.Policy getPolicy( );
     public static void setPolicy(java.security.Policy p);
// Public Instance Methods
     public abstract PermissionCollection getPermissions(CodeSource codesource);
1.4  public PermissionCollection getPermissions(ProtectionDomain domain);
1.4  public boolean implies(ProtectionDomain domain, Permission permission);
     public abstract void refresh( );
}
```

Team LiB

Principal java.security

Java 1.1

This interface represents any entity that may serve as a principal in a cryptographic transaction of any kind. A Principal may represent an individual, a computer, or an organization, for example.

```
public interface Principal {
// Public Instance Methods
     boolean equals(Object another);
     String getName( );
     int hashCode( );
     String toString( );
}
```

Implementations

Identity, javax.security.auth.kerberos.KerberosPrincipal, javax.security.auth.x500.X500Principal

Passed To

IdentityScope.getIdentity( ), ProtectionDomain.ProtectionDomain( ), javax.net.ssl.X509ExtendedKeyManager.{chooseEngineClientAlias( ), chooseEngineServerAlias( )}, javax.net.ssl.X509KeyManager.{chooseClientAlias( ), chooseServerAlias( ), getClientAliases( ), getServerAliases( )}

Returned By

java.net.SecureCacheResponse.{getLocalPrincipal( ), getPeerPrincipal( )}, java.security.Certificate.{getGuarantor( ), getPrincipal( )}, ProtectionDomain.getPrincipals( ), java.security.cert.X509Certificate.{getIssuerDN( ), getSubjectDN( )}, java.security.cert.X509CRL.getIssuerDN( ), javax.net.ssl.HandshakeCompletedEvent.{getLocalPrincipal( ), getPeerPrincipal( )}, javax.net.ssl.HttpsURLConnection.{getLocalPrincipal( ), getPeerPrincipal( )}, javax.net.ssl.SSLSession.{getLocalPrincipal( ), getPeerPrincipal( )}

PrivateKey java.security

Java 1.1 *serializable*

This interface represents a private cryptographic key. It extends the `Key` interface, but does not add any new methods. The interface exists in order to create a strong distinction between private and public keys. See also `PublicKey`.

Figure 14-30. java.security.PrivateKey


```
public interface PrivateKey extends Key {
// Public Constants
1.2  public static final long serialVersionUID;  =6034044314589513430
}
```

Implementations

`java.security.interfaces.DSAPrivateKey`, `java.security.interfaces.ECPrivateKey`, `java.security.interfaces.RSAPrivateKey`, `javax.crypto.interfaces.DHPrivateKey`

Passed To

`KeyPair.KeyPair( )`, `KeyStore.PrivateKeyEntry.PrivateKeyEntry( )`, `Signature.initSign( )`, `SignatureSpi.engineInitSign( )`, `SignedObject.SignedObject( )`, `javax.security.auth.x500.X500PrivateCredential.X500PrivateCredential( )`

Returned By

`KeyFactory.generatePrivate( )`, `KeyFactorySpi.engineGeneratePrivate( )`, `KeyPair.getPrivate( )`, `KeyStore.PrivateKeyEntry.getPrivateKey( )`, `Signer.getPrivateKey( )`, `javax.net.ssl.X509KeyManager.getPrivateKey( )`, `javax.security.auth.x500.X500PrivateCredential.getPrivateKey( )`

PrivilegedAction<T> java.security

Java 1.2

This interface defines a block of code (the `run( )` method) that is to be executed as privileged code by the `AccessController.doPrivileged( )` method. In Java 5.0 this interface is generic and the type variable *T* represents the return type of the `run( )` method. When privileged code is run with the `doPrivileged( )` method, the `AccessController` looks only at the permissions of the immediate caller, not the permissions of the entire call stack. The immediate caller is typically fully trusted system code that has a full set of permissions, and therefore the privileged code runs with that full set of permissions, even if the system code is invoked by untrusted code with no permissions whatsoever.

Privileged code is typically required only when you are writing a trusted system library (such as a Java extension package) that must read local files or perform other restricted actions, even when called by untrusted code. For example, a class that must call `System.loadLibrary( )` to load native methods should make the call to `loadLibrary( )` within the `run( )` method of a `PrivilegedAction`. If your privileged code may throw a checked exception, implement it in the `run( )` method of a `PrivilegedExceptionAction` instead.

Be very careful when implementing this interface. To minimize the possibility of security holes, keep the body of the `run( )` method as short as possible.

```
public interface PrivilegedAction<T> {
// Public Instance Methods
     T run( );
}
```

Passed To

`AccessController.doPrivileged( )`, `java.util.concurrent.Executors.callable( )`, `javax.security.auth.Subject.{doAs( )`, `doAsPrivileged( )}`

PrivilegedActionException java.security

Java 1.2 *serializable checked*

This exception class is a wrapper around an arbitrary Exception thrown by a PrivilegedExceptionAction executed by the AccessController.doPrivileged( ) method. Use getException( ) to obtain the wrapped Exception object. Or, in Java 1.4 and later, use the more general getCause( ) method.

Figure 14-31. java.security.PrivilegedActionException


```
public class PrivilegedActionException extends Exception {
// Public Constructors
     public PrivilegedActionException(Exception exception);
// Public Instance Methods
     public Exception getException( );
// Public Methods Overriding Throwable
1.4  public Throwable getCause( );
1.3  public String toString( );
}
```

Thrown By

AccessController.doPrivileged( ), javax.security.auth.Subject.{doAs( ), doAsPrivileged( )}

PrivilegedExceptionAction<T> java.security

Java 1.2

This interface is like `PrivilegedAction`, except that its `run( )` method may throw an exception. See `PrivilegedAction` for details.

```
public interface PrivilegedExceptionAction<T> {
// Public Instance Methods
     T run( ) throws Exception;
}
```

Passed To

`AccessController.doPrivileged( )`, `java.util.concurrent.Executors.callable( )`, `javax.security.auth.Subject.{doAs( )`, `doAsPrivileged( )}`

ProtectionDomain java.security

Java 1.2

This class represents a "protection domain": the set of permissions associated with code based on its source, and optionally, the identities of the users on whose behalf the code is running. Use the `getProtectionDomain( )` of a `Class` object to obtain the `ProtectionDomain` that the class is part of.

Prior to Java 1.4, a `ProtectionDomain` simply associates a `CodeSource` with the `PermissionCollection` granted to code from that source by a `Policy`. The set of permissions is static, and the `implies( )` method checks to see whether the specified `Permission` is implied by any of the permissions granted to this `ProtectionDomain`.

In Java 1.4 and later, a `ProtectionDomain` can also be created with the four-argument constructor which associates a `PermissionCollection` with a `ClassLoader` and an array of `Principal` objects in addition to a `CodeSource`. A `ProtectionDomain` of this sort represents permisssions granted to code loaded from a specified source, through a specified class loader, and running under the auspices of one or more specified principals. When a `ProtectionDomain` is instantiated with this four-argument constructor, the `PermissionCollection` is not static, and the `implies( )` method calls the `implies( )` method of the current `Policy` object before checking the specified collection of permissions. This allows security policies to be updated (for example to add new permissions for specific users) without having to restart long-running programs such as servers.

```
public class ProtectionDomain {
// Public Constructors
     public ProtectionDomain(CodeSource codesource,
        PermissionCollection permissions);
1.4  public ProtectionDomain(CodeSource codesource,
        PermissionCollection permissions, ClassLoader classloader,
Principal[ ] principals);
// Public Instance Methods
1.4  public final ClassLoader getClassLoader( );
     public final CodeSource getCodeSource( );
     public final PermissionCollection getPermissions( );
1.4  public final Principal[ ] getPrincipals( );
     public boolean implies(Permission permission);
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`ClassLoader.defineClass( )`, `java.lang.instrument.ClassFileTransformer.transform( )`, AccessControlContext.AccessControlContext( ), DomainCombiner.combine( ), java.security.Policy.{getPermissions( ), implies( )}, javax.security.auth.SubjectDomainCombiner.combine( )

Returned By

Class.getProtectionDomain( ), DomainCombiner.combine( ), javax.security.auth.SubjectDomainCombiner.combine( )

Team LiB

Team LiB

Provider java.security

Java 1.1 *cloneable serializable collection*

This class represents a security provider. It specifies class names for implementations of one or more al message digests, digital signatures, key generation, key conversion, key management, secure random r generation, certificate conversion, and algorithm parameter management. The `getName( )` , `getVersior` `getInfo( )` methods return information about the provider. `Provider` inherits from `Properties` and ma mapping of property names to property values. These name/value pairs specify the capabilities of the `Pr` implementation. Each property name has the form:

`service_type.algorithm_name`

The corresponding property value is the name of the class that implements the named algorithm. For ex a `Provider` defines properties named "Signature.DSA", "MessageDigest.MD5", and "KeyStore.JKS". The these properties are the class names of `SignatureSpi` , `MessageDigestSpi` , and `KeyStoreSpi` impleme Other properties defined by a `Provider` are used to provide aliases for algorithm names. For example, tl `Alg.Alias.MessageDigest.SHA1` might have the value "SHA", meaning that the algorithm name "SHA1 for "SHA".

In Java 5.0, the individual services provided by a `Provider` are described by the nested `Service` class, a methods for querying and setting the `Service` objects of a `Provider` are available.

Security providers are installed in an implementation-dependent way. For Sun's implementation, the *${java.home}/lib/security/java.security* file specifies the class names of all installed `Provider` implemen application can also install its own custom `Provider` with the `addProvider( )` and `insertProviderAt(` of the `Security` class. Most applications do not need to use the `Provider` class directly. Typically, only s provider implementors need to use the `Provider` class. Some applications may explicitly specify the nam desired `Provider` when calling a static `getInstance( )` factory method, however. Only applications witl demanding cryptographic needs require custom providers.

Figure 14-32. java.security.Provider

```
public abstract class Provider extends java.util.Properties {
// Protected Constructors
     protected Provider(String name, double version, String info);
// Nested Types
5.0  public static class Service;
// Public Instance Methods
```

```
     public String getInfo( );
     public String getName( );
5.0  public Provider.Service getService(String type,
        String algorithm);     synchronized
5.0  public java.util.Set<Provider.Service> getServices( );     synchronized
     public double getVersion( );
// Public Methods Overriding Properties
1.2  public void load(java.io.InputStream inStream) throws java.io.IOException;     syn
// Public Methods Overriding Hashtable
1.2  public void clear( );     synchronized
1.2  public java.util.Set<java.util.Map.Entry<Object,
        Object>> entrySet( );     synchronized
1.2  public java.util.Set<Object> keySet( );
1.2  public Object put(Object key, Object value);       synchronized
1.2  public void putAll(java.util.Map<?,?> t);              synchronized
1.2  public Object remove(Object key);              synchronized
     public String toString( );
1.2  public java.util.Collection<Object> values( );
// Protected Instance Methods
5.0  protected void putService(Provider.Service s);        synchronized
5.0  protected void removeService(Provider.Service s);      synchronized
}
```

Subclasses

AuthProvider

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Team LiB

Provider.Service java.security

Java 5.0

This nested class represents a single service (such as a hash algorithm) provided by a security Provider. The various methods return information about the service, including the name of the implementing class.

```
public static class Provider.Service {
// Public Constructors
     public Service(Provider provider, String type, String algorithm,
        String className, java.util.List<String> aliases,
        java.util.Map<String,String> attributes);
// Public Instance Methods
     public final String getAlgorithm( );
     public final String getAttribute(String name);
     public final String getClassName( );
     public final Provider getProvider( );
     public final String getType( );
     public Object newInstance(Object constructorParameter)
        throws NoSuchAlgorithmException;
     public boolean supportsParameter(Object parameter);
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

Provider.{putService( ), removeService( )}

Returned By

Provider.getService( )

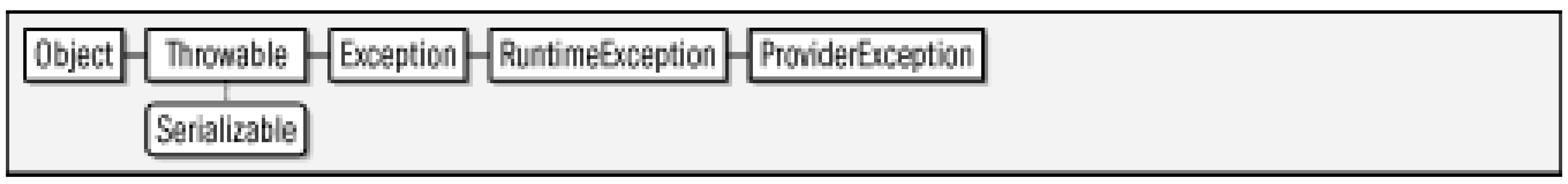
Team LiB

ProviderException java.security

Java 1.1 *serializable unchecked*

Signals that an exception has occurred inside a cryptographic service provider. Note that `ProviderException` extends `RuntimeException` and is therefore an unchecked exception that may be thrown from any method without being declared.

Figure 14-33. java.security.ProviderException




```
public class ProviderException extends RuntimeException {
// Public Constructors
     public ProviderException( );
5.0  public ProviderException(Throwable cause);
     public ProviderException(String s);
5.0  public ProviderException(String message, Throwable cause);
}
```

PublicKey java.security

Java 1.1 *serializable*

This interface represents a public cryptographic key. It extends the Key interface, but does not add any new methods. The interface exists in order to create a strong distinction between public and private keys. See also PrivateKey.

Figure 14-34. java.security.PublicKey


```
public interface PublicKey extends Key {
// Public Constants
1.2  public static final long serialVersionUID;  =7187392471159151072
}
```

Implementations

java.security.interfaces.DSAPublicKey, java.security.interfaces.ECPublicKey, java.security.interfaces.RSAPublicKey, javax.crypto.interfaces.DHPublicKey

Passed To

Identity.setPublicKey( ), IdentityScope.getIdentity( ), KeyPair.KeyPair( ), Signature.initVerify( ), SignatureSpi.engineInitVerify( ), SignedObject.verify( ), java.security.cert.Certificate.verify( ), java.security.cert.PKIXCertPathBuilderResult.PKIXCertPathBuilderResult( ), java.security.cert.PKIXCertPathValidatorResult.PKIXCertPathValidatorResult( ), java.security.cert.TrustAnchor.TrustAnchor( ), java.security.cert.X509CertSelector.setSubjectPublicKey( ), java.security.cert.X509CRL.verify( )

Returned By

java.security.Certificate.getPublicKey( ), Identity.getPublicKey( ), KeyFactory.generatePublic( ), KeyFactorySpi.engineGeneratePublic( ), KeyPair.getPublic( ), java.security.cert.Certificate.getPublicKey( ), java.security.cert.PKIXCertPathValidatorResult.getPublicKey( ), java.security.cert.TrustAnchor.getCAPublicKey( ), `java.security.cert.X509CertSelector.getSubjectPublicKey( )`

SecureClassLoader java.security

Java 1.2

This class adds protected methods to those defined by ClassLoader. The defineClass( ) method is passed the bytes of a class file as a byte[ ] or, in Java 5.0, as a ByteBuffer and a CodeSource object that represents the source of that class. It calls the getPermissions( ) method to obtain a PermissionCollection for that CodeSource and then uses the CodeSource and PermissionCollection to create a ProtectionDomain, which is passed to the defineClass( ) method of its superclass.

The default implementation of the getPermissions( ) method uses the default Policy to determine the appropriate set of permissions for a given code source. The value of SecureClassLoader is that subclasses can use its defineClass( ) method to load classes without having to work explicitly with the ProtectionDomain and Policy classes. A subclass of SecureClassLoader can define its own security policy by overriding getPermissions( ). In Java 1.2 and later, any application that implements a custom class loader should do so by extending SecureClassLoader, instead of subclassing ClassLoader directly. Most applications can use java.net.URLClassLoader, however, and never have to subclass this class.

Figure 14-35. java.security.SecureClassLoader

```
public class SecureClassLoader extends ClassLoader {
// Protected Constructors
     protected SecureClassLoader( );
     protected SecureClassLoader(ClassLoader parent);
// Protected Instance Methods
5.0  protected final Class<?> defineClass(String name,
        java.nio.ByteBuffer b, CodeSource cs);
     protected final Class<?> defineClass(String name, byte[ ] b, int off,
        int len, CodeSource cs);
     protected PermissionCollection getPermissions(CodeSource codesource);
}
```

Subclasses

java.net.URLClassLoader

SecureRandom java.security

Java 1.1 *serializable*

This class generates cryptographic-quality pseudorandom bytes. Although SecureRandom defines public constructors, the preferred technique for obtaining a SecureRandom object is to call one of the static getInstance( ) factory methods, specifying the desired pseudorandom number-generation algorithm, and, optionally, the desired provider of that algorithm. Sun's implementation of Java ships with an algorithm named "SHA1PRNG" in the "SUN" provider.

Once you have obtained a SecureRandom object, call nextBytes( ) to fill an array with pseudorandom bytes. You can also call any of the methods defined by the Random superclass to obtain random numbers. The first time one of these methods is called, the SecureRandom( ) method uses its generateSeed( ) method to seed itself. If you have a source of random or very high-quality pseudorandom bytes, you may provide your own seed by calling setSeed( ). Repeated calls to setSeed( ) augment the existing seed instead of replacing it. You can also call generateSeed( ) to generate seeds for use with other pseudorandom generators. generateSeed( ) may use a different algorithm than nextBytes( ) and may produce higher-quality randomness, usually at the expense of increased computation time.

Figure 14-36. java.security.SecureRandom

```
public class SecureRandom extends java.util.Random {
// Public Constructors
     public SecureRandom( );
     public SecureRandom(byte[ ] seed);
// Protected Constructors
1.2  protected SecureRandom(SecureRandomSpi secureRandomSpi, Provider provider);
// Public Class Methods
1.2  public static SecureRandom getInstance(String algorithm)
        throws NoSuchAlgorithmException;
1.2  public static SecureRandom getInstance(String algorithm, String provider)
        throws NoSuchAlgorithmException, NoSuchProviderException;
1.4  public static SecureRandom getInstance(String algorithm, Provider provider)
        throws NoSuchAlgorithmException;
     public static byte[ ] getSeed(int numBytes);
// Public Instance Methods
1.2  public byte[ ] generateSeed(int numBytes);
5.0  public String getAlgorithm( );   default:"NativePRNG"
```

```
1.2  public final Provider getProvider( );
     public void setSeed(byte[ ] seed);         synchronized
// Public Methods Overriding Random
     public void nextBytes(byte[ ] bytes);      synchronized
     public void setSeed(long seed);
// Protected Methods Overriding Random
     protected final int next(int numBits);
}
```

Passed To

Too many methods to list.

Type Of

`SignatureSpi.appRandom`

Team LiB

SecureRandomSpi java.security

Java 1.2 *serializable*

This abstract class defines the service-provider interface forSecureRandom. A security provider must implement a concrete subclass of this class for each pseudorandom number-generation algorithm it supports. Applications never need to use or subclass this class.

Figure 14-37. java.security.SecureRandomSpi


```
public abstract class SecureRandomSpi implements Serializable {
// Public Constructors
     public SecureRandomSpi( );
// Protected Instance Methods
     protected abstract byte[ ] engineGenerateSeed(int numBytes);
     protected abstract void engineNextBytes(byte[ ] bytes);
     protected abstract void engineSetSeed(byte[ ] seed);
}
```

Passed To

SecureRandom.SecureRandom( )

Security java.security

Java 1.1

This class defines static methods both for managing the list of installed security providers and for reading and setting the values of various properties used by the Java security system. It is essentiall an interface to the *${java.home}/lib/security/java.security* properties file that is included in Sun's implementation of Java. Use `getProperty( )` and `setProperty( )` to query or set the value of security properties whose default values are stored in that file.

One of the important features of the *java.security* properties file is that it specifies a set of security provider implementations and a preference order in which they are to be used. `getProviders( )` returns an array of `Provider` objects, in the order they are specified in the file. In Java 1.3 and later, versions of this method exist that only return providers that implement the algorithm or algorithms specified in a `String` or `Map` object. You can also look up a single named `Provider` object by name with `getProvider( )`. Note that a provider name is the string returned by `getName( )` method of the `Provider` class, not the classname of the `Provider`.

You can alter the set of providers installed by default from the `java.security` file. Use `addProvider( )` to add a new `Provider` object to the list, placing it at the end of the list, with a lower preference than all other providers. Use `insertProviderAt( )` to insert a provider into the list at a specified position. Note that provider preference positions are 1-based. Specify a position of 1 to make the provider the most preferred one. Finally, use `removeProvider( )` to remove a named provider.

In Java 1.4 and later, the `getAlgorithms` method returns a `Set` that includes the names of all supported algorithms (from any installed provider) for the specified "service". A service name specifies the category of security service you are querying. It is a case-insensitive value that has the same name as one of the key service classes from this package or security-related packagesfor example, "Signature", "MessageDigest", and "KeyStore" (from this package) or "Cipher" (from the `javax.crypto` package).

```
public final class Security {
// No Constructor
// Public Class Methods
     public static int addProvider(Provider provider);
1.4  public static java.util.Set<String> getAlgorithms(String serviceName);
     public static String getProperty(String key);
     public static Provider getProvider(String name);
     public static Provider[ ] getProviders( );
1.3  public static Provider[ ] getProviders(java.util.Map<String,String> filter);
1.3  public static Provider[ ] getProviders(String filter);
     public static int insertProviderAt(Provider provider,
        int position);     synchronized
     public static void removeProvider(String name);       synchronized
     public static void setProperty(String key, String datum);
```

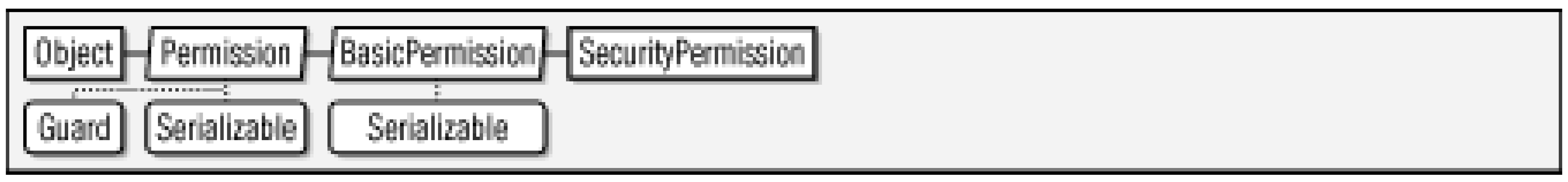
```
// Deprecated Public Methods
#    public static String getAlgorithmProperty(String algName, String propName);
}
```

SecurityPermission java.security

Java 1.2 *serializable permission*

This class is a `Permission` subclass that represents access to various methods of the `Policy`, `Security`, `Provider`, `Signer`, and `Identity` objects. `SecurityPermission` objects are defined by a name only; they do not use a list of actions. Important `SecurityPermission` names are "getPolicy" and "setPolicy", which represent the ability query and set the system security policy by invoking the `Policy.getPolicy( )` and `Policy.setPolicy( )` methods. Applications do not typically need to use this class.

Figure 14-38. java.security.SecurityPermission




```
public final class SecurityPermission extends BasicPermission {
// Public Constructors
     public SecurityPermission(String name);
     public SecurityPermission(String name, String actions);
}
```

Signature java.security

Java 1.1

This class computes or verifies a digital signature. Obtain a Signature object by calling one of the static getInstance( ) factory methods and specifying the desired digital signature algorithm and, optionally, desired provider of that algorithm. A *digital signature* is essentially a message digest encrypted by a pub encryption algorithm. Thus, to specify a digital signature algorithm, you must specify both the digest alg and the encryption algorithm. The only algorithm supported by the default "SUN" provider is "SHA1withI

Once you have obtained a Signature object, you must initialize it before you can create or verify a digit signature. To initialize a digital signature for creation, call initSign( ) and specify the private key to be to create the signature. To initialize a signature for verification, call initVerify( ) and specify the publi of the signer. Once the Signature object has been initialized, call update( ) one or more times to speci data to be signed or verified. Prior to Java 5.0, the data must be specified as an array of bytes. In Java later, you can also pass a ByteBuffer to update( ) , and this facilitates the use of the Signature class the java.nio package.

Finally, to create a digital signature, call sign( ) , passing a byte array into which the signature is store pass the bytes of the digital signature to verify( ) , which returns true if the signature is valid or fals otherwise. After calling either sign( ) or verify( ) , the Signature object is reset internally and can b to create or verify another signature.

Figure 14-39. java.security.Signature

```
public abstract class Signature extends SignatureSpi {
// Protected Constructors
     protected Signature(String algorithm);
// Protected Constants
     protected static final int SIGN;      =2
     protected static final int UNINITIALIZED;                            =0
     protected static final int VERIFY;    =3
// Public Class Methods
     public static Signature getInstance(String algorithm)
        throws NoSuchAlgorithmException;
1.4  public static Signature getInstance(String algorithm, Provider provider)
        throws NoSuchAlgorithmException;
     public static Signature getInstance(String algorithm, String provider)
throws NoSuchAlgorithmException, NoSuchProviderException;
// Public Instance Methods
     public final String getAlgorithm( );
```

```
1.4  public final AlgorithmParameters getParameters( );
1.2  public final Provider getProvider( );
     public final void initSign(PrivateKey privateKey)
        throws InvalidKeyException;
1.2  public final void initSign(PrivateKey privateKey, SecureRandom random)
        throws InvalidKeyException;
1.3  public final void initVerify(java.security.cert.Certificate certificate)
        throws InvalidKeyException;
     public final void initVerify(PublicKey publicKey)
        throws InvalidKeyException;
1.2  public final void setParameter(java.security.spec.
        AlgorithmParameterSpec params)
        throws InvalidAlgorithmParameterException;
     public final byte[ ] sign( ) throws SignatureException;
1.2  public final int sign(byte[ ] outbuf, int offset, int len) throws SignatureExcepti
5.0  public final void update(java.nio.ByteBuffer data) throws SignatureException;
     public final void update(byte b) throws SignatureException;
     public final void update(byte[ ] data) throws SignatureException;
     public final void update(byte[ ] data, int off, int len)
        throws SignatureException;
     public final boolean verify(byte[ ] signature) throws SignatureException;
1.4  public final boolean verify(byte[ ] signature, int offset, int length)
        throws SignatureException;
// Public Methods Overriding SignatureSpi
     public Object clone( ) throws CloneNotSupportedException;
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected int state;
// Deprecated Public Methods
#    public final Object getParameter(String param)
        throws InvalidParameterException;
#    public final void setParameter(String param, Object value)
        throws InvalidParameterException;
}
```

Passed To

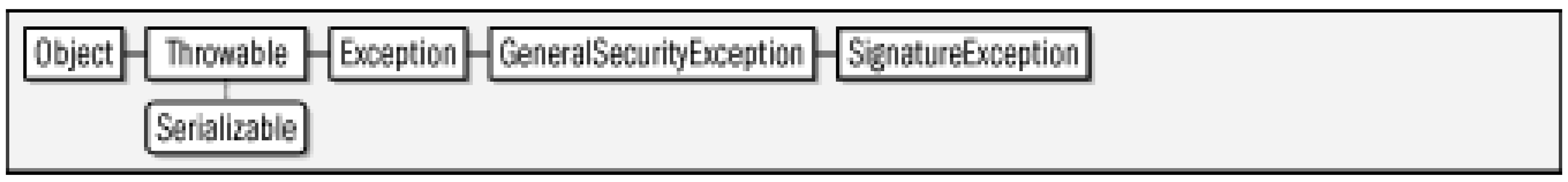
SignedObject.{SignedObject( ) , verify( )}

SignatureException java.security

Java 1.1 *serializable checked*

Signals a problem while creating or verifying a digital signature.

Figure 14-40. java.security.SignatureException




```
public class SignatureException extends GeneralSecurityException {
// Public Constructors
     public SignatureException( );
5.0  public SignatureException(Throwable cause);
     public SignatureException(String msg);
5.0  public SignatureException(String message, Throwable cause);
}
```

Thrown By

Too many methods to list.

Team LiB

SignatureSpi java.security

Java 1.2

This abstract class defines the service-provider interface for Signature. A security provider must implement a concrete subclass of this class for each digital signature algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class SignatureSpi {
// Public Constructors
     public SignatureSpi( );
// Public Methods Overriding Object
     public Object clone( ) throws CloneNotSupportedException;
// Protected Instance Methods
1.4  protected AlgorithmParameters engineGetParameters( );
     protected abstract void engineInitSign(PrivateKey privateKey)
        throws InvalidKeyException;
     protected void engineInitSign(PrivateKey privateKey, SecureRandom random)
        throws InvalidKeyException;
     protected abstract void engineInitVerify(PublicKey publicKey)
        throws InvalidKeyException;
     protected void engineSetParameter(java.security.spec.
        AlgorithmParameterSpec params)
        throws InvalidAlgorithmParameterException;
     protected abstract byte[ ] engineSign( ) throws SignatureException;
     protected int engineSign(byte[ ] outbuf, int offset, int len)
        throws SignatureException;
5.0  protected void engineUpdate(java.nio.ByteBuffer input);
     protected abstract void engineUpdate(byte b) throws SignatureException;
     protected abstract void engineUpdate(byte[ ] b, int off, int len)
        throws SignatureException;
     protected abstract boolean engineVerify(byte[ ] sigBytes)
        throws SignatureException;
1.4  protected boolean engineVerify(byte[ ] sigBytes, int offset, int length)
        throws SignatureException;
// Protected Instance Fields
     protected SecureRandom appRandom;
// Deprecated Protected Methods
#    protected abstract Object engineGetParameter(String param)
        throws InvalidParameterException;
#    protected abstract void engineSetParameter(String param, Object value)
        throws InvalidParameterException;
}
```

Subclasses

Signature

SignedObject java.security

Java 1.2 *serializable*

This class applies a digital signature to any serializable Java object. Create a `SignedObject` by specifying the object to be signed, the `PrivateKey` to use for the signature, and the `Signature` object to create the signature. The `SignedObject( )` constructor serializes the specified object into an array of bytes and creates a digital signature for those bytes.

After creation, a `SignedObject` is itself typically serialized for storage or transmission to another Java thread or process. Once the `SignedObject` is reconstituted, the integrity of the object it contains can be verified by calling `verify( )` and supplying the `PublicKey` of the signer and a `Signature` that performs the verification. Whether or not verification is performed or is successful, `getObject( )` can be called to deserialize and return the wrapped object.

Figure 14-41. java.security.SignedObject

```
public final class SignedObject implements Serializable {
// Public Constructors
     public SignedObject(Serializable object, PrivateKey signingKey,
        Signature signingEngine)
        throws java.io.IOException, InvalidKeyException, SignatureException;
// Public Instance Methods
     public String getAlgorithm( );
     public Object getObject( ) throws java.io.IOException,
        ClassNotFoundException;
     public byte[ ] getSignature( );
     public boolean verify(PublicKey verificationKey,
        Signature verificationEngine)
        throws InvalidKeyException, SignatureException;
}
```

Signer java.security

Java 1.1; Deprecated in 1.2 *@Deprecated serializable*

This deprecated class was used in Java 1.1 to represent an entity or `Principal` that has an associated `PrivateKey` that enables it to create digital signatures. As of Java 1.2, this class and the related `Identity` and `IdentityScope` classes have been replaced by `KeyStore` and `java.security.cert.Certificate`. See also `Identity`.

Figure 14-42. java.security.Signer


```
public abstract class Signer extends Identity {
// Public Constructors
     public Signer(String name);
     public Signer(String name, IdentityScope scope)
        throws KeyManagementException;
// Protected Constructors
     protected Signer( );
// Public Instance Methods
     public PrivateKey getPrivateKey( );
     public final void setKeyPair(KeyPair pair)
        throws InvalidParameterException, KeyException;
// Public Methods Overriding Identity
     public String toString( );
}
```

Timestamp java.security

Java 5.0 *serializable*

An instance of this class is an immutable signed timestamp.`getTimestamp( )` returns the timestamp as a `java.util.Date`. `getSignerCertPath( )` returns the certificate path of the Timestamping Authority (TSA) that signed the object. `Timestamp` objects are used by the `CodeSigner` class.

Figure 14-43. java.security.Timestamp


```
public final class Timestamp implements Serializable {
// Public Constructors
     public Timestamp(java.util.Date timestamp,
        java.security.cert.CertPath signerCertPath);
// Public Instance Methods
     public java.security.cert.CertPath getSignerCertPath( );
     public java.util.Date getTimestamp( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Passed To

`CodeSigner.CodeSigner( )`

Returned By

`CodeSigner.getTimestamp( )`

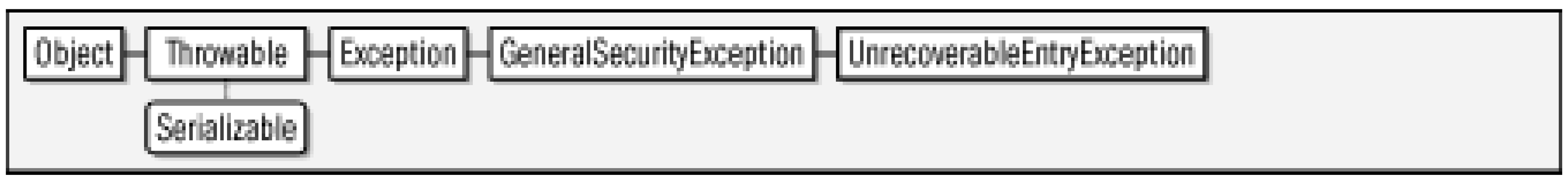
Team LiB

UnrecoverableEntryException java.security

Java 5.0 *serializable checked*

An exception of this type is thrown if a KeyStore.Entry cannot be recovered from a KeyStore.

Figure 14-44. java.security.UnrecoverableEntryException




```
public class UnrecoverableEntryException extends GeneralSecurityException {
// Public Constructors
     public UnrecoverableEntryException( );
     public UnrecoverableEntryException(String msg);
}
```

Thrown By

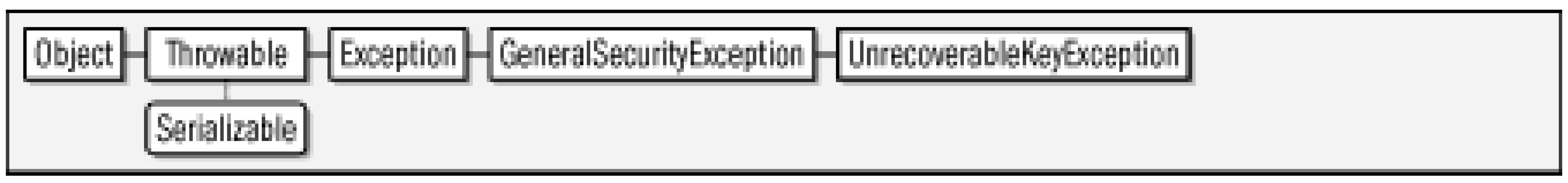
KeyStore.getEntry( ), KeyStoreSpi.engineGetEntry( )

UnrecoverableKeyException java.security

Java 1.2 *serializable checked*

This exception is thrown if a Key cannot be retrieved from a KeyStore. This commonly occurs when an incorrect password is used.

Figure 14-45. java.security.UnrecoverableKeyException




```
public class UnrecoverableKeyException extends GeneralSecurityException {
// Public Constructors
     public UnrecoverableKeyException( );
     public UnrecoverableKeyException(String msg);
}
```

Thrown By

KeyStore.getKey( ), KeyStoreSpi.engineGetKey( ), javax.net.ssl.KeyManagerFactory.init( ), javax.net.ssl.KeyManagerFactorySpi.engineInit( )

UnresolvedPermission java.security

Java 1.2 *serializable permission*

This class is used internally to provide a mechanism for delayed resolution of permissions (such as those whose implementation is in an external JAR file that has not been loaded yet). An `UnresolvedPermission` holds a representation of a `Permission` object that can later be used to create the actual `Permission` object. Java 5.0 adds methods to obtain details about the unresolved permission. Applications never need to use this class.

Figure 14-46. java.security.UnresolvedPermission


```
public final class UnresolvedPermission extends Permission
        implements Serializable {
// Public Constructors
     public UnresolvedPermission(String type, String name, String actions,
        java.security.cert.Certificate[ ] certs);
// Public Instance Methods
5.0  public String getUnresolvedActions( );
5.0  public java.security.cert.Certificate[ ] getUnresolvedCerts( );
5.0  public String getUnresolvedName( );
5.0  public String getUnresolvedType( );
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(Permission p);                      constant
     public PermissionCollection newPermissionCollection( );
     public String toString( );
}
```

Team LiB

Package java.security.cert

Java 1.2

The java.security.cert package contains classes for working with identity certificates, certificate chains (also known as certification paths) and certificate revocation lists (CRLs). It defines generic Certificate and CRL classes and also X509Certificate and X509CRL classes that provide full support for standard X.509 certificates and CRLs. The CertPath class represents a certificate chain, and CertPathValidator provides the ability to validate a certificate chain. The CertificateFactory class serves as a certificate parser, providing the ability to convert a stream of bytes (or the base64 encoding of those bytes) into a Certificate, a CertPath or a CRL object. In addition to the algorithm-independent API of CertificateFactory, this package also defines low-level algorithm-specific classes for working with certificate chains using the PKIX standards.

This package replaces the deprecated java.security.Certificate interface, and it also replaces the deprecated javax.security.cert package used by early versions of the JAAS API before javax.security.auth and its subpackages were added to the core Java platform.

Interfaces

```
public interface CertPathBuilderResult extends Cloneable;
public interface CertPathParameters extends Cloneable;
public interface CertPathValidatorResult extends Cloneable;
public interface CertSelector extends Cloneable;
public interface CertStoreParameters extends Cloneable;
public interface CRLSelector extends Cloneable;
public interface PolicyNode;
public interface X509Extension;
```

Classes

```
public abstract class Certificate implements Serializable;
   public abstract class X509Certificate extends Certificate
   implements X509Extension;
public class CertificateFactory;
public abstract class CertificateFactorySpi;
public abstract class CertPath implements Serializable;
public class CertPathBuilder;
public abstract class CertPathBuilderSpi;
public class CertPathValidator;
public abstract class CertPathValidatorSpi;
public class CertStore;
public abstract class CertStoreSpi;
```

```
public class CollectionCertStoreParameters implements CertStoreParameters;
public abstract class CRL;
   public abstract class X509CRL extends CRL implements X509Extension;
public class LDAPCertStoreParameters implements CertStoreParameters;
public abstract class PKIXCertPathChecker implements Cloneable;
public class PKIXCertPathValidatorResult implements CertPathValidatorResult;
   public class PKIXCertPathBuilderResult extends PKIXCertPathValidatorResult
   implements CertPathBuilderResult;
public class PKIXParameters implements CertPathParameters;
   public class PKIXBuilderParameters extends PKIXParameters;
public class PolicyQualifierInfo;
public class TrustAnchor;
public class X509CertSelector implements CertSelector;
public abstract class X509CRLEntry implements X509Extension;
public class X509CRLSelector implements CRLSelector;
```

Protected Nested Types

```
protected static class Certificate.CertificateRep implements Serializable;
protected static class CertPath.CertPathRep implements Serializable;
```

Exceptions

```
public class CertificateException extends java.security.GeneralSecurityException;
   public class CertificateEncodingException extends CertificateException;
   public class CertificateExpiredException extends CertificateException;
   public class CertificateNotYetValidException extends CertificateException;
   public class CertificateParsingException extends CertificateException;
public class CertPathBuilderException
extends java.security.GeneralSecurityException;
public class CertPathValidatorException
extends java.security.GeneralSecurityException;
public class CertStoreException extends java.security.GeneralSecurityException;
public class CRLException extends java.security.GeneralSecurityException;
```

Team LiB

Certificate java.security.cert

Java 1.2 *serializable*

This abstract class represents an public-key (or identity) certificate. A *certificate* is an object that contain
public key for that entity. Certificates are issued by, and bear the digital signature of, a (presumably tru
certificate authority (CA). By issuing and signing the certificate, the CA is certifying that, based on their
certificate really is who they say they are and that the public key in the certificate really does belong to
a certificate is not a trusted CA, and the certificate is accompanied by the signer's certificate which may
untrusted intermediary who provides his or her own certificate. A "chain" of such certificates is known as
`CertPath` for further details.

Use a `CertificateFactory` to parse a stream of bytes into a `Certificate` object; `getEncoded( )` rever
verify the digital signature of the entity that issued the certificate. If the signature cannot be verified, th
Call `getPublicKey( )` to obtain the `java.security.PublicKey` of the subject of the certificate. Note tha
method for obtaining the `Principal` that is associated with the `PublicKey`. That functionality is depend
See `X509Certificate.getSubjectDN( )`, for example.

Do not confuse this class with the `java.security.Certificate` interface that was defined in Java 1.1 a

Figure 14-47. java.security.cert.Certificate

```
public abstract class Certificate implements Serializable {
// Protected Constructors
     protected Certificate(String type);
// Nested Types
1.3  protected static class CertificateRep implements Serializable;
// Public Instance Methods
     public abstract byte[ ] getEncoded( ) throws CertificateEncodingException;
     public abstract java.security.PublicKey getPublicKey( );
     public final String getType( );
     public abstract void verify(java.security.PublicKey key)
        throws CertificateException, java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException, java.security.NoSuchProviderException, java.s
     public abstract void verify(java.security.PublicKey key, String sigProvider)
        throws CertificateException, java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException, java.security.NoSuchProviderException, java.s
// Public Methods Overriding Object
     public boolean equals(Object other);
     public int hashCode( );
     public abstract String toString( );
```

```
// Protected Instance Methods
1.3  protected Object writeReplace( ) throws java.io.ObjectStreamException;
}
```

Subclasses

X509Certificate

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Team LiB

Team LiB

Certificate.CertificateRep java.security.cert

Java 1.3 *serializable*

This protected inner class provides an alternate representation of a certificate that can be used for serialization purposes by the `writeReplace( )` method of some `Certificate` implementations. Applications do not typically need this class.

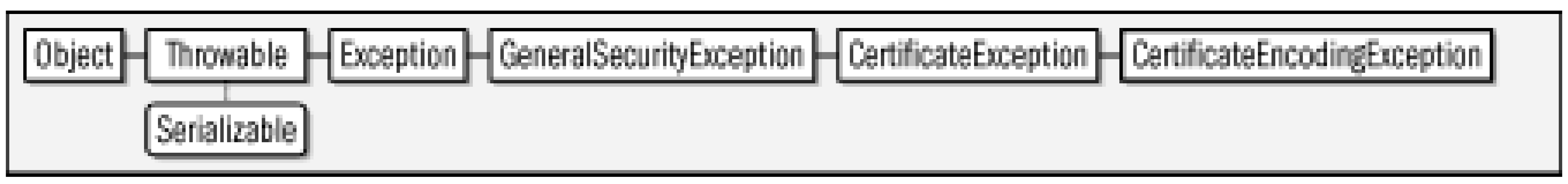
```
protected static class Certificate.CertificateRep implements Serializable {
// Protected Constructors
     protected CertificateRep(String type, byte[ ] data);
// Protected Instance Methods
     protected Object readResolve( ) throws java.io.ObjectStreamException;
}
```

CertificateEncodingException java.security.cert

Java 1.2 *serializable checked*

Signals an error while attempting to encode a certificate.

Figure 14-48. java.security.cert.CertificateEncodingException




```
public class CertificateEncodingException extends CertificateException {
// Public Constructors
     public CertificateEncodingException( );
5.0  public CertificateEncodingException(Throwable cause);
     public CertificateEncodingException(String message);
5.0  public CertificateEncodingException(String message, Throwable cause);
}
```

Thrown By

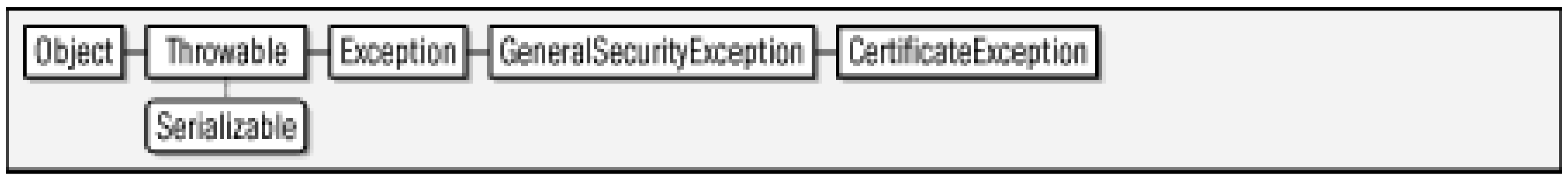
java.security.cert.Certificate.getEncoded( ), CertPath.getEncoded( ), X509Certificate.getTBSCertificate( )

CertificateException java.security.cert

Java 1.2 *serializable checked*

This class is the superclass of several more specific exception types that may be thrown when working with certificates.

Figure 14-49. java.security.cert.CertificateException




```
public class CertificateException
       extends java.security.GeneralSecurityException {
// Public Constructors
     public CertificateException( );
5.0  public CertificateException(Throwable cause);
     public CertificateException(String msg);
5.0  public CertificateException(String message, Throwable cause);
}
```

Subclasses

CertificateEncodingException, CertificateExpiredException, CertificateNotYetValidException, CertificateParsingException

Thrown By

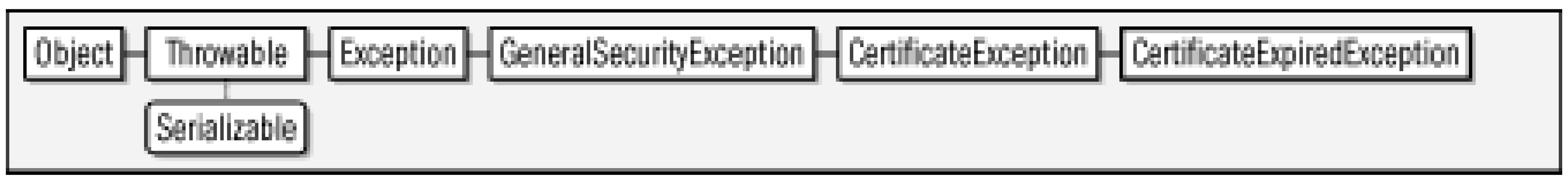
Too many methods to list.

CertificateExpiredException java.security.cert

Java 1.2 *serializable checked*

Signals that a certificate has expired or will have expired by a specified date.

Figure 14-50. java.security.cert.CertificateExpiredException




```
public class CertificateExpiredException extends CertificateException {
// Public Constructors
     public CertificateExpiredException( );
     public CertificateExpiredException(String message);
}
```

Thrown By

`X509Certificate.checkValidity( )`

Team LiB

CertificateFactory java.security.cert

Java 1.2

This class defines methods for parsing certificates, certificate chains (certification paths) and certificate revocation lists (CRLs) from byte streams. Obtain a CertificateFactory by calling one of the static getInstance( ) factory methods and specifying the type of certificate or CRL to be parsed, and, optionally, the desired service provider to perform the parsing. The default "SUN" provider defines only a single "X.509" certificate type, so you typically obtain a CertificateFactory with this code:

```
CertificateFactory certFactory = CertificateFactory.getInstance("X.509");
```

Once you have obtained a CertificateFactory for the desired type of certificate, call generateCertificate( ) to parse a Certificate from a specified byte stream, or call generateCertificates( ) to parse a group of unrelated certificates (i.e. certificates that do not form a certificate chain) from a stream and return them as a Collection of Certificate objects. Similarly, call generateCRL( ) to parse a single CRL object from a stream, and call generateCRLs( ) to parse a Collection of CRL objects from the stream. These CertificateFactory methods read to the end of the specified stream. If the stream supports mark( ) and reset( ), however, the CertificateFactory resets the stream to the position after the end of the last certificate or CRL read. If you specified a certificate type of "X.509", the Certificate and CRL objects returned by a CertificateFactory can be cast safely to X509Certificate and X509CRL. A certificate factory for X.509 certificates can parse certificates encoded in binary or printable hexadecimal form. If the certificate is in hexadecimal form, it must begin with the string "-BEGIN CERTIFICATE-" and end with the string "-END CERTIFICATE-".

The generateCertPath( ) methods return a CertPath object representing a certificate chain. These methods can create a CertPath object from a List of Certificate object, or by reading the chained certificates from a stream. Specify the encoding of the certificate chain by passing the name of the encoding standard to generateCertPath( ). The default "SUN" provider supports the "PKCS7" and the "PkiPath" encodings. getCertPathEncoding( ) returns an Iterator of the encodings supported by the current provider. The first encoding returned by the iterator is the default used when no encoding is explicitly specified.

```
public class CertificateFactory {
// Protected Constructors
     protected CertificateFactory(CertificateFactorySpi certFacSpi,
        java.security.Provider provider, String type);
// Public Class Methods
     public static final CertificateFactory getInstance(String type)
        throws CertificateException;
1.4  public static final CertificateFactory getInstance(String type,
        java.security.Provider provider)
        throws CertificateException;
```

```
    public static final CertificateFactory getInstance(String type,
       String provider)
       throws CertificateException, java.security.NoSuchProviderException;
// Public Instance Methods
    public final java.security.cert.Certificate generateCertificate
       (java.io.InputStream inStream)
       throws CertificateException;
    public final java.util.Collection<? extends java.security.cert.Certificate>
       generateCertificates(java.io.InputStream inStream)
       throws CertificateException;
1.4 public final CertPath generateCertPath(java.util.List<?
       extends java.security.cert.Certificate> certificates)
       throws CertificateException;
1.4 public final CertPath generateCertPath(java.io.InputStream inStream)
       throws CertificateException;
1.4 public final CertPath generateCertPath(java.io.InputStream inStream,
       String encoding)
       throws CertificateException;
    public final CRL generateCRL(java.io.InputStream inStream)
       throws CRLException;
    public final java.util.Collection<? extends CRL> generateCRLs
       (java.io.InputStream inStream)
       throws CRLException;
1.4 public final java.util.Iterator<String> getCertPathEncodings( );
    public final java.security.Provider getProvider( );
    public final String getType( );
}
```

Team LiB

CertificateFactorySpi java.security.cert

Java 1.2

This abstract class defines the service provider interface, or SPI, for the`CertificateFactory` class. A security provider must implement this class for each type of certificate it wishes to support. Applications never need to use or subclass this class.

```
public abstract class CertificateFactorySpi {
// Public Constructors
     public CertificateFactorySpi( );
// Public Instance Methods
     public abstract java.security.cert.Certificate engineGenerateCertificate
        (java.io.InputStream inStream)
        throws CertificateException;
     public abstract java.util.Collection<? extends java.security.cert.Certificate>
        engineGenerateCertificates(java.io.InputStream inStream)
        throws CertificateException;
1.4  public CertPath engineGenerateCertPath(java.util.List<?
        extends java.security.cert.Certificate> certificates)
        throws CertificateException;
1.4  public CertPath engineGenerateCertPath(java.io.InputStream inStream)
        throws CertificateException;
1.4  public CertPath engineGenerateCertPath(java.io.InputStream inStream,
        String encoding) throws CertificateException;
     public abstract CRL engineGenerateCRL(java.io.InputStream inStream)
        throws CRLException;
     public abstract java.util.Collection<? extends CRL> engineGenerateCRLs
        (java.io.InputStream inStream)
        throws CRLException;
1.4  public java.util.Iterator<String> engineGetCertPathEncodings( );
}
```

Passed To

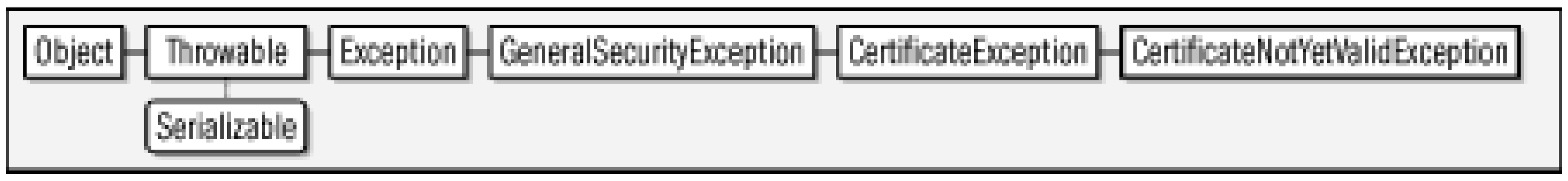
`CertificateFactory.CertificateFactory( )`

CertificateNotYetValidException java.security.cert

Java 1.2 *serializable checked*

Signals that a certificate is not yet valid or will not yet be valid on a specified date.

Figure 14-51. java.security.cert.CertificateNotYetValidException




```
public class CertificateNotYetValidException extends CertificateException {
// Public Constructors
     public CertificateNotYetValidException( );
     public CertificateNotYetValidException(String message);
}
```

Thrown By

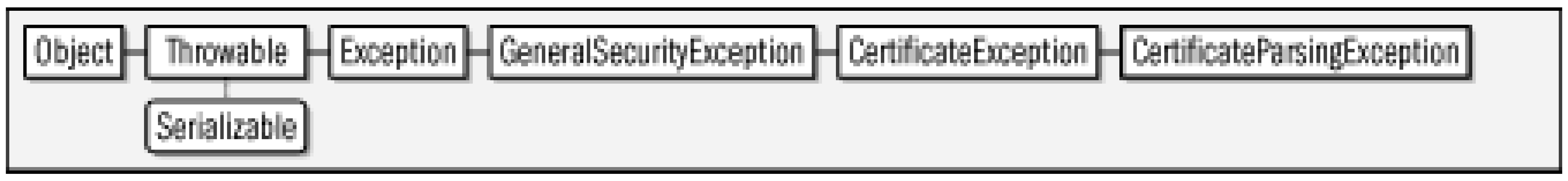
X509Certificate.checkValidity( )

CertificateParsingException java.security.cert

Java 1.2 *serializable checked*

Signals an error or other problem while parsing a certificate.

Figure 14-52. java.security.cert.CertificateParsingException




```
public class CertificateParsingException extends CertificateException {
// Public Constructors
     public CertificateParsingException( );
5.0  public CertificateParsingException(Throwable cause);
     public CertificateParsingException(String message);
5.0  public CertificateParsingException(String message, Throwable cause);
}
```

Thrown By

X509Certificate.{getExtendedKeyUsage( ), getIssuerAlternativeNames( ), getSubjectAlternativeNames( )}

Team LiB

CertPath java.security.cert

Java 1.4 *serializable*

A CertPath is a immutable sequence or chain of certificates that establishes a "certification path" from an unknown "end entity" to a known and trusted Certificate Authority or "trust anchor". Use a CertPathValidator to validate a certificate chain and establish trust in the public key presented in the certificate of the end entity.

getType( ) returns the type of the certificates in the CertPath. For X.509 certificate chains (the only type supported by the default "SUN" provider) this method returns "X.509". getCertificates( ) returns a java.util.List object that contains the Certificate objects that comprise the chain. For X.509 chains, the list contains X509Certificate objects. Also, for X.509 certificate paths, the List returned by getCertificates( ) starts with the certificate of of the end entity, and ends with a certificate signed by the trust anchor. The signer of any certificate but the last must be the subject of the next certificate in the List. If the end entity presents a certificate that is directly signed by a trust anchor (which is a not uncommon occurrence) then the List returned by getCertificates( ) consists of only that single certificate. Note that the list of certificates does not include the certificate of the trust anchor. The public keys of trusted CAs must be known by the system in advance. In Sun's JDK implementation, the public-key certificates of trusted CAs are stored in the file *jre/lib/security/cacerts*.

CertPath objects can be created with a CertificateFactory, or at a lower level with a CertPathBuilder object. A CertificateFactory can parse or decode a CertPath object from a binary stream. The getEncoded( ) methods reverse the process and encode a CertPath into an array of bytes. getEncodings( ) returns the encodings supported for a CertPath. The first returned encoding name is the default one, but you can use any supported encoding by using the one-argument version of getEncoded( ). The default "SUN" provider supports encodings named "PKCS7" and "PkiPath".

CertPath objects are immutable as is the List object returned by getCertificates( ) and the Certificate objects contained in the list. Furthermore, all CertPath methods are threadsafe.

Figure 14-53. java.security.cert.CertPath

```
public abstract class CertPath implements Serializable {
// Protected Constructors
     protected CertPath(String type);
// Nested Types
     protected static class CertPathRep implements Serializable;
// Public Instance Methods
```

```
    public abstract java.util.List<? extends java.security.cert.Certificate>
       getCertificates( );
    public abstract byte[ ] getEncoded( ) throws CertificateEncodingException;
    public abstract byte[ ] getEncoded(String encoding)
       throws CertificateEncodingException;
    public abstract java.util.Iterator<String> getEncodings( );
    public String getType( );
// Public Methods Overriding Object
    public boolean equals(Object other);
    public int hashCode( );
    public String toString( );
// Protected Instance Methods
    protected Object writeReplace( ) throws java.io.ObjectStreamException;
}
```

Passed To

java.security.CodeSigner.CodeSigner( ), java.security.Timestamp.Timestamp( ), CertPathValidator.validate( ), CertPathValidatorException.CertPathValidatorException( ), CertPathValidatorSpi.engineValidate( ), PKIXCertPathBuilderResult.PKIXCertPathBuilderResult( )

Returned By

java.security.CodeSigner.getSignerCertPath( ), java.security.Timestamp.getSignerCertPath( ), CertificateFactory.generateCertPath( ), CertificateFactorySpi.engineGenerateCertPath( ), CertPathBuilderResult.getCertPath( ), CertPathValidatorException.getCertPath( ), PKIXCertPathBuilderResult.getCertPath( )

CertPath.CertPathRep java.security.cert

Java 1.4 *serializable*

This protected inner class defines an implementation-independent representation of a `CertPath` for serialization purposes. Applications never need to use this class.

```
protected static class CertPath.CertPathRep implements Serializable {
// Protected Constructors
     protected CertPathRep(String type, byte[ ] data);
// Protected Instance Methods
     protected Object readResolve( ) throws java.io.ObjectStreamException;
}
```

CertPathBuilder java.security.cert

Java 1.4

CertPathBuilder attempts to build a certification path from a specified certificate to a trust anchor. Unlike the CertificateFactory.generateCertPath( ) method, which might be used by a server to parse a certificate chain presented to it by a client, this class is used to create a new certificate chain and might be used by a client that needs to send a certificate chain to a server. The CertPathBuilder API is provider-based, and is algorithm independent, although the use of any algorithms other than the "PKIX" standards (which work with X.509 certificate chains) require appropriate external implementations of CertPathParameters and CertPathBuilderResult.

Obtain a CertPathBuilder object by calling one of the static getInstance( ) methods, specifying the desired algorithm and, optionally, the desired provider. The "PKIX" algorithm is the only one supported by the default "SUN" provider, and is the only one that has the required algorithm-specific classes defined by this package. Once you have a CertPathBuilder, you create a CertPath object by passing a CertPathParameters object to the build( ) method. CertPathParameters is a marker interfaces that defines no method of its own, so you must use an algorithm-specific implementation such as PKIXBuilderParameters to supply the information required to build a CertPath. The build( ) method returns a CertPathBuilderResult object. Use the getCertPath( ) method of this returned object to obtain the CertPath that was built. The algorithm-specific implementation PKIXCertPathBuilderResult has additional methods that return further algorithm-specific results.

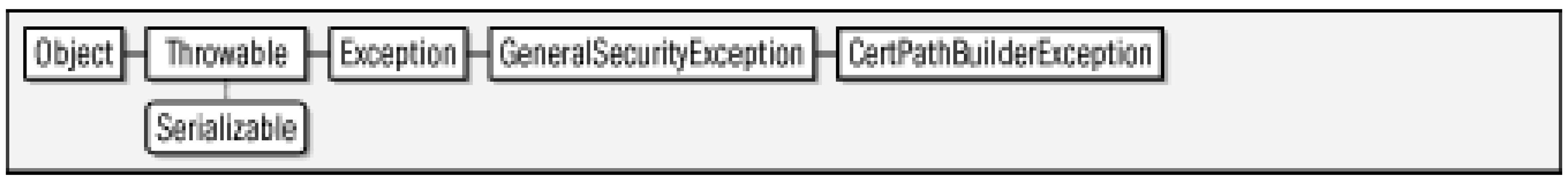
```
public class CertPathBuilder {
// Protected Constructors
     protected CertPathBuilder(CertPathBuilderSpi builderSpi,
        java.security.Provider provider, String algorithm);
// Public Class Methods
     public static final String getDefaultType( );
     public static CertPathBuilder getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static CertPathBuilder getInstance(String algorithm, String provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
     public static CertPathBuilder getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
     public final CertPathBuilderResult build(CertPathParameters params)
        throws CertPathBuilderException,
        java.security.InvalidAlgorithmParameterException;
     public final String getAlgorithm( );
     public final java.security.Provider getProvider( );
}
```

CertPathBuilderException java.security.cert

Java 1.4 *serializable checked*

Signal a problem while building a certification path with`CertPathBuilder`.

Figure 14-54. java.security.cert.CertPathBuilderException




```
public class CertPathBuilderException
        extends java.security.GeneralSecurityException {
// Public Constructors
     public CertPathBuilderException( );
     public CertPathBuilderException(Throwable cause);
     public CertPathBuilderException(String msg);
     public CertPathBuilderException(String msg, Throwable cause);
}
```

Thrown By

`CertPathBuilder.build( )`, `CertPathBuilderSpi.engineBuild( )`

CertPathBuilderResult java.security.cert

Java 1.4 *cloneable*

An object of this type is returned by the `build( )` method of a `CertPathBuilder`. The `getCertPath( )` method returns the `CertPath` object that was built; this method will never return `null`. The algorithm-specific `PKIXCertPathBuilderResult` implementation defines other methods to return additional information about the path that was built.

Figure 14-55. java.security.cert.CertPathBuilderResult


```
public interface CertPathBuilderResult extends Cloneable {
// Public Instance Methods
     Object clone( );
     CertPath getCertPath( );
}
```

Implementations

`PKIXCertPathBuilderResult`

Returned By

`CertPathBuilder.build( )`, `CertPathBuilderSpi.engineBuild( )`

CertPathBuilderSpi java.security.cert

Java 1.4

This abstract class defines the Service Provider Interface for the `CertPathBuilder`. Security providers must implement this interface, but applications never need to use it.

```
public abstract class CertPathBuilderSpi {
// Public Constructors
     public CertPathBuilderSpi( );
// Public Instance Methods
     public abstract CertPathBuilderResult engineBuild(CertPathParameters params)
        throws CertPathBuilderException,
        java.security.InvalidAlgorithmParameterException;
}
```

Passed To

`CertPathBuilder.CertPathBuilder( )`

CertPathParameters java.security.cert

Java 1.4 *cloneable*

CertPathParamters is a marker interface for objects that hold parameters (such as the set of trust anchors) for validating or building a certification path with CertPathValidator and CertPathBuilder. It defines no methods of its own, but requires that all implementations include a working clone( ) method. You must use an algorithm-specific implementation of this interface, such as PKIXParameters or PKIXBuilderParameters when validating or building a CertPath, and it is rarely useful to work with this interface directly.

Figure 14-56. java.security.cert.CertPathParameters


```
public interface CertPathParameters extends Cloneable {
// Public Instance Methods
     Object clone( );
}
```

Implementations

PKIXParameters

Passed To

CertPathBuilder.build( ), CertPathBuilderSpi.engineBuild( ), CertPathValidator.validate( ), CertPathValidatorSpi.engineValidate( ), javax.net.ssl.CertPathTrustManagerParameters.CertPathTrustManagerParameters( )

Returned By

javax.net.ssl.CertPathTrustManagerParameters.getParameters( )

Team LiB

CertPathValidator java.security.cert

Java 1.4

This class validates certificate chains, establishing a chain of trust from the end entity to a trust anchor, and thereby establishing the validity of the public key presented in the end entity's certificate. The `CertPathValidator` is provider-based and algorithm-independent. To obtain a `CertPathValidator` instance, call one of the static `getInstance( )` methods specifying the name of the desired validation algorithm and, optionally, the provider to use. The "PKIX" algorithm for validating X.509 certificates is the only one supported by the default "SUN" provider.

Once you have a `CertPathValidator` object, you can use it to validate certificate chains by passing the `CertPath` object to be validated to the `validate( )` method along with a `CertPathParameters` object that specifies valid trust anchors and other validation parameters. `CertPathParameters` is simply a marker interface, and you must use an application-specific implementation such as `PKIXParameters`. If validation fails, the `validate( )` method throws a `CertPathValidatorException` which may include the index in the chain of the certificate that failed to validate. Otherwise, if validation is successful, the `validate( )` method returns a `CertPathValidatorResult`. If you are interested in the details of the validation (such as the trust anchor that was used or the public key of the end entity), you may cast this returned value to an algorithm-specific subtype such as `PKIXCertPathValidatorResult` and use its methods to find out more about the result.

```
public class CertPathValidator {
// Protected Constructors
     protected CertPathValidator(CertPathValidatorSpi validatorSpi,
        java.security.Provider provider, String algorithm);
// Public Class Methods
     public static final String getDefaultType( );
     public static CertPathValidator getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static CertPathValidator getInstance(String algorithm,
        String provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
     public static CertPathValidator getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
     public final String getAlgorithm( );
     public final java.security.Provider getProvider( );
     public final CertPathValidatorResult validate(CertPath certPath,
        CertPathParameters params)
        throws CertPathValidatorException,
        java.security.InvalidAlgorithmParameterException;
```

```
}
```

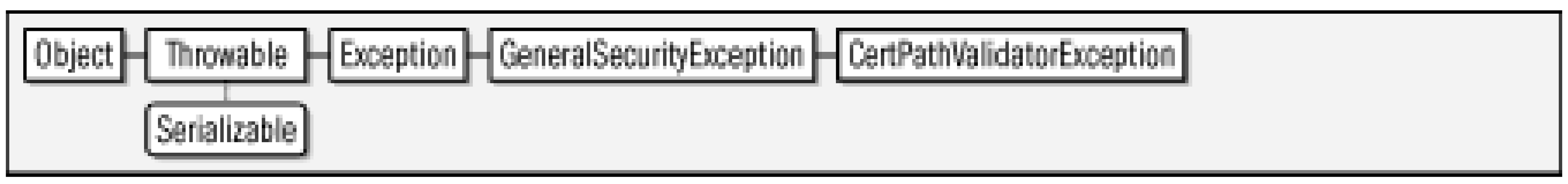

downloaded from: lib.ommolketab.ir

CertPathValidatorException java.security.cert

Java 1.4 *serializable checked*

Signals a problem while validating a certificate chain with a `CertPathValidator`. `getCertPath( )` returns the `CertPath` object that was being validated, and `getIndex( )` returns the index within the path of the certificate that caused the exception (or -1 if that information is not available).

Figure 14-57. java.security.cert.CertPathValidatorException




```
public class CertPathValidatorException
        extends java.security.GeneralSecurityException {
// Public Constructors
     public CertPathValidatorException( );
     public CertPathValidatorException(Throwable cause);
     public CertPathValidatorException(String msg);
     public CertPathValidatorException(String msg, Throwable cause);
     public CertPathValidatorException(String msg, Throwable cause,
        CertPath certPath, int index);
// Public Instance Methods
     public CertPath getCertPath( );                            default:null
     public int getIndex( );                                    default:-1
}
```

Thrown By

`CertPathValidator.validate( )`, `CertPathValidatorSpi.engineValidate( )`, `PKIXCertPathChecker.{check( ), init( )}`

CertPathValidatorResult java.security.cert

Java 1.4 *cloneable*

This marker interface defines the type of the object returned by the `validate( )` method of a `CertPathValidator`, but does not define any of the contents of that object, other to specify that it must be `Cloneable`. If you want any details about the results of validating a `CertPath`, you must cast the return value of `validate( )` to an algorithm-specific types implementation of this interface, such as `PKIXCertPathValidatorResult`.

Figure 14-58. java.security.cert.CertPathValidatorResult


```
public interface CertPathValidatorResult extends Cloneable {
// Public Instance Methods
     Object clone( );
}
```

Implementations

`PKIXCertPathValidatorResult`

Returned By

`CertPathValidator.validate( )`, `CertPathValidatorSpi.engineValidate( )`

Team LiB

CertPathValidatorSpi java.security.cert

Java 1.4

This abstract class defines the Service Provider Interface for the `CertPathValidator` class. Security providers must implement this interface, but applications never need to use it.

```
public abstract class CertPathValidatorSpi {
// Public Constructors
     public CertPathValidatorSpi( );
// Public Instance Methods
     public abstract CertPathValidatorResult engineValidate(CertPath certPath,
        CertPathParameters params)
        throws CertPathValidatorException,
        java.security.InvalidAlgorithmParameterException;
}
```

Passed To

`CertPathValidator.CertPathValidator( )`

CertSelector java.security.cert

Java 1.4 *cloneable*

This interface defines an API for determining whether a `Certificate` meets some criteria. Implementations are used to specify critera by which a certificate or certificates should be selected from a `CertStore` object. The `match( )` method should examine the `Certificate` it is passed and return `true` if it "matches" based on whatever criteria the implementation defines. See `X509CertSelector` for an implementation that works with X.509 certificates. See `CRLSelector` for a similar interface for use when selecting `CRL` objects from a `CertStore`.

Figure 14-59. java.security.cert.CertSelector


```
public interface CertSelector extends Cloneable {
// Public Instance Methods
     Object clone( );
     boolean match(java.security.cert.Certificate cert);
}
```

Implementations

`X509CertSelector`

Passed To

`CertStore.getCertificates( )`, `CertStoreSpi.engineGetCertificates( )`, `PKIXBuilderParameters.PKIXBuilderParameters( )`, `PKIXParameters.setTargetCertConstraints( )`

Returned By

`PKIXParameters.getTargetCertConstraints( )`

Team LiB

CertStore java.security.cert

Java 1.4

A CertStore object is a repository for Certificate and CRL objects. You may query a CertStore for a java.util.Collection of Certificate or CRL objects that match specified criteria by passing a CertSelector or CRLSelector to getCertificates( ) or getCRLs( ). A CertStore is conceptually similar to a java.security.KeyStore, but there are significant differences in how the two classes are intended to be used. A KeyStore is designed to store a relatively small local collection of private keys and trusted certificates. A CertStore, however, may represent a large public database (in the form of an LDAP server, for examle) of untrusted certificates.

Obtain a CertStore object by calling a getInstance( ) method and specifying the name of the desired CertStore type and a CertStoreParameters object that is specific to that type. Optionally, you may also specify the desired provider of your CertStore object. The default "SUN" provider defines two CertStore types, named "LDAP" and "Collection", which you should use with LDAPCertStoreParameters and CollectionCertStoreParameters objects, respectively. The "LDAP" type obtains certificates and CRLs from a network LDAP server, and the "Collection" type obtains them from a a specified Collection object.

The CertStore class may be directly useful to applications that want to query a LDAP server for certificates. It is also used by PKIXParameters.addCertStore( ) and PKIXParameters.setCertStores( ) to specify a source of certificates to by used by the CertPathBuilder and CertPathValidator classes.

All public methods of CertStore are threadsafe.

```
public class CertStore {
// Protected Constructors
     protected CertStore(CertStoreSpi storeSpi, java.security.Provider provider,
        String type, CertStoreParameters params);
// Public Class Methods
     public static final String getDefaultType( );
     public static CertStore getInstance(String type, CertStoreParameters params)
        throws java.security.InvalidAlgorithmParameterException,
        java.security.NoSuchAlgorithmException;
     public static CertStore getInstance(String type, CertStoreParameters params,
        String provider)
        throws java.security.InvalidAlgorithmParameterException,
        java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
     public static CertStore getInstance(String type, CertStoreParameters params,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.InvalidAlgorithmParameterException;
// Public Instance Methods
```

```
    public final java.util.Collection<? extends java.security.cert.Certificate>
       getCertificates(CertSelector selector)
       throws CertStoreException;
    public final CertStoreParameters getCertStoreParameters( );
    public final java.util.Collection<? extends CRL> getCRLs
       (CRLSelector selector)
       throws CertStoreException;
    public final java.security.Provider getProvider( );
    public final String getType( );
}
```

Passed To

PKIXParameters.addCertStore( )

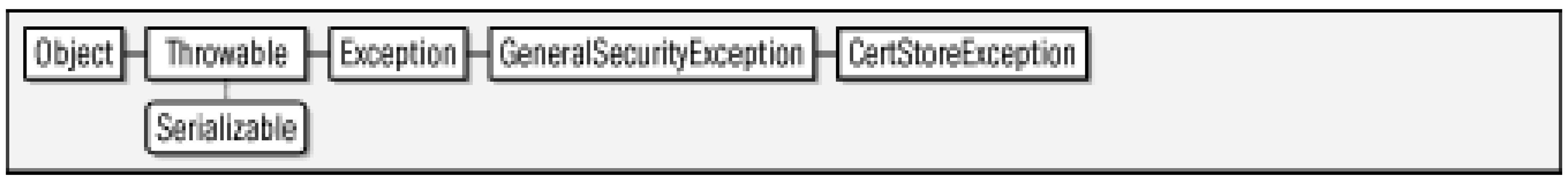
Team LiB

CertStoreException java.security.cert

Java 1.4 *serializable checked*

Signals a problem while querying a `CertStore` for certificates or CRLs.

Figure 14-60. java.security.cert.CertStoreException




```
public class CertStoreException extends java.security.GeneralSecurityException {
// Public Constructors
     public CertStoreException( );
     public CertStoreException(Throwable cause);
     public CertStoreException(String msg);
     public CertStoreException(String msg, Throwable cause);
}
```

Thrown By

`CertStore.{getCertificates( )`, `getCRLs( )}`, `CertStoreSpi.{engineGetCertificates( )`, `engineGetCRLs( )}`

CertStoreParameters java.security.cert

Java 1.4 *cloneable*

This marker interface defines the type, but not the content, of the parameters object that is passed to the `CertStore.getInstance( )` methods. It does not define any methods of its own and simply requires that all implementing classes be cloneable. Use one of the concrete implementations of this class for `CertStore` objects of type "LDAP" and "Collection".

Figure 14-61. java.security.cert.CertStoreParameters


```
public interface CertStoreParameters extends Cloneable {
// Public Instance Methods
     Object clone( );
}
```

Implementations

`CollectionCertStoreParameters`, `LDAPCertStoreParameters`

Passed To

`CertStore.{CertStore( )`, `getInstance( )}`, `CertStoreSpi.CertStoreSpi( )`

Returned By

`CertStore.getCertStoreParameters( )`

CertStoreSpi java.security.cert

Java 1.4

This abstract class defines the Service Provider Interface for the CertStore class. Security providers must implement this interface, but applications never need to use it.

```
public abstract class CertStoreSpi {
// Public Constructors
     public CertStoreSpi(CertStoreParameters params)
        throws java.security.InvalidAlgorithmParameterException;
// Public Instance Methods
     public abstract java.util.Collection<? extends java.security.cert.
        Certificate> engineGetCertificates(CertSelector selector)
        throws CertStoreException;
     public abstract java.util.Collection<? extends CRL>
        engineGetCRLs(CRLSelector selector)
        throws CertStoreException;
}
```

Passed To

CertStore.CertStore( )

CollectionCertStoreParameters java.security.cert

Java 1.4 *cloneable*

This concrete implementation of `CertStoreParameters` is used when creating a `CertStore` object of type "Collection". Pass the `Collection` of `Certificate` and `CRL` objects to be searched by the `CertStore` to the constructor method.

Figure 14-62. java.security.cert.CollectionCertStoreParameters


```
public class CollectionCertStoreParameters implements CertStoreParameters {
// Public Constructors
     public CollectionCertStoreParameters( );
     public CollectionCertStoreParameters(java.util.Collection<?> collection);
// Public Instance Methods
     public java.util.Collection<?> getCollection( );
// Methods Implementing CertStoreParameters
     public Object clone( );
// Public Methods Overriding Object
     public String toString( );
}
```

CRL java.security.cert

Java 1.2

This abstract class represents a *certificate revocation list* (CRL). A CRL is an object issued by a certificate authority (or other certificate signer) that lists certificates that have been revoked, meaning that they are now invalid and should be rejected. Use a `CertificateFactory` to parse a `CRL` from a byte stream. Use the `isRevoked( )` method to test whether a specified `Certificate` is listed on the `CRL`. Note that type-specific `CRL` subclasses, such as `X509CRL`, may provide access to substantially more information about the revocation list.

```
public abstract class CRL {
// Protected Constructors
     protected CRL(String type);
// Public Instance Methods
     public final String getType( );
     public abstract boolean isRevoked(java.security.cert.Certificate cert);
// Public Methods Overriding Object
     public abstract String toString( );
}
```

Subclasses

`X509CRL`

Passed To

`CRLSelector.match( )`, `X509CRLSelector.match( )`

Returned By

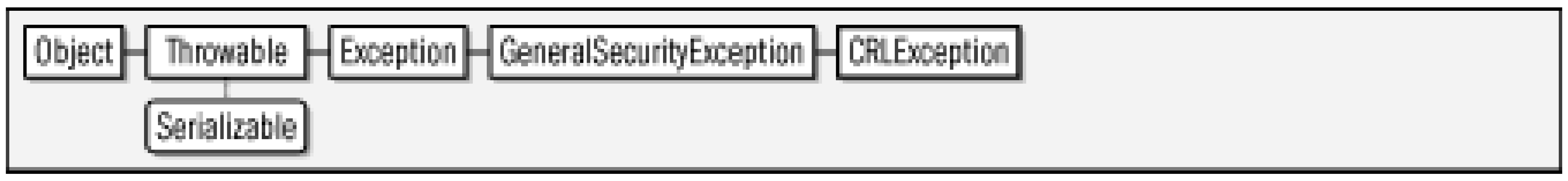
`CertificateFactory.generateCRL( )`, `CertificateFactorySpi.engineGenerateCRL( )`

CRLException java.security.cert

Java 1.2 *serializable checked*

Signals an error or other problem while working with a CRL.

Figure 14-63. java.security.cert.CRLException




```
public class CRLException extends java.security.GeneralSecurityException {
// Public Constructors
     public CRLException( );
5.0  public CRLException(Throwable cause);
     public CRLException(String message);
5.0  public CRLException(String message, Throwable cause);
}
```

Thrown By

`CertificateFactory.{generateCRL( ), generateCRLs( )}`, `CertificateFactorySpi.{engineGenerateCRL( ), engineGenerateCRLs( )}`, `X509CRL.{getEncoded( ), getTBSCertList( ), verify( )}`, `X509CRLEntry.getEncoded( )`

CRLSelector java.security.cert

Java 1.4 *cloneable*

This interface defines an API for determining whether a `CRL` object meets some criteria. Implementations are used to specify critera by which a `CRL` objects should be selected from a `CertStore`. The `match( )` method should examine the `CRL` it is passed and return `true` if it "matches" based on whatever criteria the implementation defines. See `X509CRLSelector` for an implementation that works with X.509 certificates. See `CertSelector` for a similar interface for use when selecting `Certificate` objects from a `CertStore`.

Figure 14-64. java.security.cert.CRLSelector


```
public interface CRLSelector extends Cloneable {
// Public Instance Methods
     Object clone( );
     boolean match(CRL crl);
}
```

Implementations

`X509CRLSelector`

Passed To

`CertStore.getCRLs( )`, `CertStoreSpi.engineGetCRLs( )`

Team LiB

LDAPCertStoreParameters java.security.cert

Java 1.4 *cloneable*

This concrete implementation of `CertStoreParameters` is used when creating a `CertStore` object of type "LDAP". It specifies the hostname of the LDAP server to connect to and, optionally, the port to connect on.

Figure 14-65. java.security.cert.LDAPCertStoreParameters


```
public class LDAPCertStoreParameters implements CertStoreParameters {
// Public Constructors
     public LDAPCertStoreParameters( );
     public LDAPCertStoreParameters(String serverName);
     public LDAPCertStoreParameters(String serverName, int port);
// Public Instance Methods
     public int getPort( );                          default:389
     public String getServerName( );                 default:"localhost"
// Methods Implementing CertStoreParameters
     public Object clone( );
// Public Methods Overriding Object
     public String toString( );
}
```

PKIXBuilderParameters java.security.cert

Java 1.4 *cloneable*

Instances of this class are used to specify parameters to the `build( )` method of a `CertPathBuilder` object. These parameters must include the two mandatory ones passed to the constructors. The first is a source of trust anchors, which may be supplied as a `Set` of `trustAnchor` objects or as a `java.security.KeyStore` object. The second required parameter is a `CertSelector` object (typically an `X509CertSelector`) that specifies the selection criteria for the certificate that is to have the certification path built. In addition to these parameters that are passed to the constructor, this class also inherits a number of methods for setting other parameters, and defines `setMaxPathLength( )` for specifying the maximum length of the certificate chain that is built.

Figure 14-66. java.security.cert.PKIXBuilderParameters

```
public class PKIXBuilderParameters extends PKIXParameters {
// Public Constructors
     public PKIXBuilderParameters(java.security.KeyStore keystore,
        CertSelector targetConstraints)
        throws java.security.KeyStoreException,
        java.security.InvalidAlgorithmParameterException;
     public PKIXBuilderParameters(java.util.Set<TrustAnchor> trustAnchors,
        CertSelector targetConstraints)
        throws java.security.InvalidAlgorithmParameterException;
// Public Instance Methods
     public int getMaxPathLength( );
     public void setMaxPathLength(int maxPathLength);
// Public Methods Overriding PKIXParameters
     public String toString( );
}
```

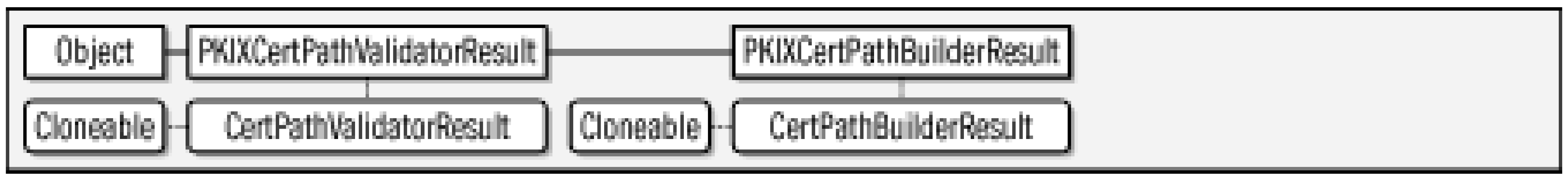
Team LiB

PKIXCertPathBuilderResult java.security.cert

Java 1.4 *cloneable*

An instance of this class is retured by the `build( )` method of a `CertPathBuilder` created for the "PKIX" algorithm. `getCertPath( )` returns the `CertPath` object that was built, and methods inherited from the superclass return additional information such as the public key of the subject of the certificate chain and the trust anchor that terminates the chain.

Figure 14-67. java.security.cert.PKIXCertPathBuilderResult




```
public class PKIXCertPathBuilderResult extends PKIXCertPathValidatorResult
     implements CertPathBuilderResult {
// Public Constructors
     public PKIXCertPathBuilderResult(CertPath certPath, TrustAnchor trustAnchor,
        PolicyNode policyTree,
        java.security.PublicKey subjectPublicKey);
// Methods Implementing CertPathBuilderResult
     public CertPath getCertPath( );
// Public Methods Overriding PKIXCertPathValidatorResult
     public String toString( );
}
```

Team LiB

PKIXCertPathChecker java.security.cert

Java 1.4 *cloneable*

This abstract class defines an extension mechanism for thePKIX certification path building and validation algorithms. Most applications will never need to use this class. You may pass one or more PKIXCertPathChecker objects to the setCertPathCheckers( ) or addCertPathChecker( ) methods of the PKIXParameters or PKIXBuilderParameters object that is passed to the build( ) or validate( ) methods of a CertPathBuilder or CertPathValidator. The check( ) method of all PKIXCertPathChecker objects registered in this way will be invoked for each certificate considered in the building or validation algorithms. check( ) should throw a CertPathValidatorException if a certificate does not the implemented test. The init( ) method is invoked to tell the checker to reset its internal state and to notify it of the direction in which certificates will be presented. Checkers are not required to support the forward direction, and should return false from isForwardCheckingSupported( ) if they do not.

Figure 14-68. java.security.cert.PKIXCertPathChecker

```
public abstract class PKIXCertPathChecker implements Cloneable {
// Protected Constructors
     protected PKIXCertPathChecker( );
// Public Instance Methods
     public abstract void check(java.security.cert.Certificate cert,
        java.util.Collection<String> unresolvedCritExts)
        throws CertPathValidatorException;
     public abstract java.util.Set<String> getSupportedExtensions( );
     public abstract void init(boolean forward) throws CertPathValidatorException;
     public abstract boolean isForwardCheckingSupported( );
// Public Methods Overriding Object
     public Object clone( );
}
```

Passed To

PKIXParameters.addCertPathChecker( )

PKIXCertPathValidatorResult java.security.cert

Java 1.4 *cloneable*

An instance of this class is returned upon successful validation by the validate( ) method of a CertPathValidator created for the "PKIX" algorithm. getPublicKey( ) returns the validated public key of the subject of the certificate chain. gettrustAnchor( ) returns the TRustAnchor that anchors the chain.

Figure 14-69. java.security.cert.PKIXCertPathValidatorResult


```
public class PKIXCertPathValidatorResult implements CertPathValidatorResult {
// Public Constructors
     public PKIXCertPathValidatorResult(TrustAnchor trustAnchor,
        PolicyNode policyTree,
        java.security.PublicKey subjectPublicKey);
// Public Instance Methods
     public PolicyNode getPolicyTree( );
     public java.security.PublicKey getPublicKey( );
     public TrustAnchor getTrustAnchor( );
// Methods Implementing CertPathValidatorResult
     public Object clone( );
// Public Methods Overriding Object
     public String toString( );
}
```

Subclasses

PKIXCertPathBuilderResult

PKIXParameters java.security.cert

Java 1.4 *cloneable*

This implementation of CertPathParameters defines parameters that are passed to the validate( ) method of a PKIX CertPathValidator and defines a subset of the parameters that are passed to the build( ) method of a PKIX CertPathBuilder. A full understanding of this class requires a detailed discussion of the PKIX certification path building and validation algorithms, which is beyond the scope of this book. However, some of the more important parameters are described here.

When you create a PKIXParameters object, you must specify which trust anchors are to be used. You can do this by passing a Set of TRustAnchor objects to the constructor, or by passing a KeyStore containing trust anchor keys to the constructor. Once a PKIXParameters object is created, you can modify the set of trustAnchor objects with setTrustAnchors( ). Specify a Set of CertStore objects to be searched for certificates with setCertStores( ) or add a single CertStore to the set with addCertStore( ). If certificate validity is to be checked for some date and time other than the current time, use setDate( ) to specify this date.

Figure 14-70. java.security.cert.PKIXParameters

```
public class PKIXParameters implements CertPathParameters {
// Public Constructors
     public PKIXParameters(java.security.KeyStore keystore)
        throws java.security.KeyStoreException,
        java.security.InvalidAlgorithmParameterException;
     public PKIXParameters(java.util.Set<TrustAnchor> trustAnchors)
throws java.security.InvalidAlgorithmParameterException;
// Public Instance Methods
     public void addCertPathChecker(PKIXCertPathChecker checker);
     public void addCertStore(CertStore store);
     public java.util.List<PKIXCertPathChecker> getCertPathCheckers( );
     public java.util.List<CertStore> getCertStores( );
     public java.util.Date getDate( );
     public java.util.Set<String> getInitialPolicies( );
     public boolean getPolicyQualifiersRejected( );
     public String getSigProvider( );
     public CertSelector getTargetCertConstraints( );
     public java.util.Set<TrustAnchor> getTrustAnchors( );
     public boolean isAnyPolicyInhibited( );
```

```
    public boolean isExplicitPolicyRequired( );
    public boolean isPolicyMappingInhibited( );
    public boolean isRevocationEnabled( );
    public void setAnyPolicyInhibited(boolean val);
    public void setCertPathCheckers(java.util.List<PKIXCertPathChecker>
       checkers);
    public void setCertStores(java.util.List<CertStore> stores);
    public void setDate(java.util.Date date);
    public void setExplicitPolicyRequired(boolean val);
    public void setInitialPolicies(java.util.Set<String> initialPolicies);
    public void setPolicyMappingInhibited(boolean val);
    public void setPolicyQualifiersRejected(boolean qualifiersRejected);
    public void setRevocationEnabled(boolean val);
    public void setSigProvider(String sigProvider);
    public void setTargetCertConstraints(CertSelector selector);
    public void setTrustAnchors(java.util.Set<TrustAnchor> trustAnchors)
throws java.security.InvalidAlgorithmParameterException;
// Methods Implementing CertPathParameters
    public Object clone( );
// Public Methods Overriding Object
    public String toString( );
}
```

Subclasses

PKIXBuilderParameters

PolicyNode java.security.cert

Java 1.4

This class represents a node in the policy tree created by the PKIX certification path validation algorithm. A discussion of X.509 policy extensions and their use in the PKIX certification path algorithms is beyond the scope of this reference.

```
public interface PolicyNode {
// Public Instance Methods
     java.util.Iterator<? extends PolicyNode> getChildren( );
     int getDepth( );
     java.util.Set<String> getExpectedPolicies( );
     PolicyNode getParent( );
     java.util.Set<? extends PolicyQualifierInfo> getPolicyQualifiers( );
     String getValidPolicy( );
     boolean isCritical( );
}
```

Passed To

PKIXCertPathBuilderResult.PKIXCertPathBuilderResult( ), PKIXCertPathValidatorResult.PKIXCertPathValidatorResult( )

Returned By

PKIXCertPathValidatorResult.getPolicyTree( )

PolicyQualifierInfo java.security.cert

Java 1.4

This class is a low-level representation of a policy qualifier information from a X.509 certificate extension. A discussion of X.509 policy extensions and their use in the PKIX certification path algorithms is beyond the scope of this reference.

```
public class PolicyQualifierInfo {
// Public Constructors
     public PolicyQualifierInfo(byte[ ] encoded) throws java.io.IOException;
// Public Instance Methods
     public final byte[ ] getEncoded( );
     public final byte[ ] getPolicyQualifier( );
     public final String getPolicyQualifierId( );
// Public Methods Overriding Object
     public String toString( );
}
```

TrustAnchor java.security.cert

Java 1.4

A trustAnchor represents a certificate authority that is trusted to "anchor" a certificate chain. A TRustAnchor object includes the X.500 distinguished name of the CA and the public key of the CA. You may specify the name and key explictly or by passing an X509Certificate to the trustAnchor( ) constructor. If you do not pass a certificate, you can specify the CA name as a String or as an X500Principal object from the javax.security.auth.x500 package. All forms of the trustAnchor( ) constructor also allow you to specify a byte array containing a binary representatior of a "Name Constraints" extension. The format and meaning of such name constraints is beyond the scope of this reference, and most applications can simply specify null for this constructor argument.

```
public class TrustAnchor {
// Public Constructors
     public TrustAnchor(X509Certificate trustedCert, byte[ ] nameConstraints);
5.0  public TrustAnchor(javax.security.auth.x500.X500Principal caPrincipal,
        java.security.PublicKey pubKey,
        byte[ ] nameConstraints);
     public TrustAnchor(String caName, java.security.PublicKey pubKey,
        byte[ ] nameConstraints);
// Public Instance Methods
5.0  public final javax.security.auth.x500.X500Principal getCA( );
     public final String getCAName( );
     public final java.security.PublicKey getCAPublicKey( );
     public final byte[ ] getNameConstraints( );
     public final X509Certificate getTrustedCert( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

PKIXCertPathBuilderResult.PKIXCertPathBuilderResult( ), PKIXCertPathValidatorResult.PKIXCertPathValidatorResult( )

Returned By

PKIXCertPathValidatorResult.getTrustAnchor( )

X509Certificate java.security.cert

Java 1.2 *serializable*

This class represents an X.509 certificate. Its various methods provide complete access to the contents of the certificate. A full understanding of this class requires detailed knowledge of the X.509 standard which is beyond the scope of this reference. Some of the more important methods are described here, however. `getSubjectDN( )` returns the `Principal` to whom this certificate applies, and the inherited `getPublicKey( )` method returns the `PublicKey` that the certificate associates with that `Principal`. `getIssuerDN( )` returns a `Principal` that represents the issuer of the certificate, and if you know the public key for that `Principal`, you can pass it to the `verify( )` method to check the digital signature of the issuer and ensure that the certificate is not forged. `checkValidity( )` checks whether the certificate has expired or has not yet gone into effect. Note that `verify( )` and `getPublicKey( )` are inherited from `Certificate`.

Obtain an `X509Certificate` object by creating a `CertificateFactory` for certificate type "X.509" and then using `generateCertificate( )` to parse an X.509 certificate from a stream of bytes. Finally, cast the `Certificate` returned by this method to an `X509Certificate`.

Figure 14-71. java.security.cert.X509Certificate

```
public abstract class X509Certificate extends java.security.cert.Certificate
     implements X509Extension {
// Protected Constructors
     protected X509Certificate( );
// Public Instance Methods
     public abstract void checkValidity( )
        throws CertificateExpiredException, CertificateNotYetValidException;
     public abstract void checkValidity(java.util.Date date)
        throws CertificateExpiredException, CertificateNotYetValidException;
     public abstract int getBasicConstraints( );
1.4  public java.util.List<String> getExtendedKeyUsage( )
        throws CertificateParsingException;
1.4  public java.util.Collection<java.util.List<?>> getIssuerAlternativeNames( )
        throws CertificateParsingException;
     public abstract java.security.Principal getIssuerDN( );
     public abstract boolean[ ] getIssuerUniqueID( );
1.4  public javax.security.auth.x500.X500Principal getIssuerX500Principal( );
     public abstract boolean[ ] getKeyUsage( );
```

```
     public abstract java.util.Date getNotAfter( );
     public abstract java.util.Date getNotBefore( );
     public abstract java.math.BigInteger getSerialNumber( );
     public abstract String getSigAlgName( );
     public abstract String getSigAlgOID( );
     public abstract byte[ ] getSigAlgParams( );
     public abstract byte[ ] getSignature( );
1.4  public java.util.Collection<java.util.List<?>> getSubjectAlternativeNames( )
        throws CertificateParsingException;
     public abstract java.security.Principal getSubjectDN( );
     public abstract boolean[ ] getSubjectUniqueID( );
1.4  public javax.security.auth.x500.X500Principal getSubjectX500Principal( );
     public abstract byte[ ] getTBSCertificate( )
        throws CertificateEncodingException;
     public abstract int getVersion( );
}
```

Passed To

trustAnchor.TrustAnchor( ), X509CertSelector.setCertificate( ), X509CRL.getRevokedCertificate( ), X509CRLSelector.setCertificateChecking( ), javax.net.ssl.X509TrustManager.{checkClientTrusted( ), checkServerTrusted( )}, javax.security.auth.x500.X500PrivateCredential.X500PrivateCredential( )

Returned By

trustAnchor.getTrustedCert( ), X509CertSelector.getCertificate( ), X509CRLSelector.getCertificateChecking( ), javax.net.ssl.X509KeyManager.getCertificateChain( ), javax.net.ssl.X509TrustManager.getAcceptedIssuers( ), javax.security.auth.x500.X500PrivateCredential.getCertificate( )

X509CertSelector java.security.cert

Java 1.4 *cloneable*

This class is a CertSelector for X.509 certificates. Its various set methods allow you to specify values f various certificate fields and extensions. The match( ) method will only return true for certificates that h the specified values for those fields and extensions. A full understanding of this class requires detailed knowledge of the X.509 standard which is beyond the scope of this reference. Some of the more importa methods are described here, however.

When you want to match exactly one specific certificate, simply pass the desired X509Certificate to setCertificate( ) . Constrain the subject of the certificate with setSubject( ) , setSubjectAlternativeNames( ) , of addSubjectAlternativeName( ) . Constrain the issuer of the certificate with setIssuer( ) . Constrain the public key of the certificate with setPublicKey( ) . Constr certificate to be valid on a given date with setCertificateValid( ) . And specify a specific issuer's seri number for the certificate with setSerialNumber( ) .

Java 5.0 adds methods for identifying certificate subjects and issuers with javax.security.auth.x500.X500Principal objects instead of with strings.

Figure 14-72. java.security.cert.X509CertSelector

```
public class X509CertSelector implements CertSelector {
// Public Constructors
     public X509CertSelector( );
// Public Instance Methods
     public void addPathToName(int type, String name)
        throws java.io.IOException;
     public void addPathToName(int type, byte[ ] name)
        throws java.io.IOException;
     public void addSubjectAlternativeName(int type, byte[ ] name)
        throws java.io.IOException;
     public void addSubjectAlternativeName(int type, String name)
        throws java.io.IOException;
     public byte[ ] getAuthorityKeyIdentifier( );              default:null
     public int getBasicConstraints( );                        default:-1
     public X509Certificate getCertificate( );                 default:null
     public java.util.Date getCertificateValid( );             default:null
     public java.util.Set<String> getExtendedKeyUsage( );    default:null
5.0  public javax.security.auth.x500.X500Principal getIssuer( );  default:null
```

```
     public byte[ ] getIssuerAsBytes( )
        throws java.io.IOException;     default:null
     public String getIssuerAsString( );                        default:null
     public boolean[ ] getKeyUsage( );                          default:null
     public boolean getMatchAllSubjectAltNames( );         default:true
     public byte[ ] getNameConstraints( );                         default:null
     public java.util.Collection<java.util.List<?>>
        getPathToNames( );     default:null
     public java.util.Set<String> getPolicy( );      default:null
     public java.util.Date getPrivateKeyValid( );          default:null
     public java.math.BigInteger getSerialNumber( );       default:null
5.0  public javax.security.auth.x500.X500Principal
        getSubject( );     default:null
     public java.util.Collection<java.util.List<?>>
        getSubjectAlternativeNames( );     default:null
     public byte[ ] getSubjectAsBytes( )
        throws java.io.IOException;     default:null
     public String getSubjectAsString( );                default:null
     public byte[ ] getSubjectKeyIdentifier( );          default:null
     public java.security.PublicKey getSubjectPublicKey( );  default:null
     public String getSubjectPublicKeyAlgID( );          default:null
     public void setAuthorityKeyIdentifier(byte[ ] authorityKeyID);
     public void setBasicConstraints(int minMaxPathLen);
     public void setCertificate(X509Certificate cert);
     public void setCertificateValid(java.util.Date certValid);
     public void setExtendedKeyUsage(java.util.Set<String> keyPurposeSet)
        throws java.io.IOException;
5.0  public void setIssuer(javax.security.auth.x500.X500Principal issuer);
     public void setIssuer(byte[ ] issuerDN) throws java.io.IOException;
     public void setIssuer(String issuerDN) throws java.io.IOException;
     public void setKeyUsage(boolean[ ] keyUsage);
     public void setMatchAllSubjectAltNames(boolean matchAllNames);
     public void setNameConstraints(byte[ ] bytes) throws java.io.IOException;
     public void setPathToNames(java.util.Collection<java.util.List<?>> names)
        throws java.io.IOException;
     public void setPolicy(java.util.Set<String> certPolicySet) throws java.io.IOExcept
     public void setPrivateKeyValid(java.util.Date privateKeyValid);
     public void setSerialNumber(java.math.BigInteger serial);
     public void setSubject(String subjectDN) throws java.io.IOException;
5.0  public void setSubject(javax.security.auth.x500.X500Principal subject);
     public void setSubject(byte[ ] subjectDN) throws java.io.IOException;
     public void setSubjectAlternativeNames(java.util.Collection<
        java.util.List<?>> names) throws java.io.IOException;
     public void setSubjectKeyIdentifier(byte[ ] subjectKeyID);
     public void setSubjectPublicKey(byte[ ] key) throws java.io.IOException;
     public void setSubjectPublicKey(java.security.PublicKey key);
     public void setSubjectPublicKeyAlgID(String oid) throws java.io.IOException;
// Methods Implementing CertSelector
     public Object clone( );
```

```
    public boolean match(java.security.cert.Certificate cert);
// Public Methods Overriding Object
    public String toString( );
}
```

Team LiB

Team LiB

X509CRL java.security.cert

Java 1.2

This class represents an X.509 CRL, which consists primarily of a set of X509CRLEntry objects. The vario
access to the full details of the CRL, and require a complete understanding of the X.509 standard, which
reference. Use verify( ) to check the digital signature of the CRL to ensure that it does indeed originat
Use the inherited isRevoked( ) method to determine whether a given certificate has been revoked. If y
date for a revoked certificate, obtain the X509CRLEntry for that certificate by calling getrevokedCertifi
to obtain the date this CRL was issued. Use getNextUpdate( ) to find if the CRL has been superseded b
geTRevokedCertificates( ) to obtain a Set of all X509CRLEntry objects from this CRL.

Obtain an X509CRL object by creating a CertificateFactory for certificate type "X.509" and then using
X.509 CRL from a stream of bytes. Finally, cast the CRL returned by this method to an X509CRL .

Figure 14-73. java.security.cert.X509CRL

```
public abstract class X509CRL extends CRL implements X509Extension {
// Protected Constructors
     protected X509CRL( );
// Public Instance Methods
     public abstract byte[ ] getEncoded( ) throws CRLException;
     public abstract java.security.Principal getIssuerDN( );
1.4  public javax.security.auth.x500.X500Principal getIssuerX500Principal( );
     public abstract java.util.Date getNextUpdate( );
5.0  public X509CRLEntry getRevokedCertificate(X509Certificate certificate);
     public abstract X509CRLEntry
        getRevokedCertificate(java.math.BigInteger serialNumber);
     public abstract java.util.Set<? extends X509CRLEntry>
        getRevokedCertificates( );
     public abstract String getSigAlgName( );
     public abstract String getSigAlgOID( );
     public abstract byte[ ] getSigAlgParams( );
     public abstract byte[ ] getSignature( );
     public abstract byte[ ] getTBSCertList( ) throws CRLException;
     public abstract java.util.Date getThisUpdate( );
     public abstract int getVersion( );
     public abstract void verify(java.security.PublicKey key)
        throws CRLException, java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException, java.security.NoSuchProviderException, java.s
```

```
    public abstract void verify(java.security.PublicKey key, String sigProvider)
       throws CRLException,
       java.security.NoSuchAlgorithmException, java.security.InvalidKeyException,
       java.security.NoSuchProviderException, java.security.SignatureException;
// Public Methods Overriding Object
    public boolean equals(Object other);
    public int hashCode( );
}
```

Team LiB

X509CRLEntry java.security.cert

Java 1.2

This class represents a single entry in an X509CRL. It contains the serial number and revocation date for a revoked certificate.

Figure 14-74. java.security.cert.X509CRLEntry


```
public abstract class X509CRLEntry implements X509Extension {
// Public Constructors
     public X509CRLEntry( );
// Public Instance Methods
5.0  public javax.security.auth.x500.X500Principal
        getCertificateIssuer( );     constant
     public abstract byte[ ] getEncoded( ) throws CRLException;
     public abstract java.util.Date getRevocationDate( );
     public abstract java.math.BigInteger getSerialNumber( );
     public abstract boolean hasExtensions( );
// Public Methods Overriding Object
     public boolean equals(Object other);
     public int hashCode( );
     public abstract String toString( );
}
```

Returned By

X509CRL.getRevokedCertificate( )

Team LiB

X509CRLSelector java.security.cert

Java 1.4 *cloneable*

This class is a `CRLSelector` implementation for X.509 CRLs. The various `set` methods allow you to specify criteria that the `match( )` method will use to accept or reject `CRL` objects. Use `addIssuerName( )` to specify the distinguished name of an acceptable issuer for the CRL, or use `setIssuerNames( )` or `setIssuers( )` to specify a `Collection` of valid issuers. Use `setDateAndTime( )` to specify a `Date` for which the CRL must be valid. Use `setMinCRLNumber( )` and `setMaxCRLNumber( )` to set bounds on the sequence number of the CRL. If you are selecting a `CRL` in order to check for revocation of a particular `X509Certificate`, pass that certificate to `setCertificateChecking( )`. This method does not actually constrain the returned `CRL` objects, but it may help a `CertStore` optimize its search for a relevant `CRL`.

Figure 14-75. java.security.cert.X509CRLSelector

```
public class X509CRLSelector implements CRLSelector {
// Public Constructors
     public X509CRLSelector( );
// Public Instance Methods
5.0  public void addIssuer(javax.security.auth.x500.X500Principal issuer);
     public void addIssuerName(String name) throws java.io.IOException;
     public void addIssuerName(byte[ ] name) throws java.io.IOException;
     public X509Certificate getCertificateChecking( ); default:null
     public java.util.Date getDateAndTime( );  default:null
     public java.util.Collection<Object> getIssuerNames( );  default:null
5.0  public java.util.Collection<javax.security.auth.x500.X500Principal>
        getIssuers( );     default:null
     public java.math.BigInteger getMaxCRL( );    default:null
     public java.math.BigInteger getMinCRL( );    default:null
     public void setCertificateChecking(X509Certificate cert);
     public void setDateAndTime(java.util.Date dateAndTime);
     public void setIssuerNames(java.util.Collection<?> names)
        throws java.io.IOException;
5.0  public void setIssuers(java.util.Collection
        <javax.security.auth.x500.X500Principal> issuers);
     public void setMaxCRLNumber(java.math.BigInteger maxCRL);
     public void setMinCRLNumber(java.math.BigInteger minCRL);
```

```
// Methods Implementing CRLSelector
     public Object clone( );
     public boolean match(CRL crl);
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

X509Extension java.security.cert

Java 1.2

This interface defines methods for handling a set of extensions to X.509 certificates and CRLs. Each extension has a name, or OID (object identifier), that identifies the type of the extension. An extension may be marked critical or noncritical. Noncritical extensions whose OIDs are not recognized can safely be ignored. However, if a critical exception is not recognized, the`Certificate` or `CRL` should be rejected. Each extension in the set has a byte array of data as its value. The interpretation of these bytes depends on the OID of the extension, of course. Specific extensions are defined by the X.509 and related standards and their details are beyond the scope of this reference.

```
public interface X509Extension {
// Public Instance Methods
     java.util.Set<String> getCriticalExtensionOIDs( );
     byte[ ] getExtensionValue(String oid);
     java.util.Set<String> getNonCriticalExtensionOIDs( );
     boolean hasUnsupportedCriticalExtension( );
}
```

Implementations

`X509Certificate`, `X509CRL`, `X509CRLEntry`

Package java.security.interfaces

Java 1.1

As its name implies, the `java.security.interfaces` package contains only interfaces. These interfaces define methods that provide algorithm-specific information (such as key values and initialization parameter values) about DSA, RSA, and EC public and private keys. If you are using the RSA algorithm, for example, and working with a `java.security.PublicKey` object, you can cast that `PublicKey` to an `RSAPublicKey` object and use the RSA-specific methods defined by `RSAPublicKey` to query the key value directly.

The `java.security.interfaces` package was introduced in Java 1.1. As of Java 1.2, the `java.security.spec` package is the preferred way for obtaining algorithm-specific information about keys and algorithm parameters. This package remains useful in Java 1.2 and later, however, for identifying the type of a given `PublicKey` or `PrivateKey` object.

The interfaces in this package are typically of interest only to programmers who are implementing a security provider or who want to implement cryptographic algorithms themselves. Use of this package typically requires some familiarity with the mathematics underlying DSA and RSA public-key cryptography.

Interfaces

```
public interface DSAKey;
public interface DSAKeyPairGenerator;
public interface DSAParams;
public interface DSAPrivateKey extends DSAKey, java.security.PrivateKey;
public interface DSAPublicKey extends DSAKey, java.security.PublicKey;
public interface ECKey;
public interface ECPrivateKey extends ECKey, java.security.PrivateKey;
public interface ECPublicKey extends ECKey, java.security.PublicKey;
public interface RSAKey;
public interface RSAMultiPrimePrivateCrtKey extends RSAPrivateKey;
public interface RSAPrivateCrtKey extends RSAPrivateKey;
public interface RSAPrivateKey extends java.security.PrivateKey, RSAKey;
public interface RSAPublicKey extends java.security.PublicKey, RSAKey;
```

Team LiB

DSAKey java.security.interfaces

Java 1.1

This interface defines a method that must be implemented by both public and private DSA keys.

```
public interface DSAKey {
// Public Instance Methods
     DSAParams getParams( );
}
```

Implementations

DSAPrivateKey, DSAPublicKey

Team LiB

DSAKeyPairGenerator java.security.interfaces

Java 1.1

This interface defines algorithm-specific `KeyPairGenerator` initialization methods for DSA keys. To generate a pair of DSA keys, use the static `getInstance( )` factory method of `java.security.KeyPairGenerator` and specify "DSA" as the desired algorithm name. If you wish to perform DSA-specific initialization, cast the returned `KeyPairGenerator` to a `DSAKeyPairGenerator` and call one of the `initialize( )` methods defined by this interface. Finally, generate the keys by calling `generateKeyPair( )` on the `KeyPairGenerator`.

```
public interface DSAKeyPairGenerator {
// Public Instance Methods
     void initialize(DSAParams params, java.security.SecureRandom random)
        throws java.security.InvalidParameterException;
     void initialize(int modlen, boolean genParams,
        java.security.SecureRandom random)
        throws java.security.InvalidParameterException;
}
```

DSAParams java.security.interfaces

Java 1.1

This interface defines methods for obtaining the DSA parametersg, p, and q. These methods are useful only if you wish to perform cryptographic computation yourself. Using these methods requires a detailed understanding of the mathematics underlying DSA public-key cryptography.

```
public interface DSAParams {
// Public Instance Methods
     java.math.BigInteger getG( );
     java.math.BigInteger getP( );
     java.math.BigInteger getQ( );
}
```

Implementations

java.security.spec.DSAParameterSpec

Passed To

DSAKeyPairGenerator.initialize( )

Returned By

DSAKey.getParams( )

Team LiB

DSAPrivateKey java.security.interfaces

Java 1.1 *serializable*

This interface represents a DSA private key and provides direct access to the underlying key value. If you are working with a private key you know is a DSA key, you can cast the PrivateKey to a DSAPrivateKey.

Figure 14-76. java.security.interfaces.DSAPrivateKey


```
public interface DSAPrivateKey extends DSAKeyjava.security.PrivateKey {
// Public Constants
1.2  public static final long serialVersionUID;  =7776497482533790279
// Public Instance Methods
     java.math.BigInteger getX( );
}
```

Team LiB

DSAPublicKey java.security.interfaces

Java 1.1 *serializable*

This interface represents a DSA public key and provides direct access to the underlying key value. If you are working with a public key you know is a DSA key, you can cast the`PublicKey` to a `DSAPublicKey`.

Figure 14-77. java.security.interfaces.DSAPublicKey


```
public interface DSAPublicKey extends DSAKeyjava.security.PublicKey {
// Public Constants
1.2  public static final long serialVersionUID;  =1234526332779022332
// Public Instance Methods
     java.math.BigInteger getY( );
}
```

Team LiB

ECKey java.security.interfaces

Java 5.0

This interface defines the API that must be implemented by all elliptic curve keys.

```
public interface ECKey {
// Public Instance Methods
     java.security.spec.ECParameterSpec getParams( );
}
```

Implementations

ECPrivateKey, ECPublicKey

Team LiB

ECPrivateKey java.security.interfaces

Java 5.0 *serializable*

This interface defines an API that must be implemented by all elliptic curve private keys.

Figure 14-78. java.security.interfaces.ECPrivateKey


```
public interface ECPrivateKey extends ECKeyjava.security.PrivateKey {
// Public Constants
     public static final long serialVersionUID;  =-7896394956925609184
// Public Instance Methods
     java.math.BigInteger getS( );
}
```

ECPublicKey java.security.interfaces

Java 5.0 *serializable*

This interface defines an API that must be implemented by all elliptic curve public keys.

Figure 14-79. java.security.interfaces.ECPublicKey


```
public interface ECPublicKey extends ECKeyjava.security.PublicKey {
// Public Constants
     public static final long serialVersionUID;  =-3314988629879632826
// Public Instance Methods
     java.security.spec.ECPoint getW( );
}
```

Team LiB

RSAKey java.security.interfaces

Java 1.3

This is a superinterface for RSAPublicKey and RSAPrivateKey; it defines a method shared by both classes. Prior to Java 1.3, the getModulus( ) method was defined independently by RSAPublicKey and RSAPrivateKey.

```
public interface RSAKey {
// Public Instance Methods
     java.math.BigInteger getModulus( );
}
```

Implementations

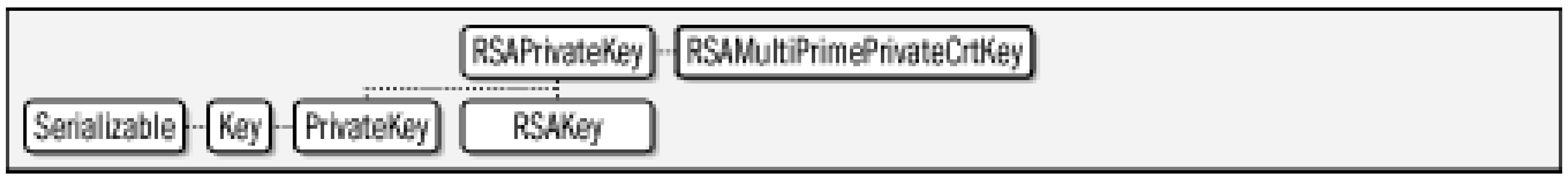
RSAPrivateKey, RSAPublicKey

RSAMultiPrimePrivateCrtKey java.security.interfaces

Java 1.4 *serializable*

This interface extends RSAPrivateKey and provides a decomposition of the private key into the various numbers used to create it. This interface is very similar to RSAPrivateCrtKey, except that it is used to represent RSA private keys that are based on more than two prime factors, and implements the addition getOtherPrimeInfo( ) method to return information about these additional prime numbers.

Figure 14-80. java.security.interfaces.RSAMultiPrimePrivateCrtKey




```
public interface RSAMultiPrimePrivateCrtKey extends RSAPrivateKey {
// Public Constants
5.0  public static final long serialVersionUID;  =618058533534628008
// Public Instance Methods
     java.math.BigInteger getCrtCoefficient( );
     java.security.spec.RSAOtherPrimeInfo[ ] getOtherPrimeInfo( );
     java.math.BigInteger getPrimeExponentP( );
     java.math.BigInteger getPrimeExponentQ( );
     java.math.BigInteger getPrimeP( );
     java.math.BigInteger getPrimeQ( );
     java.math.BigInteger getPublicExponent( );
}
```

Team LiB

RSAPrivateCrtKey java.security.interfaces

Java 1.2 *serializable*

This interface extends RSAPrivateKey and provides a decomposition (based on the Chinese remainder theorem) of the private-key value into the various pieces that comprise it. This interface is useful only if you plan to implement your own cryptographic algorithms. To use this interface, you must have a detailed understanding of the mathematics underlying RSA public-key cryptography. Given a java.security.PrivateKey object, you can use the instanceof operator to determine whether you can safely cast it to an RSAPrivateCrtKey.

Figure 14-81. java.security.interfaces.RSAPrivateCrtKey


```
public interface RSAPrivateCrtKey extends RSAPrivateKey {
// Public Constants
5.0  public static final long serialVersionUID;  =-5682214253527700368
// Public Instance Methods
     java.math.BigInteger getCrtCoefficient( );
     java.math.BigInteger getPrimeExponentP( );
     java.math.BigInteger getPrimeExponentQ( );
     java.math.BigInteger getPrimeP( );
     java.math.BigInteger getPrimeQ( );
     java.math.BigInteger getPublicExponent( );
}
```

RSAPrivateKey java.security.interfaces

Java 1.2 *serializable*

This interface represents an RSA private key and provides direct access to the underlying key values. If you are working with a private key you know is an RSA key, you can cast the `PrivateKey` to an `RSAPrivateKey`.

Figure 14-82. java.security.interfaces.RSAPrivateKey


```
public interface RSAPrivateKey extends java.security.PrivateKeyRSAKey {
// Public Constants
5.0  public static final long serialVersionUID;  =5187144804936595022
// Public Instance Methods
     java.math.BigInteger getPrivateExponent( );
}
```

Implementations

`RSAMultiPrimePrivateCrtKey`, `RSAPrivateCrtKey`

Team LiB

RSAPublicKey java.security.interfaces

Java 1.2 *serializable*

This interface represents an RSA public key and provides direct access to the underlying key values. If you are working with a public key you know is an RSA key, you can cast the PublicKey to an RSAPublicKey.

Figure 14-83. java.security.interfaces.RSAPublicKey


```
public interface RSAPublicKey extends java.security.PublicKeyRSAKey {
// Public Constants
5.0  public static final long serialVersionUID;  =-8727434096241101194
// Public Instance Methods
     java.math.BigInteger getPublicExponent( );
}
```

Team LiB

Package java.security.spec

Java 1.2

The java.security.spec package contains classes that define transparent representations for DSA, RSA, and EC public and private keys and for X.509 and PKCS#8 encodings of those keys. It also defines a transparent representation for DSA algorithm parameters. The classes in this package are used in conjunction with java.security.KeyFactory and java.security.AlgorithmParameters for converting opaque Key and AlgorithmParameters objects to and from transparent representations.

This package is not frequently used. To make use of it, you must be somewhat familiar with the mathematics that underlies DSA and RSA public-key encryption and the encoding standards that specify how keys are encoded as byte streams.

Interfaces

```
public interface AlgorithmParameterSpec;
public interface ECField;
public interface KeySpec;
```

Classes

```
public class DSAParameterSpec implements AlgorithmParameterSpec,
        java.security.interfaces.DSAParams;
public class DSAPrivateKeySpec implements KeySpec;
public class DSAPublicKeySpec implements KeySpec;
public class ECFieldF2m implements ECField;
public class ECFieldFp implements ECField;
public class ECGenParameterSpec implements AlgorithmParameterSpec;
public class ECParameterSpec implements AlgorithmParameterSpec;
public class ECPoint;
public class ECPrivateKeySpec implements KeySpec;
public class ECPublicKeySpec implements KeySpec;
public class EllipticCurve;
public abstract class EncodedKeySpec implements KeySpec;
   public class PKCS8EncodedKeySpec extends EncodedKeySpec;
   public class X509EncodedKeySpec extends EncodedKeySpec;
public class MGF1ParameterSpec implements AlgorithmParameterSpec;
public class PSSParameterSpec implements AlgorithmParameterSpec;
public class RSAKeyGenParameterSpec implements AlgorithmParameterSpec;
public class RSAOtherPrimeInfo;
public class RSAPrivateKeySpec implements KeySpec;
```

```
   public class RSAMultiPrimePrivateCrtKeySpec extends RSAPrivateKeySpec;
   public class RSAPrivateCrtKeySpec extends RSAPrivateKeySpec;
public class RSAPublicKeySpec implements KeySpec;
```

Exceptions

```
public class InvalidKeySpecException
        extends java.security.GeneralSecurityException;
public class InvalidParameterSpecException
        extends java.security.GeneralSecurityException;
```

Team LiB

AlgorithmParameterSpec java.security.spec

Java 1.2

This interface defines no methods; it marks classes that define a transparent representation of cryptographic parameters. You can use an `AlgorithmParameterSpec` object to initialize an opaque `java.security.AlgorithmParameters` object.

```
public interface AlgorithmParameterSpec {
}
```

Implementations

`DSAParameterSpec`, `ECGenParameterSpec`, `ECParameterSpec`, `MGF1ParameterSpec`, `PSSParameterSpec`, `RSAKeyGenParameterSpec`, `javax.crypto.spec.DHGenParameterSpec`, `javax.crypto.spec.DHParameterSpec`, `javax.crypto.spec.IvParameterSpec`, `javax.crypto.spec.OAEPParameterSpec`, `javax.crypto.spec.PBEParameterSpec`, `javax.crypto.spec.RC2ParameterSpec`, `javax.crypto.spec.RC5ParameterSpec`

Passed To

Too many methods to list.

Returned By

`java.security.AlgorithmParameters.getParameterSpec( )`, `java.security.AlgorithmParametersSpi.engineGetParameterSpec( )`, `PSSParameterSpec.getMGFParameters( )`, `javax.crypto.Cipher.getMaxAllowedParameterSpec( )`, `javax.crypto.spec.OAEPParameterSpec.getMGFParameters( )`

DSAParameterSpec java.security.spec

Java 1.2

This class represents algorithm parameters used with DSA public-key cryptography.

Figure 14-84. java.security.spec.DSAParameterSpec


```
public class DSAParameterSpec implements AlgorithmParameterSpec,
        java.security.interfaces.DSAParams {
// Public Constructors
     public DSAParameterSpec(java.math.BigInteger p, java.math.BigInteger q,
        java.math.BigInteger g);
// Methods Implementing DSAParams
     public java.math.BigInteger getG( );
     public java.math.BigInteger getP( );
     public java.math.BigInteger getQ( );
}
```

DSAPrivateKeySpec java.security.spec

Java 1.2

This class is a transparent representation of a DSA private key.

Figure 14-85. java.security.spec.DSAPrivateKeySpec


```
public class DSAPrivateKeySpec implements KeySpec {
// Public Constructors
     public DSAPrivateKeySpec(java.math.BigInteger x, java.math.BigInteger p,
        java.math.BigInteger q, java.math.BigInteger g);
// Public Instance Methods
     public java.math.BigInteger getG( );
     public java.math.BigInteger getP( );
     public java.math.BigInteger getQ( );
     public java.math.BigInteger getX( );
}
```

DSAPublicKeySpec java.security.spec

Java 1.2

This class is a transparent representation of a DSA public key.

Figure 14-86. java.security.spec.DSAPublicKeySpec


```
public class DSAPublicKeySpec implements KeySpec {
// Public Constructors
     public DSAPublicKeySpec(java.math.BigInteger y, java.math.BigInteger p,
        java.math.BigInteger q, java.math.BigInteger g);
// Public Instance Methods
     public java.math.BigInteger getG( );
     public java.math.BigInteger getP( );
     public java.math.BigInteger getQ( );
     public java.math.BigInteger getY( );
}
```

ECField java.security.spec

Java 5.0

This interface represents a "finite field" for elliptic curve cryptography.

```
public interface ECField {
// Public Instance Methods
     int getFieldSize( );
}
```

Implementations

ECFieldF2m, ECFieldFp

Passed To

EllipticCurve.EllipticCurve( )

Returned By

EllipticCurve.getField( )

ECFieldF2m java.security.spec

Java 5.0

This class defines an immutable representation of a "characteristic 2 finite field" for elliptic curve cryptography.

Figure 14-87. java.security.spec.ECFieldF2m


```
public class ECFieldF2m implements ECField {
// Public Constructors
     public ECFieldF2m(int m);
     public ECFieldF2m(int m, int[ ] ks);
     public ECFieldF2m(int m, java.math.BigInteger rp);
// Public Instance Methods
     public int getM( );
     public int[ ] getMidTermsOfReductionPolynomial( );
     public java.math.BigInteger getReductionPolynomial( );
// Methods Implementing ECField
     public int getFieldSize( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

ECFieldFp java.security.spec

Java 5.0

This class defines an immutable representation of a "prime finite field" for elliptic curve cryptography

Figure 14-88. java.security.spec.ECFieldFp


```
public class ECFieldFp implements ECField {
// Public Constructors
     public ECFieldFp(java.math.BigInteger p);
// Public Instance Methods
     public java.math.BigInteger getP( );
// Methods Implementing ECField
     public int getFieldSize( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Team LiB

ECGenParameterSpec java.security.spec

Java 5.0

This class specifies parameters for generating elliptic curve domain parameters.

Figure 14-89. java.security.spec.ECGenParameterSpec


```
public class ECGenParameterSpec implements AlgorithmParameterSpec {
// Public Constructors
     public ECGenParameterSpec(String stdName);
// Public Instance Methods
     public String getName( );
}
```

ECParameterSpec java.security.spec

Java 5.0

This class defines an immutable representation for a set of parameters for elliptic curve cryptography.

Figure 14-90. java.security.spec.ECParameterSpec


```
public class ECParameterSpec implements AlgorithmParameterSpec {
// Public Constructors
     public ECParameterSpec(EllipticCurve curve, ECPoint g,
        java.math.BigInteger n, int h);
// Public Instance Methods
     public int getCofactor( );
     public EllipticCurve getCurve( );
     public ECPoint getGenerator( );
     public java.math.BigInteger getOrder( );
}
```

Passed To

ECPrivateKeySpec.ECPrivateKeySpec( ), ECPublicKeySpec.ECPublicKeySpec( )

Returned By

java.security.interfaces.ECKey.getParams( ), ECPrivateKeySpec.getParams( ), ECPublicKeySpec.getParams( )

ECPoint java.security.spec

Java 5.0

This class defines an immutable representation of a point on an elliptic curve, using affine coordinates.

```
public class ECPoint {
// Public Constructors
     public ECPoint(java.math.BigInteger x, java.math.BigInteger y);
// Public Constants
     public static final ECPoint POINT_INFINITY;
// Public Instance Methods
     public java.math.BigInteger getAffineX( );
     public java.math.BigInteger getAffineY( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Passed To

ECParameterSpec.ECParameterSpec( ), ECPublicKeySpec.ECPublicKeySpec( )

Returned By

java.security.interfaces.ECPublicKey.getW( ), ECParameterSpec.getGenerator( ), ECPublicKeySpec.getW( )

ECPrivateKeySpec java.security.spec

Java 5.0

This class is an immutable representation of a private key for elliptic curve cryptography.

Figure 14-91. java.security.spec.ECPrivateKeySpec


```
public class ECPrivateKeySpec implements KeySpec {
// Public Constructors
     public ECPrivateKeySpec(java.math.BigInteger s, ECParameterSpec params);
// Public Instance Methods
     public ECParameterSpec getParams( );
     public java.math.BigInteger getS( );
}
```

ECPublicKeySpec java.security.spec

Java 5.0

This class is an immutable representation of a public key for elliptic curve cryptography.

Figure 14-92. java.security.spec.ECPublicKeySpec


```
public class ECPublicKeySpec implements KeySpec {
// Public Constructors
     public ECPublicKeySpec(ECPoint w, ECParameterSpec params);
// Public Instance Methods
     public ECParameterSpec getParams( );
     public ECPoint getW( );
}
```

EllipticCurve java.security.spec

Java 5.0

This class is an immutable representation of an elliptic curve. See ECParameterSpec.

```
public class EllipticCurve {
// Public Constructors
     public EllipticCurve(ECField field, java.math.BigInteger a,
        java.math.BigInteger b);
     public EllipticCurve(ECField field, java.math.BigInteger a,
        java.math.BigInteger b, byte[ ] seed);
// Public Instance Methods
     public java.math.BigInteger getA( );
     public java.math.BigInteger getB( );
     public ECField getField( );
     public byte[ ] getSeed( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Passed To

ECParameterSpec.ECParameterSpec( )

Returned By

ECParameterSpec.getCurve( )

EncodedKeySpec java.security.spec

Java 1.2

This abstract class represents a public or private key in an encoded format. It serves as the superclass for encoding-specific classes.

Figure 14-93. java.security.spec.EncodedKeySpec


```
public abstract class EncodedKeySpec implements KeySpec {
// Public Constructors
     public EncodedKeySpec(byte[ ] encodedKey);
// Public Instance Methods
     public byte[ ] getEncoded( );
     public abstract String getFormat( );
}
```

Subclasses

PKCS8EncodedKeySpec, X509EncodedKeySpec

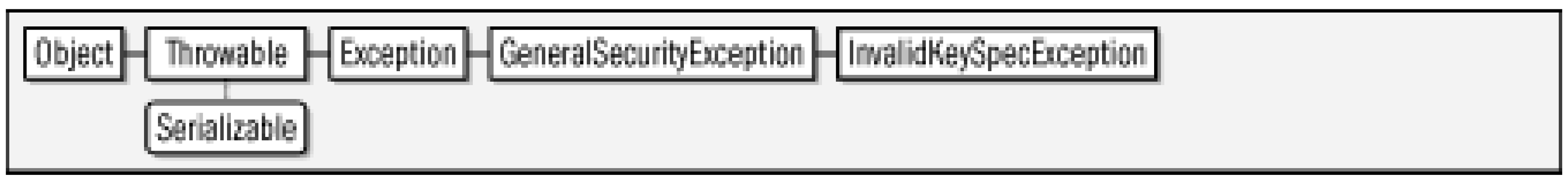
Team LiB

InvalidKeySpecException java.security.spec

Java 1.2 *serializable checked*

Signals a problem with a KeySpec.

Figure 14-94. java.security.spec.InvalidKeySpecException




```
public class InvalidKeySpecException
       extends java.security.GeneralSecurityException {
// Public Constructors
     public InvalidKeySpecException( );
5.0  public InvalidKeySpecException(Throwable cause);
     public InvalidKeySpecException(String msg);
5.0  public InvalidKeySpecException(String message, Throwable cause);
}
```

Thrown By

java.security.KeyFactory.{generatePrivate( ), generatePublic( ), getKeySpec( )}, java.security.KeyFactorySpi.{engineGeneratePrivate( ), engineGeneratePublic( ), engineGetKeySpec( )}, javax.crypto.EncryptedPrivateKeyInfo.getKeySpec( ), javax.crypto.SecretKeyFactory.{generateSecret( ), getKeySpec( )}, javax.crypto.SecretKeyFactorySpi.{engineGenerateSecret( ), engineGetKeySpec( )}

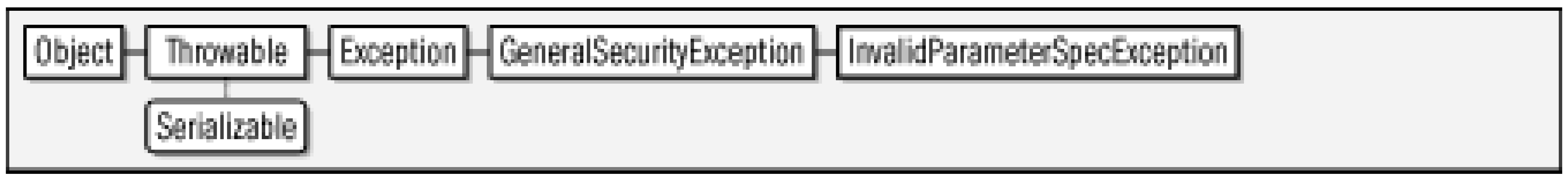
Team LiB

InvalidParameterSpecException java.security.spec

Java 1.2 *serializable checked*

Signals a problem with an `AlgorithmParameterSpec`.

Figure 14-95. java.security.spec.InvalidParameterSpecException




```
public class InvalidParameterSpecException
        extends java.security.GeneralSecurityException {
// Public Constructors
     public InvalidParameterSpecException( );
     public InvalidParameterSpecException(String msg);
}
```

Thrown By

`java.security.AlgorithmParameters.{getParameterSpec( ), init( )}`, `java.security.AlgorithmParametersSpi.{engineGetParameterSpec( ), engineInit( )}`

KeySpec java.security.spec

Java 1.2

This interface defines no methods; it marks classes that define a transparent representation of a cryptographic key. Use a `java.security.KeyFactory` to convert a `KeySpec` to and from an opaque `java.security.Key`.

```
public interface KeySpec {
}
```

Implementations

DSAPrivateKeySpec, DSAPublicKeySpec, ECPrivateKeySpec, ECPublicKeySpec, EncodedKeySpec, RSAPrivateKeySpec, RSAPublicKeySpec, javax.crypto.spec.DESedeKeySpec, javax.crypto.spec.DESKeySpec, javax.crypto.spec.DHPrivateKeySpec, javax.crypto.spec.DHPublicKeySpec, javax.crypto.spec.PBEKeySpec, javax.crypto.spec.SecretKeySpec

Passed To

java.security.KeyFactory.{generatePrivate( ), generatePublic( )}, java.security.KeyFactorySpi.{engineGeneratePrivate( ), engineGeneratePublic( )}, javax.crypto.SecretKeyFactory.generateSecret( ), javax.crypto.SecretKeyFactorySpi.engineGenerateSecret( )

Returned By

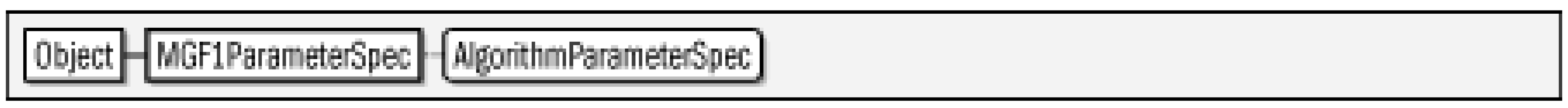
java.security.KeyFactory.getKeySpec( ), java.security.KeyFactorySpi.engineGetKeySpec( ), javax.crypto.SecretKeyFactory.getKeySpec( ), javax.crypto.SecretKeyFactorySpi.engineGetKeySpec( )

MGF1ParameterSpec java.security.spec

Java 5.0

This class represents parameters for "mask generation function" MGF1 of the OAEP Padding and RSA-PSS signature scheme, defined in the PKCS #1 standard, version 2.1. The constants represent predefined instances of the class, whose digest algorithm matches the constant name.

Figure 14-96. java.security.spec.MGF1ParameterSpec



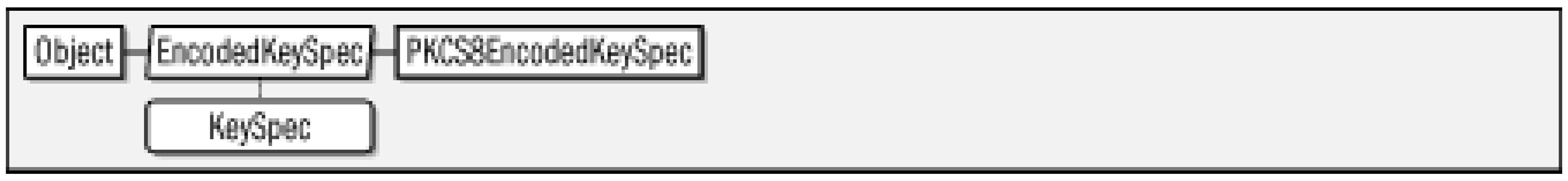

```
public class MGF1ParameterSpec implements AlgorithmParameterSpec {
// Public Constructors
     public MGF1ParameterSpec(String mdName);
// Public Constants
     public static final MGF1ParameterSpec SHA1;
     public static final MGF1ParameterSpec SHA256;
     public static final MGF1ParameterSpec SHA384;
     public static final MGF1ParameterSpec SHA512;
// Public Instance Methods
     public String getDigestAlgorithm( );
}
```

PKCS8EncodedKeySpec java.security.spec

Java 1.2

This class represents a private key, encoded according to the PKCS#8 standard.

Figure 14-97. java.security.spec.PKCS8EncodedKeySpec




```
public class PKCS8EncodedKeySpec extends EncodedKeySpec {
// Public Constructors
     public PKCS8EncodedKeySpec(byte[ ] encodedKey);
// Public Methods Overriding EncodedKeySpec
     public byte[ ] getEncoded( );
     public final String getFormat( );
}
```

Returned By

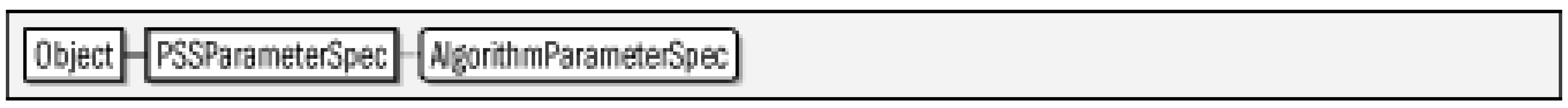
`javax.crypto.EncryptedPrivateKeyInfo.getKeySpec( )`

PSSParameterSpec java.security.spec

Java 1.4

This class represents algorithm parameters used with the RSA PSS encoding scheme, which is defined by version 2.1 of the RSA standard PKCS#1. This class has been substantially enhanced in Java 5.0.

Figure 14-98. java.security.spec.PSSParameterSpec




```
public class PSSParameterSpec implements AlgorithmParameterSpec {
// Public Constructors
     public PSSParameterSpec(int saltLen);
5.0  public PSSParameterSpec(String mdName, String mgfName,
        AlgorithmParameterSpec mgfSpec,
        int saltLen, int trailerField);
// Public Constants
5.0  public static final PSSParameterSpec DEFAULT;
// Public Instance Methods
5.0  public String getDigestAlgorithm( );
5.0  public String getMGFAlgorithm( );
5.0  public AlgorithmParameterSpec getMGFParameters( );
     public int getSaltLength( );
5.0  public int getTrailerField( );
}
```

RSAKeyGenParameterSpec java.security.spec

Java 1.3

This class represents parameters that generate public/private key pairs for RSA cryptography.

Figure 14-99. java.security.spec.RSAKeyGenParameterSpec


```
public class RSAKeyGenParameterSpec implements AlgorithmParameterSpec {
// Public Constructors
     public RSAKeyGenParameterSpec(int keysize,
        java.math.BigInteger publicExponent);
// Public Constants
     public static final java.math.BigInteger F0;
     public static final java.math.BigInteger F4;
// Public Instance Methods
     public int getKeysize( );
     public java.math.BigInteger getPublicExponent( );
}
```

Team LiB

RSAMultiPrimePrivateCrtKeySpec java.security.spec

Java 1.4

This class is a transparent representation of a multi-prime RSA private key. It is very similar to RSAPrivateCrtKeySpec, but adds an additional method for obtaining information about the other primes associated with the key.

Figure 14-100. java.security.spec.RSAMultiPrimePrivateCrtKeySpec


```
public class RSAMultiPrimePrivateCrtKeySpec extends RSAPrivateKeySpec {
// Public Constructors
     public RSAMultiPrimePrivateCrtKeySpec(java.math.BigInteger modulus,
       java.math.BigInteger publicExponent,
       java.math.BigInteger privateExponent,
       java.math.BigInteger primeP,
       java.math.BigInteger primeQ,
       java.math.BigInteger primeExponentP,
       java.math.BigInteger primeExponentQ,
       java.math.BigInteger crtCoefficient,
       RSAOtherPrimeInfo[ ] otherPrimeInfo);
// Public Instance Methods
     public java.math.BigInteger getCrtCoefficient( );
     public RSAOtherPrimeInfo[ ] getOtherPrimeInfo( );
     public java.math.BigInteger getPrimeExponentP( );
     public java.math.BigInteger getPrimeExponentQ( );
     public java.math.BigInteger getPrimeP( );
     public java.math.BigInteger getPrimeQ( );
     public java.math.BigInteger getPublicExponent( );
}
```

Team LiB

RSAOtherPrimeInfo java.security.spec

Java 1.4

This class represents the (prime, exponent, coefficient) triplet that constitues an "OtherPrimeInfo" structure that is used with RSA multi-prime private keys, as defined in version 2.1 of the PKCS#1 standard.

```
public class RSAOtherPrimeInfo {
// Public Constructors
     public RSAOtherPrimeInfo(java.math.BigInteger prime,
        java.math.BigInteger primeExponent,
        java.math.BigInteger crtCoefficient);
// Public Instance Methods
     public final java.math.BigInteger getCrtCoefficient( );
     public final java.math.BigInteger getExponent( );
     public final java.math.BigInteger getPrime( );
}
```

Passed To

RSAMultiPrimePrivateCrtKeySpec.RSAMultiPrimePrivateCrtKeySpec( )

Returned By

java.security.interfaces.RSAMultiPrimePrivateCrtKey.getOtherPrimeInfo( ), RSAMultiPrimePrivateCrtKeySpec.getOtherPrimeInfo( )

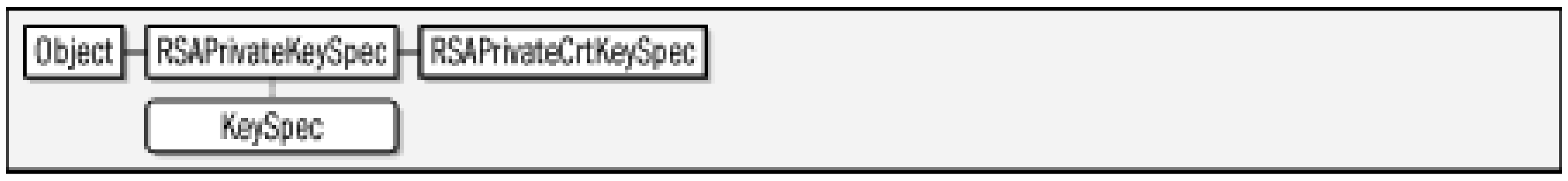
Team LiB

RSAPrivateCrtKeySpec java.security.spec

Java 1.2

This class is a transparent representation of an RSA private key including, for convenience, the Chinese remainder theorem values associated with the key.

Figure 14-101. java.security.spec.RSAPrivateCrtKeySpec




```
public class RSAPrivateCrtKeySpec extends RSAPrivateKeySpec {
// Public Constructors
     public RSAPrivateCrtKeySpec(java.math.BigInteger modulus,
        java.math.BigInteger publicExponent,
        java.math.BigInteger privateExponent,
        java.math.BigInteger primeP,
        java.math.BigInteger primeQ,
        java.math.BigInteger primeExponentP,
        java.math.BigInteger primeExponentQ,
        java.math.BigInteger crtCoefficient);
// Public Instance Methods
     public java.math.BigInteger getCrtCoefficient( );
     public java.math.BigInteger getPrimeExponentP( );
     public java.math.BigInteger getPrimeExponentQ( );
     public java.math.BigInteger getPrimeP( );
     public java.math.BigInteger getPrimeQ( );
     public java.math.BigInteger getPublicExponent( );
}
```

RSAPrivateKeySpec java.security.spec

Java 1.2

This class is a transparent representation of an RSA private key.

Figure 14-102. java.security.spec.RSAPrivateKeySpec


```
public class RSAPrivateKeySpec implements KeySpec {
// Public Constructors
     public RSAPrivateKeySpec(java.math.BigInteger modulus,
        java.math.BigInteger privateExponent);
// Public Instance Methods
     public java.math.BigInteger getModulus( );
     public java.math.BigInteger getPrivateExponent( );
}
```

Subclasses

RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKeySpec

Team LiB

RSAPublicKeySpec java.security.spec

Java 1.2

This class is a transparent representation of an RSA public key.

Figure 14-103. java.security.spec.RSAPublicKeySpec


```
public class RSAPublicKeySpec implements KeySpec {
// Public Constructors
     public RSAPublicKeySpec(java.math.BigInteger modulus,
        java.math.BigInteger publicExponent);
// Public Instance Methods
     public java.math.BigInteger getModulus( );
     public java.math.BigInteger getPublicExponent( );
}
```

Team LiB

X509EncodedKeySpec java.security.spec

Java 1.2

This class represents a public or private key encoded according to the X.509standard.

Figure 14-104. java.security.spec.X509EncodedKeySpec


```
public class X509EncodedKeySpec extends EncodedKeySpec {
// Public Constructors
     public X509EncodedKeySpec(byte[ ] encodedKey);
// Public Methods Overriding EncodedKeySpec
     public byte[ ] getEncoded( );
     public final String getFormat( );
}
```

Team LiB

Chapter 15. java.text

Package java.text

Annotation

AttributedCharacterIterator

AttributedCharacterIterator.Attribute

AttributedString

Bidi

BreakIterator

CharacterIterator

ChoiceFormat

CollationElementIterator

CollationKey

Collator

DateFormat

DateFormat.Field

DateFormatSymbols

DecimalFormat

DecimalFormatSymbols

FieldPosition

Format

Format.Field

MessageFormat

MessageFormat.Field

NumberFormat

NumberFormat.Field

ParseException

ParsePosition

RuleBasedCollator

SimpleDateFormat

StringCharacterIterator

Team LiB

Team LiB

Package java.text

Java 1.1

The `java.text` package consists of classes and interfaces that are useful for writing internationalized programs that handle local customs, such as date and time formatting and string alphabetization, correctly.

The `NumberFormat` class formats numbers, monetary quantities, and percentages as appropriate for the default or specified locale. `DateFormat` formats dates and times in a locale-specific way. The concrete `DecimalFormat` and `SimpleDateFormat` subclasses of these classes can be used for customized number, date, and time formatting. `MessageFormat` allows substitution of dynamic values, including formatted numbers and dates, into static message strings. `ChoiceFormat` formats a number using an enumerated set of string values. See the `Format` superclass for a general description of formatting and parsing strings with these classes. `Collator` compares strings according to the customary sorting order for a locale. `BreakIterator` scans text to find word, line, and sentence boundaries following locale-specific rules. The `Bidi` class of Java 1.4 implements the Unicode "bidirectional" algorithm for working with languages such as Arabic and Hebrew that display text right-to-left but display numbers left-to-right.

Interfaces

```
public interface AttributedCharacterIterator extends CharacterIterator;
public interface CharacterIterator extends Cloneable;
```

Classes

```
public class Annotation;
public static class AttributedCharacterIterator.Attribute implements Serializable;
   public static class Format.Field extends AttributedCharacterIterator.Attribute;
      public static class DateFormat.Field extends Format.Field;
      public static class MessageFormat.Field extends Format.Field;
      public static class NumberFormat.Field extends Format.Field;
public class AttributedString;
public final class Bidi;
public abstract class BreakIterator implements Cloneable;
public final class CollationElementIterator;
public final class CollationKey implements Comparable<CollationKey>;
public abstract class Collator implements java.util.Comparator<Object>, Cloneable;
   public class RuleBasedCollator extends Collator;
public class DateFormatSymbols implements Cloneable, Serializable;
public final class DecimalFormatSymbols implements Cloneable, Serializable;
public class FieldPosition;
```

```
public abstract class Format implements Cloneable, Serializable;
   public abstract class DateFormat extends Format;
      public class SimpleDateFormat extends DateFormat;
   public class MessageFormat extends Format;
   public abstract class NumberFormat extends Format;
      public class ChoiceFormat extends NumberFormat;
      public class DecimalFormat extends NumberFormat;
public class ParsePosition;
public final class StringCharacterIterator implements CharacterIterator;
```

Exceptions

```
public class ParseException extends Exception;
```

Annotation java.text

Java 1.2

This class is a wrapper for a the value of a text attribute that represents an annotation. Annotations differ from other types of text attributes in two ways. First, annotations are linked to the text they are applied to, so changing the text invalidates or corrupts the meaning of the annotation. Second, annotations cannot be merged with adjacent annotations, even if they have the same value. Putting an annotation value in an `Annotation` wrapper serves to indicate these special characteristics. Note that two of the attribute keys defined by `AttributedCharaterIterator.Attribute`, `READING` and `INPUT_METHOD_SEGMENT`, must be used with `Annotation` objects.

```
public class Annotation {
// Public Constructors
     public Annotation(Object value);
// Public Instance Methods
     public Object getValue( );
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

AttributedCharacterIterator java.text

Java 1.2 *cloneable*

This interface extends `CharacterIterator` for working with text that is marked up with attributes in some way. It defines an inner class, `AttributedCharaterIterator.Attribute`, that represents attribute keys. `AttributedCharacterIterator` defines methods for querying the attribute keys, values, and runs for the text being iterated over. `getAllAttributeKeys( )` returns the `Set` of all attribute keys that appear anywhere in the text. `getAttributes( )` returns a `Map` that contains the attribute keys and values that apply to the current character. `getAttribute( )` returns the value associated with the specified attribute key for the current character.

`geTRunStart( )` and `getrunLimit( )` return the index of the first and last characters in a run. A *run* is a string of adjacent characters for which an attribute has the same value or is undefined (i.e., has a value of `null`). A run can also be defined for a set of attributes, in which case it is a set of adjacent characters for which all attributes in the set hold a constant value (which may include `null`). Programs that process or display attributed text must usually work with it one run at a time. The no-argument versions of `getrunStart( )` and `geTRunLimit( )` return the start and end of the run that includes the current character and all attributes that are applied to the current character. The other versions of these methods return the start and end of the run of the specified attribute or set of attributes that includes the current character.

The `AttributedString` class provides a simple way to define short strings of attributed text and obtain an `AttributedCharacterIterator` over them. Most applications that process attributed text are working with attributed text from specialized data sources, stored in some specialized data format, so they need to define a custom implementation of `AttributedCharacterIterator`.

Figure 15-1. java.text.AttributedCharacterIterator

```
public interface AttributedCharacterIterator extends CharacterIterator {
// Nested Types
     public static class Attribute implements Serializable;
// Public Instance Methods
     java.util.Set<AttributedCharacterIterator.Attribute>
        getAllAttributeKeys( );
     Object getAttribute(AttributedCharacterIterator.Attribute attribute);
     java.util.Map<AttributedCharacterIterator.Attribute,Object>
        getAttributes( );
     int getRunLimit( );
     int getRunLimit(java.util.Set<? extends AttributedCharacterIterator.
        Attribute> attributes);
```

```
    int getRunLimit(AttributedCharacterIterator.Attribute attribute);
    int getRunStart( );
    int getRunStart(AttributedCharacterIterator.Attribute attribute);
    int getRunStart(java.util.Set<? extends AttributedCharacterIterator.
       Attribute> attributes);
}
```

Passed To

AttributedString.AttributedString( ), Bidi.Bidi( )

Returned By

AttributedString.getIterator( ), DecimalFormat.formatToCharacterIterator( ), Format.formatToCharacterIterator( ), MessageFormat.formatToCharacterIterator( ), SimpleDateFormat.formatToCharacterIterator( )

Team LiB

AttributedCharacterIterator.Attribute java.text

Java 1.2 *serializable*

This class defines the types of the attribute keys used with AttributedCharacterIterator and AttributedString. It defines several constant Attribute keys that are commonly used with multilingual text and input methods. The LANGUAGE key represents the language of the underlying text. The value of this key should be a Locale object. The READING key represents arbitrary reading information associated with text. The value must be an Annotation object. The INPUT_METHOD_SEGMENT key serves to define text segments (usually words) that an input method operates on. The value of this attribute should be an Annotation object that contains null. Other classes may subclass this class and define other attribute keys that are useful in other circumstances or problem domains. See, for example, java.awt.font.TextAttribute in *Java Foundation Classes in a Nutshell* (O'Reilly).

```
public static class AttributedCharacterIterator.Attribute
        implements Serializable {
// Protected Constructors
     protected Attribute(String name);
// Public Constants
     public static final AttributedCharacterIterator.Attribute
        INPUT_METHOD_SEGMENT;
     public static final AttributedCharacterIterator.Attribute LANGUAGE;
     public static final AttributedCharacterIterator.Attribute READING;
// Public Methods Overriding Object
     public final boolean equals(Object obj);
     public final int hashCode( );
     public String toString( );
// Protected Instance Methods
     protected String getName( );
     protected Object readResolve( ) throws java.io.InvalidObjectException;
}
```

Subclasses

Format.Field

Passed To

AttributedCharacterIterator.{getAttribute( ), getrunLimit( ), getrunStart( )}, AttributedString.{addAttribute( ), AttributedString( ), getIterator( )}

Team LiB

AttributedString java.text

Java 1.2

This class represents text and associated attributes. An AttributedString can be defined in terms of an underlying AttributedCharacterIterator or an underlying String. Additional attributes can be specified with the addAttribute( ) and addAttributes( ) methods. getIterator( ) returns an AttributedCharacterIterator over the AttributedString or over a specified portion of the string. Note that two of the getIterator( ) methods take an array of Attribute keys as an argument. These methods return an AttributedCharacterIterator that ignores all attributes that are not in the specified array. If the array argument is null, however, the returned iterator contains all attributes.

```
public class AttributedString {
// Public Constructors
     public AttributedString(String text);
     public AttributedString(AttributedCharacterIterator text);
     public AttributedString(String text, java.util.Map<?
        extends AttributedCharacterIterator.Attribute,?> attributes);
     public AttributedString(AttributedCharacterIterator text, int beginIndex,
        int endIndex);
     public AttributedString(AttributedCharacterIterator text, int beginIndex,
        int endIndex, AttributedCharacterIterator.Attribute[ ] attributes);
// Public Instance Methods
     public void addAttribute(AttributedCharacterIterator.Attribute attribute,
        Object value);
     public void addAttribute(AttributedCharacterIterator.Attribute attribute,
        Object value, int beginIndex, int endIndex);
     public void addAttributes(java.util.Map<?
        extends AttributedCharacterIterator.Attribute,?> attributes,
        int beginIndex, int endIndex);
     public AttributedCharacterIterator getIterator( );
     public AttributedCharacterIterator
        getIterator(AttributedCharacterIterator.Attribute[ ] attributes);
     public AttributedCharacterIterator
        getIterator(AttributedCharacterIterator.Attribute[ ] attributes,
        int beginIndex, int endIndex);
}
```

Team LiB

Bidi java.text

Java 1.4

The Bidi class implements the " Unicode Version 3.0 Bidirectional Algorithm" for working with Arabic and Hebrew text in which letters run right-to-left and numbers run left-to-right. It is named after the first four letters of "bidirectional." A full description of the bidirectional text handling and the bidirectional algorithim is beyond the scope of this book, but the simplest use case for this class is outlined here. Create a Bidi object by passing an AttributedCharacterIterator or a String and one of the DIRECTION constants (to indicate the base direction of the text) to the Bidi( ) constructor. Or use createLineBidi( ) to return a substring of an existing Bidi object (this is usually done when formatting a paragraph of text to fit on individual lines).

Once you have a Bidi object, use isLeftToRight( ) and isRightToLeft( ) to determine whether all the text has the same direction. If both of these methods return false (which is the same as isMixed( ) returning TRue) then you cannot treat the text as a single run of uni-directional text. In this case, you must break it into two or more runs of unidirectional text. getrunCount( ) returns the number of distinct runs of text. For each such numbered run, getrunStart( ) returns the index of the first character of the run, and geTRunLimit( ) returns the index of the first character past the end of the run. getrunLevel( ) returns the *level* of the text, which is an integer that represents the direction and nesting level of the text. Even levels represent left-to-right text, and odd levels represent right-to-left text. The level divided by two is the nesting level of the text. For example, left to-right text embedded within right-to-left text has a level of 2.

```
public final class Bidi {
// Public Constructors
     public Bidi(AttributedCharacterIterator paragraph);
     public Bidi(String paragraph, int flags);
     public Bidi(char[ ] text, int textStart, byte[ ] embeddings,
        int embStart, int paragraphLength, int flags);
// Public Constants
     public static final int DIRECTION_DEFAULT_LEFT_TO_RIGHT;            =-2
     public static final int DIRECTION_DEFAULT_RIGHT_TO_LEFT;            =-1
     public static final int DIRECTION_LEFT_TO_RIGHT;                    =0
     public static final int DIRECTION_RIGHT_TO_LEFT;                    =1
// Public Class Methods
     public static void reorderVisually(byte[ ] levels, int levelStart,
        Object[ ] objects, int objectStart, int count);
     public static boolean requiresBidi(char[ ] text, int start, int limit);
// Public Instance Methods
     public boolean baseIsLeftToRight( );
     public Bidi createLineBidi(int lineStart, int lineLimit);
     public int getBaseLevel( );
     public int getLength( );
     public int getLevelAt(int offset);
```

```
    public int getRunCount( );
    public int getRunLevel(int run);
    public int getRunLimit(int run);
    public int getRunStart(int run);
    public boolean isLeftToRight( );
    public boolean isMixed( );
    public boolean isRightToLeft( );
// Public Methods Overriding Object
    public String toString( );
}
```

Team LiB

BreakIterator java.text

Java 1.1 *cloneable*

This class determines character, word, sentence, and line breaks in a block of text in a way that is independent of locale and text encoding. As an abstract class, `BreakIterator` cannot be instantiated directly. Instead, you must use one of the class methods `getCharacterInstance( )`, `getWordInstance( )`, `getSentenceInstance( )`, or `getLineInstance( )` to return an instance of a nonabstract subclass of `BreakIterator`. These various factory methods return a `BreakIterator` object that is configured to locate the requested boundary types and is localized to work for the optionally specified locale.

Once you have obtained an appropriate `BreakIterator` object, use `setText( )` to specify the text in which to locate boundaries. To locate boundaries in a Java `String` object, simply specify the string. To locate boundaries in text that uses some other encoding, you must specify a `CharacterIterator` object for that text so that the `BreakIterator` object can locate the individual characters of the text. Having set the text to be searched, you can determine the character positions of characters, words, sentences, or line breaks with the `first( )`, `last( )`, `next( )`, `previous( )`, `current( )`, and `following( )` methods, which perform the obvious functions. Note that these methods do not return text itself, but merely the position of the appropriate word, sentence, or line break.

Figure 15-2. java.text.BreakIterator

```
public abstract class BreakIterator implements Cloneable {
// Protected Constructors
     protected BreakIterator( );
// Public Constants
     public static final int DONE;                                      =-1
// Public Class Methods
     public static java.util.Locale[ ] getAvailableLocales( );     synchronized
     public static BreakIterator getCharacterInstance( );
     public static BreakIterator getCharacterInstance(java.util.Locale where);
     public static BreakIterator getLineInstance( );
     public static BreakIterator getLineInstance(java.util.Locale where);
     public static BreakIterator getSentenceInstance( );
     public static BreakIterator getSentenceInstance(java.util.Locale where);
     public static BreakIterator getWordInstance( );
     public static BreakIterator getWordInstance(java.util.Locale where);
// Protected Class Methods
5.0  protected static int getInt(byte[ ] buf, int offset);
```

```
5.0  protected static long getLong(byte[ ] buf, int offset);
5.0  protected static short getShort(byte[ ] buf, int offset);
// Public Instance Methods
     public abstract int current( );
     public abstract int first( );
     public abstract int following(int offset);
     public abstract CharacterIterator getText( );
1.2  public boolean isBoundary(int offset);
     public abstract int last( );
     public abstract int next( );
     public abstract int next(int n);
1.2  public int preceding(int offset);
     public abstract int previous( );
     public void setText(String newText);
     public abstract void setText(CharacterIterator newText);
// Public Methods Overriding Object
     public Object clone( );
}
```

Team LiB

CharacterIterator java.text

Java 1.1 *cloneable*

This interface defines an API for portably iterating through the characters that make up a string of text, regardless of the encoding of that text. Such an API is necessary because the number of bytes per character is different for different encodings, and some encodings even use variable-width characters within the same string of text. In addition to allowing iteration, a class that implements the `CharacterIterator` interface for non-Unicode text also performs translation of characters from their native encoding to standard Java Unicode characters.

`CharacterIterator` is similar to `java.util.Enumeration`, but is somewhat more complex than that interface. The `first( )` and `last( )` methods return the first and last characters in the text, and the `next( )` and `prev( )` methods allow you to loop forward or backwards through the characters of the text. These methods return the `DONE` constant when they go beyond the first or last character in the text; a test for this constant can be used to terminate a loop. The `CharacterIterator` interface also allows random access to the characters in a string of text. The `getBeginIndex( )` and `getEndIndex( )` methods return the character positions for the start and end of the string, and `setIndex( )` sets the current position. `getIndex( )` returns the index of the current position, and `current( )` returns the character at that position.

Figure 15-3. java.text.CharacterIterator

```
public interface CharacterIterator extends Cloneable {
// Public Constants
     public static final char DONE;        = \uFFFF
// Public Instance Methods
     Object clone( );
     char current( );
     char first( );
     int getBeginIndex( );
     int getEndIndex( );
     int getIndex( );
     char last( );
     char next( );
     char previous( );
     char setIndex(int position);
}
```

Implementations

`AttributedCharacterIterator`, `StringCharacterIterator`

Passed To

`BreakIterator.setText( )`, `CollationElementIterator.setText( )`, `RuleBasedCollator.getCollationElementIterator( )`

Returned By

`BreakIterator.getText( )`

Team LiB

ChoiceFormat java.text

Java 1.1 *cloneable serializable*

This class is a subclass of `Format` that converts a number to a `String` in a way reminiscent of a `switch` statement or an enumerated type. Each `ChoiceFormat` object has an array of doubles known as its *limits* and an array of strings known as its *formats*. When the `format( )` method is called to format a number `x`, the `ChoiceFormat` finds an index `i` such that:

```
limits[i] <= x < limits[i+1]
```

If `x` is less than the first element of the array, the first element is used, and if it is greater than the last, the last element is used. Once the index `i` has been determined, it is used as the index into the array of strings, and the indexed string is returned as the result of the `format( )` method.

A `ChoiceFormat` object may also be created by encoding its limits and formats into a single string known as its *pattern*. A typical pattern looks like the one below, used to return the singular or plural form of a word based on the numeric value passed to the `format( )` method:

```
ChoiceFormat cf = new ChoiceFormat("0#errors|1#error|2#errors");
```

A `ChoiceFormat` object created in this way returns the string "errors" when it formats the number 0 or any number greater than or equal to 2. It returns "error" when it formats the number 1. In the syntax shown here, note the pound sign (`#`) used to separate the limit number from the string that corresponds to that case and the vertical bar (`|`) used to separate the individual cases. You can use the `applyPattern( )` method to change the pattern used by a `ChoiceFormat` object; use `toPattern( )` to query the pattern it uses.

Figure 15-4. java.text.ChoiceFormat

```
public class ChoiceFormat extends NumberFormat {
// Public Constructors
     public ChoiceFormat(String newPattern);
     public ChoiceFormat(double[ ] limits, String[ ] formats);
// Public Class Methods
     public static final double nextDouble(double d);
     public static double nextDouble(double d, boolean positive);
```

```
    public static final double previousDouble(double d);
// Public Instance Methods
    public void applyPattern(String newPattern);
    public Object[ ] getFormats( );
    public double[ ] getLimits( );
    public void setChoices(double[ ] limits, String[ ] formats);
    public String toPattern( );
// Public Methods Overriding NumberFormat
    public Object clone( );
    public boolean equals(Object obj);
    public StringBuffer format(long number, StringBuffer toAppendTo,
       FieldPosition status);
    public StringBuffer format(double number, StringBuffer toAppendTo,
       FieldPosition status);
    public int hashCode( );
    public Number parse(String text, ParsePosition status);
}
```

CollationElementIterator java.text

Java 1.1

A `CollationElementIterator` object is returned by the `getCollationElementIterator( )` method of the `RuleBasedCollator` object. The purpose of this class is to allow a program to iterate (with the `next( )` method) through the characters of a string, returning ordering values for each of the collation keys in the string. Note that collation keys are not exactly the same as characters. In the traditional Spanish collation order, for example, the two-character sequence "ch" is treated as a single collation key that comes alphabetically between the letters "c" and "d." The value returned by the `next( )` method is the collation order of the next collation key in the string. This numeric value can be directly compared to the value returned by `next( )` for other `CollationElementIterator` objects. The value returned by `next( )` can also be decomposed into primary, secondary, and tertiary ordering values with the static methods of this class. This class is used by `RuleBasedCollator` to implement its `compare( )` method and to create `CollationKey` objects. Few applications ever need to use it directly.

```
public final class CollationElementIterator {
// No Constructor
// Public Constants
     public static final int NULLORDER;                              =-1
// Public Class Methods
     public static final int primaryOrder(int order);
     public static final short secondaryOrder(int order);
     public static final short tertiaryOrder(int order);
// Public Instance Methods
1.2  public int getMaxExpansion(int order);
1.2  public int getOffset( );
     public int next( );
1.2  public int previous( );
     public void reset( );
1.2  public void setOffset(int newOffset);
1.2  public void setText(String source);
1.2  public void setText(CharacterIterator source);
}
```

Returned By

`RuleBasedCollator.getCollationElementIterator( )`

Team LiB

CollationKey java.text

Java 1.1 *comparable*

CollationKey objects compare strings more quickly than is possible with Collation.compare( ). Objects of this class are returned by Collation.getCollationKey( ). To compare two CollationKey objects, invoke the compareTo( ) method of key A, passing the key B as an argument (both CollationKey objects must be created through the same Collation object). The return value of this method is less than zero if the key A is collated before the key B, equal to zero if they are equivalent for the purposes of collation, or greater than zero if the key A is collated after the key B. Use getSourceString( ) to obtain the string represented by a CollationKey.

Figure 15-5. java.text.CollationKey

```
public final class CollationKey implements Comparable<CollationKey> {
// No Constructor
// Public Instance Methods
     public int compareTo(CollationKey target);    Implements:Comparable
     public String getSourceString( );
     public byte[ ] toByteArray( );
// Methods Implementing Comparable
     public int compareTo(CollationKey target);
// Public Methods Overriding Object
     public boolean equals(Object target);
     public int hashCode( );
}
```

Returned By

Collator.getCollationKey( ), RuleBasedCollator.getCollationKey( )

Collator java.text

Java 1.1 *cloneable*

This class compares, orders, and sorts strings in a way appropriate for the default locale or some other specified locale. Because it is an abstract class, it cannot be instantiated directly. Instead, you must use the static `getInstance( )` method to obtain an instance of a `Collator` subclass that is appropriate for the default or specified locale. You can use `getAvailableLocales( )` to determine whether a `Collator` object is available for a desired locale.

Once an appropriate `Collator` object has been obtained, you can use the `compare( )` method to compare strings. The possible return values of this method are -1, 0, and 1, which indicate, respectively, that the first string is collated before the second, that the two are equivalent for collation purposes, and that the first string is collated after the second. The `equals( )` method is a convenient shortcut for testing two strings for collation equivalence.

When sorting an array of strings, each string in the array is typically compared more than once. Using the `compare( )` method in this case is inefficient. A more efficient method for comparing strings multiple times is to use `getCollationKey( )` for each string to create `CollationKey` objects. These objects can then be compared to each other more quickly than the strings themselves can be compared.

You can customize the way the `Collator` object performs comparisons by calling `setStrength( )`. If you pass the constant `PRIMARY` to this method, the comparison looks only at primary differences in the strings; it compares letters but ignores accents and case differences. If you pass the constant `SECONDARY`, it ignores case differences but does not ignore accents. And if you pass `TERTIARY` (the default), the `Collator` object takes both accents and case differences into account in its comparison.

Figure 15-6. java.text.Collator

```
public abstract class Collator implements java.util.Comparator<Object>,
        Cloneable {
// Protected Constructors
     protected Collator( );
// Public Constants
     public static final int CANONICAL_DECOMPOSITION;                    =1
     public static final int FULL_DECOMPOSITION;                         =2
     public static final int IDENTICAL;                                  =3
     public static final int NO_DECOMPOSITION;                           =0
```

```
     public static final int PRIMARY;                                  =0
     public static final int SECONDARY;                                =1
     public static final int TERTIARY;                                 =2
// Public Class Methods
     public static java.util.Locale[ ] getAvailableLocales( );   synchronized
     public static Collator getInstance( );                 synchronized
     public static Collator
        getInstance(java.util.Locale desiredLocale);     synchronized
// Public Instance Methods
     public abstract int compare(String source, String target);
     public boolean equals(Object that);    Implements:Comparator
     public boolean equals(String source, String target);
     public abstract CollationKey getCollationKey(String source);
     public int getDecomposition( );                 synchronized
     public int getStrength( );                synchronized
     public void setDecomposition(int decompositionMode);   synchronized
     public void setStrength(int newStrength);              synchronized
// Methods Implementing Comparator
1.2  public int compare(Object o1, Object o2);
     public boolean equals(Object that);
// Public Methods Overriding Object
     public Object clone( );
     public abstract int hashCode( );
}
```

Subclasses

RuleBasedCollator

DateFormat java.text

Java 1.1 *cloneable serializable*

This class formats and parses dates and times in a locale-specific way. As an abstract class, it cannot be instantiated directly, but it provides a number of static methods that return instances of a concrete subclass you can use to format dates in a variety of ways. The getdateInstance( ) methods return a DateFormat object suitable for formatting dates in either the default locale or a specified locale. A formatting style may also optionally be specified; the constants FULL, LONG, MEDIUM, SHORT, and DEFAULT specify this style. Similarly, the getTimeInstance( ) methods return a DateFormat object that formats and parses times, and the geTDateTimeInstance( ) methods return a DateFormat object that formats both dates and times. These methods also optionally take a format style constant and a Locale. Finally, getInstance( ) returns a default DateFormat object that formats both dates and times in the SHORT format.

Once you have created a DateFormat object, you can use the setCalendar( ) and setTimeZone( ) methods if you want to format the date using a calendar or time zone other than the default. The various format( ) methods convert java.util.Date objects to strings using whatever format is encapsulated in the DateFormat object. The parse( ) and parseObject( ) methods perform the reverse operation; they parse a string formatted according to the rules of the DateFormat object and convert it into to a Date object. The DEFAULT, FULL, MEDIUM, LONG, and SHORT constants specify how verbose or compact the formatted date or time should be. The remaining constants, which all end with _FIELD, specify various fields of formatted dates and times and are used with the FieldPosition object that is optionally passed to format( ).

Figure 15-7. java.text.DateFormat

```
public abstract class DateFormat extends Format {
// Protected Constructors
     protected DateFormat( );
// Public Constants
     public static final int AM_PM_FIELD;                          =14
     public static final int DATE_FIELD;                           =3
     public static final int DAY_OF_WEEK_FIELD;                    =9
     public static final int DAY_OF_WEEK_IN_MONTH_FIELD;           =11
     public static final int DAY_OF_YEAR_FIELD;                    =10
     public static final int DEFAULT;                              =2
     public static final int ERA_FIELD;                            =0
     public static final int FULL;                                 =0
```

```
     public static final int HOUR0_FIELD;                                         =16
     public static final int HOUR1_FIELD;                                         =15
     public static final int HOUR_OF_DAY0_FIELD;                                  =5
     public static final int HOUR_OF_DAY1_FIELD;                                  =4
     public static final int LONG;                                                =1
     public static final int MEDIUM;                                              =2
     public static final int MILLISECOND_FIELD;                                   =8
     public static final int MINUTE_FIELD;                                        =6
     public static final int MONTH_FIELD;                                         =2
     public static final int SECOND_FIELD;                                        =7
     public static final int SHORT;                                               =3
     public static final int TIMEZONE_FIELD;                                      =17
     public static final int WEEK_OF_MONTH_FIELD;                                 =13
     public static final int WEEK_OF_YEAR_FIELD;                                  =12
     public static final int YEAR_FIELD;                                          =1
// Nested Types
1.4  public static class Field extends Format.Field;
// Public Class Methods
     public static java.util.Locale[ ] getAvailableLocales( );
     public static final DateFormat getDateInstance( );
     public static final DateFormat getDateInstance(int style);
     public static final DateFormat getDateInstance(int style,
        java.util.Locale aLocale);
     public static final DateFormat getDateTimeInstance( );
     public static final DateFormat getDateTimeInstance(int dateStyle,
        int timeStyle);
     public static final DateFormat getDateTimeInstance(int dateStyle,
        int timeStyle, java.util.Locale aLocale);
     public static final DateFormat getInstance( );
     public static final DateFormat getTimeInstance( );
     public static final DateFormat getTimeInstance(int style);
     public static final DateFormat getTimeInstance(int style,
        java.util.Locale aLocale);
// Public Instance Methods
     public final String format(java.util.Date date);
     public abstract StringBuffer format(java.util.Date date,
        StringBuffer toAppendTo, FieldPosition fieldPosition);
     public java.util.Calendar getCalendar( );
     public NumberFormat getNumberFormat( );
     public java.util.TimeZone getTimeZone( );
     public boolean isLenient( );
     public java.util.Date parse(String source) throws ParseException;
     public abstract java.util.Date parse(String source, ParsePosition pos);
     public void setCalendar(java.util.Calendar newCalendar);
     public void setLenient(boolean lenient);
     public void setNumberFormat(NumberFormat newNumberFormat);
     public void setTimeZone(java.util.TimeZone zone);
// Public Methods Overriding Format
     public Object clone( );
```

```
    public final StringBuffer format(Object obj, StringBuffer toAppendTo,
       FieldPosition fieldPosition);
    public Object parseObject(String source, ParsePosition pos);
// Public Methods Overriding Object
    public boolean equals(Object obj);
    public int hashCode( );
// Protected Instance Fields
    protected java.util.Calendar calendar;
    protected NumberFormat numberFormat;
}
```

Subclasses

SimpleDateFormat

Team LiB

DateFormat.Field java.text

Java 1.4 *serializable*

This class defines a typesafe enumeration of `AttributedCharacterIterator.Attribute` objects that may be used by the `AttributedCharacterIterator` returned by the `formatToCharacterIterator( )` inherited from `Format`, or that may be used when creating a `FieldPosition` object with which to obtain the bounds of a specific date field in formatted output. Note that the constants defined by this class correspond closely to the integer constants defined by `java.util.Calendar`, and that this class defines methods for converting between the two sets of constants.

```
public static class DateFormat.Field extends Format.Field {
// Protected Constructors
     protected Field(String name, int calendarField);
// Public Constants
     public static final DateFormat.Field AM_PM;
     public static final DateFormat.Field DAY_OF_MONTH;
     public static final DateFormat.Field DAY_OF_WEEK;
     public static final DateFormat.Field DAY_OF_WEEK_IN_MONTH;
     public static final DateFormat.Field DAY_OF_YEAR;
     public static final DateFormat.Field ERA;
     public static final DateFormat.Field HOUR0;
     public static final DateFormat.Field HOUR1;
     public static final DateFormat.Field HOUR_OF_DAY0;
     public static final DateFormat.Field HOUR_OF_DAY1;
     public static final DateFormat.Field MILLISECOND;
     public static final DateFormat.Field MINUTE;
     public static final DateFormat.Field MONTH;
     public static final DateFormat.Field SECOND;
     public static final DateFormat.Field TIME_ZONE;
     public static final DateFormat.Field WEEK_OF_MONTH;
     public static final DateFormat.Field WEEK_OF_YEAR;
     public static final DateFormat.Field YEAR;
// Public Class Methods
     public static DateFormat.Field ofCalendarField(int);
// Public Instance Methods
     public int getCalendarField( );
// Protected Methods Overriding AttributedCharacterIterator.Attribute
     protected Object readResolve( ) throws java.io.InvalidObjectException;
}
```

Team LiB

DateFormatSymbols java.text

Java 1.1 *cloneable serializable*

This class defines accessor methods for the various pieces of data, such as names of months and days, used by `SimpleDateFormat` to format and parse dates and times. You do not typically need to use this class unless you are formatting dates for an unsupported locale or in some highly customize way.

Figure 15-8. java.text.DateFormatSymbols


```
public class DateFormatSymbols implements Cloneable, Serializable {
// Public Constructors
     public DateFormatSymbols( );
     public DateFormatSymbols(java.util.Locale locale);
// Public Instance Methods
     public String[ ] getAmPmStrings( );
     public String[ ] getEras( );
     public String getLocalPatternChars( );
     public String[ ] getMonths( );
     public String[ ] getShortMonths( );
     public String[ ] getShortWeekdays( );
     public String[ ] getWeekdays( );
     public String[ ][ ] getZoneStrings( );
     public void setAmPmStrings(String[ ] newAmpms);
     public void setEras(String[ ] newEras);
     public void setLocalPatternChars(String newLocalPatternChars);
     public void setMonths(String[ ] newMonths);
     public void setShortMonths(String[ ] newShortMonths);
     public void setShortWeekdays(String[ ] newShortWeekdays);
     public void setWeekdays(String[ ] newWeekdays);
     public void setZoneStrings(String[ ][ ] newZoneStrings);
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Passed To

`SimpleDateFormat.{setDateFormatSymbols( )`, `SimpleDateFormat( )}`

Returned By

`SimpleDateFormat.getDateFormatSymbols( )`

Team LiB

Team LiB

DecimalFormat java.text

Java 1.1 *cloneable serializable*

This is the concrete Format class used by NumberFormat for all locales that use base 10 numbers. Most applications do not need to use this class directly; they can use the static methods of NumberFormat to obtain a default NumberFormat object for a desired locale and then perform minor locale-independent customizations on that object.

Applications that require highly customized number formatting and parsing may create custom DecimalFormat objects by passing a suitable pattern to the DecimalFormat( ) constructor method. The applyPattern( ) method can change this pattern. A pattern consists of a string of characters from the table below. For example:

```
"$#,##0.00;($#,##0.00)"
```

Character	Meaning
#	A digit; zeros show as absent.
0	A digit; zeros show as 0.
.	The locale-specific decimal separator.
,	The locale-specific grouping separator (comma).
-	The locale-specific negative prefix.
%	Shows value as a percentage.
;	Separates positive number format (on left) from optiona negative number format (on right).
'	Quotes a reserved character, so it appears literally in the output (apostrophe).
other	Appears literally in output.

A DecimalFormatSymbols object can be specified optionally when creating a DecimalFormat object. If one is not specified, a DecimalFormatSymbols object suitable for the default locale is used.

In Java 5.0, DecimalFormat can return java.math.BigDecimal values from its parse( ) method. Call setParseBigDecimal( ) to enable this feature. This is useful when working with very large numbers, very precise numbers, or financial applications that use BigDecimal to avoid rounding errors.

Figure 15-9. java.text.DecimalFormat


```
public class DecimalFormat extends NumberFormat {
// Public Constructors
     public DecimalFormat( );
     public DecimalFormat(String pattern);
     public DecimalFormat(String pattern, DecimalFormatSymbols symbols);
// Public Instance Methods
     public void applyLocalizedPattern(String pattern);
     public void applyPattern(String pattern);
     public DecimalFormatSymbols getDecimalFormatSymbols( );
     public int getGroupingSize( );                         default:3
     public int getMultiplier( );                           default:1
     public String getNegativePrefix( );                    default:"-"
     public String getNegativeSuffix( );                    default:""
     public String getPositivePrefix( );                    default:""
     public String getPositiveSuffix( );                    default:""
     public boolean isDecimalSeparatorAlwaysShown( );       default:false
5.0  public boolean isParseBigDecimal( );    default:false
     public void setDecimalFormatSymbols(DecimalFormatSymbols newSymbols);
     public void setDecimalSeparatorAlwaysShown(boolean newValue);
     public void setGroupingSize(int newValue);
     public void setMultiplier(int newValue);
     public void setNegativePrefix(String newValue);
     public void setNegativeSuffix(String newValue);
5.0  public void setParseBigDecimal(boolean newValue);
     public void setPositivePrefix(String newValue);
     public void setPositiveSuffix(String newValue);
     public String toLocalizedPattern( );
     public String toPattern( );
// Public Methods Overriding NumberFormat
     public Object clone( );
     public boolean equals(Object obj);
5.0  public final StringBuffer format(Object number, StringBuffer toAppendTo,
        FieldPosition pos);
     public StringBuffer format(double number, StringBuffer result,
        FieldPosition fieldPosition);
     public StringBuffer format(long number, StringBuffer result,
        FieldPosition fieldPosition);
1.4  public java.util.Currency getCurrency( );
5.0  public int getMaximumFractionDigits( ); default:3
5.0  public int getMaximumIntegerDigits( );          default:2147483647
5.0  public int getMinimumFractionDigits( );         default:0
5.0  public int getMinimumIntegerDigits( );          default:1
     public int hashCode( );
```

```
     public Number parse(String text, ParsePosition pos);
1.4  public void setCurrency(java.util.Currency currency);
1.2  public void setMaximumFractionDigits(int newValue);
1.2  public void setMaximumIntegerDigits(int newValue);
1.2  public void setMinimumFractionDigits(int newValue);
1.2  public void setMinimumIntegerDigits(int newValue);
// Public Methods Overriding Format
1.4  public AttributedCharacterIterator formatToCharacterIterator(Object obj);
}
```

DecimalFormatSymbols java.text

Java 1.1 *cloneable serializable*

This class defines the various characters and strings, such as the decimal point, percent sign, and thousands separator, used by `DecimalFormat` when formatting numbers. You do not typically use this class directly unless you are formatting dates for an unsupported locale or in some highly customized way.

Figure 15-10. java.text.DecimalFormatSymbols


```
public final class DecimalFormatSymbols implements Cloneable, Serializable {
// Public Constructors
     public DecimalFormatSymbols( );
     public DecimalFormatSymbols(java.util.Locale locale);
// Public Instance Methods
1.4  public java.util.Currency getCurrency( );
1.2  public String getCurrencySymbol( );    default:"$"
     public char getDecimalSeparator( );                          default:.
     public char getDigit( );                                     default:#
     public char getGroupingSeparator( );                         default:,
     public String getInfinity( );                                default:"\u221E"
1.2  public String getInternationalCurrencySymbol( );   default:"USD"
     public char getMinusSign( );                                 default:-
1.2  public char getMonetaryDecimalSeparator( );   default:.
     public String getNaN( );                                     default:"\uFFFD"
     public char getPatternSeparator( );                          default:;
     public char getPercent( );                                   default:%
     public char getPerMill( );                                   default:\u2030
     public char getZeroDigit( );                                 default:0
1.4  public void setCurrency(java.util.Currency currency);
1.2  public void setCurrencySymbol(String currency);
     public void setDecimalSeparator(char decimalSeparator);
     public void setDigit(char digit);
     public void setGroupingSeparator(char groupingSeparator);
     public void setInfinity(String infinity);
1.2  public void setInternationalCurrencySymbol(String currencyCode);
     public void setMinusSign(char minusSign);
```

```
1.2  public void setMonetaryDecimalSeparator(char sep);
     public void setNaN(String NaN);
     public void setPatternSeparator(char patternSeparator);
     public void setPercent(char percent);
     public void setPerMill(char perMill);
     public void setZeroDigit(char zeroDigit);
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Passed To

DecimalFormat.{DecimalFormat( ), setDecimalFormatSymbols( )}

Returned By

DecimalFormat.getDecimalFormatSymbols( )

FieldPosition java.text

Java 1.1

FieldPosition objects are optionally passed to the format( ) methods of the Format class and its subclasses to return information about the start and end positions of a specific part or "field" of the formatted string. This kind of information is often useful for aligning formatted strings in columnsfor example, aligning the decimal points in a column of numbers.

The field of interest is specified when the FieldPosition( ) constructor is called. The NumberFormat and DateFormat classes define integer various constants (which end with the string _FIELD) that can be used here. In Java 1.4 and later you can also construct a FieldPosition by specifying the Format.Field object that identifies the field. (For constant Field instances, see DateFormat.Field, MessageFormat.Field and NumberFormat.Field.)

After a FieldPosition has been created and passed to a format( ) method, use getBeginIndex( ) and getEndIndex( ) methods of this class to obtain the starting and ending character positions of the desired field of the formatted string.

```
public class FieldPosition {
// Public Constructors
1.4  public FieldPosition(Format.Field attribute);
     public FieldPosition(int field);
1.4  public FieldPosition(Format.Field attribute, int fieldID);
// Public Instance Methods
     public int getBeginIndex( );
     public int getEndIndex( );
     public int getField( );
1.4  public Format.Field getFieldAttribute( );
1.2  public void setBeginIndex(int bi);
1.2  public void setEndIndex(int ei);
// Public Methods Overriding Object
1.2  public boolean equals(Object obj);
1.2  public int hashCode( );
1.2  public String toString( );
}
```

Passed To

ChoiceFormat.format( ), DateFormat.format( ), DecimalFormat.format( ), Format.format( ), MessageFormat.format( ), NumberFormat.format( ), SimpleDateFormat.format( )

Format java.text

Java 1.1 *cloneable serializable*

This abstract class is the base class for all number, date, and string formatting classes in the `java.text` package. It defines the key formatting and parsing methods that are implemented by all subclasses. `format( )` converts an object to a string using the formatting rules encapsulated by the `Format` subclass and optionally appends the resulting string to an existing `StringBuffer`. `parseObject( )` performs the reverse operation; it parses a formatted string and returns the corresponding object. Status information for these two operations is returned in `FieldPosition` and `ParsePosition` objects.

Java 1.4 defined a variant on the `format( )` method. `formatToCharacterIterator( )` performs the same formating operation as `format( )` but returns the result as an `AtttributedCharacterIterator` which uses attributes to identify the various parts (such the integer part, the decimal separtator, and the fractional part of a formatted number) of the formatted string. The attribute keys are all instances of the `Format.Field` inner class. Each of the `Format` subclasses define a `Field` subclass that defines a set of `Field` constants, (such as `NumberFormat.Field.DECIMAL_SEPARATOR`) for use by the character iterator returned by this method. See `ChoiceFormat`, `DateFormat`, `MessageFormat`, and `NumberFormat` for subclasses that perform specific types of formatting.

Figure 15-11. java.text.Format

```
public abstract class Format implements Cloneable, Serializable {
// Public Constructors
     public Format( );
// Nested Types
1.4  public static class Field extends AttributedCharacterIterator.Attribute;
// Public Instance Methods
     public final String format(Object obj);
     public abstract StringBuffer format(Object obj, StringBuffer toAppendTo,
        FieldPosition pos);
1.4  public AttributedCharacterIterator formatToCharacterIterator(Object obj);
     public Object parseObject(String source) throws ParseException;
     public abstract Object parseObject(String source, ParsePosition pos);
// Public Methods Overriding Object
     public Object clone( );
}
```

Subclasses

DateFormat, MessageFormat, NumberFormat

Passed To

MessageFormat.{setFormat( ), setFormatByArgumentIndex( ), setFormats( ), setFormatsByArgumentIndex( )}

Returned By

MessageFormat.{getFormats( ), getFormatsByArgumentIndex( )}

Format.Field java.text

Java 1.4 *serializable*

This inner class extends `AttributedCharacterIterator.Attribute` and serves as the common superclass for `DateFormat.Field`, `MessageFormat.Field`, and `NumberFormat.Field`. See those specific subclasses for details.

```
public static class Format.Field extends AttributedCharacterIterator.Attribute {
// Protected Constructors
     protected Field(String name);
}
```

Subclasses

`DateFormat.Field`, `MessageFormat.Field`, `NumberFormat.Field`

Passed To

`FieldPosition.FieldPosition( )`

Returned By

`FieldPosition.getFieldAttribute( )`

MessageFormat java.text

Java 1.1 *cloneable serializable*

This class formats and substitutes objects into specified positions in a message string (also known as the pattern string). It provides the closest Java equivalent to the `printf( )` function of the C programming language. If a message is to be displayed only a single time, the simplest way to use the `MessageFormat` class is through the static `format( )` method. This method is passed a message or pattern string and an array of argument objects to be formatted and substituted into the string. If the message is to be displayed several times, it makes more sense to create a `MessageFormat` object, supplying the pattern string, and then call the `format( )` instance method of this object, supplying the array of objects to be formatted into the message.

The message or pattern string used by the `MessageFormat` contains digits enclosed in curly braces to indicate where each argument should be substituted. The sequence "`{0}`" indicates that the first object should be converted to a string (if necessary) and inserted at that point, while the sequence "`{3}`" indicates that the fourth object should be inserted. If the object to be inserted is not a string, `MessageFormat` checks to see if it is a `Date` or a subclass of `Number`. If so, it uses a default `DateFormat` or `NumberFormat` object to convert the value to a string. If not, it simply invokes the object's `toString( )` method to convert it.

A digit within curly braces in a pattern string may be followed optionally by a comma, and one of the words "date", "time", "number", or "choice", to indicate that the corresponding argument should be formatted as a date, time, number, or choice before being substituted into the pattern string. Any of these keywords can additionally be followed by a comma and additional pattern information to be used in formatting the date, time, number, or choice. (See `SimpleDateFormat`, `DecimalFormat`, and `ChoiceFormat` for more information.)

You can pass a `Locale` to the constructor or call `setLocale( )` to specify a nondefault locale that the `MessageFormat` should use when obtaining `DateFormat` and `NumberFormat` objects to format dates, time, and numbers inserted into the pattern. You can change the `Format` object used at a particular position in the pattern with the `setFormat( )` method, or change all `Format` objects with `setFormats( )`. Both of these methods depend on the order of in which arguments are displayed in the pattern string. The pattern string is often subject to localization and the arguments may appear in different orders in different localizations of the pattern. Therefore, in Java 1.4 and later it is usually more convenient to use the "ByArgumentIndex" versions of the `setFormat( )`, `setFormats( )` methods, and `getFormats( )` methods.

You can set a new pattern for the `MessageFormat` object by calling `applyPattern( )`, and you can obtain a string that represents the current formatting pattern by calling `toPattern( )`. `MessageFormat` also supports a `parse( )` method that can parse an array of objects out of a specified string, according to the specified pattern.

Figure 15-12. java.text.MessageFormat


```
public class MessageFormat extends Format {
// Public Constructors
     public MessageFormat(String pattern);
1.4  public MessageFormat(String pattern, java.util.Locale locale);
// Nested Types
1.4  public static class Field extends Format.Field;
// Public Class Methods
     public static String format(String pattern, Object... arguments);
// Public Instance Methods
     public void applyPattern(String pattern);
     public final StringBuffer format(Object[ ] arguments, StringBuffer result,
        FieldPosition pos);
     public Format[ ] getFormats( );
1.4  public Format[ ] getFormatsByArgumentIndex( );
     public java.util.Locale getLocale( );
     public Object[ ] parse(String source) throws ParseException;
     public Object[ ] parse(String source, ParsePosition pos);
     public void setFormat(int formatElementIndex, Format newFormat);
1.4  public void setFormatByArgumentIndex(int argumentIndex, Format newFormat);
     public void setFormats(Format[ ] newFormats);
1.4  public void setFormatsByArgumentIndex(Format[ ] newFormats);
     public void setLocale(java.util.Locale locale);
     public String toPattern( );
// Public Methods Overriding Format
     public Object clone( );
     public final StringBuffer format(Object arguments, StringBuffer result,
        FieldPosition pos);
1.4  public AttributedCharacterIterator
        formatToCharacterIterator(Object arguments);
     public Object parseObject(String source, ParsePosition pos);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

MessageFormat.Field java.text

Java 1.4 *serializable*

This class defines an `ARGUMENT` `AttributedCharacterIterator.Attribute` constant that is be used by the `AttributedCharacterIterator` returned by `MessageFormat.formatToCharacterIterator( )` to identify portions of the formatted message that are derived from the arguments passed to `formatToCharacterIterator( )`. The value associated with this `ARGUMENT` attribute will be an `Integer` specifying the argument number.

```
public static class MessageFormat.Field extends Format.Field {
// Protected Constructors
     protected Field(String name);
// Public Constants
     public static final MessageFormat.Field ARGUMENT;
// Protected Methods Overriding AttributedCharacterIterator.Attribute
     protected Object readResolve( ) throws java.io.InvalidObjectException;
}
```

NumberFormat java.text

Java 1.1 *cloneable serializable*

This class formats and parses numbers in a locale-specific way. As an abstract class, it cannot be instantiated directly, but it provides a number of static methods that return instances of a concrete subclass you can use for formatting. The `getInstance( )` method returns a `NumberFormat` object suitable for normal formatting of numbers in either the default locale or in a specified locale. `getIntegerInstance( )`, `getCurrencyInstance( )`, and `getPercentInstance( )` return `NumberFormat` objects for formatting numbers that are integers, or represent monetary amounts or percentages. These methods return a `NumberFormat` suitable for the default locale, or for the specified `Locale` object. `getAvailableLocales( )` returns an array of locales for which `NumberFormat` objects are available. In Java 1.4 and later, use `setCurrency( )` to provide a `java.util.Currency` object for use when formating monetary values. Note that the `NumberFormat` class is not intended for the display of very large or very small numbers that require exponential notation, and it may not gracefully handle infinite or `NaN` (not-a-number) values.

Once you have created a suitable `NumberFormat` object, you can customize its localeindependent behavior with `setMaximumFractionDigits( )`, `setGroupingUsed( )`, and similar `set` methods. In order to customize the locale-dependent behavior, you can use `instanceof` to test if the `NumberFormat` object is an instance of `DecimalFormat`, and, if so, cast it to that type. The `DecimalFormat` class provides complete control over number formatting. Note, however, that a `NumberFormat` customized in this way may no longer be appropriate for the desired locale.

After creating and customizing a `NumberFormat` object, you can use the various `format( )` methods to convert numbers to strings or string buffers, and you can use the `parse( )` or `parseObject( )` methods to convert strings to numbers. You can also use the `formatToCharacterIterator( )` method inherited from `Format` (and overridden by `DecimalFormat`) in place of `format( )`. The constants defined by this class are to be used by the `FieldPosition` object.

Figure 15-13. java.text.NumberFormat

```
public abstract class NumberFormat extends Format {
// Public Constructors
     public NumberFormat( );
// Public Constants
     public static final int FRACTION_FIELD;                          =1
     public static final int INTEGER_FIELD;                           =0
// Nested Types
```

```
1.4  public static class Field extends Format.Field;
// Public Class Methods
     public static java.util.Locale[ ] getAvailableLocales( );
     public static final NumberFormat getCurrencyInstance( );
     public static NumberFormat getCurrencyInstance(java.util.Locale inLocale);
     public static final NumberFormat getInstance( );
     public static NumberFormat getInstance(java.util.Locale inLocale);
1.4  public static final NumberFormat getIntegerInstance( );
1.4  public static NumberFormat getIntegerInstance(java.util.Locale inLocale);
     public static final NumberFormat getNumberInstance( );
     public static NumberFormat getNumberInstance(java.util.Locale inLocale);
     public static final NumberFormat getPercentInstance( );
     public static NumberFormat getPercentInstance(java.util.Locale inLocale);
// Public Instance Methods
     public final String format(long number);
     public final String format(double number);
     public abstract StringBuffer format(long number, StringBuffer toAppendTo,
        FieldPosition pos);
     public abstract StringBuffer format(double number, StringBuffer toAppendTo,
        FieldPosition pos);
1.4  public java.util.Currency getCurrency( );
     public int getMaximumFractionDigits( );
     public int getMaximumIntegerDigits( );
     public int getMinimumFractionDigits( );
     public int getMinimumIntegerDigits( );
     public boolean isGroupingUsed( );
     public boolean isParseIntegerOnly( );
     public Number parse(String source) throws ParseException;
     public abstract Number parse(String source, ParsePosition parsePosition);
1.4  public void setCurrency(java.util.Currency currency);
     public void setGroupingUsed(boolean newValue);
     public void setMaximumFractionDigits(int newValue);
     public void setMaximumIntegerDigits(int newValue);
     public void setMinimumFractionDigits(int newValue);
     public void setMinimumIntegerDigits(int newValue);
     public void setParseIntegerOnly(boolean value);
// Public Methods Overriding Format
     public Object clone( );
     public StringBuffer format(Object number, StringBuffer toAppendTo,
        FieldPosition pos);
     public final Object parseObject(String source, ParsePosition pos);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Subclasses

ChoiceFormat, DecimalFormat

Passed To

DateFormat.setNumberFormat( )

Returned By

DateFormat.getNumberFormat( )

Type Of

DateFormat.numberFormat

NumberFormat.Field java.text

Java 1.4 *serializable*

This class defines a typesafe enumeration of `AttributedCharacterIterator.Attribute` objects that may be used by the `AttributedCharacterIterator` returned by `formatToCharacterIterator( )` method inherited from the `Format` class, or that may be used when creating a `FieldPosition` object to pass to `format( )` in order to obtain the bounds of a specific number field (such as the decimal point for aligning numbers) in formatted output.

```
public static class NumberFormat.Field extends Format.Field {
// Protected Constructors
     protected Field(String name);
// Public Constants
     public static final NumberFormat.Field CURRENCY;
     public static final NumberFormat.Field DECIMAL_SEPARATOR;
     public static final NumberFormat.Field EXPONENT;
     public static final NumberFormat.Field EXPONENT_SIGN;
     public static final NumberFormat.Field EXPONENT_SYMBOL;
     public static final NumberFormat.Field FRACTION;
     public static final NumberFormat.Field GROUPING_SEPARATOR;
     public static final NumberFormat.Field INTEGER;
     public static final NumberFormat.Field PERCENT;
     public static final NumberFormat.Field PERMILLE;
     public static final NumberFormat.Field SIGN;
// Protected Methods Overriding AttributedCharacterIterator.Attribute
     protected Object readResolve( ) throws java.io.InvalidObjectException;
}
```

ParseException java.text

Java 1.1 *serializable checked*

Signals that a string has an incorrect format and cannot be parsed. It is typically thrown by the `parse( )` or `parseObject( )` methods of `Format` and its subclasses, but is also thrown by certain methods in the `java.text` package that are passed patterns or other rules in string form. The `getErrorOffset( )` method of this class returns the character position at which the parsing error occurred in the offending string.

Figure 15-14. java.text.ParseException


```
public class ParseException extends Exception {
// Public Constructors
     public ParseException(String s, int errorOffset);
// Public Instance Methods
     public int getErrorOffset( );
}
```

Thrown By

`DateFormat.parse( )`, `Format.parseObject( )`, `MessageFormat.parse( )`, `NumberFormat.parse( )`, `RuleBasedCollator.RuleBasedCollator( )`

ParsePosition java.text

Java 1.1

ParsePosition objects are passed to the parse( ) and parseObject( ) methods of Format and its subclasses. The ParsePosition class represents the position in a string at which parsing should begin or at which parsing stopped. Before calling a parse( ) method, you can specify the starting position of parsing by passing the desired index to the ParsePosition( ) constructor or by calling the setIndex( ) of an existing ParsePosition object. When parse( ) returns, you can determine where parsing ended by calling getIndex( ). When parsing multiple objects or values from a string, a single ParsePosition object can be used sequentially.

```
public class ParsePosition {
// Public Constructors
     public ParsePosition(int index);
// Public Instance Methods
1.2  public int getErrorIndex( );
     public int getIndex( );
1.2  public void setErrorIndex(int ei);
     public void setIndex(int index);
// Public Methods Overriding Object
1.2  public boolean equals(Object obj);
1.2  public int hashCode( );
1.2  public String toString( );
}
```

Passed To

ChoiceFormat.parse( ), DateFormat.{parse( ), parseObject( )}, DecimalFormat.parse( ), Format.parseObject( ), MessageFormat.{parse( ), parseObject( )}, NumberFormat.{parse( ), parseObject( )}, SimpleDateFormat.parse( )

Team LiB

RuleBasedCollator java.text

Java 1.1 *cloneable*

This class is a concrete subclass of the abstract `Collator` class. It performs collations using a table of ru are specified in textual form. Most applications do not use this class directly; instead they call `Collator.getInstance( )` to obtain a `Collator` object (typically a `RuleBasedCollator` object) that implements the default collation order for a specified or default locale. You should need to use this class you are collating strings for a locale that is not supported by default or if you need to implement a highl customized collation order.

Figure 15-15. java.text.RuleBasedCollator


```
public class RuleBasedCollator extends Collator {
// Public Constructors
     public RuleBasedCollator(String rules) throws ParseException;
// Public Instance Methods
1.2  public CollationElementIterator getCollationElementIterator(CharacterIterator sour
     public CollationElementIterator getCollationElementIterator(String source);
     public String getRules( );
// Public Methods Overriding Collator
     public Object clone( );
     public int compare(String source, String target);                  synchronized
     public boolean equals(Object obj);
     public CollationKey getCollationKey(String source);                synchronized
     public int hashCode( );
}
```

Team LiB

SimpleDateFormat java.text

Java 1.1 *cloneable serializable*

This is the concrete Format subclass used by DateFormat to handle the formatting and parsing of dates. Most applications should not use this class directly; instead, they should obtain a localized DateFormat object by calling one of the static methods of DateFormat.

SimpleDateFormat formats dates and times according to a pattern, which specifies the positions of the various fields of the date, and a DateFormatSymbols object, which specifies important auxiliary data, such as the names of months. Applications that require highly customized date or time formatting can create a custom SimpleDateFormat object by specifying the desired pattern. This creates a SimpleDateFormat object that uses the DateFormatSymbols object for the default locale. You may also specify an locale explicitly, to use the DateFormatSymbols object for that locale. You can even provide an explicit DateFormatSymbols object of your own if you need to format dates and times for an unsupported locale.

You can use the applyPattern( ) method of a SimpleDateFormat to change the formatting pattern used by the object. The syntax of this pattern is described in the following table. Any characters in the format string that do not appear in this table appear literally in the formatted date.

Field	Full form	Short form
Year	yyyy (4 digits)	yy (2 digits)
Month	MMM (name)	MM (2 digits), M (1 or 2 digits)
Day of week	EEEE	EE
Day of month	dd (2 digits)	d (1 or 2 digits)
Hour (1-12)	hh (2 digits)	h (1 or 2 digits)
Hour (0-23)	HH (2 digits)	H (1 or 2 digits)
Hour (0-11)	KK	K
Hour (1-24)	kk	k
Minute	mm	
Second	ss	
Millisecond	SSS	
AM/PM	a	
Time zone	zzzz	zz

Field	Full form	Short form
Day of week in month	F (e.g., 3rd Thursday)	
Day in year	DDD (3 digits)	D (1, 2, or 3 digits)
Week in year	ww	
Era (e.g., BC/AD)	G	

Figure 15-16. java.text.SimpleDateFormat


```
public class SimpleDateFormat extends DateFormat {
// Public Constructors
     public SimpleDateFormat( );
     public SimpleDateFormat(String pattern);
     public SimpleDateFormat(String pattern, java.util.Locale locale);
     public SimpleDateFormat(String pattern, DateFormatSymbols formatSymbols);
// Public Instance Methods
     public void applyLocalizedPattern(String pattern);
     public void applyPattern(String pattern);
1.2  public java.util.Date get2DigitYearStart( );
     public DateFormatSymbols getDateFormatSymbols( );
1.2  public void set2DigitYearStart(java.util.Date startDate);
     public void setDateFormatSymbols(DateFormatSymbols newFormatSymbols);
     public String toLocalizedPattern( );
     public String toPattern( );
// Public Methods Overriding DateFormat
     public Object clone( );
     public boolean equals(Object obj);
     public StringBuffer format(java.util.Date date, StringBuffer toAppendTo,
        FieldPosition pos);
     public int hashCode( );
     public java.util.Date parse(String text, ParsePosition pos);
// Public Methods Overriding Format
1.4  public AttributedCharacterIterator formatToCharacterIterator(Object obj);
}
```

StringCharacterIterator java.text

Java 1.1 *cloneable*

This class is a trivial implementation of the CharacterIterator interface that works for text stored in Java String objects. See CharacterIterator for details.

Figure 15-17. java.text.StringCharacterIterator


```
public final class StringCharacterIterator implements CharacterIterator {
// Public Constructors
     public StringCharacterIterator(String text);
     public StringCharacterIterator(String text, int pos);
     public StringCharacterIterator(String text, int begin, int end, int pos);
// Public Instance Methods
1.2  public void setText(String text);
// Methods Implementing CharacterIterator
     public Object clone( );
     public char current( );
     public char first( );
     public int getBeginIndex( );
     public int getEndIndex( );
     public int getIndex( );
     public char last( );
     public char next( );
     public char previous( );
     public char setIndex(int p);
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Team LiB

Chapter 16. java.util and Subpackages

This chapter documents the `java.util` package, and each of its subpackages. Those packages are:

`java.util`

This package defines many important and commonly used utility classes, the most important o which are the various `Collection`, `Set`, `List`, and `Map` implementations. In Java 5.0 the collection classes and interfaces have been converted into generic types.

`java.util.concurrent`

This package includes utilities for concurrent programming, including threadsafe collection classes, threadpool implementations, and synchronizer utilities.

`java.util.concurrent.atomic`

This package includes classes that define atomic operations on primitive values or object references.

`java.util.concurrent.locks`

This package contains low-level lock and condition utilities.

`java.util.jar`

This package defines classes for reading and writing JAR (Java ARchive) files. They are based on the classes of the `java.util.zip` package.

`java.util.logging`

This package defines a powerful and flexible logging API for Java applications.

`java.util.prefs`

This package allows applications to set and query persistent values for user-specific preferences or system-wide configuration parameters.

`java.util.regex`

This package defines an API for textual pattern matching using regular expressions.

`java.util.zip`

This package defines classes for reading and writing ZIP files and for compressing and uncompressing data using the "gzip" format.

Team LiB

Package java.util

Java 1.0

The java.util package defines a number of useful classes, primarily collections classes that are useful for working with groups of objects. This package should not be considered merely a utility package that separate from the rest of the language; it is an integral and frequently used part of the Java platform.

The most important classes in java.util are the collections classes. Prior to Java 1.2, these were Vector , a growable list of objects, and Hashtable , a mapping between arbitrary key and value objects Java 1.2 adds an entire collections framework consisting of the Collection , Map , Set , List , SortedMap , and SortedSet interfaces and the classes that implement them. Other important classes and interfaces of the collections framework are Comparator , Collections , Arrays , Iterator , and ListIterator . Java 1.4 extends the Collections framework with the addition of new Map and Set implementations, and a new RandomAccess marker interface used by List implementations. Java 5.0 adds a Queue collection interface and implementations. It also adds EnumSet and EnumMap which efficiently implement the Set and Map interfaces for use with enumerated types. Most importantly, Java 5.0 modifies all collection interfaces and classes to be generic types, which enable type-safe collections such as List<String> . BitSet is a related class that is not actually part of the Collections framework (and is not even a set). It provides a very compact representation of an arbitrary-size array or list of boolean values or bits. Its API was substantially enhanced in Java 1.4.

The other classes of the package are also quite useful. Date , Calendar , and TimeZone work with dates and times. Currency represents a national currency. Locale represents the language and related text formatting conventions of a country, region, or culture. ResourceBundle and its subclasses represent a bundle of localized resources that are read in by an internationalized program at runtime. Random generates and returns pseudorandom numbers in a variety of forms. StringTokenizer is a simple parse that breaks a string into tokens. In Java 1.3 and later, Timer and TimerTask provide a powerful API for scheduling code to be run by a background thread, once or repetitively, at a specified time in the future In Java 5.0, the Formatter class enables poweful formatted text output in the style of the C programming language's printf( ) function. The Java 5.0 Scanner class is a text tokenizer or scanner that can also parse numbers and match tokens based on regular expressions.

Interfaces

```
public interface Collection<E> extends Iterable<E>;
public interface Comparator<T>;
public interface Enumeration<E>;
public interface EventListener;
public interface Formattable;
public interface Iterator<E>;
public interface List<E> extends Collection<E>;
public interface ListIterator<E> extends Iterator<E>;
public interface Map<K, V>;
public interface Map.Entry<K, V>;
```

```
public interface Observer;
public interface Queue<E> extends Collection<E>;
public interface RandomAccess;
public interface Set<E> extends Collection<E>;
public interface SortedMap<K, V> extends Map<K, V>;
public interface SortedSet<E> extends Set<E>;
```

Enumerated Types

```
public enum Formatter.BigDecimalLayoutForm;
```

Collections

```
public abstract class AbstractCollection<E> implements Collection<E>;
   public abstract class AbstractList<E> extends AbstractCollection<E>
        implements List<E>;
      public abstract class AbstractSequentialList<E> extends AbstractList<E>;
         public class LinkedList<E> extends AbstractSequentialList<E>
                      implements List<E>, Queue<E>, Cloneable, Serializable;
      public class ArrayList<E> extends AbstractList<E> implements List<E>,
        RandomAccess, Cloneable, Serializable;
      public class Vector<E> extends AbstractList<E> implements List<E>,
        RandomAccess, Cloneable, Serializable;
         public class Stack<E> extends Vector<E>;
   public abstract class AbstractQueue<E> extends AbstractCollection<E>
        implements Queue<E>;
      public class PriorityQueue<E> extends AbstractQueue<E>
        implements Serializable;
   public abstract class AbstractSet<E> extends AbstractCollection<E>
        implements Set<E>;
      public abstract class EnumSet<E extends Enum<E>> extends AbstractSet<E>
        implements Cloneable, Serializable;
      public class HashSet<E> extends AbstractSet<E> implements Set<E>,
        Cloneable, Serializable;
         public class LinkedHashSet<E> extends HashSet<E> implements Set<E>,
        Cloneable, Serializable;
      public class TreeSet<E> extends AbstractSet<E> implements SortedSet<E>,
        Cloneable, Serializable;
public abstract class AbstractMap<K, V> implements Map<K, V>;
   public class EnumMap<K extends Enum<K>, V> extends AbstractMap<K, V>
        implements Serializable, Cloneable;
   public class HashMap<K, V> extends AbstractMap<K, V> implements Map<K, V>,
        Cloneable, Serializable;
      public class LinkedHashMap<K, V> extends HashMap<K, V>
        implements Map<K, V>;
   public class IdentityHashMap<K, V> extends AbstractMap<K, V>
        implements Map<K, V>, Serializable, Cloneable;
   public class TreeMap<K, V> extends AbstractMap<K, V>
```

```
        implements SortedMap<K, V>, Cloneable, Serializable;
   public class WeakHashMap<K, V> extends AbstractMap<K, V> implements Map<K, V>;
public class Hashtable<K, V> extends Dictionary<K, V> implements Map<K, V>,
        Cloneable, Serializable;
   public class Properties extends Hashtable<Object, Object>;
```

Events

```
public class EventObject implements Serializable;
```

Other Classes

```
public class Arrays;
public class BitSet implements Cloneable, Serializable;
public abstract class Calendar implements Serializable, Cloneable, Comparable<Calendar>;
   public class GregorianCalendar extends Calendar;
public class Collections;
public final class Currency implements Serializable;
public class Date implements Serializable, Cloneable, Comparable<Date>;
public abstract class Dictionary<K, V>;
public abstract class EventListenerProxy implements EventListener;
public class FormattableFlags;
public final class Formatter implements java.io.Closeable, java.io.Flushable;
public final class Locale implements Cloneable, Serializable;
public class Observable;
public final class PropertyPermission extends java.security.BasicPermission;
public class Random implements Serializable;
public abstract class ResourceBundle;
   public abstract class ListResourceBundle extends ResourceBundle;
   public class PropertyResourceBundle extends ResourceBundle;
public final class Scanner implements Iterator<String>;
public class StringTokenizer implements Enumeration<Object>;
public class Timer;
public abstract class TimerTask implements Runnable;
public abstract class TimeZone implements Cloneable, Serializable;
   public class SimpleTimeZone extends TimeZone;
public final class UUID implements Serializable, Comparable<UUID>;
```

Exceptions

```
public class ConcurrentModificationException extends RuntimeException;
public class EmptyStackException extends RuntimeException;
public class FormatterClosedException extends IllegalStateException;
public class IllegalFormatException extends IllegalArgumentException;
   public class DuplicateFormatFlagsException extends IllegalFormatException;
   public class FormatFlagsConversionMismatchException extends IllegalFormatException;
   public class IllegalFormatCodePointException extends IllegalFormatException;
```

```
    public class IllegalFormatConversionException extends IllegalFormatException;
    public class IllegalFormatFlagsException extends IllegalFormatException;
    public class IllegalFormatPrecisionException extends IllegalFormatException;
    public class IllegalFormatWidthException extends IllegalFormatException;
    public class MissingFormatArgumentException extends IllegalFormatException;
    public class MissingFormatWidthException extends IllegalFormatException;
    public class UnknownFormatConversionException extends IllegalFormatException;
    public class UnknownFormatFlagsException extends IllegalFormatException;
public class InvalidPropertiesFormatException extends java.io.IOException;
public class MissingResourceException extends RuntimeException;
public class NoSuchElementException extends RuntimeException;
    public class InputMismatchException extends NoSuchElementException;
public class TooManyListenersException extends Exception;
```

Team LiB

AbstractCollection<E> java.util

Java 1.2 *collection*

This abstract class is a partial implementation of Collection that makes it easy to define custom Collection implementations. To create an unmodifiable collection, simply override size( ) and iterator( ). The Iterator object returned by iterator( ) has to support only the hasNext( ) and next( ) methods. To define a modifiable collection, you must additionally override the add( ) method of AbstractCollection and make sure the Iterator returned by iterator( ) supports the remove( ) method. Some subclasses may choose to override other methods to tune performance. In addition, it is conventional that all subclasses provide two constructors: one that takes no arguments and one that accepts a Collection argument that specifies the initial contents of the collection.

Note that if you subclass AbstractCollection directly, you are implementing a *bag*an unordered collection that allows duplicate elements. If your add( ) method rejects duplicate elements, you should subclass AbstractSet instead. See also AbstractList.

Figure 16-1. java.util.AbstractCollection<E>

```
public abstract class AbstractCollection<E> implements Collection<E> {
// Protected Constructors
     protected AbstractCollection( );
// Methods Implementing Collection
     public boolean add(E o);
     public boolean addAll(Collection<? extends E> c);
     public void clear( );
     public boolean contains(Object o);
     public boolean containsAll(Collection<?> c);
     public boolean isEmpty( );
     public abstract Iterator<E> iterator( );
     public boolean remove(Object o);
     public boolean removeAll(Collection<?> c);
     public boolean retainAll(Collection<?> c);
     public abstract int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Public Methods Overriding Object
     public String toString( );
}
```

Subclasses

AbstractList, AbstractQueue, AbstractSet

downloaded from: lib.ommolketab.ir

AbstractList<E> java.util

Java 1.2 *collection*

This abstract class is a partial implementation of the `List` interface that makes it easy to define custom `List` implementations based on random-access list elements (such as objects stored in an array). If you want to base a `List` implementation on a sequential-access data model (such as a linked list), subclass `AbstractSequentialList` instead.

To create an unmodifiable `List` , simply subclass `AbstractList` and override the (inherited) `size( )` an `get( )` methods. To create a modifiable list, you must also override `set( )` and, optionally, `add( )` and `remove( )` . These three methods are optional, so unless you override them, they simply throw an `UnsupportedOperationException` . All other methods of the `List` interface are implemented in terms of `size( )` , `get( )` , `set( )` , `add( )` , and `remove( )` . In some cases, you may want to override these other methods to improve performance. By convention, all `List` implementations should define two constructors: one that accepts no arguments and another that accepts a `Collection` of initial elements for the list.

Figure 16-2. java.util.AbstractList<E>

```
public abstract class AbstractList<E> extends AbstractCollection<E> implements List<E>
// Protected Constructors
     protected AbstractList( );
// Methods Implementing List
     public boolean add(E o);
     public void add(int index, E element);
     public boolean addAll(int index, Collection<? extends E> c);
     public void clear( );
     public boolean equals(Object o);
     public abstract E get(int index);
     public int hashCode( );
     public int indexOf(Object o);
     public Iterator<E> iterator( );
     public int lastIndexOf(Object o);
     public ListIterator<E> listIterator( );
     public ListIterator<E> listIterator(int index);
     public E remove(int index);
     public E set(int index, E element);
     public List<E> subList(int fromIndex, int toIndex);
// Protected Instance Methods
```

```
    protected void removeRange(int fromIndex, int toIndex);
// Protected Instance Fields
    protected transient int modCount;
}
```

Subclasses

AbstractSequentialList , ArrayList , Vector

AbstractMap<K,V> java.util

Java 1.2 *collection*

This abstract class is a partial implementation of the `Map` interface that makes it easy to define simple custom `Map` implementations. To define an unmodifiable map, subclass `AbstractMap` and override the `entrySet( )` method so that it returns a set of `Map.Entry` objects. (Note that you must also implement `Map.Entry`, of course.) The returned set should not support `add( )` or `remove( )`, and its iterator should not support `remove( )`. In order to define a modifiable `Map`, you must additionally override the `put( )` method and provide support for the `remove( )` method of the iterator returned by `enTRySet( ).iterator( )`. In addition, it is conventional that all `Map` implementations define two constructors: one that accepts no arguments and another that accepts a `Map` of initial mappings.

`AbstractMap` defines all `Map` methods in terms of its `entrySet( )` and `put( )` methods and the `remove( )` method of the entry set iterator. Note, however, that the implementation is based on a linear search of the `Set` returned by `enTRySet( )` and is not efficient when the `Map` contains more than a handful of entries. Some subclasses may want to override additional `AbstractMap` methods to improve performance. `HashMap` and `treeMap` use different algorithms are are substantially more efficient.

Figure 16-3. java.util.AbstractMap<K,V>

```
public abstract class AbstractMap<K,V> implements Map<K,V> {
// Protected Constructors
     protected AbstractMap( );
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public abstract Set<Map.Entry<K,V>> entrySet( );
     public boolean equals(Object o);
     public V get(Object key);
     public int hashCode( );
     public boolean isEmpty( );
     public Set<K> keySet( );
     public V put(K key, V value);
     public void putAll(Map<? extends K,? extends V> t);
     public V remove(Object key);
     public int size( );
     public Collection<V> values( );
```

```
// Public Methods Overriding Object
     public String toString( );
// Protected Methods Overriding Object
1.4  protected Object clone( ) throws CloneNotSupportedException;
}
```

Subclasses

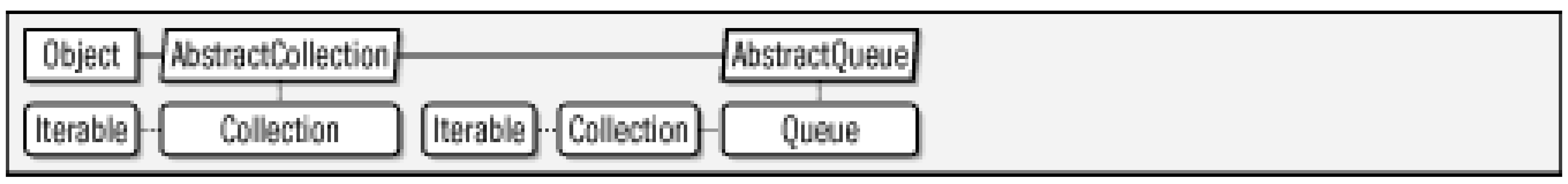
EnumMap, HashMap, IdentityHashMap, TReeMap, WeakHashMap, java.util.concurrent.ConcurrentHashMap

AbstractQueue<E> java.util

Java 5.0 *collection*

This abstract class provides a framework for simple `Queue` implementations. A concrete subclass must implement `offer( )`, `peek( )`, and `poll( )` and must also implement the inherited `size( )` and `iterator( )` methods of the `Collection` interface. The `Iterator` returned by `iterator( )` must suppo the `remove( )` operation.

Figure 16-4. java.util.AbstractQueue<E>




```
public abstract class AbstractQueue<E> extends AbstractCollection<E> implements Queue<E
// Protected Constructors
     protected AbstractQueue( );
// Methods Implementing Collection
     public boolean add(E o);
     public boolean addAll(Collection<? extends E> c);
     public void clear( );
// Methods Implementing Queue
     public E element( );
     public E remove( );
}
```

Subclasses

`PriorityQueue`, `java.util.concurrent.ArrayBlockingQueue`, `java.util.concurrent.ConcurrentLinkedQueue`, `java.util.concurrent.DelayQueue`, `java.util.concurrent.LinkedBlockingQueue`, `java.util.concurrent.PriorityBlockingQueue`, `java.util.concurrent.SynchronousQueue`

AbstractSequentialList<E> java.util

Java 1.2 *collection*

This abstract class is a partial implementation of the `List` interface that makes it easy to define `List` implementations based on a sequential-access data model, as is the case with the `LinkedList` subclass. To implement a `List` based on an array or other random-access model, subclass `AbstractList` instead.

To implement an unmodifiable list, subclass this class and override the `size( )` and `listIterator( )` methods. `listIterator( )` must return a `ListIterator` that defines the `hasNext( )`, `hasPrevious( )`, `next( )`, `previous( )`, and `index( )` methods. If you want to allow the list to be modified, the `ListIterator` should also support the `set( )` method and, optionally, the `add( )` and `remove( )` methods. `AbstractSequentialList` implements all other `List` methods in terms of these methods. Some subclasses may want to override additional methods to improve performance. In addition, it is conventional that all `List` implementations define two constructors: one that accepts nc arguments and another that accepts a `Collection` of initial elements for the list.

Figure 16-5. java.util.AbstractSequentialList<E>

```
public abstract class AbstractSequentialList<E> extends AbstractList<E> {
// Protected Constructors
     protected AbstractSequentialList( );
// Public Methods Overriding AbstractList
     public void add(int index, E element);
     public boolean addAll(int index, Collection<? extends E> c);
     public E get(int index);
     public Iterator<E> iterator( );
     public abstract ListIterator<E> listIterator(int index);
     public E remove(int index);
     public E set(int index, E element);
}
```

Subclasses

`LinkedList`

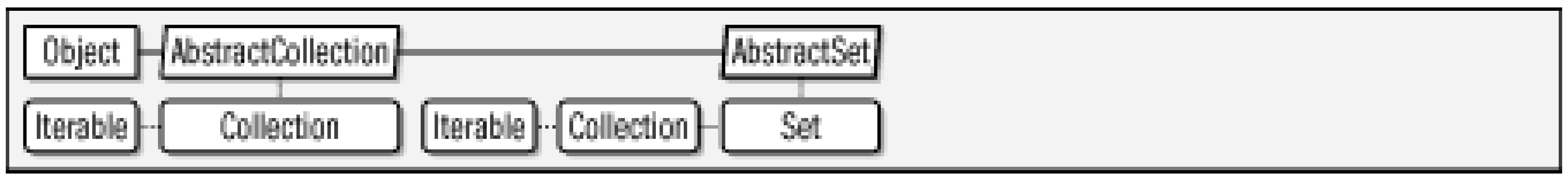
Team LiB

AbstractSet<E> java.util

Java 1.2 *collection*

This abstract class is a partial implementation of the Set interface that makes it easy to create custom Set implementations. Since Set defines the same methods as Collection , you can subclass AbstractSet exactly as you would subclass AbstractCollection . See AbstractCollection for details. Note, however, that when subclassing AbstractSet , you should be sure that your add( ) method and your constructors do not allow duplicate elements to be added to the set. See also AbstractList .

Figure 16-6. java.util.AbstractSet<E>




```
public abstract class AbstractSet<E> extends AbstractCollection<E> implements Set<E> {
// Protected Constructors
     protected AbstractSet( );
// Methods Implementing Set
     public boolean equals(Object o);
     public int hashCode( );
1.3  public boolean removeAll(Collection<?> c);
}
```

Subclasses

EnumSet , HashSet , treeSet , java.util.concurrent.CopyOnWriteArraySet

ArrayList<E> java.util

Java 1.2 *cloneable serializable collection*

This class is a List implementation based on an array (that is recreated as necessary as the list grows or shrinks). ArrayList implements all optional List and Collection methods and allows list elements of any type (including null). Because ArrayList is based on an array, the get( ) and set( ) methods are very efficient. (This is not the case for the LinkedList implementation, for example.) ArrayList is a general-purpose implementation of List and is quite commonly used. ArrayList is very much like the Vector class, except that its methods are not synchronized. If you are using an ArrayList in a multithreaded environment, you should explicitly synchronize any modifications to the list, or wrap the list with Collections.synchronizedList( ). See List and Collection for details on the methods of ArrayList. See also LinkedList.

An ArrayList has a *capacity*, which is the number of elements in the internal array that contains the elements of the list. When the number of elements exceeds the capacity, a new array, with a larger capacity, must be created. In addition to the List and Collection methods, ArrayList defines a couple of methods that help you manage this capacity. If you know in advance how many elements an ArrayList will contain, you can call ensureCapacity( ), which can increase efficiency by avoiding incremental reallocation of the internal array. You can also pass an initial capacity value to the ArrayList( ) constructor. Finally, if an ArrayList has reached its final size and will not change in the future, you can call TRimToSize( ) to reallocate the internal array with a capacity that matches the list size exactly. When the ArrayList will have a long lifetime, this can be a useful technique to reduce memory usage.

Figure 16-7. java.util.ArrayList<E>

```
public class ArrayList<E> extends AbstractList<E> implements List<E>,
        RandomAccess, Cloneable, Serializable {
// Public Constructors
     public ArrayList( );
     public ArrayList(int initialCapacity);
     public ArrayList(Collection<? extends E> c);
// Public Instance Methods
     public void ensureCapacity(int minCapacity);
     public void trimToSize( );
```

```
// Methods Implementing List
     public boolean add(E o);
     public void add(int index, E element);
     public boolean addAll(Collection<? extends E> c);
     public boolean addAll(int index, Collection<? extends E> c);
     public void clear( );
     public boolean contains(Object elem);
     public E get(int index);
     public int indexOf(Object elem);
     public boolean isEmpty( );                            default:true
     public int lastIndexOf(Object elem);
5.0  public boolean remove(Object o);
     public E remove(int index);
     public E set(int index, E element);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Protected Methods Overriding AbstractList
     protected void removeRange(int fromIndex, int toIndex);
// Public Methods Overriding Object
     public Object clone( );
}
```

Returned By

`Collections.list( )`

Arrays java.util

Java 1.2

This class defines static methods for sorting, searching, and performing other useful operations on array defines the asList( ) method, which returns a List wrapper around a specified array of objects. Any cl made to the List are also made to the underlying array. This is a powerful method that allows any array to be manipulated in any of the ways a List can be manipulated. It provides a link between arrays and t collections framework.

The various sort( ) methods sort an array (or a specified portion of an array) in place. Variants of the defined for arrays of each primitive type and for arrays of Object . For arrays of primitive types, the sort according to the natural ordering of the type. For arrays of objects, the sorting is done according to the Comparator , or, if the array contains only java.lang.Comparable objects, according to the ordering de that interface. When sorting an array of objects, a stable sorting algorithm is used so that the relative o equal objects is not disturbed. (This allows repeated sorts to order objects by key and subkey, for exam

The binarySearch( ) methods perform an efficient search (in logarithmic time) of a sorted array for a s value. If a match is found in the array, binarySearch( ) returns the index of the match. If no match is method returns a negative number. For a negative return value r , the index -(r+1) specifies the array i which the specified value can be inserted to maintain the sorted order of the array. When the array to b is an array of objects, the elements of the array must all implement java.lang.Comparable , or you mu a Comparator object to compare them.

The equals( ) methods test whether two arrays are equal. Two arrays of primitive type are equal if the the same number of elements and if corresponding pairs of elements are equal according to the == opera arrays of objects are equal if they contain the same number of elements and if corresponding pairs of el equal according to the equals( ) method defined by those objects. The fill( ) methods fill an array o specified range of an array with the specified value.

Java 5.0 adds hashCode( ) methods that compute a hashcode for the contents of the array. These metl compatible with the equals( ) methods: equal( ) arrays will always have the same hashCode( ) . Java adds deepEquals( ) and deepHashCode( ) methods that handle multi-dimensional arrays. Finally, the toString( ) and deepToString( ) methods convert arrays to strings. The returned strings are a comm separated list of elements enclosed in square brackets.

```
public class Arrays {
// No Constructor
// Public Class Methods
     public static <T> List<T> asList(T ... a);
     public static int binarySearch(char[ ] a, char key);
     public static int binarySearch(short[ ] a, short key);
     public static int binarySearch(long[ ] a, long key);
     public static int binarySearch(int[ ] a, int key);
     public static int binarySearch(float[ ] a, float key);
     public static int binarySearch(Object[ ] a, Object key);
```

```
     public static int binarySearch(byte[ ] a, byte key);
     public static int binarySearch(double[ ] a, double key);
     public static <T> int binarySearch(T[ ] a, T key, Comparator<? super T> c);
5.0  public static boolean deepEquals(Object[ ] a1, Object[ ] a2);
5.0  public static int deepHashCode(Object[ ] a);
5.0  public static String deepToString(Object[ ] a);
     public static boolean equals(boolean[ ] a, boolean[ ] a2);
     public static boolean equals(long[ ] a, long[ ] a2);
     public static boolean equals(float[ ] a, float[ ] a2);
     public static boolean equals(double[ ] a, double[ ] a2);
     public static boolean equals(char[ ] a, char[ ] a2);
     public static boolean equals(byte[ ] a, byte[ ] a2);
     public static boolean equals(int[ ] a, int[ ] a2);
     public static boolean equals(short[ ] a, short[ ] a2);
     public static boolean equals(Object[ ] a, Object[ ] a2);
     public static void fill(char[ ] a, char val);
     public static void fill(short[ ] a, short val);
     public static void fill(byte[ ] a, byte val);
     public static void fill(int[ ] a, int val);
     public static void fill(double[ ] a, double val);
     public static void fill(boolean[ ] a, boolean val);
     public static void fill(Object[ ] a, Object val);
     public static void fill(float[ ] a, float val);
     public static void fill(long[ ] a, long val);
     public static void fill(int[ ] a, int fromIndex, int toIndex, int val);
     public static void fill(double[ ] a, int fromIndex, int toIndex, double val);
     public static void fill(short[ ] a, int fromIndex, int toIndex, short val);
     public static void fill(char[ ] a, int fromIndex, int toIndex, char val);
     public static void fill(float[ ] a, int fromIndex, int toIndex, float val);
     public static void fill(byte[ ] a, int fromIndex, int toIndex, byte val);
     public static void fill(boolean[ ] a, int fromIndex, int toIndex, boolean val);
     public static void fill(Object[ ] a, int fromIndex, int toIndex, Object val);
     public static void fill(long[ ] a, int fromIndex, int toIndex, long val);
5.0  public static int hashCode(short[ ] a);
5.0  public static int hashCode(char[ ] a);
5.0  public static int hashCode(long[ ] a);
5.0  public static int hashCode(int[ ] a);
5.0  public static int hashCode(byte[ ] a);
5.0  public static int hashCode(double[ ] a);
5.0  public static int hashCode(Object[ ] a);
5.0  public static int hashCode(boolean[ ] a);
5.0  public static int hashCode(float[ ] a);
     public static void sort(Object[ ] a);
     public static void sort(short[ ] a);
     public static void sort(float[ ] a);
     public static void sort(double[ ] a);
     public static void sort(long[ ] a);
     public static void sort(byte[ ] a);
     public static void sort(char[ ] a);
```

```
     public static void sort(int[ ] a);
     public static <T> void sort(T[ ] a, Comparator<? super T> c);
     public static void sort(short[ ] a, int fromIndex, int toIndex);
     public static void sort(int[ ] a, int fromIndex, int toIndex);
     public static void sort(char[ ] a, int fromIndex, int toIndex);
     public static void sort(long[ ] a, int fromIndex, int toIndex);
     public static void sort(float[ ] a, int fromIndex, int toIndex);
     public static void sort(double[ ] a, int fromIndex, int toIndex);
     public static void sort(byte[ ] a, int fromIndex, int toIndex);
     public static void sort(Object[ ] a, int fromIndex, int toIndex);
     public static <T> void sort(T[ ] a, int fromIndex, int toIndex, Comparator<? super
5.0  public static String toString(float[ ] a);
5.0  public static String toString(boolean[ ] a);
5.0  public static String toString(Object[ ] a);
5.0  public static String toString(double[ ] a);
5.0  public static String toString(int[ ] a);
5.0  public static String toString(long[ ] a);
5.0  public static String toString(short[ ] a);
5.0  public static String toString(byte[ ] a);
5.0  public static String toString(char[ ] a);
}
```

Team LiB

BitSet java.util

Java 1.0 *cloneable serializable*

This class implements an array or list of boolean values storing them using a very compact representation that requires only about one bit per value stored. It implements methods for setting, querying, and flipping the values stored at any given position within the list, for counting the number of true values stored in the list, and for finding the next TRue or false value in the list. It also defines a number of methods that perform bitwise boolean operations on two BitSet objects. Despite its name, BitSet does not implement the Set interface, and does not even have the behavior associated with a set; it is a list or vector for boolean values, but is not related to the List interface or Vector class. This class was introduced in Java 1.0, but was substantially enhanced in Java 1.4; note that many of the methods described below are only available in Java 1.4 and later.

Create a BitSet with the BitSet( ) constructor. You may optionally specify a size (the number of bits) for the BitSet, but this merely provides an optimization since a BitSet will grow as needed to accomodate any number of boolean values. BitSet does not define a precise notion of the size of a "set." The size( ) method returns the number of boolean values that can be stored before more internal storage needs to be allocated. The length( ) method returns one more than the highest index of a set bit (i.e., a true value). This means that a BitSet that contains all false values will have a length( ) of zero. If your code needs to remember the index of the highest value stored in a BitSet, regardless of whether that value was TRue or false, then you should maintain that length information separately from the BitSet.

Set values in a BitSet with the set( ) method. There are four versions of this method. Two set the value at a specific index, and two set values for a range of indexes. Two of the set( ) methods do not take a value argument to set: they "set" the specified bit or range of bites, which means they store the value true. The other two methods take a boolean argument, allowing you to set the specified value or range of values to true (a set bit) or false (a clear bit). There are also two clear( ) methods that "clear" (or set to false) the value at the specified index or range of indexes. The flip( ) methods flip, or toggle (change TRue to false and false to TRue), the value or values at the specified index or range. The set( ), clear( ), and flip( ) methods, as well as all other BitSet methods that operate on a range of values specify the range with two index values. They define the range as the values starting from, and including, the value stored at the first specified index up to, *but not including*, the value stored at the second specified index. (A number of methods of String and related classes follow the same convention for specifying a range of characters.)

To test the value stored at a specified location, use get( ), which returns true if the specified bit is set, or false if it is not set. There is also a get( ) method that specifies a range of bits, and returns their state in the form of a BitSet: this get( ) method is analogous to the substring( ) method of a String. Because a BitSet does not define a maximum index, it is legal to pass any non-negative value to get( ). If the index you specify is greater than or equal to the value returned by length( ), then the returned value will always be false.

cardinality( ) returns the number of true values (or of set bits) stored in a BitSet. isEmpty( ) returns true if a BitSet has no true values stored in it (in this case, both length( ) and cardinality( ) return 0). nextSetBit( ) returns the first index at or after the specified index at which a true value is stored (or at which the bit is set). You can use this method in a loop to iterate through the indexes of true values. nextClearBit( ) is similar, but searches the BitSet for false values (clear bits) intead. The intersects( ) method returns true if the target BitSet and the argument BitSet intersect: that is if there is at least one index at which both BitSet objects have a true value.

BitSet defines several methods that perform bitwise Boolean operations. These methods combine the BitSet on which they are invoked (called the "target" BitSet below) with the BitSet passed as an argument, and store the result in the target BitSet. If you want to perform a Boolean operation without altering the original BitSet, you should first make a copy of the original with the clone( ) method and invoke the method on the copy. The and( ) method preforms a bitwise Boolean AND operation, much like the & does when applied to integer arguments. A value in the target BitSet will be true only if it was originally true *and* the value at the same index of argument BitSet is also TRue. For all false values in the argument BitSet, and( ) sets the corresponding value in the target BitSet to false, leaving other values unchanged. The andNot( ) method combines a Boolean AND operation with a Boolean NOT operation on the argument BitSet (it does not alter the contents of that argument BitSet, hoever). The result is that for all TRue values in the argument BitSet, the corresponding values in the target BitSet are set to false.

The or( ) method performs a bitwise Boolean OR operation like the | operator: a value in the BitSet will be set to true if its original value was TRue *or* the corresponding value in the argument BitSet was true. For all TRue values in the argument BitSet, the or( ) method sets the corresponding value in the target BitSet to true, leaving the other values unchanged. The xor( ) method performs an "exclusive OR" operation: sets a value in the target BitSet to TRue if it was originally true or if the corresponding value in the argument BitSet was true. If both values were false, or if both values were true, however, it sets the value to false.

Finally, the toString( ) method returns a String representation of a BitSet that consists of a list within curly braces of the indexes at which TRue values are stored.

The BitSet class is not threadsafe.

Figure 16-8. java.util.BitSet

```
public class BitSet implements Cloneable, Serializable {
// Public Constructors
     public BitSet( );
     public BitSet(int nbits);
// Public Instance Methods
     public void and(BitSet set);
1.2  public void andNot(BitSet set);
1.4  public int cardinality( );
1.4  public void clear( );
     public void clear(int bitIndex);
```

```
1.4  public void clear(int fromIndex, int toIndex);
1.4  public void flip(int bitIndex);
1.4  public void flip(int fromIndex, int toIndex);
     public boolean get(int bitIndex);
1.4  public BitSet get(int fromIndex, int toIndex);
1.4  public boolean intersects(BitSet set);
1.4  public boolean isEmpty( );                                       default:true
1.2  public int length( );
1.4  public int nextClearBit(int fromIndex);
1.4  public int nextSetBit(int fromIndex);
     public void or(BitSet set);
     public void set(int bitIndex);
1.4  public void set(int bitIndex, boolean value);
1.4  public void set(int fromIndex, int toIndex);
1.4  public void set(int fromIndex, int toIndex, boolean value);
     public int size( );
     public void xor(BitSet set);
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
}
```

Team LiB

Calendar java.util

Java 1.1 *cloneable serializable comparable*

This abstract class defines methods that perform date and time arithmetic. It also includes methods tha convert dates and times to and from the machine-usable millisecond format used by the `Date` class and units such as minutes, hours, days, weeks, months, and years that are more useful to humans. As an abstract class, `Calendar` cannot be directly instantiated. Instead, it provides static `getInstance( )` methods that return instances of a `Calendar` subclass suitable for use in a specified or default locale witl specified or default time zone. See also `Date` , `DateFormat` , and `TimeZone` .

`Calendar` defines a number of useful constants. Some of these are values that represent days of the we and months of the year. Other constants, such as `HOUR` and `DAY_OF_WEEK` , represent various fields of da and time information. These field constants are passed to a number of `Calendar` methods, such as `get(` and `set( )` , in order to indicate what particular date or time field is desired.

`setTime( )` and the various `set( )` methods set the date represented by a `Calendar` object. The `add(` method adds (or subtracts) values to a calendar field, incrementing the next larger field when the field being set rolls over. `roll( )` does the same, without modifying anything but the specified field. `before(` and `after( )` compare two `Calendar` objects. Many of the methods of the `Calendar` class are replacements for methods of `Date` that have been deprecated as of Java 1.1. While the `Calendar` class converts a time value to its various hour, day, month, and other fields, it is not intended to present thos fields in a form suitable for display to the end user. That function is performed by the `java.text.DateFormat` class, which handles internationalization issues.

`Calendar` implements `Comparable` in Java 5.0, but not in earlier releases.

Figure 16-9. java.util.Calendar

```
public abstract class Calendar implements Serializable, Cloneable, Comparable<Calendar>
// Protected Constructors
     protected Calendar( );
     protected Calendar(TimeZone zone, Locale aLocale);
// Public Constants
     public static final int AM;                                              =0
     public static final int AM_PM;                                           =9
     public static final int APRIL;                                           =3
     public static final int AUGUST;                                          =7
     public static final int DATE;                                            =5
     public static final int DAY_OF_MONTH;                                    =5
```

```
    public static final int DAY_OF_WEEK;                                =7
    public static final int DAY_OF_WEEK_IN_MONTH;                       =8
    public static final int DAY_OF_YEAR;                                =6
    public static final int DECEMBER;                                   =11
    public static final int DST_OFFSET;                                 =16
    public static final int ERA;                                        =0
    public static final int FEBRUARY;                                   =1
    public static final int FIELD_COUNT;                                =17
    public static final int FRIDAY;                                     =6
    public static final int HOUR;                                       =10
    public static final int HOUR_OF_DAY;                                =11
    public static final int JANUARY;                                    =0
    public static final int JULY;                                       =6
    public static final int JUNE;                                       =5
    public static final int MARCH;                                      =2
    public static final int MAY;                                        =4
    public static final int MILLISECOND;                                =14
    public static final int MINUTE;                                     =12
    public static final int MONDAY;                                     =2
    public static final int MONTH;                                      =2
    public static final int NOVEMBER;                                   =10
    public static final int OCTOBER;                                    =9
    public static final int PM;                                         =1
    public static final int SATURDAY;                                   =7
    public static final int SECOND;                                     =13
    public static final int SEPTEMBER;                                  =8
    public static final int SUNDAY;                                     =1
    public static final int THURSDAY;                                   =5
    public static final int TUESDAY;                                    =3
    public static final int UNDECIMBER;                                 =12
    public static final int WEDNESDAY;                                  =4
    public static final int WEEK_OF_MONTH;                              =4
    public static final int WEEK_OF_YEAR;                               =3
    public static final int YEAR;                                       =1
    public static final int ZONE_OFFSET;                                =15
// Public Class Methods
    public static Locale[ ] getAvailableLocales( );               synchronized
    public static Calendar getInstance( );
    public static Calendar getInstance(Locale aLocale);
    public static Calendar getInstance(TimeZone zone);
    public static Calendar getInstance(TimeZone zone, Locale aLocale);
// Public Instance Methods
    public abstract void add(int field, int amount);
    public boolean after(Object when);
    public boolean before(Object when);
    public final void clear( );
    public final void clear(int field);
    public int get(int field);
1.2 public int getActualMaximum(int field);
```

```
1.2  public int getActualMinimum(int field);
     public int getFirstDayOfWeek( );
     public abstract int getGreatestMinimum(int field);
     public abstract int getLeastMaximum(int field);
     public abstract int getMaximum(int field);
     public int getMinimalDaysInFirstWeek( );
     public abstract int getMinimum(int field);
     public final Date getTime( );
     public long getTimeInMillis( );
     public TimeZone getTimeZone( );
     public boolean isLenient( );
     public final boolean isSet(int field);
1.2  public void roll(int field, int amount);
     public abstract void roll(int field, boolean up);
     public void set(int field, int value);
     public final void set(int year, int month, int date);
     public final void set(int year, int month, int date, int hourOfDay, int minute);
     public final void set(int year, int month, int date, int hourOfDay, int minute,
        int second);
     public void setFirstDayOfWeek(int value);
     public void setLenient(boolean lenient);
     public void setMinimalDaysInFirstWeek(int value);
     public final void setTime(Date date);
     public void setTimeInMillis(long millis);
     public void setTimeZone(TimeZone value);
// Methods Implementing Comparable
5.0  public int compareTo(Calendar anotherCalendar);
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object obj);
1.2  public int hashCode( );
     public String toString( );
// Protected Instance Methods
     protected void complete( );
     protected abstract void computeFields( );
     protected abstract void computeTime( );
     protected final int internalGet(int field);
// Protected Instance Fields
     protected boolean areFieldsSet;
     protected int[ ] fields;
     protected boolean[ ] isSet;
     protected boolean isTimeSet;
     protected long time;
}
```

Subclasses

GregorianCalendar

Passed To

java.text.DateFormat.setCalendar( ) , javax.xml.datatype.Duration.{addTo( ) , getTimeInMillis( ) , normalizeWith( )}

Returned By

java.text.DateFormat.getCalendar( )

Type Of

java.text.DateFormat.calendar

Team LiB

Team LiB

Collection<E> java.util

Java 1.2 *collection*

This interface represents a group, or collection, of objects. In Java 5.0 this is a generic interface and the type variable *E* represents the type of the objects in the collection. The objects may or may not be ordered, and the collection may or may not contain duplicate objects.`Collection` is not often implemented directly. Instead, most collection classes implement one of the more specific subinterfaces: `Set`, an unordered collection that does not allow duplicates, or`List`, an ordered collection that does allow duplicates.

The `Collection` type provides a general way to refer to any set, list, or other collection of objects; it defines generic methods that work with any collection.`contains( )` and `containsAll( )` test whether the `Collection` contains a specified object or all the objects in a given collection.`isEmpty( )` returns `true` if the `Collection` has no elements, or `false` otherwise. `size( )` returns the number of elements in the `Collection`. `iterator( )` returns an `Iterator` object that allows you to iterate through the objects in the collection. `toArray( )` returns the objects in the `Collection` in a new array of type `Object`. Another version of `toArray( )` takes an array as an argument and stores all elements of the `Collection` (which must all be compatible with the array) into that array. If the array is not big enough, the method allocates a new, larger array of the same type. If the array is too big, the method stores `null` into the first empty element of the array. This version of `toArray( )` returns the array that was passed in or the new array, if one was allocated.

The previous methods all query or extract the contents of a collection. The`Collection` interface also defines methods for modifying the contents of the collection.`add( )` and `addAll( )` add an object or a collection of objects to a `Collection`. `remove( )` and `removeAll( )` remove an object or collection. `retainAll( )` is a variant that removes all objects except those in a specified `Collection`. `clear( )` removes all objects from the collection. All these modification methods except `clear( )` return `true` if the collection was modified as a result of the call. An interface cannot specify constructors, but it is conventional that all implementations of`Collection` provide at least two standard constructors: one that takes no arguments and creates an empty collection, and a copy constructor that accepts a `Collection` object that specifies the initial contents of the new `Collection`.

Implementations of `Collection` and its subinterfaces are not required to support all operations defined by the `Collection` interface. All modification methods listed above are optional; an implementation (such as an immutable `Set` implementation) that does not support them simply throws `java.lang.UnsupportedOperationException` for these methods. Furthermore, implementations are free to impose restrictions on the types of objects that can be members of a collection. Some implementations might require elements to be of a particular type, for example, and others might not allow `null` as an element.

See also `Set`, `List`, `Map`, and `Collections`.

Figure 16-10. java.util.Collection<E>


```
public interface Collection<E> extends Iterable<E> {
// Public Instance Methods
     boolean add(E o);
     boolean addAll(Collection<? extends E> c);
     void clear( );
     boolean contains(Object o);
     boolean containsAll(Collection<?> c);
     boolean equals(Object o);
     int hashCode( );
     boolean isEmpty( );
     Iterator<E> iterator( );
     boolean remove(Object o);
     boolean removeAll(Collection<?> c);
     boolean retainAll(Collection<?> c);
     int size( );
     Object[ ] toArray( );
     <T> T[ ] toArray(T[ ] a);
}
```

Implementations

AbstractCollection, List, Queue, Set

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Collections java.util

Java 1.2

This class defines static methods and constants that are useful for working with collections and maps. O commonly used methods is `sort( )` , which sorts a `List` in place (the list cannot be immutable, of cours sorting algorithm is stable, which means that equal elements retain the same relative order. One versio uses a specified `Comparator` to perform the sort; the other relies on the natural ordering of the list elem requires all the elements to implement `java.lang.Comparable` . `reverseOrder( )` returns a `Comparato` reverses the order of another `Comparator` or that reverse the natural ordering of `Comparable` objects.

A related method is `binarySearch( )` . It efficiently (in logarithmic time) searches a sorted `List` for a sp object and returns the index at which a matching object is found. If no match is found, it returns a nega For a negative return value `r` , the value `-(r+1)` specifies the index at which the specified object can be the list to maintain the sorted order of the list. As with `sort( )` , `binarySearch( )` can be passed a `Com` defines the order of the sorted list. If no `Comparator` is specified, the list elements must all implement `Co` and the list is assumed to be sorted according to the natural ordering defined by this interface.

See `Arrays` for methods that perform sorting and searching operations on arrays instead of collections.

The various methods whose names begin with `synchronized` return a threadsafe collection object wrapp the specified collection. `Vector` and `Hashtable` are the only two collection objects threadsafe by default. methods to obtain a `synchronized` wrapper object if you are using any other type of `Collection` or `Map` multithreaded environment where more than one thread can modify it.

The various methods whose names begin with `unmodifiable` function like `synchronized` methods. They `Collection` or `Map` object wrapped around the specified collection. The returned object is unmodifiable, its `add( )` , `remove( )` , `set( )` , `put( )` , etc. methods all throw `java.lang.UnsupportedOperationE` Java 5.0, the "checked" methods return wrapped collections that enforce a specified element type for th so that it is not possible to add an element of the wrong type.

In addition to the "synchronized", "unmodifiable", and "checked" methods, `Collections` defines a numb methods that return special-purpose collections or maps: `singleton( )` returns an unmodifiable set tha only the specified object. `singletonList( )` and `singletonMap( )` return an immutable list and an imm respectively, each of which contains only a single entry. The `Collections` class also defines related cons `EMPTY_LIST` , `EMPTY_SET` , and `EMPTY_MAP` , which are immutable `List` , `Set` , and `Map` objects that conta elements or mappings. In Java 5.0, the `emptySet( )` , `emptyList( )` , and `emptyMap( )` methods are p alternatives to these constants, because they are generic methods and return correctly parameterized e collections. `nCopies( )` creates a new immutable `List` that contains a specified number of copies of a sp object. `list( )` returns a `List` object that represents the elements of the specified `Enumeration` object. `enumeration( )` does the reverse: it returns an `Enumeration` for a `Collection` , which is useful when w code that uses the old `Enumeration` interface instead of the newer `Iterator` interface.

The `Collections` class also defines methods that mutate a collection. These methods throw an `UnsupportedOperationException` if the target collection is does not allow mutation. `copy( )` copies ele source list into a destination list. `fill( )` replaces all elements of the specified list with the specified obj swaps the elements at two specified indexes of a `List` . `replaceAll( )` replaces all elements in a `List` t to (using the equals( ) method) with another object, and returns true if any replacements were done. reverses the order of the elements in a list. rotate( ) "rotates" a list, adding the specified number to th each element, and wrapping elements from the end of the list back to the front of the list. (Specifying a rotation rotates the list in the other direction.) shuffle( ) randomizes the order of elements in a list, us internal source of randomness or the Random pseudorandom number generator you provide. In Java 5.0,) method adds the specified elements to the specified collection. This method is a varargs method and a elements to be specified in an array or listed individually in the argument list.

Finally, Collections defines methods (in addition to the binarySearch( ) methods described above) th elements of a collection: min( ) and max( ) methods search an unordered Collection for the minimum maximum elements, according either to a specified Comparator or to the natural order defined by the Co elements themselves. indexOfSubList( ) and lastIndexOfSubList( ) search a specified list forward o for a subsequence of elements that match (using equals( )) the elements the a second specified list. T the start index of any such matching sublist, or return -1 if no match was found. These methods are like indexOf( ) and lastIndexOf( ) methods of String , and do not require the List to be sorted, as the binarySearch( ) methods do. In Java 5.0, frequency( ) returns the number of occurences of a specifi a specified collection, and disjoint( ) determines whether two collections are entirely disjointwhether elements in common.

```
public class Collections {
// No Constructor
// Public Constants
     public static final List EMPTY_LIST;
1.3  public static final Map EMPTY_MAP;
     public static final Set EMPTY_SET;
// Public Class Methods
5.0  public static <T> boolean addAll(Collection<? super T> c, T ... a);
     public static <T> int binarySearch(List<? extends Comparable<? super T>> list, T k
     public static <T> int binarySearch(List<? extends T> list, T key, Comparator<? sup
5.0  public static <E> Collection<E> checkedCollection(Collection<E> c, Class<E> type);
5.0  public static <E> List<E> checkedList(List<E> list, Class<E> type);
5.0  public static <K,V> Map<K,V> checkedMap(Map<K,V> m, Class<K> keyType, Class<V> val
5.0  public static <E> Set<E> checkedSet(Set<E> s, Class<E> type);
5.0  public static <K,V> SortedMap<K,V> checkedSortedMap(SortedMap<K,V> m, Class<K> key
Class<V> valueType);
5.0  public static <E> SortedSet<E> checkedSortedSet(SortedSet<E> s, Class<E> type);
     public static <T> void copy(List<? super T> dest, List<? extends T> src);
5.0  public static boolean disjoint(Collection<?> c1, Collection<?> c2);
5.0  public static final <T> List<T> emptyList( );
5.0  public static final <K,V> Map<K,V> emptyMap( );
5.0  public static final <T> Set<T> emptySet( );
     public static <T> Enumeration<T> enumeration(Collection<T> c);
     public static <T> void fill(List<? super T> list, T obj);
5.0  public static int frequency(Collection<?> c, Object o);
1.4  public static int indexOfSubList(List<?> source, List<?> target);
1.4  public static int lastIndexOfSubList(List<?> source, List<?> target);
1.4  public static <T> ArrayList<T> list(Enumeration<T> e);
     public static <T extends Object&Comparable<? super T>> T max(Collection<? extends 
     public static <T> T max(Collection<? extends T> coll, Comparator<? super T> comp);
     public static <T extends Object&Comparable<? super T>> T min(Collection<? extends 
```

```
    public static <T> T min(Collection<? extends T> coll, Comparator<? super T> comp);
    public static <T> List<T> nCopies(int n, T o);
1.4 public static <T> boolean replaceAll(List<T> list, T oldVal, T newVal);
    public static void reverse(List<?> list);
    public static <T> Comparator<T> reverseOrder( );
5.0 public static <T> Comparator<T> reverseOrder(Comparator<T> cmp);
1.4 public static void rotate(List<?> list, int distance);
    public static void shuffle(List<?> list);
    public static void shuffle(List<?> list, Random rnd);
    public static <T> Set<T> singleton(T o);
1.3 public static <T> List<T> singletonList(T o);
1.3 public static <K,V> Map<K,V> singletonMap(K key, V value);
    public static <T extends Comparable<? super T>> void sort(List<T> list);
    public static <T> void sort(List<T> list, Comparator<? super T> c);
1.4 public static void swap(List<?> list, int i, int j);
    public static <T> Collection<T> synchronizedCollection(Collection<T> c);
    public static <T> List<T> synchronizedList(List<T> list);
    public static <K,V> Map<K,V> synchronizedMap(Map<K,V> m);
    public static <T> Set<T> synchronizedSet(Set<T> s);
    public static <K,V> SortedMap<K,V> synchronizedSortedMap(SortedMap<K,V> m);
    public static <T> SortedSet<T> synchronizedSortedSet(SortedSet<T> s);
    public static <T> Collection<T> unmodifiableCollection(Collection<? extends T> c);
    public static <T> List<T> unmodifiableList(List<? extends T> list);
    public static <K,V> Map<K,V> unmodifiableMap(Map<? extends K,? extends V> m);
    public static <T> Set<T> unmodifiableSet(Set<? extends T> s);
    public static <K,V> SortedMap<K,V> unmodifiableSortedMap(SortedMap<K,? extends V>
    public static <T> SortedSet<T> unmodifiableSortedSet(SortedSet<T> s);
}
```

Team LiB

Comparator<T> java.util

Java 1.2

This interface defines a compare( ) method that specifies a total ordering for a set of objects, allowing those objects to be sorted. The Comparator is used when the objects to be ordered do not have a natural ordering defined by the Comparable interface, or when you want to order them using something other than their natural ordering. Comparator has been made generic in Java 5.0 and the type variable *T* represents the type of objects being compared.

The compare( ) method is passed two objects. If the first argument is less than the second argument or should be placed before the second argument in a sorted list, compare( ) should return a negative integer. If the first argument is greater than the second argument or should be placed after the second argument in a sorted list, compare( ) should return a positive integer. If the two objects are equivalent or if their relative position in a sorted list does not matter, compare( ) should return 0. Comparator implementations may assume that both Object arguments are of appropriate types and cast them as desired. If either argument is not of the expected type, the compare( ) method throws a ClassCastException.

Note that the magnitude of the numbers returned by compare( ) does not matter, only whether they are less than, equal to, or greater than zero. In most cases, you should implement a Comparator so that compare(o1,o2) returns 0 if and only if o1.equals(o2) returns TRue. This is particularly important when using a Comparator to impose an ordering on a treeSet or a treeMap.

See Collections and Arrays for various methods that use Comparator objects for sorting and searching. See also the related java.lang.Comparable interface.

```
public interface Comparator<T> {
// Public Instance Methods
     int compare(T o1, T o2);
     boolean equals(Object obj);
}
```

Implementations

java.text.Collator

Passed To

Arrays.{binarySearch( ), sort( )}, Collections.{binarySearch( ), max( ), min( ), reverseOrder( ), sort( )}, PriorityQueue.PriorityQueue( ), treeMap.TreeMap( ), treeSet.TreeSet( ), java.util.concurrent.PriorityBlockingQueue.PriorityBlockingQueue( )

Returned By

Collections.reverseOrder( ), PriorityQueue.comparator( ), SortedMap.comparator( ), SortedSet.comparator( ), treeMap.comparator( ), TReeSet.comparator( ), java.util.concurrent.PriorityBlockingQueue.comparator( )

Type Of

String.CASE_INSENSITIVE_ORDER

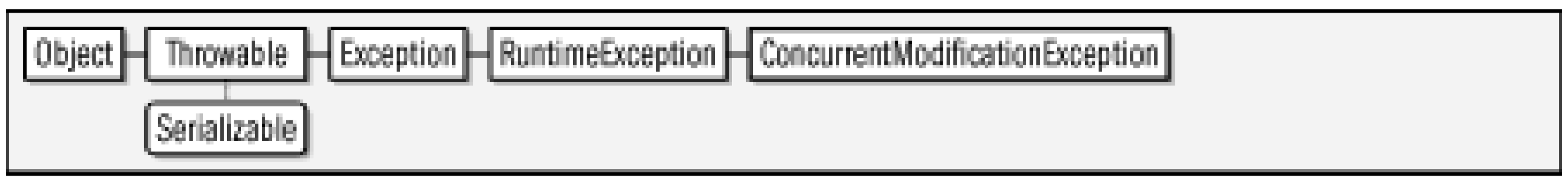
Team LiB

ConcurrentModificationException java.util

Java 1.2 *serializable unchecked*

Signals that a modification has been made to a data structure at the same time some other operatior is in progress and that, as a result, the correctness of the ongoing operation cannot be guaranteed. I is typically thrown by an `Iterator` or `ListIterator` object to stop an iteration if it detects that the underlying collection has been modified while the iteration is in progress.

Figure 16-11. java.util.ConcurrentModificationException




```
public class ConcurrentModificationException extends RuntimeException {
// Public Constructors
     public ConcurrentModificationException( );
     public ConcurrentModificationException(String message);
}
```

Team LiB

Currency java.util

Java 1.4 *serializable*

Instances of this class represent a currency. Obtain a `Currency` object by passing a "currency code" such as "USD" for U.S. Dollars or "EUR" for Euros to `getInstance( )`. Once you have a `Currency` object, use `getSymbol( )` to obtain the currency symbol (which is often different from the currency code) for the default locale or for a specified `Locale`. The symbol for a USD would be "$" in a U.S locale, but might be "US$" in other locales, for example. If no symbol is known, this method returns the currency code.

Use `geTDefaultFractionDigits( )` to determine how many fractional digits are conventionally used with the currency. This method returns 2 for the U.S. Dollar and other currencies that are divided into hundredths, but returns 3 for the Jordanian Dinar (JOD) and other currencies which are traditionally divided into thousandths, and returns 0 for the Japanese Yen (JPY) and other currencies that have a small unit value and are not usually divided into fractional parts at all. Currency codes are standardized by the ISO 4217 standard. For a complete list of currencies and currency codes see the website of the "maintenance agency" for this standard: http://www.iso.org/iso/en/prods-services/popstds/currencycodeslist.html.

Figure 16-12. java.util.Currency

```
public final class Currency implements Serializable {
// No Constructor
// Public Class Methods
     public static Currency getInstance(String currencyCode);
     public static Currency getInstance(Locale locale);
// Public Instance Methods
     public String getCurrencyCode( );
     public int getDefaultFractionDigits( );
     public String getSymbol( );
     public String getSymbol(Locale locale);
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`java.text.DecimalFormat.setCurrency( )`, `java.text.DecimalFormatSymbols.setCurrency(`

), `java.text.NumberFormat.setCurrency( )`

Returned By

`java.text.DecimalFormat.getCurrency( )`, `java.text.DecimalFormatSymbols.getCurrency( )`, `java.text.NumberFormat.getCurrency( )`

Team LiB

Team LiB

Date java.util

Java 1.0 *cloneable serializable comparable*

This class represents dates and times and lets you work with them in a system-independent way. You ca create a Date by specifying the number of milliseconds from the epoch (midnight GMT, January 1st, 197 or the year, month, date, and, optionally, the hour, minute, and second. Years are specified as the num of years since 1900. If you call the Date constructor with no arguments, the Date is initialized to the current time and date. The instance methods of the class allow you to get and set the various date and time fields, to compare dates and times, and to convert dates to and from string representations. As of Java 1.1, many of the date methods have been deprecated in favor of the methods of the Calendar clas

Figure 16-13. java.util.Date

```
public class Date implements Serializable, Cloneable, Comparable<Date> {
// Public Constructors
     public Date( );
     public Date(long date);
#    public Date(String s);
#    public Date(int year, int month, int date);
#    public Date(int year, int month, int date, int hrs, int min);
#    public Date(int year, int month, int date, int hrs, int min, int sec);
// Public Instance Methods
     public boolean after(Date when);
     public boolean before(Date when);
     public long getTime( );                          default:1101702237486
     public void setTime(long time);
// Methods Implementing Comparable
1.2  public int compareTo(Date anotherDate);
// Public Methods Overriding Object
1.2  public Object clone( );
     public boolean equals(Object obj);
     public int hashCode( );
     public String toString( );
// Deprecated Public Methods
#    public int getDate( );                          default:28
#    public int getDay( );                           default:0
#    public int getHours( );                         default:20
#    public int getMinutes( );                                        default:23
```

```
#    public int getMonth( );                               default:10
#    public int getSeconds( );                                              default:57
#    public int getTimezoneOffset( );                                       default:480
#    public int getYear( );                                default:104
#    public static long parse(String s);
#    public void setDate(int date);
#    public void setHours(int hours);
#    public void setMinutes(int minutes);
#    public void setMonth(int month);
#    public void setSeconds(int seconds);
#    public void setYear(int year);
#    public String toGMTString( );
#    public String toLocaleString( );
#    public static long UTC(int year, int month, int date, int hrs, int min, int sec);
}
```

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Dictionary<K,V> java.util

Java 1.0

This abstract class is the superclass of `Hashtable`. Other hashtable-like data structures might also extend this class. See `Hashtable` for more information. As of Java 1.2, the `Map` interface replaces the functionality of this class.

```
public abstract class Dictionary<K,V> {
// Public Constructors
     public Dictionary( );
// Public Instance Methods
     public abstract Enumeration<V> elements( );
     public abstract V get(Object key);
     public abstract boolean isEmpty( );
     public abstract Enumeration<K> keys( );
     public abstract V put(K key, V value);
     public abstract V remove(Object key);
     public abstract int size( );
}
```

Subclasses

`Hashtable`

DuplicateFormatFlagsException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when the format string contains duplicate format flags for the same conversion specifier.

Figure 16-14. java.util.DuplicateFormatFlagsException

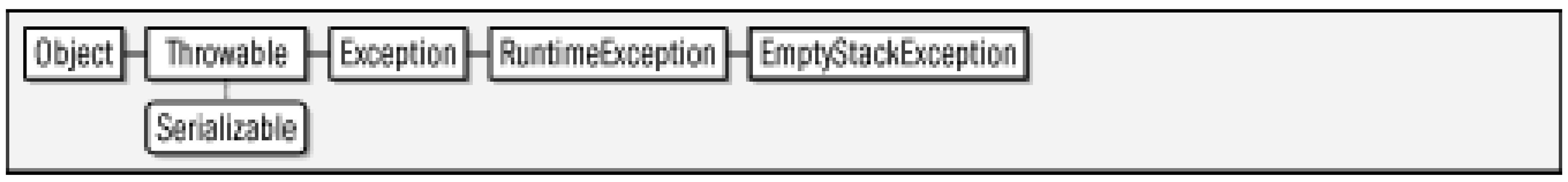

```
public class DuplicateFormatFlagsException extends IllegalFormatException {
// Public Constructors
     public DuplicateFormatFlagsException(String f);
// Public Instance Methods
     public String getFlags( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

EmptyStackException java.util

Java 1.0 *serializable unchecked*

Signals that a Stack object is empty.

Figure 16-15. java.util.EmptyStackException




```
public class EmptyStackException extends RuntimeException {
// Public Constructors
     public EmptyStackException( );
}
```

Team LiB

Enumeration<E> java.util

Java 1.0

This interface defines the methods necessary to enumerate, or iterate, through a set of values, such as the set of values contained in a hashtable. This interface is superseded in Java 1.2 by the `Iterator` inteface. In Java 5.0 this interface has been made generic and defines the type variable *E* to represent the type of the objects being enumerated.

An `Enumeration` is usually not instantiated directly, but instead is created by the object that is to have its values enumerated. A number of classes, such as `Vector` and `Hashtable`, have methods that return `Enumeration` objects.

To use an `Enumeration` object, you use its two methods in a loop. `hasMoreElements( )` returns `TRue` if there are more values to be enumerated and can determine whether a loop should continue. Within a loop, a call to `nextElement( )` returns a value from the enumeration. An `Enumeration` makes no guarantees about the order in which the values are returned. The values in an `Enumeration` can be iterated through only once; there is no way to reset it to the beginning.

```
public interface Enumeration<E> {
// Public Instance Methods
     boolean hasMoreElements( );
     E nextElement( );
}
```

Implementations

`StringTokenizer`

Passed To

`java.io.SequenceInputStream.SequenceInputStream( )`, `Collections.list( )`

Returned By

Too many methods to list.

EnumMap<K extends Enum<K>,V> java.util

Java 5.0 *cloneable serializable collection*

This class is a Map implementation for use with enumerated types. The key type *K* must be an enumerated type, and all keys must be enumerated constants defined by that type. null keys are not permitted. The value type *V* is unrestricted and null values are permitted.

The EnumMap implementation is based on an array of elements of type *V*. The length of this array is the same as the number of constants defined by the enumerated type *K*. All Map operations execute in constant time. The iterators of the keySet( ), enTRySet( ), and values( ) collections iterate their elements in the ordinal order of the enumerated constants. EnumMap is not threadsafe, but its iterators are based on a snapshot of the underlying array and never throw ConcurrentModificationException.

Figure 16-16. java.util.EnumMap<K extends Enum<K>,V>

```
public class EnumMap<K extends Enum<K>,V>
        extends AbstractMap<K,V> implements Serializable, Cloneable {
// Public Constructors
     public EnumMap(EnumMap<K,? extends V> m);
     public EnumMap(Class<K> keyType);
     public EnumMap(Map<K,? extends V> m);
// Public Instance Methods
     public EnumMap<K,V> clone( );
     public V put(K key, V value);
// Public Methods Overriding AbstractMap
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public Set<Map.Entry<K,V>> entrySet( );
     public boolean equals(Object o);
     public V get(Object key);
     public Set<K> keySet( );
     public void putAll(Map<? extends K,? extends V> m);
     public V remove(Object key);
     public int size( );
     public Collection<V> values( );
```

```
}
```

Team LiB

EnumSet<E extends Enum<E>> java.util

Java 5.0 *cloneable serializable collection*

This Set implementation is specialized for use with enumerated constants. The element type *E* must be an enumerated type, and null is not allowed as a member of the set.

EnumSet does not define a constructor. Instead, it defines various static factory methods for creating sets. Use one of the of( ) methods for creating an EnumSet and initializing its elements. For efficiency, versions of this method that accept one through five arguments are defined. If you pass more than five arguments, the varargs version will be invoked. The allOf( ) and noneOf( ) methods define full and empty sets but require the Class of the enumerated type since they do not have any other arguments to define the element type. complementOf( ) returns an EnumSet that contains all enumerated constants not contained by the specified EnumSet . The range( ) factory creates a set that includes the two specified values and any enumerated constants that fall between them in the enumerated type declaration. (Note that this definition of a range includes both endpoints and differs from most Java methods, in which the second argument specifies the first value past the end of the range.)

The EnumSet implementation is based on a bit vector that includes one bit for each constant defined by the enumerated type *E* . Because of this compact and efficient representation, basic Set operations occur in constant time, and the Iterator returns enumerated constants in the order in which they are declared in the type *E* . EnumSet is not threadsafe, but the Iterator uses a copy of the internal bit vector and never throws ConcurrentModificationException .

Figure 16-17. java.util.EnumSet<E extends Enum<E>>

```
public abstract class EnumSet<E extends Enum<E>>
        extends AbstractSet<E> implements Cloneable, Serializable {
// No Constructor
// Public Class Methods
     public static <E extends Enum<E>> EnumSet<E> allOf(Class<E> elementType);
     public static <E extends Enum<E>> EnumSet<E> complementOf(EnumSet<E> s);
     public static <E extends Enum<E>> EnumSet<E> copyOf(EnumSet<E> s);
     public static <E extends Enum<E>> EnumSet<E> copyOf(Collection<E> c);
     public static <E extends Enum<E>> EnumSet<E> noneOf(Class<E> elementType);
     public static <E extends Enum<E>> EnumSet<E> of(E e);
     public static <E extends Enum<E>> EnumSet<E> of(E first, E ... rest);
     public static <E extends Enum<E>> EnumSet<E> of(E e1, E e2);
     public static <E extends Enum<E>> EnumSet<E> of(E e1, E e2, E e3);
```

```
    public static <E extends Enum<E>> EnumSet<E> of(E e1, E e2, E e3, E e4);
    public static <E extends Enum<E>> EnumSet<E> of(E e1, E e2, E e3, E e4, E e5);
    public static <E extends Enum<E>> EnumSet<E> range(E from, E to);
// Public Instance Methods
    public EnumSet<E> clone( );
}
```

EventListener java.util

Java 1.1 *event listener*

`EventListener` is a base interface for the event model that is used by AWT and Swing in Java 1.1 and later. This interface defines no methods or constants; it serves simply as a tag that identifies objects that act as event listeners. The event listener interfaces in the `java.awt.event`, `java.beans`, and `javax.swing.event` packages extend this interface.

```
public interface EventListener {
}
```

Implementations

`EventListenerProxy`, `java.util.prefs.NodeChangeListener`, `java.util.prefs.PreferenceChangeListener`, `javax.net.ssl.HandshakeCompletedListener`, `javax.net.ssl.SSLSessionBindingListener`

Passed To

`EventListenerProxy.EventListenerProxy( )`

Returned By

`EventListenerProxy.getListener( )`

EventListenerProxy java.util

Java 1.4

This abstract class serves as the superclass for event listener proxy objects. Subclasses of this class implement an event listener interface and serve as a wrapper around an event listener of that type, defining methods that provide additional information about the listener. See `java.beans.PropertyChangeListenerProxy` for an explanation of how event listener proxy objects are used.

Figure 16-18. java.util.EventListenerProxy


```
public abstract class EventListenerProxy implements EventListener {
// Public Constructors
     public EventListenerProxy(EventListener listener);
// Public Instance Methods
     public EventListener getListener( );
}
```

EventObject java.util

Java 1.1 *serializable event*

`EventObject` serves as the superclass for all event objects used by the event model introduced in Java 1.1 for AWT and JavaBeans and also used by Swing in Java 1.2. This class defines a generic type of event; it is extended by the more specific event classes in the `java.awt`, `java.awt.event`, `java.beans`, and `javax.swing.event` packages. The only common feature shared by all events is a source object, which is the object that, in some way, generated the event. The source object is passed to the `EventObject( )` constructor and is returned by the `getSource( )` method.

Figure 16-19. java.util.EventObject


```
public class EventObject implements Serializable {
// Public Constructors
     public EventObject(Object source);
// Public Instance Methods
     public Object getSource( );
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Fields
     protected transient Object source;
}
```

Subclasses

`java.util.prefs.NodeChangeEvent`, `java.util.prefs.PreferenceChangeEvent`, `javax.net.ssl.HandshakeCompletedEvent`, `javax.net.ssl.SSLSessionBindingEvent`

FormatFlagsConversionMismatchException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when a conversion specifier and a format flag specified with it are incompatible.

Figure 16-20. java.util.FormatFlagsConversionMismatchException


```
public class FormatFlagsConversionMismatchException extends IllegalFormatException {
// Public Constructors
     public FormatFlagsConversionMismatchException(String f, char c);
// Public Instance Methods
     public char getConversion( );
     public String getFlags( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

Formattable java.util

Java 5.0

This interface should be implemented by classes that want to interact with the Formatter class more intimately than is possible with the toString method. When a Formattable object is the argument for a %s or %S conversion, its formatTo( ) method is invoked rather than its toString( ) method. formatTo) is responsible for formatting a textual representation of the object to the specified *formatter* , subject the constraints imposed by the *flags* , *width* , and *precision* arguments.

The *flags* argument is a bitmask of zero or more FormattableFlags constants. Each flag provides information about the format specification that resulted in the invocation of formatTo( ) . FormattableFlags.ALTERNATE indicates that the # flag was used and that the Formattable should form itself using some alternate form. The interpretation of the alternate form is entirely up to the Formattabl implementation. LEFT_JUSTIFY means that the - flag was used and that the Formattable should pad its output on the right, instead of on the left. UPPERCASE indicates that the %S conversion was used instead %s and the Formattable should output uppercase characters instead of lowercase.

The *width* and *precision* arguments specify the width and precision specified along with the %s format specifier, or -1 if no width and precision are specified. The Formattable object should treat these values the same way that Formatter does. The text to be output should first be truncated to fit within *precisi* characters and then padded on the left (or right if the LEFT_JUSTIFY flag is set) with spaces for a total length of *width* characters. Note that a Formattable implementation may fulfill the obligations imposed the LEFT_JUSTIFY and UPPERCASE flags and the *width* and *precision* arguments by constructing a suitable format string to pass back to the specified Formatter .

If a Formattable implementation wants to perform locale-specific formatting, it can query the Locale of the Formatter with the locale( ) method. Note, however, that the returned value is the locale specifie when the Formatter was created, not the Locale , if any, passed to the format( ) method. There is no way for a Formattable object to access that Locale .

```
public interface Formattable {
// Public Instance Methods
     void formatTo(java.util.Formatter formatter, int flags, int width, int precision);
}
```

FormattableFlags java.util

Java 5.0

This class defines three constants representing flags that may be passed as a bitmask to the `Formattable.formatTo( )` method. See `Formattable` for the interpretation of these flags.

```
public class FormattableFlags {
// No Constructor
// Public Constants
     public static final int ALTERNATE;                                    =4
     public static final int LEFT_JUSTIFY;                                 =1
     public static final int UPPERCASE;                                    =2
}
```

Formatter java.util

Java 5.0 *closeable flushable*

The Formatter class is a utility for formatting text in the style of the printf( ) method of the C programming language. Every Formatter has an associated java.lang.Appendable object (such as a StringBuilder or PrintWriter) that is specified when the Formatter is created. format( ) is a varargs method that expects a "format string" argument followed by some number of Object arguments. The format string uses a grammar, described in detail later in the entry, to specify how the arguments that follow are to be converted to strings. After the arguments are converted, they are substituted into the format string, and the resulting text is appended to the Appendable . A variant of the format( ) method accepts a Locale object that can affect the argument conversions.

For ease of use, a Formatter never throws a java.io.IOException , even when the underlying Appendable tHRows one. When using a Formatter with a stream-based Appendable object that may throw an IOException , you can use the ioException( ) method to obtain the most recently thrown exception, or null if no exception has been thrown by the Appendable .

Formatter implements the Closeable and Flushable interfaces of the java.io package, and its close( ) and flush( ) methods call the corresponding methods on its Appendable object, if that object itself implements Closeable or Flushable . When a Formatter sends its output to a stream or similar Appendable , remember to call close( ) when you are done with it. It is always safe to cal close( ) even if the underlying Appendable is not Closeable . Note that once a Formatter has been closed, no other method except ioException( ) may be called.

locale( ) returns the Locale passed to the Formatter( ) constructor or null . out( ) returns the Appendable that this Formatter sends its output to. toString( ) returns the result of calling toString( ) on that Appendable . This is useful when the Appendable is a StringBuilder , for example, as it is when the no-argument version of the Formatter( ) constructor is used. If the Appendable is a stream class, however, the toString( ) method is not typically useful.

Note that the Java 5.0 API provides a number of convenience methods that use the Formatter class, and in many cases it is unnecessary to create a Formatter object explicitly. See the static String.format( ) method and the format( ) and printf( ) methods of java.io.PrintWriter and java.io.PrintStream .

If you do need to create a Formatter object explicitly, you can choose from a number of constructors. The most general case is to pass the desired Appendable or the desired Locale and Appendable objects to the constructor. The no-argument constructor is a convenience that creates a StringBuilder to append to. Obtain this StringBuilder with out( ) or obtain its contents as a String with toString( ) . If you specify a single Locale argument, the resulting Formatter uses the specified locale with a StringBuilder .

You can use a Formatter to write formatted output to a file by specifying either the File object or filename as a String . Variants of these constructors allow you to specify the name of the charset to use for character-to-byte conversion and also a Locale . Note that these methods overwrite existing files rather than appending to them. Other constructors create an Appendable object for you based on the java.io.OutputStream or java.io.PrintStream you specify. In the OutputStream case, you may optionally specify the charset to use or the charset and a Locale .

The Format String and Format Specifiers

The API for Formatter and Formatter -based convenience methods is relatively simple. The power of these formatting methods lies in the format string that is the first argument (or second argument if a Locale is specified) to the various format( ) and printf( ) methods. The format string may contain any amount of regular text, which is printed or appended literally to the destination Appendable object. This plain text may be interspersed with *format specifiers* which specify how a subsequent argument is to be formatted as a string. In contrast to the simple API, the grammar for these format specifiers is surprisingly complex. Experienced C programmers will find that the grammar is largely compatible with the printf( ) format string grammar of the standard C library.

Each format specifier begins with a percent sign and ends with a one- or two-character conversion type that specifies most of the details of the conversion and formatting. In between these two are optional flags that provide additional details about how the formatting should be done. The general syntax of a format specifier is as follows. Square brackets indicate optional items:

```
%[argument][flags][width][.precision]type
```

Note that the percent sign and the *type* are the only two required portions of a format specifier. We begin, therefore, with a listing of conversion types (see Table 16-1). A discussion of *argument* , *flags* , *width* , and *precision* follows. In the table of conversion types below, if uppercase and lowercase variants of the type specifier are listed together, the uppercase variant produces the same output as the lowercase variant except that all lowercase letters are converted to uppercase. Note that format( ) never throws NullPointerException because of null arguments following the format string. A null argument is formatted as "null" or "NULL" for all conversion characters except %b and %B , which produce "false" or "FALSE".

Table 16-1. Formatter conversion types

Conversion	Description
Simple conversions	
%%	Outputs a single percent sign.This is simply an escape sequence used to embed percent signs literally in the output string. This conversion does not use an argument.
%n	Outputs the platform-specific line separator. This conversion represents the value returned by System.getProperty("line.separator") . This conversion does not use an argument.
%s, %S	Formats and outputs the argument as a string, optionally converting it to uppercase for the %S conversion. The argument may be of any type. If the argument implements Formattable , its formatTo( ) method is called to perform the formatting. Otherwise, its toString( ) method is called to convert it to a string. If the argument is null , the output string is "null" or "NULL".

Conversion	Description
`%c, %C`	Outputs the argument as a single character. The argument type must be `Byte` , `Short` , `Character` , or `Integer` . The argument value must represent a valid Unicode code point. (See `Character.isValidCodePoint( )` .)
`%b, %B`	Outputs the argument value as the string "true" or "false" (or "TRUE" or "FALSE"). The argument may be of any type and any value. If it is a `Boolean` argument, the output reflects the argument value. Otherwise, if the argument is `null` , the output is "false" or "FALSE". For any other value, the output is "true" or "TRUE". Note that this differs from normal Java conversions in which `boolean` values are not convertible to or from any other type.
`%h, %H`	Outputs the hexadecimal representation of the hashcode for the argument. Arguments of any type and value are allowed. This conversion type is useful mainly for debugging.
Numeric Conversions	
`%d`	Formats the argument as a base-10 integer. The argument must be a `Byte` , `Short` , `Integer` , `Long` , or `BigInteger` .
`%o`	Formats the argument as a base-8 octal integer. The allowed argument types are the same as for `%d` . For any argument type other than `BigInteger` , the value is treated as unsigned.
`%x, %X`	Formats the argument as a base-16 hexadecimal integer. The allowed argument types and values are the same as for `%d` . For any argument type other than `BigInteger` , the value is treated as unsigned.
`%e, %E`	Formats the argument as a base-10 floating-point number, using exponential notation. The output consists of a single digit, a locale-specific decimal point, and the number of fractional digits specified by the *`precision`* of the format specifier, or six fractional digits if no *`precision`* is specified. These digits are followed by the letter `e` or `E` and the exponent of the number. The argument must be a `Float` , `Double` , or `BigDecimal` . The values `NaN` and `Infinity` are formatted as "NaN" and "Infinity" or their uppercase equivalents.
`%f`	Formats the argument as a floating-point number in base-10, without using exponential notation. If the number is large, this may produce quite a few digits. Because exponential notation is never used, the output will never include a letter, and there is no uppercase variant of this conversion. Legal argument types and special-case values are as for `%e` .
`%g, %G`	Formats the argument as a base-10 floating-point number, displaying no more than the number of significant digits specified by the *`precision`* of the format specifier, or no more than 6 significant digits if no *`precision`* is specified. If the value has more than the allowed number of significant digits, it is printed using exponential notation (see `%e`) to limit the display to the specified number of digits. Otherwise, all digits of the value are printed explicitly as they would be with the `%f` conversion type. Legal argument types and special case values are as for `%e` .
`%a, %A`	Formats the argument in hexadecimal floating-point format. Legal argument types and special case values are as for `%e` .

Conversion	Description
Dates and Times	
%t, %T	All date and time format types are two-letter codes beginning with %t or %T . The specific format types are listed below, in alphabetical order, using %t as the prefix. For uppercase, use %T instead. Upper- and lowercase variants of the second letter of a time or date format type are sometimes completely unrelated. Other times, the lowercase conversion produces an abbreviation of the value produced by the uppercase conversion. The argument for a date or time conversion must be a Date , Calendar , or Long . In the case of Long , the value is interpreted as milliseconds since the epoch, as in System currentTimeMillis( ) .
%tA	The locale-specific full name of the day of the week.
%ta	The locale-specific abbreviation of the day of the week.
%tB	The locale-specific name of the month. See %tm .
%tb	The locale-specific abbreviation for the month.
%tC	The century: the year divided by 100, with leading zeros if necessary to produce a value from 00 to 99
%tc	The complete date and time. Equivalent to "%ta %tb %td %tT %tZ %tY".
%td	The date in a short numeric form used in the US locale. Equivalent to "%tm/%td/%ty".
%td	The day of the month, as a two-digit number between 01 and 31. See %te .
%tE	The date expressed as milliseconds since Midnight UTC on January 1st, 1970.
%te	The day of the month as a one- or two-digit number without leading zeros between 1 and 31. See %td .
%tF	The numeric date in ISO8601 format: %tY-%tm-%td.
%tH	Hour of the day using a 24-hour clock, formatted as two digits between 00 and 23. See %tI .
%th	The abbreviated month name. Same as %tb .
%tI	Hour of the day using a 12-hour clock, formatted as two digits between 01 and 12. See %tH and %tP .
%tj	The day of the year as three digits with leading zeros if necessary: 001-366
%tk	Hour of the day on a 24-hour clock using one or two digits without a leading zero: 0-23. See %tl .
%tL	Milliseconds within the second, expressed as three digits with leading zeros: 000-999.
%tl	Hour of the day on a 12-hour clock using one or two digits without a leading zero: 1-12.
%tM	Minute within the hour as two digits with a leading zero if necessary: 00-59.

Conversion	Description
%tm	The month of the year as a two-digit number between 01 and 12, or between 01 and 13 for lunar calendars. See %tB and %tb .
%tN	Nanosecond within the second, expressed as nine digits with leading zeros if necessary. Note that platforms are not required to able to resolve times with nanosecond precision.
%tP	The locale-specific morning or afternoon indicator (such as "am" or "pm") used with 12-hour clocks. %tP uses lowercase and %TP uses uppercase.
%tp	Like %tP but uses uppercase for both %tp and %Tp variants.
%tr	The hour and minute on a 24-hour clock. Equivalent to "%tH:%tM".
%tr	The hour, minute, and second on a 12-hour clock. Equivalent to "%tI:%tM:%tS %tP" except that the am/pm indicator %tP may be in a different locale-dependent position.
%tS	Seconds within the minute, as two digits with a leading zero if necessary. The range is normally 00-59, but a value of 60 is allowed for leap seconds.
%ts	Seconds since the beginning of the epoch. See%tE .
%tT	The time in hours, minutes, and seconds using 24-hour format. Equivalent to "%tH:%tM:%tS".
%tY	The year, using at least four digits, formatted with leading zeros, if necessary.
%ty	The last two digits of the year, 00-99
%tZ	An abbreviation for the time zone.
%tz	The time zone as numeric offset from GMT.

Argument Specifier

Every format specifier in a format string except for %% and %n requires an argument that contains the value to format. These arguments follow the format string in the call to format( ) or printf( ) . By default, a format specifier uses the next unused argument. In the following printf( ) call, the first and second %s format specifiers format the second and third arguments, respectively:

```
out.printf("Name: %s %s%n", first, last);
```

If a format specifier includes the character < after the % , it specifies that the argument of the previous format specifier should be reused. This allows the same object (such as a date) to be formatted more than once (yielding a formatted date and time, for example):

```
out.printf("Date: %tD%nTime: %<tr%n", System.currentTimeMillis( ));
```

It is an error to use < in the first format specifier of a format string.

Argument numbers may also be specified absolutely. If the% sign is followed by one or more digits and a $ sign, those digits specify an argument number. For example %1$d specifies that the first argument following the format string should be formatted as an integer. Absolute argument numbers are particularly useful for localization since the different translations of a message may need to interpolate the arguments in a different order. The following example includes a format string that might be used in a locale where a person's family name is typically printed (in uppercase) before the given name. Note that the arguments are not passed in the same order that they are formatted.

```
String name = String.format("%2$S, %1$s", firstname, lastname);
```

Neither absolute argument indexing with a number and $ character or relative argument indexing with < affect the order in which arguments are interpolated for format specifiers that use neither $ or < . The first format specifier that has neither an absolute or relative argument specification uses the first argument following the format string, regardless of what has come before. The code above could be rewritten like this, for example:

```
String name = String.format("%2$S, %s", firstname, lastname);
```

Flags

Following the optional argument specifier, a format specifier may include one or more flag characters. The defined flags, their effects, and the format types for which they are legal are specified in Table 16-2 :

Table 16-2. Formatter flags

Flag	Description
-	A hyphen specifies that the formatted value should be left-justified within the specified *width* . This flag can be used with any conversion type except %n as long as the conversion specifier also includes a *width* (see below). When a width is specified without this flag, the formatted string is padded on the left to produce right-justified output.
#	The # flag specifies that output should appear in an "alternate form" that depends on the type being formatted. For %o conversions, this flag specifies that the output should include a leading 0. For %x and %X conversions, it specifies that output should include a leading 0x or 0X . For the %s and %S conversions, the # flag may be used if the argument implements Formattable . In this case, the flag is passed on to the formatTo( ) method of the argument, and it is up to that formatTo( ) method to produce its output in some alternate form.
+	This flag specifies that numeric output should always include a sign: a value that is nonnegative will have "+" added in front of it. This flag may be used with any numeric conversion that may yield a signed result. This includes %d , %e , %f , %g , %a , and their uppercase variants. It also includes %o , %x , and %X conversions applied to BigInteger arguments.

Flag	Description
	The space character is a (hard-to-read) flag that specifies that non-negative values should be prefixed with a space. This flag may be used with the same conversion and argument types as the `+` flag, and is useful when aligning positive and negative numbers in a column
`(`	This flag specifies that negative numbers should be enclosed in parentheses, as is commonly done in financial statements, for example. This flag may be used with the same format and argument types as the `+` flag, except that it may not be used with `%a` conversions.
`0`	The digit zero, used as a flag, specifies that numeric values should be padded on the left (after the sign character, if any) with zeros. This flag may be used only if a width is specified, and may not be used in conjunction with the `-` flag.
`,`	This flag specifies that numbers should be formatted using the locale-specific grouping separator. In the US locale, for example, a comma would appear every three digits to separate the number into thousands, millions, and so on. This flag may be used with `%d` , `%e` , `%E` , `%f` , `%g` , and `%G` conversions only.

Width

The *`width`* portion of a format specifier is one or more digits that specify the minimum number of characters to be produced. If the formatted value is narrower than the specified width, (by default) it is padded on the left with spaces, producing a right-justified value. The `-` and `0` flags can be used to specify left-justification or padding with zeros instead.

A width may be specified with any format type except `%n` .

Precision

The *`precision`* portion of a format specifier is one or more digits following a decimal point. The meaning of this number depends on which format type it is used with:

- For `%e` , `%E` , and `%f` , the precision specifies the number of digits to appear after the decimal point. Zeros are appended on the right, if necessary. The default precision is 6.
- For `%g` and `%G` format types, the precision specifies the total number of significant digits to be displayed. As a corollary, it specifies the largest and smallest values that can be displayed without resorting to exponential notation. The default precision is 6. If a precision of 0 is specified, it is treated as a precision of 1.
- For `%s` , `%h` and `%b` format types, and their uppercase variants, the precision specifies the maximum number of characters to be output. If no precision is specified, there is no maximum. If the formatted output would exceed the *`precision`* of characters, it is truncated. If *`precision`* is smaller than *`width`* , the formatted value is first truncated as necessary and then padded within the specified *`width`* .
- Specifying a precision for any other conversion type causes an exception at runtime.

Synopsis

Figure 16-21. java.util.Formatter


```
public final class Formatter implements java.io.Closeable, java.io.Flushable {
// Public Constructors
     public Formatter( );
     public Formatter(java.io.PrintStream ps);
     public Formatter(java.io.OutputStream os);
     public Formatter(java.io.File file) throws java.io.FileNotFoundException;
     public Formatter(String fileName) throws java.io.FileNotFoundException;
     public Formatter(Locale l);
     public Formatter(Appendable a);
     public Formatter(java.io.OutputStream os, String csn)
        throws java.io.UnsupportedEncodingException;
     public Formatter(java.io.File file, String csn)
        throws java.io.FileNotFoundException, java.io.UnsupportedEncodingException;
     public Formatter(Appendable a, Locale l);
     public Formatter(String fileName, String csn)
        throws java.io.FileNotFoundException, java.io.UnsupportedEncodingException;
     public Formatter(String fileName, String csn, Locale l)
        throws java.io.FileNotFoundException, java.io.UnsupportedEncodingException;
     public Formatter(java.io.File file, String csn, Locale l)
        throws java.io.FileNotFoundException, java.io.UnsupportedEncodingException;
     public Formatter(java.io.OutputStream os, String csn, Locale l)
        throws java.io.UnsupportedEncodingException;
// Nested Types
     public enum BigDecimalLayoutForm;
// Public Instance Methods
     public java.util.Formatter format(String format, Object... args);
     public java.util.Formatter format(Locale l, String format, Object... args);
     public java.io.IOException ioException( );
     public Locale locale( );
     public Appendable out( );
// Methods Implementing Closeable
     public void close( );
// Methods Implementing Flushable
     public void flush( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`Formattable.formatTo( )`

Team LiB

Formatter.BigDecimalLayoutForm java.util

Java 5.0 *serializable comparable enum*

This enumerated type is intended for internal use by the `Formatter` class, but was inadvertently declared `public`. This type serves no useful purpose and should not be used. It will likely be removed in a future release.

```
public enum Formatter.BigDecimalLayoutForm {
// Enumerated Constants
     SCIENTIFIC,
     DECIMAL_FLOAT;
// Public Class Methods
     public static Formatter.BigDecimalLayoutForm valueOf(String name);
     public static final Formatter.BigDecimalLayoutForm[ ] values( );
}
```

Team LiB

FormatterClosedException java.util

Java 5.0 *serializable unchecked*

An exception of this type is thrown when an attempt is made to use a `Formatter` whose `close( )` method has been called.

Figure 16-22. java.util.FormatterClosedException


```
public class FormatterClosedException extends IllegalStateException {
// Public Constructors
     public FormatterClosedException( );
}
```

GregorianCalendar java.util

Java 1.1 *cloneable serializable comparable*

This concrete subclass of Calendar implements the standard solar calendar with years numbered from tl of Christ that is used is most locales throughout the world. You do not typically use this class directly, bu obtain a Calendar object suitable for the default locale by calling Calendar.getInstance( ) . See Caler details on working with Calendar objects. There is a discontinuity in the Gregorian calendar that represe historical switch from the Julian calendar to the Gregorian calendar. By default, GregorianCalendar assu that this switch occurs on October 15, 1582. Most programs need not be concerned with the switch.

Figure 16-23. java.util.GregorianCalendar


```
public class GregorianCalendar extends Calendar {
// Public Constructors
     public GregorianCalendar( );
     public GregorianCalendar(Locale aLocale);
     public GregorianCalendar(TimeZone zone);
     public GregorianCalendar(TimeZone zone, Locale aLocale);
     public GregorianCalendar(int year, int month, int dayOfMonth);
     public GregorianCalendar(int year, int month, int dayOfMonth, int hourOfDay,
        int minute);
     public GregorianCalendar(int year, int month, int dayOfMonth, int hourOfDay, int m
        int second);
// Public Constants
     public static final int AD;                                          =1
     public static final int BC;                                          =0
// Public Instance Methods
     public final Date getGregorianChange( );
     public boolean isLeapYear(int year);
     public void setGregorianChange(Date date);
// Public Methods Overriding Calendar
     public void add(int field, int amount);
5.0  public Object clone( );
     public boolean equals(Object obj);
1.2  public int getActualMaximum(int field);
1.2  public int getActualMinimum(int field);
     public int getGreatestMinimum(int field);
     public int getLeastMaximum(int field);
```

```
     public int getMaximum(int field);
     public int getMinimum(int field);
5.0  public TimeZone getTimeZone( );
     public int hashCode( );
     public void roll(int field, boolean up);
1.2  public void roll(int field, int amount);
5.0  public void setTimeZone(TimeZone zone);
// Protected Methods Overriding Calendar
     protected void computeFields( );
     protected void computeTime( );
}
```

Passed To

javax.xml.datatype.DatatypeFactory.newXMLGregorianCalendar( )

Returned By

javax.xml.datatype.XMLGregorianCalendar.toGregorianCalendar( )

HashMap<K,V> java.util

Java 1.2 *cloneable serializable collection*

This class implements the Map interface using an internal hashtable. It supports all optional Map methods and value objects of any types, and allows null to be used as a key or a value. Because HashMap is base hashtable data structure, the get( ) and put( ) methods are very efficient. HashMap is much like the Ha class, except that the HashMap methods are not synchronized (and are therefore faster), and HashMap a to be used as a key or a value. If you are working in a multithreaded environment, or if compatibility wi versions of Java is a concern, use Hashtable . Otherwise, use HashMap .

If you know in advance approximately how many mappings a HashMap will contain, you can improve effic specifying *initialCapacity* when you call the HashMap( ) constructor. The *initialCapacity* argume the *loadFactor* argument should be greater than the number of mappings the HashMap will contain. A g for *loadFactor* is 0.75; this is also the default value. See Map for details on the methods of HashMap . Se TReeMap and HashSet .

Figure 16-24. java.util.HashMap<K,V>

```
public class HashMap<K,V> extends AbstractMap<K,V> implements Map<K,V>, Cloneable, Seria
// Public Constructors
     public HashMap( );
     public HashMap(int initialCapacity);
     public HashMap(Map<? extends K,? extends V> m);
     public HashMap(int initialCapacity, float loadFactor);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public Set<Map.Entry<K,V>> entrySet( );
     public V get(Object key);
     public boolean isEmpty( );                          default:true
     public Set<K> keySet( );
     public V put(K key, V value);
     public void putAll(Map<? extends K,? extends V> m);
     public V remove(Object key);
     public int size( );
     public Collection<V> values( );
// Public Methods Overriding AbstractMap
```

```
    public Object clone( );
}
```

Subclasses

LinkedHashMap

Team LiB

HashSet<E> java.util

Java 1.2 *cloneable serializable collection*

This class implements Set using an internal hashtable. It supports all optional Set and Collection meth and allows any type of object or null to be a member of the set. Because HashSet is based on a hashtal the basic add( ) , remove( ) , and contains( ) methods are all quite efficient. HashSet makes no guarantee about the order in which the set elements are enumerated by the Iterator returned by iterator( ) . The methods of HashSet are not synchronized . If you are using it in a multithreaded environment, you must explicitly synchronize all code that modifies the set or obtain a synchronized wra for it by calling Collections.synchronizedSet( ) .

If you know in advance approximately how many mappings a HashSet will contain, you can improve efficiency by specifying *initialCapacity* when you call the HashSet( ) constructor. The *initialCapac* argument times the *loadFactor* argument should be greater than the number of mappings the HashSet contain. A good value for *loadFactor* is 0.75; this is also the default value. See Set and Collection for details on the methods of HashSet . See also TReeSet and HashMap .

Figure 16-25. java.util.HashSet<E>

```
public class HashSet<E> extends AbstractSet<E> implements Set<E>, Cloneable, Serializabl
// Public Constructors
     public HashSet( );
     public HashSet(Collection<? extends E> c);
     public HashSet(int initialCapacity);
     public HashSet(int initialCapacity, float loadFactor);
// Methods Implementing Set
     public boolean add(E o);
     public void clear( );
     public boolean contains(Object o);
     public boolean isEmpty( );                          default:true
     public Iterator<E> iterator( );
     public boolean remove(Object o);
     public int size( );
// Public Methods Overriding Object
     public Object clone( );
}
```

Subclasses

LinkedHashSet

Team LiB

Hashtable<K,V> java.util

Java 1.0 *cloneable serializable collection*

This class implements a hashtable data structure, which maps key objects to value objects and allows the efficient lookup of the value associated with a given key. In Java 1.2 and later `Hashtable` has been modified to impement the `Map` interface. The `HashMap` class is typically preferred over this one, although the `synchronized` methods of this class are useful in multi-threaded applications. (But see `java.util.concurrent.ConcurrentHashMap`.) In Java 5.0 this class has been made generic along with the `Map` interface. The type variable *K* represents the type of the hashtable keys and the type variable *V* represents the type of the hashtable values.

`put( )` associates a value with a key in a `Hashtable`. `get( )` retrieves a value for a specified key. `remove( )` deletes a key/value association. `keys( )` and `elements( )` return `Enumeration` objects that allow you to iterate through the complete set of keys and values stored in the table. Objects used as keys in a `Hashtable` must have valid `equals( )` and `hashCode( )` methods (the versions inherited from `Object` are okay). `null` is not legal as a key or value in a `Hashtable`.

Figure 16-26. java.util.Hashtable<K,V>

```
public class Hashtable<K,V> extends Dictionary<K,V> implements Map<K,V>,
        Cloneable, Serializable {
// Public Constructors
     public Hashtable( );
1.2  public Hashtable(Map<? extends K,? extends V> t);
     public Hashtable(int initialCapacity);
     public Hashtable(int initialCapacity, float loadFactor);
// Public Instance Methods
     public void clear( );         Implements:Map synchronized
     public boolean contains(Object value);         synchronized
     public boolean containsKey(Object key);        Implements:Map synchronized
     public V get(Object key);   Implements:Map synchronized
     public boolean isEmpty( );    Implements:Map synchronized default:true
     public V put(K key, V value);                  Implements:Map synchronized
     public V remove(Object key);                   Implements:Map synchronized
     public int size( );           Implements:Map synchronized
// Methods Implementing Map
     public void clear( );                           synchronized
```

```
     public boolean containsKey(Object key);                  synchronized
1.2  public boolean containsValue(Object value);
1.2  public Set<Map.Entry<K,V>> entrySet( );
1.2  public boolean equals(Object o);                         synchronized
     public V get(Object key);                           synchronized
1.2  public int hashCode( );                           synchronized
     public boolean isEmpty( );                      synchronized default:true
1.2  public Set<K> keySet( );
     public V put(K key, V value);                       synchronized
1.2  public void putAll(Map<? extends K,? extends V> t);     synchronized
     public V remove(Object key);                        synchronized
     public int size( );                                   synchronized
1.2  public Collection<V> values( );
// Public Methods Overriding Dictionary
     public Enumeration<V> elements( );                     synchronized
     public Enumeration<K> keys( );                         synchronized
// Public Methods Overriding Object
     public Object clone( );                               synchronized
     public String toString( );                            synchronized
// Protected Instance Methods
     protected void rehash( );
}
```

Subclasses

Properties

IdentityHashMap<K,V> java.util

Java 1.4 *cloneable serializable collection*

This Map implementation has a API that is very similar to HashMap, and uses an internal hashtable, like HashMap does. However, it behaves differently from HashMap in one very important way. When testing two keys to see if they are equal, HashMap, LinkedHashMap and treeMap use the equals( ) method to determine whether the two objects are indistinguishable in terms of their content or state. IdentityHashMap is different: it uses the == operator to determine whether the two key objects are identicalwhether they are exactly the same object. This one difference in how key equality is tested has profound ramifications for the behavior of the Map. In most cases, the equality testing of a HashMap, LinkedHashMap or TReeMap is the appropriate behavior, and you should use one of those classes. For certain purposes, however, the identity testing of IdentityHashMap is what is required.

Figure 16-27. java.util.IdentityHashMap<K,V>

```
public class IdentityHashMap<K,V> extends AbstractMap<K,V> implements Map<K,V>,
        Serializable, Cloneable {
// Public Constructors
     public IdentityHashMap( );
     public IdentityHashMap(int expectedMaxSize);
     public IdentityHashMap(Map<? extends K,? extends V> m);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public Set<Map.Entry<K,V>> entrySet( );
     public boolean equals(Object o);
     public V get(Object key);
     public int hashCode( );
     public boolean isEmpty( );                          default:true
     public Set<K> keySet( );
     public V put(K key, V value);
     public void putAll(Map<? extends K,? extends V> t);
     public V remove(Object key);
     public int size( );
     public Collection<V> values( );
// Public Methods Overriding AbstractMap
     public Object clone( );
```

```
}
```

IllegalFormatCodePointException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when an `int` used to represent a Unicode character is out of range.

Figure 16-28. java.util.IllegalFormatCodePointException


```
public class IllegalFormatCodePointException extends IllegalFormatException {
// Public Constructors
     public IllegalFormatCodePointException(int c);
// Public Instance Methods
     public int getCodePoint( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

IllegalFormatConversionException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when the type of the `format( )` or `printf( )` argument does not match the type required by the corresponding conversion specifier in the format string.

Figure 16-29. java.util.IllegalFormatConversionException


```
public class IllegalFormatConversionException extends IllegalFormatException {
// Public Constructors
     public IllegalFormatConversionException(char c, Class<?> arg);
// Public Instance Methods
     public Class<?> getArgumentClass( );
     public char getConversion( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

IllegalFormatException java.util

Java 5.0 *serializable unchecked*

An exception of this type is thrown by a `Formatter` when there is problem with the format string. This package defines many subclasses of this exception type to describe particular format string problems.

Figure 16-30. java.util.IllegalFormatException


```
public class IllegalFormatException extends IllegalArgumentException {
// No Constructor
}
```

Subclasses

`DuplicateFormatFlagsException`, `FormatFlagsConversionMismatchException`, `IllegalFormatCodePointException`, `IllegalFormatConversionException`, `IllegalFormatFlagsException`, `IllegalFormatPrecisionException`, `IllegalFormatWidthException`, `MissingFormatArgumentException`, `MissingFormatWidthException`, `UnknownFormatConversionException`, `UnknownFormatFlagsException`

Team LiB

IllegalFormatFlagsException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when a format string contains an illegal combination of flags.

Figure 16-31. java.util.IllegalFormatFlagsException


```
public class IllegalFormatFlagsException extends IllegalFormatException {
// Public Constructors
     public IllegalFormatFlagsException(String f);
// Public Instance Methods
     public String getFlags( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

IllegalFormatPrecisionException java.util

Java 5.0 *serializable unchecked*

An IllegalFormatException of this type is thrown by a Formatter when the precision of a format string is illegal.

Figure 16-32. java.util.IllegalFormatPrecisionException


```
public class IllegalFormatPrecisionException extends IllegalFormatException {
// Public Constructors
     public IllegalFormatPrecisionException(int p);
// Public Instance Methods
     public int getPrecision( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

IllegalFormatWidthException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when the width of a format string is illegal.

Figure 16-33. java.util.IllegalFormatWidthException

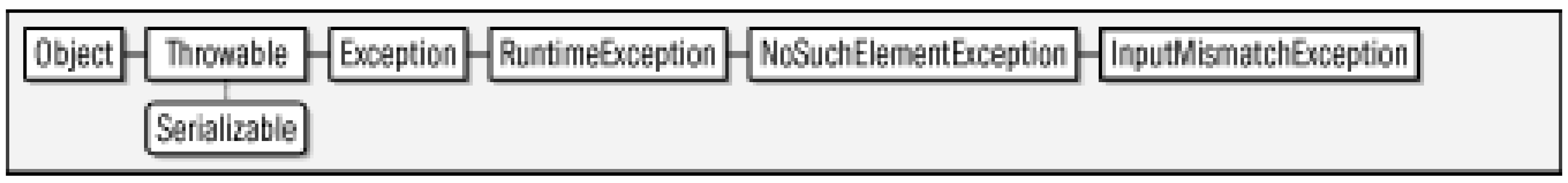

```
public class IllegalFormatWidthException extends IllegalFormatException {
// Public Constructors
     public IllegalFormatWidthException(int w);
// Public Instance Methods
     public int getWidth( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

InputMismatchException java.util

Java 5.0 *serializable unchecked*

An exception of this type is thrown by a `Scanner` that is not of the expected type or is out of range. Note that the `Scanner` implements the `Iterator` interface, and this exception is a subclass of `NoSuchElementException`, which is thrown by `Iterator.next( )` when no more elements are available.

Figure 16-34. java.util.InputMismatchException




```
public class InputMismatchException extends NoSuchElementException {
// Public Constructors
     public InputMismatchException( );
     public InputMismatchException(String s);
}
```

InvalidPropertiesFormatException java.util

Java 5.0 *serializable checked*

An exception of this type is thrown by `Properties.loadFromXML( )` if the specified input stream does not contain appropriate XML.

Figure 16-35. java.util.InvalidPropertiesFormatException


```
public class InvalidPropertiesFormatException extends java.io.IOException {
// Public Constructors
     public InvalidPropertiesFormatException(String message);
     public InvalidPropertiesFormatException(Throwable cause);
}
```

Thrown By

`Properties.loadFromXML( )`

Iterator<E> java.util

Java 1.2

This interface defines methods for iterating, or enumerating, the elements of a collection. It has been made generic in Java 5.0 and the type variable *E* represents the type of the elements in the collection. The hasNext( ) method returns true if there are more elements to be enumerated or false if all elements have already been returned. The next( ) method returns the next element. These two methods make it easy to loop through an iterator with code such as the following:

```
for(Iterator i = c.iterator( ); i.hasNext( ); )
    processObject(i.next( ));
```

In Java 5.0, collections and other classes that can return an Iterator implement the java.lang.Iterable interface, which allows them to be iterated much more simply with the for/in looping statement.

The Iterator interface is much like the Enumeration interface. In Java 1.2, Iterator is preferred over Enumeration because it provides a well-defined way to safely remove elements from a collection while the iteration is in progress. The remove( ) method removes the object most recently returned by next( ) from the collection that is being iterated through. Note, however, that support for remove( ) is optional; if an Iterator does not support remove( ), it throws a java.lang.UnsupportedOperationException when you call it. While you are iterating through a collection, you are allowed to modify the collection only by calling the remove( ) method of the Iterator. If the collection is modified in any other way while an iteration is ongoing, the Iterator may fail to operate correctly, or it may throw a ConcurrentModificationException.

```
public interface Iterator<E> {
// Public Instance Methods
     boolean hasNext( );
     E next( );
     void remove( );
}
```

Implementations

ListIterator, Scanner

Returned By

Too many methods to list.

Team LiB

LinkedHashMap<K,V> java.util

Java 1.4 *cloneable serializable collection*

This class is a `Map` implementation based on a hashtable, just like its superclass `HashMap` . It defines no new public methods, and can be used exactly as `HashMap` is used. What is unique about this `Map` is that i addition to the hashtable data structure, it also uses a doubly-linked list to connect the keys of the `Map` into an internal list which defines a predictable iteration order.

You can iterate through the keys or values of a `LinkedHashMap` by calling `enTRySet( )` , `keySet( )` , or `values( )` and then obtaining an `Iterator` for the returned collection, just as you would for a `HashMap` . When you do this, however, the keys and/or values are returned in a well-defined order rather than the essentially random order provided by a `HashMap` . The default ordering for `LinkedHashMap` is the insertio order of the key: the first key inserted into the `Map` is enumerated first (as is the value associated with it and the last entry inserted is enumerated last. Note that this order is not affect by re-insertions. That is a `LinkedHashMap` contains a mapping from a key *`k`* to a value *`v1`* , and you call the `put( )` method to map from *`k`* to a new value *`v2`* , this does not change the insertion order, or the iteration order of the k *`k`* . The iteration order of a value in the map is the iteration order of the key with which it is associated.

Insertion order is the default iteration order for this class, but if you instantiate a `LinkedHashMap` with th three-argument constructor, and pass `true` for the third argument, then the iteration order will be base on access order: the first key returned by an iterator is the one that was least-recently used in a `get( )` or `put( )` operation. The last key returned is the one that has been most-recently used. As with insertio order, the `values( )` collection is iterated in the order defined by the keys with which those values are associated.

"Access ordering" is particularly useful for implementing "LRU" caches from which the Least-Recently Us elements are periodically purged. To facilitate this use, `LinkedHashMap` defines the protected `removeEldestEntry( )` method. Each time the `put( )` method is called (or for each mapping added by `putAll( )`) the `LinkedHashMap` calls `removeEldestEntry( )` and passes the least-recently used (or firs inserted if insertion order is being used) `Map.Entry` object. If the method returns `true` , then that entry will be removed from the map. In `LinkedHashMap` , `removeEldestEntry( )` always returns `false` , and old entries are never automatically removed, but you can override this behavior in a subclass. The decision to remove an old entry might be based on the content of the entry itself, or might more simply be based on the `size( )` of the `LinkedHashMap` . Note that `removeEldestEntry( )` need simply return `true` or `false` ; it should not remove the entry itself.

Figure 16-36. java.util.LinkedHashMap<K,V>

```
public class LinkedHashMap<K,V> extends HashMap<K,V> implements Map<K,V> {
```

```
// Public Constructors
     public LinkedHashMap( );
     public LinkedHashMap(int initialCapacity);
     public LinkedHashMap(Map<? extends K,? extends V> m);
     public LinkedHashMap(int initialCapacity, float loadFactor);
     public LinkedHashMap(int initialCapacity, float loadFactor, boolean accessOrder);
// Methods Implementing Map
     public void clear( );
     public boolean containsValue(Object value);
     public V get(Object key);
// Protected Instance Methods
     protected boolean removeEldestEntry(Map.Entry<K,V> eldest);     constant
}
```

Team LiB

LinkedHashSet<E> java.util

Java 1.4 *cloneable serializable collection*

This subclass of `HashSet` is a `Set` implementation based on a hashtable. It defines no new methods and just like a `HashSet` is used. What is unique about a `LinkedHashSet` is that in addition to the hashtable da structure, it also uses a doubly-linked list to connect the elements of the set into an internal list in the o which they were inserted. This means that the `Iterator` returned by the inherited `iterator( )` method enumerates the elements of the set in the order which they were inserted. By contrast, the elements of `HashSet` are enumerated in an order that is essentially random. Note that the iteration order is not affec reinsertion of set elements. That is, if you attempt to add an element that already exists in the set, the iteration order of the set is not modified. If you delete an element and then reinsert it, the insertion ord therefore the iteration order, does change.

Figure 16-37. java.util.LinkedHashSet<E>

```
public class LinkedHashSet<E> extends HashSet<E> implements Set<E>, Cloneable, Serializa
// Public Constructors
     public LinkedHashSet( );
     public LinkedHashSet(Collection<? extends E> c);
     public LinkedHashSet(int initialCapacity);
     public LinkedHashSet(int initialCapacity, float loadFactor);
}
```

LinkedList<E> java.util

Java 1.2 *cloneable serializable collection*

This class implements the List interface in terms of a doubly linked list. In Java 5.0, it also implements the Queue interface and uses its list as a first-in, first-out (FIFO) queue. LinkedList is a generic type, and the type variable *E* represents the type of the elements of the list. LinkedList supports all optional methods of List, Queue and Collection and allows list elements of any type, including null (in this it differs from most Queue implementations, which prohibit null elements).

Because LinkedList is implemented with a linked list data structure, the get( ) and set( ) methods are substantially less efficient than the same methods for an ArrayList. However, a LinkedList may be more efficient when the add( ) and remove( ) methods are used frequently. The methods of LinkedList are not synchronized. If you are using a LinkedList in a multithreaded environment, you must explicitly synchronize any code that modifies the list or obtain a synchronized wrapper object with Collections.synchronizedList( ).

In addition to the methods defined by the List interface, LinkedList defines methods to get the first and last elements of the list, to add an element to the beginning or end of the list, and to remove the first or last element of the list. These convenient and efficient methods make LinkedList well-suited for use as a stack or queue. See List and Collection for details on the methods of LinkedList. See also ArrayList.

Figure 16-38. java.util.LinkedList<E>

```
public class LinkedList<E> extends AbstractSequentialList<E>
 implements List<E>, Queue<E>, Cloneable, Serializable {
// Public Constructors
     public LinkedList( );
     public LinkedList(Collection<? extends E> c);
// Public Instance Methods
     public void addFirst(E o);
     public void addLast(E o);
     public E getFirst( );
     public E getLast( );
     public E removeFirst( );
     public E removeLast( );
```

```
// Methods Implementing List
     public boolean add(E o);
     public void add(int index, E element);
     public boolean addAll(Collection<? extends E> c);
     public boolean addAll(int index, Collection<? extends E> c);
     public void clear( );
     public boolean contains(Object o);
     public E get(int index);
     public int indexOf(Object o);
     public int lastIndexOf(Object o);
     public ListIterator<E> listIterator(int index);
     public boolean remove(Object o);
     public E remove(int index);
     public E set(int index, E element);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
5.0  public E element( );
5.0  public boolean offer(E o);
5.0  public E peek( );
5.0  public E poll( );
5.0  public E remove( );
// Public Methods Overriding Object
     public Object clone( );
}
```

List<E> java.util

Java 1.2 *collection*

This interface represents an ordered collection of objects. In Java 5.0 `List` is a generic interface and the type variable *`E`* represents the type of the objects in the list. Each element in a `List` has an index, or position, in the list, and elements can be inserted, queried, and removed by index. The first element of a `List` has an index of `0`. The last element in a list has index `size( )-1`.

In addition to the methods defined by the superinterface, `Collection`, `List` defines a number of methods for working with its indexed elements. `get( )` and `set( )` query and set the object at a particular index, respectively. Versions of `add( )` and `addAll( )` that take an *`index`* argument insert an object or `Collection` of objects at a specified index. The versions of `add( )` and `addAll( )` that do not take an *`index`* argument insert an object or collection of objects at the end of the list. `List` defines a version of `remove( )` that removes the object at a specified index.

The `iterator( )` method is just like the `iterator( )` method of `Collection`, except that the `Iterator` it returns is guaranteed to enumerate the elements of the `List` in order. `listIterator( )` returns a `ListIterator` object, which is more powerful than a regular `Iterator` and allows the list to be modified while iteration proceeds. `listIterator( )` can take an index argument to specify where in the list iteration should begin.

`indexOf( )` and `lastIndexOf( )` perform linear searches from the beginning and end, respectively, of the list, searching for a specified object. Each method returns the index of the first matching objec it finds, or -1 if it does not find a match. Finally, `subList( )` returns a `List` that contains only a specified contiguous range of list elements. The returned list is simply a view into the original list, so changes in the original `List` are visible in the returned `List`. This `subList( )` method is particularly useful if you want to sort, search, `clear( )`, or otherwise manipulate only a partial range of a larger list.

An interface cannot specify constructors, but it is conventional that all implementations of `List` provide at least two standard constructors: one that takes no arguments and creates an empty list, and a copy constructor that accepts an arbitrary `Collection` object that specifies the initial contents of the new `List`.

As with `Collection`, `List` methods that change the contents of the list are optional, and implementations that do not support them simply throw `java.lang.UnsupportedOperationException`. Different implementations of `List` may have significantly different efficiency characteristics. For example, the `get( )` and `set( )` methods of an `ArrayList` are much more efficient than those of a `LinkedList`. On the other hand, the `add( )` and `remove( )` methods of a `LinkedList` can be more efficient than those of an `ArrayList`. See also `Collection`, `Set`, `Map`, `ArrayList`, and `LinkedList`.

Figure 16-39. java.util.List<E>


```
public interface List<E> extends Collection<E> {
// Public Instance Methods
     boolean add(E o);
     void add(int index, E element);
     boolean addAll(Collection<? extends E> c);
     boolean addAll(int index, Collection<? extends E> c);
     void clear( );
     boolean contains(Object o);
     boolean containsAll(Collection<?> c);
     boolean equals(Object o);
     E get(int index);
     int hashCode( );
     int indexOf(Object o);
     boolean isEmpty( );
     Iterator<E> iterator( );
     int lastIndexOf(Object o);
     ListIterator<E> listIterator( );
     ListIterator<E> listIterator(int index);
     boolean remove(Object o);
     E remove(int index);
     boolean removeAll(Collection<?> c);
     boolean retainAll(Collection<?> c);
     E set(int index, E element);
     int size( );
     List<E> subList(int fromIndex, int toIndex);
     Object[ ] toArray( );
     <T> T[ ] toArray(T[ ] a);
}
```

Implementations

AbstractList, ArrayList, LinkedList, Vector, java.util.concurrent.CopyOnWriteArrayList

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

Collections.EMPTY_LIST

ListIterator<E> java.util

Java 1.2

This interface is an extension of `Iterator` for use with ordered collections, or lists. It defines methods to iterate forward and backward through a list, to determine the list index of the elements being iterated, and, for mutable lists, to safely insert, delete, and edit elements in the list while the iteration is in progress. For some lists, notably `LinkedList`, using an iterator to enumerate the list's elements may be substantially more efficient than looping through the list by index and calling `get( )` repeatedly.

Like the `Iterator` interface, `ListIterator` has been made generic in Java 5.0. The type variable *`E`* represents the type of the elements on the list.

`hasNext( )` and `next( )` are the most commonly used methods of `ListIterator`; they iterate forward through the list. See `Iterator` for details. In addition to these two methods, however, `ListIterator` also defines `hasPrevious( )` and `previous( )` that allow you to iterate backward through the list. `previous( )` returns the previous element on the list or throws a `NoSuchElementException` if there is no previous element. `hasPrevious( )` returns `TRue` if a subsequent call to `previous( )` returns an object. `nextIndex( )` and `previousIndex( )` return the index of the object that would be returned by a subsequent call to `next( )` or `previous( )`. If `next( )` or `previous( )` throw a `NoSuchElementException`, `nextIndex( )` returns the size of the list, and `previousIndex( )` returns -1.

`ListIterator` defines three optionally supported methods that provide a safe way to modify the contents of the underlying list while the iteration is in progress. `add( )` inserts a new object into the list, immediately before the object that would be returned by a subsequent call to `next( )`. Calling `add( )` does not affect the value that is returned by `next( )`, however. If you call `previous( )` immediately after calling `add( )`, the method returns the object you just added. `remove( )` deletes from the list the object most recently returned by `next( )` or `previous( )`. You can only call `remove( )` once per call to `next( )` or `previous( )`. If you have called `add( )`, you must call `next( )` or `previous( )` again before calling `remove( )`. `set( )` replaces the object most recently returned by `next( )` or `previous( )` with the specified object. If you have called `add( )` or `remove( )`, you must call `next( )` or `previous( )` again before calling `set( )`. Remember that support for the `add( )`, `remove( )`, and `set( )` methods is optional. Iterators for immutable lists never support them, of course. An unsupported method throws a `java.lang.UnsupportedOperationException` when called. Also, when an iterator is in use, all modifications should be made through the iterator rather than to the list itself. If the underlying list is modified while an iteration is ongoing, the `ListIterator` may fail to operate correctly or may throw a `ConcurrentModificationException`.

Figure 16-40. java.util.ListIterator<E>

```
public interface ListIterator<E> extends Iterator<E> {
// Public Instance Methods
     void add(E o);
     boolean hasNext( );
     boolean hasPrevious( );
     E next( );
     int nextIndex( );
     E previous( );
     int previousIndex( );
     void remove( );
     void set(E o);
}
```

Returned By

AbstractList.listIterator( ), AbstractSequentialList.listIterator( ), LinkedList.listIterator( ), List.listIterator( ), java.util.concurrent.CopyOnWriteArrayList.listIterator( )

ListResourceBundle java.util

Java 1.1

This abstract class provides a simple way to define a `ResourceBundle`. You may find it easier to subclass `ListResourceBundle` than to subclass `ResourceBundle` directly. `ListResourceBundle` provides implementations for the abstract `handleGetObject( )` and `getKeys( )` methods defined by `ResourceBundle` and adds its own abstract `getContents( )` method a subclass must override. `getContents( )` returns an `Object[ ][ ]` an array of arrays of objects. This array can have any number of elements. Each element of this array must itself be an array with two elements: the first element of each subarray should be a `String` that specifies the name of a resource, and the corresponding second element should be the value of that resource; this value can be an `Object` of any desired type. See also `ResourceBundle` and `PropertyResourceBundle`.

Figure 16-41. java.util.ListResourceBundle

```
public abstract class ListResourceBundle extends ResourceBundle {
// Public Constructors
     public ListResourceBundle( );
// Public Methods Overriding ResourceBundle
     public Enumeration<String> getKeys( );
     public final Object handleGetObject(String key);
// Protected Instance Methods
     protected abstract Object[ ][ ] getContents( );
}
```

Locale java.util

Java 1.1 *cloneable serializable*

The Locale class represents a locale: a political, geographical, or cultural region that typically has a distinct language and distinct customs and conventions for such things as formatting dates, times, and numbers. The Locale class defines a number of constants that represent commonly used locales. Locale also defines a static getdefault( ) method that returns the default Locale object, which represents a locale value inherited from the host system. getAvailableLocales( ) returns the list of all locales supported by the underlying system. If none of these methods for obtaining a Locale object are suitable, you can explicitly create your own Locale object. To do this, you must specify a language code and optionally a country code and variant string. getISOCountries( ) and getISOLanguages( ) return the list of supported country codes and language codes.

The Locale class does not implement any internationalization behavior itself; it merely serves as a locale identifier for those classes that can localize their behavior. Given a Locale object, you can invoke the various getdisplay methods to obtain a description of the locale suitable for display to a user. These methods may themselves take a Locale argument, so the names of languages and countries can be localized as appropriate.

Figure 16-42. java.util.Locale

```
public final class Locale implements Cloneable, Serializable {
// Public Constructors
1.4  public Locale(String language);
     public Locale(String language, String country);
     public Locale(String language, String country, String variant);
// Public Constants
     public static final Locale CANADA;
     public static final Locale CANADA_FRENCH;
     public static final Locale CHINA;
     public static final Locale CHINESE;
     public static final Locale ENGLISH;
     public static final Locale FRANCE;
     public static final Locale FRENCH;
     public static final Locale GERMAN;
     public static final Locale GERMANY;
     public static final Locale ITALIAN;
     public static final Locale ITALY;
```

```
     public static final Locale JAPAN;
     public static final Locale JAPANESE;
     public static final Locale KOREA;
     public static final Locale KOREAN;
     public static final Locale PRC;
     public static final Locale SIMPLIFIED_CHINESE;
     public static final Locale TAIWAN;
     public static final Locale TRADITIONAL_CHINESE;
     public static final Locale UK;
     public static final Locale US;
// Public Class Methods
1.2  public static Locale[ ] getAvailableLocales( );
     public static Locale getDefault( );
1.2  public static String[ ] getISOCountries( );
1.2  public static String[ ] getISOLanguages( );
     public static void setDefault(Locale newLocale);                    synchronized
// Public Instance Methods
     public String getCountry( );
     public final String getDisplayCountry( );
     public String getDisplayCountry(Locale inLocale);
     public final String getDisplayLanguage( );
     public String getDisplayLanguage(Locale inLocale);
     public final String getDisplayName( );
     public String getDisplayName(Locale inLocale);
     public final String getDisplayVariant( );
     public String getDisplayVariant(Locale inLocale);
     public String getISO3Country( ) throws MissingResourceException;
     public String getISO3Language( ) throws MissingResourceException;
     public String getLanguage( );
     public String getVariant( );
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object obj);
     public int hashCode( );
     public final String toString( );
}
```

Passed To

Too many methods to list.

Returned By

java.text.BreakIterator.getAvailableLocales( ), java.text.Collator.getAvailableLocales( ), java.text.DateFormat.getAvailableLocales( ), java.text.MessageFormat.getLocale( ), java.text.NumberFormat.getAvailableLocales( ), Calendar.getAvailableLocales( ), java.util.Formatter.locale( ), ResourceBundle.getLocale( ), Scanner.locale( ), javax.security.auth.callback.LanguageCallback.getLocale( )

Map<K,V> java.util

Java 1.2 *collection*

This interface represents a collection of mappings, or associations, between key objects and value objects. Hashtables and associative arrays are examples of maps. In Java 5.0 this interface has been made generic. The type variable *K* represents the type of the keys held by the map and the type variable *V* represents the type of the values associated with those keys.

The set of key objects in a `Map` must not have any duplicates; the collection of value objects is under no such constraint. The key objects should usually be immutable objects, or, if they are not, care should be taken that they do not change while in use in a `Map`. As of Java 1.2, the `Map` interface replaces the abstract `Dictionary` class. Although a `Map` is not a `Collection`, the `Map` interface is still considered an integral part, along with `Set`, `List`, and others, of the Java collections framework.

You can add a key/value association to a `Map` with the `put( )` method. Use `putAll( )` to copy all mappings from one `Map` to another. Call `get( )` to look up the value object associated with a specified key object. Use `remove( )` to delete the mapping between a specified key and its value, or use `clear( )` to delete all mappings from a `Map`. `size( )` returns the number of mappings in a `Map`, and `isEmpty( )` tests whether the `Map` contains no mappings. `containsKey( )` tests whether a `Map` contains the specified key object, and `containsValue( )` tests whether it contains the specified value. (For most implementations, `containsValue( )` is a much more expensive operation than `containsKey( )`, however.) `keySet( )` returns a `Set` of all key objects in the `Map`. `values( )` returns a `Collection` (not a `Set`, since it may contain duplicates) of all value objects in the map. `entrySet( )` returns a `Set` of all mappings in a `Map`. The elements of this returned `Set` are `Map.Entry` objects. The collections returned by `values( )`, `keySet( )`, and `entrySet( )` are based on the `Map` itself, so changes to the `Map` are reflected in the collections.

An interface cannot specify constructors, but it is conventional that all implementations of `Map` provide at least two standard constructors: one that takes no arguments and creates an empty map, and a copy constructor that accepts a `Map` object that specifies the initial contents of the new `Map`.

Implementations are required to support all methods that query the contents of a `Map`, but support for methods that modify the contents of a `Map` is optional. If an implementation does not support a particular method, the implementation of that method simply throws a `java.lang.UnsupportedOperationException`. See also `Collection`, `Set`, `List`, `HashMap`, `Hashtable`, `WeakHashMap`, `SortedMap`, and `treeMap`.

```
public interface Map<K,V> {
// Nested Types
     public interface Entry<K,V>;
// Public Instance Methods
     void clear( );
     boolean containsKey(Object key);
     boolean containsValue(Object value);
     Set<Map.Entry<K,V>> entrySet( );
```

```
    boolean equals(Object o);
    V get(Object key);
    int hashCode( );
    boolean isEmpty( );
    Set<K> keySet( );
    V put(K key, V value);
    void putAll(Map<? extends K,? extends V> t);
    V remove(Object key);
    int size( );
    Collection<V> values( );
}
```

Implementations

AbstractMap, HashMap, Hashtable, IdentityHashMap, LinkedHashMap, SortedMap, WeakHashMap, java.util.concurrent.ConcurrentMap, java.util.jar.Attributes

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Type Of

Collections.EMPTY_MAP, java.util.jar.Attributes.map

Team LiB

Map.Entry<K,V> java.util

Java 1.2

This interface represents a single mapping, or association, between a key object and a value object in a Map. Like Map itself, Map.Entry has been made generic in Java 5.0 and defines the same type variables that Map does.

The enTRySet( ) method of a Map returns a Set of Map.Entry objects that represent the set of mappings in the map. Use the iterator( ) method of that Set to enumerate these Map.Entry objects. Use getKey( ) and getValue( ) to obtain the key and value objects for the entry. Use the optionally supported setValue( ) method to change the value of an entry. This method throws a java.lang.UnsupportedOperationException if it is not supported by the implementation.

```
public interface Map.Entry<K,V> {
// Public Instance Methods
     boolean equals(Object o);
     K getKey( );
     V getValue( );
     int hashCode( );
     V setValue(V value);
}
```

Passed To

LinkedHashMap.removeEldestEntry( )

MissingFormatArgumentException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when a `format( )` or `printf( )` method does not have enough arguments to match the number conversion specifiers in the format string.

Figure 16-43. java.util.MissingFormatArgumentException

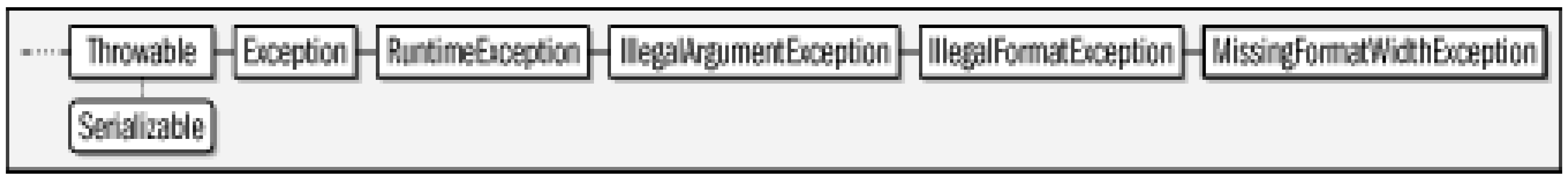

```
public class MissingFormatArgumentException extends IllegalFormatException {
// Public Constructors
     public MissingFormatArgumentException(String s);
// Public Instance Methods
     public String getFormatSpecifier( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

MissingFormatWidthException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when a format conversion requires a field width, but the width is omitted.

Figure 16-44. java.util.MissingFormatWidthException




```
public class MissingFormatWidthException extends IllegalFormatException {
// Public Constructors
     public MissingFormatWidthException(String s);
// Public Instance Methods
     public String getFormatSpecifier( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

MissingResourceException java.util

Java 1.1 *serializable unchecked*

Signals that no `ResourceBundle` can be located for the desired locale or that a named resource cannot be found within a given `ResourceBundle`. `getClassName( )` returns the name of the `ResourceBundle` class in question, and `getKey( )` returns the name of the resource that cannot be located.

Figure 16-45. java.util.MissingResourceException


```
public class MissingResourceException extends RuntimeException {
// Public Constructors
     public MissingResourceException(String s, String className, String key);
// Public Instance Methods
     public String getClassName( );
     public String getKey( );
}
```

Thrown By

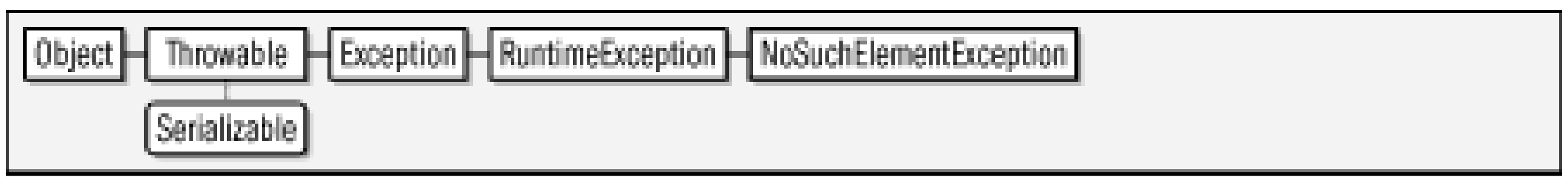
`Locale.{getISO3Country( ), getISO3Language( )}`

NoSuchElementException java.util

Java 1.0 *serializable unchecked*

Signals that there are no elements in an object (such as a `Vector`) or that there are no more elements in an object (such as an `Enumeration`).

Figure 16-46. java.util.NoSuchElementException




```
public class NoSuchElementException extends RuntimeException {
// Public Constructors
     public NoSuchElementException( );
     public NoSuchElementException(String s);
}
```

Subclasses

`InputMismatchException`

Observable java.util

Java 1.0

This class is the superclass for classes that want to provide notifications of state changes to interested Observer objects. Register an Observer to be notified by passing it to the addObserver( ) method of an Observable, and de-register it by passing it to the deleteObserver( ) method. You can delete all observers registered for an Observable with deleteObservers( ), and can find out how many observers have been added with countObservers( ). Note that there is not a method to enumerate the particular Observer objects that have been added.

An Observable subclass should call the protected method setChanged( ) when its state has changed in some way. This sets a "state changed" flag. After an operation or series of operations tha may have caused the state to change, the Observable subclass should call notifyObservers( ), optionally passing an arbitrary Object argument. If the state changed flag is set, this notifyObservers( ) calls the update( ) method of each registered Observer (in some arbitrary order), passing the Observable object, and the optional argument, if any. Once the update( ) method of each Observable has been called, notifyObservers( ) calls clearChanged( ) to clear the state changed flag. If notifyObservers( ) is called when the state changed flag is not set, it does not do anything. You can use hasChanged( ) to query the current state of the changed flag.

The Observable class and Observer interface are not commonly used. Most applications prefer the event-based notification model defined by the JavaBeans component framework and by the EventObject class and EventListener interface of this package.

```
public class Observable {
// Public Constructors
     public Observable( );
// Public Instance Methods
     public void addObserver(Observer o);                          synchronized
     public int countObservers( );                          synchronized
     public void deleteObserver(Observer o);                       synchronized
     public void deleteObservers( );                        synchronized
     public boolean hasChanged( );                          synchronized
     public void notifyObservers( );
     public void notifyObservers(Object arg);
// Protected Instance Methods
     protected void clearChanged( );                        synchronized
     protected void setChanged( );                          synchronized
}
```

Passed To

Observer.update( )

Observer java.util

Java 1.0

This interface defines the `update( )` method required for an object to observe subclasses of `Observable`. An `Observer` registers interest in an `Observable` object by calling the `addObserver( )` method of `Observable`. `Observer` objects that have been registered in this way have their `update( )` methods invoked by the `Observable` when that object has changed.

This interface is conceptually similar to, but less commonly used than, the `EventListener` interface and its various event-specific subinterfaces.

```
public interface Observer {
// Public Instance Methods
     void update(Observable o, Object arg);
}
```

Passed To

`Observable.{addObserver( ), deleteObserver( )}`

Team LiB

PriorityQueue<E> java.util

Java 5.0 *serializable collection*

This class is a `Queue` implementation that orders its elements according to a specified `Comparator` or orders `Comparable` elements according to their `compareTo( )` methods. The head of the queue (the element removed by `remove( )` and `poll( )`) is the smallest element on the queue according to this ordering. The `Iterator` return by the `iterator( )` method is not guaranteed to iterate the elements in their sorted order.

`PriorityQueue` is unbounded and prohibits `null` elements. It is not threadsafe.

Figure 16-47. java.util.PriorityQueue<E>

```
public class PriorityQueue<E> extends AbstractQueue<E> implements Serializable {
// Public Constructors
     public PriorityQueue( );
     public PriorityQueue(int initialCapacity);
     public PriorityQueue(SortedSet<? extends E> c);
     public PriorityQueue(PriorityQueue<? extends E> c);
     public PriorityQueue(Collection<? extends E> c);
     public PriorityQueue(int initialCapacity, Comparator<? super E> comparator);
// Public Instance Methods
     public Comparator<? super E> comparator( );
// Methods Implementing Collection
     public Iterator<E> iterator( );
     public boolean remove(Object o);
     public int size( );
// Methods Implementing Queue
     public boolean offer(E o);
     public E peek( );
     public E poll( );
// Public Methods Overriding AbstractQueue
     public boolean add(E o);
     public void clear( );
}
```

Team LiB

Properties java.util

Java 1.0 *cloneable serializable collection*

This class is an extension of Hashtable that allows key/value pairs to be read from and written to a stream. The Properties class implements the system properties list, which supports user customization by allowing programs to look up the values of named resources. Because the load( ) and store( ) methods provide an easy way to read and write properties from and to a text stream, this class provides a convenient way to implement an application configuration file.

When you create a Properties object, you may specify another Properties object that contains default values. Keys (property names) and values are associated in a Properties object with the Hashtable method put( ) . Values are looked up with getProperty( ) ; if this method does not find the key in the current Properties object, it looks in the default Properties object that was passed to the constructor method. A default value can also be specified, in case the key is not found at all. Use setProperty( ) to add a property name/value pair to the Properties object. This Java 1.2 method is preferred over the inherited put( ) method because it enforces the constraint that property names and values be strings.

propertyNames( ) returns an enumeration of all property names (keys) stored in the Properties object and (recursively) all property names stored in the default Properties object associated with it. list( ) prints the properties stored in a Properties object, which can be useful for debugging. store( ) writes a Properties object to a stream, writing one property per line, in name=value format. As of Java 1.2, store( ) is preferred over the deprecated save( ) method, which writes properties in the same way but suppresses any I/O exceptions that may be thrown in the process. The second argument to both store( ) and save( ) is a comment that is written out at the beginning of the property file. Finally, load( ) reads key/value pairs from a stream and stores them in a Properties object. It is suitable for reading both properties written with store( ) and hand-edited properties files. In Java 5.0, storeToXML( ) and loadFromXML( ) are alternatives that write and read properties files using a simple XML grammar.

Figure 16-48. java.util.Properties

```
public class Properties extends Hashtable<Object,Object> {
// Public Constructors
     public Properties( );
     public Properties(Properties defaults);
// Public Instance Methods
     public String getProperty(String key);
     public String getProperty(String key, String defaultValue);
```

```
1.1  public void list(java.io.PrintWriter out);
     public void list(java.io.PrintStream out);
     public void load(java.io.InputStream inStream)
        throws java.io.IOException;     synchronized
5.0  public void loadFromXML(java.io.InputStream in)
        throws java.io.IOException, InvalidPropertiesFormatException;     synchronized
     public Enumeration<?> propertyNames( );
1.2  public Object setProperty(String key, String value);           synchronized
1.2  public void store(java.io.OutputStream out, String comments)
        throws java.io.IOException;     synchronized
5.0  public void storeToXML(java.io.OutputStream os, String comment)
        throws java.io.IOException;     synchronized
5.0  public void storeToXML(java.io.OutputStream os, String comment, String encoding)
throws java.io.IOException;     synchronized
// Protected Instance Fields
     protected Properties defaults;
// Deprecated Public Methods
#    public void save(java.io.OutputStream out, String comments);     synchronized
}
```

Subclasses

java.security.Provider

Passed To

System.setProperties( ) , javax.xml.transform.Transformer.setOutputProperties( )

Returned By

System.getProperties( ) , javax.xml.transform.Templates.getOutputProperties( ) , javax.xml.transform.Transformer.getOutputProperties( )

PropertyPermission java.util

Java 1.2 *serializable permission*

This class is a `java.security.Permission` that governs read and write access to system properties with `System.getProperty( )` and `System.setProperty( )`. A `PropertyPermission` object has a name, or target, and a comma-separated list of actions. The name of the permission is the name of the property of interest. The action string can be "read" for `getProperty( )` access, "write" for `setProperty( )` access, or "read,write" for both types of access. `PropertyPermission` extends `java.security.BasicPermission`, so the name of the property supports simple wildcards. The name "*" represents any property name. If a name ends with ".*", it represents any property names that share the specified prefix. For example, the name "java.*" represents "java.version", "java.vendor", "java.vendor.url", and all other properties that begin with "java".

Granting access to system properties is not overtly dangerous, but caution is still necessary. Some properties, such as "user.home", reveal details about the host system that malicious code can use to mount an attack. Programmers writing system-level code and system administrators configuring security policies may need to use this class, but applications never need to use it.

Figure 16-49. java.util.PropertyPermission

```
public final class PropertyPermission extends java.security.BasicPermission {
// Public Constructors
     public PropertyPermission(String name, String actions);
// Public Methods Overriding BasicPermission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(java.security.Permission p);
     public java.security.PermissionCollection newPermissionCollection( );
}
```

PropertyResourceBundle java.util

Java 1.1

This class is a concrete subclass of ResourceBundle . It reads a Properties file from a specified InputS and implements the ResourceBundle API for looking up named resources from the resulting Properties object. A Properties file contains lines of the form:

name=value

Each such line defines a named property with the specified String value. Although you can instantiate a PropertyResourceBundle yourself, it is more common to simply define a Properties file and then allow ResourceBundle.getBundle( ) to look up that file and return the necessary PropertyResourceBundle object. See also Properties and ResourceBundle .

Figure 16-50. java.util.PropertyResourceBundle

```
public class PropertyResourceBundle extends ResourceBundle {
// Public Constructors
     public PropertyResourceBundle(java.io.InputStream stream) throws java.io.IOExcepti
// Public Methods Overriding ResourceBundle
     public Enumeration<String> getKeys( );
     public Object handleGetObject(String key);
}
```

Team LiB

Queue<E> java.util

Java 5.0 *collection*

A `Queue<E>` is an ordered `Collection` of elements of type *E*. Unlike `List`, the `Queue` interface does not permit indexed access to its elements: elements may be inserted at the *tail* of the queue and may be removed from the *head* of the queue, but the elements in between may not be accessed by their position. Unlike `Set`, `Queue` implementations do not prohibit duplicate elements.

Queues may be manipulated through the methods of the `Collection` interface, including iteration via the `iterator( )` method and the `Iterator` object it returns. It is more common to manipulate queues through the more specialized methods defined by the `Queue` interface, however. Place an element at the tail of the queue with `offer( )`. If the queue is already full, `offer( )` returns `false`. Remove an element from the head of the queue with `remove( )` or `poll( )`. These methods differ only in the case of an empty queue: `remove( )` throws an unchecked `NoSuchElementException` and `poll( )` returns `null`. (Most queue implementations prohibit `null` elements for this reason, but `LinkedList` is an exception.) Query the element at the head of a queue without removing it with `element( )` or `peek( )`. If the queue is empty, `element( )` tHRows `NoSuchElementException` and `peek( )` returns `null`.

Most `Queue` implementations order their elements in first-in, first-out (FIFO) order. Other implementations may provide other orderings. A queue `Iterator` is not required to traverse the queue's elements in order. A `Queue` implementation with a fixed size is a *bounded* queue. When a bounded queue is full, it is not possible to insert a new element until an element is first removed. Unlike the `List` and `Set` interfaces, the `Queue` interface does not require implementations to override the `equals( )` method, and `Queue` implementations typically do not override it.

In Java 5.0, the `LinkedList` class has been retrofitted to implement `Queue` as well as `List`. `PriorityQueue` is a `Queue` implementation that orders elements based on the `Comparable` or `Comparator` interfaces. `AbstractQueue` is an abstract implementation that offers partial support for simple `Queue` implementations. The `java.util.concurrent` package defines a `BlockingQueue` interface that extends this implementation and includes `Queue` and `BlockingQueue` implementations that are useful in multithreaded programming.

Figure 16-51. java.util.Queue<E>

```
public interface Queue<E> extends Collection<E> {
// Public Instance Methods
     E element( );
     boolean offer(E o);
     E peek( );
```

```
    E poll( );
    E remove( );
}
```

Implementations

AbstractQueue, LinkedList, java.util.concurrent.BlockingQueue, java.util.concurrent.ConcurrentLinkedQueue

Team LiB

Team LiB

Random java.util

Java 1.0 *serializable*

This class implements a pseudorandom number generator suitable for games and similar applications. If you need a cryptographic-strength source of pseudorandomness, see `java.security.SecureRandom`. `nextdouble( )` and `nextFloat( )` return a value between 0.0 and 1.0. `nextLong( )` and the no-argument version of `nextInt( )` return `long` and `int` values distributed across the range of those data types. As of Java 1.2, if you pass an argument to `nextInt( )`, it returns a value between zero (inclusive) and the specified number (exclusive). `nextGaussian( )` returns pseudorandom floating-point values with a Gaussian distribution; the mean of the values is 0.0 and the standard deviation is 1.0.`nextBoolean( )` returns a pseudorandom `boolean` value, and `nextBytes( )` fills in the specified `byte` array with pseudorandom bytes. You can use the `setSeed( )` method or the optional constructor argument to initialize the pseudorandom number generator with some variable seed value other than the current time (the default) or with a constant to ensure a repeatable sequence of pseudorandomness.

Figure 16-52. java.util.Random

```
public class Random implements Serializable {
// Public Constructors
     public Random( );
     public Random(long seed);
// Public Instance Methods
1.2  public boolean nextBoolean( );
1.1  public void nextBytes(byte[ ] bytes);
     public double nextDouble( );
     public float nextFloat( );
     public double nextGaussian( );                          synchronized
     public int nextInt( );
1.2  public int nextInt(int n);
     public long nextLong( );
     public void setSeed(long seed);                         synchronized
// Protected Instance Methods
1.1  protected int next(int bits);
}
```

Subclasses

`java.security.SecureRandom`

Passed To

`java.math.BigInteger.{BigInteger( )`, `probablePrime( )}`, `Collections.shuffle( )`

Team LiB

RandomAccess java.util

Java 1.4

This marker interface is implemented by `List` implementations to advertise that they provide efficient (usually constant time) random access to all list elements. `ArrayList` and `Vector` implement this interface, but `LinkedList` does not. Classes that manipulate generic `List` objects may want to test for this interface with `instanceof` and use different algorithms for lists that provide efficient random access than they use for lists that are most efficiently accessed sequentially.

```
public interface RandomAccess {
}
```

Implementations

`ArrayList`, `Vector`, `java.util.concurrent.CopyOnWriteArrayList`

ResourceBundle java.util

Java 1.1

This abstract class allows subclasses to define sets of localized resources that can then be dynamically l
needed by internationalized programs. Such resources may include user-visible text and images that ap
application, as well as more complex things such as Menu objects. Use getBundle( ) to load a Resource
subclass that is appropriate for the default or specified locale. Use getObject( ) , getString( ) , and
getStringArray( ) to look up a named resource in a bundle. To define a bundle, provide implementati
handleGetObject( ) and getKeys( ) . It is often easier, however, to subclass ListResourceBundle or
Properties file that is used by PropertyResourceBundle . The name of any localized ResourceBundle c
define should include the locale language code, and, optionally, the locale country code.

```
public abstract class ResourceBundle {
// Public Constructors
     public ResourceBundle( );
// Public Class Methods
     public static final ResourceBundle getBundle(String baseName);
     public static final ResourceBundle getBundle(String baseName, Locale locale);
1.2  public static ResourceBundle getBundle(String baseName, Locale locale, ClassLoader
// Public Instance Methods
     public abstract Enumeration<String> getKeys( );
1.2  public Locale getLocale( );
     public final Object getObject(String key);
     public final String getString(String key);
     public final String[ ] getStringArray(String key);
// Protected Instance Methods
     protected abstract Object handleGetObject(String key);
     protected void setParent(ResourceBundle parent);
// Protected Instance Fields
     protected ResourceBundle parent;
}
```

Subclasses

ListResourceBundle , PropertyResourceBundle

Passed To

java.util.logging.LogRecord.setResourceBundle( )

Returned By

`java.util.logging.Logger.getResourceBundle( )`, `java.util.logging.LogRecord.getResourceBu`

Team LiB

Team LiB

Scanner java.util

Java 5.0

This class is a text scanner or tokenizer. It can read input from any Readable object, and convenience constructors can read text from a specified string, file, byte stream, or byte channel. The constructors fc files, byte streams, and byte channels optionally allow you to specify the name of the charset to use for byte-to-character conversions.

After creating a Scanner , you can configure it. useDelimiter( ) specifies a regular expression (as a java.util.regex.Pattern or a String) that represents the token delimiter. The default delimiter is ar run of whitespace. useLocale( ) specifies the Locale to use for scanning numbers: this may affect things like the character expected for decimal points and the thousands separator. useRadix( ) specifies the radix, or base, in which numbers should be parsed. Any value between 2 and 36 is allowed. These configuration methods may be called at any time and are not required to be called before scanning begins.

Scanner implements the Iterable<String> interface, and you can use the hasNext( ) and next( ) methods of this interface to break the input into a series of String tokens separated by whitespace or by the delimiter specified with useDelimiter( ) . In addition to these Iterable methods, however, Scanner defines a number of next *X* and hasNext *X* methods for various numeric types *X* . nextLine(returns the next line of input. Two variants of the next( ) method accept a regular expression as an argument and return the next chunk of text matching a specified regular expression. The corresponding hasNext( ) methods accept a regular expression and return TRue if the input matches it.

The skip( ) method ignores delimiters and skips text matching the specified regular expression. findInLine( ) looks ahead for text matching the specified regular expression in the current line. If a match is found, the Scanner advances past that text and returns it. Otherwise, the Scanner returns nul without advancing. findWithinHorizon( ) is similar but looks for a match within the specified number characters (a horizon of 0 specifies an unlimited number).

The next( ) methods and its next *X* variants throw a NoSuchElementException if there is no more inpu text. They throw an InputMismatchException (a subclass of NoSuchElementException) if the next token cannot be parsed as the specified type or does not match the specified pattern. The Readable object that the Scanner reads text from may throw a java.io.IOException , but, for ease of use, the Scanner never propagates this exception. If an IOException occurs, the Scanner assumes that no more input is available from the Readable . Call ioException( ) to obtain the most recent IOException , if any, thrown by the Readable .

The close( ) method checks whether the Readable object implements the Closeable interface and, if so, calls the close( ) method on that object. Once close( ) has been called, any attempt to read tokens from the Scanner results in an IllegalStateException .

See also StringTokenizer and java.io.StreamTokenizer .

Figure 16-53. java.util.Scanner


```
public final class Scanner implements Iterator<String> {
// Public Constructors
     public Scanner(Readable source);
     public Scanner(java.nio.channels.ReadableByteChannel source);
     public Scanner(java.io.InputStream source);
     public Scanner(java.io.File source) throws java.io.FileNotFoundException;
     public Scanner(String source);
     public Scanner(java.nio.channels.ReadableByteChannel source, String charsetName);
     public Scanner(java.io.InputStream source, String charsetName);
     public Scanner(java.io.File source, String charsetName)
        throws java.io.FileNotFoundException;
// Public Instance Methods
     public void close( );
     public java.util.regex.Pattern delimiter( );
     public String findInLine(String pattern);
     public String findInLine(java.util.regex.Pattern pattern);
     public String findWithinHorizon(java.util.regex.Pattern pattern, int horizon);
     public String findWithinHorizon(String pattern, int horizon);
     public boolean hasNext(java.util.regex.Pattern pattern);
     public boolean hasNext(String pattern);
     public boolean hasNextBigDecimal( );
     public boolean hasNextBigInteger( );
     public boolean hasNextBigInteger(int radix);
     public boolean hasNextBoolean( );
     public boolean hasNextByte( );
     public boolean hasNextByte(int radix);
     public boolean hasNextDouble( );
     public boolean hasNextFloat( );
     public boolean hasNextInt( );
     public boolean hasNextInt(int radix);
     public boolean hasNextLine( );
     public boolean hasNextLong( );
     public boolean hasNextLong(int radix);
     public boolean hasNextShort( );
     public boolean hasNextShort(int radix);
     public java.io.IOException ioException( );
     public Locale locale( );
     public java.util.regex.MatchResult match( );
     public String next(String pattern);
     public String next(java.util.regex.Pattern pattern);
     public java.math.BigDecimal nextBigDecimal( );
     public java.math.BigInteger nextBigInteger( );
     public java.math.BigInteger nextBigInteger(int radix);
     public boolean nextBoolean( );
     public byte nextByte( );
```

```
    public byte nextByte(int radix);
    public double nextDouble( );
    public float nextFloat( );
    public int nextInt( );
    public int nextInt(int radix);
    public String nextLine( );
    public long nextLong( );
    public long nextLong(int radix);
    public short nextShort( );
    public short nextShort(int radix);
    public int radix( );
    public Scanner skip(java.util.regex.Pattern pattern);
    public Scanner skip(String pattern);
    public Scanner useDelimiter(java.util.regex.Pattern pattern);
    public Scanner useDelimiter(String pattern);
    public Scanner useLocale(Locale locale);
    public Scanner useRadix(int radix);
// Methods Implementing Iterator
    public boolean hasNext( );
    public String next( );
    public void remove( );
// Public Methods Overriding Object
    public String toString( );
}
```

Team LiB

Set<E> java.util

Java 1.2 *collection*

This interface represents an unordered `Collection` of objects that contains no duplicate elements. That is, a `Set` cannot contain two elements `e1` and `e2` where `e1.equals(e2)`, and it can contain at most one `null` element. The `Set` interface defines the same methods as its superinterface, `Collection`. It constrains the `add( )` and `addAll( )` methods from adding duplicate elements to the `Set`. In Java 5.0 `Set` is a generic interface and the type variable *E* represents the type of the objects in the set.

An interface cannot specify constructors, but it is conventional that all implementations of `Set` provide at least two standard constructors: one that takes no arguments and creates an empty set, and a copy constructor that accepts a `Collection` object that specifies the initial contents of the new `Set`. This copy constructor must ensure that duplicate elements are not added to the `Set`, of course.

As with `Collection`, the `Set` methods that modify the contents of the set are optional, and implementations that do not support the methods throw `java.lang.UnsupportedOperationException`. See also `Collection`, `List`, `Map`, `SortedSet`, `HashSet`, and `TReeSet`.

Figure 16-54. java.util.Set<E>

```
public interface Set<E> extends Collection<E> {
// Public Instance Methods
     boolean add(E o);
     boolean addAll(Collection<? extends E> c);
     void clear( );
     boolean contains(Object o);
     boolean containsAll(Collection<?> c);
     boolean equals(Object o);
     int hashCode( );
     boolean isEmpty( );
     Iterator<E> iterator( );
     boolean remove(Object o);
     boolean removeAll(Collection<?> c);
     boolean retainAll(Collection<?> c);
     int size( );
     Object[ ] toArray( );
     <T> T[ ] toArray(T[ ] a);
```

```
}
```

Implementations

AbstractSet, HashSet, LinkedHashSet, SortedSet

Passed To

java.security.cert.PKIXBuilderParameters.PKIXBuilderParameters( ), java.security.cert.PKIXParameters.{PKIXParameters( ), setInitialPolicies( ), setTrustAnchors( )}, java.security.cert.X509CertSelector.{setExtendedKeyUsage( ), setPolicy( )}, java.text.AttributedCharacterIterator.{getRunLimit( ), getrunStart( )}, Collections.{checkedSet( ), synchronizedSet( ), unmodifiableSet( )}, javax.security.auth.Subject.Subject( )

Returned By

Too many methods to list.

Type Of

Collections.EMPTY_SET

SimpleTimeZone java.util

Java 1.1 *cloneable serializable*

This concrete subclass of TimeZone is a simple implementation of that abstract class that is suitable for u that use the Gregorian calendar. Programs do not normally need to instantiate this class directly; instea one of the static factory methods of TimeZone to obtain a suitable TimeZone subclass. The only reason to this class directly is if you need to support a time zone with nonstandard daylight-savings-time rules. In you can call setStartRule( ) and setEndRule( ) to specify the starting and ending dates of daylight-s for the time zone.

Figure 16-55. java.util.SimpleTimeZone


```
public class SimpleTimeZone extends TimeZone {
// Public Constructors
     public SimpleTimeZone(int rawOffset, String ID);
     public SimpleTimeZone(int rawOffset, String ID, int startMonth, int startDay,
        int startDayOfWeek, int startTime,
        int endMonth, int endDay,
        int endDayOfWeek, int endTime);
1.2  public SimpleTimeZone(int rawOffset, String ID, int startMonth, int startDay,
        int startDayOfWeek, int startTime,
        int endMonth, int endDay, int endDayOfWeek,
        int endTime, int dstSavings);
1.4  public SimpleTimeZone(int rawOffset, String ID, int startMonth, int startDay,
        int startDayOfWeek, int startTime,
        int startTimeMode, int endMonth,
        int endDay, int endDayOfWeek, int endTime,
        int endTimeMode, int dstSavings);
// Public Constants
1.4  public static final int STANDARD_TIME;                          =1
1.4  public static final int UTC_TIME;                               =2
1.4  public static final int WALL_TIME;                              =0
// Public Instance Methods
1.2  public void setDSTSavings(int millisSavedDuringDST);
1.2  public void setEndRule(int endMonth, int endDay, int endTime);
     public void setEndRule(int endMonth, int endDay, int endDayOfWeek, int endTime);
1.2  public void setEndRule(int endMonth, int endDay, int endDayOfWeek, int endTime,
        boolean after);
```

```
1.2  public void setStartRule(int startMonth, int startDay, int startTime);
     public void setStartRule(int startMonth, int startDay, int startDayOfWeek, int sta
1.2  public void setStartRule(int startMonth, int startDay, int startDayOfWeek, int sta
        boolean after);
     public void setStartYear(int year);
// Public Methods Overriding TimeZone
     public Object clone( );
1.2  public int getDSTSavings( );
1.4  public int getOffset(long date);
     public int getOffset(int era, int year, int month, int day, int dayOfWeek, int mil
     public int getRawOffset( );
1.2  public boolean hasSameRules(TimeZone other);
     public boolean inDaylightTime(Date date);
     public void setRawOffset(int offsetMillis);
     public boolean useDaylightTime( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );                                     synchronized
     public String toString( );
}
```

SortedMap<K,V> java.util

Java 1.2 *collection*

This interface represents a Map object that keeps its set of key objects in sorted order. As with Map, it is conventional that all implementations of this interface define a no-argument constructor to create an empty map and a copy constructor that accepts a Map object that specifies the initial contents of the SortedMap. Furthermore, when creating a SortedMap, there should be a way to specify a Comparator object to sort the key objects of the map. If no Comparator is specified, all key objects must implement the java.lang.Comparable interface so they can be sorted in their natural order. See also Map, treeMap, and SortedSet.

The inherited keySet( ), values( ), and entrySet( ) methods return collections that can be iterated in the sorted order. firstKey( ) and lastKey( ) return the lowest and highest key values in the SortedMap. subMap( ) returns a SortedMap that contains only mappings for keys from (and including) the first specified key up to (but not including) the second specified key. headMap( ) returns a SortedMap that contains mappings whose keys are less than (but not equal to) the specified key. tailMap( ) returns a SortedMap that contains mappings whose keys are greater than or equal to the specified key. subMap( ), headMap( ), and tailMap( ) return SortedMap objects that are simply views of the original SortedMap; any changes in the original map are reflected in the returned map and vice versa.

Figure 16-56. java.util.SortedMap<K,V>

```
public interface SortedMap<K,V> extends Map<K,V> {
// Public Instance Methods
     Comparator<? super K> comparator( );
     K firstKey( );
     SortedMap<K,V> headMap(K toKey);
     K lastKey( );
     SortedMap<K,V> subMap(K fromKey, K toKey);
     SortedMap<K,V> tailMap(K fromKey);
}
```

Implementations

treeMap

Passed To

Collections.{checkedSortedMap( ), synchronizedSortedMap( ), unmodifiableSortedMap( )}, treeMap.TreeMap( )

Returned By

java.nio.charset.Charset.availableCharsets( ), Collections.{checkedSortedMap( ), synchronizedSortedMap( ), unmodifiableSortedMap( )}, treeMap.{headMap( ), subMap( ), tailMap( )}, java.util.jar.Pack200.Packer.properties( ), java.util.jar.Pack200.Unpacker.properties( )

Team LiB

SortedSet<E> java.util

Java 1.2 *collection*

This interface is a `Set` that sorts its elements and guarantees that its `iterator( )` method returns an `Iterator` that enumerates the elements of the set in sorted order. As with the `Set` interface, it is conventional for all implementations of `SortedSet` to provide a no-argument constructor that creates an empty set and a copy constructor that expects a `Collection` object specifying the initial (unsorted) contents of the set. Furthermore, when creating a `SortedSet`, there should be a way to specify a `Comparator` object that compares and sorts the elements of the set. If no `Comparator` is specified, the elements of the set must all implement `java.lang.Comparable` so they can be sorted in their natural order. See also `Set`, `treeSet`, and `SortedMap`.

`SortedSet` defines a few methods in addition to those it inherits from the `Set` interface. `first( )` and `last( )` return the lowest and highest objects in the set. `headSet( )` returns all elements from the beginning of the set up to (but not including) the specified element. `tailSet( )` returns all elements between (and including) the specified element and the end of the set. `subSet( )` returns all elements of the set from (and including) the first specified element up to (but excluding) the second specified element. Note that all three methods return a `SortedSet` that is implemented as a view onto the original `SortedSet`. Changes in the original set are visible through the returned set and vice versa.

Figure 16-57. java.util.SortedSet<E>

```
public interface SortedSet<E> extends Set<E> {
// Public Instance Methods
     Comparator<? super E> comparator( );
     E first( );
     SortedSet<E> headSet(E toElement);
     E last( );
     SortedSet<E> subSet(E fromElement, E toElement);
     SortedSet<E> tailSet(E fromElement);
}
```

Implementations

`treeSet`

Passed To

`Collections.{checkedSortedSet( ), synchronizedSortedSet( ), unmodifiableSortedSet( )}`, `PriorityQueue.PriorityQueue( )`, `treeSet.TreeSet( )`

Returned By

`Collections.{checkedSortedSet( ), synchronizedSortedSet( ), unmodifiableSortedSet( )}`, `treeSet.{headSet( ), subSet( ), tailSet( )}`

Team LiB

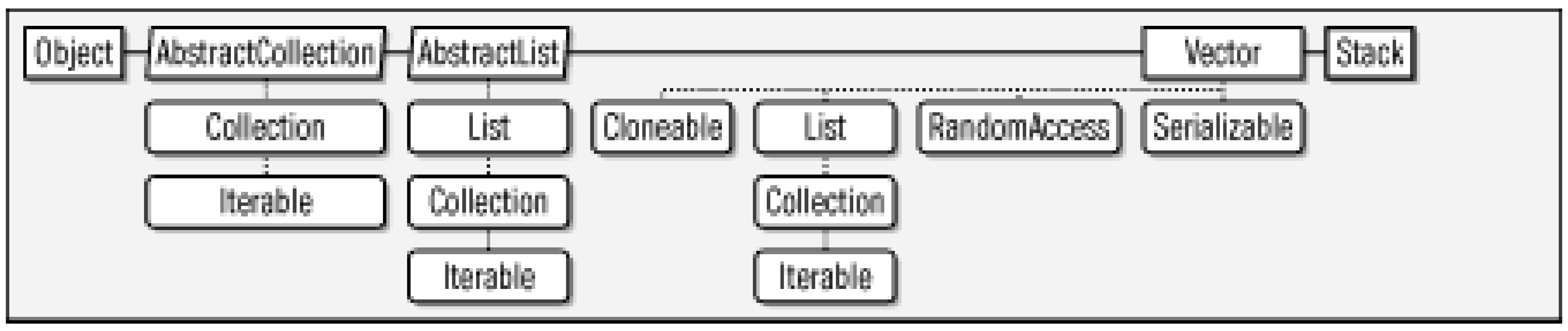
Team LiB

Stack<E> java.util

Java 1.0 *cloneable serializable collection*

This class implements a last-in-first-out (LIFO) stack of objects. `push( )` puts an object on the top of the stack. `pop( )` removes and returns the top object from the stack. `peek( )` returns the top object without removing it. In Java 1.2, you can instead use a `LinkedList` as a stack.

Figure 16-58. java.util.Stack<E>




```
public class Stack<E> extends Vector<E> {
// Public Constructors
     public Stack( );
// Public Instance Methods
     public boolean empty( );
     public E peek( );                                   synchronized
     public E pop( );                                    synchronized
     public E push(E item);
     public int search(Object o);                      synchronized
}
```

StringTokenizer java.util

Java 1.0

When a StringTokenizer is instantiated with a String, it breaks the string up into tokens separated by any of the characters in the specified string of delimiters. (For example, words separated by space and tab characters are tokens.) The hasMoreTokens( ) and nextToken( ) methods obtain the tokens in order. countTokens( ) returns the number of tokens in the string. StringTokenizer implements the Enumeration interface, so you may also access the tokens with the familiar hasMoreElements( ) and nextElement( ) methods. When you create a StringTokenizer, you can specify a string of delimiter characters to use for the entire string, or you can rely on the default whitespace delimiters. You can also specify whether the delimiters themselves should be returned as tokens. Finally, you can optionally specify a new string of delimiter characters when you call nextToken( ).

Figure 16-59. java.util.StringTokenizer

```
public class StringTokenizer implements Enumeration<Object> {
// Public Constructors
     public StringTokenizer(String str);
     public StringTokenizer(String str, String delim);
     public StringTokenizer(String str, String delim, boolean returnDelims);
// Public Instance Methods
     public int countTokens( );
     public boolean hasMoreTokens( );
     public String nextToken( );
     public String nextToken(String delim);
// Methods Implementing Enumeration
     public boolean hasMoreElements( );
     public Object nextElement( );
}
```

Team LiB

Timer java.util

Java 1.3

This class implements a timer: its methods allow you to schedule one or more runnable TimerTask objects to be executed (once or repetitively) by a background thread at a specified time in the future You can create a timer with the Timer( ) constructor. The no-argument version of this constructor creates a regular non-daemon background thread, which means that the Java VM will not terminate while the timer thread is running. Pass true to the constructor if you want the background thread to be a daemon thread. In Java 5.0 you can also specify the name of the background thread when creating a Timer.

Once you have created a Timer, you can schedule TimerTask objects to be run in the future with the various schedule( ) and scheduleAtFixedRate( ) methods. To schedule a task for a single execution, use one of the two-argument schedule( ) methods and specify the desired execution time either as a number of milliseconds in the future or as an absolute Date. If the number of milliseconds is 0, or if the Date object represents a time already passed, the task is scheduled for immediate execution.

To schedule a repeating task, use one of the three-argument versions of schedule( ) or scheduleAtFixedRate( ). These methods are passed an argument that specifies the time (either as a number of milliseconds or as a Date object) of the first execution of the task and another argument, *period*, that specifies the number of milliseconds between repeated executions of the task. The schedule( ) methods schedule the task for *fixed-interval* execution. That is, each execution is scheduled for *period* milliseconds after the previous execution *ends*. Use schedule( ) for tasks such as animation, where it is important to have a relatively constant interval between executions. The scheduleAtFixedRate( ) methods, on the other hand, schedule tasks for *fixed-rate* execution. That is, each repetition of the task is scheduled for *period* milliseconds after the previous execution *begins*. Use scheduleAtFixedRate( ) for tasks, such as updating a clock display, that must occur at specific absolute times rather than at fixed intervals.

A single Timer object can comfortably schedule many TimerTask objects. Note, however, that all tasks scheduled by a single Timer share a single thread. If you are scheduling many rapidly repeating tasks, or if some tasks take a long time to execute, other tasks may have their scheduled executions delayed.

When you are done with a Timer, call cancel( ) to stop its associated thread from running. This is particularly important when you are using a timer whose associated thread is not a daemon thread, because otherwise the timer thread can prevent the Java VM from exiting. To cancel the execution of a particular task, use the cancel( ) method of TimerTask.

```
public class Timer {
// Public Constructors
     public Timer( );
     public Timer(boolean isDaemon);
5.0  public Timer(String name);
```

```
5.0  public Timer(String name, boolean isDaemon);
// Public Instance Methods
     public void cancel( );
5.0  public int purge( );
     public void schedule(TimerTask task, long delay);
     public void schedule(TimerTask task, Date time);
     public void schedule(TimerTask task, long delay, long period);
     public void schedule(TimerTask task, Date firstTime, long period);
     public void scheduleAtFixedRate(TimerTask task, long delay, long period);
     public void scheduleAtFixedRate(TimerTask task, Date firstTime, long period);
}
```

Team LiB

TimerTask java.util

Java 1.3 *runnable*

This abstract Runnable class represents a task that is scheduled with a Timer object for one-time or repeated execution in the future. You can define a task by subclassing TimerTask and implementing the abstract run( ) method. Schedule the task for future execution by passing an instance of your subclass to one of the schedule( ) or scheduleAtFixedRate( ) methods of Timer. The Timer object will then invoke the run( ) method at the scheduled time or times.

Call cancel( ) to cancel the one-time or repeated execution of a TimerTask( ). This method returns TRue if a pending execution was actually canceled. It returns false if the task has already been canceled, was never scheduled, or was scheduled for one-time execution and has already been executed. scheduledExecutionTime( ) returns the time in milliseconds at which the most recent execution of the TimerTask was scheduled to occur. When the host system is heavily loaded, the run( ) method may not be invoked exactly when scheduled. Some tasks may choose to do nothing i they are not invoked on time. The run( ) method can compare the return values of scheduledExecutionTime( ) and System.currentTimeMillis( ) to determine whether the current invocation is sufficiently timely.

Figure 16-60. java.util.TimerTask

```
public abstract class TimerTask implements Runnable {
// Protected Constructors
     protected TimerTask( );
// Public Instance Methods
     public boolean cancel( );
     public long scheduledExecutionTime( );
// Methods Implementing Runnable
     public abstract void run( );
}
```

Passed To

Timer.{schedule( ), scheduleAtFixedRate( )}

TimeZone java.util

Java 1.1 *cloneable serializable*

The TimeZone class represents a time zone; it is used with the Calendar and DateFormat classes. As an abstract class, TimeZone cannot be directly instantiated. Instead, you should call the static getdefault( ) method to obtain a TimeZone object that represents the time zone inherited from the host operating system. Or you can call the static getTimeZone( ) method with the name of the desired zone. You can obtain a list of the supported time-zone names by calling the static getAvailableIDs( ) method.

Once you have a TimeZone object, you can call inDaylightTime( ) to determine whether, for a given Date, daylight-savings time is in effect for that time zone. Call getID( ) to obtain the name of the time zone. Call getOffset( ) for a given date to determine the number of milliseconds to add to GMT to convert to the time zone.

Figure 16-61. java.util.TimeZone

```
public abstract class TimeZone implements Cloneable, Serializable {
// Public Constructors
     public TimeZone( );
// Public Constants
1.2  public static final int LONG;                                  =1
1.2  public static final int SHORT;                                 =0
// Public Class Methods
     public static String[ ] getAvailableIDs( );                 synchronized
     public static String[ ] getAvailableIDs(int rawOffset);     synchronized
     public static TimeZone getDefault( );                 synchronized
     public static TimeZone getTimeZone(String ID);                  synchronized
     public static void setDefault(TimeZone zone);              synchronized
// Public Instance Methods
1.2  public final String getDisplayName( );
1.2  public final String getDisplayName(Locale locale);
1.2  public final String getDisplayName(boolean daylight, int style);
1.2  public String getDisplayName(boolean daylight, int style, Locale locale);
1.4  public int getDSTSavings( );
     public String getID( );
1.4  public int getOffset(long date);
```

```
     public abstract int getOffset(int era, int year, int month, int day,
        int dayOfWeek, int milliseconds);
     public abstract int getRawOffset( );
1.2  public boolean hasSameRules(TimeZone other);
     public abstract boolean inDaylightTime(Date date);
     public void setID(String ID);
     public abstract void setRawOffset(int offsetMillis);
     public abstract boolean useDaylightTime( );
// Public Methods Overriding Object
     public Object clone( );
}
```

Subclasses

SimpleTimeZone

Passed To

java.text.DateFormat.setTimeZone( ), Calendar.{Calendar( ), getInstance( ), setTimeZone( )}, GregorianCalendar.{GregorianCalendar( ), setTimeZone( )}, SimpleTimeZone.hasSameRules( ), javax.xml.datatype.XMLGregorianCalendar.toGregorianCalendar( )

Returned By

java.text.DateFormat.getTimeZone( ), Calendar.getTimeZone( ), GregorianCalendar.getTimeZone( ), javax.xml.datatype.XMLGregorianCalendar.getTimeZone( )

TooManyListenersException java.util

Java 1.1 *serializable checked*

Signals that an AWT component, JavaBeans component, or Swing component can have only one `EventListener` object registered for some specific type of event. That is, it signals that a particular event is a unicast event rather than a multicast event. This exception type serves a formal purpose in the Java event model; its presence in the `throws` clause of an `EventListener` registration method (even if the method never actually throws the exception) signals that an event is a unicast event.

Figure 16-62. java.util.TooManyListenersException


```
public class TooManyListenersException extends Exception {
// Public Constructors
     public TooManyListenersException( );
     public TooManyListenersException(String s);
}
```

Team LiB

TreeMap<K,V> java.util

Java 1.2 *cloneable serializable collection*

This class implements the SortedMap interface using an internal Red-Black tree data structure and guarantees that the keys and values of the mapping can be enumerated in ascending order of keys. treeMap supports all optional Map methods. The objects used as keys in a TReeMap must all be mutually Comparable, or an appropriate Comparator must be provided when the treeMap is created. Because treeMap is based on a binary tree data structure, the get( ), put( ), remove( ), and containsKey( ) methods operate in relatively efficient logarithmic time. If you do not need the sorting capability of TReeMap, however, use HashMap instead, as it is even more efficient. See Map and SortedMap for details on the methods of treeMap. See also the related treeSet class.

In order for a TReeMap to work correctly, the comparison method from the Comparable or Comparator interface must be consistent with the equals( ) method. That is, the equals( ) method must compare two objects as equal if and only if the comparison method also indicates those two objects are equal.

The methods of treeMap are not synchronized. If you are working in a multithreaded environment, you must explicitly synchronize all code that modifies the treeMap, or obtain a synchronized wrapper with Collections.synchronizedMap( ).

Figure 16-63. java.util.TreeMap<K,V>

```
public class TreeMap<K,V> extends AbstractMap<K,V> implements SortedMap<K,V>,
      Cloneable, Serializable {
// Public Constructors
     public TreeMap( );
     public TreeMap(Comparator<? super K> c);
     public TreeMap(SortedMap<K,? extends V> m);
     public TreeMap(Map<? extends K,? extends V> m);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public Set<Map.Entry<K,V>> entrySet( );
     public V get(Object key);
     public Set<K> keySet( );
     public V put(K key, V value);
```

```
    public void putAll(Map<? extends K,? extends V> map);
    public V remove(Object key);
    public int size( );
    public Collection<V> values( );
// Methods Implementing SortedMap
    public Comparator<? super K> comparator( );
    public K firstKey( );
    public SortedMap<K,V> headMap(K toKey);
    public K lastKey( );
    public SortedMap<K,V> subMap(K fromKey, K toKey);
    public SortedMap<K,V> tailMap(K fromKey);
// Public Methods Overriding AbstractMap
    public Object clone( );
}
```

Team LiB

TreeSet<E> java.util

Java 1.2 *cloneable serializable collection*

This class implements SortedSet, provides support for all optional methods, and guarantees that the elements of the set can be enumerated in ascending order. In order to be sorted, the elements of the set must all be mutually Comparable objects, or they must all be compatible with a Comparator object that is specified when the treeSet is created. TReeSet is implemented on top of a treeMap, so its add( ), remove( ), and contains( ) methods all operate in relatively efficient logarithmic time. If you do not need the sorting capability of treeSet, however, use HashSet instead, as it is significantly more efficient. See Set, SortedSet, and Collection for details on the methods of TReeSet.

In order for a treeSet to operate correctly, the Comparable or Comparator comparison method must be consistent with the equals( ) method. That is, the equals( ) method must compare two objects as equal if and only if the comparison method also indicates those two objects are equal.

The methods of TReeSet are not synchronized. If you are working in a multithreaded environment, you must explicitly synchronize code that modifies the contents of the set, or obtain a synchronized wrapper with Collections.synchronizedSet( ).

Figure 16-64. java.util.TreeSet<E>

```
public class TreeSet<E> extends AbstractSet<E> implements SortedSet<E>, Cloneable,
       Serializable {
// Public Constructors
     public TreeSet( );
     public TreeSet(Comparator<? super E> c);
     public TreeSet(SortedSet<E> s);
     public TreeSet(Collection<? extends E> c);
// Methods Implementing Set
     public boolean add(E o);
     public boolean addAll(Collection<? extends E> c);
     public void clear( );
     public boolean contains(Object o);
```

```
    public boolean isEmpty( );                                  default:true
    public Iterator<E> iterator( );
    public boolean remove(Object o);
    public int size( );
// Methods Implementing SortedSet
    public Comparator<? super E> comparator( );
    public E first( );
    public SortedSet<E> headSet(E toElement);
    public E last( );
    public SortedSet<E> subSet(E fromElement, E toElement);
    public SortedSet<E> tailSet(E fromElement);
// Public Methods Overriding Object
    public Object clone( );
}
```

Team LiB

UnknownFormatConversionException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when an unknown conversion specifier is included in a format string.

Figure 16-65. java.util.UnknownFormatConversionException

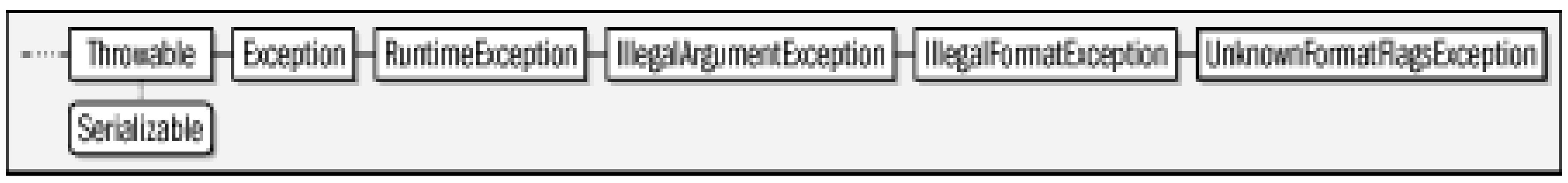

```
public class UnknownFormatConversionException extends IllegalFormatException {
// Public Constructors
     public UnknownFormatConversionException(String s);
// Public Instance Methods
     public String getConversion( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

UnknownFormatFlagsException java.util

Java 5.0 *serializable unchecked*

An `IllegalFormatException` of this type is thrown by a `Formatter` when unknown flags are specified in a format string.

Figure 16-66. java.util.UnknownFormatFlagsException




```
public class UnknownFormatFlagsException extends IllegalFormatException {
// Public Constructors
     public UnknownFormatFlagsException(String f);
// Public Instance Methods
     public String getFlags( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

UUID java.util

Java 5.0 *serializable comparable*

This class is an immutable representation of 128-bit Universal Unique Identifier, or UUID, which serves as an identifier that is (with very high probability) globally unique. Create a UUID based on random bits with the `randomUUID( )` factory method. Create a UUID based on the MD5 hash code of an array of bytes with the `nameUUIDFromBytes( )` factory method. Or create a UUID by parsing a string with the `fromString( )` factory method. The standard string format of a UUID is 32 hexadecimal digits, broken into five hyphen-separated groups of 8, 4, 4, 4, and 12 digits. For example:

```
7cbf3e1a-d521-40ac-87f1-e28b17530f60
```

Both lowercase and uppercase hex digits are allowed. The `toString( )` method converts a UUID object to a string using this standard format. You can also create a UUID object by explicitly passing the 128 bits in the form of two `long` values to the `UUID( )` constructor, but this option should be used only if you are intimately familiar with the relevant UUID standards.

The `toString( )` and `equals( )` methods define the most common operations on a UUID. The `UUID` class implements the `Comparable` interface and defines an ordering for `UUID` objects. Note, however, that the ordering does not represent any meaningful property, such as generation order, of the underlying bits.

Various accessor methods provide details about the bits of a `UUID`, but these details are rarely useful. `getLeastSignificantBits( )` and `getMostSignificantBits( )` return the bits of a UUID as two `long` values. `version( )` and `variant( )` return the version and variant of the UUID, which specify the type (random, name-based, time-based) and bit layout of the UUID. `timestamp( )`, `clockSequence( )`, and `node( )` return values only for time-based UUIDs that have a `version( )` of 1. Note that the `UUID` class does not provide a factory method for creating a time-based UUID.

Figure 16-67. java.util.UUID

```
public final class UUID implements Serializable, Comparable<UUID> {
// Public Constructors
     public UUID(long mostSigBits, long leastSigBits);
// Public Class Methods
     public static UUID fromString(String name);
```

```
    public static UUID nameUUIDFromBytes(byte[ ] name);
    public static UUID randomUUID( );
// Public Instance Methods
    public int clockSequence( );
    public long getLeastSignificantBits( );
    public long getMostSignificantBits( );
    public long node( );
    public long timestamp( );
    public int variant( );
    public int version( );
// Methods Implementing Comparable
    public int compareTo(UUID val);
// Public Methods Overriding Object
    public boolean equals(Object obj);
    public int hashCode( );
    public String toString( );
}
```

Team LiB

Vector<E> java.util

Java 1.0 *cloneable serializable collection*

This class implements an ordered collectionessentially an arrayof objects that can grow or shrink as nec
Java 1.2, Vector has been modified to implement the List interface. Unless the synchronized methods
Vector class are actually needed, ArrayList is preferred in Java 1.2 and later. In Java 5.0 this class ha
made generic. The type variable *E* represents the type of the elements of the vector.

Vector is useful when you need to keep track of a number of objects, but do not know in advance how
will be. Use setElementAt( ) to set the object at a given index of a Vector. Use elementAt( ) to retri
object stored at a specified index. Call add( ) to append an object to the end of the Vector or to insert
at any specified position. Use removeElementAt( ) to delete the element at a specified index or removeE
) to remove a specified object from the vector. size( ) returns the number of objects currently in the V
elements( ) returns an Enumeration that allows you to iterate through those objects. capacity( ) is n
same as size( ); it returns the maximum number of objects a Vector can hold before its internal stor
be resized. Vector automatically resizes its internal storage for you, but if you know in advance how ma
a Vector will contain, you can increase its efficiency by pre-allocating this many elements with ensureCa
.

Figure 16-68. java.util.Vector<E>

```
public class Vector<E> extends AbstractList<E> implements List<E>,
RandomAccess, Cloneable, Serializable {
// Public Constructors
     public Vector( );
1.2  public Vector(Collection<? extends E> c);
     public Vector(int initialCapacity);
     public Vector(int initialCapacity, int capacityIncrement);
// Public Instance Methods
     public void addElement(E obj);                      synchronized
     public int capacity( );                               synchronized
     public boolean contains(Object elem);          Implements:List
     public void copyInto(Object[ ] anArray);                    synchronized
     public E elementAt(int index);                      synchronized
     public Enumeration<E> elements( );
     public void ensureCapacity(int minCapacity);                 synchronized
```

```
     public E firstElement( );                                     synchronized
     public int indexOf(Object elem);                        Implements:List
     public int indexOf(Object elem, int index);                          synchronized
     public void insertElementAt(E obj, int index);                             synchronized
     public boolean isEmpty( );                                Implements:List synchronized def
     public E lastElement( );                                      synchronized
     public int lastIndexOf(Object elem);                    Implements:List synchronized
     public int lastIndexOf(Object elem, int index);                            synchronized
     public void removeAllElements( );                             synchronized
     public boolean removeElement(Object obj);                            synchronized
     public void removeElementAt(int index);                              synchronized
     public void setElementAt(E obj, int index);                          synchronized
     public void setSize(int newSize);                           synchronized
     public int size( );                                       Implements:List synchronized
     public void trimToSize( );                                    synchronized
// Methods Implementing List
1.2  public boolean add(E o);                                synchronized
1.2  public void add(int index, E element);
1.2  public boolean addAll(Collection<? extends E> c);      synchronized
1.2  public boolean addAll(int index, Collection<? extends E> c);     synchronized
1.2  public void clear( );
     public boolean contains(Object elem);
1.2  public boolean containsAll(Collection<?> c);           synchronized
1.2  public boolean equals(Object o);                             synchronized
1.2  public E get(int index);                                synchronized
1.2  public int hashCode( );                                   synchronized
     public int indexOf(Object elem);
     public boolean isEmpty( );                                    synchronized default:true
     public int lastIndexOf(Object elem);                                 synchronized
1.2  public boolean remove(Object o);
1.2  public E remove(int index);                             synchronized
1.2  public boolean removeAll(Collection<?> c);             synchronized
1.2  public boolean retainAll(Collection<?> c);             synchronized
1.2  public E set(int index, E element);                          synchronized
     public int size( );                                           synchronized
1.2  public List<E> subList(int fromIndex, int toIndex);     synchronized
1.2  public Object[ ] toArray( );                                synchronized
1.2  public <T> T[ ] toArray(T[ ] a);                          synchronized
// Protected Methods Overriding AbstractList
1.2  protected void removeRange(int fromIndex, int toIndex);        synchronized
// Public Methods Overriding AbstractCollection
     public String toString( );                                    synchronized
// Public Methods Overriding Object
     public Object clone( );                                       synchronized
// Protected Instance Fields
     protected int capacityIncrement;
     protected int elementCount;
     protected Object[ ] elementData;
}
```

Subclasses

Stack

WeakHashMap<K,V> java.util

Java 1.2 *collection*

This class implements `Map` using an internal hashtable. It is similar in features and performance to `HashMap`, except that it uses the capabilities of the `java.lang.ref` package, so that the key-to-value mappings it maintains do not prevent the key objects from being reclaimed by the garbage collector. When there are no more references to a key object except for the weak reference maintained by the `WeakHashMap`, the garbage collector reclaims the object, and the `WeakHashMap` deletes the mapping between the reclaimed key and its associated value. If there are no references to the value object except for the one maintained by the `WeakHashMap`, the value object also becomes available for garbage collection. Thus, you can use a `WeakHashMap` to associate an auxiliary value with an object without preventing either the object (the key) or the auxiliary value from being reclaimed. See `HashMap` for a discussion of the implementation features of this class. See `Map` for a description of the methods it defines.

`WeakHashMap` is primarily useful with objects whose `equals( )` methods use the `==` operator for comparison. It is less useful with key objects of type `String`, for example, because there can be multiple `String` objects that are equal to one another and, even if the original key value has been reclaimed by the garbage collector, it is always possible to pass a `String` with the same value to the `get( )` method.

Figure 16-69. java.util.WeakHashMap<K,V>

```
public class WeakHashMap<K,V> extends AbstractMap<K,V> implements Map<K,V> {
// Public Constructors
     public WeakHashMap( );
     public WeakHashMap(int initialCapacity);
1.3  public WeakHashMap(Map<? extends K,? extends V> t);
     public WeakHashMap(int initialCapacity, float loadFactor);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
1.4  public boolean containsValue(Object value);
     public Set<Map.Entry<K,V>> entrySet( );
     public V get(Object key);
     public boolean isEmpty( );                          default:true
1.4  public Set<K> keySet( );
     public V put(K key, V value);
```

```
1.4  public void putAll(Map<? extends K,? extends V> m);
     public V remove(Object key);
     public int size( );
1.4  public Collection<V> values( );
}
```


downloaded from: lib.ommolketab.ir

Team LiB

Package java.util.concurrent

Java 5.0

This package includes a number of powerful utilities for multithreaded programming. Most of these utilit

Collections

This package extends the Java Collections Framework, adding the threadsafe classes ConcurrentH
, CopyOnWriteArraySet , and ConcurrentLinkedQueue . These classes achieve threadsafety with
synchronized methods, greatly increasing the number of threads that can safely use them concur
implements the ConcurrentMap interface, which adds important atomic methods to the base java.

In addition to these Map , List , Set , and Queue implementations, this package also defines the Blocki
queues are important in many concurrent algorithms, and this package provides a variety of useful impl
ArrayBlockingQueue , DelayQueue , LinkedBlockingQueue , PriorityBlockingQueue , and Synchron

Asynchronous Execution with Thread Pools

java.util.concurrent provides a robust framework for asynchronous execution of tasks defined
java.lang.Runnable interface or the new Callable interface. The Executor , ExecutorService
ScheduledExecutorService interfaces define methods for executing (or scheduling for future exe
tasks. The Future interface represents the future result of the asynchronous execution of a task. T
ScheduledThreadPoolExecutor are executor implementations based on highly configurable threa
provides convenient factory methods for obtaining instances of these thread pool implementations

Synchronizers

A number of classes in this package are useful for synchronizing two or more concurrent threads.
CyclicBarrier , Exchanger , and Semaphore .

Interfaces

```
public interface BlockingQueue<E> extends java.util.Queue<E>;
public interface Callable<V>;
public interface CompletionService<V>;
public interface ConcurrentMap<K, V> extends java.util.Map<K, V>;
public interface Delayed extends Comparable<Delayed>;
```

```
public interface Executor;
public interface ExecutorService extends Executor;
public interface Future<V>;
public interface RejectedExecutionHandler;
public interface ScheduledExecutorService extends ExecutorService;
public interface ScheduledFuture<V> extends Delayed, Future<V>;
public interface ThreadFactory;
```

Enumerated Types

```
public enum TimeUnit;
```

Collections

```
public class ArrayBlockingQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable;
public class ConcurrentHashMap<K, V> extends java.util.AbstractMap<K, V>
        implements ConcurrentMap<K, V> Serializable;
public class ConcurrentLinkedQueue<E> extends java.util.AbstractQueue<E>
        implements java.util.Queue<E>, Serializable;
public class CopyOnWriteArrayList<E> implements java.util.List<E>, java.util.RandomAcce
public class CopyOnWriteArraySet<E> extends java.util.AbstractSet<E>
        implements Serializable;
public class DelayQueue<E extends Delayed> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>;
public class LinkedBlockingQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable;
public class PriorityBlockingQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable;
public class SynchronousQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable;
```

Other Classes

```
public abstract class AbstractExecutorService implements ExecutorService;
   public class ThreadPoolExecutor extends AbstractExecutorService;
      public class ScheduledThreadPoolExecutor extends ThreadPoolExecutor
         implements ScheduledExecutorService;
public class CountDownLatch;
public class CyclicBarrier;
public class Exchanger<V>;
public class ExecutorCompletionService<V> implements CompletionService<V>;
public class Executors;
public class FutureTask<V> implements Future<V>, Runnable;
public class Semaphore implements Serializable;
public static class ThreadPoolExecutor.AbortPolicy implements RejectedExecutionHandler;
public static class ThreadPoolExecutor.CallerRunsPolicy implements RejectedExecutionHan
```

```
public static class ThreadPoolExecutor.DiscardOldestPolicy implements RejectedExecution
public static class ThreadPoolExecutor.DiscardPolicy implements RejectedExecutionHandle
```

Exceptions

```
public class BrokenBarrierException extends Exception;
public class CancellationException extends IllegalStateException;
public class ExecutionException extends Exception;
public class RejectedExecutionException extends RuntimeException;
public class TimeoutException extends Exception;
```

Team LiB

AbstractExecutorService java.util.concurrent

Java 5.0

This abstract class implements the submit( ), invokeAll( ), and invokeAny( ) methods of the Exec
interface. It does not implement the ExecutorService shutdown methods or the crucial execute( ) me
asynchronous execution of Runnable tasks.

The methods implemented by AbstractExecutorService wrap the submitted Callable or Runnable tas
FutureTask object. FutureTask implements Runnable and Future, which are first passed to the abstra
) method to be run asynchronously and then returned to the caller.

See ThreadPoolExecutor for a concrete implementation, and see Executors for convenient ExecutorSe
factory methods.

Figure 16-70. java.util.concurrent.AbstractExecutorService

```
public abstract class AbstractExecutorService implements ExecutorService {
// Public Constructors
     public AbstractExecutorService( );
// Methods Implementing ExecutorService
     public <T> java.util.List<Future<T>> invokeAll(java.util.Collection<Callable<T>> t
        throws InterruptedException;
     public <T> java.util.List<Future<T>> invokeAll(java.util.Collection<Callable<T>> t
        long timeout, TimeUnit unit) throws InterruptedException;
     public <T> T invokeAny(java.util.Collection<Callable<T>> tasks)
        throws InterruptedException, ExecutionException;
     public <T> T invokeAny(java.util.Collection<Callable<T>> tasks, long timeout, Time
        throws InterruptedException, ExecutionException, TimeoutException;
     public Future<?> submit(Runnable task);
     public <T> Future<T> submit(Callable<T> task);
     public <T> Future<T> submit(Runnable task, T result);
}
```

Subclasses

ThreadPoolExecutor

ArrayBlockingQueue<E> java.util.concurrent

Java 5.0 *serializable collection*

This BlockingQueue implementation uses an array to store queue elements. The internal array has a fix specified when the queue is created, which means that this is a bounded queue and the put( ) method b the queue has no more room. ArrayBlockingQueue orders its elements on a first-in, first-out (FIFO) bas BlockingQueue implementations, null elements are prohibited.

If you pass TRue as the second argument to the ArrayBlockingQueue constructor, the queue enforces a policy for blocked threads: threads blocked in put( ) or take( ) are themselves queued in FIFO order, a thread that has been waiting the longest is served first. This prevents thread starvation but may decrea throughput for the ArrayBlockingQueue .

Figure 16-71. java.util.concurrent.ArrayBlockingQueue<E>

```
public class ArrayBlockingQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable {
// Public Constructors
     public ArrayBlockingQueue(int capacity);
     public ArrayBlockingQueue(int capacity, boolean fair);
     public ArrayBlockingQueue(int capacity, boolean fair, java.util.Collection<? extend
// Methods Implementing BlockingQueue
     public int drainTo(java.util.Collection<? super E> c);
     public int drainTo(java.util.Collection<? super E> c, int maxElements);
     public boolean offer(E o);
     public boolean offer(E o, long timeout, TimeUnit unit) throws InterruptedException
     public E poll(long timeout, TimeUnit unit) throws InterruptedException;
     public void put(E o) throws InterruptedException;
     public int remainingCapacity( );
     public E take( ) throws InterruptedException;
// Methods Implementing Collection
     public void clear( );
     public boolean contains(Object o);
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);
```

```
    public int size( );
    public Object[ ] toArray( );
    public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
    public E peek( );
    public E poll( );
// Public Methods Overriding AbstractCollection
    public String toString( );
}
```

BlockingQueue<E> java.util.concurrent

Java 5.0 *collection*

This interface extends the java.util.Queue interface of the Java Collections Framework and adds blocking put( ) and take( ) methods. Blocking queues are useful in many concurrent algorithms in which a producer thread puts objects onto a queue and a consumer thread removes them for some kind of processing. The producer thread must block if a bounded queue fills up, and the consumer thread must block if no objects are available on the queue.

In addition to put( ) and take( ) methods that block indefinitely, BlockingQueue also defines timed versions of the Queue methods offer( ) and poll( ) that wait up to the specified time. The timeout is specified as both a long and a TimeUnit constant.

drainTo( ) removes all available elements from a BlockingQueue, adds them to the specified collection, and returns the number of elements removed from the queue. drainTo( ) does not block. A variant on this method puts an upper bound on the number of elements removed from the queue.

remainingCapacity( ) returns the number of elements that can be added to the queue before it becomes full or returns Integer.MAX_VALUE if the BlockingQueue is not a bounded queue. For bounded queues, this method provides a hint as to whether a call to put( ) will block.

BlockingQueue implementations are not allowed to accept null elements. The BlockingQueue interface refines the Collection.add( ) and Queue.offer( ) contracts to indicate that these methods throw NullPointerException if passed a null value.

Figure 16-72. java.util.concurrent.BlockingQueue<E>

```
public interface BlockingQueue<E> extends java.util.Queue<E> {
// Public Instance Methods
     boolean add(E o);
     int drainTo(java.util.Collection<? super E> c);
     int drainTo(java.util.Collection<? super E> c, int maxElements);
     boolean offer(E o);
     boolean offer(E o, long timeout, TimeUnit unit) throws InterruptedException;
     E poll(long timeout, TimeUnit unit) throws InterruptedException;
     void put(E o) throws InterruptedException;
     int remainingCapacity( );
     E take( ) throws InterruptedException;
}
```

Implementations

`ArrayBlockingQueue`, `DelayQueue`, `LinkedBlockingQueue`, `PriorityBlockingQueue`, `SynchronousQueue`

Passed To

`ExecutorCompletionService.ExecutorCompletionService( )`, `ThreadPoolExecutor.ThreadPoolExecutor( )`

Returned By

`ScheduledThreadPoolExecutor.getQueue( )`, `ThreadPoolExecutor.getQueue( )`

BrokenBarrierException java.util.concurrent

Java 5.0 *serializable checked*

An exception of this type is thrown when a thread calls `CyclicBarrier.await( )` on a broken barrier, or when the barrier is broken while a thread is waiting. A `CyclicBarrier` enters a broken state when one of the waiting threads is interrupted or times out.

Figure 16-73. java.util.concurrent.BrokenBarrierException


```
public class BrokenBarrierException extends Exception {
// Public Constructors
     public BrokenBarrierException( );
     public BrokenBarrierException(String message);
}
```

Thrown By

`CyclicBarrier.await( )`

Team LiB

Callable<V> java.util.concurrent

Java 5.0

This interface is a generalized form of the `java.lang.Runnable` interface. Unlike the `run( )` method of `Runnable`, the `call( )` method of `Callable` can return a value and throw an `Exception`. `Callable` is a generic type, and the type variable *V* represents the return type of the `call( )` method.

An `ExecutorService` accepts `Callable` objects for asynchronous execution and returns a `Future` object representing the future result of the `call( )` method.

```
public interface Callable<V> {
// Public Instance Methods
     V call( ) throws Exception;
}
```

Passed To

`AbstractExecutorService.submit( )`, `CompletionService.submit( )`, `ExecutorCompletionService.submit( )`, `Executors.{privilegedCallable( ), privilegedCallableUsingCurrentClassLoader( )}`, `ExecutorService.submit( )`, `FutureTask.FutureTask( )`, `ScheduledExecutorService.schedule( )`, `ScheduledThreadPoolExecutor.{schedule( ), submit( )}`

Returned By

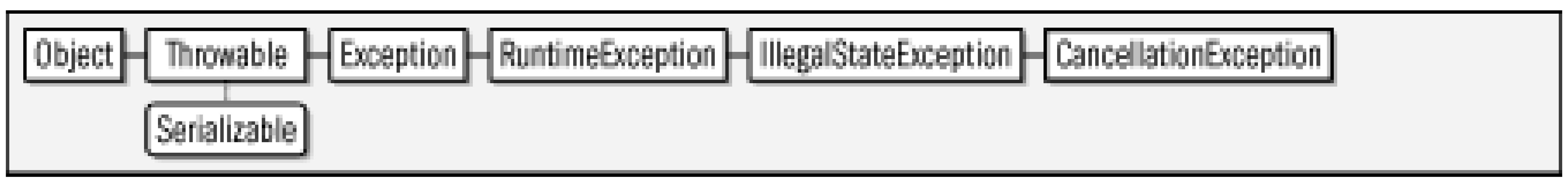
`Executors.{callable( ), privilegedCallable( ), privilegedCallableUsingCurrentClassLoader( )}`

CancellationException java.util.concurrent

Java 5.0 *serializable unchecked*

An exception of this type is thrown to indicate that the result of a computation cannot be retrieved because the computation was canceled. The `get( )` method of the `Future` interface may throw a `CancellationException`, for example.

Figure 16-74. java.util.concurrent.CancellationException




```
public class CancellationException extends IllegalStateException {
// Public Constructors
     public CancellationException( );
     public CancellationException(String message);
}
```

Team LiB

CompletionService<V> java.util.concurrent

Java 5.0

This interface combines the features of an `ExecutorService` with the features of a `BlockingQueue`. A producer thread may submit `Callable` or `Runnable` tasks for asynchronous execution. As each submitted task completes, its result, in the form of a `Future` object, becomes available to be removed from the queue by a consumer thread that calls `poll( )` or `take( )`.

This generic type declares a type variable *V*, which represents the result type of all tasks on the queue.

```
public interface CompletionService<V> {
// Public Instance Methods
     Future<V> poll( );
     Future<V> poll(long timeout, TimeUnit unit) throws InterruptedException;
     Future<V> submit(Callable<V> task);
     Future<V> submit(Runnable task, V result);
     Future<V> take( ) throws InterruptedException;
}
```

Implementations

`ExecutorCompletionService`

Team LiB

ConcurrentHashMap<K,V> java.util.concurrent

Java 5.0 *serializable collection*

This class is a threadsafe implementation of the `java.util.Map` interface, and of the atomic operations a by the `ConcurrentMap` interface. This class is intended as a drop-in replacement for `java.util.Hashtab` is more efficient than that class, however, because it provides threadsafety without using `synchronized` methods that lock the entire data structure. `ConcurrentHashMap` allows any number of concurrent read operations without locking. Locking is required for updates to a `ConcurrentHashMap` , but the internal da structure is segmented so that only the segment being updated is locked, and reads and writes can proc concurrently in other segments. You can specify the number of internal segments with the *concurrencyL* argument to the constructor. The default is 16. Set this to the approximate number of updater threads y expect to access the data structure. Like `Hashtable` , `ConcurrentHashMap` does not allow `null` keys or v (Note that this differs from the behavior of `java.util.HashMap` .)

Figure 16-75. java.util.concurrent.ConcurrentHashMap<K,V>

```
public class ConcurrentHashMap<K,V> extends java.util.AbstractMap<K,V>
 implements ConcurrentMap<K,V>, Serializable {
// Public Constructors
     public ConcurrentHashMap( );
     public ConcurrentHashMap(java.util.Map<? extends K,? extends V> t);
     public ConcurrentHashMap(int initialCapacity);
     public ConcurrentHashMap(int initialCapacity, float loadFactor, int concurrencyLev
// Public Instance Methods
     public boolean contains(Object value);
     public java.util.Enumeration<V> elements( );
     public java.util.Enumeration<K> keys( );
// Methods Implementing ConcurrentMap
     public V putIfAbsent(K key, V value);
     public boolean remove(Object key, Object value);
     public V replace(K key, V value);
     public boolean replace(K key, V oldValue, V newValue);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object key);
     public boolean containsValue(Object value);
     public java.util.Set<java.util.Map.Entry<K,V>> entrySet( );
     public V get(Object key);
```

```
    public boolean isEmpty( );                          default:true
    public java.util.Set<K> keySet( );
    public V put(K key, V value);
    public void putAll(java.util.Map<? extends K,? extends V> t);
    public V remove(Object key);
    public int size( );
    public java.util.Collection<V> values( );
}
```

Team LiB

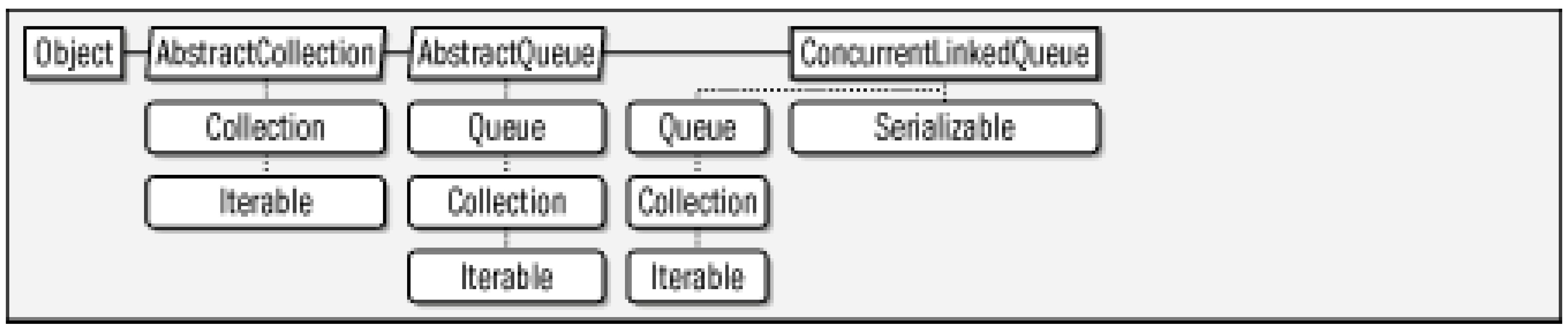
Team LiB

ConcurrentLinkedQueue<E> java.util.concurrent

Java 5.0 *serializable collection*

This class is a threadsafe implementation of the `java.util.Queue` interface (but not of the `BlockingQueue` interface). It provides threadsafety without using `synchronized` methods that would lock the entire data structure. `ConcurrentLinkedQueue` is unbounded and orders its elements on a first-in, first-out (FIFO) basis. `null` elements are not allowed. This implementation uses a linked-list data structure internally. Note that the `size( )` method must traverse the internal data structure and is therefore a relatively expensive operation for this class.

Figure 16-76. java.util.concurrent.ConcurrentLinkedQueue<E>




```
public class ConcurrentLinkedQueue<E> extends java.util.AbstractQueue<E>
 implements java.util.Queue<E>, Serializable {
// Public Constructors
     public ConcurrentLinkedQueue( );
     public ConcurrentLinkedQueue(java.util.Collection<? extends E> c);
// Methods Implementing Collection
     public boolean add(E o);
     public boolean contains(Object o);
     public boolean isEmpty( );                          default:true
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
     public boolean offer(E o);
     public E peek( );
     public E poll( );
}
```

ConcurrentMap<K,V> java.util.concurrent

Java 5.0 *collection*

This interface extends the `java.util.Map` interface to add four important atomic methods. As with the `Map` interface, the type variables *K* and *V* represent the types of the mapped keys and values.

`putIfAbsent( )` atomically tests whether a key is already defined in the map, and if not, maps it to the specified value. `remove( )` atomically removes the specified key from the map, but only if it is mapped to the specified value. It returns `true` if it modified the map. There are two versions of the atomic `replace( )` method. The first checks whether the specified value is already mapped to a value. If so, it replaces the existing mapping with the specified value and returns `true`. Otherwise, it returns `false`. The three-argument version of `replace( )` maps the specified key to the specified new value, but only if the key is currently mapped to the specified old value. It returns `true` if the replacement was made and `false` otherwise.

Figure 16-77. java.util.concurrent.ConcurrentMap<K,V>

```
public interface ConcurrentMap<K,V> extends java.util.Map<K,V> {
// Public Instance Methods
     V putIfAbsent(K key, V value);
     boolean remove(Object key, Object value);
     V replace(K key, V value);
     boolean replace(K key, V oldValue, V newValue);
}
```

Implementations

`ConcurrentHashMap`

CopyOnWriteArrayList<E> java.util.concurrent

Java 5.0 *cloneable serializable collection*

This class is a threadsafe `java.util.List` implementation based on an array. Any number of read opera may proceed concurrently. All update methods are `synchronized` and make a completely new copy of th internal array, so this class is best suited to applications in which reads greatly outnumber updates. The `Iterator` of a `CopyOnWriteArrayList` operates on the copy of the array that was current when the `iterator( )` method was called: it does not see any updates that occur after the call to `iterator( )` an guaranteed never to throw `ConcurrentModificationException` . Update methods of the `Iterator` and `ListIterator` interfaces are not supported and throw `UnsupportedOperationException` .

`CopyOnWriteArrayList` defines a few useful methods beyond those specified by the `List` interface. `addIfAbsent( )` atomically adds an element to the list, but only if the list does not already contain that element. `addAllAbsent( )` adds all elements of a collection that are not already in the list. Two new `ind )` and `lastIndexOf( )` methods are defined that specify a starting index for the search. These provide a convenient alternative to using a `subList( )` view when searching for repeated matches in a list.

Figure 16-78. java.util.concurrent.CopyOnWriteArrayList<E>

```
public class CopyOnWriteArrayList<E> implements java.util.List<E>,
        java.util.RandomAccess, Cloneable, Serializable {
// Public Constructors
     public CopyOnWriteArrayList( );
     public CopyOnWriteArrayList(java.util.Collection<? extends E> c);
     public CopyOnWriteArrayList(E[ ] toCopyIn);
// Public Instance Methods
     public int addAllAbsent(java.util.Collection<? extends E> c);     synchronized
     public boolean addIfAbsent(E element);                            synchronized
     public int indexOf(E elem, int index);
     public int lastIndexOf(E elem, int index);
// Methods Implementing List
     public boolean add(E element);                           synchronized
     public void add(int index, E element);                            synchronized
     public boolean addAll(java.util.Collection<? extends E> c);     synchronized
     public boolean addAll(int index, java.util.Collection<? extends E> c);     synchro
     public void clear( );                                     synchronized
     public boolean contains(Object elem);
     public boolean containsAll(java.util.Collection<?> c);
```

```
    public boolean equals(Object o);
    public E get(int index);
    public int hashCode( );
    public int indexOf(Object elem);
    public boolean isEmpty( );                           default:true
    public java.util.Iterator<E> iterator( );
    public int lastIndexOf(Object elem);
    public java.util.ListIterator<E> listIterator( );
    public java.util.ListIterator<E> listIterator(int index);
    public boolean remove(Object o);                     synchronized
    public E remove(int index);                          synchronized
    public boolean removeAll(java.util.Collection<?> c);       synchronized
    public boolean retainAll(java.util.Collection<?> c);       synchronized
    public E set(int index, E element);                  synchronized
    public int size( );
    public java.util.List<E> subList(int fromIndex, int toIndex);     synchronized
    public Object[ ] toArray( );
    public <T> T[ ] toArray(T[ ] a);
// Public Methods Overriding Object
    public Object clone( );
    public String toString( );
}
```

Team LiB

CopyOnWriteArraySet<E> java.util.concurrent

Java 5.0 *serializable collection*

This class is a threadsafe `java.util.Set` implementation based on the `CopyOnWriteArrayList` class. Be the data structure is array-based, the `contains( )` method is `O(n)` ; this means that this class is suitabl for relatively small sets. Because the data structure uses copy-on-write, the class is best suited to cases read operations and traversals greatly outnumber update operations. Iteration over the members of the efficient, and the `Iterator` returned by `iterator( )` never throws `ConcurrentModificationException` `remove( )` method of the iterator throws `UnsupportedOperationException` . See also `CopyOnWriteArr`
.

Figure 16-79. java.util.concurrent.CopyOnWriteArraySet<E>

```
public class CopyOnWriteArraySet<E> extends java.util.AbstractSet<E> implements Seriali
// Public Constructors
     public CopyOnWriteArraySet( );
     public CopyOnWriteArraySet(java.util.Collection<? extends E> c);
// Methods Implementing Set
     public boolean add(E o);
     public boolean addAll(java.util.Collection<? extends E> c);
     public void clear( );
     public boolean contains(Object o);
     public boolean containsAll(java.util.Collection<?> c);
     public boolean isEmpty( );                              default:true
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);
     public boolean retainAll(java.util.Collection<?> c);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Public Methods Overriding AbstractSet
     public boolean removeAll(java.util.Collection<?> c);
}
```

Team LiB

CountDownLatch java.util.concurrent

Java 5.0

This class synchronizes threads. All threads that call `await( )` block until the `countDown( )` method is invoked a specified number of times. The required number of calls is specified when the `CountDownLatch` is created. Once `countDown( )` has been called the required number of times, all threads blocked in `await( )` are allowed to resume, and any subsequent calls to `await( )` do not block. `getCount( )` returns the number of calls to `countDown( )` that must still be made before the threads blocked in `await( )` can resume. Note that there is no way to reset the count. Once a `CountDownLatch` has "latched," it remains in that state forever. Create a new `CountDownLatch` if you need to synchronize another group of threads. Contrast this class with `CyclicBarrier` .

```
public class CountDownLatch {
// Public Constructors
     public CountDownLatch(int count);
// Public Instance Methods
     public void await( ) throws InterruptedException;
     public boolean await(long timeout, TimeUnit unit) throws InterruptedException;
     public void countDown( );
     public long getCount( );
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

CyclicBarrier java.util.concurrent

Java 5.0

This class synchronizes a group of *n* threads, where *n* is specified to the `CyclicBarrier( )` constructor. Threads call the `await( )` method, which blocks until *n* threads are waiting. In the simple case, all *n* threads are then allowed to proceed, and the `CyclicBarrier` resets itself until it has another *n* threads blocked in `await( )`.

More complex behavior is possible if you pass a `Runnable` object to the `CyclicBarrier` constructor. This `Runnable` is a "barrier action" and when the last of the *n* threads invokes `await( )`, that method uses the thread to invoke the `run( )` method of the `Runnable`. This `Runnable` is typically used to perform some sort of coordinating action on the blocked threads. When the `run( )` method returns, the `CyclicBarrier` allows all blocked threads to resume.

When threads resume from `await( )`, the return value of `await( )` is an integer that represents the order in which they called `await( )`. This is useful if you want to be able to distinguish between otherwise identical worker threads. For example, you might have the thread that arrived first perform some special action while the remaining threads resume.

If any thread times out or is interrupted while blocked in `await( )`, the `CyclicBarrier` is said to be "broken," and all waiting threads (and any threads that subsequently call `await( )`) wake up with a `BrokenBarrierException`. Waiting threads also receive a `BrokenBarrierException` if the `CyclicBarrier` is `reset( )`. The `reset( )` method is the only way to restore a broken barrier to its initial state. This is difficult to coordinate properly, however, unless one controller thread is coded differently from the other threads at the barrier.

```
public class CyclicBarrier {
// Public Constructors
     public CyclicBarrier(int parties);
     public CyclicBarrier(int parties, Runnable barrierAction);
// Public Instance Methods
     public int await( ) throws InterruptedException, BrokenBarrierException;
     public int await(long timeout, TimeUnit unit)
        throws InterruptedException, BrokenBarrierException, TimeoutException;
     public int getNumberWaiting( );
     public int getParties( );
     public boolean isBroken( );
     public void reset( );
}
```

Team LiB

Delayed java.util.concurrent

Java 5.0 *comparable*

An object that implements this interface has an associated delay. Typically, it is some kind of task, such as a `Callable`, that has been scheduled to execute at some future time. `getdelay( )` returns the remaining time, measured in the specified `TimeUnit`. If no time remains, `geTDelay( )` should return zero or a negative value. See `ScheduledFuture` and `DelayQueue`.

Figure 16-80. java.util.concurrent.Delayed


```
public interface Delayed extends Comparable<Delayed> {
// Public Instance Methods
     long getDelay(TimeUnit unit);
}
```

Implementations

`ScheduledFuture`

Passed To

`DelayQueue.{add( ), offer( ), put( )}`

Returned By

`DelayQueue.{peek( ), poll( ), take( )}`

DelayQueue<E extends Delayed> java.util.concurrent

Java 5.0 *collection*

This BlockingQueue implementation restricts its elements to instances of some class *E* that implements the Delay interface. null elements are not allowed. Elements on the queue are ordered by the amount of delay remaining. The element whose getdelay( ) method returns the smallest value is the first to be removed from the queue. No element may be removed, however, until its getdelay( ) method returns zero or a negative number.

Figure 16-81. java.util.concurrent.DelayQueue<E extends Delayed>

```
public class DelayQueue<E extends Delayed> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E> {
// Public Constructors
     public DelayQueue( );
     public DelayQueue(java.util.Collection<? extends E> c);
// Public Instance Methods
     public E peek( );
     public E poll( );
// Methods Implementing BlockingQueue
     public boolean add(E o);
     public int drainTo(java.util.Collection<? super E> c);
     public int drainTo(java.util.Collection<? super E> c, int maxElements);
     public boolean offer(E o);
     public boolean offer(E o, long timeout, TimeUnit unit);
     public E poll(long timeout, TimeUnit unit) throws InterruptedException;
     public void put(E o);
     public int remainingCapacity( );
     public E take( ) throws InterruptedException;
// Methods Implementing Collection
     public void clear( );
     public java.util.Iterator<E> iterator( );
```

```
    public boolean remove(Object o);
    public int size( );
    public Object[ ] toArray( );
    public <T> T[ ] toArray(T[ ] array);
}
```

Exchanger<V> java.util.concurrent

Java 5.0

This class allows two threads to rendezvous and exchange data. This is a generic type, and the type variable *V* represents the type of data to be exchanged. Each thread should call `exchange( )` and pass the value of type *V* that it wants to exchange. The first thread to call `exchange( )` blocks until the second thread calls it. At that point, both threads resume. Both threads receive as their return value the object of type *V* passed by the other thread. Note that this class also defines a timed version of `exchange( )` that throws a `TimeoutException` if no exchange occurs within the specified timeout interval. Unlike a `CountDownLatch`, which is a one-shot latch, and `CyclicBarrier` which can be "broken," an `Exchanger` may be reused for any number of exchanges.

```
public class Exchanger<V> {
// Public Constructors
     public Exchanger( );
// Public Instance Methods
     public V exchange(V x) throws InterruptedException;
     public V exchange(V x, long timeout, TimeUnit unit)
        throws InterruptedException, TimeoutException;
}
```

Team LiB

ExecutionException java.util.concurrent

Java 5.0 *serializable checked*

An exception of this type is like a checked wrapper around an arbitrary exception thrown while executing a task. The `get( )` method of a `Future` object, for example, throws an `ExecutionException` if the `call( )` method of a `Callable` throws an exception. `ExecutionException` may also be thrown by `ExecutorService.invokeAny( )`. Use the `THRowable.getCause( )` method to obtain the exception object that the `ExecutionException` wraps.

Figure 16-82. java.util.concurrent.ExecutionException


```
public class ExecutionException extends Exception {
// Public Constructors
     public ExecutionException(Throwable cause);
     public ExecutionException(String message, Throwable cause);
// Protected Constructors
     protected ExecutionException( );
     protected ExecutionException(String message);
}
```

Thrown By

`AbstractExecutorService.invokeAny( )`, `ExecutorService.invokeAny( )`, `Future.get( )`, `FutureTask.get( )`

Executor java.util.concurrent

Java 5.0

This interface defines a mechanism for executing Runnable tasks. A variety of implementations are possible for the execute( ) method. An implementation might simply synchronously invoke the run( ) method of the specified Runnable. Another implementation might create and start a new thread for each Runnable object it is passed. Another might select an existing thread from a thread pool to run the Runnable or queue the Runnable for future execution when a thread becomes available.

ExecutorService extends this interface with methods to execute Callable tasks and methods for canceling tasks. THReadPoolExecutor is an ExecutorService implementation that creates a configurable thread pool. Finally, the Executors class defines a number of factory methods for easily obtaining ExecutorService instances.

```
public interface Executor {
// Public Instance Methods
     void execute(Runnable command);
}
```

Implementations

ExecutorService

Passed To

ExecutorCompletionService.ExecutorCompletionService( )

ExecutorCompletionService<V> java.util.concurrent

Java 5.0

This class implements the CompletionService interface, which uses an Executor object passed to its constructor for executing the tasks passed to its submit( ) method. As these tasks complete, their result (or exception) is placed, in the form of a Future object, on an internal queue and becomes available for removal with the blocking take( ) method or the nonblocking or timed poll( ) methods.

This class is useful when you want to execute a number of tasks concurrently and want to process thei results in whatever order they complete. See Executors for a source of Executor objects to use with this class.

Figure 16-83. java.util.concurrent.ExecutorCompletionService<V>

```
public class ExecutorCompletionService<V> implements CompletionService<V> {
// Public Constructors
     public ExecutorCompletionService(Executor executor);
     public ExecutorCompletionService(Executor executor, BlockingQueue<Future<V>>
        completionQueue);
// Methods Implementing CompletionService
     public Future<V> poll( );
     public Future<V> poll(long timeout, TimeUnit unit) throws InterruptedException;
     public Future<V> submit(Callable<V> task);
     public Future<V> submit(Runnable task, V result);
     public Future<V> take( ) throws InterruptedException;
}
```

Team LiB

Executors java.util.concurrent

Java 5.0

This utility class defines static factory methods for creating ExecutorService and ScheduledExecutorSe objects. Each of the factory methods has a variant that allows you to explicitly specify a ThreadFactory newSingleThreadExecutor( ) returns an ExecutorService that uses a single thread and an unbounde waiting tasks. newFixedThreadPool( ) returns an ExecutorService that uses a thread pool with the sp number of threads and an unbounded queue. newCachedThreadPool( ) returns an ExecutorService th queue tasks but instead creates as many threads as are needed. When a task terminates, its thread is c reuse. Cached threads are allowed to terminate if they remain unused for 60 seconds.

newSingleThreadScheduledExecutor( ) returns a ScheduledExecutorService that uses a single threa tasks. newScheduledThreadPool( ) returns a ScheduledExecutorService that uses a thread pool of th size.

The factory methods of this class typically return instances of ThreadPoolExecutor and ScheduledThreadPoolExecutor . If the returned objects are cast to these implementing types, they car (to change the thread pool size, for example). If you want to prevent this from happening, use the unconfigurableExecutorService( ) and unconfigurableScheduledExecutorService( ) methods to wrapper objects that implement only the ExecutorService and ScheduledExecutorService methods a permit configuration.

Other methods of this class include callable( ) , which returns a Callable object wrapped around a Ru an optional result, and defaultThreadFactory( ) , which returns a basic ThreadFactory object. Execut define methods related to access control and the Java security system. A variant of the callable( ) me Callable around a java.security.PrivilegedAction . privilegedCallable( ) is intended to be inv within a PrivilegedAction being run with AccessController.doPrivileged( ) . When passed a Call way, it returns a new Callable that can be used later to invoke the original callable in a privileged acces context, granting it permissions that it would not otherwise have.

```
public class Executors {
// No Constructor
// Public Class Methods
     public static Callable<Object> callable(java.security.PrivilegedAction action);
     public static Callable<Object> callable(Runnable task);
     public static Callable<Object> callable(java.security.PrivilegedExceptionAction ac
     public static <T> Callable<T> callable(Runnable task, T result);
     public static ThreadFactory defaultThreadFactory( );
     public static ExecutorService newCachedThreadPool( );
     public static ExecutorService newCachedThreadPool(ThreadFactory threadFactory);
     public static ExecutorService newFixedThreadPool(int nThreads);
     public static ExecutorService newFixedThreadPool(int nThreads, ThreadFactory threa
     public static ScheduledExecutorService newScheduledThreadPool(int corePoolSize);
     public static ScheduledExecutorService newScheduledThreadPool(int corePoolSize,
        ThreadFactory threadFactory);
```

```
    public static ExecutorService newSingleThreadExecutor( );
    public static ExecutorService newSingleThreadExecutor(ThreadFactory threadFactory)
    public static ScheduledExecutorService newSingleThreadScheduledExecutor( );
    public static ScheduledExecutorService newSingleThreadScheduledExecutor(ThreadFact
       threadFactory);
    public static <T> Callable<T> privilegedCallable(Callable<T> callable);
    public static <T> Callable<T> privilegedCallableUsingCurrentClassLoader
       (Callable<T> callable);
    public static ThreadFactory privilegedThreadFactory( );
    public static ExecutorService unconfigurableExecutorService(ExecutorService execut
    public static ScheduledExecutorService unconfigurableScheduledExecutorService
       (ScheduledExecutorService executor);
}
```

Team LiB

ExecutorService java.util.concurrent

Java 5.0

This interface extends Executor to add methods to obtain a Future result of the asynchronous executio Callable task. It also adds methods for graceful termination or shutdown of an ExecutorService . ThreadPoolExecutor is a useful and highly configurable implementation of this interface. An easy way t obtain instances of this class is through the factory methods of the Executors utility class. Note that ExecutorService is not a generic type; it does not declare any type variables. It does have a number o generic methods, however, that use the type variable *T* to represent the result type of Callable and Fu objects.

The submit( ) method allows you to submit a Callable<T> object to an ExecutorService for executio Typical ExecutorService implementations invoke the call( ) method of the Callable on another thre and the return value (of type *T*) of the method is therefore not available when the call to submit( ) returns. submit( ) therefore returns a Future<T> object: the promise of a return value of type *T* at so point in the future. See the Future interface for further details.

Two variants on the submit( ) method accept a java.lang.Runnable task instead of a Callable task. run( ) method of a Runnable has no return value, so the two-argument version of submit( ) accepts dummy return value of type *T* and returns a Future<T> that makes this dummy value available when th Runnable has completed running. The other Runnable variant of the submit( ) method takes no return value and returns a Future<?> value. The get( ) method of this Future object returns null when the Runnable is done.

Other ExecutorService methods execute Callable objects synchronously. invokeAll( ) is passed a java.util.Collection of Callable<T> tasks. It executes them and blocks until all have completed, or an optionally specified timeout has elapsed. invokeAll( ) returns the results of the tasks as a List of Future<T> objects. Note that a Callable<T> task can complete either by returning a result of type T or throwing an exception.

invokeAny( ) is also passed a Collection of Callable<T> objects. It blocks until any one of these Callable tasks has returned a value of type *T* and returns that value. Tasks that terminate by throwing exception are ignored. If all tasks throw an exception, invokeAny( ) throws an ExecutionException . Before invokeAny( ) returns, it cancels the execution of any still-running Callable tasks. Like invokeA) , invokeAny( ) has a variant with a timeout value.

ExecutorService defines several methods for gracefully shutting down the service. shutdown( ) puts th ExecutorService into a special state in which no new tasks may be submitted for execution, but all cur running tasks continue running. isShutdown( ) returns true if the ExecutorService has entered this s awaitTermination( ) blocks until all executing tasks in an ExecutorService that was shut down are completed (or until a specified timeout elapses). Once this has occurred, the isTerminated( ) method returns true . The shutdownNow( ) method shuts down an ExecutorService more abruptly: it attempt abort all currently executing tasks (typically via Thread.interrupt( )) and returns a List of the tasks have not yet started executing.

Figure 16-84. java.util.concurrent.ExecutorService


```
public interface ExecutorService extends Executor {
// Public Instance Methods
     boolean awaitTermination(long timeout, TimeUnit unit) throws InterruptedException;
     <T> java.util.List<Future<T>> invokeAll(java.util.Collection<Callable<T>> tasks)
        throws InterruptedException;
     <T> java.util.List<Future<T>> invokeAll(java.util.Collection<Callable<T>> tasks,
        long timeout, TimeUnit unit) throws InterruptedException;
     <T> T invokeAny(java.util.Collection<Callable<T>> tasks)
        throws InterruptedException, ExecutionException;
     <T> T invokeAny(java.util.Collection<Callable<T>> tasks, long timeout, TimeUnit un
        throws InterruptedException, ExecutionException, TimeoutException;
     boolean isShutdown( );
     boolean isTerminated( );
     void shutdown( );
     java.util.List<Runnable> shutdownNow( );
     <T> Future<T> submit(Callable<T> task);
     Future<?> submit(Runnable task);
     <T> Future<T> submit(Runnable task, T result);
}
```

Implementations

AbstractExecutorService , ScheduledExecutorService

Passed To

Executors.unconfigurableExecutorService( )

Returned By

Executors.{newCachedThreadPool( ) , newFixedThreadPool( ) , newSingleThreadExecutor( ) , unconfigurableExecutorService( )}

Team LiB

Future<V> java.util.concurrent

Java 5.0

This interface represents the result of a computation that may not be available until some time in the future. Future is a generic type, with a type variable *V*. *V* represents the type of the future value to be returned by the get( ) method. A Future<V> value is typically obtained by submitting a Callable<V> to an ExecutorService for asynchronous execution.

The key method of the Future interface is get( ). It returns the result (of type *V*) of the computation, blocking, if necessary, until that result is ready. get( ) throws a CancellationException if the computation is canceled with the cancel( ) method before it completes. If the computation throws an exception of its own (as the Callable.call( ) method can), get( ) tHRows an ExecutionException wrapped around that exception. Additionally, the timed version of the get( ) method throws a TimeoutException if the timeout elapses before the computation completes.

As noted above, the computation represented by a Future object can be canceled by calling its cancel( ) method. This method returns true if the computation was canceled successfully, and false otherwise. If you pass false to cancel( ), any computation that has started running is allowed to complete. In this case, only computations that have not yet started can be canceled. If you pass true to the cancel( ) method, running computations are interrupted with Thread.interrupt( ). Note, however, that interrupting a thread does not guarantee that it will stop running.

isCancelled( ) returns true if a Future was canceled before it completed (either by returning a value or throwing an exception). isDone( ) returns true if the computation represented by a Future is finished running. This may be because it returned a value, threw an exception, or was canceled. If isDone( ) returns true, the get( ) method does not block.

```
public interface Future<V> {
// Public Instance Methods
     boolean cancel(boolean mayInterruptIfRunning);
     V get( ) throws InterruptedException, ExecutionException;
     V get(long timeout, TimeUnit unit) throws InterruptedException,
        ExecutionException, TimeoutException;
     boolean isCancelled( );
     boolean isDone( );
}
```

Implementations

FutureTask, ScheduledFuture

Returned By

Too many methods to list.

FutureTask<V> java.util.concurrent

Java 5.0 *runnable*

This class is a Runnable wrapper around a Callable object (or around another Runnable). FutureTask is a generic type and the type variable *V* represents the return type of the wrapped Callable object. AbstractExecutorService uses FutureTask to convert Callable objects passed to the submit( ) method into Runnable objects it can pass to the execute( ) method.

FutureTask also implements the Future interface, which means that the get( ) method waits for the run( ) method to complete and provides access to the result (or exception) of the Callable's execution.

The protected methods set( ) and setException( ) are invoked when the Callable returns a value or throws an exception. done( ) is invoked when the Callable completes or is canceled. Subclasses can override any of these methods to insert hooks for notification, logging, and so on.

Figure 16-85. java.util.concurrent.FutureTask<V>

```
public class FutureTask<V> implements Future<V>, Runnable {
// Public Constructors
     public FutureTask(Callable<V> callable);
     public FutureTask(Runnable runnable, V result);
// Methods Implementing Future
     public boolean cancel(boolean mayInterruptIfRunning);
     public V get( ) throws InterruptedException, ExecutionException;
     public V get(long timeout, TimeUnit unit) throws InterruptedException,
        ExecutionException, TimeoutException;
     public boolean isCancelled( );
     public boolean isDone( );
// Methods Implementing Runnable
     public void run( );
// Protected Instance Methods
     protected void done( );                                          empty
     protected boolean runAndReset( );
     protected void set(V v);
     protected void setException(Throwable t);
}
```

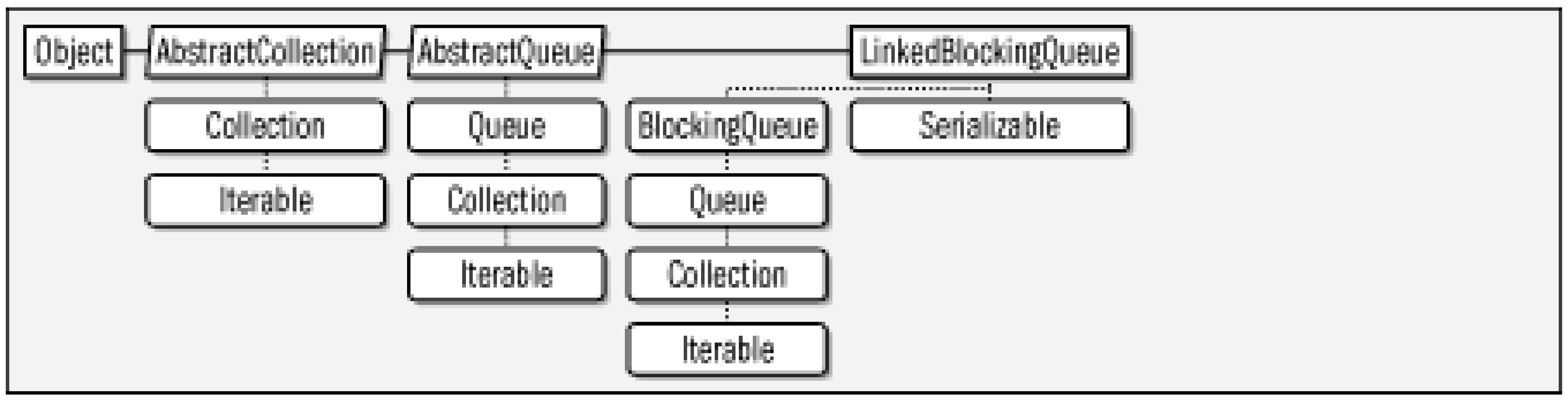
Team LiB

LinkedBlockingQueue<E> java.util.concurrent

Java 5.0 *serializable collection*

This threadsafe class implements the BlockingQueue interface based on a linked-list data structure. It orders elements on a first-in, first-out (FIFO) basis. You may specify a maximum queue capacity, creati bounded queue. The default capacity is Integer.MAX_VALUE , which is effectively unbounded. null eleme are not permitted.

Figure 16-86. java.util.concurrent.LinkedBlockingQueue<E>




```
public class LinkedBlockingQueue<E> extends java.util.AbstractQueue<E>
implements BlockingQueue<E>, Serializable {
// Public Constructors
     public LinkedBlockingQueue( );
     public LinkedBlockingQueue(int capacity);
     public LinkedBlockingQueue(java.util.Collection<? extends E> c);
// Methods Implementing BlockingQueue
     public int drainTo(java.util.Collection<? super E> c);
     public int drainTo(java.util.Collection<? super E> c, int maxElements);
     public boolean offer(E o);
     public boolean offer(E o, long timeout, TimeUnit unit) throws InterruptedException
     public E poll(long timeout, TimeUnit unit) throws InterruptedException;
     public void put(E o) throws InterruptedException;
     public int remainingCapacity( );
     public E take( ) throws InterruptedException;
// Methods Implementing Collection
     public void clear( );
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
     public E peek( );
```

```
    public E poll( );
// Public Methods Overriding AbstractCollection
    public String toString( );
}
```

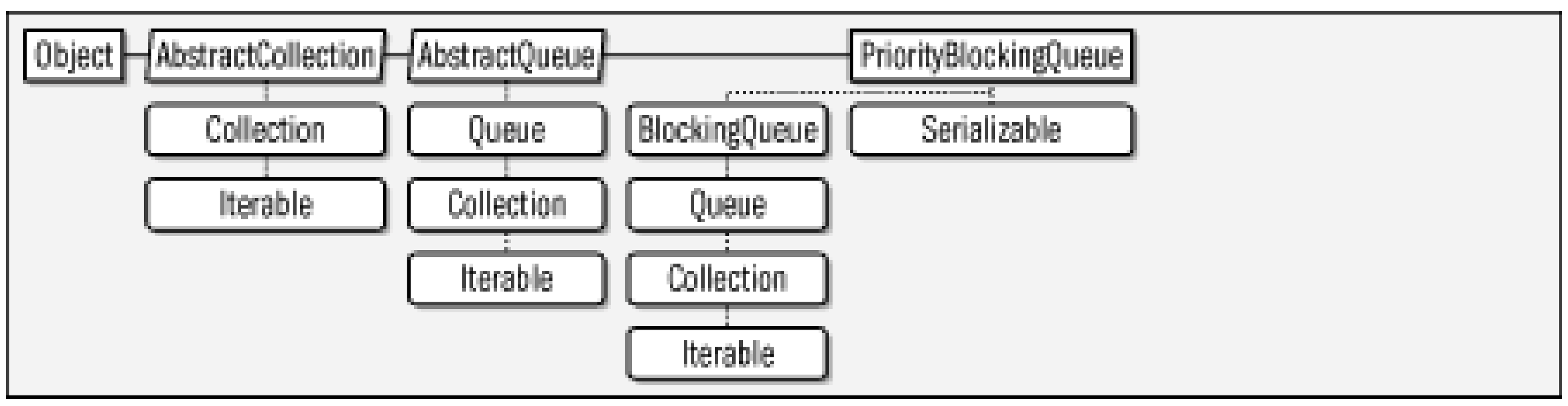
Team LiB

PriorityBlockingQueue<E> java.util.concurrent

Java 5.0 *serializable collection*

This threadsafe class implements the `BlockingQueue` interface. It is an unbounded queue that orders its elements according to a `Comparator` , or, for `Comparable` elements, according to their `compareTo( )` method. The head of the queue (the next element to be removed) is always the smallest element. Note that the `Iterator` returned by the `iterator( )` method is not guaranteed to return elements in this order. See also `java.util.PriorityQueue` .

Figure 16-87. java.util.concurrent.PriorityBlockingQueue<E>




```
public class PriorityBlockingQueue<E> extends java.util.AbstractQueue<E>
 implements BlockingQueue<E>, Serializable {
// Public Constructors
     public PriorityBlockingQueue( );
     public PriorityBlockingQueue(int initialCapacity);
     public PriorityBlockingQueue(java.util.Collection<? extends E> c);
     public PriorityBlockingQueue(int initialCapacity, java.util.Comparator<? super E>
        comparator);
// Public Instance Methods
     public java.util.Comparator<? super E> comparator( );
// Methods Implementing BlockingQueue
     public boolean add(E o);
     public int drainTo(java.util.Collection<? super E> c);
     public int drainTo(java.util.Collection<? super E> c, int maxElements);
     public boolean offer(E o);
     public boolean offer(E o, long timeout, TimeUnit unit);
     public E poll(long timeout, TimeUnit unit) throws InterruptedException;
     public void put(E o);
     public int remainingCapacity( );
     public E take( ) throws InterruptedException;
// Methods Implementing Collection
     public void clear( );
     public boolean contains(Object o);
```

```
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);
     public int size( );
     public Object[ ] toArray( );
     public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
     public E peek( );
     public E poll( );
// Public Methods Overriding AbstractCollection
     public String toString( );
}
```

Team LiB

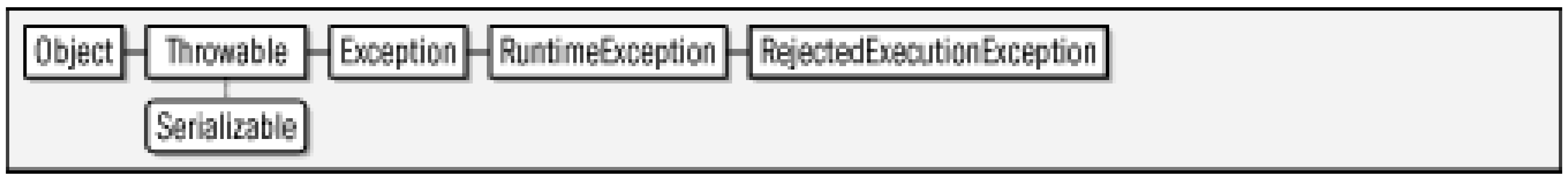
Team LiB

RejectedExecutionException java.util.concurrent

Java 5.0 *serializable unchecked*

An exception of this type is thrown by an `Executor` when it cannot accept a task for execution. When a `ThreadPoolExecutor` cannot accept a task, it attempts to invoke a `RejectedExecutionHandler`. `THReadPoolExecutor` defines several nested implementations of that handler interface that can handle the rejected task without throwing an exception of this type.

Figure 16-88. java.util.concurrent.RejectedExecutionException




```
public class RejectedExecutionException extends RuntimeException {
// Public Constructors
     public RejectedExecutionException( );
     public RejectedExecutionException(Throwable cause);
     public RejectedExecutionException(String message);
     public RejectedExecutionException(String message, Throwable cause);
}
```

Team LiB

RejectedExecutionHandler java.util.concurrent

Java 5.0

This interface defines an API for a handler method invoked by a `ThreadPoolExecutor` when its `execute( )` method cannot accept any more `Runnable` objects. This can occur when both the thread pool and the queue of waiting tasks is full, or when the `THReadPoolExecutor` has been shut down. Register an instance of this class with the `setRejectedExecutionHandler( )` method of `ThreadPoolExecutor`. `ThreadPoolExecutor` includes several predefined implementations of this interface as static member classes. If the `rejectedExecution( )` method cannot arrange for the `Runnable` to be run and does not wish to simply discard that task, it should throw a `RejectedExecutionException` which propagates up to the caller that submitted the task for execution.

```
public interface RejectedExecutionHandler {
// Public Instance Methods
     void rejectedExecution(Runnable r, ThreadPoolExecutor executor);
}
```

Implementations

`ThreadPoolExecutor.AbortPolicy`, `ThreadPoolExecutor.CallerRunsPolicy`, `ThreadPoolExecutor.DiscardOldestPolicy`, `ThreadPoolExecutor.DiscardPolicy`

Passed To

`ScheduledThreadPoolExecutor.ScheduledThreadPoolExecutor( )`, `ThreadPoolExecutor.{setRejectedExecutionHandler( ), ThreadPoolExecutor( )}`

Returned By

`ThreadPoolExecutor.getRejectedExecutionHandler( )`

ScheduledExecutorService java.util.concurrent

Java 5.0

This interface extends Executor and ExecutorService to add methods for scheduling Callable or Runnable tasks for future execution on a one-time basis or a repeating basis. The schedule( ) methods schedule a Callable or a Runnable task for one-time execution after a specified delay. The delay is specified by a long plus a TimeUnit . When a Callable<V> is scheduled, the result is a ScheduledFuture<V> . This is like a Future<V> object but also implements the Delay interface so you can call getdelay( ) to find out how much time remains before execution begins. If you schedule( ) a Runnable object, the result is a ScheduledFuture<?> . Since a Runnable has no return value, the get(method of this ScheduledFuture returns null , but the cancel( ) , geTDelay( ) , and isDone( ) methods remain useful.

ScheduledExecutorService provides two alternatives for scheduling Runnable tasks for repeated execution. (See also java.util.Timer , which has similar methods.) scheduleAtFixedRate( ) begins the first execution of the Runnable after *initialDelay* time units, and begins subsequent executions a multiples of *period* time units after that. This means that the Runnable runs at a fixed rate, regardless of how long each execution takes. scheduleWithFixedDelay( ) also begins the first execution after *initialDelay* time units. But it waits for this first execution (and all subsequent executions) to comple before scheduling the next execution for *delay* time units in the future. Both methods return a ScheduledFuture object that you can use to cancel( ) the repeated execution of tasks. If the task is not canceled, the ScheduledExecutorService runs it repeatedly until the service is shut down (see ExecutorService) or the Runnable throws an exception.

Figure 16-89. java.util.concurrent.ScheduledExecutorService

```
public interface ScheduledExecutorService extends ExecutorService {
// Public Instance Methods
     <V> ScheduledFuture<V> schedule(Callable<V> callable, long delay, TimeUnit unit);
     ScheduledFuture<?> schedule(Runnable command, long delay, TimeUnit unit);
     ScheduledFuture<?> scheduleAtFixedRate(Runnable command, long initialDelay,
        long period, TimeUnit unit);
     ScheduledFuture<?> scheduleWithFixedDelay(Runnable command, long initialDelay,
        long delay, TimeUnit unit);
}
```

Implementations

`ScheduledThreadPoolExecutor`

Passed To

`Executors.unconfigurableScheduledExecutorService( )`

Returned By

`Executors.{newScheduledThreadPool( )`, `newSingleThreadScheduledExecutor( )`, `unconfigurableScheduledExecutorService( )}`

Team LiB

ScheduledFuture<V> java.util.concurrent

Java 5.0 *comparable*

This interface extends Future and Delayed and adds no methods of its own. A ScheduledFuture represents a computation and the future result of that computation just as Future does, but it adds a getdelay( ) method that returns the amount of time until the computation begins. See ScheduledExecutorService.

Figure 16-90. java.util.concurrent.ScheduledFuture<V>


```
public interface ScheduledFuture<V> extends DelayedFuture<V> {
}
```

Returned By

ScheduledExecutorService.{schedule( ), scheduleAtFixedRate( ), scheduleWithFixedDelay( )}, ScheduledThreadPoolExecutor.{schedule( ), scheduleAtFixedRate( ), scheduleWithFixedDelay( )}

Team LiB

ScheduledThreadPoolExecutor java.util.concurrent

Java 5.0

This class extends ThreadPoolExecutor to implement the methods of the ScheduledExecutorService i
to allow tasks to be submitted for execution once or repeatedly at some scheduled time in the future. In
this class are usually obtained through the static factory methods of the Executors utility class. You can
explicitly create one with the ScheduledThreadPoolExecutors( ) constructor. ScheduledThreadPoolEx
always creates its own unbounded work queue, which means that you cannot pass a queue to the const
Also, there is no need to specify a *maximumPoolSize* since this configuration parameter is irrelevant wit
unbounded queues.

Note that tasks submitted to a ScheduledThreadPoolExecutor are not guaranteed to run at the schedu
That is the time at which they first become eligible to run. If all threads are busy with other tasks, howe
eligible tasks may get queued up to run later.

This class provides functionality similar to java.util.Timer but adds multithreaded capability and the a
work with Callable and Future objects.

Figure 16-91. java.util.concurrent.ScheduledThreadPoolExecutor

```
public class ScheduledThreadPoolExecutor extends ThreadPoolExecutor
        implements ScheduledExecutorService {
// Public Constructors
     public ScheduledThreadPoolExecutor(int corePoolSize);
     public ScheduledThreadPoolExecutor(int corePoolSize, ThreadFactory threadFactory);
     public ScheduledThreadPoolExecutor(int corePoolSize, RejectedExecutionHandler hand
     public ScheduledThreadPoolExecutor(int corePoolSize, ThreadFactory threadFactory,
 RejectedExecutionHandler handler);
// Public Instance Methods
     public boolean getContinueExistingPeriodicTasksAfterShutdownPolicy( );
     public boolean getExecuteExistingDelayedTasksAfterShutdownPolicy( );
     public void setContinueExistingPeriodicTasksAfterShutdownPolicy(boolean value);
     public void setExecuteExistingDelayedTasksAfterShutdownPolicy(boolean value);
// Methods Implementing Executor
     public void execute(Runnable command);
// Methods Implementing ExecutorService
     public void shutdown( );
     public java.util.List<Runnable> shutdownNow( );
     public Future<?> submit(Runnable task);
```

```
     public <T> Future<T> submit(Callable<T> task);
     public <T> Future<T> submit(Runnable task, T result);
// Methods Implementing ScheduledExecutorService
     public <V> ScheduledFuture<V> schedule(Callable<V> callable, long delay, TimeUnit
     public ScheduledFuture<?> schedule(Runnable command, long delay, TimeUnit unit);
     public ScheduledFuture<?> scheduleAtFixedRate(Runnable command, long initialDelay,
        long period, TimeUnit unit);
     public ScheduledFuture<?> scheduleWithFixedDelay(Runnable command, long initialDel
        long delay, TimeUnit unit);
// Public Methods Overriding ThreadPoolExecutor
     public BlockingQueue<Runnable> getQueue( );
     public boolean remove(Runnable task);
}
```

Team LiB

Team LiB

Semaphore java.util.concurrent

Java 5.0 *serializable*

This class implements *semaphores*, a classic thread synchronization primitive that can be used to implement mutual exclusion and wait/notify-style thread synchronization. A `Semaphore` maintains some fixed number (specified when the `Semaphore( )` constructor is called) of *`permits`*. The `acquire( )` method blocks until a permit is available, then decrements the number of available permits and returns. The `release( )` method does the reverse: it increments the number of permits, possibly unblocking a thread waiting in `acquire( )`.

If you pass `true` as the second argument to the `Semaphore( )` constructor, the semaphore treats waiting threads fairly by placing them on a FIFO queue in the order they called `acquire( )` and granting permits to the threads in this order. This prevents thread starvation.

Figure 16-92. java.util.concurrent.Semaphore

```
public class Semaphore implements Serializable {
// Public Constructors
     public Semaphore(int permits);
     public Semaphore(int permits, boolean fair);
// Public Instance Methods
     public void acquire( ) throws InterruptedException;
     public void acquire(int permits) throws InterruptedException;
     public void acquireUninterruptibly( );
     public void acquireUninterruptibly(int permits);
     public int availablePermits( );
     public int drainPermits( );
     public final int getQueueLength( );
     public final boolean hasQueuedThreads( );
     public boolean isFair( );
     public void release( );
     public void release(int permits);
     public boolean tryAcquire( );
     public boolean tryAcquire(int permits);
     public boolean tryAcquire(long timeout, TimeUnit unit)
        throws InterruptedException;
     public boolean tryAcquire(int permits, long timeout, TimeUnit unit)
        throws InterruptedException;
// Public Methods Overriding Object
```

```
        public String toString( );
// Protected Instance Methods
        protected java.util.Collection<Thread> getQueuedThreads( );
        protected void reducePermits(int reduction);
}
```

Team LiB

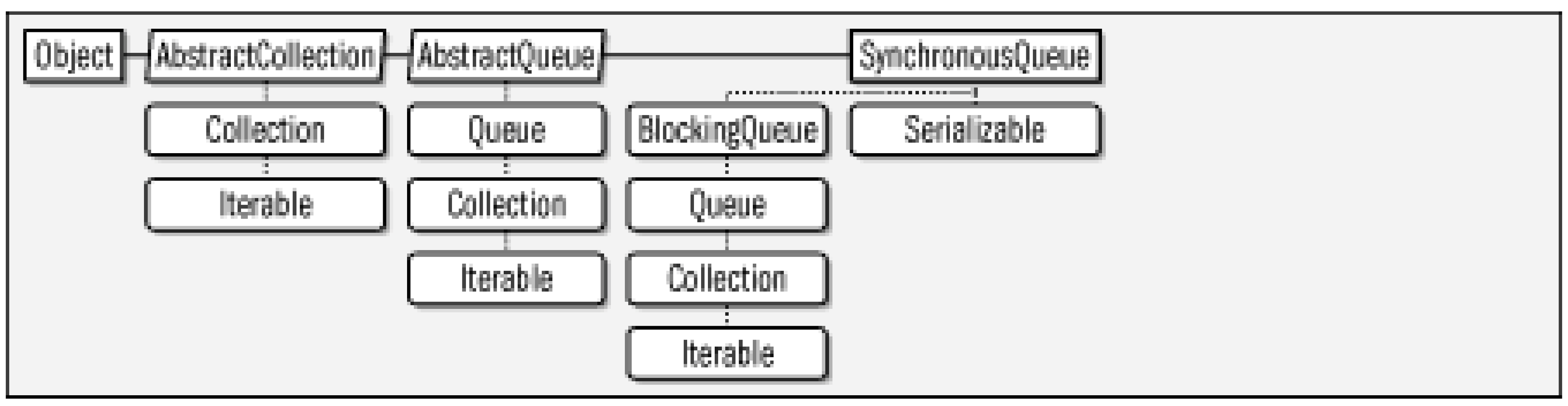
SynchronousQueue<E> java.util.concurrent

Java 5.0 *serializable collection*

This BlockingQueue implementation is the degenerate case of a bounded queue with a capacity of zero. to put( ) blocks until a corresponding call to take( ) , and vice versa. You can think of this as an Excha that does only a one-way exchange.

The size( ) and remainingCapacity( ) methods always return 0. The peek( ) method always returns The iterator( ) method returns an Iterator for which the hasNext( ) method returns false .

Figure 16-93. java.util.concurrent.SynchronousQueue<E>




```
public class SynchronousQueue<E> extends java.util.AbstractQueue<E>
        implements BlockingQueue<E>, Serializable {
// Public Constructors
     public SynchronousQueue( );
     public SynchronousQueue(boolean fair);
// Methods Implementing BlockingQueue
     public int drainTo(java.util.Collection<? super E> c);
     public int drainTo(java.util.Collection<? super E> c, int maxElements);
     public boolean offer(E o);
     public boolean offer(E o, long timeout, TimeUnit unit) throws InterruptedException
     public E poll(long timeout, TimeUnit unit) throws InterruptedException;
     public void put(E o) throws InterruptedException;
     public int remainingCapacity( );                                   constant
     public E take( ) throws InterruptedException;
// Methods Implementing Collection
     public void clear( );                                              empty
     public boolean contains(Object o);                               constant
     public boolean containsAll(java.util.Collection<?> c);
     public boolean isEmpty( );                                         constant defa
     public java.util.Iterator<E> iterator( );
     public boolean remove(Object o);                                 constant
     public boolean removeAll(java.util.Collection<?> c);       constant
```

```
    public boolean retainAll(java.util.Collection<?> c);       constant
    public int size( );                                                  constant
    public Object[ ] toArray( );
    public <T> T[ ] toArray(T[ ] a);
// Methods Implementing Queue
    public E peek( );                                                    constant
    public E poll( );
}
```

Team LiB

ThreadFactory java.util.concurrent

Java 5.0

An instance of this interface is an object that creates Thread objects to run Runnable objects. You might define a THReadFactory if you want to set the priority, name, or ThreadGroup of the threads used by a ThreadPoolExecutor, for example. A number of the factory methods of the Executors utility class rely on THReadPoolExecutor and accept a ThreadFactory argument.

```
public interface ThreadFactory {
// Public Instance Methods
     Thread newThread(Runnable r);
}
```

Passed To

Executors.{newCachedThreadPool( ), newFixedThreadPool( ), newScheduledThreadPool( ), newSingleThreadExecutor( ), newSingleThreadScheduledExecutor( )}, ScheduledThreadPoolExecutor.ScheduledThreadPoolExecutor( ), ThreadPoolExecutor.{setThreadFactory( ), ThreadPoolExecutor( )}

Returned By

Executors.{defaultThreadFactory( ), privilegedThreadFactory( )}, ThreadPoolExecutor.getThreadFactory( )

Team LiB

ThreadPoolExecutor java.util.concurrent

Java 5.0

This class implements the ExecutorService interface to execute tasks using a highly configurable thread pool. The easiest way to instantiate this class is through the static factory methods of the Executors class. If you want a more highly configured thread pool, you can instantiate it directly.

Four configuration parameters must be passed to every THReadPoolExecutor( ) constructor; two others are optional. Many of these parameters may also be queried and adjusted after the executor has been created through various ThreadPoolExecutor accessor methods. The most important configuration parameters specify the size of the thread pool, and the queue that the executor uses to hold tasks that it cannot currently run. *corePoolSize* is the number of threads that the pool should hold under normal usage. As tasks are submitted to the ThreadPoolExecutor, a new thread is created for each task until the total number of threads reaches this size.

If *corePoolSize* tHReads have already been created, newly submitted tasks are placed on the work queue. As these core threads finish the tasks they are executing, they take( ) a new task from the work queue. You must specify the *workQueue* when you call the ThreadPoolExecutor( ) constructor. It may be any BlockingQueue object and the behavior of the thread pool depends strongly on the behavior of the queue you specify. Options include an unbounded LinkedBlockingQueue, a bounded ArrayBlockingQueue with a capacity of your choosing, or even a SynchronousQueue which has a capacity of zero and cannot actually accept a task unless a thread is already waiting to execute it.

If the work queue becomes empty, it is inefficient to leave all the core threads sitting idly waiting for work. Threads are terminated if they are idle for more than the "keep alive" time. You specify this time with the *keepAliveTime* parameter and a TimeUnit constant.

If the work queue fills up, the *maximumPoolSize* parameter comes into play. ThreadPoolExecutor prefers to maintain *corePoolSize* threads but allows this number to grow up to *maximumPoolSize*. A new thread is created only when the *workQueue* is full. If you specify an unbounded work queue, *maximumPoolSize* is irrelevant because the queue never fills up. If on the other hand you specify a SynchronousQueue (which is always full), if none of the existing threads are waiting for a new task, a new thread is always created (up to the maximumPoolSize limit).

If a THReadPoolExecutor has already created the maximum number of threads and its work queue is full, it must reject any newly submitted tasks. The default behavior is to throw a RejectedExecutionException. You can alter this behavior by specifying a RejectedExecutionHandler object to the ThreadPoolExecutor( ) constructor or with the setRejectedExecutionHandler( ) method. The four inner classes of this class are implementations of four handlers that address this case. See their individual entries for details.

The final way that you can customize a ThreadPoolExecutor is to pass THReadFactory to the constructor or to the setThreadFactory( ) method. If you do not specify a factory, the THReadPoolExecutor obtains one with Executors.defaultThreadFactory( ).

Figure 16-94. java.util.concurrent.ThreadPoolExecutor


```
public class ThreadPoolExecutor extends AbstractExecutorService {
// Public Constructors
     public ThreadPoolExecutor(int corePoolSize, int maximumPoolSize,
        long keepAliveTime, TimeUnit unit, BlockingQueue<Runnable> workQueue);
     public ThreadPoolExecutor(int corePoolSize, int maximumPoolSize,
        long keepAliveTime, TimeUnit unit, BlockingQueue<Runnable> workQueue,
        ThreadFactory threadFactory);
     public ThreadPoolExecutor(int corePoolSize, int maximumPoolSize,
        long keepAliveTime, TimeUnit unit, BlockingQueue<Runnable> workQueue,
        RejectedExecutionHandler handler);
     public ThreadPoolExecutor(int corePoolSize, int maximumPoolSize,
        long keepAliveTime, TimeUnit unit, BlockingQueue<Runnable> workQueue,
        ThreadFactory threadFactory,
RejectedExecutionHandler handler);
// Nested Types
     public static class AbortPolicy implements RejectedExecutionHandler;
     public static class CallerRunsPolicy implements RejectedExecutionHandler;
     public static class DiscardOldestPolicy implements RejectedExecutionHandler;
     public static class DiscardPolicy implements RejectedExecutionHandler;
// Public Instance Methods
     public int getActiveCount( );
     public long getCompletedTaskCount( );
     public int getCorePoolSize( );
     public long getKeepAliveTime(TimeUnit unit);
     public int getLargestPoolSize( );
     public int getMaximumPoolSize( );
     public int getPoolSize( );
     public BlockingQueue<Runnable> getQueue( );
     public RejectedExecutionHandler getRejectedExecutionHandler( );
     public long getTaskCount( );
     public ThreadFactory getThreadFactory( );
     public boolean isTerminating( );
     public int prestartAllCoreThreads( );
     public boolean prestartCoreThread( );
     public void purge( );
     public boolean remove(Runnable task);
     public void setCorePoolSize(int corePoolSize);
     public void setKeepAliveTime(long time, TimeUnit unit);
     public void setMaximumPoolSize(int maximumPoolSize);
     public void setRejectedExecutionHandler(RejectedExecutionHandler handler);
     public void setThreadFactory(ThreadFactory threadFactory);
// Methods Implementing Executor
```

```
    public void execute(Runnable command);
// Methods Implementing ExecutorService
    public boolean awaitTermination(long timeout, TimeUnit unit)
       throws InterruptedException;
    public boolean isShutdown( );
    public boolean isTerminated( );
    public void shutdown( );
    public java.util.List<Runnable> shutdownNow( );
// Protected Methods Overriding Object
    protected void finalize( );
// Protected Instance Methods
    protected void afterExecute(Runnable r, Throwable t);              empty
    protected void beforeExecute(Thread t, Runnable r);                empty
    protected void terminated( );                                        empty
}
```

Subclasses

ScheduledThreadPoolExecutor

Passed To

RejectedExecutionHandler.rejectedExecution( ), ThreadPoolExecutor.AbortPolicy.rejectedExecution( ), ThreadPoolExecutor.CallerRunsPolicy.rejectedExecution( ), ThreadPoolExecutor.DiscardOldestPolicy.rejectedExecution( ), THReadPoolExecutor.DiscardPolicy.rejectedExecution( )

ThreadPoolExecutor.AbortPolicy java.util.concurrent

Java 5.0

This `RejectedExecutionHandler` implementation simply throws a `RejectedExecutionException` .

```
public static class ThreadPoolExecutor.AbortPolicy implements RejectedExecutionHandler {
// Public Constructors
     public AbortPolicy( );
// Methods Implementing RejectedExecutionHandler
     public void rejectedExecution(Runnable r, ThreadPoolExecutor e);
}
```

Team LiB

ThreadPoolExecutor.CallerRunsPolicy java.util.concurrent

Java 5.0

This RejectedExecutionHandler implementation runs the rejected Runnable object directly in the callin thread, causing that thread to block until the Runnable completes. If the ThreadPoolExecutor has been down, the Runnable is simply discarded instead of being run.

```
public static class ThreadPoolExecutor.CallerRunsPolicy implements RejectedExecutionHan
// Public Constructors
     public CallerRunsPolicy( );
// Methods Implementing RejectedExecutionHandler
     public void rejectedExecution(Runnable r, ThreadPoolExecutor e);
}
```

Team LiB

ThreadPoolExecutor.DiscardOldestPolicy java.util.concurrent

Java 5.0

This RejectedExecutionHandler implementation discards the rejected Runnable if the ThreadPoolExec been shut down. Otherwise, it discards the oldest pending task that has not run and tries again to execu rejected task.

```
public static class ThreadPoolExecutor.DiscardOldestPolicy implements RejectedExecution
// Public Constructors
     public DiscardOldestPolicy( );
// Methods Implementing RejectedExecutionHandler
     public void rejectedExecution(Runnable r, ThreadPoolExecutor e);
}
```

ThreadPoolExecutor.DiscardPolicy java.util.concurrent

Java 5.0

This `RejectedExecutionHandler` implementation silently discards the rejected `Runnable` .

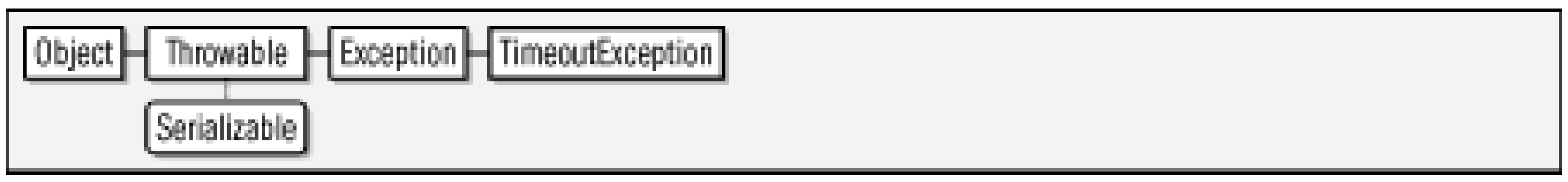
```
public static class ThreadPoolExecutor.DiscardPolicy implements RejectedExecutionHandle
// Public Constructors
     public DiscardPolicy( );
// Methods Implementing RejectedExecutionHandler
     public void rejectedExecution(Runnable r, ThreadPoolExecutor e);     empty
}
```

TimeoutException java.util.concurrent

Java 5.0 *serializable checked*

An exception of this type is thrown by timed methods to indicate that the specified timeout has elapsed. Other timed methods are able to indicate their timeout status in a `boolean` or other return value.

Figure 16-95. java.util.concurrent.TimeoutException




```
public class TimeoutException extends Exception {
// Public Constructors
     public TimeoutException( );
     public TimeoutException(String message);
}
```

Thrown By

`AbstractExecutorService.invokeAny( )`, `CyclicBarrier.await( )`, `Exchanger.exchange( )`, `ExecutorService.invokeAny( )`, `Future.get( )`, `FutureTask.get( )`

TimeUnit java.util.concurrent

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type represent granularities of time. Timeout and delay specifications throughout the `java.util.concurrent` package are specified by a `long` value and `TimeUnit` constant that specifies the interpretation of that value.

`TimeUnit` defines conversion methods that convert values expressed in one unit to values in another unit. More interestingly, it defines convenient alternatives to`THRead.sleep( )`, `Thread.join( )`, and `Object.wait( )`.

Figure 16-96. java.util.concurrent.TimeUnit


```
public enum TimeUnit {
// Enumerated Constants
     NANOSECONDS,
     MICROSECONDS,
     MILLISECONDS,
     SECONDS;
// Public Class Methods
     public static TimeUnit valueOf(String name);
     public static final TimeUnit[ ] values( );
// Public Instance Methods
     public long convert(long duration, TimeUnit unit);
     public void sleep(long timeout) throws InterruptedException;
     public void timedJoin(Thread thread, long timeout) throws InterruptedException;
     public void timedWait(Object obj, long timeout) throws InterruptedException;
     public long toMicros(long duration);
     public long toMillis(long duration);
     public long toNanos(long duration);
     public long toSeconds(long duration);
}
```

Passed To

Too many methods to list.

Package java.util.concurrent.atomic

Java 5.0

This package includes classes that provide atomic operations on boolean, integer, and reference values. Instances of the classes defined here have the properties of `volatile` fields but also add atomic operations like the canonical `compareAndSet( )`, which verifies that the field holds an expected value, and, if it does, sets it to a new value. The classes also define a `weakCompareAndSet( )` method that may be more efficient than `compareAndSet( )` but may also fail to set the value even when the field holds the expected value.

The "Array" classes provide atomic access to arrays of values and provide `volatile` access semantics for array elements, which is not possible with the `volatile` modifier itself. The "FieldUpdater" classes use reflection to provide atomic operations on a named `volatile` field of an existing class. The `AtomicMarkableReference` class and `AtomicStampedReference` class maintain a reference value and an associated `boolean` or `int` value and allow the two values to be atomically manipulated together. These classes can be useful in concurrent algorithms that detect concurrent updates with version numbering, for example.

Most implementations of this package rely on low-level atomic instructions in the underlying CPU and perform atomic operations without the overhead of locking.

Classes

```
public class AtomicBoolean implements Serializable;
public class AtomicInteger extends Number implements Serializable;
public class AtomicIntegerArray implements Serializable;
public abstract class AtomicIntegerFieldUpdater<T>;
public class AtomicLong extends Number implements Serializable;
public class AtomicLongArray implements Serializable;
public abstract class AtomicLongFieldUpdater<T>;
public class AtomicMarkableReference<V>;
public class AtomicReference<V> implements Serializable;
public class AtomicReferenceArray<E> implements Serializable;
public abstract class AtomicReferenceFieldUpdater<T, V>;
public class AtomicStampedReference<V>;
```

AtomicBoolean java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class holds a boolean value. In addition to the `get( )` and `set( )` iterators, it provides atomic `compareAndSet( )`, `weakCompareAndSet( )`, and `getAndSet( )` operations.

Figure 16-97. java.util.concurrent.atomic.AtomicBoolean


```
public class AtomicBoolean implements Serializable {
// Public Constructors
     public AtomicBoolean( );
     public AtomicBoolean(boolean initialValue);
// Public Instance Methods
     public final boolean compareAndSet(boolean expect, boolean update);
     public final boolean get( );
     public final boolean getAndSet(boolean newValue);
     public final void set(boolean newValue);
     public boolean weakCompareAndSet(boolean expect, boolean update);
// Public Methods Overriding Object
     public String toString( );
}
```

AtomicInteger java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class holds an `int` value. It extends `java.lang.Number`, but unlike the `Integer` class, it is mutable. Access the `int` value with the `get( )` method and the various methods inherited from `Number`. You can set the value with the `set( )` method or through various atomic methods. In addition to the basic `compareAndSet( )` and `weakCompareAndSet( )` methods, this class defines methods for atomic pre-increment, post-increment, pre-decrement and post-decrement operations as well as generalized `addAndGet( )` and `getAndAdd( )` methods. `addAndGet( )` atomically adds the specified amount to the stored value and returns the new value.`getAndAdd( )` atomically returns the current value and then adds the specified amount to it.

Figure 16-98. java.util.concurrent.atomic.AtomicInteger

```
public class AtomicInteger extends Number implements Serializable {
// Public Constructors
     public AtomicInteger( );
     public AtomicInteger(int initialValue);
// Public Instance Methods
     public final int addAndGet(int delta);
     public final boolean compareAndSet(int expect, int update);
     public final int decrementAndGet( );
     public final int get( );
     public final int getAndAdd(int delta);
     public final int getAndDecrement( );                          default:0
     public final int getAndIncrement( );                          default:-1
     public final int getAndSet(int newValue);
     public final int incrementAndGet( );
     public final void set(int newValue);
     public final boolean weakCompareAndSet(int expect, int update);
// Public Methods Overriding Number
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
// Public Methods Overriding Object
     public String toString( );
}
```

downloaded from: lib.ommolketab.ir

AtomicIntegerArray java.util.concurrent.atomic

Java 5.0 *serializable*

This class holds an array of `int` values. It provides threadsafe access to the array elements, treating each as if it was a `volatile` field, and defines atomic operations on them. The methods of this class are like those of `AtomicInteger`, except that each has an additional parameter that specifies the array index. Create an `AtomicIntegerArray` by specifying the desired array length or an actual `int[ ]` from which initial values can be copied.

Figure 16-99. java.util.concurrent.atomic.AtomicIntegerArray


```
public class AtomicIntegerArray implements Serializable {
// Public Constructors
     public AtomicIntegerArray(int[ ] array);
     public AtomicIntegerArray(int length);
// Public Instance Methods
     public final int addAndGet(int i, int delta);
     public final boolean compareAndSet(int i, int expect, int update);
     public final int decrementAndGet(int i);
     public final int get(int i);
     public final int getAndAdd(int i, int delta);
     public final int getAndDecrement(int i);
     public final int getAndIncrement(int i);
     public final int getAndSet(int i, int newValue);
     public final int incrementAndGet(int i);
     public final int length( );
     public final void set(int i, int newValue);
     public final boolean weakCompareAndSet(int i, int expect, int update);
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

AtomicIntegerFieldUpdater<T> java.util.concurrent.atomic

Java 5.0

This class uses `java.lang.reflect` to provide atomic operations for named volatile `int` fields within existing types. Obtain an instance of this class with the `newUpdater( )` factory method. Pass the name of the field (which must have been declared `volatile int`) to be updated and the class that it is defined within to this factory method. The instance methods of the resulting `AtomicIntegerFieldUpdater` object are like those of the `AtomicInteger` class but require you to specify the object whose field is to be manipulated. This is a generic type, and the type variable *T* represents the type whose `volatile int` field is being updated.

```
public abstract class AtomicIntegerFieldUpdater<T> {
// Protected Constructors
     protected AtomicIntegerFieldUpdater( );
// Public Class Methods
     public static <U> AtomicIntegerFieldUpdater<U> newUpdater(Class<U> tclass,
        String fieldName);
// Public Instance Methods
     public int addAndGet(T obj, int delta);
     public abstract boolean compareAndSet(T obj, int expect, int update);
     public int decrementAndGet(T obj);
     public abstract int get(T obj);
     public int getAndAdd(T obj, int delta);
     public int getAndDecrement(T obj);
     public int getAndIncrement(T obj);
     public int getAndSet(T obj, int newValue);
     public int incrementAndGet(T obj);
     public abstract void set(T obj, int newValue);
     public abstract boolean weakCompareAndSet(T obj, int expect, int update);
}
```

Team LiB

AtomicLong java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class holds a mutable `long` value and defines atomic operations on that value. It behaves just like `AtomicInteger`, with the substitution of `long` for `int`.

Figure 16-100. java.util.concurrent.atomic.AtomicLong


```
public class AtomicLong extends Number implements Serializable {
// Public Constructors
     public AtomicLong( );
     public AtomicLong(long initialValue);
// Public Instance Methods
     public final long addAndGet(long delta);
     public final boolean compareAndSet(long expect, long update);
     public final long decrementAndGet( );
     public final long get( );
     public final long getAndAdd(long delta);
     public final long getAndDecrement( );                    default:0
     public final long getAndIncrement( );                    default:-1
     public final long getAndSet(long newValue);
     public final long incrementAndGet( );
     public final void set(long newValue);
     public final boolean weakCompareAndSet(long expect, long update);
// Public Methods Overriding Number
     public double doubleValue( );
     public float floatValue( );
     public int intValue( );
     public long longValue( );
// Public Methods Overriding Object
     public String toString( );
}
```

AtomicLongArray java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class provides atomic operations for an array of `long` values. See `AtomicIntegerArray`, which offers the equivalent operations for `int` arrays.

Figure 16-101. java.util.concurrent.atomic.AtomicLongArray


```
public class AtomicLongArray implements Serializable {
// Public Constructors
     public AtomicLongArray(long[ ] array);
     public AtomicLongArray(int length);
// Public Instance Methods
     public long addAndGet(int i, long delta);
     public final boolean compareAndSet(int i, long expect, long update);
     public final long decrementAndGet(int i);
     public final long get(int i);
     public final long getAndAdd(int i, long delta);
     public final long getAndDecrement(int i);
     public final long getAndIncrement(int i);
     public final long getAndSet(int i, long newValue);
     public final long incrementAndGet(int i);
     public final int length( );
     public final void set(int i, long newValue);
     public final boolean weakCompareAndSet(int i, long expect, long update);
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

AtomicLongFieldUpdater<T> java.util.concurrent.atomic

Java 5.0

This class uses `java.lang.reflect` to define atomic operations for named `volatile long` fields of a spe
See `AtomicIntegerFieldUpdater` , which is very similar.

```
public abstract class AtomicLongFieldUpdater<T> {
// Protected Constructors
     protected AtomicLongFieldUpdater( );
// Public Class Methods
     public static <U> AtomicLongFieldUpdater<U> newUpdater(Class<U> tclass, String fie
// Public Instance Methods
     public long addAndGet(T obj, long delta);
     public abstract boolean compareAndSet(T obj, long expect, long update);
     public long decrementAndGet(T obj);
     public abstract long get(T obj);
     public long getAndAdd(T obj, long delta);
     public long getAndDecrement(T obj);
     public long getAndIncrement(T obj);
     public long getAndSet(T obj, long newValue);
     public long incrementAndGet(T obj);
     public abstract void set(T obj, long newValue);
     public abstract boolean weakCompareAndSet(T obj, long expect, long update);
}
```

Team LiB

AtomicMarkableReference<V> java.util.concurrent.atomic

Java 5.0

This threadsafe class holds a mutable reference to an object of type *V* and also holds a mutable `boolean` value or "mark." It defines atomic operations and volatile access semantics for the reference and the mark. The `set( )` method unconditionally sets the reference and mark value. The `get( )` method queries both, returning the reference as its return value, and storing the current value of the mark in element 0 of the specified `boolean` array. The reference and mark can also be queried individually (and nonatomically) with `getreference( )` and `isMarked( )`.

The atomic `compareAndSet( )` and `weakCompareAndSet( )` methods take expected and new values for both the reference and the mark, and neither is set to its new value unless both match their expected values. `attemptMark( )` atomically sets the value of the mark but only if the reference is equal to the expected value. Like `weakCompareAndSet( )`, this method may fail spuriously, even if the reference does equal the expected value. Repeated invocation eventually succeeds, however, as long as the expected value is correct, and other threads are not continuously changing the reference value.

```
public class AtomicMarkableReference<V> {
// Public Constructors
     public AtomicMarkableReference(V initialRef, boolean initialMark);
// Public Instance Methods
     public boolean attemptMark(V expectedReference, boolean newMark);
     public boolean compareAndSet(V expectedReference, V newReference,
        boolean expectedMark, boolean newMark);
     public V get(boolean[ ] markHolder);
     public V getReference( );
     public boolean isMarked( );
     public void set(V newReference, boolean newMark);
     public boolean weakCompareAndSet(V expectedReference, V newReference,
        boolean expectedMark, boolean newMark);
}
```

Team LiB

AtomicReference<V> java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class holds a mutable reference to an object of type *V*, provides `volatile` access semantics, and defines atomic operations for manipulating that value. `get( )` and `set( )` are ordinary accessor methods for the reference. `compareAndSet( )`, `weakCompareAndSet( )`, and `getAndSet( )` perform the two named operations atomically. `compareAndSet( )` is the canonical atomic operation: the reference is compared to an expected value, and, if it matches, is set to a new value. `compareAndSet( )` returns true if it set the value or `false` otherwise. `weakCompareAndSet( )` is similar but may fail to set the reference even if it does match the expected value (it is guaranteed to succeed eventually if the operation is repeatedly retried, however).

Figure 16-102. java.util.concurrent.atomic.AtomicReference<V>

```
public class AtomicReference<V> implements Serializable {
// Public Constructors
     public AtomicReference( );
     public AtomicReference(V initialValue);
// Public Instance Methods
     public final boolean compareAndSet(V expect, V update);
     public final V get( );
     public final V getAndSet(V newValue);
     public final void set(V newValue);
     public final boolean weakCompareAndSet(V expect, V update);
// Public Methods Overriding Object
     public String toString( );
}
```

AtomicReferenceArray<E> java.util.concurrent.atomic

Java 5.0 *serializable*

This threadsafe class holds an array of elements of type *E*. It provides volatile access semantics for these array elements and defines atomic operations for manipulating them. Its methods are like those of AtomicReference with the addition of a parameter that specifies the array index of the desired element.

Figure 16-103. java.util.concurrent.atomic.AtomicReferenceArray<E>


```
public class AtomicReferenceArray<E> implements Serializable {
// Public Constructors
     public AtomicReferenceArray(E[ ] array);
     public AtomicReferenceArray(int length);
// Public Instance Methods
     public final boolean compareAndSet(int i, E expect, E update);
     public final E get(int i);
     public final E getAndSet(int i, E newValue);
     public final int length( );
     public final void set(int i, E newValue);
     public final boolean weakCompareAndSet(int i, E expect, E update);
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

AtomicReferenceFieldUpdater<T,V> java.util.concurrent.atomi

Java 5.0

This threadsafe class uses `java.lang.reflect` to provide atomic operations for a named volatile field of type *V* within an object of type *T* . Its instance methods are like those of `AtomicReference` and the stat `newUpdater( )` factory method is like that of `AtomicIntegerFieldUpdater` .

```
public abstract class AtomicReferenceFieldUpdater<T,V> {
// Protected Constructors
     protected AtomicReferenceFieldUpdater( );
// Public Class Methods
     public static <U,W> AtomicReferenceFieldUpdater<U,W> newUpdater(Class<U> tclass,
        Class<W> vclass, String fieldName);
// Public Instance Methods
     public abstract boolean compareAndSet(T obj, V expect, V update);
     public abstract V get(T obj);
     public V getAndSet(T obj, V newValue);
     public abstract void set(T obj, V newValue);
     public abstract boolean weakCompareAndSet(T obj, V expect, V update);
}
```

AtomicStampedReference<V> java.util.concurrent.atomic

Java 5.0

This threadsafe class holds a mutable reference to an object of type *V* and also holds a mutable `int` value or "stamp." It defines atomic operations and volatile access semantics for the reference and the stamp. This class works just like `AtomicMarkableReference` except that an `int` "stamp" replaces the `boolean` "mark." See `AtomicMarkableReference` for further details.

```
public class AtomicStampedReference<V> {
// Public Constructors
     public AtomicStampedReference(V initialRef, int initialStamp);
// Public Instance Methods
     public boolean attemptStamp(V expectedReference, int newStamp);
     public boolean compareAndSet(V expectedReference, V newReference,
        int expectedStamp, int newStamp);
     public V get(int[ ] stampHolder);
     public V getReference( );
     public int getStamp( );
     public void set(V newReference, int newStamp);
     public boolean weakCompareAndSet(V expectedReference, V newReference,
        int expectedStamp, int newStamp);
}
```

Team LiB

Package java.util.concurrent.locks

Java 5.0

This package defines Lock and associated Condition interfaces as well as concrete implementations (su as ReentrantLock) that provide an alternative to locking with synchronized blocks and methods and tc waiting with the wait( ) , notify( ) , and notifyAll( ) methods of Object .

Although Lock and Condition are somewhat more complex to use than the built-in locking, waiting, anc notification mechanisms of Object , they are also more flexible. Lock , for example, does not require tha locks be block-structured and enables algorithms such as "hand-over-hand locking" for traversing linked structures. A thread waiting to acquire a Lock can time out or be interrupted, which is not possible with synchronized locking. Also, more than one Condition can be associated with a given Lock , which is sir not possible with Object -based locking and waiting.

The ReadWriteLock interface and its ReentrantReadWriteLock implementation allow multiple concurren readers but only a single writer thread to hold the lock.

Interfaces

```
public interface Condition;
public interface Lock;
public interface ReadWriteLock;
```

Classes

```
public abstract class AbstractQueuedSynchronizer implements Serializable;
public class AbstractQueuedSynchronizer.ConditionObject implements Condition, Serializal
public class LockSupport;
public class ReentrantLock implements Lock, Serializable;
public class ReentrantReadWriteLock implements ReadWriteLock, Serializable;
public static class ReentrantReadWriteLock.ReadLock implements Lock, Serializable;
public static class ReentrantReadWriteLock.WriteLock implements Lock, Serializable;
```

Team LiB

AbstractQueuedSynchronizer java.util.concurrent.locks

Java 5.0 *serializable*

This abstract class is a low-level utility. A concrete subclass can be used as a helper class for implement interface or for implementing synchronizer utilities like the`CountDownLatch` class of `java.util.concurr` Subclasses must define `tryAcquire( )` , `TRyRelease( )` , `tryAcquireShared( )` , `tryReleaseShared(` `isHeldExclusively` .

Figure 16-104. java.util.concurrent.locks.AbstractQueuedSynchronize


```
public abstract class AbstractQueuedSynchronizer implements Serializable {
// Protected Constructors
     protected AbstractQueuedSynchronizer( );
// Nested Types
     public class ConditionObject implements Condition, Serializable;
// Public Instance Methods
     public final void acquire(int arg);
     public final void acquireInterruptibly(int arg) throws InterruptedException;
     public final void acquireShared(int arg);
     public final void acquireSharedInterruptibly(int arg) throws InterruptedException;
     public final java.util.Collection<Thread> getExclusiveQueuedThreads( );
     public final Thread getFirstQueuedThread( );
     public final java.util.Collection<Thread> getQueuedThreads( );
     public final int getQueueLength( );
     public final java.util.Collection<Thread> getSharedQueuedThreads( );
     public final java.util.Collection<Thread> getWaitingThreads(AbstractQueuedSynchron
        ConditionObject condition);
     public final int getWaitQueueLength(AbstractQueuedSynchronizer.ConditionObject con
     public final boolean hasContended( );
     public final boolean hasQueuedThreads( );
     public final boolean hasWaiters(AbstractQueuedSynchronizer.ConditionObject conditi
     public final boolean isQueued(Thread thread);
     public final boolean owns(AbstractQueuedSynchronizer.ConditionObject condition);
     public final boolean release(int arg);
     public final boolean releaseShared(int arg);
     public final boolean tryAcquireNanos(int arg, long nanosTimeout)
        throws InterruptedException;
     public final boolean tryAcquireSharedNanos(int arg, long nanosTimeout)
        throws InterruptedException;
// Public Methods Overriding Object
```

```
    public String toString( );
// Protected Instance Methods
    protected final boolean compareAndSetState(int expect, int update);
    protected final int getState( );
    protected boolean isHeldExclusively( );
    protected final void setState(int newState);
    protected boolean tryAcquire(int arg);
    protected int tryAcquireShared(int arg);
    protected boolean tryRelease(int arg);
    protected boolean tryReleaseShared(int arg);
}
```

Team LiB

Team LiB

AbstractQueuedSynchronizer.ConditionObject java.util.concurr

Java 5.0 *serializable*

This class implements the Condition interface and is suitable for use with an AbstractQueuedSynchron:

```
public class AbstractQueuedSynchronizer.ConditionObject implements Condition, Serializal
// Public Constructors
     public ConditionObject( );
// Methods Implementing Condition
     public final void await( ) throws InterruptedException;
     public final boolean await(long time, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
     public final long awaitNanos(long nanosTimeout) throws InterruptedException;
     public final void awaitUninterruptibly( );
     public final boolean awaitUntil(java.util.Date deadline) throws InterruptedExcepti
     public final void signal( );
     public final void signalAll( );
// Protected Instance Methods
     protected final java.util.Collection<Thread> getWaitingThreads( );
     protected final int getWaitQueueLength( );
     protected final boolean hasWaiters( );
}
```

Passed To

AbstractQueuedSynchronizer.{getWaitingThreads( ), getWaitQueueLength( ), hasWaiters( ),

Team LiB

Condition java.util.concurrent.locks

Java 5.0

This interface defines an alternative to the wait( ), notify( ), and notifyAll( ) methods of java.lang.Object. Condition objects are always associated with a corresponding Lock. Obtain a Condition with the newCondition( ) method of Lock.

There are five choices for waiting. The no-argument version of await( ) is the simplest: it blocks until the thread is signaled or interrupted. awaitUninterruptibly( ) blocks until the thread is signaled and ignores interrupts. The other three waiting methods are timed waits: they all wait until signaled, interrupted, or until the specified time elapses. await( ) and awaitUntil( ) return TRue if they are signaled and false if a timeout occurs. awaitNanos( ) specifies the timeout in nanoseconds. It returns zero or a negative number if the timeout elapses. If it wakes up because of a signal (or because of a spurious wakeup), it returns an estimate of the time remaining in the timeout If it turns out that the thread needs to continue waiting, this return value can be used as the new timeout value.

The signal( ) and signalAll( ) methods are just like the notify( ) and notifyAll( ) methods of Object. signal( ) wakes up one waiting thread, and signalAll( ) wakes up all waiting threads.

Locking considerations apply to the use of a Condition object just as they apply to the use of the wait( ) and notify( ) methods of Object. Before a thread can call any of the waiting or signaling methods of a Condition, it must hold the Lock associated with the condition. When the thread begins waiting, it automatically relinquishes the Lock, and when it awakes because of a signal, timeout, or interrupt, it must reacquire the lock before it can proceed. A thread is guaranteed to hold the lock when it returns from one of the waiting methods.

Threads waiting on a Condition may wake up spuriously, just as they may when waiting on an Object. Therefore, calls to wait on a Condition are typically written in the form of a loop so that the desired condition is retested when the thread wakes up.

```
public interface Condition {
// Public Instance Methods
     void await( ) throws InterruptedException;
     boolean await(long time, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
     long awaitNanos(long nanosTimeout) throws InterruptedException;
     void awaitUninterruptibly( );
     boolean awaitUntil(java.util.Date deadline) throws InterruptedException;
     void signal( );
     void signalAll( );
}
```

Implementations

`AbstractQueuedSynchronizer.ConditionObject`

Passed To

`ReentrantLock.{getWaitingThreads( )`, `getWaitQueueLength( )`, `hasWaiters( )}`, `ReentrantReadWriteLock.{getWaitingThreads( )`, `getWaitQueueLength( )`, `hasWaiters( )}`

Returned By

`Lock.newCondition( )`, `ReentrantLock.newCondition( )`, `ReentrantReadWriteLock.ReadLock.newCondition( )`, `ReentrantReadWriteLock.WriteLock.newCondition( )`

Team LiB

Lock java.util.concurrent.locks

Java 5.0

This interface represents a flexible API for preventing thread concurrency with locking. Lock defines four methods for acquiring a lock. The simplest method is lock( ) which blocks indefinitely and uninterruptibly until the lock is acquired. This method is similar to entering a synchronized block. lockInterruptibly( ) blocks until the lock is acquired or until the thread is interrupted. The no-argument version of tryLock( ) acquires the lock and returns TRue if the lock is currently available or returns false without blocking if the lock is unavailable. The two-argument version of tryLock( ) is a timed method: it blocks until it acquires the lock (in which case it returns true), or until the specified timeout elapses (in which case it returns false), or until the thread is interrupted (in which case it throws InterruptedException).

Once a Lock has been acquired, no other thread can acquire it until it is released with the unlock( ) method. In order to ensure that locks are always released, even in the presence of unanticipated exceptions, it is typical to begin a try block immediately after acquiring the lock and to call unlock( ) from the associated finally clause.

Obtain a Condition object associated with a Lock by calling newCondition( ). See Condition for details. See ReentrantLock for a concrete implementation of the Lock interface.

```
public interface Lock {
// Public Instance Methods
     void lock( );
     void lockInterruptibly( ) throws InterruptedException;
     Condition newCondition( );
     boolean tryLock( );
     boolean tryLock(long time, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
     void unlock( );
}
```

Implementations

ReentrantLock, ReentrantReadWriteLock.ReadLock, ReentrantReadWriteLock.WriteLock

Returned By

ReadWriteLock.{readLock( ), writeLock( )}, ReentrantReadWriteLock.{readLock( ), writeLock( )}

Team LiB

LockSupport java.util.concurrent.locks

Java 5.0

This class provides a low-level alternative to the deprecated methods `Thread.suspend( )` and `THRead.resume( )`. The `park( )`, `parkNanos( )`, and `parkUntil( )` methods suspend, or park, the thread until it is unparked by another thread with `unpark( )`, or until it is interrupted by another thread, or until the specified time elapses. `parkNanos( )` parks the thread for the specified number of nanoseconds. `parkUntil( )` parks the thread until the specified time, using the millisecond representation of `System.currentTimeMillis( )`. Any call to these parking methods may return spuriously, so it is important to call `park( )` in a loop that can repark the thread if it should not have resumed.

Unpark a thread with the `unpark( )` method. Note that while the parking methods affect the current thread, the `unpark( )` method affects the thread you specify. If the specified thread is not parked, the next time that thread calls one of the `park( )` methods, it returns immediately instead of blocking.

```
public class LockSupport {
// No Constructor
// Public Class Methods
     public static void park( );
     public static void parkNanos(long nanos);
     public static void parkUntil(long deadline);
     public static void unpark(Thread thread);
}
```

ReadWriteLock java.util.concurrent.locks

Java 5.0

This interface represents a pair of Lock objects with special locking behavior that is useful for concurrent algorithms in which reader threads frequently access a data structure and writer threads only infrequently modify the structure. The Lock returned by readLock( ) may be locked by multiple threads at the same time as long as no thread has the writeLock( ) locked. See ReentrantReadWriteLock for a concrete implementation with implementation-specific locking details

```
public interface ReadWriteLock {
// Public Instance Methods
     Lock readLock( );
     Lock writeLock( );
}
```

Implementations

ReentrantReadWriteLock

Team LiB

ReentrantLock java.util.concurrent.locks

Java 5.0 *serializable*

This class implements the Lock interface and adds instrumentation methods to determine what thread currently holds the lock, to return the number of threads waiting to acquire the lock or waiting on an associated Condition , and to test whether a specified thread is waiting to acquire the lock.

The name of this class includes the term "reentrant" because the thread that holds the lock can call any of the locking methods again, and they return immediately without blocking.isHeldByCurrentThread( ) tests whether the current thread already holds the lock. getHoldCount( ) returns the number of times that the current thread has acquired this lock. unlock( ) must be called this number of times before the lock is actually relinquished.

A "fair" lock may be created by passing true to the ReentrantLock( ) constructor. If you do this, the lock will always be granted to the thread that has been waiting for it the longest.

Figure 16-105. java.util.concurrent.locks.ReentrantLock

```
public class ReentrantLock implements Lock, Serializable {
// Public Constructors
     public ReentrantLock( );
     public ReentrantLock(boolean fair);
// Public Instance Methods
     public int getHoldCount( );                                              default:0
     public final int getQueueLength( );                                      default:0
     public int getWaitQueueLength(Condition condition);
     public final boolean hasQueuedThread(Thread thread);
     public final boolean hasQueuedThreads( );
     public boolean hasWaiters(Condition condition);
     public final boolean isFair( );                                          default:false
     public boolean isHeldByCurrentThread( );                                 default:false
     public boolean isLocked( );                                              default:false
// Methods Implementing Lock
     public void lock( );
     public void lockInterruptibly( ) throws InterruptedException;
     public Condition newCondition( );
     public boolean tryLock( );
     public boolean tryLock(long timeout, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
```

```
    public void unlock( );
// Public Methods Overriding Object
    public String toString( );
// Protected Instance Methods
    protected Thread getOwner( );
    protected java.util.Collection<Thread> getQueuedThreads( );
    protected java.util.Collection<Thread> getWaitingThreads(Condition condition);
}
```

Team LiB

ReentrantReadWriteLock java.util.concurrent.locks

Java 5.0 *serializable*

This class implements the `ReadWriteLock` interface. The locks returned by the `readLock( )` and `writeLock( )` methods are instances of the inner classes `ReadLock` and `WriteLock`. `ReentrantReadWriteLock` defines a "fair mode" and includes instrumentation methods like `ReentrantLock` does.

Any number of threads can acquire the read lock as long as no thread holds or is attempting to acquire the write lock. When a thread attempts to acquire the write lock, no new read locks are granted. When all existing readers have relinquished the lock, the writer acquires the lock, and no reads are allowed until the writer has relinquished it. A thread that holds the write lock may downgrade to a read lock by acquiring the read lock and then relinquishing the write lock.

Because the read lock is not exclusive, it cannot have a `Condition` associated with it. The `ReadLock.newCondition( )` method throws `UnsupportedOperationException`.

Figure 16-106. java.util.concurrent.locks.ReentrantReadWriteLock

```
public class ReentrantReadWriteLock implements ReadWriteLock, Serializable {
// Public Constructors
     public ReentrantReadWriteLock( );
     public ReentrantReadWriteLock(boolean fair);
// Nested Types
     public static class ReadLock implements Lock, Serializable;
     public static class WriteLock implements Lock, Serializable;
// Public Instance Methods
     public final int getQueueLength( );                              default:0
     public int getReadLockCount( );                                  default:0
     public int getWaitQueueLength(Condition condition);
     public int getWriteHoldCount( );                                 default:0
     public final boolean hasQueuedThread(Thread thread);
     public final boolean hasQueuedThreads( );
     public boolean hasWaiters(Condition condition);
     public final boolean isFair( );                                  default:false
     public boolean isWriteLocked( );                                 default:false
     public boolean isWriteLockedByCurrentThread( );                  default:false
     public ReentrantReadWriteLock.ReadLock readLock( );
     public ReentrantReadWriteLock.WriteLock writeLock( );
```

```
// Public Methods Overriding Object
     public String toString( );
// Protected Instance Methods
     protected Thread getOwner( );
     protected java.util.Collection<Thread> getQueuedReaderThreads( );
     protected java.util.Collection<Thread> getQueuedThreads( );
     protected java.util.Collection<Thread> getQueuedWriterThreads( );
     protected java.util.Collection<Thread> getWaitingThreads(Condition condition);
}
```

Passed To

ReentrantReadWriteLock.ReadLock.ReadLock( ) , ReentrantReadWriteLock.WriteLock.WriteLock( )

Team LiB

ReentrantReadWriteLock.ReadLock java.util.concurrent.locks

Java 5.0 *serializable*

A Lock implementation for reader threads. Any number of threads can acquire the lock as long as the corresponding WriteLock is not held. newCondition( ) throws UnsupportedOperationException .

```
public static class ReentrantReadWriteLock.ReadLock implements Lock, Serializable {
// Protected Constructors
     protected ReadLock(ReentrantReadWriteLock lock);
// Methods Implementing Lock
     public void lock( );
     public void lockInterruptibly( ) throws InterruptedException;
     public Condition newCondition( );
     public boolean tryLock( );
     public boolean tryLock(long timeout, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
     public void unlock( );
// Public Methods Overriding Object
     public String toString( );
}
```

Returned By

ReentrantReadWriteLock.readLock( )

Team LiB

ReentrantReadWriteLock.WriteLock java.util.concurrent.locks

Java 5.0 *serializable*

A Lock implementation for writer threads. This lock can be acquired only when all holders of the corresponding ReadLock have relinquished the locks. While this lock is held, no other thread may acquire either this lock or the corresponding ReadLock .

```
public static class ReentrantReadWriteLock.WriteLock implements Lock, Serializable {
// Protected Constructors
     protected WriteLock(ReentrantReadWriteLock lock);
// Methods Implementing Lock
     public void lock( );
     public void lockInterruptibly( ) throws InterruptedException;
     public Condition newCondition( );
     public boolean tryLock( );
     public boolean tryLock(long timeout, java.util.concurrent.TimeUnit unit)
        throws InterruptedException;
     public void unlock( );
// Public Methods Overriding Object
     public String toString( );
}
```

Returned By

ReentrantReadWriteLock.writeLock( )

Team LiB

Package java.util.jar

Java 1.2

The java.util.jar package contains classes for reading and writing Java archive, or JAR, files. A JAR file is nothing more than a ZIP file whose first entry is a specially named manifest file that contains attributes and digital signatures for the ZIP file entries that follow it. Many of the classes in this package are relatively simple extensions of classes from the java.util.zip package.

The easiest way to read a JAR file is with the random-access JarFile class. This class allows you to obtain the JarEntry that describes any named file within the JAR archive. It also allows you to obtain an enumeration of all entries in the archive and an InputStream for reading the bytes of a specific JarEntry. Each JarEntry describes a single entry in the archive and allows access to the Attributes and the digital signatures associated with the entry. The JarFile also provides access to the Manifest object for the JAR archive; this object contains Attributes for all entries in the JAR file. Attributes is a mapping of attribute name/value pairs, of course, and the inner class Attributes.Name defines constants for various standard attribute names.

You can also read a JAR file with JarInputStream. This class requires to you read each entry of the file sequentially, however. JarOutputStream allows you to write out a JAR file sequentially. Finally, you can also read an entry within a JAR file and manifest attributes for that entry with a java.net.JarURLConnection object.

Interfaces

```
public interface Pack200.Packer;
public interface Pack200.Unpacker;
```

Collections

```
public class Attributes implements java.util.Map<Object, Object>, Cloneable;
```

Other Classes

```
public static class Attributes.Name;
public class JarEntry extends java.util.zip.ZipEntry;
public class JarFile extends java.util.zip.ZipFile;
public class JarInputStream extends java.util.zip.ZipInputStream;
public class JarOutputStream extends java.util.zip.ZipOutputStream;
public class Manifest implements Cloneable;
public abstract class Pack200;
```

Exceptions

```
public class JarException extends java.util.zip.ZipException;
```

Team LiB

Attributes java.util.jar

Java 1.2 *cloneable collection*

This class is a `java.util.Map` that maps the attribute names of a JAR file manifest to arbitrary string values. The JAR manifest format specifies that attribute names can contain only the ASCII characters A to Z (uppercase and lowercase), the digits 0 through 9, and the hyphen and underscore characters. Thus, this class uses `Attributes.Name` as the type of attribute names, in addition to the more general `String` class. Although you can create your own `Attributes` objects, you more commonly obtain `Attributes` objects from a `Manifest`.

Figure 16-107. java.util.jar.Attributes


```
public class Attributes implements java.util.Map<Object,Object>, Cloneable {
// Public Constructors
     public Attributes( );
     public Attributes(java.util.jar.Attributes attr);
     public Attributes(int size);
// Nested Types
     public static class Name;
// Public Instance Methods
     public String getValue(String name);
     public String getValue(Attributes.Name name);
     public String putValue(String name, String value);
// Methods Implementing Map
     public void clear( );
     public boolean containsKey(Object name);
     public boolean containsValue(Object value);
     public java.util.Set<java.util.Map.Entry<Object,Object>> entrySet( );
     public boolean equals(Object o);
     public Object get(Object name);
     public int hashCode( );
     public boolean isEmpty( );                          default:true
     public java.util.Set<Object> keySet( );
     public Object put(Object name, Object value);
     public void putAll(java.util.Map<?,?> attr);
     public Object remove(Object name);
     public int size( );
```

```
    public java.util.Collection<Object> values( );
// Public Methods Overriding Object
    public Object clone( );
// Protected Instance Fields
    protected java.util.Map<Object,Object> map;
}
```

Returned By

java.net.JarURLConnection.{getAttributes( ), getMainAttributes( )}, JarEntry.getAttributes( ), Manifest.{getAttributes( ), getMainAttributes( )}

Java 1.2

This class represents the name of an attribute in an Attributes object. It defines constants for the various standard attribute names used in JAR file manifests. Attribute names can contain only ASCII letters, digits, and the hyphen and underscore characters. Any other Unicode characters are illegal.

```
public static class Attributes.Name {
// Public Constructors
     public Name(String name);
// Public Constants
     public static final Attributes.Name CLASS_PATH;
     public static final Attributes.Name CONTENT_TYPE;
1.3  public static final Attributes.Name EXTENSION_INSTALLATION;
1.3  public static final Attributes.Name EXTENSION_LIST;
1.3  public static final Attributes.Name EXTENSION_NAME;
     public static final Attributes.Name IMPLEMENTATION_TITLE;
1.3  public static final Attributes.Name IMPLEMENTATION_URL;
     public static final Attributes.Name IMPLEMENTATION_VENDOR;
1.3  public static final Attributes.Name IMPLEMENTATION_VENDOR_ID;
     public static final Attributes.Name IMPLEMENTATION_VERSION;
     public static final Attributes.Name MAIN_CLASS;
     public static final Attributes.Name MANIFEST_VERSION;
     public static final Attributes.Name SEALED;
     public static final Attributes.Name SIGNATURE_VERSION;
     public static final Attributes.Name SPECIFICATION_TITLE;
     public static final Attributes.Name SPECIFICATION_VENDOR;
     public static final Attributes.Name SPECIFICATION_VERSION;
// Public Methods Overriding Object
     public boolean equals(Object o);
     public int hashCode( );
     public String toString( );
}
```

Passed To

java.util.jar.Attributes.getValue( )

JarEntry java.util.jar

Java 1.2 *cloneable*

This class extends `java.util.zip.ZipEntry`; it represents a single file in a JAR archive and the manifest attributes and digital signatures associated with that file.`JarEntry` objects can be read from a JAR file with `JarFile` or `JarInputStream`, and they can be written to a JAR file with `JarOutputStream`. Use `getAttributes( )` to obtain the `Attributes` for the entry. Use `getCertificates( )` to obtain a `java.security.cert.Certificate` array that contains the certificate chains for all digital signatures associated with the file. In Java 5.0, this digital signature information may be more conveniently retrieved as an array of`CodeSigner` objects.

Figure 16-108. java.util.jar.JarEntry

```
public class JarEntry extends java.util.zip.ZipEntry {
// Public Constructors
     public JarEntry(String name);
     public JarEntry(java.util.zip.ZipEntry ze);
     public JarEntry(JarEntry je);
// Public Instance Methods
     public java.util.jar.Attributes getAttributes( ) throws java.io.IOException;
     public java.security.cert.Certificate[ ] getCertificates( );
5.0  public java.security.CodeSigner[ ] getCodeSigners( );
}
```

Returned By

`java.net.JarURLConnection.getJarEntry( )`, `JarFile.getJarEntry( )`, `JarInputStream.getNextJarEntry( )`

JarException java.util.jar

Java 1.2 *serializable checked*

Signals an error while reading or writing a JAR file.

Figure 16-109. java.util.jar.JarException


```
public class JarException extends java.util.zip.ZipException {
// Public Constructors
     public JarException( );
     public JarException(String s);
}
```

JarFile java.util.jar

Java 1.2

This class represents a JAR file and allows the manifest, file list, and individual files to be read from the . extends `java.util.zip.ZipFile` , and its use is similar to that of its superclass. Create a `JarFile` by sp a filename or `File` object. If you do not want `JarFile` to attempt to verify any digital signatures contain `JarFile` , pass an optional boolean argument of `false` to the `JarFile( )` constructor. As of Java 1.3, te JAR files can be automatically deleted when they are closed. To take advantage of this feature, pass `ZipFile.OPEN_READ|ZipFile.OPEN_DELETE` as the *mode* argument to the `JarFile( )` constructor.

Once you have created a `JarFile` object, obtain the JAR `Manifest` with `getManifest( )` . Obtain an enumeration of the `java.util.zip.ZipEntry` objects in the file with `entries( )` . Get the `JarEntry` for specified file in the JAR file with `getJarEntry( )` . To read the contents of a specific entry in the JAR file the `JarEntry` or `ZipEntry` object that represents that entry, pass it to `getInputStream( )` , and then re the end of that stream. `JarFile` does not support the creation of new JAR files or the modification of exi files.

Figure 16-110. java.util.jar.JarFile

```
public class JarFile extends java.util.zip.ZipFile {
// Public Constructors
     public JarFile(String name) throws java.io.IOException;
     public JarFile(java.io.File file) throws java.io.IOException;
     public JarFile(String name, boolean verify) throws java.io.IOException;
     public JarFile(java.io.File file, boolean verify) throws java.io.IOException;
1.3  public JarFile(java.io.File file, boolean verify, int mode) throws java.io.IOExcep
// Public Constants
     public static final String MANIFEST_NAME;                  ="META-INF/MANIFEST.MF"
// Public Instance Methods
     public JarEntry getJarEntry(String name);
     public Manifest getManifest( ) throws java.io.IOException;
// Public Methods Overriding ZipFile
     public java.util.Enumeration<JarEntry> entries( );
     public java.util.zip.ZipEntry getEntry(String name);
     public java.io.InputStream getInputStream(java.util.zip.ZipEntry ze)
        throws java.io.IOException;     synchronized
}
```

Passed To

`Pack200.Packer.pack( )`

Returned By

`java.net.JarURLConnection.getJarFile( )`

Team LiB

JarInputStream java.util.jar

Java 1.2 *closeable*

This class allows a JAR file to be read from an input stream. It extends java.util.ZipInputStream and much like that class is used. To create a JarInputStream , simply specify the InputStream from which t you do not want the JarInputStream to attempt to verify any digital signatures contained in the JAR file false as the second argument to the JarInputStream( ) constructor. The JarInputStream( ) constru reads the JAR manifest entry, if one exists. The manifest must be the first entry in the JAR file. getManif returns the Manifest object for the JAR file.

Once you have created a JarInputStream , call getNextJarEntry( ) or getNextEnTRy( ) to obtain the or java.util.zip.ZipEntry object that describes the next entry in the JAR file. Then, call a read( ) me (including the inherited versions) to read the contents of that entry. When the stream reaches the end c getNextJarEntry( ) again to start reading the next entry in the file. When all entries have been read fr JAR file, getNextJarEntry( ) and getNextEntry( ) return null .

Figure 16-111. java.util.jar.JarInputStream

```
public class JarInputStream extends java.util.zip.ZipInputStream {
// Public Constructors
     public JarInputStream(java.io.InputStream in) throws java.io.IOException;
     public JarInputStream(java.io.InputStream in, boolean verify) throws java.io.IOExc
// Public Instance Methods
     public Manifest getManifest( );
     public JarEntry getNextJarEntry( ) throws java.io.IOException;
// Public Methods Overriding ZipInputStream
     public java.util.zip.ZipEntry getNextEntry( ) throws java.io.IOException;
     public int read(byte[ ] b, int off, int len) throws java.io.IOException;
// Protected Methods Overriding ZipInputStream
     protected java.util.zip.ZipEntry createZipEntry(String name);
}
```

Passed To

Pack200.Packer.pack( )

downloaded from: lib.ommolketab.ir

JarOutputStream java.util.jar

Java 1.2 *closeable flushable*

This class can write a JAR file to an arbitrary OutputStream . JarOutputStream extends java.util.zip.ZipOutputStream and is used much like that class is used. Create a JarOutputStream b specifying the stream to write to and, optionally, the Manifest object for the JAR file. The JarOutputStr constructor starts by writing the contents of the Manifest object into an appropriate JAR file entry. It is programmer's responsibility to ensure that the contents of the JAR entries written subsequently match t specified in the Manifest object. This class provides no explicit support for attaching digital signatures t the JAR file.

After creating a JarOutputStream , call putNextEntry( ) to specify the JarEntry or java.util.zip.Zi be written to the stream. Then, call any of the inherited write( ) methods to write the contents of the e stream. When that entry is finished, call putNextEntry( ) again to begin writing the next entry. When y written all JAR file entries in this way, call close( ) . Before writing any entry, you may call the inherite setMethod( ) and setLevel( ) methods to specify how the entry should be compressed. See java.util.zip.ZipOutputStream .

Figure 16-112. java.util.jar.JarOutputStream

```
public class JarOutputStream extends java.util.zip.ZipOutputStream {
// Public Constructors
     public JarOutputStream(java.io.OutputStream out) throws java.io.IOException;
     public JarOutputStream(java.io.OutputStream out, Manifest man) throws java.io.IOEx
// Public Methods Overriding ZipOutputStream
     public void putNextEntry(java.util.zip.ZipEntry ze) throws java.io.IOException;
}
```

Passed To

Pack200.Unpacker.unpack( )

Team LiB

Manifest java.util.jar

Java 1.2 *cloneable*

This class represents the manifest entry of a JAR file. getMainAttributes( ) returns an Attributes obj that represents the manifest attributes that apply to the entire JAR file. getAttributes( ) returns an Attributes object that represents the manifest attributes specified for a single file in the JAR file. getEn) returns a java.util.Map that maps the names of entries in the JAR file to the Attributes objects ass with those entries. getEnTRies( ) returns the Map object used internally by the Manifest . You can edit contents of the Manifest by adding, deleting, or editing entries in the Map . read( ) reads manifest entr from an input stream, merging them into the current set of entries. write( ) writes the Manifest out tc specified output stream.

Figure 16-113. java.util.jar.Manifest

```
public class Manifest implements Cloneable {
// Public Constructors
     public Manifest( );
     public Manifest(Manifest man);
     public Manifest(java.io.InputStream is) throws java.io.IOException;
// Public Instance Methods
     public void clear( );
     public java.util.jar.Attributes getAttributes(String name);
     public java.util.Map<String,java.util.jar.Attributes> getEntries( );     default:H
     public java.util.jar.Attributes getMainAttributes( );
     public void read(java.io.InputStream is) throws java.io.IOException;
     public void write(java.io.OutputStream out) throws java.io.IOException;
// Public Methods Overriding Object
     public Object clone( );
     public boolean equals(Object o);
     public int hashCode( );
}
```

Passed To

java.net.URLClassLoader.definePackage( ) , JarOutputStream.JarOutputStream( )

Returned By

java.net.JarURLConnection.getManifest( ), JarFile.getManifest( ), JarInputStream.getMani
)

Team LiB

Team LiB

Pack200 java.util.jar

Java 5.0

This class is a factory for creating `Pack200.Packer` and `Pack200.Unpacker` objects for compressing JAR files to Pack200 archives and for uncompresssing those archives back into JAR files.

```
public abstract class Pack200 {
// No Constructor
// Nested Types
     public interface Packer;
     public interface Unpacker;
// Public Class Methods
     public static Pack200.Packer newPacker( );                    synchronized
     public static Pack200.Unpacker newUnpacker( );
}
```

Team LiB

Pack200.Packer java.util.jar

Java 5.0

This interface defines the API for an object that can convert a JAR file to an output stream in Pack200 (c
Pack200) format. Obtain a `Packer` object with the `Pack200.newPacker( )` factory method. Configure th
before using it by setting properties in the `Map` returned by the `properties( )` method. The constants d
class represent the names (and in some cases values) of properties that can be set. Pack a JAR file by p
`JarFile` or `JarInputStream` to a `pack( )` method along with the byte output stream to which the packe
representation should be written. You can monitor the progress of the packer engine by querying the `PRO`
property in the `properties( )` map. The value is the completion percentage as an integer between 0 ar
to indicate a stall or error.) If you want to be notified of changes to the `PROGRESS` property, register a
`java.beans.PropertyChangeListener` with `addPropertyChangeListener( )`. See also the *pack200* cc
Chapter 8 .

```
public interface Pack200.Packer {
// Public Constants
     public static final String CLASS_ATTRIBUTE_PFX;                      ="pack.class.a
     public static final String CODE_ATTRIBUTE_PFX;                       ="pack.code.at
     public static final String DEFLATE_HINT;                             ="pack.deflate
     public static final String EFFORT;                                   ="pack.effort"
     public static final String ERROR;                                    ="error"
     public static final String FALSE;                                    ="false"
     public static final String FIELD_ATTRIBUTE_PFX;                      ="pack.field.a
     public static final String KEEP;                                     ="keep"
     public static final String KEEP_FILE_ORDER;                          ="pack.keep.fi
     public static final String LATEST;                                   ="latest"
     public static final String METHOD_ATTRIBUTE_PFX;                     ="pack.method.
     public static final String MODIFICATION_TIME;                        ="pack.modific
     public static final String PASS;                                     ="pass"
     public static final String PASS_FILE_PFX;                            ="pack.pass.fi
     public static final String PROGRESS;                                 ="pack.progres
     public static final String SEGMENT_LIMIT;                            ="pack.segment
     public static final String STRIP;                                    ="strip"
     public static final String TRUE;                                     ="true"
     public static final String UNKNOWN_ATTRIBUTE;                        ="pack.unknown
// Event Registration Methods (by event name)
     void addPropertyChangeListener(java.beans.PropertyChangeListener listener);
     void removePropertyChangeListener(java.beans.PropertyChangeListener listener);
// Public Instance Methods
     void pack(JarInputStream in, java.io.OutputStream out) throws java.io.IOException;
     void pack(JarFile in, java.io.OutputStream out) throws java.io.IOException;
     java.util.SortedMap<String,String> properties( );
}
```

Returned By

`Pack200.newPacker( )`

Pack200.Unpacker java.util.jar

Java 5.0

This interface defines an API for converting a file or stream in Pack200 (or gzipped Pack200) format into in the form of a JarOutputStream . Obtain an Unpacker object with the Pack200.newUnpacker( ) meth Before using an unpacker, you may configure it by setting properties in the Map returned by the propert method. Unpack a JAR file with the unpack( ) method, specifying a File or stream of packed bytes. Mo progress of the unpacker by querying the PROGRESS key in the Map returned by properties( ) . The val be an Integer representing a completion percentage between 0 and 100. If you want to be notified of c the PROGRESS property, register a java.beans.PropertyChangeListener with addPropertyChangeList . See also the *unpack200* command in Chapter 8 .

```
public interface Pack200.Unpacker {
// Public Constants
     public static final String DEFLATE_HINT;                           ="unpack.defla
     public static final String FALSE;                                  ="false"
     public static final String KEEP;                                   ="keep"
     public static final String PROGRESS;                               ="unpack.progr
     public static final String TRUE;                                   ="true"
// Event Registration Methods (by event name)
     void addPropertyChangeListener(java.beans.PropertyChangeListener listener);
     void removePropertyChangeListener(java.beans.PropertyChangeListener listener);
// Public Instance Methods
     java.util.SortedMap<String,String> properties( );
     void unpack(java.io.InputStream in, JarOutputStream out) throws java.io.IOExceptio
     void unpack(java.io.File in, JarOutputStream out) throws java.io.IOException;
}
```

Returned By

Pack200.newUnpacker( )

Package java.util.logging

Java 1.4

The `java.util.logging` package defines a sophisticated and highly-configurable logging facility that Java applications can use to emit, filter, format, and output warning, diagnostic, tracing and debugging messages. An application generates log messages by calling various methods of a `Logger` object. The content of a log message (with other pertinent details such as the time and sequence number) is encapsulated in a `LogRecord` object generated by the `Logger`. A `Handler` object represents a destination for `LogRecord` objects. Concrete subclasses of `Handler` support destinations such as files and sockets. Most `Handler` objects have an associated `Formatter` that converts a `LogRecord` object into the actual text that is logged. The subclasses `SimpleFormatter` and `XMLFormatter` produce simple plain-text log messages and detailed XML logs respectively.

Each log message has an associated severity level. The `Level` class defines a type-safe enumeration of defined levels. `Logger` and `Handler` objects both have an associated `Level`, and discard any log messages whose severity is less than that specified level. In addition to this level-based filtering, `Logger` and `Handler` objects may also have an associated `Filter` object which may be implemented to filter log messages based on any desired criteria.

Applications that desire complete control over the logs they generate can create a `Logger` object, along with `Handler`, `Formatter` and `Filter` objects that control the destination, content, and appearance of the log. Simpler applications need only to create a Logger for themselves, and can leave the rest to the `LogManager` class. `LogManager` reads a system-wide configuration file (or a configuration class) and automatically directs log messages to a standard destination (or destinations) for the system. In Java 5.0, `LoggingMXBean` defines an interface for monitoring and management of the logging facility through the `javax.management` packages (which are beyond the scope of this book).

Interfaces

```
public interface Filter;
public interface LoggingMXBean;
```

Classes

```
public class ErrorManager;
public abstract class Formatter;
   public class SimpleFormatter extends Formatter;
   public class XMLFormatter extends Formatter;
public abstract class Handler;
   public class MemoryHandler extends Handler;
   public class StreamHandler extends Handler;
```

```
      public class ConsoleHandler extends StreamHandler;
      public class FileHandler extends StreamHandler;
      public class SocketHandler extends StreamHandler;
public class Level implements Serializable;
public class Logger;
public final class LoggingPermission extends java.security.BasicPermission;
public class LogManager;
public class LogRecord implements Serializable;
```

Team LiB

Team LiB

ConsoleHandler java.util.logging

Java 1.4

This Handler subclass formats LogRecord objects and outputs the resulting string to the System.err output stream. When a ConsoleHandler is created, the various properties inherited from Handler are initialized using system-wide defaults obtained by querying named values with LogManager.getProperty( ). The table below lists these properties, the value passed to getProperty( ), and the default value used if getProperty( ) returns null. See Handler for further details.

Handler property	LogManager property name	Default
level	java.util.logging.ConsoleHandler.level	Level.INFO
filter	java.util.logging.ConsoleHandler.filter	null
formatter	java.util.logging.ConsoleHandler.formatter	SimpleFormatter
encoding	java.util.logging.ConsoleHandler.encoding	platform default

Figure 16-114. java.util.logging.ConsoleHandler

```
public class ConsoleHandler extends StreamHandler {
// Public Constructors
     public ConsoleHandler( );
// Public Methods Overriding StreamHandler
     public void close( );
     public void publish(LogRecord record);
}
```

ErrorManager java.util.logging

Java 1.4

An important feature of the Logging API is that the logging methods called by applications never throw exceptions: it is not reasonable to expect programmers to nest all their logging calls within `try/catch` blocks, and even if they did, there is no useful way for an application to recover from an exception in the logging subsystem. Since handler classes such as `FileHandler` are inherently subject to I/O exceptions, the `ErrorManager` provides a way for a handler to report an exception instead of simply discarding it.

All `Handler` objects have an instance of `ErrorManager` associated with them. If an exception occurs in the handler, it passes the exception, along with a message and one of the error code constants defined by `ErrorManager` to the `error( )` method. `error( )` writes a message describing the exception to `System.err`, but does so only the first time it is called: the expectation is that a `Handler` that throws an exception once will continue to throw the same exception with each subsequent log message, and it is not useful to flood `System.err` with repeated error messages. You can of course define subclasses of `ErrorManager` that override `error( )` to provide some other reporting mechanism. If you do this, register an instance of your custom `ErrorManager` by calling the `setErrorManager( )` method of your `Handler`.

```
public class ErrorManager {
// Public Constructors
     public ErrorManager( );
// Public Constants
     public static final int CLOSE_FAILURE;                          =3
     public static final int FLUSH_FAILURE;                          =2
     public static final int FORMAT_FAILURE;                         =5
     public static final int GENERIC_FAILURE;                        =0
     public static final int OPEN_FAILURE;                           =4
     public static final int WRITE_FAILURE;                          =1
// Public Instance Methods
     public void error(String msg, Exception ex, int code);          synchronized
}
```

Passed To

`Handler.setErrorManager( )`

Returned By

`Handler.getErrorManager( )`

Team LiB

FileHandler java.util.logging

Java 1.4

This `Handler` subclass formats `LogRecord` objects and outputs the resulting strings to a file or to a rotating set of files. Arguments passed to the `FileHandler( )` constructor specify which file or files are used, and how they are used. The arguments are optional, and if they are not specified, defaults are obtained through `LogManager.getProperty( )` as described below. The constructor arguments are:

pattern

A string containing substitution characters that describes one or more files to use. The substitutio performed to convert this pattern to a filename are described below.

limit

An approximate maximum file size for the log file, or 0 for no limit. If *count* is set to greater than one, then when a log file reaches this maximum, `FileHandler` closes it, renames it, and then star a new log with the original filename.

count

When *limit* is set to be nonzero, this arguemnt specifies the number of old log files to retain.

append

`TRue` if the `FileHandler` should append to log messages already in the named file, or `false` if it should overwrite the file.

The *pattern* argument is the most important of these: it specifies which file or files the `FileHandler` wil write to. `FileHandler` performs the following substitutions on the specified pattern to convert it to a filename:

For	Substitute
/	The directory separator character for the platform. This means that you can always use a forward slash in your patterns, even on Windows filesystems that use backward slashes.

For	Substitute
%%	A single literal percent sign.
%h	The user's home directory: the value of the system property "user.home".
%t	The temporary directory for the system.
%u	A unique number to be used to distinguish this log file from other log files with the same pattern (this may be necessary when multiple Java programs are creating logs at the same time).
%g	The "generation number" of old log files when the *limit* argument is nonzero and the *count* argument is greater than one. FileHandler always writes log records into a file in which %g is replaced by 0. But when that file fills up, it is closed and renamed with the 0 replaced by a 1. Olde files are similarly renamed, with their generation number being incremented. When the number o log files reaches the number specifed by *count* , then the oldest file is deleted to make room for the new one.

When a FileHandler is created, the LogManager.getProperty( ) method is used to obtain defaults for any unspecified constructor arguments, and also to obtian initial values for the various properties inherited from Handler . The table below lists these arguments and properties, the value passed to getProperty( ) , and the default value used if getProperty( ) returns null . See Handler for further details.

Property or argument	LogManager property name	Default
level	java.util.logging.FileHandler.level	Level.ALL
filter	java.util.logging.FileHandler.filter	null
formatter	java.util.logging.FileHandler.formatter	XMLFormatter
encoding	java.util.logging.FileHandler.encoding	platform default
pattern	java.util.logging.FileHandler.pattern	%h/java%u.log
limit	java.util.logging.FileHandler.limit	0 (no limit)
count	java.util.logging.FileHandler.count	1
append	java.util.logging.FileHandler.append	false

Figure 16-115. java.util.logging.FileHandler

```
public class FileHandler extends StreamHandler {
// Public Constructors
     public FileHandler( ) throws java.io.IOException, SecurityException;
     public FileHandler(String pattern) throws java.io.IOException, SecurityException;
```

```
    public FileHandler(String pattern, boolean append)
       throws java.io.IOException, SecurityException;
    public FileHandler(String pattern, int limit, int count)
       throws java.io.IOException, SecurityException;
    public FileHandler(String pattern, int limit, int count,
       boolean append) throws java.io.IOException, SecurityException;
// Public Methods Overriding StreamHandler
    public void close( ) throws SecurityException;                synchronized
    public void publish(LogRecord record);                      synchronized
}
```

Team LiB

Filter java.util.logging

Java 1.4

This interface defines the method that a class must implement if it wants to filter log messages for a `Logger` or `Handler` class. `isLoggable( )` should return `true` if the specified `LogRecord` contains information that should be logged. It should return `false` if the `LogRecord` should be filtered out not appear in any destination log. Note that both `Logger` and `Handler` provide built-in filtering based on the severity level of the `LogRecord`. This `Filter` interface exists to provide a customized filtering capability.

```
public interface Filter {
// Public Instance Methods
     boolean isLoggable(LogRecord record);
}
```

Passed To

`Handler.setFilter( )`, `Logger.setFilter( )`

Returned By

`Handler.getFilter( )`, `Logger.getFilter( )`

Formatter java.util.logging

Java 1.4

A Formatter object is used by a Handler to convert a LogRecord to a String prior to logging it. Most applications can simply use one one of the pre-defined concrete subclasses:SimpleFormatter or XMLFormatter. Applications requiring custom formatting of log messages will need to subclass this class and define the format( ) method to perform the desired conversion. Such subclasses may find the formatMessage( ) method useful: it performs localization using java.util.ResourceBundle and formatting using the facilities of the java.text package. getHead( ) and getTail( ) return a prefix and suffix (such as opening and closing XML tags) for a log file.

```
public abstract class Formatter {
// Protected Constructors
     protected Formatter( );
// Public Instance Methods
     public abstract String format(LogRecord record);
     public String formatMessage(LogRecord record);                     synchronized
     public String getHead(Handler h);
     public String getTail(Handler h);
}
```

Subclasses

SimpleFormatter, XMLFormatter

Passed To

Handler.setFormatter( ), StreamHandler.StreamHandler( )

Returned By

Handler.getFormatter( )

Handler java.util.logging

Java 1.4

A Handler takes LogRecord objects from a Logger and, if their severity level is high enough, formats and publishes them to some destination (a file or socket, for example). The subclasses of this abstract class support various destinations, and implement destination-specific publish( ), flush( ) and close( ) methods.

In addition to the destination-specific abstract methods, this class also defines concrete methods used by most Handler subclasses. These are property getter and setter methods to specify the severity Level of logging messages to be handled, an optional Filter, a Formatter to convert log messages from LogRecord objects to text, a text encoding for the output text, and an ErrorManager to handle any exceptions that arise during log output. Subclass-specific defaults for each of these properties are typically defined as properties of LogManager and are read from a system-wide logging configuration file.

In the simplest uses of the Logging API, a Logger sends it log messages to one or more handlers defined by the LogManager class for its "root logger". In this case there is no need for the application to ever instantiate or use a Handler directly. Applications that want custom control over the destination of their logs create and configure an instance of a Handler subclass, but never need to call its publish( ), flush( ) or close( ) methods directly: that is done by the Logger.

```
public abstract class Handler {
// Protected Constructors
     protected Handler( );
// Public Instance Methods
     public abstract void close( ) throws SecurityException;
     public abstract void flush( );
     public String getEncoding( );
     public ErrorManager getErrorManager( );
     public Filter getFilter( );
     public java.util.logging.Formatter getFormatter( );
     public Level getLevel( );                                   synchronized
     public boolean isLoggable(LogRecord record);
     public abstract void publish(LogRecord record);
     public void setEncoding(String encoding) throws SecurityException,
        java.io.UnsupportedEncodingException;
     public void setErrorManager(ErrorManager em);
     public void setFilter(Filter newFilter) throws SecurityException;
     public void setFormatter(java.util.logging.Formatter newFormatter)
        throws SecurityException;
     public void setLevel(Level newLevel) throws SecurityException;     synchronized
// Protected Instance Methods
     protected void reportError(String msg, Exception ex, int code);
```

```
}
```

Subclasses

MemoryHandler, StreamHandler

Passed To

java.util.logging.Formatter.{getHead( ), getTail( )}, Logger.{addHandler( ), removeHandler( )}, MemoryHandler.MemoryHandler( ), XMLFormatter.{getHead( ), getTail( )}

Returned By

Logger.getHandlers( )

Level java.util.logging

Java 1.4 *serializable*

This class defines constants that represent the seven standard severity levels for log messages plus con that turn logging off and enable logging at any level. When logging is enabled at one severity level, it is enabled at all higher levels. The seven level constants, in order from most severe to least severe are: SE WARNING , INFO , CONFIG , FINE , FINER , and FINEST . The constant ALL enable logging of any message, regardless of its level. The constant OFF disables logging entirely. Note that these constants are all Level objects, rather than integers. This provides type safety.

Application code should rarely, if ever, need to use any of the methods of this class: instead they can si use the constants it defines.

Figure 16-116. java.util.logging.Level

```
public class Level implements Serializable {
// Protected Constructors
     protected Level(String name, int value);
     protected Level(String name, int value, String resourceBundleName);
// Public Constants
     public static final Level ALL;
     public static final Level CONFIG;
     public static final Level FINE;
     public static final Level FINER;
     public static final Level FINEST;
     public static final Level INFO;
     public static final Level OFF;
     public static final Level SEVERE;
     public static final Level WARNING;
// Public Class Methods
     public static Level parse(String name) throws IllegalArgumentException;     synchr
// Public Instance Methods
     public String getLocalizedName( );
     public String getName( );
     public String getResourceBundleName( );
     public final int intValue( );
// Public Methods Overriding Object
     public boolean equals(Object ox);
     public int hashCode( );
     public final String toString( );
```

```
}
```

Passed To

Too many methods to list.

Returned By

Handler.getLevel( ), Logger.getLevel( ), LogRecord.getLevel( ), MemoryHandler.getPushLev

Team LiB

Logger java.util.logging

Java 1.4

A Logger object is used to emit log messages. Logger does not have a public constructor, but there are ways to obtain a Logger object to use in your code:

- Typically, applications call the static getLogger( ) method to create or lookup a named Logger wit hierarchy of named loggers. Loggers have dot-separated hierarchical names, which should be base name of the class or package that uses them. Loggers obtained in this way inherit their logging lev resource bundle (for localization), and Handler objects from their ancestors in the hierarchy and, ultimately, from the root Logger defined by the global LogManager .
- Applets that require a Logger with no security restrictions should use the static getAnonymousLogge method to create an unnamed Logger that is not part of the hierarchy of named Logger objects ma by the LogManager . A Logger created by this method has the LogManager root logger as its parent inherits the logging level and handlers of that root logger.
- Finally, the static Logger.global field refers to a pre-defined Logger named "global"; programmer find this pre-defined Logger convenient during the early stages of application development, but it s not be used in production code.

Once a suitable Logger has been obtained, there are a variety of methods that can be used to create a l message:

- The log( ) methods log a specified message at the specified level, with optional parameters that c used in message localization. These methods examine the call stack and make an attempt to deter the class and method name from which the method is emitted. Because of code optimization and ju time compilation techniques, however, they may not always be able to determine this information.
- The logp( ) ("log precise") methods are like the log( ) methods but allow you to explicitly specify name of the class and method that are emitting the log message.
- The logrb( ) methods are like the logp( ) methods, but additionally take the name of a resource to use for localizing the message.
- entering( ) , exiting( ) , and tHRowing( ) are convenience methods for emitting log messages trace the execution of a program. These methods use a logging level of Level.FINER . Note that th variants of entering( ) and exiting( ) that allow specification of method arguments and return
- Finally, Logger defines a set of easy-to-use convenience methods for logging a simple message at specific logging level. These methods have the same names as the logging levels: severe( ) , warn) , info( ) , config( ) , fine( ) , finer( ) , finest( ) .

A Logger has an associated logging Level , and discards any log messages with a severity lower than th

severity level is initialized from the system configuration file, which is usually the desired behavior. You
explicitly override this setting with setLevel( ) . You might want to do this if you created the Logger wi
getAnonymousLogger( ) and have read the desired logging level from a configuration file of your own.
based filtering of log messages is not sufficient, you can associate a Filter with your Logger by calling
setFilter . If you do this, any log messages rejected by the Filter will be discarded.

A Logger sends its log messages to any Handler objects that have been registered with addHandler( )
getHandlers( ) to obtain an array of all registered handlers, and call removeHandler( ) to de-register
handler. By default, all log messages are also sent to the handlers of the parent logger and any other ar
loggers. Since all named and anonymous loggers have the LogManager root logger as a parent or ancest
loggers by default send their log messages to the handlers defined in the system logging configuration f
LogManager for details. If you do not want a Logger to use the handlers of its ancestors, pass false to
setUseParentHandlers( ) .

getLogger( ) and getAnonymousLogger( ) allow you to specify the name of a java.util.ResourceBu
for use in localizing log messages, and logrb( ) allows you to specify the name of a resource bundle to
localize a specific log message. If a resource bundle is specified for the Logger or for a specific log messa
then the message argument to the various logging methods is treated not as a literal message but inste
localization key for which a localized version is to be looked up in the resource bundle. As part of the
localization, any parameters, such as those specified by the *param1* and *params* arguments to the log(
method are substituted into the localized message string as per java.text.MessageFormat . (Note, how
that this localization and formatting is not performed by the Logger itself: instead, it simply stores the
ResourceBundle and parameters in the LogRecord . It is the Formatter associated with the output Hand
object that actually performs the localization.)

All the methods of this class are threadsafe and do not require external synchronization.

```
public class Logger {
// Protected Constructors
     protected Logger(String name, String resourceBundleName);
// Public Constants
     public static final Logger global;
// Public Class Methods
     public static Logger getAnonymousLogger( );                    synchronized
     public static Logger getAnonymousLogger(String resourceBundleName);     synchroniz
     public static Logger getLogger(String name);                  synchronized
     public static Logger getLogger(String name, String resourceBundleName);     synchr
// Public Instance Methods
     public void addHandler(Handler handler) throws SecurityException;     synchronized
     public void config(String msg);
     public void entering(String sourceClass, String sourceMethod);
     public void entering(String sourceClass, String sourceMethod, Object param1);
     public void entering(String sourceClass, String sourceMethod, Object[ ] params);
     public void exiting(String sourceClass, String sourceMethod);
     public void exiting(String sourceClass, String sourceMethod, Object result);
     public void fine(String msg);
     public void finer(String msg);
     public void finest(String msg);
     public Filter getFilter( );
     public Handler[ ] getHandlers( );                          synchronized
     public Level getLevel( );
```

```
    public String getName( );
    public Logger getParent( );
    public java.util.ResourceBundle getResourceBundle( );
    public String getResourceBundleName( );
    public boolean getUseParentHandlers( );                    synchronized
    public void info(String msg);
    public boolean isLoggable(Level level);
    public void log(LogRecord record);
    public void log(Level level, String msg);
    public void log(Level level, String msg, Throwable thrown);
    public void log(Level level, String msg, Object param1);
    public void log(Level level, String msg, Object[ ] params);
    public void logp(Level level, String sourceClass, String sourceMethod,
       String msg);
    public void logp(Level level, String sourceClass, String sourceMethod,
       String msg, Object param1);
    public void logp(Level level, String sourceClass, String sourceMethod,
       String msg, Object[ ] params);
    public void logp(Level level, String sourceClass, String sourceMethod,
       String msg, Throwable thrown);
    public void logrb(Level level, String sourceClass, String sourceMethod,
       String bundleName, String msg);
    public void logrb(Level level, String sourceClass, String sourceMethod,
       String bundleName, String msg, Object param1);
    public void logrb(Level level, String sourceClass, String sourceMethod,
       String bundleName, String msg, Throwable thrown);
    public void logrb(Level level, String sourceClass, String sourceMethod,
       String bundleName, String msg, Object[ ] params);
    public void removeHandler(Handler handler) throws SecurityException;     synchroni
    public void setFilter(Filter newFilter) throws SecurityException;
    public void setLevel(Level newLevel) throws SecurityException;
    public void setParent(Logger parent);
    public void setUseParentHandlers(boolean useParentHandlers);       synchronized
    public void severe(String msg);
    public void throwing(String sourceClass, String sourceMethod, Throwable thrown);
    public void warning(String msg);
}
```

Passed To

LogManager.addLogger( )

Returned By

LogManager.getLogger( )

LoggingMXBean java.util.logging

Java 5.0

This interface defines the API for the `javax.management` "management bean" for the logging system. Obtain an instance with the static method `LogManager.getLoggingMXBean( )`. The methods of this class allow the monitoring of all registered loggers and their logging level and allow management to change the logging level of any named logger.

```
public interface LoggingMXBean {
// Public Instance Methods
     String getLoggerLevel(String loggerName);
     java.util.List<String> getLoggerNames( );
     String getParentLoggerName(String loggerName);
     void setLoggerLevel(String loggerName, String levelName);
}
```

Returned By

`LogManager.getLoggingMXBean( )`

LoggingPermission java.util.logging

Java 1.4 *serializable permission*

This class is a java.security.Permission that governs the use of security-sensitive logging methods. T single defined name (or target) for LoggingPermission is "control" which represents permission to invok various logging control methods such as Logger.setLevel( ) and LogManager.readConfiguration( ) methods in this package that throw SecurityException all require a LoggingPermission named "contro order to run. Application programmers never need to use this class. System adminstrators configuring s policies may need to be familiar with it.

Figure 16-117. java.util.logging.LoggingPermission


```
public final class LoggingPermission extends java.security.BasicPermission {
// Public Constructors
     public LoggingPermission(String name, String actions) throws IllegalArgumentExcept
}
```

Team LiB

LogManager java.util.logging

Java 1.4

As its name implies, this class is the manager for the java.util.logging API. It has three specific purposes: (1) to read a logging configuration file and create the default Handler objects specified in that file; (2) to manage a set of Logger objects, arranging them into a tree based on their heirarchical names and (3) to create and manage the unnamed Logger object that serves as the parent or ancestor of every other Logger . This class handles the important behind-the-scenes details that makes the Logging API w Typical applications can make use of logging without ever having to use this class explicitly. Although its is not commonly used by application programmers, it is still useful to understand the LogManager class, s is described in detail here.

There is a single global instance of LogManager , which is obtained with the static getLogManager( ) method. By default, this global log manager object is an instance of the LogManager class itself. You may instead instantiate an instance of a subclass of LogManager by specifing the full class name of the subcla as the value of the system property java.util.logging.manager .

One of the primary purposes of the LogManager class is to read a java.util.Properties file that specif the default logging configuration for the system. By default, this file is named *logging.properties* and is stored in the *jre/lib* directory of the Java installation. If you want to run a Java application using a differe logging configuration, you can edit the default configuration file, but it is typically easier to create a new configuation file and tell the JVM about it by setting the system property java.util.logging.config.fi to the name of your customized configuration file.

The most important purpose of the configuration file is to specify a set of Handler objects to which all log messages are sent. This is done by setting the handlers property in the file to a space-separated list of Handler class names. The LogManager will load the specified classes, and instantiate each one (using th default no-arg constructor), and then register those Handler objects on the root Logger , where they are inherited by all other loggers. (We'll see more about the root logger below.) Each of these Handler objec further configures itself by reading additional properties from the configuration file, as described in the documentation for each handler class.

The configuration file may also contain property name that are formed by appending ".level" to the nam a logger. The value of any such property is taken as the name of a logging Level for the named Logger . When the named logger is created and registered with the LogManager (described below) its logging leve automatically set to the specified level.

An application or any custom Handler or Formatter subclass or Filter implementation can read its own properties from the logging configuration file with the getProperty( ) method of LogManager . This is a useful way to provide customizability for logging-related classes.

In addition to managing the configuration file properties, a second purpose of LogManager is to maintain tree of Logger objects organized into a hierarchy based on their dot-separated hierarchical names. The addLogger( ) method registers a new Logger object with the LogManager and inserts it into the tree. Th method is called automatically by the Logger.getLogger( ) factory method, however, so you never nee to call it yourself. The getLogger( ) method of LogManager finds and returns a named Logger object wi the tree. Use getLoggerNames( ) to obtain an Enumeration of the names of all registered loggers.

At the root of the tree is a root logger, created by the LogManager , and initialized with default Handler objects specified in the logging configuration file as described above. This root logger has no name, and can obtain a reference to it by passing the empty string to the getLogger( ) method. Except for this roc logger and anonymous loggers (see Logger.getAnonymousLogger( )), all loggers have names, and the are typically named after the package or class for which they provide logging. When a named logger is registered with the LogManager , the LogManager examines its name and inserts it into the tree of logge at the appropriate place: a logger named "java.util.logging" would be inserted as the child of a logger named "java.util", if any such logger existed, or as a child of a logger named "java", or, if no logger with that name existed either, it would be inserted as a child of the root logger named "". When the LogManag determines the position of a logger within the tree of loggers, it calls the setParent( ) method of the newly-registered Logger to tell it who its parent is. This is important because, by default, loggers inherit their logging level and handlers from their parent. Although the Logger.setParent( ) method is public, is intended for use only by the LogManager class.

Anonymous loggers created with Logger.getAnonymousLogger( ) do not have names, and are not part the logger tree. When they are created, however, their parent is set to the root logger of the LogManage For this reason, anonymous loggers inherit the default handlers specified in the logging configuration file

The readConfiguration( ) methods are used to force the LogManager to re-read the system configurat file, or to read a new configuration file from the specified stream. Both versions of the method generate java.beans.PropertyChangeEvent and use it to notify any listeners that have been registered with addPropertyChangeListener . Both methods also first invoke the reset( ) method which discards the properties of the current configuration file, removes and closes all handlers for all loggers, and sets the logging level of all loggers to null , except for the root logger's logging level, which it sets to Level.INFO It is unlikely that you would ever want to invoke reset( ) yourself. A number of LogManager methods throw a SecurityException if the caller does not have appropriate permissions. You can use checkAcce) to test whether the current calling context has the required LoggingPermission named "control".

All LogManager methods can be safely used by multiple threads.

```
public class LogManager {
// Protected Constructors
     protected LogManager( );
// Public Constants
5.0  public static final String LOGGING_MXBEAN_NAME;      ="java.util.logging:type=Loggi
// Public Class Methods
5.0  public static LoggingMXBean getLoggingMXBean( );                  synchronized
     public static LogManager getLogManager( );
// Event Registration Methods (by event name)
     public void addPropertyChangeListener(java.beans.PropertyChangeListener l)
        throws SecurityException;
     public void removePropertyChangeListener(java.beans.PropertyChangeListener l)
        throws SecurityException;
// Public Instance Methods
     public boolean addLogger(Logger logger);                      synchronized
     public void checkAccess( ) throws SecurityException;
     public Logger getLogger(String name);                         synchronized
     public java.util.Enumeration<String> getLoggerNames( );       synchronized
     public String getProperty(String name);
     public void readConfiguration( ) throws java.io.IOException, SecurityException;
```

```
    public void readConfiguration(java.io.InputStream ins)
       throws java.io.IOException, SecurityException;
    public void reset( ) throws SecurityException;
}
```

Team LiB

Team LiB

LogRecord java.util.logging

Java 1.4 *serializable*

Instances of this class are used to represent log messages as they are passed between Logger, Handler, Filter and Formatter objects. LogRecord defines a number of JavaBeans-type property getter and setter methods. The values of the various properties encapsulate all details of the log message. The LogRecord( ) constructor takes arguments for the two most important properties: the log level and the log message (or localization key). The constructor also initializes the millis property to the current time, the sequenceNumber property to a unique (within the VM) value that can be used to compare the order of two log messages, and the threadID property to a unique identifier for the current thread. All other properties of the LogRecord are left uninitialized with their default null values.

Figure 16-118. java.util.logging.LogRecord

```
public class LogRecord implements Serializable {
// Public Constructors
     public LogRecord(Level level, String msg);
// Public Instance Methods
     public Level getLevel( );
     public String getLoggerName( );
     public String getMessage( );
     public long getMillis( );
     public Object[ ] getParameters( );
     public java.util.ResourceBundle getResourceBundle( );
     public String getResourceBundleName( );
     public long getSequenceNumber( );
     public String getSourceClassName( );
     public String getSourceMethodName( );
     public int getThreadID( );
     public Throwable getThrown( );
     public void setLevel(Level level);
     public void setLoggerName(String name);
     public void setMessage(String message);
     public void setMillis(long millis);
     public void setParameters(Object[ ] parameters);
     public void setResourceBundle(java.util.ResourceBundle bundle);
     public void setResourceBundleName(String name);
     public void setSequenceNumber(long seq);
```

```
    public void setSourceClassName(String sourceClassName);
    public void setSourceMethodName(String sourceMethodName);
    public void setThreadID(int threadID);
    public void setThrown(Throwable thrown);
}
```

Passed To

ConsoleHandler.publish( ), FileHandler.publish( ), Filter.isLoggable( ), java.util.logging.Formatter.{format( ), formatMessage( )}, Handler.{isLoggable( ), publish( )}, Logger.log( ), MemoryHandler.{isLoggable( ), publish( )}, SimpleFormatter.format( ), SocketHandler.publish( ), StreamHandler.{isLoggable( ), publish( )}, XMLFormatter.format( )

Team LiB

MemoryHandler java.util.logging

Java 1.4

A MemoryHandler stores LogRecord objects in a fixed-sized buffer in memory. When the buffer fills up, it discards the oldest record one each time a new record arrives. It maintains a reference to another Handler object, and whenever the push( ) method is called, or whenver a LogRecord arrives with a level at or higher than the pushLevel threshold, it "pushes" all of buffered LogRecord objects to that other Handler object, which typically formats and outputs them to some appropriate destination. Because MemoryHandler never outputs log records itself, it does not use the formatter or encoding properties inherited from its superclass.

When you create a MemoryHandler, you can specify the target Handler object, the size of the in-memory buffer, and the value of the pushLevel property, or you can omit these constructor arguments and rely on system-wide defaults obtained with LogManager.getProperty( ). MemoryHandler also uses LogManager.getProperty( ) to obtain initial values for the level and filter properties inherited from Handler. The table below lists these properties, as well as the *target*, *size*, and *pushLevel* constructor arguments, the value passed to getProperty( ), and the default value used if getProperty( ) returns null. See Handler for further details.

Property or argument	LogManager property name	Default
level	java.util.logging.MemoryHandler.level	Level.ALL
filter	java.util.logging.MemoryHandler.filter	null
target	java.util.logging.MemoryHandler.target	no default
size	java.util.logging.MemoryHandler.size	1000 log records
pushLevel	java.util.logging.MemoryHandler.push	Level.SEVERE

Figure 16-119. java.util.logging.MemoryHandler

```
public class MemoryHandler extends Handler {
// Public Constructors
     public MemoryHandler( );
     public MemoryHandler(Handler target, int size, Level pushLevel);
// Public Instance Methods
     public Level getPushLevel( );                           synchronized
```

```
    public void push( );                                  synchronized
    public void setPushLevel(Level newLevel) throws SecurityException;
// Public Methods Overriding Handler
    public void close( ) throws SecurityException;
    public void flush( );
    public boolean isLoggable(LogRecord record);
    public void publish(LogRecord record);                        synchronized
}
```

Team LiB

SimpleFormatter java.util.logging

Java 1.4

This `Formatter` subclass converts a `LogRecord` object to a human-readable log message that is typically one or two lines long. See also `XMLFormatter`.

Figure 16-120. java.util.logging.SimpleFormatter


```
public class SimpleFormatter extends java.util.logging.Formatter {
// Public Constructors
     public SimpleFormatter( );
// Public Methods Overriding Formatter
     public String format(LogRecord record);                      synchronized
}
```

SocketHandler java.util.logging

Java 1.4

This `Handler` subclass formats `LogRecord` objects and outputs the resulting strings to a network socket. When you create a `SocketHandler`, you can pass the hostname and port of the socket to the constructor or you can rely on system-wide defaults obtained with `LogManager.getProperty( )`. `SocketHandler` also uses `LogManager.getProperty( )` to obtain initial values for the properties inherited from `Handler`. The table below lists these properties, as well as the host and port arguments, the value passed to `getProperty( )`, and the default value used if `getProperty( )` returns `null`. See `Handler` for further details.

Handler property	LogManager property name	Default
level	java.util.logging.SocketHandler.level	Level.ALL
filter	java.util.logging.SocketHandler.filter	null
formatter	java.util.logging.SocketHandler.formatter	XMLFormatter
encoding	java.util.logging.SocketHandler.encoding	platform default
hostname	java.util.logging.SocketHandler.host	no default
port	java.util.logging.SocketHandler.port	no default

Figure 16-121. java.util.logging.SocketHandler

```
public class SocketHandler extends StreamHandler {
// Public Constructors
     public SocketHandler( ) throws java.io.IOException;
     public SocketHandler(String host, int port) throws java.io.IOException;
// Public Methods Overriding StreamHandler
     public void close( ) throws SecurityException;                synchronized
     public void publish(LogRecord record);                      synchronized
}
```

StreamHandler java.util.logging

Java 1.4

This `Handler` subclass sends log messages to an arbitrary `java.io.OutputStream` . It exists primarily tc as the common superclass of `ConsoleHandler` , `FileHandler` , and `SocketHandler` .

Figure 16-122. java.util.logging.StreamHandler


```
public class StreamHandler extends Handler {
// Public Constructors
     public StreamHandler( );
     public StreamHandler(java.io.OutputStream out, java.util.logging.Formatter formatt
// Public Methods Overriding Handler
     public void close( ) throws SecurityException;                  synchronized
     public void flush( );                                  synchronized
     public boolean isLoggable(LogRecord record);
     public void publish(LogRecord record);                        synchronized
     public void setEncoding(String encoding) throws SecurityException,
        java.io.UnsupportedEncodingException;
// Protected Instance Methods
     protected void setOutputStream(java.io.OutputStream out)
        throws SecurityException;     synchronized
}
```

Subclasses

`ConsoleHandler` , `FileHandler` , `SocketHandler`

XMLFormatter java.util.logging

Java 1.4

This Formatter subclass converts a LogRecord to an XML-formatted string. The format( ) method returns a <record> element, which always contains <date>, <millis>, <sequence>, <level> and <message> tags, and may also contain <logger>, <class>, <method>, <thread>, <key>, <catalog>, <param>, and <exception> tags. See http://java.sun.com/dtd/logger.dtd for the DTD of the output document.

The getHead( ) and getTail( ) methods are overridden to return opening and closing <log> and </log> tags to surround all output <record> tags. Note however, that if an application terminates abnormally, the logging facility may be unable to terminate the log file with the closing <log> tag.

Figure 16-123. java.util.logging.XMLFormatter

```
public class XMLFormatter extends java.util.logging.Formatter {
// Public Constructors
     public XMLFormatter( );
// Public Methods Overriding Formatter
     public String format(LogRecord record);
     public String getHead(Handler h);
     public String getTail(Handler h);
}
```

Team LiB

Package java.util.prefs

Java 1.4

The java.util.prefs package contains classes and interfaces for managing persistant user and system-wide preferences for Java applications and classes. Most applications will use only the Preferences class itself. Some will also use the event objects and listener interfaces defined by this package, and some may need to explicitly catch the types of exceptions defined by this package. Application programmers never need to use the PreferencesFactory interface or the AbstractPreferences class, which are intended for Preferences implementors only.

To use the Preferences class, first use a static method to obtain an appropriate Preferences object or objects, and then use a get( ) method to query a preference value or a put( ) method to set a preference value. The code below shows a typical usage. See the Preferences class for details.

```
import java.util.prefs.Preferences;
public class TextEditor {
  // some constants that define default values for preferences
  public static final int WIDTH_DEFAULT = 80;
  public static final String DICTIONARY_DEFAULT = "";
  // Fields to be initialized from preference values
  public int width;             // Screen width in columns
  public String dictionary;     // Dictionary name for spell-checking
  public void initPrefs( ) {
    // Get Preferences objects for user and system preferences for this package
    Preferences userprefs = Preferences.userNodeForPackage(TextEditor.class);
    Preferences sysprefs = Preferences.systemNodeForPackage(TextEditor.class);
    // Look up preference values.  Note that we always pass a default value
    width = userprefs.getInt("width", WIDTH_DEFAULT);
    // Look up a user preference using a system preference as the default
    dictionary = userprefs.get("dictionary",
                               sysprefs.get("dictionary",
                                            DICTIONARY_DEFAULT));
  }
}
```

Interfaces

```
public interface NodeChangeListener extends java.util.EventListener;
public interface PreferenceChangeListener extends java.util.EventListener;
public interface PreferencesFactory;
```

Events

```
public class NodeChangeEvent extends java.util.EventObject;
public class PreferenceChangeEvent extends java.util.EventObject;
```

Other Classes

```
public abstract class Preferences;
   public abstract class AbstractPreferences extends Preferences;
```

Exceptions

```
public class BackingStoreException extends Exception;
public class InvalidPreferencesFormatException extends Exception;
```

Team LiB

AbstractPreferences java.util.prefs

Java 1.4

This class implements all the abstract methods of `Preferences` on top of a smaller set of abstract metho
Programmers creating a Preferences implementation (or "service provider") can subclass this class and ı
define only the nine methods whose names end in "Spi". Application programmers never need to use thi
class.

Figure 16-124. java.util.prefs.AbstractPreferences


```
public abstract class AbstractPreferences extends Preferences {
// Protected Constructors
     protected AbstractPreferences(AbstractPreferences parent, String name);
// Event Registration Methods (by event name)
     public void addNodeChangeListener(NodeChangeListener ncl);
        Overrides:Preferences
     public void removeNodeChangeListener(NodeChangeListener ncl);
        Overrides:Preferences
     public void addPreferenceChangeListener(PreferenceChangeListener pcl);
        Overrides:Preferences
     public void removePreferenceChangeListener(PreferenceChangeListener pcl);
        Overrides:Preferences
// Public Methods Overriding Preferences
     public String absolutePath( );
     public String[ ] childrenNames( ) throws BackingStoreException;
     public void clear( ) throws BackingStoreException;
     public void exportNode(java.io.OutputStream os) throws java.io.IOException,
        BackingStoreException;
     public void exportSubtree(java.io.OutputStream os) throws java.io.IOException,
        BackingStoreException;
     public void flush( ) throws BackingStoreException;
     public String get(String key, String def);
     public boolean getBoolean(String key, boolean def);
     public byte[ ] getByteArray(String key, byte[ ] def);
     public double getDouble(String key, double def);
     public float getFloat(String key, float def);
     public int getInt(String key, int def);
     public long getLong(String key, long def);
     public boolean isUserNode( );
     public String[ ] keys( ) throws BackingStoreException;
```

```
    public String name( );
    public Preferences node(String path);
    public boolean nodeExists(String path) throws BackingStoreException;
    public Preferences parent( );
    public void put(String key, String value);
    public void putBoolean(String key, boolean value);
    public void putByteArray(String key, byte[ ] value);
    public void putDouble(String key, double value);
    public void putFloat(String key, float value);
    public void putInt(String key, int value);
    public void putLong(String key, long value);
    public void remove(String key);
    public void removeNode( ) throws BackingStoreException;
    public void sync( ) throws BackingStoreException;
    public String toString( );
// Protected Instance Methods
    protected final AbstractPreferences[ ] cachedChildren( );
    protected abstract String[ ] childrenNamesSpi( ) throws BackingStoreException;
    protected abstract AbstractPreferences childSpi(String name);
    protected abstract void flushSpi( ) throws BackingStoreException;
    protected AbstractPreferences getChild(String nodeName) throws BackingStoreExcepti
    protected abstract String getSpi(String key);
    protected boolean isRemoved( );
    protected abstract String[ ] keysSpi( ) throws BackingStoreException;
    protected abstract void putSpi(String key, String value);
    protected abstract void removeNodeSpi( ) throws BackingStoreException;
    protected abstract void removeSpi(String key);
    protected abstract void syncSpi( ) throws BackingStoreException;
// Protected Instance Fields
    protected final Object lock;
    protected boolean newNode;
}
```

Team LiB

BackingStoreException java.util.prefs

Java 1.4 *serializable checked*

Signals that a Preferences method could not complete because of an implementation-specific problem with the preferences database. The most commonly used methods of the Preferences class do not throw this exception, and are guaranteed to succeed even if the implementation's preferences data is not available. Note that although this class inherits the Serializable interface, implementations are no actually required to be serializable.

Figure 16-125. java.util.prefs.BackingStoreException


```
public class BackingStoreException extends Exception {
// Public Constructors
     public BackingStoreException(Throwable cause);
     public BackingStoreException(String s);
}
```

Thrown By

Too many methods to list.

InvalidPreferencesFormatException java.util.prefs

Java 1.4 *serializable checked*

Signals a syntax error in XML preference data. Note that although this class inherits the Serializable interface, implementations are not actually required to be serializable.

Figure 16-126. java.util.prefs.InvalidPreferencesFormatException


```
public class InvalidPreferencesFormatException extends Exception {
// Public Constructors
     public InvalidPreferencesFormatException(String message);
     public InvalidPreferencesFormatException(Throwable cause);
     public InvalidPreferencesFormatException(String message, Throwable cause);
}
```

Thrown By

Preferences.importPreferences( )

NodeChangeEvent java.util.prefs

Java 1.4 *serializable event*

A NodeChangeEvent object is passed to the methods of any NodeChangeListener objects registered on a Preferences object when a child Preferences node is added or removed. getChild( ) returns the Preferences object that was added or removed. getParent( ) returns the parent Preferences node from which the child was added or removed. This parent Preferences object is the one on which the NodeChangeListener was registered.

Although this class inherits the Serializable interface, it is not actually serializable.

Figure 16-127. java.util.prefs.NodeChangeEvent

```
public class NodeChangeEvent extends java.util.EventObject {
// Public Constructors
     public NodeChangeEvent(Preferences parent, Preferences child);
// Public Instance Methods
     public Preferences getChild( );
     public Preferences getParent( );
}
```

Passed To

NodeChangeListener.{childAdded( ), childRemoved( )}

NodeChangeListener java.util.prefs

Java 1.4 *event listener*

This interface defines the methods that an object must implement if it wants to be notified when a child preferences node is added to or removed from a `Preferences` object. When such an addition or removal occurs, the parent `Preferences` object passes a `NodeChangeEvent` object to the appropriate method of any `NodeChangeListener` objects that have been registered through the `Preferences.addNodeChangeListener( )` method.

Figure 16-128. java.util.prefs.NodeChangeListener


```
public interface NodeChangeListener extends java.util.EventListener {
// Public Instance Methods
     void childAdded(NodeChangeEvent evt);
     void childRemoved(NodeChangeEvent evt);
}
```

Passed To

`AbstractPreferences.{addNodeChangeListener( ), removeNodeChangeListener( )}`, `Preferences.{addNodeChangeListener( ), removeNodeChangeListener( )}`

PreferenceChangeEvent java.util.prefs

Java 1.4 *serializable event*

A `PreferenceChangeEvent` object is passed to the `preferenceChange( )` method of any `PreferenceChangeListener` objects registered on a `Preferences` object whenever a preferences value is added to, removed from, or modified in that `Preferences` node. `getNode( )` returns the affected `Preferences` object. `getKey( )` returns name of the modified preference. If the preference value was added or modified, `getNewValue( )` returns that value. If a preference was deleted, `getNewValue( )` returns `null`.

Although this class inherits the `Serializable` interface, it is not actually serializable.

Figure 16-129. java.util.prefs.PreferenceChangeEvent

```
public class PreferenceChangeEvent extends java.util.EventObject {
// Public Constructors
     public PreferenceChangeEvent(Preferences node, String key, String newValue);
// Public Instance Methods
     public String getKey( );
     public String getNewValue( );
     public Preferences getNode( );
}
```

Passed To

`PreferenceChangeListener.preferenceChange( )`

PreferenceChangeListener java.util.prefs

Java 1.4 *event listener*

This interface defines the method that an object must implement if it wants to be notified when a preference key/value pair is added to, removed from, or changed in a`Preferences` object. After any such change, the `Preferences` object passes a `PreferenceChangeEvent` object describing the change to the `preferenceChange( )` method of any `PreferenceChangeListener` objects that have been registered through the `Preferences.addPreferenceChangeListener( )` method.

Figure 16-130. java.util.prefs.PreferenceChangeListener


```
public interface PreferenceChangeListener extends java.util.EventListener {
// Public Instance Methods
     void preferenceChange(PreferenceChangeEvent evt);
}
```

Passed To

`AbstractPreferences.{addPreferenceChangeListener( ), removePreferenceChangeListener( )}`, `Preferences.{addPreferenceChangeListener( ), removePreferenceChangeListener( )}`

Preferences java.util.prefs

Java 1.4

A Preferences object represents a mapping between preference names, which are case-sensitive string corresponding preference values. get( ) allows you to query the string value of a named preference, an) allows you to set a string value for a named preference. Although all preference values are stored as s various convenience methods whose names begin with "get" and "put" exist to convert preference value type boolean byte[ ] , double , float , int , and long to and from strings.

The remove( ) method allows you to delete a named preference altogether, and clear( ) deletes all preference values stored in a Preferences object. The keys( ) method returns an array of strings that the names of all preferences in the Preferences object.

Preference values are stored in some implementation-dependent back-end which may be a file, a LDAP directory server, the Windows Registry, or any other persistant "backing store". Note that all the get( ) methods of this class require a default value to be specified. They return this default if no value has bee for the named preference, or if the backing store is unavailable for any reason. The Preferences class is completely independent of the underlying implementation, except that it enforces an 80-character limit preference names and Preference node names (see below), and a 8192-character limit on preference v strings.

Preferences does not have a public construtor. To obtain a Preferences object for use in your applicati must must use one of the static methods described below. Each Preferences object is a node in a hierar Preferences nodes. There are two distinct hierarchies: one stores user-specific preferences, and one st system-wide preferences. All Preferences nodes (in either hierarchy) have a unique name and use the sa naming convention that Unix filesystems use. Applications (and classes) may store their preferences in a Preferences node with any name, but the convention is to use a node name that corresponds to the pa name of the application or class, with all "." characters in the package name converted to "/" characters example, the preferences node used by java.lang.System would be "/java/lang".

Preferences defines static methods that you can use to obtain the Preferences objects your applicatior requires. Pass a Class object to systemNodeForPackage( ) and userNodeForPackage( ) to obtain the and user Preferences objects that are specific to the package of that class. If you want a Preferences specific to a single class rather than to the package, you can pass the class name to the node( ) methoc package-specific node returned by systemNodeForPackage( ) or userNodeForPackage( ) . If you want navigate the entire tree of preferences nodes (which most applications never need to do) call systemRoot and userRoot( ) to obtain the root node of the two hierarchies, and then use the node( ) method to loc child nodes of those roots.

Various Preferences methods allow you to traverse the preferences hierarchies. parent( ) returns the Preferences node. childrenNames( ) returns an array of the relative names of all children of a Prefer node. node( ) returns a named Preferences object from the hierarchy. If the specified node name beg a slash, it is an absolute name and is interpreted relative to the root of the hierarchy. Otherwise, it is a name and is interpreted relative to the Preferences object on which node( ) was called. nodeExists(allows you to test whether a named node exists. removeNode( ) allows you to delete an entire Preferer node from the hierarchy (useful when uninstalling an application). name( ) returns the simple name of a Preferences node, relative to its parent. absoutePath( ) returns the full, absolute name of the node, r to the root of the hierarchy. Finally, isUserNode( ) allows you to determine whether a Preferences obj part of the user or system hierarchies.

Many applications will simply read their preference values once at startup. Long-lived applications or applications that want to respond dynamically to modifications to preferences (such as applications that tightly integrated with a graphical desktop) may use addPreferenceChangeListener( ) to register a PreferenceChangeListener to recieve notifications of preference changes (in the form of PreferenceChangeEvent objects). Applications that are interested in changes to the Preferences hierar itself can register a NodeChangeListener .

put( ) and the various type-specific put...( ) convenience methods may return asynchonously, befor new preference value is stored persistantly within the backing store. Call flush( ) to force any preferen changes to this Preferences node (and any of its descendants in the hierarchy) to be stored persistantl that it is not necessary to call flush( ) before an application terminates: all preferences will eventually made persistant.) More than one application (within more than one Java virtual machine) may set prefe values in the same Preferences node at the same time. Call sync( ) to ensure that future calls to get(its related convenience methods retrieve current preference values set by this or other virtual machines that the flush( ) and sync( ) operations are typically much more expensive than get( ) and put( ) operations, and applications do not often need to use them.

Preferences implementations ensure that all the methods of this class are thread safe. If multiple threa multiple VMs write store the same preferences concurrently, their values may overwrite one another, bu preference data will not be corrupted. Note that, for simplicity, Preferences does not define any way to multiple preferences in a single atomic transaction. If you need to ensure atomicity for multiple preferen values, define a data format that allows you to store all the requisite values in a single string, and set ar query those values with a single call to put( ) or get( ) .

The contents of a Preferences node, or of a node and all of its descendants may be exported as an XML with exportNode( ) and exportSubtree( ) . The static importPreferences( ) method reads an expor XML file back into the preferences hierarchy. These methods allow backups to be made of preference da allow preferences to be transferred between systems or between users.

Prior to Java 1.4, application preferences were sometimes managed with the java.util.Properties object.

```
public abstract class Preferences {
// Protected Constructors
     protected Preferences( );
// Public Constants
     public static final int MAX_KEY_LENGTH;                         =80
     public static final int MAX_NAME_LENGTH;                        =80
     public static final int MAX_VALUE_LENGTH;                       =8192
// Public Class Methods
     public static void importPreferences(java.io.InputStream is)
throws java.io.IOException, InvalidPreferencesFormatException;
     public static Preferences systemNodeForPackage(Class<?> c);
     public static Preferences systemRoot( );
     public static Preferences userNodeForPackage(Class<?> c);
     public static Preferences userRoot( );
// Event Registration Methods (by event name)
     public abstract void addNodeChangeListener(NodeChangeListener ncl);
```

```
    public abstract void removeNodeChangeListener(NodeChangeListener ncl);
    public abstract void addPreferenceChangeListener(PreferenceChangeListener pcl);
    public abstract void removePreferenceChangeListener(PreferenceChangeListener pcl);
// Public Instance Methods
    public abstract String absolutePath( );
    public abstract String[ ] childrenNames( ) throws BackingStoreException;
    public abstract void clear( ) throws BackingStoreException;
    public abstract void exportNode(java.io.OutputStream os) throws java.io.IOExceptio
        BackingStoreException;
    public abstract void exportSubtree(java.io.OutputStream os) throws java.io.IOExcep
        BackingStoreException;
    public abstract void flush( ) throws BackingStoreException;
    public abstract String get(String key, String def);
    public abstract boolean getBoolean(String key, boolean def);
    public abstract byte[ ] getByteArray(String key, byte[ ] def);
    public abstract double getDouble(String key, double def);
    public abstract float getFloat(String key, float def);
    public abstract int getInt(String key, int def);
    public abstract long getLong(String key, long def);
    public abstract boolean isUserNode( );
    public abstract String[ ] keys( ) throws BackingStoreException;
    public abstract String name( );
    public abstract Preferences node(String pathName);
    public abstract boolean nodeExists(String pathName) throws BackingStoreException;
    public abstract Preferences parent( );
    public abstract void put(String key, String value);
    public abstract void putBoolean(String key, boolean value);
    public abstract void putByteArray(String key, byte[ ] value);
    public abstract void putDouble(String key, double value);
    public abstract void putFloat(String key, float value);
    public abstract void putInt(String key, int value);
    public abstract void putLong(String key, long value);
    public abstract void remove(String key);
    public abstract void removeNode( ) throws BackingStoreException;
    public abstract void sync( ) throws BackingStoreException;
// Public Methods Overriding Object
    public abstract String toString( );
}
```

Subclasses

AbstractPreferences

Passed To

NodeChangeEvent.NodeChangeEvent( ) , PreferenceChangeEvent.PreferenceChangeEvent( )

Returned By

AbstractPreferences.{node( ), parent( )}, NodeChangeEvent.{getChild( ), getParent( )}, PreferenceChangeEvent.getNode( ), PreferencesFactory.{systemRoot( ), userRoot( )}

Team LiB

PreferencesFactory java.util.prefs

Java 1.4

The PreferencesFactory interface defines the factory methods used by the static methods of the Preferences class to obtain the root Preferences nodes for user-specific and system-wide preferences hierarchies. Application programmers never need to use this interface.

An implementation of the preferences API for a specific back-end data store must include an implementation of this interface that works with that data store. Sun's implementation of Java includes a default filesystem-based implementation, which you can override by specifying the name of a PreferencesFactory implementation as the value of the "java.util.prefs.PreferencesFactory" system property.

```
public interface PreferencesFactory {
// Public Instance Methods
     Preferences systemRoot( );
     Preferences userRoot( );
}
```

Package java.util.regex

Java 1.4

This small package provides a facility for textual pattern matching with regular expressions. Pattern objects represent regular expressions, which are specified using a syntax very close to the one used by the Perl programming language. The Matcher class encapsulates a Pattern and a java.lang.CharSequence of text, and defines various methods for matching the pattern to the text. In Java 5.0, the MatchResult interface represents the result of a match. Matcher implements this interface and can be queried directly.

In addition to the pattern matching methods defined in this package, the java.lang.String class has been augmented in Java 1.4 with a number of convenience methods for matching strings against regular expressions that are specified in their text form as strings, rather than in their compiled form as Pattern objects. Applications with simple pattern matching needs can use these convenience methods and may never have to directly use the Pattern or Matcher classes.

Interfaces

```
public interface MatchResult;
```

Classes

```
public final class Matcher implements MatchResult;
public final class Pattern implements Serializable;
```

Exceptions

```
public class PatternSyntaxException extends IllegalArgumentException;
```

Team LiB

Matcher java.util.regex

Java 1.4

A Matcher objects encapsulate a regular expression and a string of text (a Pattern and a java.lang.CharSequence) and defines methods for matching the pattern to the text in several different ways, for obtaining details about pattern matches, and for doing search-and-replace operations on the text. Matcher has no public constructor. Obtain a Matcher by passing the character sequence to be matched to the matcher( ) method of the desired Pattern object. You can also reuse an existing Matcher object with a new character sequence (but the same Pattern) by passing a new CharSequence to the matcher's reset( ) method. In Java 5.0, you can use a new Pattern object on the current character sequence with the usePattern( ) method.

Once you have created or reset a Matcher, there are three types of comparisons you can perform between the regular expression and the character sequence. All three comparisons operate on the current *region* of the character sequence. By default, this region is the entire sequence. In Java 5.0, however, you can set the bound of the region with region( ). The simplest type of comparison is the matches( ) method. It returns TRue if the pattern matches the complete region of the character sequence, and returns false otherwise. The lookingAt( ) method is similar: it returns true if the pattern matches the complete region, or if it matches some subsequence at the beginning of the region. If the pattern does not match the start of the region, lookingAt( ) returns false. matches( ) requires the pattern to match both the beginning and ending of the region, and lookingAt( ) requires the pattern to match the beginning. The find( ) method, on the other hand, has neither of these requirements: it returns true if the pattern matches any part of the region. As will be described below, find( ) has some special behavior that allows it to be used in a loop to find all matches in the text.

If matches( ), lookingAt( ), or find( ) return TRue, then several other Matcher methods can be used to obtain details about the matched text. The MatchResult interface defines the start( ), end( ) and group( ) methods that return the starting position, the ending position and the text of the match, and of any matching subexpressions within the Pattern. See MatchResult for details. The MatchResult interface is new in Java 5.0, but Matcher implements all of its methods in Java 1.4 as well. Calling MatchResult methods on a Matcher returns results from the most recent match. If you want to store these results, call toMatchResult( ) to obtain an indepedent, immutable MatchResult object whose methods can be queried later.

The no-argument version of find( ) has special behavior that makes it suitable for use in a loop to find all matches of a pattern within a region. The first time find( ) is called after a Matcher is created or after the reset( ) method is called, it starts it search at the beginning of the string. If it finds a match, it stores the start and end position of the matched text. If reset( ) is not called in the meantime, then the next call to find( ) searches again but starts the search at the first character after the match: at the position returned by end( ). (If the previous call to find( ) matched the empty string, then the next call begins at end( )+1 instead.) In this way, it is possible to find all matches of a pattern within a string simply by calling find( ) repeatedly until it returns false indicating that no match was found. After each repeated call to find( ) you can use the MatchResult methods to obtain more information about the text that matched the pattern and any of its subpatterns.

Matcher also defines methods that perform search-and-replace operations. replaceFirst( ) searches the character sequence for the first subsequence that matches the pattern. It then returns a string that is the character sequence with the matched text replaced with the specified replacement string. replaceAll( ) is similar, but replaces all matching subsequences within the character sequence instead of just replacing the first. The replacement string passed to replaceFirst( ) and replaceAll( ) is not always replaced literally. If the replacement contains a dollar sign followed by an integer that is a valid group number, then the dollar sign and the number are replaced by the text that matched the numbered group. If you want to include a literal dollar sign in the replacement string, preceed it with a backslash. In Java 5.0, you can use the static quoteReplacement( ) method to properly quote any special characters in a replacement string so that the string will be interpreted literally.

replaceFirst( ) and replaceAll( ) are convenience methods that cover the most common search-and-replace cases. However, Matcher also defines lower-level methods that you can use to do a custom search-and-replace operation in conjunction with calls to find( ), and build up a modified string in a StringBuffer. In order to understand this search-and-replace procedure, you must know that a Matcher maintains a "append position", which starts at zero when the Matcher is created, and is restored to zero by the reset( ) method. The appendReplacement( ) method is designed to be used after a successful call to find( ). It copies all the text between the append position and the character before the start( ) position for the last match into the specified string buffer. Then it appends the specified replacement text to that string buffer (performing the same substitutions that replaceAll( ) does). Finally, it sets the append position to the end( ) of the last match, so that a subsequent call to appendReplacement( ) starts at a new character. appendReplacement( ) is intended for use after a call to find( ) that returns TRue. When find( ) cannot find another match and returns false, you should complete the replacement operation by calling appendTail( ): this method copies all text between the end( ) position of the last match and the end of the character sequence into the specified StringBuffer.

The reset( ) method has been mentioned several times. It erases any saved information about the last match, and restores the Matcher to its initial state so that subsequent calls to find( ) and appendReplacement( ) start at the begining of the character sequence. The one-argument version of reset( ) also allows you to specify an entirely new character sequence to match against. It is important to understand that several other Matcher methods call reset( ) themselves before they perform their operation. They are: matches( ), lookingAt( ), the one-argument version of find( ), replaceAll( ), and replaceFirst( ).

Prior to Java 5.0, the region of the input text that a Matcher operates on is the entire character sequence. In Java 5.0, you can define a different region with the region( ) method, which specifies the position of the first character in the region and the position of the first character after the end of the region. regionStart( ) and regionEnd( ) return the current value of these region bounds. By default, regions are "anchoring" which means that the start and end of the region match the ^ and $ anchors. (See Pattern for regular expression grammar details.) Call useAnchoringBounds( ) to turn anchoring bounds on or off in Java 5.0. The bounds of a region are "opaque" by default, which means that the Matcher will not look through the bounds in an attempt to match look-ahead or look-behind assertions (see Pattern). In Java 5.0, you can make the bounds transparent with useTransparentBounds(true).

Matcher is not threadsafe, and should not be used by more than one thread concurrently.

Figure 16-131. java.util.regex.Matcher


```
public final class Matcher implements MatchResult {
// No Constructor
// Public Class Methods
5.0  public static String quoteReplacement(String s);
// Public Instance Methods
     public Matcher appendReplacement(StringBuffer sb, String replacement);
     public StringBuffer appendTail(StringBuffer sb);
     public int end( );                                       Implements:MatchResult
     public int end(int group);                              Implements:MatchResult
     public boolean find( );
     public boolean find(int start);
     public String group( );                                  Implements:MatchResult
     public String group(int group);                         Implements:MatchResult
     public int groupCount( );                                Implements:MatchResult
5.0  public boolean hasAnchoringBounds( );
5.0  public boolean hasTransparentBounds( );
5.0  public boolean hitEnd( );
     public boolean lookingAt( );
     public boolean matches( );
     public Pattern pattern( );
5.0  public Matcher region(int start, int end);
5.0  public int regionEnd( );
5.0  public int regionStart( );
     public String replaceAll(String replacement);
     public String replaceFirst(String replacement);
5.0  public boolean requireEnd( );
     public Matcher reset( );
     public Matcher reset(CharSequence input);
     public int start( );                                     Implements:MatchResult
     public int start(int group);                            Implements:MatchResult
5.0  public MatchResult toMatchResult( );
5.0  public Matcher useAnchoringBounds(boolean b);
5.0  public Matcher usePattern(Pattern newPattern);
5.0  public Matcher useTransparentBounds(boolean b);
// Methods Implementing MatchResult
     public int end( );
     public int end(int group);
     public String group( );
     public String group(int group);
     public int groupCount( );
     public int start( );
     public int start(int group);
// Public Methods Overriding Object
5.0  public String toString( );
}
```

Returned By

`Pattern.matcher( )`

MatchResult java.util.regex

Java 5.0

This interface represents the results of a regular expression matching operation performed by a Matcher. Matcher implements this interface directly, and you can use the methods defined here to obtain the results of the most recent match performed by a Matcher. You can also save those most recent match results in a separate immutable MatchResult object by calling the toMatchResult( ) method of the Matcher.

The no-argument versions of the start( ) and end( ) method return the index of the first character that matched the pattern and the index of the last character that matched plus one (the index of the first character following the matched text), respectively. Some regular expressions can match the empty string. If this occurs, end( ) returns the same value as start( ). The no-argument version of group( ) returns the text that matched the pattern.

If the matched Pattern includes capturing subexpressions within parentheses, the other methods of this interface provide details about the text that matched each of those subexpressions. Pass a group number to start( ), end( ), or group( ) to obtain the start, end, or text that matched the specified group. groupCount( ) returns the number of subexpressions. Groups are numbered from 1, however, so legal group numbers run from 1 to the value returned by groupCount( ). Groups are ordered from left-to-right within the regular expression. When there are nested groups, their ordering is based on the position of the opening left parenthesis that begins the group. Group 0 represents the entire regular expression, so passing 0 to start( ), end( ), or group( ) is the same as calling the no-argument version of the method.

```
public interface MatchResult {
// Public Instance Methods
     int end( );
     int end(int group);
     String group( );
     String group(int group);
     int groupCount( );
     int start( );
     int start(int group);
}
```

Implementations

Matcher

Returned By

java.util.Scanner.match( ), Matcher.toMatchResult( )

Pattern java.util.regex

Java 1.4 *serializable*

This class represents a regular expression. It has no public constructor: obtain a `Pattern` by calling one of the static `compile( )` methods, passing the string representation of the regular expression, and an optional bitmask of flags that modify the behavior of the regex. `pattern( )` and `flags( )` return the string form of the regular expression and the bitmask that were passed to `compile( )`.

If you want to perform only a single match operation with a regular expression, and don't need to use any of the flags, you don't have to create a `Pattern` object: simply pass the string representation of the pattern and the `CharSequence` to be matched to the static `matches( )` method: the method returns `TRue` if the specified pattern matches the complete specified text, or returns `false` otherwise.

`Pattern` represents a regular expression, but does not actually define any primitive methods for matching regular expressions to text. To do that, you must create a `Matcher` object that encapsulates a pattern and the text it is to be compared with. Do this by calling the `matcher( )` method and specifying the `CharSequence` you want to match against. See `Matcher` for a description of what you can do with it.

The `split( )` methods are the exception to the rule that you must obtain a `Matcher` in order to be able to do anything with a `Pattern` (although they create and use a `Matcher` internally). They take a `CharSequence` as input, and split it into substrings, using text that matches the regular expression as the delimiter, returning the substrings as a `String[ ]`. The two-argument version of `split( )` takes an integer argument that specifies the maximum number of substrings to break the input into.

Pattern defines the following flags that control various aspects of how regular expression matching is performed. The flags are the following:

`CANON_EQ`

> The Unicode standard sometimes allows more than one way to specify the same character. If this flag is set, characters are compared by comparing their full canonical decompositions, so that characters will match even if expressed in different ways. Enabling this flag typically slows down performance. Unlike all the other flags, there is no way to temporarily enable this flag within a pattern.

`CASE_INSENSITIVE`

> Match letters without regard to case. By default this flag only affects the comparisons of ASCII letters. Also set the `UNICODE_CASE` flag if you want to ignore the case of all Unicode characters.

You can enable this flag within a pattern with `(?i)`.

`COMMENTS`

If this flag is set, then whitespace and comments within a pattern are ignored. Comments are all characters between a `#` and end of line. You can enable this flag within a pattern with `(?x)`

`DOTALL`

If this flag is set, then the . expression matches any character. If it is not set, then it does not match line terminator characters. This is also known as "single-line mode" and you can enable it within a pattern with `(?s)`.

`MULTILINE`

If this flag is set, then the `^` and `$` anchors match not only at the beginning and end of the input string, but also at the beginning and end of any lines within that string. Within a pattern you can enable this flag with `(?m)`.

`UNICODE_CASE`

If this flag is set along with the `CASE_INSENSITIVE` flag, then case-insensitive comparison is done for all Unicode letters, rather than just for ASCII letters. You can enable both flags within a pattern with `(?iu)`.

`UNIX_LINES`

If this flag is set, then only the newline character is considered a line terminator for the purposes of ., `^`, and `$`. If the flag is not set, then newlines (`\n`) carriage returns (`\r`) and carriage return newline sequences (`\r\n`) are all considered line terminators, as are the Unicode characters `\u0085` ("next line") `\u2028` ("line separator") and `\u2029` ("paragraph separator"). You can turn this flag on within a pattern with `(?d)`.

Although the API for the `Pattern` class is quite simple, the syntax for the text representation of regular expressions is fairly complex. A complete tutorial on regular expressions is beyond the scope of this book. The table below, is a quick-reference for regular expression syntax. It is very similar to the syntax used in Perl. Note that many of the syntax elements of a regular expression include a backslash character, such as `\d` to match one of the digits 0-9. Because Java strings also use the backslash character as an escape, you must double the backslashes when expressing a regular expression as a string literal: "\\d". In Java 5.0, the static `quote( )` method quotes all special characters in a string so that you can match arbitrary text literally without worrying that punctuation in that text will be interpreted specially. For complete details on regular expressions see a book like *Programming Perl* by Larry Wall et. al., or *Mastering Regular Expressions* by Jeffrey E. F. Friedl.

Table 16-3. Java regular expression quick reference

Syntax	Matches
Single characters	
x	The character *x*, as long as *x* is not a punctuation character with special meaning in the regular expression syntax.
p	The punctuation character *p*.
\\\\	The backslash character
\n	Newline character \u000A.
\t	Tab character \u0009.
\r	Carriage return character \u000D.
\f	Form feed character \u000C.
\e	Escape character \u001B.
\a	Bell (alert) character \u0007.
\u*xxxx*	Unicode character with hexadecimal code *xxxx*.
\x*xx*	Character with hexadecimal code *xx*.
\0*n*	Character with octal code *n*.
\0*nn*	Character with octal code *nn*.
\0*nnn*	Character with octal code *nnn*, where *nnn* <= 377.
\c*x*	The control character ^*x*.
Character classes	
[...]	One of the characters between the brackets. Characters may be specified literally, and the syntax also allows the specification of character ranges, with intersection, union, and subtraction operators. See specific examples below.
[^...]	Any one character not between the brackets.
[a-z0-9]	Character range: a character between (inclusive) a and z or 0 and 9.
[0-9[a-fA-F]]	Union of classes: same as [0-9a-fA-F]
[a-z&&[aeiou]]	Intersection of classes: same as [aeiou].
[a-z&&[^aeiou]]	Subtraction: the characters a through z except for the vowels.
.	Any character except a line terminator. If the DOTALL flag is set, then it matches any character including line terminators.

Syntax	Matches
`\d`	ASCII digit: `[0-9]`.
`\D`	Anything but an ASCII digit: `[^\d]`.
`\s`	ASCII whitespace: `[ \t\n\f\r\x0B]`
`\S`	Anything but ASCII whitespace: [^\s].
`\w`	ASCII word character: `[a-zA-Z0-9_]`.
`\W`	Anything but ASCII word characters: `[^\w]`.
`\p{`*group*`}`	Any character in the named group. See group names below. Many of the group names are from POSIX, which is why p is used for this character class.
`\P{`*group*`}`	Any character not in the named group.
`\p{Lower}`	ASCII lowercase letter: `[a-z]`.
`\p{Upper}`	ASCII uppercase: `[A-Z]`.
`\p{ASCII}`	Any ASCII character: `[\x00-\x7f]`.
`\p{Alpha}`	ASCII letter: `[a-zA-Z]`.
`\p{Digit}`	ASCII digit: `[0-9]`.
`\p{XDigit}`	Hexadecimal digit: `[0-9a-fA-F]`.
`\p{Alnum}`	ASCII letter or digit: `[\p{Alpha}\p{Digit}]`.
`\p{Punct}`	ASCII punctuation: one of `!"#$%& ( )*+,-./:;<=>?@[\]^_ {|}~]`.
`\p{Graph}`	visible ASCII character: `[\p{Alnum}\p{Punct}]`.
`\p{Print}`	visible ASCII character: same as `\p{Graph}`.
`\p{Blank}`	ASCII space or tab: `[ \t]`.
`\p{Space}`	ASCII whitespace: `[ \t\n\f\r\x0b]`.
`\p{Cntrl}`	ASCII control character: `[\x00-\x1f\x7f]`.
`\p{`*category*`}`	Any character in the named Unicode category. Category names are one or two letter codes defined by the Unicode standard. One letter codes include`L` for letter, `N` for number, `S` for symbol, `Z` for separator, and `P` for punctuation. Two letter codes represent subcategories, such as `Lu` for uppercase letter, `Nd` for decimal digit, `Sc` for currency symbol, `Sm` for math symbol, and `Zs` for space separator. See `java.lang.Character` for a set of constants that correspond to these subcategories; however, note that the full set of one- and two-letter codes is not documented in this book.
`\p{`*block*`}`	Any character in the named Unicode block. In Java regular expressions, block names begin with "In", followed by mixed-case capitalization of the Unicode block name, without spaces or underscores. For example: `\p{InOgham}` or `\p{InMathematicalOperators}`. See `java.lang.Character.UnicodeBlock` for a list of Unicode block names.

Syntax	Matches
Sequences, alternatives, groups, and references	
xy	Match *x* followed by *y*.
x | *y*	Match *x* or *y*.
`(...)`	Grouping. Group subexpression within parentheses into a single unit that can be used with `*`, `+`, `?`, `|`, and so on. Also "capture" the characters that match this group for use later.
`(?:...)`	Grouping only. Group subexpression as with `( )`, but do not capture the text that matched.
`\`*n*	Match the same characters that were matched when capturing group number *n* was first matched. Be careful when *n* is followed by another digit: the largest number that is a valid group number will be used.
Repetition[1]	
x`?`	zero or one occurrence of *x*; i.e., *x* is optional.
x`*`	zero or more occurrences of *x*.
x`+`	one or more occurrences of *x*.
x`{`*n*`}`	exactly *n* occurrences of *x*.
x`{`*n*`,}`	*n* or more occurrences of *x*.
x`{`*n*,*m*`}`	at least *n*, and at most *m* occurrences of *x*.
Anchors[2]	
`^`	The beginning of the input string, or if the `MULTILINE` flag is specified, the beginning of the string or of any new line.
`$`	The end of the input string, or if the `MULTILINE` flag is specified, the end of the string or of line within the string.
`\b`	A word boundary: a position in the string between a word and a nonword character.
`\B`	A position in the string that is not a word boundary.
`\A`	The beginning of the input string. Like `^`, but never matches the beginning of a new line, regardless of what flags are set.
`\Z`	The end of the input string, ignoring any trailing line terminator.
`\z`	The end of the input string, including any line terminator.
`\G`	The end of the previous match.

Syntax	Matches
(?=*x*)	A positive look-ahead assertion. Require that the following characters match *x*, but do not include those characters in the match.
(?!*x*)	A negative look-ahead assertion. Require that the following characters do not match the pattern *x*.
(?<=*x*)	A positive look-behind assertion. Require that the characters immediately before the position match *x*, but do not include those characters in the match. *x* must be a pattern with a fixed number of characters.
(?<!*x*)	A negative look-behind assertion. Require that the characters immediately before the position do not match *x*. *x* must be a pattern with a fixed number of characters.
Miscellaneous	
(?>*x*)	Match *x* independently of the rest of the expression, without considering whether the match causes the rest of the expression to fail to match. Useful to optimize certain complex regular expressions. A group of this form does not capture the matched text.
(?*onflags*-*offflags*)	Don t match anything, but turn on the flags specified by *onflags*, and turn off the flags specified by *offflags*. These two strings are combinations in any order of the following letters and correspond to the following Pattern constants: i (CASE_INSENSITIVE), d (UNIX_LINES), m (MULTILINE), s (DOTALL), u (UNICODE_CASE), and x (COMMENTS). Flag settings specified in this way take effect at the point that they appear in the expression and persist until the end of the expression, or until the end of the parenthesized group of which they are a part, or until overridden by another flag setting expression.
(?*onflags*-*offflags*:*x*)	Match *x*, applying the specified flags to this subexpression only. This is a noncapturing group, like (?:...), with the addition of flags.
\Q	Don't match anything, but quote all subsequent pattern text until \E. All characters within such a quoted section are interpreted as literal characters to match, and none (except \E) have special meanings.
\E	Don't match anything; terminate a quote started with \Q.
#comment	If the COMMENT flag is set, pattern text between a # and the end of the line is considered a comment and is ignored.

[1] These repetition characters are known as "greedy quantifiers," because they match as many occurrences of x as possible while still allowing the rest of the regular expression to match. If you want a "reluctant quantifier" which matches as few occurrences as possible while still allowing the rest of the regular expression to match, follow the quantifiers above with a question mark. For example, use *? instead of *, and use {2,}? instead of {2,}. Or, if you follow a quantifier with a plus sign instead of a question mark, then you specify a "possessive quantifier" which matches as many occurrences as possible, even if it means that the rest of the regular expression will not match. Possessive quantifiers can be useful when you are sure that they will not adversely affect the rest of the match, because they can be implemented more efficiently than regular "greedy quantifiers."

[2] Anchors do not match characters but instead match the zero-width positions between characters, "anchoring" the match to a position at which a specific condition holds.

Figure 16-132. java.util.regex.Pattern


```
public final class Pattern implements Serializable {
// No Constructor
// Public Constants
     public static final int CANON_EQ;                                    =128
     public static final int CASE_INSENSITIVE;                            =2
     public static final int COMMENTS;                                    =4
     public static final int DOTALL;                                      =32
5.0  public static final int LITERAL;                                 =16
     public static final int MULTILINE;                                   =8
     public static final int UNICODE_CASE;                                =64
     public static final int UNIX_LINES;                                  =1
// Public Class Methods
     public static Pattern compile(String regex);
     public static Pattern compile(String regex, int flags);
     public static boolean matches(String regex, CharSequence input);
5.0  public static String quote(String s);
// Public Instance Methods
     public int flags( );
     public Matcher matcher(CharSequence input);
     public String pattern( );
     public String[ ] split(CharSequence input);
     public String[ ] split(CharSequence input, int limit);
// Public Methods Overriding Object
5.0  public String toString( );
}
```

Passed To

java.util.Scanner.{findInLine( ), findWithinHorizon( ), hasNext( ), next( ), skip( ), useDelimiter( )}, Matcher.usePattern( )

Returned By

java.util.Scanner.delimiter( ), Matcher.pattern( )

Team LiB

PatternSyntaxException java.util.regex

Java 1.4 *serializable unchecked*

Signals a syntax error in the text representation of a regular expression. An exception of this type may be thrown by the `Pattern.compile( )` and `Pattern.matches( )` methods, and also by the `String` `matches( )`, `replaceFirst( )`, `replaceAll( )` and `split( )` methods which call those `Pattern` methods.

`getPattern( )` returns the text that contained the syntax error, and `getIndex( )` returns the approximate location of the error within that text, or -1, if the location is not known. `geTDescription( )` returns an error message that provides further detail about the error. The inherited `getMessage( )` method combines the information provided by these other three methods into a single multiline message.

Figure 16-133. java.util.regex.PatternSyntaxException

```
public class PatternSyntaxException extends IllegalArgumentException {
// Public Constructors
     public PatternSyntaxException(String desc, String regex, int index);
// Public Instance Methods
     public String getDescription( );
     public int getIndex( );
     public String getPattern( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

Package java.util.zip

Java 1.1

The java.util.zip package contains classes for data compression and decompression. The Deflater and Inflater classes perform data compression and decompression. DeflaterOutputStream and InflaterInputStream apply that functionality to byte streams; the subclasses of these streams implement both the GZIP and ZIP compression formats. TheAdler32 and CRC32 classes implement the Checksum interface and compute the checksums required for data compression.

Interfaces

```
public interface Checksum;
```

Classes

```
public class Adler32 implements Checksum;
public class CheckedInputStream extends java.io.FilterInputStream;
public class CheckedOutputStream extends java.io.FilterOutputStream;
public class CRC32 implements Checksum;
public class Deflater;
public class DeflaterOutputStream extends java.io.FilterOutputStream;
   public class GZIPOutputStream extends DeflaterOutputStream;
   public class ZipOutputStream extends DeflaterOutputStream implements ZipConstants;
public class Inflater;
public class InflaterInputStream extends java.io.FilterInputStream;
   public class GZIPInputStream extends InflaterInputStream;
   public class ZipInputStream extends InflaterInputStream implements ZipConstants;
public class ZipEntry implements Cloneable, ZipConstants;
public class ZipFile implements ZipConstants;
```

Exceptions

```
public class DataFormatException extends Exception;
public class ZipException extends java.io.IOException;
```

Adler32 java.util.zip

Java 1.1

This class implements the `Checksum` interface and computes a checksum on a stream of data using the Adler-32 algorithm. This algorithm is significantly faster than the CRC-32 algorithm and is almost as reliable. The `CheckedInputStream` and `CheckedOutputStream` classes provide a higher-level interface to computing checksums on streams of data.

Figure 16-134. java.util.zip.Adler32


```
public class Adler32 implements Checksum {
// Public Constructors
     public Adler32( );
// Public Instance Methods
     public void update(byte[ ] b);
// Methods Implementing Checksum
     public long getValue( );                          default:1
     public void reset( );
     public void update(int b);
     public void update(byte[ ] b, int off, int len);
}
```

CheckedInputStream java.util.zip

Java 1.1 *closeable*

This class is a subclass of `java.io.FilterInputStream`; it allows a stream to be read and a checksum computed on its contents at the same time. This is useful when you want to check the integrity of a stream of data against a published checksum value. To create a `CheckedInputStream`, you must specify both the stream it should read and a `Checksum` object, such as `CRC32`, that implements the particular checksum algorithm you desire. The `read( )` and `skip( )` methods are the same as those of other input streams. As bytes are read, they are incorporated into the checksum that is being computed. The `getChecksum( )` method does not return the checksum value itself, but rather the `Checksum` object. You must call the `getValue( )` method of this object to obtain the checksum value.

Figure 16-135. java.util.zip.CheckedInputStream

```
public class CheckedInputStream extends java.io.FilterInputStream {
// Public Constructors
     public CheckedInputStream(java.io.InputStream in, Checksum cksum);
// Public Instance Methods
     public Checksum getChecksum( );
// Public Methods Overriding FilterInputStream
     public int read( ) throws java.io.IOException;
     public int read(byte[ ] buf, int off, int len) throws java.io.IOException;
     public long skip(long n) throws java.io.IOException;
}
```

CheckedOutputStream java.util.zip

Java 1.1 *closeable flushable*

This class is a subclass of `java.io.FilterOutputStream` that allows data to be written to a stream and a checksum computed on that data at the same time. To create a `CheckedOutputStream`, you must specify both the output stream to write its data to and a `Checksum` object, such as an instance of `Adler32`, that implements the particular checksum algorithm you desire. The `write( )` methods are similar to those of other `OutputStream` classes. The `getChecksum( )` method returns the `Checksum` object. You must call `getValue( )` on this object in order to obtain the actual checksum value.

Figure 16-136. java.util.zip.CheckedOutputStream

```
public class CheckedOutputStream extends java.io.FilterOutputStream {
// Public Constructors
     public CheckedOutputStream(java.io.OutputStream out, Checksum cksum);
// Public Instance Methods
     public Checksum getChecksum( );
// Public Methods Overriding FilterOutputStream
     public void write(int b) throws java.io.IOException;
     public void write(byte[ ] b, int off, int len) throws java.io.IOException;
}
```

Team LiB

Checksum java.util.zip

Java 1.1

This interface defines the methods required to compute a checksum on a stream of data. The checksum is computed based on the bytes of data supplied by the `update( )` methods; the current value of the checksum can be obtained at any time with the `getValue( )` method. `reset( )` resets the checksum to its default value; use this method before beginning a new stream of data. The checksum value computed by a `Checksum` object and returned through the `getValue( )` method must fit into a `long` value. Therefore, this interface is not suitable for the cryptographic checksum algorithms used in cryptography and security. The classes `CheckedInputStream` and `CheckedOutputStream` provide a higher-level API for computing a checksum on a stream of data. See also `java.security.MessageDigest`.

```
public interface Checksum {
// Public Instance Methods
     long getValue( );
     void reset( );
     void update(int b);
     void update(byte[ ] b, int off, int len);
}
```

Implementations

`Adler32`, `CRC32`

Passed To

`CheckedInputStream.CheckedInputStream( )`, `CheckedOutputStream.CheckedOutputStream( )`

Returned By

`CheckedInputStream.getChecksum( )`, `CheckedOutputStream.getChecksum( )`

CRC32 java.util.zip

Java 1.1

This class implements the `Checksum` interface and computes a checksum on a stream of data using the CRC-32 algorithm. The `CheckedInputStream` and `CheckedOutputStream` classes provide a higher-level interface to computing checksums on streams of data.

Figure 16-137. java.util.zip.CRC32


```
public class CRC32 implements Checksum {
// Public Constructors
     public CRC32( );
// Public Instance Methods
     public void update(byte[ ] b);
// Methods Implementing Checksum
     public long getValue( );                           default:0
     public void reset( );
     public void update(int b);
     public void update(byte[ ] b, int off, int len);
}
```

Type Of

`GZIPInputStream.crc`, `GZIPOutputStream.crc`

Team LiB

DataFormatException java.util.zip

Java 1.1 *serializable checked*

Signals that invalid or corrupt data has been encountered while uncompressing data.

Figure 16-138. java.util.zip.DataFormatException


```
public class DataFormatException extends Exception {
// Public Constructors
     public DataFormatException( );
     public DataFormatException(String s);
}
```

Thrown By

`Inflater.inflate( )`

Team LiB

Deflater java.util.zip

Java 1.1

This class implements the general ZLIB data-compression algorithm used by the *gzip* and *PKZip* compression programs. The constants defined by this class are used to specify the compression strategy and the compression speed/strength tradeoff level to be used. If you set the *nowrap* argument to the constructor to `true`, the ZLIB header and checksum data are omitted from the compressed output, which is the format both *gzip* and *PKZip* use.

The important methods of this class are `setInput( )`, which specifies input data to be compressed, and `deflate( )`, which compresses the data and returns the compressed output. The remaining methods exist so that `Deflater` can be used for stream-based compression, as it is in higher-level classes, such as `GZIPOutputStream` and `ZipOutputStream`. These stream classes are sufficient in most cases. Most applications do not need to use `Deflater` directly. The `Inflater` class uncompresses data compressed with a `Deflater` object.

```
public class Deflater {
// Public Constructors
     public Deflater( );
     public Deflater(int level);
     public Deflater(int level, boolean nowrap);
// Public Constants
     public static final int BEST_COMPRESSION;                         =9
     public static final int BEST_SPEED;                               =1
     public static final int DEFAULT_COMPRESSION;                      =-1
     public static final int DEFAULT_STRATEGY;                         =0
     public static final int DEFLATED;                                 =8
     public static final int FILTERED;                                 =1
     public static final int HUFFMAN_ONLY;                             =2
     public static final int NO_COMPRESSION;                           =0
// Public Instance Methods
     public int deflate(byte[ ] b);
     public int deflate(byte[ ] b, int off, int len);          synchronized
     public void end( );                                   synchronized
     public void finish( );                                synchronized
     public boolean finished( );                           synchronized
     public int getAdler( );                               synchronized default:1
5.0  public long getBytesRead( );                      synchronized default:0
5.0  public long getBytesWritten( );                   synchronized default:0
     public int getTotalIn( );                           default:0
     public int getTotalOut( );                          default:0
     public boolean needsInput( );
     public void reset( );                                 synchronized
```

```
    public void setDictionary(byte[ ] b);
    public void setDictionary(byte[ ] b, int off, int len);     synchronized
    public void setInput(byte[ ] b);
    public void setInput(byte[ ] b, int off, int len);          synchronized
    public void setLevel(int level);                         synchronized
    public void setStrategy(int strategy);                        synchronized
// Protected Methods Overriding Object
    protected void finalize( );
}
```

Passed To

`DeflaterOutputStream.DeflaterOutputStream( )`

Type Of

`DeflaterOutputStream.def`

DeflaterOutputStream java.util.zip

Java 1.1 *closeable flushable*

This class is a subclass of `java.io.FilterOutputStream` ; it filters a stream of data by compressing (deflating) it and then writing the compressed data to another output stream. To create a `DeflaterOutputStream` , you must specify both the stream it is to write to and a `Deflater` object to perform the compression. You can set various options on the `Deflater` object to specify just what type of compression is to be performed. Once a `DeflaterOutputStream` is created, its `write( )` and `close( )` methods are the same as those of other output streams. The `InflaterInputStream` class can read data written with a `DeflaterOutputStream` . A `DeflaterOutputStream` writes raw compressed data; applications often prefer one of its subclasses, `GZIPOutputStream` or `ZipOutputStream` , that wraps the raw compressed data within a standard file format.

Figure 16-139. java.util.zip.DeflaterOutputStream

```
public class DeflaterOutputStream extends java.io.FilterOutputStream {
// Public Constructors
     public DeflaterOutputStream(java.io.OutputStream out);
     public DeflaterOutputStream(java.io.OutputStream out, Deflater def);
     public DeflaterOutputStream(java.io.OutputStream out, Deflater def, int size);
// Public Instance Methods
     public void finish( ) throws java.io.IOException;
// Public Methods Overriding FilterOutputStream
     public void close( ) throws java.io.IOException;
     public void write(int b) throws java.io.IOException;
     public void write(byte[ ] b, int off, int len) throws java.io.IOException;
// Protected Instance Methods
     protected void deflate( ) throws java.io.IOException;
// Protected Instance Fields
     protected byte[ ] buf;
     protected Deflater def;
}
```

Subclasses

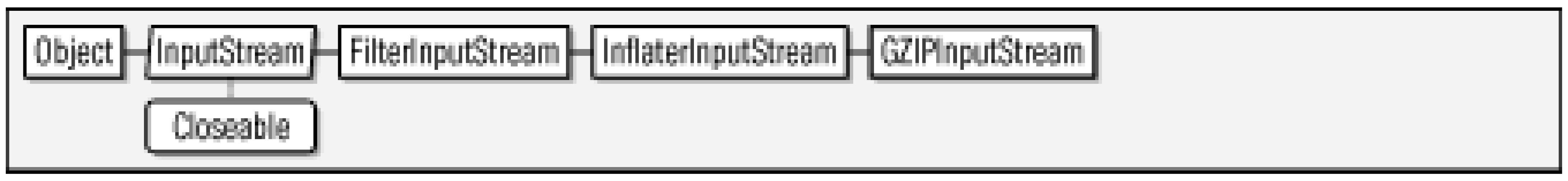
`GZIPOutputStream` , `ZipOutputStream`

GZIPInputStream java.util.zip

Java 1.1 *closeable*

This class is a subclass of `InflaterInputStream` that reads and uncompresses data compressed in *gzip* format. To create a `GZIPInputStream` , simply specify the `InputStream` to read compressed data from a optionally, a buffer size for the internal decompression buffer. Once a`GZIPInputStream` is created, you c use the `read( )` and `close( )` methods as you would with any input stream.

Figure 16-140. java.util.zip.GZIPInputStream




```
public class GZIPInputStream extends InflaterInputStream {
// Public Constructors
     public GZIPInputStream(java.io.InputStream in) throws java.io.IOException;
     public GZIPInputStream(java.io.InputStream in, int size) throws java.io.IOExceptio
// Public Constants
     public static final int GZIP_MAGIC;                                    =35615
// Public Methods Overriding InflaterInputStream
     public void close( ) throws java.io.IOException;
     public int read(byte[ ] buf, int off, int len) throws java.io.IOException;
// Protected Instance Fields
     protected CRC32 crc;
     protected boolean eos;
}
```

Team LiB

GZIPOutputStream java.util.zip

Java 1.1 *closeable flushable*

This class is a subclass of `DeflaterOutputStream` that compresses and writes data using the *gzip* file for create a `GZIPOutputStream` , specify the `OutputStream` to write to and, optionally, a size for the interna buffer. Once the `GZIPOutputStream` is created, you can use the `write( )` and `close( )` methods as you output stream.

Figure 16-141. java.util.zip.GZIPOutputStream


```
public class GZIPOutputStream extends DeflaterOutputStream {
// Public Constructors
     public GZIPOutputStream(java.io.OutputStream out) throws java.io.IOException;
     public GZIPOutputStream(java.io.OutputStream out, int size) throws java.io.IOExcep
// Public Methods Overriding DeflaterOutputStream
     public void finish( ) throws java.io.IOException;
     public void write(byte[ ] buf, int off, int len) throws java.io.IOException;     s
// Protected Instance Fields
     protected CRC32 crc;
}
```

Inflater java.util.zip

Java 1.1

This class implements the general ZLIB data-decompression algorithm used by *gzip* , *PKZip* , and other d compression applications. It decompresses or inflates data compressed through the `Deflater` class. The methods of this class are `setInput( )` , which specifies input data to be decompressed, and `inflate( )` decompresses the input data into an output buffer. A number of other methods exist so that this class c for stream-based decompression, as it is in the higher-level classes, such as `GZIPInputStream` and `ZipI` . These stream-based classes are sufficient in most cases. Most applications do not need to use `Inflater`

```
public class Inflater {
// Public Constructors
     public Inflater( );
     public Inflater(boolean nowrap);
// Public Instance Methods
     public void end( );                                       synchronized
     public boolean finished( );                               synchronized
     public int getAdler( );                                   synchronized default:1
5.0  public long getBytesRead( );                          synchronized default:0
5.0  public long getBytesWritten( );                       synchronized default:0
     public int getRemaining( );                               synchronized default:0
     public int getTotalIn( );                               default:0
     public int getTotalOut( );                              default:0
     public int inflate(byte[ ] b) throws DataFormatException;
     public int inflate(byte[ ] b, int off, int len) throws DataFormatException;     sy
     public boolean needsDictionary( );                        synchronized
     public boolean needsInput( );                             synchronized
     public void reset( );                                     synchronized
     public void setDictionary(byte[ ] b);
     public void setDictionary(byte[ ] b, int off, int len);     synchronized
     public void setInput(byte[ ] b);
     public void setInput(byte[ ] b, int off, int len);          synchronized
// Protected Methods Overriding Object
     protected void finalize( );
}
```

Passed To

`InflaterInputStream.InflaterInputStream( )`

Type Of

`InflaterInputStream.inf`

InflaterInputStream java.util.zip

Java 1.1 *closeable*

This class is a subclass of `java.io.FilterInputStream`; it reads a specified stream of compressed input data (typically one that was written with `DeflaterOutputStream` or a subclass) and filters that data by uncompressing (inflating) it. To create an `InflaterInputStream`, specify both the input stream to read from and an `Inflater` object to perform the decompression. Once an `InflaterInputStream` is created, the `read( )` and `skip( )` methods are the same as those of other input streams. The `InflaterInputStream` uncompresses raw data. Applications often prefer one of its subclasses, `GZIPInputStream` or `ZipInputStream`, that work with compressed data written in the standard *gzip* and *PKZip* file formats.

Figure 16-142. java.util.zip.InflaterInputStream

```
public class InflaterInputStream extends java.io.FilterInputStream {
// Public Constructors
     public InflaterInputStream(java.io.InputStream in);
     public InflaterInputStream(java.io.InputStream in, Inflater inf);
     public InflaterInputStream(java.io.InputStream in, Inflater inf, int size);
// Public Methods Overriding FilterInputStream
1.2  public int available( ) throws java.io.IOException;
1.2  public void close( ) throws java.io.IOException;
5.0  public void mark(int readlimit);                           synchronized empty
5.0  public boolean markSupported( );                                   constant
     public int read( ) throws java.io.IOException;
     public int read(byte[ ] b, int off, int len) throws java.io.IOException;
5.0  public void reset( ) throws java.io.IOException;                   synchronized
     public long skip(long n) throws java.io.IOException;
// Protected Instance Methods
     protected void fill( ) throws java.io.IOException;
// Protected Instance Fields
     protected byte[ ] buf;
     protected Inflater inf;
     protected int len;
}
```

Subclasses

GZIPInputStream, ZipInputStream

ZipEntry java.util.zip

Java 1.1 *cloneable*

This class describes a single entry (typically a compressed file) stored within a ZIP file. The various methods get and set various pieces of information about the entry. The `ZipEntry` class is used by `ZipFile` and `ZipInputStream`, which read ZIP files, and by `ZipOutputStream`, which writes ZIP files.

When you are reading a ZIP file, a `ZipEntry` object returned by `ZipFile` or `ZipInputStream` contains the name, size, modification time, and other information about an entry in the file. When writing a ZIP file, on the other hand, you must create your own `ZipEntry` objects and initialize them to contain the entry name and other appropriate information before writing the contents of the entry

Figure 16-143. java.util.zip.ZipEntry

```
public class ZipEntry implements Cloneable, ZipConstants {
// Public Constructors
     public ZipEntry(String name);
1.2  public ZipEntry(ZipEntry e);
// Public Constants
     public static final int DEFLATED;                                        =8
     public static final int STORED;                                          =0
// Public Instance Methods
     public String getComment( );
     public long getCompressedSize( );
     public long getCrc( );
     public byte[ ] getExtra( );
     public int getMethod( );
     public String getName( );
     public long getSize( );
     public long getTime( );
     public boolean isDirectory( );
     public void setComment(String comment);
1.2  public void setCompressedSize(long csize);
     public void setCrc(long crc);
     public void setExtra(byte[ ] extra);
     public void setMethod(int method);
     public void setSize(long size);
     public void setTime(long time);
```

```
// Public Methods Overriding Object
1.2  public Object clone( );
1.2  public int hashCode( );
     public String toString( );
}
```

Subclasses

java.util.jar.JarEntry

Passed To

java.util.jar.JarEntry.JarEntry( ), java.util.jar.JarFile.getInputStream( ), java.util.jar.JarOutputStream.putNextEntry( ), ZipFile.getInputStream( ), ZipOutputStream.putNextEntry( )

Returned By

java.util.jar.JarFile.getEntry( ), java.util.jar.JarInputStream.{createZipEntry( ), getNextEnTRy( )}, ZipFile.getEntry( ), ZipInputStream.{createZipEntry( ), getNextEntry( )}

ZipException java.util.zip

Java 1.1 *serializable checked*

Signals that an error has occurred in reading or writing a ZIP file.

Figure 16-144. java.util.zip.ZipException


```
public class ZipException extends java.io.IOException {
// Public Constructors
     public ZipException( );
     public ZipException(String s);
}
```

Subclasses

`java.util.jar.JarException`

Thrown By

`ZipFile.ZipFile( )`

Team LiB

ZipFile java.util.zip

Java 1.1

This class reads the contents of ZIP files. It uses a random-access file internally so that the entries of th file do not have to be read sequentially, as they do with the ZipInputStream class. A ZipFile object car created by specifying the ZIP file to be read either as a String filename or as a File object. In Java 1.3, temporary ZIP files can be marked for automatic deletion when they are closed. To take advantage of th feature, pass ZipFile.OPEN_READ|ZipFile.OPEN_DELETE as the *mode* argument to the ZipFile( ) constructor.

Once a ZipFile is created, the getEntry( ) method returns a ZipEntry object for a named entry, and enTRies( ) method returns an Enumeration object that allows you to loop through all the ZipEntry obj for the file. To read the contents of a specific ZipEntry within the ZIP file, pass the ZipEntry to getInputStream( ) ; this returns an InputStream object from which you can read the entry's contents.

Figure 16-145. java.util.zip.ZipFile

```
public class ZipFile implements ZipConstants {
// Public Constructors
     public ZipFile(String name) throws java.io.IOException;
     public ZipFile(java.io.File file) throws ZipException, java.io.IOException;
1.3  public ZipFile(java.io.File file, int mode) throws java.io.IOException;
// Public Constants
1.3  public static final int OPEN_DELETE;                              =4
1.3  public static final int OPEN_READ;                                =1
// Public Instance Methods
     public void close( ) throws java.io.IOException;
     public java.util.Enumeration<? extends ZipEntry> entries( );
     public ZipEntry getEntry(String name);
     public java.io.InputStream getInputStream(ZipEntry entry) throws java.io.IOExcepti
     public String getName( );
1.2  public int size( );
// Protected Methods Overriding Object
1.3  protected void finalize( ) throws java.io.IOException;
}
```

Subclasses

`java.util.jar.JarFile`

ZipInputStream java.util.zip

Java 1.1 *closeable*

This class is a subclass of InflaterInputStream that reads the entries of a ZIP file in sequential order. Create a ZipInputStream by specifying the InputStream from which it is to read the contents of the ZIP file. Once the ZipInputStream is created, you can use getNextEntry( ) to begin reading data from the next entry in the ZIP file. This method must be called beforeread( ) is called to begin reading the first entry. getNextEnTRy( ) returns a ZipEntry object that describes the entry being read, or null when there are no more entries to be read from the ZIP file.

The read( ) methods of ZipInputStream read until the end of the current entry and then return -1, indicating that there is no more data to read. To continue with the next entry in the ZIP file, you must call getNextEntry( ) again. Similarly, the skip( ) method only skips bytes within the current entry. closeEntry( ) can be called to skip the remaining data in the current entry, but it is usually easier simply to call getNextEnTRy( ) to begin the next entry.

Figure 16-146. java.util.zip.ZipInputStream

```
public class ZipInputStream extends InflaterInputStream implements ZipConstants {
// Public Constructors
     public ZipInputStream(java.io.InputStream in);
// Public Instance Methods
     public void closeEntry( ) throws java.io.IOException;
     public ZipEntry getNextEntry( ) throws java.io.IOException;
// Public Methods Overriding InflaterInputStream
1.2  public int available( ) throws java.io.IOException;
     public void close( ) throws java.io.IOException;
     public int read(byte[ ] b, int off, int len) throws java.io.IOException;
     public long skip(long n) throws java.io.IOException;
// Protected Instance Methods
1.2  protected ZipEntry createZipEntry(String name);
}
```

Subclasses

java.util.jar.JarInputStream

ZipOutputStream java.util.zip

Java 1.1 *closeable flushable*

This class is a subclass of DeflaterOutputStream that writes data in ZIP file format to an output stream writing any data to the ZipOutputStream , you must begin an entry within the ZIP file with putNextEntr ZipEntry object passed to this method should specify at least a name for the entry. Once you have beg with putNextEntry( ) , you can write the contents of that entry with the write( ) methods. When you end of an entry, you can begin a new one by calling putNextEntry( ) again, you can close the current e closeEntry( ) , or you can close the stream itself with close( ) .

Before beginning an entry with putNextEntry( ) , you can set the compression method and level with s) and setLevel( ) . The constants DEFLATED and STORED are the two legal values for setMethod( ) . If STORED , the entry is stored in the ZIP file without any compression. If you use DEFLATED , you can also s compression speed/strength tradeoff by passing a number from 1 to 9 to setLevel( ) , where 9 gives th strongest and slowest level of compression. You can also use the constants Deflater.BEST_SPEED , Deflater.BEST_COMPRESSION , and Deflater.DEFAULT_COMPRESSION with the setLevel( ) method.

If you are storing an entry without compression, the ZIP file format requires that you specify, in advanc size and CRC-32 checksum in the ZipEntry object for the entry. An exception is thrown if these values a specified or specified incorrectly.

Figure 16-147. java.util.zip.ZipOutputStream

```
public class ZipOutputStream extends DeflaterOutputStream implements ZipConstants {
// Public Constructors
     public ZipOutputStream(java.io.OutputStream out);
// Public Constants
     public static final int DEFLATED;                                   =8
     public static final int STORED;                                     =0
// Public Instance Methods
     public void closeEntry( ) throws java.io.IOException;
     public void putNextEntry(ZipEntry e) throws java.io.IOException;
     public void setComment(String comment);
     public void setLevel(int level);
     public void setMethod(int method);
// Public Methods Overriding DeflaterOutputStream
     public void close( ) throws java.io.IOException;
     public void finish( ) throws java.io.IOException;
     public void write(byte[ ] b, int off, int len) throws java.io.IOException;     syn
```

```
}
```

Subclasses

java.util.jar.JarOutput Stream

Team LiB

Chapter 17. javax.crypto and Subpackages

This chapter documents the cryptographic features (including encryption and decryption) of the `javax.crypto` package and its subpackages. These packages were originally part of the Java Cryptography Extension (JCE) before being integrated into Java 1.4, which is why they have the "javax" extension prefix. All of the commonly-used cryptography classes are in the `javax.crypto` package itself. The `javax.crypto.interfaces` subpackage defines algorithm-specific interfaces for certain type of cryptographic keys. The `javax.crypto.spec` subpackage defines classes that provide a transparent, portable, and provider-independent representation of cryptographic keys and related objects.

Team LiB

Package javax.crypto

Java 1.4

The javax.crypto package defines classes and interfaces for various cryptographic operations. The central class is Cipher , which is used to encrypt and decrypt data. CipherInputStream and CipherOutputStream are utility classes that use a Cipher object to encrypt or decrypt streaming data. SealedObject is another important utility class that uses a Cipher object to encrypt an arbitrary serializable Java object.

The KeyGenerator class creates the SecretKey objects used by Cipher for encryption and decryption. SecretKeyFactory encodes and decodes SecretKey objects. The KeyAgreement class enables two or more parties to agree on a SecretKey in such a way that an eavesdropper cannot determine the key. The Mac class computes a message authentication code (MAC) that can ensure the integrity of a transmission between two parties who share a SecretKey . A MAC is akin to a digital signature, except that it is based on a secret key instead of a public/private key pair.

Like the java.security package, the javax.crypto package is provider-based, so that arbitrary cryptographic implementations may be plugged into any Java installation. Various classes in this packag have names that end in Spi. These classes define a service-provider interface and must be implemented by each cryptographic provider that wishes to provide an implementation of a particular cryptographic service or algorithm.

This package was originally shipped as part of the Java Cryptography Extension (JCE), but it has been added to the core platform in Java 1.4. A version of the JCE is still available (see http://java.sun.com/security) as a standard extension for Java 1.2 and Java 1.3. This package is distributed with a cryptographic provider named "SunJCE" that includes a robust set of implementations for Cipher , KeyAgreement , Mac , and other classes. This provider is installed by the default java.security properties in Java 1.4 distributions.

A full tutorial on cryptography is beyond the scope of this chapter and of this book. In order to use this package, you need to have a basic understanding of cryptographic algorithms such as DES. In order to take full advantage of this package, you also need to have a detailed understanding of things like feedback modes, padding schemes, the Diffie-Hellman key-agreement protocol, and so on. For a good introduction to modern cryptography in Java, see *Java Cryptography* by Jonathan Knudsen (O'Reilly). Fo more in-depth coverage, not specific to Java, see *Applied Cryptography* by Bruce Schneier (Wiley).

Interfaces

```
public interface SecretKey extends java.security.Key;
```

Classes

```
public class Cipher;
   public class NullCipher extends Cipher;
public class CipherInputStream extends java.io.FilterInputStream;
public class CipherOutputStream extends java.io.FilterOutputStream;
public abstract class CipherSpi;
public class EncryptedPrivateKeyInfo;
public class ExemptionMechanism;
public abstract class ExemptionMechanismSpi;
public class KeyAgreement;
public abstract class KeyAgreementSpi;
public class KeyGenerator;
public abstract class KeyGeneratorSpi;
public class Mac implements Cloneable;
public abstract class MacSpi;
public class SealedObject implements Serializable;
public class SecretKeyFactory;
public abstract class SecretKeyFactorySpi;
```

Exceptions

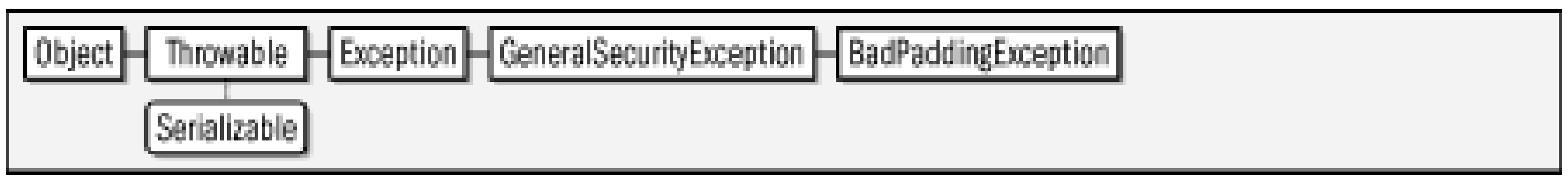
```
public class BadPaddingException extends java.security.GeneralSecurityException;
public class ExemptionMechanismException extends java.security.GeneralSecurityException
public class IllegalBlockSizeException extends java.security.GeneralSecurityException;
public class NoSuchPaddingException extends java.security.GeneralSecurityException;
public class ShortBufferException extends java.security.GeneralSecurityException;
```

BadPaddingException javax.crypto

Java 1.4 *serializable checked*

Signals that input data to a `Cipher` is not padded correctly.

Figure 17-1. javax.crypto.BadPaddingException




```
public class BadPaddingException extends java.security.GeneralSecurityException {
// Public Constructors
     public BadPaddingException( );
     public BadPaddingException(String msg);
}
```

Thrown By

`Cipher.doFinal( )`, `CipherSpi.engineDoFinal( )`, `SealedObject.getObject( )`

Team LiB

Cipher javax.crypto

Java 1.4

This class performs encryption and decryption of byte arrays. Cipher is provider-based, so to obtain a Ci object, you must call the static getInstance( ) factory method. The arguments to getInstance( ) are a that describes the type of encryption desired and, optionally, the name of the provider whose implemen should be used. To specify the desired type of encryption, you can simply specify the name of an encryp algorithm, such as "DES". In Java 5.0, the "SunJCE" provider supports the following algorithm names:

AES	DES	RSA
AESWrap	DESede	PBEWithMD5AndDES
ARCFOUR	DESedeWrap	PBEWithMD5AndTripleDES
Blowfish	RC2	PBEWithSHA1AndRC2_40

Advanced users may specify a three-part algorithm name that includes the encryption algorithm, the alg operating mode, and the padding scheme. These three parts are separated by slash characters, as in "DES/CBC/PKCS5Padding". Finally, if you are requesting a block cipher algorithm in a stream mode, you specify the number of bits to be processed at a time by following the name of the feedback mode with a number of bits. For example: "DES/CFB8/NoPadding". Details of supported operating modes and paddin schemes are beyond the scope of this book. In Java 5.0, you can obtain details about the services availa through the SunJCE (or any other) provider through the java.security.Provider.Services class.

Once you have obtained a Cipher object for the desired cryptographic algorithm, mode, and padding sch you must initialize it by calling one of the init( ) methods. The first argument to init( ) is one of the constants ENCRYPT_MODE or DECRYPT_MODE . The second argument is a java.security.Key object that performs the encryption or decryption. If you use one of the symmetric (i.e., nonpublic key) encryption algorithms supported by the "SunJCE" provider, this Key object is a SecretKey implementation. Note tha some cryptographic providers restrict the maximum allowed key length based on a jurisdiction policy file Java 5.0 you can query the maximum allowed key length for a named encryption algorithm with getMaxAllowedKeyLength( ) . You can optionally pass a java.security.SecureRandom object to init(provide a source of randomness. If you do not, the Cipher implementation provides its own pseudorand number generator.

Some cryptographic algorithms require additional initialization parameters; these can be passed to init(a java.security.AlgorithmParameters object or as a java.security.spec.AlgorithmParameterSpe object. When encrypting, you can omit these parameters, and the Cipher implementation uses default v or generates appropriate random parameters for you. In this case, you should call getParameters( ) af performing encryption to obtain the AlgorithmParameters used to encrypt. These parameters are requi order to decrypt, and must therefore be saved or transferred along with the encrypted data. Of the algo supported by the "SunJCE" provider, the block ciphers "DES", "DESede", and "Blowfish" all require an initialization vector when they are used in "CBC", "CFB", "OFB", or "PCBC" mode. You can represent an initialization vector with a javax.crypto.spec.IvParameterSpec object and obtain the raw bytes of the initialization vector used by a Cipher with the getIV( ) method. The "PBEWithMD5AndDES" algorithm r a salt and iteration count as parameters. These can be specified with a javax.crypto.spec.PBEParameterSpec object.

Once you have obtained and initialized a Cipher object, you are ready to use it for encryption or decrypt you have only a single array of bytes to encrypt or decrypt, pass that input array to one of the doFinal(methods. Some versions of this method return the encrypted or decrypted bytes as the return value of t function. Other versions store the encrypted or decrypted bytes to another byte array you specify. If you choose to use one of these latter methods, you should first call getOutputSize( ) to determine the requ size of the output array. If you want to encrypt or decrypt data from a streaming source or have more t one array of data, pass the data to one of the update( ) methods, calling it as many times as necessary pass the last array of data to one of the doFinal( ) methods. If you are working with streaming data, c using the CipherInputStream and CipherOutputStream classes instead.

Java 5.0 adds versions of the update( ) and doFinal( ) that work with ByteBuffer objects, which facil the use of encryption and decryption with the New I/O API of java.nio .

```
public class Cipher {
// Protected Constructors
     protected Cipher(CipherSpi cipherSpi, java.security.Provider provider,
        String transformation);
// Public Constants
     public static final int DECRYPT_MODE;                              =2
     public static final int ENCRYPT_MODE;                              =1
     public static final int PRIVATE_KEY;                               =2
     public static final int PUBLIC_KEY;                                =1
     public static final int SECRET_KEY;                                =3
     public static final int UNWRAP_MODE;                               =4
     public static final int WRAP_MODE;                                 =3
// Public Class Methods
     public static final Cipher getInstance(String transformation)
throws java.security.NoSuchAlgorithmException, NoSuchPaddingException;
     public static final Cipher getInstance(String transformation, String provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException, NoSuchPaddingException;
     public static final Cipher getInstance(String transformation,
        java.security.Provider provider) throws java.security.NoSuchAlgorithmException,
        NoSuchPaddingException;
5.0  public static final int getMaxAllowedKeyLength(String transformation)
        throws java.security.NoSuchAlgorithmException;
5.0  public static final java.security.spec.AlgorithmParameterSpec
        getMaxAllowedParameterSpec(String transformation)
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
     public final byte[ ] doFinal( ) throws IllegalBlockSizeException, BadPaddingExcept:
     public final byte[ ] doFinal(byte[ ] input)
```

```
      throws IllegalBlockSizeException, BadPaddingException;
   public final int doFinal(byte[ ] output, int outputOffset)
      throws IllegalBlockSizeException, ShortBufferException, BadPaddingException;
5.0 public final int doFinal(java.nio.ByteBuffer input, java.nio.ByteBuffer output)
      throws ShortBufferException, IllegalBlockSizeException, BadPaddingException;
   public final byte[ ] doFinal(byte[ ] input, int inputOffset, int inputLen)
      throws IllegalBlockSizeException, BadPaddingException;
   public final int doFinal(byte[ ] input, int inputOffset, int inputLen, byte[ ] out
      throws ShortBufferException, IllegalBlockSizeException, BadPaddingException;
   public final int doFinal(byte[ ] input, int inputOffset, int inputLen,
      byte[ ] output, int outputOffset)
      throws ShortBufferException, IllegalBlockSizeException, BadPaddingException;
   public final String getAlgorithm( );
   public final int getBlockSize( );
   public final ExemptionMechanism getExemptionMechanism( );
   public final byte[ ] getIV( );
   public final int getOutputSize(int inputLen);
   public final java.security.AlgorithmParameters getParameters( );
   public final java.security.Provider getProvider( );
   public final void init(int opmode, java.security.cert.Certificate certificate)
      throws java.security.InvalidKeyException;
   public final void init(int opmode, java.security.Key key)
      throws java.security.InvalidKeyException;
   public final void init(int opmode, java.security.Key key,
      java.security.AlgorithmParameters params)
      throws java.security.InvalidKeyException,
      java.security.InvalidAlgorithmParameterException;
   public final void init(int opmode, java.security.cert.Certificate certificate,
      java.security.SecureRandom random)
      throws java.security.InvalidKeyException;
   public final void init(int opmode, java.security.Key key,
      java.security.SecureRandom random)
      throws java.security.InvalidKeyException;
   public final void init(int opmode, java.security.Key key,
      java.security.spec.AlgorithmParameterSpec params)
      throws java.security.InvalidKeyException,
      java.security.InvalidAlgorithmParameterException;
   public final void init(int opmode, java.security.Key key,
      java.security.spec.AlgorithmParameterSpec params,
      java.security.SecureRandom random)
      throws java.security.InvalidKeyException,
      java.security.InvalidAlgorithmParameterException;
   public final void init(int opmode, java.security.Key key,
      java.security.AlgorithmParameters params,
      java.security.SecureRandom random)
      throws java.security.InvalidKeyException,
      java.security.InvalidAlgorithmParameterException;
   public final java.security.Key unwrap(byte[ ] wrappedKey, String wrappedKeyAlgorit
      int wrappedKeyType) throws java.security.InvalidKeyException,
      java.security.NoSuchAlgorithmException;
```

```
     public final byte[ ] update(byte[ ] input);
5.0  public final int update(java.nio.ByteBuffer input, java.nio.ByteBuffer output)
        throws ShortBufferException;
     public final byte[ ] update(byte[ ] input, int inputOffset, int inputLen);
     public final int update(byte[ ] input, int inputOffset, int inputLen, byte[ ] outp
        throws ShortBufferException;
     public final int update(byte[ ] input, int inputOffset, int inputLen, byte[ ] outp
        int outputOffset) throws ShortBufferException;
     public final byte[ ] wrap(java.security.Key key) throws IllegalBlockSizeException,
        java.security.InvalidKeyException;
}
```

Subclasses

NullCipher

Passed To

CipherInputStream.CipherInputStream( ) , CipherOutputStream.CipherOutputStream( ) , EncryptedPrivateKeyInfo.getKeySpec( ) , SealedObject.{getObject( ) , SealedObject( )}

CipherInputStream javax.crypto

Java 1.4 *closeable*

This class is an input stream that uses a `Cipher` object to encrypt or decrypt the bytes it reads from another stream. You must initialize the `Cipher` object before passing it to the `CipherInputStream( )` constructor.

Figure 17-2. javax.crypto.CipherInputStream


```
public class CipherInputStream extends java.io.FilterInputStream {
// Public Constructors
     public CipherInputStream(java.io.InputStream is, Cipher c);
// Protected Constructors
     protected CipherInputStream(java.io.InputStream is);
// Public Methods Overriding FilterInputStream
     public int available( ) throws java.io.IOException;
     public void close( ) throws java.io.IOException;
     public boolean markSupported( );                              constant
     public int read( ) throws java.io.IOException;
     public int read(byte[ ] b) throws java.io.IOException;
     public int read(byte[ ] b, int off, int len) throws java.io.IOException;
     public long skip(long n) throws java.io.IOException;
}
```

CipherOutputStream javax.crypto

Java 1.4 *closeable flushable*

This class is an output stream that uses a `Cipher` object to encrypt or decrypt bytes before passing them to another output stream. You must initialize the `Cipher` object before passing it to the `CipherOutputStream( )` constructor. If you are using a `Cipher` with any kind of padding, you must not call `flush( )` until you are done writing all data to the stream; otherwise decryption fails.

Figure 17-3. javax.crypto.CipherOutputStream


```
public class CipherOutputStream extends java.io.FilterOutputStream {
// Public Constructors
     public CipherOutputStream(java.io.OutputStream os, Cipher c);
// Protected Constructors
     protected CipherOutputStream(java.io.OutputStream os);
// Public Methods Overriding FilterOutputStream
     public void close( ) throws java.io.IOException;
     public void flush( ) throws java.io.IOException;
     public void write(int b) throws java.io.IOException;
     public void write(byte[ ] b) throws java.io.IOException;
     public void write(byte[ ] b, int off, int len) throws java.io.IOException;
}
```

Team LiB

CipherSpi javax.crypto

Java 1.4

This abstract class defines the service-provider interface for Cipher . A cryptographic provider must impl concrete subclass of this class for each encryption algorithm it supports. A provider can implement a sep class for each combination of algorithm, mode, and padding scheme it supports or implement more gen classes and leave the mode and/or padding scheme to be specified in calls to engineSetMode( ) and engineSetPadding( ) . Applications never need to use or subclass this class.

```
public abstract class CipherSpi {
// Public Constructors
     public CipherSpi( );
// Protected Instance Methods
5.0  protected int engineDoFinal(java.nio.ByteBuffer input, java.nio.ByteBuffer output)
        throws ShortBufferException, IllegalBlockSizeException, BadPaddingException;
     protected abstract byte[ ] engineDoFinal(byte[ ] input, int inputOffset, int input
        throws IllegalBlockSizeException, BadPaddingException;
     protected abstract int engineDoFinal(byte[ ] input, int inputOffset, int inputLen,
        byte[ ] output, int outputOffset)
        throws ShortBufferException, IllegalBlockSizeException, BadPaddingException;
     protected abstract int engineGetBlockSize( );
     protected abstract byte[ ] engineGetIV( );
     protected int engineGetKeySize(java.security.Key key)
        throws java.security.InvalidKeyException;
     protected abstract int engineGetOutputSize(int inputLen);
     protected abstract java.security.AlgorithmParameters engineGetParameters( );
     protected abstract void engineInit(int opmode, java.security.Key key,
        java.security.SecureRandom random)
        throws java.security.InvalidKeyException;
     protected abstract void engineInit(int opmode, java.security.Key key,
        java.security.AlgorithmParameters params,
        java.security.SecureRandom random)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException;
     protected abstract void engineInit(int opmode, java.security.Key key,
        java.security.spec.AlgorithmParameterSpec params,
        java.security.SecureRandom rando m)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException;
     protected abstract void engineSetMode(String mode)
        throws java.security.NoSuchAlgorithmException;
     protected abstract void engineSetPadding(String padding) throws NoSuchPaddingExcep
     protected java.security.Key engineUnwrap(byte[ ] wrappedKey, String wrappedKeyAlgo
        int wrappedKeyType)
```

```
        throws java.security.InvalidKeyException,
        java.security.NoSuchAlgorithmException;
5.0  protected int engineUpdate(java.nio.ByteBuffer input, java.nio.ByteBuffer output)
        throws ShortBufferException;
     protected abstract byte[ ] engineUpdate(byte[ ] input, int inputOffset, int inputL
     protected abstract int engineUpdate(byte[ ] input, int inputOffset, int inputLen,
        byte[ ] output, int outputOffset)
        throws ShortBufferException;
     protected byte[ ] engineWrap(java.security.Key key)
        throws IllegalBlockSizeException, java.security.InvalidKeyException;
}
```

Passed To

Cipher.Cipher( )

Team LiB

EncryptedPrivateKeyInfo javax.crypto

Java 1.4

This class represents an encrypted private key. getEncryptedData( ) returns the encrypted bytes. getAlgName( ) and getAlgParameters( ) return the algorithm name and parameters used to encrypt i Pass a Cipher object to getKeySpec( ) to decrypt the key.

```
public class EncryptedPrivateKeyInfo {
// Public Constructors
     public EncryptedPrivateKeyInfo(byte[ ] encoded) throws java.io.IOException;
     public EncryptedPrivateKeyInfo(java.security.AlgorithmParameters algParams,
        byte[ ] encryptedData) throws java.security.NoSuchAlgorithmException;
     public EncryptedPrivateKeyInfo(String algName, byte[ ] encryptedData)
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
     public String getAlgName( );
     public java.security.AlgorithmParameters getAlgParameters( );
     public byte[ ] getEncoded( ) throws java.io.IOException;
     public byte[ ] getEncryptedData( );
5.0  public java.security.spec.PKCS8EncodedKeySpec getKeySpec(java.security.Key decrypt
        throws java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException;
     public java.security.spec.PKCS8EncodedKeySpec getKeySpec(Cipher cipher)
        throws java.security.spec.InvalidKeySpecException;
5.0  public java.security.spec.PKCS8EncodedKeySpec getKeySpec(java.security.Key decrypt
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException;
5.0  public java.security.spec.PKCS8EncodedKeySpec getKeySpec(java.security.Key decrypt
        String providerName) throws java.security.NoSuchProviderException,
        java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException;
}
```

Team LiB

ExemptionMechanism javax.crypto

Java 1.4

Some countries place legal restrictions on the use of cryptographic algorithms. In some cases, a program may be exempt from these restrictions if it implements an "exemption mechanism" such as key recovery, key escrow, or key weakening. This class defines a very general API to such mechanism. This class is rarely used, and is not supported in the default implementation provided by Sun. Using this class successfully is quite complex, and is beyond the scope of this reference. For details, see the discussion "How to Make Applications `Exempt' from Cryptographic Restrictions" in the *JCE Reference Guide* which is part of the standard bundle of documentation shipped by Sun with the JDK.

```
public class ExemptionMechanism {
// Protected Constructors
     protected ExemptionMechanism(ExemptionMechanismSpi exmechSpi,
        java.security.Provider provider, String mechanism);
// Public Class Methods
     public static final ExemptionMechanism getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static final ExemptionMechanism getInstance(String algorithm,
        String provider) throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
     public static final ExemptionMechanism getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
     public final byte[ ] genExemptionBlob( ) throws IllegalStateException,
        ExemptionMechanismException;
     public final int genExemptionBlob(byte[ ] output)
        throws IllegalStateException, ShortBufferException,
        ExemptionMechanismException;
     public final int genExemptionBlob(byte[ ] output, int outputOffset)
        throws IllegalStateException, ShortBufferException,
        ExemptionMechanismException;
     public final String getName( );
     public final int getOutputSize(int inputLen) throws IllegalStateException;
     public final java.security.Provider getProvider( );
     public final void init(java.security.Key key)
         throws java.security.InvalidKeyException,
         ExemptionMechanismException;
     public final void init(java.security.Key key,
         java.security.spec.AlgorithmParameterSpec params)
         throws java.security.InvalidKeyException,
         java.security.InvalidAlgorithmParameterException,
```

```
        ExemptionMechanismException;
    public final void init(java.security.Key key,
        java.security.AlgorithmParameters params)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException,
        ExemptionMechanismException;
    public final boolean isCryptoAllowed(java.security.Key key)
        throws ExemptionMechanismException;
// Protected Methods Overriding Object
    protected void finalize( );
}
```

Returned By

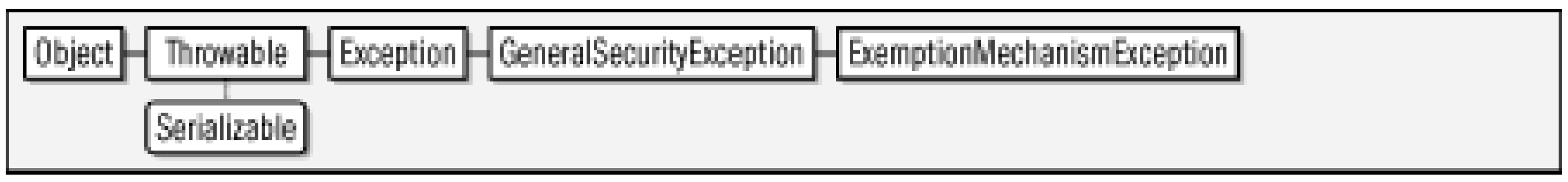
Cipher.getExemptionMechanism( )

ExemptionMechanismException javax.crypto

Java 1.4 *serializable checked*

Signals a problem in one of the `ExcemptionMechanism` methods.

Figure 17-4. javax.crypto.ExemptionMechanismException




```
public class ExemptionMechanismException extends java.security.GeneralSecurityException
// Public Constructors
     public ExemptionMechanismException( );
     public ExemptionMechanismException(String msg);
}
```

Thrown By

`ExemptionMechanism.{genExemptionBlob( )`, `init( )`, `isCryptoAllowed( )}`, `ExemptionMechanismSpi.{engineGenExemptionBlob( )`, `engineInit( )}`

Team LiB

ExemptionMechanismSpi javax.crypto

Java 1.4

This abstract class defines the Service Provider Interface for ExemptionMechanism . Security providers m implement this interface, but applications never need to use it. Note that the default "SunJCE" provider provide an implementation.

```
public abstract class ExemptionMechanismSpi {
// Public Constructors
     public ExemptionMechanismSpi( );
// Protected Instance Methods
     protected abstract byte[ ] engineGenExemptionBlob( ) throws ExemptionMechanismExce
     protected abstract int engineGenExemptionBlob(byte[ ] output, int outputOffset)
throws ShortBufferException, ExemptionMechanismException;
     protected abstract int engineGetOutputSize(int inputLen);
     protected abstract void engineInit(java.security.Key key)
throws java.security.InvalidKeyException, ExemptionMechanismException;
     protected abstract void engineInit(java.security.Key key,
        java.security.AlgorithmParameters params)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException,
        ExemptionMechanismException;
     protected abstract void engineInit(java.security.Key key,
        java.security.spec.AlgorithmParameterSpec params)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException,
        ExemptionMechanismException;
}
```

Passed To

ExemptionMechanism.ExemptionMechanism( )

IllegalBlockSizeException javax.crypto

Java 1.4 *serializable checked*

Signals that the length of data provided to a block cipher (as implemented, for example, by`Cipher` and `SealedObject`) does not match the block size for the cipher.

Figure 17-5. javax.crypto.IllegalBlockSizeException


```
public class IllegalBlockSizeException extends java.security.GeneralSecurityException {
// Public Constructors
     public IllegalBlockSizeException( );
     public IllegalBlockSizeException(String msg);
}
```

Thrown By

`Cipher.{doFinal( )` , `wrap( )}` , `CipherSpi.{engineDoFinal( )` , `engineWrap( )}` , `SealedObject.{getObject( )` , `SealedObject( )}`

Team LiB

KeyAgreement javax.crypto

Java 1.4

This class provides an API to a key-agreement protocol that allows two or more parties to agree on a se without exchanging any secrets and in such a way that an eavesdropper listening in on the communicati between those parties cannot determine the secret key. The KeyAgreement class is algorithm-independe provider-based, so you must obtain a KeyAgreement object by calling one of the static getInstance( ) f methods and specifying the name of the desired key agreement algorithm and, optionally, the name of t desired provider of that algorithm. The "SunJCE" provider implements a single key-agreement algorithm "DiffieHellman".

To use a KeyAgreement object, each party first calls the init( ) method and supplies a Key object of its Then, each party obtains a Key object from one of the other parties to the agreement and calls doPhase(Each party obtains an intermediate Key object as the return value of doPhase( ), and these keys are ag exchanged and passed to doPhase( ). This process typically repeats n -1 times, where n is the number parties, but the actual number of repetitions is algorithm-dependent. When doPhase( ) is called the last the second argument must be TRue to indicate that it is the last phase of the agreement. After all calls to doPhase( ) have been made, each party calls generateSecret( ) to obtain an array of bytes or a Secr object for a named algorithm type. All parties obtain the same bytes or SecretKey from this method. Th KeyAgreement class is not responsible for the transfer of Key objects between parties or for mutual authentication among the parties. These tasks must be accomplished through some external mechanism

The most common type of key agreement is "DiffieHellman" key agreement between two parties. It proc follows. First, both parties obtain a java.security.KeyPairGenerator for the "DiffieHellman" algorithm it to generate a java.security.KeyPair of Diffie-Hellman public and private keys. Each party passes its key to the init( ) method of its KeyAgreement object. (The init( ) method can be passed a java.security.spec.AlgorithmParameterSpec object, but the Diffie-Hellman protocol does not require additional parameters.) Next, the two parties exchange public keys, typically through some kind of netw mechanism (the KeyAgreement class is not responsible for the actual exchange of keys). Each party pas public key of the other party to the doPhase( ) method of its KeyAgreement object. There are only two p to this agreement, so only one phase is required, and the second argument to doPhase( ) is true. At th both parties call generateSecret( ) to obtain the shared secret key.

A three-party Diffie-Hellman key agreement requires two phases and is slightly more complicated. Let's three parties Alice, Bob, and Carol. Each generates a key pair and uses its private key to initialize its KeyAgreement object, as before. Then Alice passes her public key to Bob, Bob passes his to Carol, and C passes hers to Alice. Each party passes this public key to doPhase( ). Since this is not the final doPhase the second argument is false, and doPhase( ) returns an intermediate Key object. The three parties ex these intermediate keys again in the same way: Alice to Bob, Bob to Carol, and Carol to Alice. Now each passes the intermediate key it has received to doPhase( ) a second time, passing true to indicate that t the final phase. Finally, all three can call generateSecret( ) to obtain a shared key to encrypt future communication.

```
public class KeyAgreement {
// Protected Constructors
```

```
    protected KeyAgreement(KeyAgreementSpi keyAgreeSpi, java.security.Provider provide
       String algorithm);
// Public Class Methods
    public static final KeyAgreement getInstance(String algorithm)
       throws java.security.NoSuchAlgorithmException;
    public static final KeyAgreement getInstance(String algorithm, String provider)
       throws java.security.NoSuchAlgorithmException,
       java.security.NoSuchProviderException;
    public static final KeyAgreement getInstance(String algorithm, java.security.
       Provider provider) throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
    public final java.security.Key doPhase(java.security.Key key, boolean lastPhase)
       throws java.security.InvalidKeyException, IllegalStateException;
    public final byte[ ] generateSecret( ) throws IllegalStateException;
    public final SecretKey generateSecret(String algorithm)
       throws IllegalStateException, java.security.NoSuchAlgorithmException,
       java.security.InvalidKeyException;
    public final int generateSecret(byte[ ] sharedSecret, int offset)
       throws IllegalStateException, ShortBufferException;
    public final String getAlgorithm( );
    public final java.security.Provider getProvider( );
    public final void init(java.security.Key key) throws java.security.InvalidKeyExcept
    public final void init(java.security.Key key, java.security.SecureRandom random)
       throws java.security.InvalidKeyException;
    public final void init(java.security.Key key, java.security.spec
       .AlgorithmParameterSpec params)
       throws java.security.InvalidKeyException,
       java.security.InvalidAlgorithmParameterException;
    public final void init(java.security.Key key, java.security.spec
       .AlgorithmParameterSpec params,
       java.security.SecureRandom random)
       throws java.security.InvalidKeyException,
       java.security.InvalidAlgorithmParameterException;
}
```

KeyAgreementSpi javax.crypto

Java 1.4

This abstract class defines the service-provider interface for KeyAgreement . A cryptographic provider must implement a concrete subclass of this class for each encryption algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class KeyAgreementSpi {
// Public Constructors
     public KeyAgreementSpi( );
// Protected Instance Methods
     protected abstract java.security.Key engineDoPhase(java.security.Key key,
        boolean lastPhase) throws java.security.InvalidKeyException,
        IllegalStateException;
     protected abstract byte[ ] engineGenerateSecret( ) throws IllegalStateException;
     protected abstract SecretKey engineGenerateSecret(String algorithm)
        throws IllegalStateException,
        java.security.NoSuchAlgorithmException,
        java.security.InvalidKeyException;
     protected abstract int engineGenerateSecret(byte[ ] sharedSecret, int offset)
        throws IllegalStateException, ShortBufferException;
     protected abstract void engineInit(java.security.Key key,
        java.security.SecureRandom random)
        throws java.security.InvalidKeyException;
     protected abstract void engineInit(java.security.Key key,
        java.security.spec.AlgorithmParameterSpec params,
        java.security.SecureRandom random)
        throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException;
}
```

Passed To

KeyAgreement.KeyAgreement( )

Team LiB

KeyGenerator javax.crypto

Java 1.4

This class provides an API for generating secret keys for symmetric cryptography. It is similar to `java.security.KeyPairGenerator` , which generates public/private key pairs for asymmetric or public-key cryptography. `KeyGenerator` is algorithm-independent and provider-based, so you must obtain a `KeyGenerator` instance by calling one of the static `getInstance( )` factory methods and specifying the name of the cryptographic algorithm for which a key is desired and, optionally, the name of the security provider whose key-generation implementation is to be used. InJava 5.0 the "SunJCE" provider includes `KeyGenerator` implementations algorithms with the following names:

AES	DESede	HmacSHA384
ARCFOUR	HmacMD5	HmacSHA512
Blowfish	HmacSHA1	RC2
DES	HmacSHA256	

Once you have obtained a `KeyGenerator` , you initialize it with the `init( )` method. You can provide a `java.security.spec.AlgorithmParameterSpec` object to provide algorithm-specific initialization parameters or simply specify the desired size (in bits) of the key to be generated. In either case, you ca also specify a source of randomness in the form of a`SecureRandom` object. If you do not specify a `SecureRandom` , the `KeyGenerator` instantiates one of its own. None of the algorithms supported by the "SunJCE" provider require algorithm-specific parameters.

After calling `getInstance( )` to obtain a `KeyGenerator` and `init( )` to initialize it, simply call `generateKey( )` to create a new `SecretKey` . Remember that the `SecretKey` must be kept secret. Take precautions when storing or transmitting the key, so that it does not fall into the wrong hands. You may want to use a `java.security.KeyStore` object to store the key in a password-protected form.

```
public class KeyGenerator {
// Protected Constructors
     protected KeyGenerator(KeyGeneratorSpi keyGenSpi, java.security.Provider provider,
        String algorithm);
// Public Class Methods
     public static final KeyGenerator getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static final KeyGenerator getInstance(String algorithm,
        java.security.Provider provider) throws java.security.NoSuchAlgorithmException;
```

```
    public static final KeyGenerator getInstance(String algorithm,
       String provider) throws java.security.NoSuchAlgorithmException,
       java.security.NoSuchProviderException;
// Public Instance Methods
    public final SecretKey generateKey( );
    public final String getAlgorithm( );
    public final java.security.Provider getProvider( );
    public final void init(int keysize);
    public final void init(java.security.spec.AlgorithmParameterSpec params)
       throws java.security.InvalidAlgorithmParameterException;
    public final void init(java.security.SecureRandom random);
    public final void init(int keysize, java.security.SecureRandom random);
    public final void init(java.security.spec.AlgorithmParameterSpec params,
       java.security.SecureRandom random)
       throws java.security.InvalidAlgorithmParameterException;
}
```

KeyGeneratorSpi javax.crypto

Java 1.4

This abstract class defines the service-provider interface for KeyGenerator . A cryptographic provider mu implement a concrete subclass of this class for each key-generation algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class KeyGeneratorSpi {
// Public Constructors
     public KeyGeneratorSpi( );
// Protected Instance Methods
     protected abstract SecretKey engineGenerateKey( );
     protected abstract void engineInit(java.security.SecureRandom random);
     protected abstract void engineInit(int keysize, java.security.SecureRandom random)
     protected abstract void engineInit(java.security.spec.AlgorithmParameterSpec param
        java.security.SecureRandom random)
        throws java.security.InvalidAlgorithmParameterException;
}
```

Passed To

KeyGenerator.KeyGenerator( )

Team LiB

Mac javax.crypto

Java 1.4 *cloneable*

This class defines an API for computing a *message authentication code* (MAC) that can check the integrit information transmitted between two parties that share a secret key. A MAC is similar to a digital signat that it is generated with a secret key rather than with a public/private key pair. The Mac class is algorithr independent and provider-based. Obtain a Mac object by calling one of the static getInstance( ) factory and specifying the name of the desired MAC algorithm and, optionally, the name of the provider of the c implementation. In Java 5.0 The "SunJCE" provider implement MAC algorithms with the following names

HmacMD5	HmacSHA1	HmacSHA256
HmacSHA384	HmacSHA512	HmacPBESHA1

After obtaining a Mac object, initialize it by calling the init( ) method and specifying a SecretKey and, java.security.spec.AlgorithmParameterSpec object. The "HmacMD5" and "HmacSHA1" algorithms c kind of SecretKey ; they are not restricted to a particular cryptographic algorithm. And neither algorithr AlgorithmParameterSpec object.

After obtaining and initializing a Mac object, specify the data for which the MAC is to be computed. If the contained in a single byte array, simply pass it to doFinal( ) . If the data is streaming or is stored in va locations, you can supply the data in multiple calls to update( ) . In Java 5.0, you can pass a ByteBuffe update( ) which facilities use with the java.nio New I/O API. End the series of update( ) calls with a doFinal( ) . Note that some versions of doFinal( ) return the MAC data as the function return value. version stores the MAC data in a byte array you supply. If you use this version of doFinal( ) , be sure t getMacLength( ) to instantiate an array of the correct length.

A call to doFinal( ) resets the internal state of a Mac object. If you want to compute a MAC for part of y and then proceed to compute the MAC for the full data, you should clone( ) the Mac object before callin) . Note, however, that Mac implementations are not required to implement Cloneable .

Figure 17-6. javax.crypto.Mac

```
public class Mac implements Cloneable {
// Protected Constructors
     protected Mac(MacSpi macSpi, java.security.Provider provider, String algorithm);
// Public Class Methods
     public static final Mac getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
```

```
    public static final Mac getInstance(String algorithm, String provider)
       throws java.security.NoSuchAlgorithmException,
       java.security.NoSuchProviderException;
    public static final Mac getInstance(String algorithm, java.security.Provider provi
       throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
    public final byte[ ] doFinal( ) throws IllegalStateException;
    public final byte[ ] doFinal(byte[ ] input) throws IllegalStateException;
    public final void doFinal(byte[ ] output, int outOffset)
       throws ShortBufferException, IllegalStateException;
    public final String getAlgorithm( );
    public final int getMacLength( );
    public final java.security.Provider getProvider( );
    public final void init(java.security.Key key) throws java.security.InvalidKeyExcept
    public final void init(java.security.Key key, java.security.spec
       .AlgorithmParameterSpec params) throws java.security.InvalidKeyException,
       java.security.InvalidAlgorithmParameterException;
    public final void reset( );
    public final void update(byte input) throws IllegalStateException;
5.0 public final void update(java.nio.ByteBuffer input);
    public final void update(byte[ ] input) throws IllegalStateException;
    public final void update(byte[ ] input, int offset, int len) throws IllegalStateEx
// Public Methods Overriding Object
    public final Object clone( ) throws CloneNotSupportedException;
}
```

Team LiB

MacSpi javax.crypto

Java 1.4

This abstract class defines the service-provider interface for Mac. A cryptographic provider must implement a concrete subclass of this class for each MAC algorithm it supports. Applications never need to use or subclass this class.

```
public abstract class MacSpi {
// Public Constructors
     public MacSpi( );
// Public Methods Overriding Object
     public Object clone( ) throws CloneNotSupportedException;
// Protected Instance Methods
     protected abstract byte[ ] engineDoFinal( );
     protected abstract int engineGetMacLength( );
     protected abstract void engineInit(java.security.Key key, java.security.spec.
        AlgorithmParameterSpec params) throws java.security.InvalidKeyException,
        java.security.InvalidAlgorithmParameterException;
     protected abstract void engineReset( );
5.0  protected void engineUpdate(java.nio.ByteBuffer input);
     protected abstract void engineUpdate(byte input);
     protected abstract void engineUpdate(byte[ ] input, int offset, int len);
}
```

Passed To

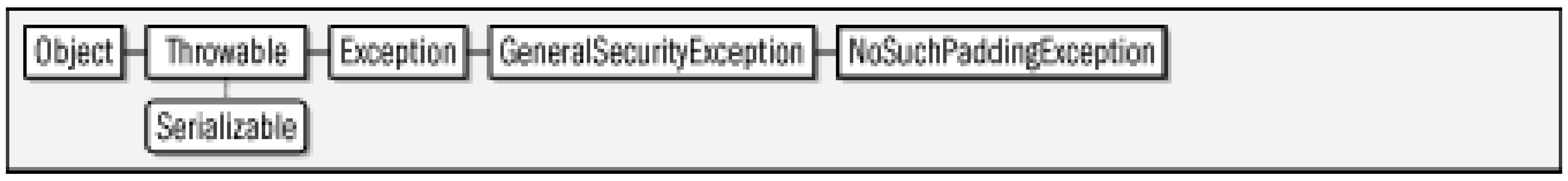
Mac.Mac( )

NoSuchPaddingException javax.crypto

Java 1.4 *serializable checked*

Signals that no implementation of the requested padding scheme can be found.

Figure 17-7. javax.crypto.NoSuchPaddingException




```
public class NoSuchPaddingException extends java.security.GeneralSecurityException {
// Public Constructors
     public NoSuchPaddingException( );
     public NoSuchPaddingException(String msg);
}
```

Thrown By

`Cipher.getInstance( )`, `CipherSpi.engineSetPadding( )`

NullCipher javax.crypto

Java 1.4

This trivial subclass of `Cipher` implements an identity cipher that does not transform plain text in any way. Unlike `Cipher` objects returned by `Cipher.getInstance( )`, a `NullCipher` must be created with the `NullCipher( )` constructor.

Figure 17-8. javax.crypto.NullCipher


```
public class NullCipher extends Cipher {
// Public Constructors
     public NullCipher( );
}
```

SealedObject javax.crypto

Java 1.4 *serializable*

This class is a wrapper around a serializable object. It serializes the object and encrypts the resulting data stream, thereby protecting the confidentiality of the object. Create a `SealedObject` by specifying the object to be sealed and a `Cipher` object to perform the encryption. Retrieve the sealed object by calling `getObject( )` and specifying the `Cipher` or `java.security.Key` to use for decryption. The `SealedObject` keeps track of the encryption algorithm and parameters so that a `Key` object alone can decrypt the object.

Figure 17-9. javax.crypto.SealedObject


```
public class SealedObject implements Serializable {
// Public Constructors
     public SealedObject(Serializable object, Cipher c)
        throws java.io.IOException, IllegalBlockSizeException;
// Protected Constructors
     protected SealedObject(SealedObject so);
// Public Instance Methods
     public final String getAlgorithm( );
     public final Object getObject(java.security.Key key)
        throws java.io.IOException, ClassNotFoundException,
        java.security.NoSuchAlgorithmException, java.security.InvalidKeyException;
     public final Object getObject(Cipher c)
        throws java.io.IOException, ClassNotFoundException,
        IllegalBlockSizeException, BadPaddingException;
     public final Object getObject(java.security.Key key, String provider)
        throws java.io.IOException, ClassNotFoundException,
        java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException,
        java.security.InvalidKeyException;
// Protected Instance Fields
     protected byte[ ] encodedParams;
}
```

Team LiB

SecretKey javax.crypto

Java 1.4 *serializable*

This interface represents a secret key used for symmetric cryptographic algorithms that depend on both sender and receiver knowing the same secret. `SecretKey` extends the `java.security.Key` interface, but does not add any new methods. The interface exists in order to keep secret keys distinct from the public and private keys used in public-key, or asymmetric, cryptography. See also `java.security.PublicKey` and `java.security.PrivateKey` .

A secret key is nothing more than arrays of bytes and does not require a specialized encoding format. Therefore, an implementation of this interface should return the format name "RAW" from `getFormat( )` and should return the bytes of the key from `getEncoded( )` . (These two methods are defined by the `java.security.Key` interface that `SecretKey` extends.)

Figure 17-10. javax.crypto.SecretKey

```
public interface SecretKey extends java.security.Key {
// Public Constants
5.0  public static final long serialVersionUID;                    =-479587870959514
}
```

Implementations

`javax.crypto.interfaces.PBEKey` , `javax.crypto.spec.SecretKeySpec` , `javax.security.auth.kerberos.KerberosKey`

Passed To

`java.security.KeyStore.SecretKeyEntry.SecretKeyEntry( )` , `SecretKeyFactory.{getKeySpec( ), translateKey( )}` , `SecretKeyFactorySpi.{engineGetKeySpec( ), engineTranslateKey( )}`

Returned By

`java.security.KeyStore.SecretKeyEntry.getSecretKey( )` , `KeyAgreement.generateSecret( )` , `KeyAgreementSpi.engineGenerateSecret( )` , `KeyGenerator.generateKey( )` , `KeyGeneratorSpi.engineGenerateKey( )` , `SecretKeyFactory.{generateSecret( ), translateKey( )}` , `SecretKeyFactorySpi.{engineGenerateSecret( ), engineTranslateKey( )}` , `javax.security.auth.kerberos.KerberosTicket.getSessionKey( )`

downloaded from: lib.ommolketab.ir

SecretKeyFactory javax.crypto

Java 1.4

This class defines an API for translating a secret key between its opaque SecretKey representation and its transparent javax.crypto.SecretKeySpec representation. It is much like java.security.KeyFactory , except that it works with secret (or symmetric) keys rather than with public and private (asymmetric) keys. SecretKeyFactory is algorithm-independent and provider-based, so you must obtain a SecretKeyFactory object by calling one of the static getInstance( ) factory methods and specifying the name of the desired secret-key algorithm and, optionally, the name of the provider whose implementation is desired. In Java 5.0, the "SunJCE" provider provides SecretKeyFactory implementations for algorithms with the following names:

DES	DESede	PBE
PBEWithMD5AndDES	PBEWithMD5AndTripleDES	PBEWithSHA1AndDESede
PBEWithSHA1AndRC2		

Once you have obtained a SecretKeyFactory , use generateSecret( ) to create a SecretKey from a java.security.spec.KeySpec (or its subclass, javax.crypto.spec.SecretKeySpec). Or call getKeySpec( ) to obtain a KeySpec for a Key object. Because there can be more than one suitable type of KeySpec , getKeySpec( ) requires a Class object to specify the type of the KeySpec to be created. See also DESKeySpec , DESedeKeySpec , and PBEKeySpec in the javax.crypto.spec package.

```
public class SecretKeyFactory {
// Protected Constructors
     protected SecretKeyFactory(SecretKeyFactorySpi keyFacSpi,
        java.security.Provider provider, String algorithm);
// Public Class Methods
     public static final SecretKeyFactory getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static final SecretKeyFactory getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
     public static final SecretKeyFactory getInstance(String algorithm,
        String provider) throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
// Public Instance Methods
     public final SecretKey generateSecret(java.security.spec.KeySpec keySpec)
        throws java.security.spec.InvalidKeySpecException;
     public final String getAlgorithm( );
     public final java.security.spec.KeySpec getKeySpec(SecretKey key, Class keySpec)
        throws java.security.spec.InvalidKeySpecException;
```

```
    public final java.security.Provider getProvider( );
    public final SecretKey translateKey(SecretKey key)
       throws java.security.InvalidKeyException;
}
```

Team LiB

Team LiB

SecretKeyFactorySpi javax.crypto

Java 1.4

This abstract class defines the service-provider interface for SecretKeyFactory. A cryptographic provider must implement a concrete subclass of this class for each type of secret key it supports. Applications never need to use or subclass this class.

```
public abstract class SecretKeyFactorySpi {
// Public Constructors
     public SecretKeyFactorySpi( );
// Protected Instance Methods
     protected abstract SecretKey engineGenerateSecret
        (java.security.spec.KeySpec keySpec)
        throws java.security.spec.InvalidKeySpecException;
     protected abstract java.security.spec.KeySpec engineGetKeySpec
        (SecretKey key, Class keySpec)
        throws java.security.spec.InvalidKeySpecException;
     protected abstract SecretKey engineTranslateKey
        (SecretKey key) throws java.security.InvalidKeyException;
}
```

Passed To

SecretKeyFactory.SecretKeyFactory( )

ShortBufferException javax.crypto

Java 1.4 *serializable checked*

Signals that an output buffer is too short to hold the results of an operation.

Figure 17-11. javax.crypto.ShortBufferException


```
public class ShortBufferException extends java.security.GeneralSecurityException {
// Public Constructors
     public ShortBufferException( );
     public ShortBufferException(String msg);
}
```

Thrown By

Too many methods to list.

Team LiB

Package javax.crypto.interfaces

Java 1.4

The interfaces in the `javax.crypto.interfaces` package define the public methods that must be supported by various types of encryption keys. The "DH" interfaces respresent Diffie-Hellman public/private key pairs used in the Diffie-Hellman key-agreement protocol. The "PBE" iterface is for Password-Based Encryption. These interfaces are typically of interest only to programmers who are implementing a cryptographic provider or who want to implement cryptographic algorithms themselves. Use of this package requires basic familiarity with the encryption algorithms and the mathematics that underlie them. Note that the `javax.crypto.spec` package contains classes that provide algorithm-specific details about encryption keys.

Interfaces

```
public interface DHKey;
public interface DHPrivateKey extends DHKey, java.security.PrivateKey;
public interface DHPublicKey extends DHKey, java.security.PublicKey;
public interface PBEKey extends javax.crypto.SecretKey;
```

Team LiB

DHKey javax.crypto.interfaces

Java 1.4

This interface represents a Diffie-Hellman key. The `javax.crypto.spec.DHParameterSpec` returned by `getParams( )` specifies the parameters that generate the key; they define a key family. See the subinterfaces `DHPublicKey` and `DHPrivateKey` for the actual key values.

```
public interface DHKey {
// Public Instance Methods
     javax.crypto.spec.DHParameterSpec getParams( );
}
```

Implementations

`DHPrivateKey`, `DHPublicKey`

DHPrivateKey javax.crypto.interfaces

Java 1.4 *serializable*

This interface represents a Diffie-Hellman private key. Note that it extends two interfaces:`DHKey` and `java.security.PrivateKey` . `getX( )` returns the private-key value. If you are working with a `PrivateKey` you know is a Diffie-Hellman key, you can cast your `PrivateKey` to a `DHPrivateKey` .

Figure 17-12. javax.crypto.interfaces.DHPrivateKey


```
public interface DHPrivateKey extends DHKeyjava.security.PrivateKey {
// Public Constants
5.0  public static final long serialVersionUID;                      =2211791113380396553
// Public Instance Methods
     java.math.BigInteger getX( );
}
```

Team LiB

DHPublicKey javax.crypto.interfaces

Java 1.4 *serializable*

This interface represents a Diffie-Hellman public key. Note that it extends two interfaces: `DHKey` and `java.security.PublicKey`. `getY( )` returns the public-key value. If you are working with a `PublicKey` you know is a Diffie-Hellman key, you can cast your `PublicKey` to a `DHPublicKey`.

Figure 17-13. javax.crypto.interfaces.DHPublicKey


```
public interface DHPublicKey extends DHKey, java.security.PublicKey {
// Public Constants
5.0  public static final long serialVersionUID;                    =-6628103563352519193
// Public Instance Methods
     java.math.BigInteger getY( );
}
```

PBEKey javax.crypto.interfaces

Java 1.4 *serializable*

This interface represents a key for password-based encryption. If you are working with a `SecretKey` that you know is a password-based key, you can cast it to a `PBEKey` .

Figure 17-14. javax.crypto.interfaces.PBEKey


```
public interface PBEKey extends javax.crypto.SecretKey {
// Public Constants
5.0  public static final long serialVersionUID;                    =-1430015993304333
// Public Instance Methods
     int getIterationCount( );
     char[ ] getPassword( );
     byte[ ] getSalt( );
}
```

Team LiB

Package javax.crypto.spec

Java 1.4

The javax.crypto.spec package contains classes that define transparent java.security.spec.KeySpe and java.security.spec.AlgorithmParameterSpec representations of secret keys, Diffie-Hellman pub and private keys, and parameters used by various cryptographic algorithms. The classes in this package are used in conjunction with java.security.KeyFactory , javax.crypto.SecretKeyFactory and java.security.AlgorithmParameters for converting opaque Key , and AlgorithmParameters objects and from transparent representations. In order to make good use of this package, you must be familiar with the specifications of the various cryptographic algorithms it supports and the basic mathematics tha underlie those algorithms.

Classes

```
public class DESedeKeySpec implements java.security.spec.KeySpec;
public class DESKeySpec implements java.security.spec.KeySpec;
public class DHGenParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class DHParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class DHPrivateKeySpec implements java.security.spec.KeySpec;
public class DHPublicKeySpec implements java.security.spec.KeySpec;
public class IvParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class OAEPParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class PBEKeySpec implements java.security.spec.KeySpec;
public class PBEParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class PSource;
   public static final class PSource.PSpecified extends PSource;
public class RC2ParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class RC5ParameterSpec implements java.security.spec.AlgorithmParameterSpec;
public class SecretKeySpec implements java.security.spec.KeySpec, javax.crypto.SecretKe
```

Team LiB

DESedeKeySpec javax.crypto.spec

Java 1.4

This class is a transparent representation of a DESede (triple-DES) key. The key is 24 bytes long.

Figure 17-15. javax.crypto.spec.DESedeKeySpec


```
public class DESedeKeySpec implements java.security.spec.KeySpec {
// Public Constructors
     public DESedeKeySpec(byte[ ] key) throws java.security.InvalidKeyException;
     public DESedeKeySpec(byte[ ] key, int offset) throws java.security.InvalidKeyExcep
// Public Constants
     public static final int DES_EDE_KEY_LEN;                            =24
// Public Class Methods
     public static boolean isParityAdjusted(byte[ ] key, int offset)
        throws java.security.InvalidKeyException;
// Public Instance Methods
     public byte[ ] getKey( );
}
```

DESKeySpec javax.crypto.spec

Java 1.4

This class is a transparent representation of a DES key. The key is eight bytes long.

Figure 17-16. javax.crypto.spec.DESKeySpec


```
public class DESKeySpec implements java.security.spec.KeySpec {
// Public Constructors
     public DESKeySpec(byte[ ] key) throws java.security.InvalidKeyException;
     public DESKeySpec(byte[ ] key, int offset) throws java.security.InvalidKeyExceptio
// Public Constants
     public static final int DES_KEY_LEN;                                =8
// Public Class Methods
     public static boolean isParityAdjusted(byte[ ] key, int offset)
        throws java.security.InvalidKeyException;
     public static boolean isWeak(byte[ ] key, int offset)
        throws java.security.InvalidKeyException;
// Public Instance Methods
     public byte[ ] getKey( );
}
```

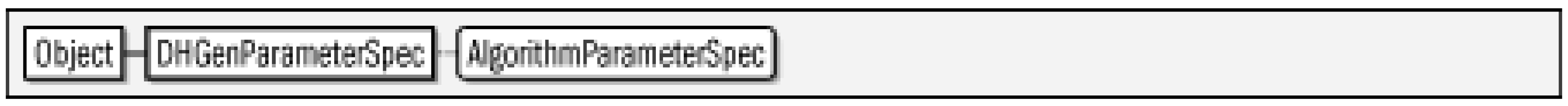
Team LiB

DHGenParameterSpec javax.crypto.spec

Java 1.4

This class is a transparent representation of the values needed to generate a set of Diffie-Hellman parameters (see `DHParameterSpec`). An instance of this class can be passed to the `init( )` method of a `java.security.AlgorithmParameterGenerator` that computes Diffie-Hellman parameters.

Figure 17-17. javax.crypto.spec.DHGenParameterSpec




```
public class DHGenParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public DHGenParameterSpec(int primeSize, int exponentSize);
// Public Instance Methods
     public int getExponentSize( );
     public int getPrimeSize( );
}
```

DHParameterSpec javax.crypto.spec

Java 1.4

This class is a transparent representation of the set of parameters required by the Diffie-Hellman key-agreement algorithm. All parties to the key agreement must share these parameters and use them to generate a Diffie-Hellman public/private key pair.

Figure 17-18. javax.crypto.spec.DHParameterSpec


```
public class DHParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public DHParameterSpec(java.math.BigInteger p, java.math.BigInteger g);
     public DHParameterSpec(java.math.BigInteger p, java.math.BigInteger g, int l);
// Public Instance Methods
     public java.math.BigInteger getG( );
     public int getL( );
     public java.math.BigInteger getP( );
}
```

Returned By

`javax.crypto.interfaces.DHKey.getParams( )`

DHPrivateKeySpec javax.crypto.spec

Java 1.4

This `java.security.spec.KeySpec` is a transparent representation of a Diffie-Hellman private key.

Figure 17-19. javax.crypto.spec.DHPrivateKeySpec


```
public class DHPrivateKeySpec implements java.security.spec.KeySpec {
// Public Constructors
     public DHPrivateKeySpec(java.math.BigInteger x,
        java.math.BigInteger p,
        java.math.BigInteger g);
// Public Instance Methods
     public java.math.BigInteger getG( );
     public java.math.BigInteger getP( );
     public java.math.BigInteger getX( );
}
```

DHPublicKeySpec javax.crypto.spec

Java 1.4

This `java.security.spec.KeySpec` is a transparent representation of a Diffie-Hellman public key.

Figure 17-20. javax.crypto.spec.DHPublicKeySpec


```
public class DHPublicKeySpec implements java.security.spec.KeySpec {
// Public Constructors
     public DHPublicKeySpec(java.math.BigInteger y, java.math.BigInteger p,
        java.math.BigInteger g);
// Public Instance Methods
     public java.math.BigInteger getG( );
     public java.math.BigInteger getP( );
     public java.math.BigInteger getY( );
}
```

IvParameterSpec javax.crypto.spec

Java 1.4

This `java.security.spec.AlgorithmParameterSpec` is a transparent representation of an *initialization vector* or IV. An IV is required for block ciphers used in feedback mode, such as DES in CBC mode.

Figure 17-21. javax.crypto.spec.IvParameterSpec


```
public class IvParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public IvParameterSpec(byte[ ] iv);
     public IvParameterSpec(byte[ ] iv, int offset, int len);
// Public Instance Methods
     public byte[ ] getIV( );
}
```

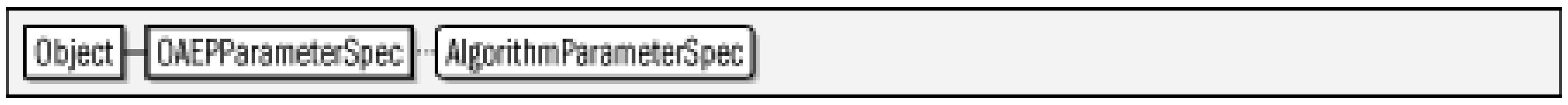
Team LiB

OAEPParameterSpec javax.crypto.spec

Java 5.0

This class specifies parameters for OAEP padding, defined by thePKCS #1 standard.

Figure 17-22. javax.crypto.spec.OAEPParameterSpec




```
public class OAEPParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public OAEPParameterSpec(String mdName, String mgfName,
        java.security.spec.AlgorithmParameterSpec mgfSpec,
        PSource pSrc);
// Public Constants
     public static final OAEPParameterSpec DEFAULT;
// Public Instance Methods
     public String getDigestAlgorithm( );
     public String getMGFAlgorithm( );
     public java.security.spec.AlgorithmParameterSpec getMGFParameters( );
     public PSource getPSource( );
}
```

PBEKeySpec javax.crypto.spec

Java 1.4

This class is a transparent representation of a password used in password-based encryption (PBE). The password is stored as a `char` array rather than as a `String` , so that the characters of the password can overwritten when they are no longer needed (for increased security).

Figure 17-23. javax.crypto.spec.PBEKeySpec

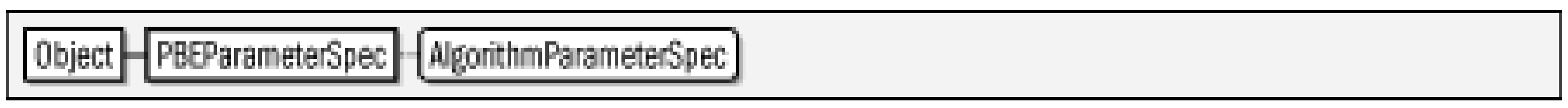

```
public class PBEKeySpec implements java.security.spec.KeySpec {
// Public Constructors
     public PBEKeySpec(char[ ] password);
     public PBEKeySpec(char[ ] password, byte[ ] salt, int iterationCount);
     public PBEKeySpec(char[ ] password, byte[ ] salt, int iterationCount, int keyLengt
// Public Instance Methods
     public final void clearPassword( );
     public final int getIterationCount( );
     public final int getKeyLength( );
     public final char[ ] getPassword( );
     public final byte[ ] getSalt( );
}
```

PBEParameterSpec javax.crypto.spec

Java 1.4

This class is a transparent representation of the parameters used with the password-based encryption algorithm defined by PKCS#5.

Figure 17-24. javax.crypto.spec.PBEParameterSpec




```
public class PBEParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public PBEParameterSpec(byte[ ] salt, int iterationCount);
// Public Instance Methods
     public int getIterationCount( );
     public byte[ ] getSalt( );
}
```

PSource javax.crypto.spec

Java 5.0

This class is a representation of the source of "encoding input P" inOAEP padding, defined by the PKCS #1 standard.

```
public class PSource {
// Protected Constructors
     protected PSource(String pSrcName);
// Nested Types
     public static final class PSpecified extends PSource;
// Public Instance Methods
     public String getAlgorithm( );
}
```

Subclasses

PSource.PSpecified

Passed To

OAEPParameterSpec.OAEPParameterSpec( )

Returned By

OAEPParameterSpec.getPSource( )

PSource.PSpecified javax.crypto.spec

Java 5.0

This class extends and is nested within PSource. It explicitly specifies the bytes of "encoding input P" for OAEP padding.

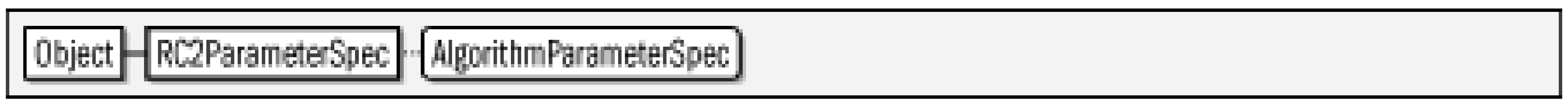
```
public static final class PSource.PSpecified extends PSource {
// Public Constructors
     public PSpecified(byte[ ]);
// Public Constants
     public static final PSource.PSpecified DEFAULT;
// Public Instance Methods
     public byte[ ] getValue( );
}
```

RC2ParameterSpec javax.crypto.spec

Java 1.4

This class is a transparent representation of the parameters used by the RC2 encryption algorithm. An object of this class initializes a `Cipher` object that implements RC2. Note that the "SunJCE" provider supplied by Sun does not implement RC2.

Figure 17-25. javax.crypto.spec.RC2ParameterSpec




```
public class RC2ParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public RC2ParameterSpec(int effectiveKeyBits);
     public RC2ParameterSpec(int effectiveKeyBits, byte[ ] iv);
     public RC2ParameterSpec(int effectiveKeyBits, byte[ ] iv, int offset);
// Public Instance Methods
     public int getEffectiveKeyBits( );
     public byte[ ] getIV( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

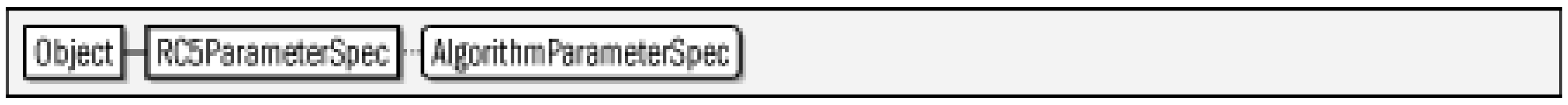
Team LiB

RC5ParameterSpec javax.crypto.spec

Java 1.4

This class is a transparent representation of the parameters used by the RC5 encryption algorithm. An o this class initializes a Cipher object that implements RC5. Note that the "SunJCE" provider supplied by S not implement RC5.

Figure 17-26. javax.crypto.spec.RC5ParameterSpec




```
public class RC5ParameterSpec implements java.security.spec.AlgorithmParameterSpec {
// Public Constructors
     public RC5ParameterSpec(int version, int rounds, int wordSize);
     public RC5ParameterSpec(int version, int rounds, int wordSize, byte[ ] iv);
     public RC5ParameterSpec(int version, int rounds, int wordSize, byte[ ] iv, int off
// Public Instance Methods
     public byte[ ] getIV( );
     public int getRounds( );
     public int getVersion( );
     public int getWordSize( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

SecretKeySpec javax.crypto.spec

Java 1.4 *serializable*

This class is a transparent and algorithm-independent representation of a secret key. This class is useful only for encryption algorithms (such as DES and DESede) whose secret keys can be represented as arbitrary byte arrays and do not require auxiliary parameters. Note that `SecretKeySpec` implements the `javax.crypto.SecretKey` interface directly, so no algorithm-specific `javax.crypto.SecretKeyFactory` object is required.

Figure 17-27. javax.crypto.spec.SecretKeySpec


```
public class SecretKeySpec implements java.security.spec.KeySpec, javax.crypto.SecretKe
// Public Constructors
     public SecretKeySpec(byte[ ] key, String algorithm);
     public SecretKeySpec(byte[ ] key, int offset, int len, String algorithm);
// Methods Implementing Key
     public String getAlgorithm( );
     public byte[ ] getEncoded( );
     public String getFormat( );
// Public Methods Overriding Object
     public boolean equals(Object obj);
     public int hashCode( );
}
```

Chapter 18. javax.net and javax.net.ssl

This chapter documents the `javax.net` package and, more importantly, its subpackage `javax.net.ssl`. These packages were originally defined by the Java Secure Sockets Extension (JSSE) before they were integrated into Java 1.4, which is why they have a "javax" prefix.

`javax.net` is a small package that simply defines abstract factory classes for creating network sockets and servers sockets. `javax.net.ssl` provides subclasses of these factory classes that have the specific purpose of creating sockets and server sockets that enable secure network communication through the SSL protocol and the closely-related TLS protocol.

Team LiB

Package javax.net

Java 1.4

This small package defines factory classes for creating sockets and server sockets. These factory classes can be used to create regular `java.net.Socket` and `java.net.ServerSocket` objects. More importantly, however, these factory classes can be subclassed to serve as factories for other types of sockets such as the SSL-enabled sockets of the `javax.net.ssl` package.

Classes

```
public abstract class ServerSocketFactory;
public abstract class SocketFactory;
```

Team LiB

ServerSocketFactory javax.net

Java 1.4

This abstract class defines a factory API for creating server socket objects. Use the static `getdefault( )` method to obtain a default `ServerSocketFactory` object that is suitable for creating regular `java.net.ServerSocket` sockets. Once you have a `ServerSocketFactory` object, call one of the `createServerSocket( )` methods to create a new socket and optionally bind it to a local port and specify the allowed backlog of queued connections. See `javax.net.ssl.SSLServerSocketFactory` for a socket factory that can create secure `javax.net.ssl.SSLServerSocket` objects.

```
public abstract class ServerSocketFactory {
// Protected Constructors
     protected ServerSocketFactory( );
// Public Class Methods
     public static ServerSocketFactory getDefault( );
// Public Instance Methods
     public java.net.ServerSocket createServerSocket( ) throws java.io.IOException;
     public abstract java.net.ServerSocket createServerSocket(int port)
        throws java.io.IOException;
     public abstract java.net.ServerSocket createServerSocket(int port,
        int backlog) throws java.io.IOException;
     public abstract java.net.ServerSocket createServerSocket(int port,
        int backlog, java.net.InetAddress ifAddress) throws java.io.IOException;
}
```

Subclasses

`javax.net.ssl.SSLServerSocketFactory`

Returned By

`javax.net.ssl.SSLServerSocketFactory.getDefault( )`

Team LiB

SocketFactory javax.net

Java 1.4

This abstract class defines a factory API for creating socket objects. Use the static`getdefault( )` method to obtain a default `SocketFactory` object that is suitable for creating regular `java.net.Socket` sockets. (This default `SocketFactory` is the one used by the `Socket( )` constructor, which usually provides an easier way to create normal sockets.) Once you have a `SocketFactory` object, call one of the `createSocket( )` methods to create a new socket and optionally connect it to a remote host and optionally bind it to a local address and port. See `javax.net.ssl.SSLSocketFactory` for a socket factory that can create secure `javax.net.ssl.SSLSocket` objects.

```
public abstract class SocketFactory {
// Protected Constructors
     protected SocketFactory( );
// Public Class Methods
     public static SocketFactory getDefault( );
// Public Instance Methods
     public java.net.Socket createSocket( ) throws java.io.IOException;
     public abstract java.net.Socket createSocket(String host, int port)
        throws java.io.IOException, java.net.UnknownHostException;
     public abstract java.net.Socket createSocket(java.net.InetAddress host,
        int port) throws java.io.IOException;
     public abstract java.net.Socket createSocket(java.net.InetAddress address,
        int port, java.net.InetAddress localAddress,
        int localPort)
        throws java.io.IOException;
     public abstract java.net.Socket createSocket(String host, int port,
        java.net.InetAddress localHost, int localPort)
        throws java.io.IOException, java.net.UnknownHostException;
}
```

Subclasses

`javax.net.ssl.SSLSocketFactory`

Returned By

`javax.net.ssl.SSLSocketFactory.getDefault( )`

Team LiB

Package javax.net.ssl

Java 1.4

This package defines an API for secure network sockets using the SSL (Secure Sockets Layer) protocol, or the closely related TLS (Transport Layer Security) protocol. It defines the SSLSocket and SSLServerSocket subclasses of the java.net socket and server socket classes. And it defines SSLSocketFactory and SSLServerSocketFactory subclasses of the javax.net factory classes to create those SSL-enabled sockets and server sockets. Clients that want to perform simple SSL-enabled networking can create an SSLSocket with code like the following:

```
SSLSocketFactory factory = SSLSocketFactory.getDefault( );
SSLSocket securesock = (SSLSocket)factory.getSocket(hostname,
                                                     443);     // https port
```

Once an SSLSocket has been created, it can be used just like a normal java.net.Socket. Once a connection is established over an SSLSocket, you can use the getSession( ) method to obtain an SSLSession object that provides information about the connection. Note that despite the name of this package and of its key classes, it supports the TLS protocol in addition to the SSL. (The default provider in Sun's implementation supports SSL 3.0 and TLS 1.0.) The TLS protocol is closely related to SSL, and we'll simply use the term SSL here.

The SSLSocket class allows you to do arbitrary networking with an SSL-enabled peer. The most common use of SSL today is with the https: protocol on the web. The addition of this package to the core Java platform enables support for https: URLs in the java.net.URL class, which allows you to securely transfer data over the web without having to directly use this package at all. When you call openConnection( ) on a https: URL, the URLConnection object that is returned can be cast to an HttpsURLConnection object, which defines some SSL-specific methods. See java.net.URL and java.net.URLConnection for more information about networking with URLs.

Although the code shown above to create a SSLSocket is quite simple, this package is much more complex because it exposes a lot of SSL infrastructure so that applications with advanced networking needs can configure it as needed. Also, like all security-related packages, this one is provider-based and algorithm-independent, which adds a layer of complexity. If you want to explore this package beyond the two socket classes, the two factory classes, and the HttpsURLConnection class, start with SSLContext. This class is a factory for socket factories, and as such is the central class of the API. To customize the way SSL networking is done, you create an SSLContext optionally specifing the desired provider of the implementation. Next, you initialize the SSLContext by providing a custom KeyManager as a source of authentication information to be supplied to the remote host if required, a custom TRustManager as a verifier for the authentication information (if any) presented by the remote host, and a custom java.security.SecureRandom object as a source of randomness. Once the SSLContext is initialized in this way, you can use it to create SSLSocketFactory and SSLServerSocketFactory objects that use the KeyManager and trustManager objects you supplied.

In Java 5.0, the SSLContext can also be used to create an SSLEngine object, which performs transport-independent SSL encryption of outbound packets and SSL decryption of inbound packets. This enables the use of SSL with the nonblocking networking facilities of the`java.nio.channels` package, for example.

Interfaces

```
public interface HandshakeCompletedListener extends java.util.EventListener;
public interface HostnameVerifier;
public interface KeyManager;
public interface ManagerFactoryParameters;
public interface SSLSession;
public interface SSLSessionBindingListener extends java.util.EventListener;
public interface SSLSessionContext;
public interface TrustManager;
public interface X509KeyManager extends KeyManager;
public interface X509TrustManager extends TrustManager;
```

Enumerated Types

```
public enum SSLEngineResult.HandshakeStatus;
public enum SSLEngineResult.Status;
```

Events

```
public class HandshakeCompletedEvent extends java.util.EventObject;
public class SSLSessionBindingEvent extends java.util.EventObject;
```

Other Classes

```
public class CertPathTrustManagerParameters implements ManagerFactoryParameters;
public abstract class HttpsURLConnection extends java.net.HttpURLConnection;
public class KeyManagerFactory;
public abstract class KeyManagerFactorySpi;
public class KeyStoreBuilderParameters implements ManagerFactoryParameters;
public class SSLContext;
public abstract class SSLContextSpi;
public abstract class SSLEngine;
public class SSLEngineResult;
public final class SSLPermission extends java.security.BasicPermission;
public abstract class SSLServerSocket extends java.net.ServerSocket;
public abstract class SSLServerSocketFactory extends javax.net.ServerSocketFactory;
public abstract class SSLSocket extends java.net.Socket;
public abstract class SSLSocketFactory extends javax.net.SocketFactory;
public class TrustManagerFactory;
public abstract class TrustManagerFactorySpi;
```

```
public abstract class X509ExtendedKeyManager implements X509KeyManager;
```

Exceptions

```
public class SSLException extends java.io.IOException;
   public class SSLHandshakeException extends SSLException;
   public class SSLKeyException extends SSLException;
   public class SSLPeerUnverifiedException extends SSLException;
   public class SSLProtocolException extends SSLException;
```

Team LiB

CertPathTrustManagerParameters javax.net.ssl

Java 5.0

This class implements the `ManagerFactoryParameters` interface and wraps a `java.security.cert.CertPathParameters` object used to initialize a `trustManager` based on a certifica
See the `init( )` method of `TRustManagerFactory` .

Figure 18-1. javax.net.ssl.CertPathTrustManagerParameters


```
public class CertPathTrustManagerParameters implements ManagerFactoryParameters {
// Public Constructors
     public CertPathTrustManagerParameters(java.security.cert.CertPathParameters parame
// Public Instance Methods
     public java.security.cert.CertPathParameters getParameters( );
}
```

HandshakeCompletedEvent javax.net.ssl

Java 1.4 *serializable event*

An instance of this class is passed to the handshakeCompleted( ) method of any registered HandshakeCompletedListener objects by an SSLSocket when that socket completes the handshake pha establishing a connection. The various methods of a HandshakeCompletedEvent return information (such the name of the cipher suite in use and the certificate chain of the remote host) that was determined du that handshake.

Note that the getPeerCertificateChain( ) method returns an object from the javax.security.cert package, which is not documented in this book. The method and package exist only for backward compa with earlier versions of the JSSE API, and should be considered deprecated. Use getPeerCertificates(which uses java.security.cert instead.

Figure 18-2. javax.net.ssl.HandshakeCompletedEvent

```
public class HandshakeCompletedEvent extends java.util.EventObject {
// Public Constructors
     public HandshakeCompletedEvent(SSLSocket sock, SSLSession s);
// Public Instance Methods
     public String getCipherSuite( );
     public java.security.cert.Certificate[ ] getLocalCertificates( );
5.0  public java.security.Principal getLocalPrincipal( );
     public javax.security.cert.X509Certificate[ ] getPeerCertificateChain( )
        throws SSLPeerUnverifiedException;
     public java.security.cert.Certificate[ ] getPeerCertificates( )
        throws SSLPeerUnverifiedException;
5.0  public java.security.Principal getPeerPrincipal( ) throws SSLPeerUnverifiedExcepti
     public SSLSession getSession( );
     public SSLSocket getSocket( );
}
```

Passed To

HandshakeCompletedListener.handshakeCompleted( )

HandshakeCompletedListener javax.net.ssl

Java 1.4 *event listener*

This interface is implemented by any class that wants to receive notifications (in the form of a call to `handshakeCompleted( )` method) when an `SSLSocket` completes the SSL handshake. Register a `HandshakeCompletedListener` for an `SSLSocket` by passing it to the `addHandshakeCompletedListener( )` method of the socket. When the socket completes the handshake phase of connection, it will call the `handshakeCompleted( )` method of all registered listeners, passing in a `HandshakeCompletedEvent` object.

Figure 18-3. javax.net.ssl.HandshakeCompletedListener


```
public interface HandshakeCompletedListener extends java.util.EventListener {
// Public Instance Methods
     void handshakeCompleted(HandshakeCompletedEvent event);
}
```

Passed To

`SSLSocket.{addHandshakeCompletedListener( ), removeHandshakeCompletedListener( )}`

Team LiB

HostnameVerifier javax.net.ssl

Java 1.4

An object that implements this interface may be used with an `HttpsURLConnection` object to handle the case in which the hostname that appears in the URL does not match the hostname obtained during the SSL handshake with the server. This occurs, for example, when a website uses the secure certificate of its parent web hosting company, for example. In this situation, the `verify( )` method of the `HostnameVerifier` is called to determine whether the connection should proceed or not. `verify( )` should return `true` to allow the connection to proceed, and should return `false` to cause the connection to fail. The *`hostname`* argument to `verify( )` specifies the hostname that appeared in the URL. The *`session`* argument specifies the `SSLSession` object that was established during the handshake. Call `getPeerHost( )` on this object to determine the hostname reported during server authentication. If no `HostnameVerifier` is registered with a `HttpsURLConnection` object, and no default verifier is registered with the `HttpsURLConnection` class, then hostname mismatches will always cause the connection to fail. In user-driven applications such as web browsers, a `HostnameVerifier` can be used to ask the user whether to proceed or not.

```
public interface HostnameVerifier {
// Public Instance Methods
     boolean verify(String hostname, SSLSession session);
}
```

Passed To

`HttpsURLConnection.{setDefaultHostnameVerifier( ), setHostnameVerifier( )}`

Returned By

`HttpsURLConnection.{getDefaultHostnameVerifier( ), getHostnameVerifier( )}`

Type Of

`HttpsURLConnection.hostnameVerifier`

Team LiB

HttpsURLConnection javax.net.ssl

Java 1.4

This class is a java.net.URLConnection for a URL that uses the https: protocol. It extends java.net.HttpURLConnection and, in addition to inheriting the methods of its superclasses, it defines methods for specifying the SSLSocketFactory and HostnameVerifier to use when establishing the connection. Static versions of these methods allow you to specify a default factory and verifier objects for use with all HttpsURLConnection objects. After the connection has been established, several other methods exist to obtain information (such as the cipher suite and the server certificates) about the connection itself.

Obtain a HttpsURLConnection object by calling the openConnection( ) method of a URL that uses the https:// protocol specifier, and casting the returned value to this type. The HttpsURLConnection object is unconnected at this point, and you can call setHostnameVerifier( ) and setSSLSocketFactory( ) to customize the way the connection is made. (If you do not specify a HostnameVerifier for the instance, or a default one for the class, then hostname mismatches will always cause the connection to fail. If you do not specify an SSLSocketFactory for the instance or class, then a default one will be used.) To connect, call the inherited connect( ) method, and then call the inherited getContent( ) to retrieve the content of the URL as an object, or use the inherited getInputStream( ) to obtain a java.io.InputStream with which you can read the content of the URL.

Figure 18-4. javax.net.ssl.HttpsURLConnection

```
public abstract class HttpsURLConnection extends java.net.HttpURLConnection {
// Protected Constructors
     protected HttpsURLConnection(java.net.URL url);
// Public Class Methods
     public static HostnameVerifier getDefaultHostnameVerifier( );
     public static SSLSocketFactory getDefaultSSLSocketFactory( );
     public static void setDefaultHostnameVerifier(HostnameVerifier v);
     public static void setDefaultSSLSocketFactory(SSLSocketFactory sf);
// Public Instance Methods
     public abstract String getCipherSuite( );
     public HostnameVerifier getHostnameVerifier( );
     public abstract java.security.cert.Certificate[ ] getLocalCertificates( );
5.0  public java.security.Principal getLocalPrincipal( );
5.0  public java.security.Principal getPeerPrincipal( )
        throws SSLPeerUnverifiedException;
```

```
    public abstract java.security.cert.Certificate[ ] getServerCertificates( )
       throws SSLPeerUnverifiedException;
    public SSLSocketFactory getSSLSocketFactory( );
    public void setHostnameVerifier(HostnameVerifier v);
    public void setSSLSocketFactory(SSLSocketFactory sf);
// Protected Instance Fields
    protected HostnameVerifier hostnameVerifier;
}
```

KeyManager javax.net.ssl

Java 1.4

This is a marker interface to identify key manager objects. A key manager is responsible for obtaining and managing authentication credentials (such as a certificate chain and an associated private key) that the local host can use to authenticate itself to the remote host. It is usually used on the server-side of an SSL connection, but can be used on the client-side as well.

Use a `KeyManagerFactory` to obtain `KeyManager` objects. `KeyManager` objects returned by a `KeyManagerFactory` can always be cast to a subinterface specific to a particular type of authentication credentials. See `X509KeyManager`, for example.

```
public interface KeyManager {
}
```

Implementations

`X509KeyManager`

Passed To

`SSLContext.init( )`, `SSLContextSpi.engineInit( )`

Returned By

`KeyManagerFactory.getKeyManagers( )`, `KeyManagerFactorySpi.engineGetKeyManagers( )`

Team LiB

KeyManagerFactory javax.net.ssl

Java 1.4

A KeyManagerFactory is responsible for creating KeyManager objects for a specific key management algorithm. Obtain a KeyManagerFactory object by calling one of the getInstance( ) methods and specifying the desired algorithm and, optionally, the desired provider. In Java 1.4, the "SunX509" algorithm is the only one supported by the default "SunJSSE" provider. After calling getInstance( ), you initialize the factory object with init( ). For the "SunX509" algorithm, you always use the two-argument version of init( ) passing in a KeyStore object that contains the private keys and certificates required by X509KeyManager objects, and also specifying the password used to protect the private keys in that KeyStore. Once a KeyManagerFactory has been created and initialized, use it to create a KeyManager by calling getKeyManagers( ). This method returns an array of KeyManager objects because some key management algorithms may handle more than one type of key. The "SunX509" algorithm manages only X509 keys, and always returns an array with an X509KeyManager object as its single element. This returned array is typically passed to the init( ) method of an SSLContext object.

If a KeyStore and password are not passed to the init( ) method of the KeyManagerFactory for the "SunX509" algorithm, then the factory uses attempts to read a KeyStore from the file specified by the javax.net.ssl.keyStore system property using the password specified by the javax.net.ssl.keyStorePassword. The type of the keystore is specified by javax.net.ssl.keyStoreType.

```
public class KeyManagerFactory {
// Protected Constructors
     protected KeyManagerFactory(KeyManagerFactorySpi factorySpi,
       java.security.Provider provider, String algorithm);
// Public Class Methods
     public static final String getDefaultAlgorithm( );
     public static final KeyManagerFactory getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static final KeyManagerFactory getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
     public static final KeyManagerFactory getInstance(String algorithm,
        String provider) throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
// Public Instance Methods
     public final String getAlgorithm( );
     public final KeyManager[ ] getKeyManagers( );
     public final java.security.Provider getProvider( );
     public final void init(ManagerFactoryParameters spec)
        throws java.security.InvalidAlgorithmParameterException;
     public final void init(java.security.KeyStore ks, char[ ] password)
```

```
        throws java.security.KeyStoreException,
        java.security.NoSuchAlgorithmException,
        java.security.UnrecoverableKeyException;
}
```

Team LiB

KeyManagerFactorySpi javax.net.ssl

Java 1.4

This abstract class defines the Service Provider Interface for `KeyManagerFactory` . Security providers must implement this interface, but applications never need to use it.

```
public abstract class KeyManagerFactorySpi {
// Public Constructors
     public KeyManagerFactorySpi( );
// Protected Instance Methods
     protected abstract KeyManager[ ] engineGetKeyManagers( );
     protected abstract void engineInit(ManagerFactoryParameters spec)
        throws java.security.InvalidAlgorithmParameterException;
     protected abstract void engineInit(java.security.KeyStore ks, char[ ] password)
throws java.security.KeyStoreException, java.security.NoSuchAlgorithmException,
        java.security.UnrecoverableKeyException;
}
```

Passed To

`KeyManagerFactory.KeyManagerFactory( )`

KeyStoreBuilderParameters javax.net.ssl

Java 5.0

This class implements the `ManagerFactoryParameters` interface and encapsulates a `java.util.List` of `java.security.KeyStore.Builder` object for use by an `X509KeyManager`. See the `init( )` method of `KeyManagerFactory`.

Figure 18-5. javax.net.ssl.KeyStoreBuilderParameters


```
public class KeyStoreBuilderParameters implements ManagerFactoryParameters {
// Public Constructors
     public KeyStoreBuilderParameters(java.util.List parameters);
     public KeyStoreBuilderParameters(java.security.KeyStore.Builder builder);
// Public Instance Methods
     public java.util.List getParameters( );
}
```

Team LiB

ManagerFactoryParameters javax.net.ssl

Java 1.4

This marker interface identifies objects that provide algorithm-specific or provider-specific initialization parameters for KeyManagerFactory and trustManagerFactory objects. In the default "SunJSSE" provider shiped by Sun, the only supported type for these factory classes is "SunX509". Factories of these types need to be initialized with a KeyStore object but do not require any specialized ManagerFactoryParameters object. Therefore, the javax.net.ssl package does not define any subinterfaces of this interface, and it is never used with the default provider. Third-party or future providers may use it, however.

```
public interface ManagerFactoryParameters {
}
```

Implementations

CertPathTrustManagerParameters, KeyStoreBuilderParameters

Passed To

KeyManagerFactory.init( ), KeyManagerFactorySpi.engineInit( ), TRustManagerFactory.init( ), TRustManagerFactorySpi.engineInit( )

Team LiB

SSLContext javax.net.ssl

Java 1.4

This class is a factory for socket and server socket factories. Although most applications do not need to this class directly, it is the central class of the javax.net.ssl package. Most applications use the default SSLSocketFactory and SSLServerSocketFactory objects returned by the static getdefault( ) methoc those classes. Applications that want to perform SSL networking using a security provider other than the default provider, or that want to customize key management or trust management for the SSL connecti should use custom socket factories created from a custom SSLContext . In Java 5.0, this class also inclu createSSLEngine( ) factory methods for creating SSLEngine objects.

Create an SSLContext by passing the name of the desired secure socket protocol and, optionally, the de provider to getInstance( ) . The default "SunJSSE" provider supports protocol strings "SSL", "SSLv2", "SSLv3", "TLS", and "TLSv1". Once you have created an SSLContext object, call its init( ) method to s the KeyManager , trustManager , and SecureRandom objects it requires. If any of the init( ) argument null , a default value will be used. Finally, obtain a SSLSocketFactory and SSLServerSocketFactory by calling getSocketFactory( ) and getServerSocketFactory( ) .

```
public class SSLContext {
// Protected Constructors
     protected SSLContext(SSLContextSpi contextSpi, java.security.Provider provider,
        String protocol);
// Public Class Methods
     public static SSLContext getInstance(String protocol)
        throws java.security.NoSuchAlgorithmException;
     public static SSLContext getInstance(String protocol, String provider)
        throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
     public static SSLContext getInstance(String protocol, java.security.Provider provi
        throws java.security.NoSuchAlgorithmException;
// Public Instance Methods
5.0  public final SSLEngine createSSLEngine( );
5.0  public final SSLEngine createSSLEngine(String peerHost, int peerPort);
     public final SSLSessionContext getClientSessionContext( );
     public final String getProtocol( );
     public final java.security.Provider getProvider( );
     public final SSLSessionContext getServerSessionContext( );
     public final SSLServerSocketFactory getServerSocketFactory( );
     public final SSLSocketFactory getSocketFactory( );
     public final void init(KeyManager[ ] km, TrustManager[ ] tm,
        java.security.SecureRandom random)
        throws java.security.KeyManagementException;
}
```

Team LiB

SSLContextSpi javax.net.ssl

Java 1.4

This abstract class defines the Service Provider Interface for SSLContext. Security providers must implement this interface, but applications never need to use it.

```
public abstract class SSLContextSpi {
// Public Constructors
     public SSLContextSpi( );
// Protected Instance Methods
5.0  protected abstract SSLEngine engineCreateSSLEngine( );
5.0  protected abstract SSLEngine engineCreateSSLEngine(String host, int port);
     protected abstract SSLSessionContext engineGetClientSessionContext( );
     protected abstract SSLSessionContext engineGetServerSessionContext( );
     protected abstract SSLServerSocketFactory engineGetServerSocketFactory( );
     protected abstract SSLSocketFactory engineGetSocketFactory( );
     protected abstract void engineInit(KeyManager[ ] km, TrustManager[ ] tm,
        java.security.SecureRandom sr)
        throws java.security.KeyManagementException;
}
```

Passed To

SSLContext.SSLContext( )

Team LiB

SSLEngine javax.net.ssl

Java 5.0

This class performs SSL handshaking, encryption and decryption, but does not send or receive messages over the network. This leaves the network transport mechanism up to the user of this class, and enables SSL communication using the nonblocking I/O mechanisms of the `java.nio` package. The price of this flexibility is that your code must follow a relatively complex protocol to use an `SSLEngine` correctly.

Create an `SSLEngine` with `SSLContext.createSSLEngine( )`. Next, configure it with the various setter methods to specify authentication requirements, encryption algorithms, etc. After creating and configuring an engine, you use it to encrypt outbound data from one `ByteBuffer` to another with `wrap( )` and to decrypt inbound data from one byte buffer to another with `unwrap( )`. (Note that the `wrap( )` and `unwrap( )` methods also come in gathering and scattering variants.) Both methods return an `SSLEngineResult`.

The initial call or calls to `wrap( )` produce outbound handshaking data without consuming any of the source bytes in the buffer you provide. Initial calls to `unwrap( )` may consume inbound handshaking data without producing any result bytes. Monitor the `SSLEngineResult.HandshakeStatus` value to ensure that handshaking is proceeding as needed. When handshaking is complete, you can call `getSession( )` to obtain the `SSLSession` object that describes session details negotiated during handshaking. Remember that either peer of an SSL connection may request a new handshake at any time; this means that you must monitor the `HandshakeStatus` after every `wrap( )` or `unwrap( )` call in case a new handshake has been requested. You can request a new handshake yourself with `beginHandshake( )`.

As part of the handshaking protocol, the `SSLEngine` typically needs to use the `KeyManager` or `trustManager` of the originating `SSLContext` object. Rather than blocking a `wrap( )` or `unwrap( )` method while these operations are performed, it instead returns an `SSLResult.HandshakeStatus`, indicating that a task needs to be performed. When this happens, you must call `geTDelegatedTask( )` repeatedly, calling the `run( )` methods of the `Runnable` objects it returns until it returns `null` to indicate that all necessary tasks have been completed. (If it returns more than one `Runnable`, it is safe to run them in parallel (with a `java.util.concurrent.ExecutorCompletionService`, for example). Once all such tasks have been run, the original call to `wrap( )` or `unwrap( )` should be repeated.

When you are done sending outbound data, call `closeOutbound( )`, and then call `wrap( )` one or more times to flush any remaining data from the engine. Call `wrap( )` until the returned `SSLEngineResult.Status` indicates that the connection has closed. Similarly, if you are done reading inbound data, call `closeInbound( )` and final calls to `unwrap( )` until the connection is closed.

It is safe for one thread to call `wrap( )` while another thread is calling `unwrap( )`. It is not safe, however, for either method to be called by two threads at once.

```
public abstract class SSLEngine {
// Protected Constructors
```

```
    protected SSLEngine( );
    protected SSLEngine(String peerHost, int peerPort);
// Public Instance Methods
    public abstract void beginHandshake( ) throws SSLException;
    public abstract void closeInbound( ) throws SSLException;
    public abstract void closeOutbound( );
    public abstract Runnable getDelegatedTask( );
    public abstract String[ ] getEnabledCipherSuites( );
    public abstract String[ ] getEnabledProtocols( );
    public abstract boolean getEnableSessionCreation( );
    public abstract SSLEngineResult.HandshakeStatus getHandshakeStatus( );
    public abstract boolean getNeedClientAuth( );
    public String getPeerHost( );
    public int getPeerPort( );
    public abstract SSLSession getSession( );
    public abstract String[ ] getSupportedCipherSuites( );
    public abstract String[ ] getSupportedProtocols( );
    public abstract boolean getUseClientMode( );
    public abstract boolean getWantClientAuth( );
    public abstract boolean isInboundDone( );
    public abstract boolean isOutboundDone( );
    public abstract void setEnabledCipherSuites(String[ ] suites);
    public abstract void setEnabledProtocols(String[ ] protocols);
    public abstract void setEnableSessionCreation(boolean flag);
    public abstract void setNeedClientAuth(boolean need);
    public abstract void setUseClientMode(boolean mode);
    public abstract void setWantClientAuth(boolean want);
    public SSLEngineResult unwrap(java.nio.ByteBuffer src, java.nio.
       ByteBuffer dst) throws SSLException;
    public SSLEngineResult unwrap(java.nio.ByteBuffer src, java.nio.
       ByteBuffer[ ] dsts) throws SSLException;
    public abstract SSLEngineResult unwrap(java.nio.ByteBuffer src,
       java.nio.ByteBuffer[ ] dsts, int offset,
       int length) throws SSLException;
    public SSLEngineResult wrap(java.nio.ByteBuffer[ ] srcs, java.nio.
       ByteBuffer dst) throws SSLException;
    public SSLEngineResult wrap(java.nio.ByteBuffer src, java.nio.
       ByteBuffer dst) throws SSLException;
    public abstract SSLEngineResult wrap(java.nio.ByteBuffer[ ] srcs,
       int offset, int length,
       java.nio.ByteBuffer dst) throws SSLException;
}
```

Passed To

X509ExtendedKeyManager.{chooseEngineClientAlias( ), chooseEngineServerAlias( )}

Returned By

`SSLContext.createSSLEngine( )`, `SSLContextSpi.engineCreateSSLEngine( )`

Team LiB

SSLEngineResult javax.net.ssl

Java 5.0

An object of this type is returned by the wrap( ) and unwrap( ) methods of an SSLEngine. Use the methods of this object to determine how much data was consumed and produced and to obtain the Status of the operation and the HandshakeStatus of the connection. These two nested enumerated types return important values. Correct operation of an SSLEngine requires that your code respond correctly to the Status and HandshakeStatus results.

```
public class SSLEngineResult {
// Public Constructors
     public SSLEngineResult(SSLEngineResult.Status status, SSLEngineResult.
        HandshakeStatus handshakeStatus,
        int bytesConsumed, int bytesProduced);
// Nested Types
     public enum HandshakeStatus;
     public enum Status;
// Public Instance Methods
     public final int bytesConsumed( );
     public final int bytesProduced( );
     public final SSLEngineResult.HandshakeStatus getHandshakeStatus( );
     public final SSLEngineResult.Status getStatus( );
// Public Methods Overriding Object
     public String toString( );
}
```

Returned By

SSLEngine.{unwrap( ), wrap( )}

SSLEngineResult.HandshakeStatus javax.net.ssl

Java 5.0 *serializable comparable enum*

The constants defined by this enumerated type specify the handshake status of the SSLEngine and often specify the action your code must take next in order to ensure correct operation. The values are the following:

NOT_HANDSHAKING

Handshaking is not currently in progress.

FINISHED

Handshaking just completed as a result of the wrap( ) or unwrap( ) call that generated this value.

NEED_WRAP

The SSLEngine needs to send more handshake data, so a call to wrap( ) is necessary.

NEED_UNWRAP

The SSLEngine needs to receive more handshake data, so a call to unwrap( ) is necessary.

NEED_TASK

The SSLEngine needs to perform an authentication or related task, so you must repeatedly call getdelegatedTask( ) and run( ) any Runnable objects it returns.

```
public enum SSLEngineResult.HandshakeStatus {
// Enumerated Constants
     NOT_HANDSHAKING,
     FINISHED,
     NEED_TASK,
     NEED_WRAP,
     NEED_UNWRAP;
```

```
// Public Class Methods
     public static SSLEngineResult.HandshakeStatus valueOf(String name);
     public static final SSLEngineResult.HandshakeStatus[ ] values( );
}
```

Passed To

SSLEngineResult.SSLEngineResult( )

Returned By

SSLEngine.getHandshakeStatus( ), SSLEngineResult.getHandshakeStatus( )

Team LiB

Team LiB

SSLEngineResult.Status javax.net.ssl

Java 5.0 *serializable comparable enum*

The constants of this enumerated type indicate the status of a `wrap( )` or `unwrap( )` operation:

`OK`

The operation completed normally.

`CLOSED`

The most recent call to `wrap( )` or `unwrap( )` completed the closing handshake and closed the outbound or inbound connection. Or, that connection is already closed, and so the `wrap( )` or `unwrap( )` call could not proceed.

`BUFFER_OVERFLOW`

There were not enough bytes in the destination buffer to hold the results. Drain the buffer and try again.

`BUFFER_UNDERFLOW`

There were not enough incoming bytes in the source buffer to produce a complete output packet. Fill the buffer with more bytes from the network and call `unwrap( )` again.

```
public enum SSLEngineResult.Status {
// Enumerated Constants
     BUFFER_UNDERFLOW,
     BUFFER_OVERFLOW,
     OK,
     CLOSED;
// Public Class Methods
     public static SSLEngineResult.Status valueOf(String name);
     public static final SSLEngineResult.Status[ ] values( );
}
```

Passed To

SSLEngineResult.SSLEngineResult( )

Returned By

SSLEngineResult.getStatus( )

SSLException javax.net.ssl

Java 1.4 *serializable checked*

Signals an SSL-related problem. This class serves as the common superclass of more specific SSL exception subclasses.

Figure 18-6. javax.net.ssl.SSLException


```
public class SSLException extends java.io.IOException {
// Public Constructors
5.0  public SSLException(Throwable cause);
     public SSLException(String reason);
5.0  public SSLException(String message, Throwable cause);
}
```

Subclasses

SSLHandshakeException, SSLKeyException, SSLPeerUnverifiedException, SSLProtocolException

Thrown By

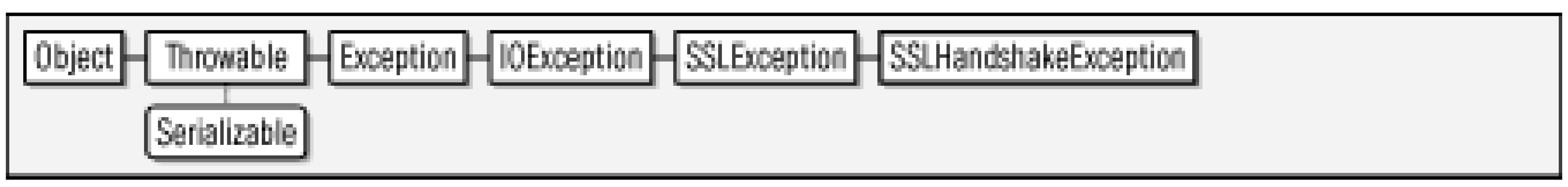
SSLEngine.{beginHandshake( ), closeInbound( ), unwrap( ), wrap( )}

SSLHandshakeException javax.net.ssl

Java 1.4 *serializable checked*

Signals that the SSL handshake failed for some reason other than failed authentication (see `SSLPeerUnverifiedException`). For example, it may be thrown because the client and server count not agree on a mutually-acceptable cipher suite. When this exception is thrown, the `SSLSocket` object is no longer usable.

Figure 18-7. javax.net.ssl.SSLHandshakeException




```
public class SSLHandshakeException extends SSLException {
// Public Constructors
     public SSLHandshakeException(String reason);
}
```

Team LiB

SSLKeyException javax.net.ssl

Java 1.4 *serializable checked*

Signals a problem with the public key certificate and private key used by a server (or client) for authentication.

Figure 18-8. javax.net.ssl.SSLKeyException


```
public class SSLKeyException extends SSLException {
// Public Constructors
     public SSLKeyException(String reason);
}
```

SSLPeerUnverifiedException javax.net.ssl

Java 1.4 *serializable checked*

Signals that authentication of the remote host was not successfully completed.

Figure 18-9. javax.net.ssl.SSLPeerUnverifiedException


```
public class SSLPeerUnverifiedException extends SSLException {
// Public Constructors
     public SSLPeerUnverifiedException(String reason);
}
```

Thrown By

java.net.SecureCacheResponse.{getPeerPrincipal( ), getServerCertificateChain( )}, HandshakeCompletedEvent.{getPeerCertificateChain( ), getPeerCertificates( ), getPeerPrincipal( )}, HttpsURLConnection.{getPeerPrincipal( ), getServerCertificates( )}, SSLSession.{getPeerCertificateChain( ), getPeerCertificates( ), getPeerPrincipal( )}

SSLPermission javax.net.ssl

Java 1.4 *serializable permission*

This `Permission` class controls access to sensitive methods in the `javax.net.ssl` package. The two defined target names are "setHostnameVerifier" and "getSSLSessionContext". The first is required in order to call `HttpURLConnection.setHostnameVerifier( )` and `HttpURLConnection.setDefaultHostnameVerifier( )`. The second permission target is required in order to call `SSLSession.getSessionContext( )`.

Figure 18-10. javax.net.ssl.SSLPermission


```
public final class SSLPermission extends java.security.BasicPermission {
// Public Constructors
     public SSLPermission(String name);
     public SSLPermission(String name, String actions);
}
```

SSLProtocolException javax.net.ssl

Java 1.4 *serializable checked*

Signals a problem at the SSL protocol level. An exception of this type usually indicates that there is a bug in the SSL implementation being used locally or on the remote host.

Figure 18-11. javax.net.ssl.SSLProtocolException


```
public class SSLProtocolException extends SSLException {
// Public Constructors
     public SSLProtocolException(String reason);
}
```

SSLServerSocket javax.net.ssl

Java 1.4

This class is an SSL-enabled subclass of `java.net.ServerSocket` that is used to listen for and accept connections from clients and to create `SSLSocket` objects for communicating with those clients. Create an `SSLServerSocket` and bind it to a local port by calling one of the inherited `getServerSocket( )` methods of an `SSLServerSocketFactory`. Once a `SSLServerSocket` is created, use it as you would a regular `ServerSocket`: call the inherited `accept( )` method to wait for and accept a connection from a client, returning a `Socket` object. With `SSLServerSocket`, the `Socket` returned by `accept( )` can always be cast to an instance of `SSLSocket`.

`SSLServerSocket` defines methods for setting the enabled protocols and cipher suites, and for querying the full set of supported protocols and suites. See `SSLSocket`, which has methods with the same names, for details. If your server desires or requires authentication by its clients, call `setWantClientAuth( )` or `setNeedClientAuth( )`. These methods cause the `SSLSocket` objects returned by `accept( )` to be configured to request or require client authentication.

In typical SSL networking scenarios, the client requires the server to provide authentication information. When you create an `SSLServerSocket` using the default `SSLServerSocketFactory`, the authentication information required is an X.509 public key certificate and the corresponding private key. The default `SSLServerSocketFactory` uses an `X509KeyManager` to obtain this information. The default `X509KeyManager` attempts to read this information from the `java.security.KeyStore` file specified by the system property `javax.net.ssl.keyStore`. It uses the value of the the `javax.net.ssl.keyStorePassword` as the keystore password, and uses the value of the `javax.net.ssl.keyStoreType` system property to specify the keystore type. The key store should only contain valid keys and certificate chains that identify the server; the `X509KeyManager` automatically chooses a key and certificat chain that are appropriate for the client.

Figure 18-12. javax.net.ssl.SSLServerSocket

```
public abstract class SSLServerSocket extends java.net.ServerSocket {
// Protected Constructors
     protected SSLServerSocket( ) throws java.io.IOException;
     protected SSLServerSocket(int port) throws java.io.IOException;
     protected SSLServerSocket(int port, int backlog) throws java.io.IOException;
     protected SSLServerSocket(int port, int backlog, java.net.InetAddress address)
        throws java.io.IOException;
// Public Instance Methods
     public abstract String[ ] getEnabledCipherSuites( );
     public abstract String[ ] getEnabledProtocols( );
```

```
    public abstract boolean getEnableSessionCreation( );
    public abstract boolean getNeedClientAuth( );
    public abstract String[ ] getSupportedCipherSuites( );
    public abstract String[ ] getSupportedProtocols( );
    public abstract boolean getUseClientMode( );
    public abstract boolean getWantClientAuth( );
    public abstract void setEnabledCipherSuites(String[ ] suites);
    public abstract void setEnabledProtocols(String[ ] protocols);
    public abstract void setEnableSessionCreation(boolean flag);
    public abstract void setNeedClientAuth(boolean need);
    public abstract void setUseClientMode(boolean mode);
    public abstract void setWantClientAuth(boolean want);
}
```

SSLServerSocketFactory javax.net.ssl

Java 1.4

This class is a javax.net.ServerSocketFactory for creating SSLServerSocket objects. Most applications use the default SSLServerSocketFactory returned by the static getdefault( ) method. Once this SSLServerSocketFactory has been obtained, they use one of the inherited createServerSocket( ) methods to create and optionally bind a new SSLServerSocket . The return value of the createServerSocket( ) methods is a java.net.ServerSocket object, but you can safely cast this object to a SSLServerSocket if you need to.

Applications that need to customize the SSL configuration and cannot use the default server socket factory may obtain a custom SSLServerSocketFactory from an SSLContext , which is essentially a factory for socket factories. See SSLContext for details.

Figure 18-13. javax.net.ssl.SSLServerSocketFactory

```
public abstract class SSLServerSocketFactory extends javax.net.ServerSocketFactory {
// Protected Constructors
     protected SSLServerSocketFactory( );
// Public Class Methods
     public static javax.net.ServerSocketFactory getDefault( );           synchronized
// Public Instance Methods
     public abstract String[ ] getDefaultCipherSuites( );
     public abstract String[ ] getSupportedCipherSuites( );
}
```

Returned By

SSLContext.getServerSocketFactory( ) , SSLContextSpi.engineGetServerSocketFactory( )

SSLSession javax.net.ssl

Java 1.4

A SSLSession object contains information about the SSL connection established through an SSLSocket . Use the the getSession( ) method of a SSLSocket to obtain the SSLSession object for that socket. Many of the SSLSession methods return information that was obtained during the handshake phase of the connection. getProtocol( ) returns the specific version of the SSL or TLS protocol in use. getCipherSuite( ) returns the name of the cipher suite negotiated for the connection. getPeerHost( ) returns the name of the remote host, and getPeerCertificates( ) returns the certificate chain, if any, that was received from the remote host during authentication. In Java 5.0 and later the peer's identity can also be queried with getPeerPrincipal( )

The invalidate( ) method ends the session. It does not affect any current connections, but all future connections and any re-negotiations of existing connections will need to establish a new SSLSession . isValid( ) determines whether a session is still valid.

Multiple SSL connections between two hosts may share the same SSLSession as long as they are using the same protocol version and cipher suite. There is no way to enumerate the SSLSocket objects that share a session, but these sockets can exchange information by using putValue( ) to bind a shared object to some well-known name that can be looked up by other sockets with getValue( ) . removeValue( ) removes such a binding, and getValueNames( ) returns an array of all names that have objects bound to them in this session. Objects bound and unbound with putValue( ) and removeValue( ) may implement SSLSessionBindingListener to be notified when they are bound and unbound.

Note that the getPeerCertificateChain( ) method returns an object from the javax.security.cert package, which is not documented in this book. The method and package exist only for backward compatibility with earlier versions of the JSSE API, and should be considered deprecated. Use getPeerCertificates( ) , which uses java.security.cert instead.

```
public interface SSLSession {
// Public Instance Methods
5.0  int getApplicationBufferSize( );
     String getCipherSuite( );
     long getCreationTime( );
     byte[ ] getId( );
     long getLastAccessedTime( );
     java.security.cert.Certificate[ ] getLocalCertificates( );
5.0  java.security.Principal getLocalPrincipal( );
5.0  int getPacketBufferSize( );
     javax.security.cert.X509Certificate[ ] getPeerCertificateChain( )
        throws SSLPeerUnverifiedException;
     java.security.cert.Certificate[ ] getPeerCertificates( )
        throws SSLPeerUnverifiedException;
     String getPeerHost( );
```

```
5.0  int getPeerPort( );
5.0  java.security.Principal getPeerPrincipal( ) throws SSLPeerUnverifiedException;
     String getProtocol( );
     SSLSessionContext getSessionContext( );
     Object getValue(String name);
     String[ ] getValueNames( );
     void invalidate( );
5.0  boolean isValid( );
     void putValue(String name, Object value);
     void removeValue(String name);
}
```

Passed To

HandshakeCompletedEvent.HandshakeCompletedEvent( ) , HostnameVerifier.verify( ) , SSLSessionBindingEvent.SSLSessionBindingEvent( )

Returned By

HandshakeCompletedEvent.getSession( ) , SSLEngine.getSession( ) , SSLSessionBindingEvent.getSession( ) , SSLSessionContext.getSession( ) , SSLSocket.getSession( )

Team LiB

SSLSessionBindingEvent javax.net.ssl

Java 1.4 *serializable event*

An object of this type is passed to the valueBound( ) and valueUnbound( ) methods of and object that implements SSLSessionBindingListener when that object is bound or unbound in a SSLSession with the putValue( ) or removeValue( ) methods of SSLSession. getName( ) returns the name to which the object was bound or unbound, and getSession( ) returns the SSLSession object in which the binding was created or removed.

Figure 18-14. javax.net.ssl.SSLSessionBindingEvent


```
public class SSLSessionBindingEvent extends java.util.EventObject {
// Public Constructors
     public SSLSessionBindingEvent(SSLSession session, String name);
// Public Instance Methods
     public String getName( );
     public SSLSession getSession( );
}
```

Passed To

SSLSessionBindingListener.{valueBound( ), valueUnbound( )}

Team LiB

SSLSessionBindingListener javax.net.ssl

Java 1.4 *event listener*

This interface is implemented by an object that want to be notified when it is bound or unbound in ar `SSLSession` object. If the object passed to the `putValue( )` method of a `SSLSession` implements this interface, then its `valueBound( )` method will be called by `putValue( )`, and its `valueUnbound( )` method will be called when that object is removed from the `SSLSession` with `removeValue( )` or when it is replaced with a new object by `putValue( )`. The argument to both methods of this interface is a `SSLSessionBindingEvent`, which specifies both the name to which the object was bound or unbound, and the `SSLSession` within which it was bound or unbound.

Figure 18-15. javax.net.ssl.SSLSessionBindingListener

```
public interface SSLSessionBindingListener extends java.util.EventListener {
// Public Instance Methods
     void valueBound(SSLSessionBindingEvent event);
     void valueUnbound(SSLSessionBindingEvent event);
}
```

SSLSessionContext javax.net.ssl

Java 1.4

A SSLSessionContext groups and controls SSLSession objects. It is a low-level interface and is not commonly used in application code. getIds( ) returns an Enumeration of session IDs, and getSession( ) returns the SSLSession object associated with one of those IDs. setSessionCacheSize( ) specifies the total number of concurrent sessions allowed in the group, and setSessionTimeout( ) specifies the timeout length for those sessions. An SSLSessionContext can serve as a cache for SSLSession objects, facilitating reuse of those objects for multiple connections between the same two hosts.

Providers are not required to support this interface. Those that do return an implementing object from the getSessionContext( ) method of an SSLSession object, and also return implementing objects from the getClientSessionContext( ) and getServerSessionContext( ) methods of an SSLContext object, providing separate control over client and server SSL connections.

```
public interface SSLSessionContext {
// Public Instance Methods
     java.util.Enumeration getIds( );
     SSLSession getSession(byte[ ] sessionId);
     int getSessionCacheSize( );
     int getSessionTimeout( );
     void setSessionCacheSize(int size) throws IllegalArgumentException;
     void setSessionTimeout(int seconds) throws IllegalArgumentException;
}
```

Returned By

SSLContext.{getClientSessionContext( ), getServerSessionContext( )}, SSLContextSpi.{engineGetClientSessionContext( ), engineGetServerSessionContext( )}, SSLSession.getSessionContext( )

Team LiB

SSLSocket javax.net.ssl

Java 1.4

An SSLSocket is a "secure socket" subclass of java.net.Socket that implements the SSL or TLS protoc commonly used to authenticate a server to a client and to encrypt the data transferred between the two SSLSocket for connecting to a SSL-enabled server by calling one of the createSocket( ) methods of a SSLSocketFactory object. See SSLSocketFactory for details. If you are writing server code, then you w SSLSocket for communicating with an SSL-enabled client from the inherited accept( ) method of an SS See SSLServerSocket for details.

SSLSocket inherits all of the standard socket method of its superclass, and can be used for networking j ordinary java.net.Socket object. In addition, however, it also defines methods that control how the se is established. These methods may be called before the SSL "handshake" occurs. The handshake does n socket is first created and connected, so that you can configure various SSL parameters that control hov occurs. Calling startHandshake( ), getSession( ), or reading or writing data on the socket trigger a you must configure the socket before doing any of these things. If you want to be notified when the han call addHandshakeCompletedListener( ) to register a listener object to receive the notification.

getSupportedProtocols( ) returns a list of secure socket protocols that are supported by the socket ir setEnabledProtocols( ) allows you to specify the name or names of the supported protocols that you for this socket. getSupportedCipherSuite( ) returns the full set of cipher suites supported by the unde provider. setEnabledCipherSuites( ) specifies a list of one or more cipher suites that you are willing t connection. Note that not all supported cipher suites are enabled by default: only suites that provide enc require the server to authenticate itself to the client are enabled. If you want to allow the server to rema you can use setEnabledCipherSuites( ) to enable a nonauthenticating suite. Specific protocols and cip not described here because using them correctly requires a detailed understanding of cryptography, whi scope of this reference. Most applications can simply rely on the default set of enabled protocols and cip

If you are writing a server and have obtained an SSLSocket by accepting a connection on an SSLServerS you may call setWantClientAuth( ) to request that the client authenticate itself to you, and you may c setNeedClientAuth( ) to require that the client authenticate itself during the handshake. Note, howev usually more efficient to request or require client authentication on the server socket than it is to call th each SSLSocket it creates.

The configuration methods described above must be called before the SSL handshake occurs. Call getSes obtain an SSLSession object that you can query for for information about the handshake, such as the pr suite in use, and the identity of the server. Note that a call to getSession( ) will cause the handshake t not already occurred, so you can call this method at any time.

Figure 18-16. javax.net.ssl.SSLSocket

```
public abstract class SSLSocket extends java.net.Socket {
// Protected Constructors
     protected SSLSocket( );
     protected SSLSocket(String host, int port)
        throws java.io.IOException, java.net.UnknownHostException;
     protected SSLSocket(java.net.InetAddress address, int port)
        throws java.io.IOException;
     protected SSLSocket(String host, int port, java.net.InetAddress clientAddress,
        int clientPort) throws java.io.IOException,
        java.net.UnknownHostException;
     protected SSLSocket(java.net.InetAddress address, int port, java.net.InetAddress c
        int clientPort) throws java.io.IOException;
// Event Registration Methods (by event name)
     public abstract void addHandshakeCompletedListener(HandshakeCompletedListener list
     public abstract void removeHandshakeCompletedListener(HandshakeCompletedListener l
// Public Instance Methods
     public abstract String[ ] getEnabledCipherSuites( );
     public abstract String[ ] getEnabledProtocols( );
     public abstract boolean getEnableSessionCreation( );
     public abstract boolean getNeedClientAuth( );
     public abstract SSLSession getSession( );
     public abstract String[ ] getSupportedCipherSuites( );
     public abstract String[ ] getSupportedProtocols( );
     public abstract boolean getUseClientMode( );
     public abstract boolean getWantClientAuth( );
     public abstract void setEnabledCipherSuites(String[ ] suites);
     public abstract void setEnabledProtocols(String[ ] protocols);
     public abstract void setEnableSessionCreation(boolean flag);
     public abstract void setNeedClientAuth(boolean need);
     public abstract void setUseClientMode(boolean mode);
     public abstract void setWantClientAuth(boolean want);
     public abstract void startHandshake( ) throws java.io.IOException;
}
```

Passed To

`HandshakeCompletedEvent.HandshakeCompletedEvent( )`

Returned By

`HandshakeCompletedEvent.getSocket( )`

Team LiB

SSLSocketFactory javax.net.ssl

Java 1.4

This class is a javax.net.SocketFactory for creating SSLSocket objects. Most applications use the default SSLSocketFactory returned by the static getdefault( ) method. Once this SSLSocketFactory has been obtained, they use one of the inherited createSocket( ) methods to create, and optionally connect and bind, a new SSLSocket . The return value of the createSocket( ) methods is a java.net.Socket object, but you can safely cast this object to a SSLSocket if you need to. SSLSocketFactory defines one new version of createSocket( ) in addition to the ones it inherits from its superclass. This version of the method creates an SSLSocket that is layered over an existing Socket object rather than creating a new socket entirely from scratch.

Applications that need to customize the SSL configuration and cannot use the default socket factory may obtain a custom SSLSocketFactory from an SSLContext , which is essentially a factory for socket factories. See SSLContext for details.

Figure 18-17. javax.net.ssl.SSLSocketFactory

```
public abstract class SSLSocketFactory extends javax.net.SocketFactory {
// Public Constructors
     public SSLSocketFactory( );
// Public Class Methods
     public static javax.net.SocketFactory getDefault( );                synchronized
// Public Instance Methods
     public abstract java.net.Socket createSocket(java.net.Socket s, String host,
        int port, boolean autoClose)
        throws java.io.IOException;
     public abstract String[ ] getDefaultCipherSuites( );
     public abstract String[ ] getSupportedCipherSuites( );
}
```

Passed To

HttpsURLConnection.{setDefaultSSLSocketFactory( ) , setSSLSocketFactory( )}

Returned By

HttpsURLConnection.{getDefaultSSLSocketFactory( ) , getSSLSocketFactory( )} , `SSLContext.getSocketFactory( )`, `SSLContextSpi.engineGetSocketFactory( )`

Team LiB

TrustManager javax.net.ssl

Java 1.4

This is a marker interface to identify trust manager objects. A trust manager is responsible for examining the authentication credentials (such as a certificate chain) presented by the remote host and deciding whether to trust those credentials and accept them. A`trustManager` is usually used an SSL client to decide whether the SSL server is authentic, but may also be used by an SSL server when client authentication is also required.

Use a `trustManagerFactory` to obtain `trustManager` objects. `TRustManager` objects returned by a `trustManagerFactory` can always be cast to a subinterface specific to a specific type of keys. See `X509trustManager`, for exmaple.

```
public interface TrustManager {
}
```

Implementations

`X509trustManager`

Passed To

`SSLContext.init( )`, `SSLContextSpi.engineInit( )`

Returned By

`trustManagerFactory.getTrustManagers( )`, `trustManagerFactorySpi.engineGetTrustManagers( )`

TrustManagerFactory javax.net.ssl

Java 1.4

A trustManagerFactory is responsible for creating TRustManager objects for a specific trust management algorithm. Obtain a trustManagerFactory object by calling one of the getInstance( ) methods and specifying the desired algorithm and, optionally, the desired provider. In Java 1.4, the "SunX509" algorithm is the only one supported by the default "SunJSSE" provider. After calling getInstance( ), you initialize the factory object with init( ). For the "SunX509" algorithm, you pass a KeyStore object to init( ). This KeyStore should contain the public keys of trusted CAs (certification authorities). Once a trustManagerFactory has been created and initialized, use it to create a TRustManager by calling gettrustManagers( ). This method returns an array of trustManager objects because some trust management algorithms may handle more than one type of key or certificate. The "SunX509" algorithm manages only X.509 keys, and always returns an array with an X509trustManager object as its single element. This returned array is typically passed to the init( ) method of an SSLContext object.

If no KeyStore is passed to the init( ) method of the TRustManagerFactory for the "SunX509" algorithm, then the factory uses a KeyStore created from the file named by the system property javax.net.ssl.trustStore if that property is defined. (It also uses the key store type and password specified by the properties javax.net.ssl.trustStoreType and javax.net.ssl.trustStorePassword.) Otherwise, it uses the file *jre/lib/security/jssecacerts* in the Java distribution, if it exists. Otherwise it uses the file *jre/lib/security/cacerts* which is part of Sun's Java distribution. Sun ships a default *cacerts* file that contains certificates for several well-known and reputable CAs. You can use the *keytool* program to edit the *cacerts* keystore (the default password is "changeit").

```
public class TrustManagerFactory {
// Protected Constructors
     protected TrustManagerFactory(TrustManagerFactorySpi factorySpi, java.security.
        Provider provider, String algorithm);
// Public Class Methods
     public static final String getDefaultAlgorithm( );
     public static final TrustManagerFactory getInstance(String algorithm)
        throws java.security.NoSuchAlgorithmException;
     public static final TrustManagerFactory getInstance(String algorithm,
        java.security.Provider provider)
        throws java.security.NoSuchAlgorithmException;
     public static final TrustManagerFactory getInstance(String algorithm,
        String provider) throws java.security.NoSuchAlgorithmException,
        java.security.NoSuchProviderException;
// Public Instance Methods
     public final String getAlgorithm( );
     public final java.security.Provider getProvider( );
     public final TrustManager[ ] getTrustManagers( );
```

```
    public final void init(ManagerFactoryParameters spec)
       throws java.security.InvalidAlgorithmParameterException;
    public final void init(java.security.KeyStore ks)
       throws java.security.KeyStoreException;
}
```

Team LiB

TrustManagerFactorySpi javax.net.ssl

Java 1.4

This abstract class defines the Service Provider Interface for `trustManagerFactory`. Security providers must implement this interface, but applications never need to use it.

```
public abstract class TrustManagerFactorySpi {
// Public Constructors
     public TrustManagerFactorySpi( );
// Protected Instance Methods
     protected abstract TrustManager[ ] engineGetTrustManagers( );
     protected abstract void engineInit(ManagerFactoryParameters spec)
        throws java.security.InvalidAlgorithmParameterException;
     protected abstract void engineInit(java.security.KeyStore ks)
        throws java.security.KeyStoreException;
}
```

Passed To

`TRustManagerFactory.TrustManagerFactory( )`

X509ExtendedKeyManager javax.net.ssl

Java 5.0

This class implements the X509KeyManager interface and extends it with two methods.

Figure 18-18. javax.net.ssl.X509ExtendedKeyManager


```
public abstract class X509ExtendedKeyManager implements X509KeyManager {
// Protected Constructors
     protected X509ExtendedKeyManager( );
// Public Instance Methods
     public String chooseEngineClientAlias(String[ ] keyType,
        java.security.Principal[ ] issuers,
        SSLEngine engine);     constant
     public String chooseEngineServerAlias(String keyType,
        java.security.Principal[ ] issuers,
        SSLEngine engine);     constant
}
```

Team LiB

X509KeyManager javax.net.ssl

Java 1.4

This interface is a KeyManager for working with X.509 certificates. An X509KeyManager is used during the SSL handshake by a peer that authenticates itself by providing an X.509 certificate chain to the remote host. This is usually done on the server side of the SSL connection, and can be done on the client-side as well, although that is uncommon. Obtain an X509KeyManager object either by implementing your own or from a KeyManagerFactory created with an algorithm of "SunX509". Applications do not call the methods of an X509KeyManager themselves. Instead, they simply supply an appropriate X509KeyManager object to the SSLContext object that is responsible for setting up SSL connections. When the system needs to authenticate itself during an SSL handshake, it calls various methods of the key manager object to obtain the information in needs.

An X509KeyManager retrieves keys and certificae chains from the KeyStore object that was passed to the init( ) method of the KeyManagerFactory object from which it was created. getPrivateKey( ) and getCertificateChain( ) return the private key and the certificate chain for a specified alias. The other methods are called to list all aliases in the keystore or to choose one alias from the keystore that matches the specified keytype and certificate authority criteria. In this way, a X509KeyManager can choose a certificate chain (and it corresponding key) based on the types of keys and the list of certificate authorities recognized by the remote host.

Figure 18-19. javax.net.ssl.X509KeyManager

```
public interface X509KeyManager extends KeyManager {
// Public Instance Methods
     String chooseClientAlias(String[ ] keyType, java.security.Principal[ ] issuers,
        java.net.Socket socket);
     String chooseServerAlias(String keyType, java.security.Principal[ ] issuers,
        java.net.Socket socket);
     java.security.cert.X509Certificate[ ] getCertificateChain(String alias);
     String[ ] getClientAliases(String keyType, java.security.Principal[ ] issuers);
     java.security.PrivateKey getPrivateKey(String alias);
     String[ ] getServerAliases(String keyType, java.security.Principal[ ] issuers);
}
```

Implementations

X509ExtendedKeyManager

Team LiB

X509TrustManager javax.net.ssl

Java 1.4

This interface is a `trustManager` for working with X.509 certificates. Trust managers are used during the handshake phase of SSL connection to determine whether the authentication credentials presented by the remote host are trusted. This is usually done on the client-side of an SSL connection, but may also be done on the server side. Obtain an `X509TRustManager` either by implementing your own or from a `trustManagerFactory` that was created to use the "SunX509" algorithm. Applications do call the methods of this interface themselves; instead, they simply provide an appropriate `X509trustManager` object to the `SSLContext` object that is responsible for setting up SSL connections. When the system needs to determine whether the authentication credentials presented by the remote host are trusted, it calls the methods of the trust manager.

Figure 18-20. javax.net.ssl.X509TrustManager

```
public interface X509TrustManager extends TrustManager {
// Public Instance Methods
     void checkClientTrusted(java.security.cert.X509Certificate[ ] chain,
        String authType) throws java.security.cert.CertificateException;
     void checkServerTrusted(java.security.cert.X509Certificate[ ] chain,
        String authType) throws java.security.cert.CertificateException;
     java.security.cert.X509Certificate[ ] getAcceptedIssuers( );
}
```

Chapter 19. javax.security.auth and Subpackages

This chapter documents the `javax.security.auth` package and its subpackages, which, together, form the Java Authentication and Authorization Service, or JAAS. Before being integrated into Java 1.4, JAAS was available as a standard extension, which is why these packages have the "javax" prefix. The individual packages are the following:

`javax.security.auth`

This top-level package defines the `Subject` class that is central to JAAS.

`javax.security.auth.callback`

This package defines a callback API to enable communication (such as the exchange of a username and password) between a low-level login module and the end-user.

`javax.security.auth.kerberos`

This package contains JAAS classes related to the Kerberos network authentication protocol.

`javax.security.auth.login`

This package defines the `LoginContext` class and related classes used by applications to perform a JAAS login.

`javax.security.auth.spi`

This package defines the "service provider interface" for JAAS.

`javax.security.auth.x500`

This package includes JAAS classes related to X.500 principals.

Team LiB

Package javax.security.auth

Java 1.4

This is the top-level package of the Java Authentication and Authorization Service (JAAS). The key class is `Subject`, which represents an authenticated user, and defines static methods that allow Java code be run as (i.e., using the permissions of) a specified `Subject`. The remaining classes and interfaces in this package are important parts of the JAAS infrastructure, but are not commonly used in application code. Applications do not create `Subject` objects directly, but typically obtain them from a `javax.security.auth.login.LoginContext` constructed with a `javax.security.auth.callback.CallbackHandler`.

Interfaces

```
public interface Destroyable;
public interface Refreshable;
```

Classes

```
public final class AuthPermission extends java.security.BasicPermission;
public abstract class Policy;
public final class PrivateCredentialPermission extends java.security.Permission;
public final class Subject implements Serializable;
public class SubjectDomainCombiner implements java.security.DomainCombiner;
```

Exceptions

```
public class DestroyFailedException extends Exception;
public class RefreshFailedException extends Exception;
```

AuthPermission javax.security.auth

Java 1.4 *serializable permission*

This java.security.Permission class governs the use of various methods in this package and its subpackages. The target name of the permission specifies which methods are allowed; AuthPermission objects have no actions list. Application programmers never need to use this class directly. System implementors may need to use it, and system administrators who configure security policies may need to be familiar with the following table of target names and the permissions they represent:

Target name	Gives permission to
doAs	Invoke Subject.doAs( ) methods.
doAsPrivileged	Invoke Subject.doAsPriviliged( ) methods.
getSubject	Invoke Subject.getSubject( ).
getSubjectFromDomainCombiner	Invoke SubjectDomainCombiner.getSubject( ).
setReadOnly	Invoke Subject.setReadOnly( ).
modifyPrincipals	Modify the Set of principals associated with a Subject.
modifyPublicCredentials	Modify the Set of public credentials associated with a Subject.
modifyPrivateCredentials	Modify the Set of private credentials associated with a Subject.
refreshCredential	Invoke the refresh( ) method of a Refreshable credential class.
destroyCredential	Invoke the destroy( ) method of a Destroyable credential class.
createLoginContext.*name*	Instantiate a LoginContext with the specified *name*. If *name* is * , it allows a LoginContext of any name to be created.
getLoginConfiguration	Invoke the getConfiguration( ) method of javax.security.auth.login.Configuration.
setLoginConfiguration	Invoke the setConfiguration( ) method of javax.security.auth.login.Configuration.
refreshLoginConfiguration	Invoke the refresh( ) method of javax.security.auth.login.Configuration.

javax.security.auth.AuthPermission


```
public final class AuthPermission extends java.security.BasicPermission {
// Public Constructors
     public AuthPermission(String name);
     public AuthPermission(String name, String actions);
}
```

Team LiB

Destroyable javax.security.auth

Java 1.4

Classes that encapsulate sensitive information, such as security credentials, may implement this interface to provide an API that allows the sensitive information to be destroyed or erased. The `destroy( )` method erases or clears the sensitive information. It may throw a `DestroyFailedException` if the information cannot be erased for any reason. It may also throw a `SecurityException` if the caller does not have whatever permissions are required. Once `destroy( )` has been called on an object, the `isDestroyed( )` method returns `true`. Once an object has been destroyed, any other methods it defines may throw an `IllegalStateException`.

```
public interface Destroyable {
// Public Instance Methods
     void destroy( ) throws DestroyFailedException;
     boolean isDestroyed( );
}
```

Implementations

`java.security.KeyStore.PasswordProtection`, `javax.security.auth.kerberos.KerberosKey`, `javax.security.auth.kerberos.KerberosTicket`, `javax.security.auth.x500.X500PrivateCredential`

DestroyFailedException javax.security.auth

Java 1.4 *serializable checked*

Signals that the `destroy( )` method of a `Destroyable` object did not succeed.

Figure 19-1. javax.security.auth.DestroyFailedException


```
public class DestroyFailedException extends Exception {
// Public Constructors
     public DestroyFailedException( );
     public DestroyFailedException(String msg);
}
```

Thrown By

`java.security.KeyStore.PasswordProtection.destroy( )`, `Destroyable.destroy( )`, `javax.security.auth.kerberos.KerberosKey.destroy( )`, `javax.security.auth.kerberos.KerberosTicket.destroy( )`

Policy javax.security.auth

Java 1.4; Deprecated in 1.4 *@Deprecated*

This deprecated class represents a Subject-based security policy. Because the JAAS API (this package and its subpackages) were introduced as an extension to the core Java platform, this class was required to augment the `java.security.Policy` class which, prior to Java 1.4, had no provisions for Subject-based authorization. In Java 1.4, however, `java.security.Policy` has been extended to represent security policies based on code origin, code signers, and subjects. Thus, this class is no longer required and has been deprecated.

```
public abstract class Policy {
// Protected Constructors
     protected Policy( );
// Public Class Methods
     public static javax.security.auth.Policy getPolicy( );
     public static void setPolicy(javax.security.auth.Policy policy);
// Public Instance Methods
     public abstract java.security.PermissionCollection getPermissions(Subject subject,
        java.security.CodeSource cs);
     public abstract void refresh( );
}
```

Team LiB

PrivateCredentialPermission javax.security.auth

Java 1.4 *serializable permission*

This Permission class protects access to private credential objects belonging to a Subject (as specified by a set of one or more Principal objects). Application programmers rarely need to use it. System programmers implementing new private credentials classes may need to use it, and system administrators configuring security policy files should be familiar with it.

The only defined action for PrivateCredentialPermssion is "read". The target name for this permission has a complex syntax and specifies the name of the credential class and a list of one or more principals. Each principal is specified as the name of the Principal class followed by the principal name in quotes. For example, a security policy file might contain a statement like the following to allow permission to read the private KerberosKey credentials of a KerberosPrincipal named "david".

```
permission  javax.security.auth.PrivateCredentialPermission
    "javax.security.auth.kerberos.KerberosKey \
             javax.security.auth.kerberos.KerberosPrincipal \"david\"",
    "read";
```

The target name syntax for PrivateCredentialPermission also allows the use of the "*" wildcard in place of the credential class name or in place of the Principal class name and/or name.

Figure 19-2. javax.security.auth.PrivateCredentialPermission

```
public final class PrivateCredentialPermission extends java.security.Permission {
// Public Constructors
     public PrivateCredentialPermission(String name, String actions);
// Public Instance Methods
     public String getCredentialClass( );
     public String[ ][ ] getPrincipals( );
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(java.security.Permission p);
     public java.security.PermissionCollection newPermissionCollection( );     constant
}
```

Refreshable javax.security.auth

Java 1.4

A class implements this interface if its instances that have a limited period of validity (as some security credentials do) and need to be periodically "refreshed" in order to remain valid. `isCurrent( )` returns `true` if the object is currently valid, and `false` if it has expired and needs to be refreshed. `refresh( )` attempts to revalidate or extend the validity of the object. It throws a `RefreshFailedException` if it does not succeed. (And may also throw a `SecurityException` if the caller does not have the requisite permissions.)

```
public interface Refreshable {
// Public Instance Methods
     boolean isCurrent( );
     void refresh( ) throws RefreshFailedException;
}
```

Implementations

`javax.security.auth.kerberos.KerberosTicket`

RefreshFailedException javax.security.auth

Java 1.4 *serializable checked*

Signals that the `refresh( )` method of a `Refreshable` object failed.

Figure 19-3. javax.security.auth.RefreshFailedException


```
public class RefreshFailedException extends Exception {
// Public Constructors
     public RefreshFailedException( );
     public RefreshFailedException(String msg);
}
```

Thrown By

`Refreshable.refresh( )`, `javax.security.auth.kerberos.KerberosTicket.refresh( )`

Team LiB

Subject javax.security.auth

Java 1.4 *serializable*

The Subject class is the key abstraction of the JAAS API. It represents a person or other entity, and cor of:

- a java.util.Set of Principal objects that specify the identity (or identities) of the Subject .
- a Set of objects that specify the public credentials, such as the public key certificates of the Subjec
- a Set of objects that specify the private credentials, such as the private keys and Kerberos tickets Subject .

Subject defines methods that allow you to retreive each of these three sets, or to retreive a subset of e that contains only objects of a specified Class . Unless the Subject is read-only, you can use the metho java.util.Set to modify each of the three sets. Once setReadOnly( ) has been called, however, the s become immutable and their contents may not be modified.

Application code does not typically create Subject objects itself. Instead, it obtains a Subject that repre the authenticated user of the application by calling the login( ) and getSubject( ) methods of a javax.security.auth.login.LoginContext object.

Once an authenticated Subject has been obtained from a LoginContext , an application can call the doA method to run code using the permissions granted to that Subject combined with the permissions grant the code itself. doAs( ) runs the code defined in the run( ) method of a PrivilegedAction or PrivilegedExceptionAction object. doAsPrivileged( ) is a similar method but executes the specifiec) method using the Subject's permissions only, unconstrained by unprivileged code in the call stack.

Note that many of the methods of this class throw a SecurityException if the caller has not been grant requisite AuthPermission .

Figure 19-4. javax.security.auth.Subject

```
public final class Subject implements Serializable {
// Public Constructors
     public Subject( );
     public Subject(boolean readOnly, java.util.Set<? extends java.security.Principal>
        principals, java.util.Set<?> pubCredentials,
        java.util.Set<?> privCredentials);
// Public Class Methods
```

```
    public static Object doAs(Subject subject, java.security.PrivilegedExceptionAction
       action) throws java.security.PrivilegedActionException;
    public static Object doAs(Subject subject, java.security.PrivilegedAction action);
    public static Object doAsPrivileged(Subject subject, java.security.
       PrivilegedExceptionAction action, java.security.AccessControlContext acc)
       throws java.security.PrivilegedActionException;
    public static Object doAsPrivileged(Subject subject, java.security.PrivilegedActio
       action, java.security.AccessControlContext acc);
    public static Subject getSubject(java.security.AccessControlContext acc);
// Public Instance Methods
    public java.util.Set<java.security.Principal> getPrincipals( );
    public <T extends java.security.Principal> java.util.Set<T> getPrincipals(Class<T>
    public java.util.Set<Object> getPrivateCredentials( );
    public <T> java.util.Set<T> getPrivateCredentials(Class<T> c);
    public java.util.Set<Object> getPublicCredentials( );
    public <T> java.util.Set<T> getPublicCredentials(Class<T> c);
    public boolean isReadOnly( );                                           default:false
    public void setReadOnly( );
// Public Methods Overriding Object
    public boolean equals(Object o);
    public int hashCode( );
    public String toString( );
}
```

Passed To

java.security.AuthProvider.login( ) , javax.security.auth.Policy.getPermissions( ) , SubjectDomainCombiner.SubjectDomainCombiner( ) , javax.security.auth.login.LoginContext.LoginContext( ) , javax.security.auth.spi.LoginModule.initialize( )

Returned By

SubjectDomainCombiner.getSubject( ) , javax.security.auth.login.LoginContext.getSubject(

SubjectDomainCombiner javax.security.auth

Java 1.4

This class implements the DomainCombiner interface. It is used to merge permissions based on code source and code signers with permissions granted to the specified Subject . A SubjectDomainCombiner is created by the Subject.doAs( ) and Subject.doAsPrivileged( ) methods for use in by the AccessControlContext .

Figure 19-5. javax.security.auth.SubjectDomainCombiner


```
public class SubjectDomainCombiner implements java.security.DomainCombiner {
// Public Constructors
     public SubjectDomainCombiner(Subject subject);
// Public Instance Methods
     public Subject getSubject( );
// Methods Implementing DomainCombiner
     public java.security.ProtectionDomain[ ] combine(java.security.ProtectionDomain[ ]
        currentDomains,
        java.security.ProtectionDomain[ ] assignedDomains);
}
```

Team LiB

Package javax.security.auth.callback

Java 1.4

This package defines a mechanism that allows the low-level code of a `javax.security.auth.spi.LoginModule` to interact with the end-user of an application to obtain a username, password, or other authentication-related information. The `LoginModule` sends messages and requests for information in the form of objects that implement the `Callback` interface. An application that wants to authenticate a user provides (via a `javax.security.auth.login.LoginContext`) a `CallbackHandler` object to convert these `Callback` objects into text or GUI-based interactions with the user. An application that want to provide a customized login interface must implement its own `CallbackHandler`. The `CallbackHandler` API consists of only a single method, but the implementation of that method can require a substantial amount of code. See the various `Callback` classes for directions on how a `CallbackHandler` should handle them.

Sun's J2SE SDK for Java 1.4 ships with two implementations of `CallbackHandler`, both in the package `com.sun.security.auth.callback`. Although these classes are not guaranteed to exist in all distributions, text-based applications may use the `TextCallbackHandler`, and GUI-based applications may use the `DialogCallbackHandler`. Programmers wanting to write a custom `CallbackHandler` may also find it useful to study the source code of these two existing handlers.

Interfaces

```
public interface Callback;
public interface CallbackHandler;
```

Classes

```
public class ChoiceCallback implements Callback, Serializable;
public class ConfirmationCallback implements Callback, Serializable;
public class LanguageCallback implements Callback, Serializable;
public class NameCallback implements Callback, Serializable;
public class PasswordCallback implements Callback, Serializable;
public class TextInputCallback implements Callback, Serializable;
public class TextOutputCallback implements Callback, Serializable;
```

Exceptions

```
public class UnsupportedCallbackException extends Exception;
```

Callback javax.security.auth.callback

Java 1.4

This interface defines no methods but serves as a "marker interface" to identify the type of objects that can be passed to the `handle( )` method of a `CallbackHandler`. All of the classes in this package, with the exception of `UnsupportedCallbackException` implement this interface.

```
public interface Callback {
}
```

Implementations

`ChoiceCallback`, `ConfirmationCallback`, `LanguageCallback`, `NameCallback`, `PasswordCallback`, `TextInputCallback`, `TextOutputCallback`

Passed To

`CallbackHandler.handle( )`, `UnsupportedCallbackException.UnsupportedCallbackException( )`

Returned By

`UnsupportedCallbackException.getCallback( )`

Team LiB

CallbackHandler javax.security.auth.callback

Java 1.4

A CallbackHandler is responsible for communication between the end-user of an application and the javax.security.auth.spi.LoginModule that is performing authentication of that user on behalf of the javax.security.auth.login.LoginContext instantiated by the application. When an application needs to authenticate a user, it creates a LoginContext and specifies a CallbackHandler object for that context. The underlying LoginModule uses the CallbackHandler to communicate with the end userfor example prompting them to enter a name and password.

The LoginModule passes an array of objects that implement the Callback interface to the handle( ) method of CallbackHandler. The handle( ) method must determine the type of Callback object, and display the information and/or prompt for the input it represents. Different Callback classes have different purposes and must be handled differently. NameCallback and PasswordCallback are two of the most commonly used: they represent requests for the user's name and password. TextOutputCallback is also common: it represents a request to display a message (such as "Authentication Failed") to the user. See the descriptions of the individual Callback classes for information on how a CallbackHandler should handle them. CallbackHandler implementations are not required to support every type of Callback and my throw an UnsupportedCallbackException if passed a Callback object of a type they do not recognize or do not support.

The handle( ) method is passed an array of Callback objects. A CallbackHandler (such as a typical console-based handler) may choose to handle the Callback objects one at a time, prompting for and returning the user's input before moving on to the next. Or (for example in GUI-based handlers) it may choose to present all of the callbacks in a single unified "login dialog box". LoginModule implementations may, of course, call the handle( ) method more than once. Note, finally, that if a CallbackHandler implementation has knowledge of the user from some other source, it is allowed to handle certain callbacks automatically, such as automatically providing the user's name for a NameCallback.

Java installations may have a default CallbackHandler registered by setting the auth.login.defaultCallbackHandler security property to the name of the implementing class. No such default is defined by the default security policy that ships with Sun's distribution of Java 1.4. Sun's Java 1.4 SDK does include CallbackHandler implementations to perform text-based and GUI-based communication in the classes TextCallbackHandler and DialogCallbackHandler in the com.sun.security.auth.callback package. Note that these are part of Sun's implementation, and are not part of the specification; they are not guaranteed to exist in all releases.

```
public interface CallbackHandler {
// Public Instance Methods
     void handle(Callback[ ] callbacks)
        throws java.io.IOException, UnsupportedCallbackException;
}
```

Passed To

java.security.AuthProvider.{login( ), setCallbackHandler( )}, java.security.KeyStore.CallbackHandlerProtection.CallbackHandlerProtection( ), javax.security.auth.login.LoginContext.LoginContext( ), javax.security.auth.spi.LoginModule.initialize( )

Returned By

java.security.KeyStore.CallbackHandlerProtection.getCallbackHandler( )

ChoiceCallback javax.security.auth.callback

Java 1.4 *serializable*

A Callback of this type represents a request to display set of text choices and allow the user to select one or more of them. A `CallbackHandler`, should display the prompt returned by `getPrompt( )` and also the strings returned by `getChoices( )`. If `allowMultipleSelections( )` is `true`, then it should allow the user to select zero or more; otherwise, it should only allow the user to select a single one. In either case, the `CallbackHandler` should also call `geTDefaultChoice( )` and make the choice at the returned index the default choice. When the user has made her selection, the `CallbackHandler` should pass the index of a single selection to `setSelectedIndex( )`, or the indexes of multiple selections to `setSelectedIndexes( )`.

Figure 19-6. javax.security.auth.callback.ChoiceCallback

```
public class ChoiceCallback implements Callback, Serializable {
// Public Constructors
     public ChoiceCallback(String prompt, String[ ] choices, int defaultChoice,
        boolean multipleSelectionsAllowed);
// Public Instance Methods
     public boolean allowMultipleSelections( );
     public String[ ] getChoices( );
     public int getDefaultChoice( );
     public String getPrompt( );
     public int[ ] getSelectedIndexes( );
     public void setSelectedIndex(int selection);
     public void setSelectedIndexes(int[ ] selections);
}
```

Team LiB

ConfirmationCallback javax.security.auth.callback

Java 1.4 *serializable*

A `Callback` of this type represents a request to ask the user a yes/no or multiple-choice question. A `CallbackHandler` should first call `getPrompt( )` to obtain the text of the question. It should also call `getMessageType( )` to determine the message type (`INFORMATION` , `WARNING` , or `ERROR`) and present th question to the user in a suitable manner based on that type.

Next, the `CallbackHandler` must determine the appropriate set of responses to the question. It does th by calling `getOptionType( )` . The return values have the following meanings:

`YES_NO_OPTION`

The `CallbackHandler` should allow the user to respond to the question with a "yes" or a "no" (or localized equivalents).

`YES_NO_CANCEL_OPTION`

The `CallbackHandler` should allow "yes", "no", and "cancel" (or their localized equivalents) responses.

`OK_CANCEL_OPTION`

The `CallbackHandler` should allow "ok" and "cancel" (or their localized equivalents) responses.

`UNSPECIFIED_OPTION`

The `CallbackHandler` should call `getOptions( )` and use present all strings it returns as possible responses.

In each of these cases, the `CallbackHandler` should also call `getdefaultOption( )` to determine which response should be presented as the default response. If `getOptionType( )` returned `UNSPECIFIED_TYPI` then `getdefaultOption( )` returns an index into the array of options returned by `getOptions( )` . Otherwise `getdefaultOption( )` returns one of the constants `YES` , `NO` , `OK` , or `CANCEL` .

When the user has selected a response to the callback, the `CallbackHandler` should pass that response `setSelectedIndex( )` . The response value should be one of the constants `YES` , `NO` , `OK` , or `CANCEL` , or index into the array of options returned by `getOptions( )` .

Figure 19-7. javax.security.auth.callback.ConfirmationCallback


```
public class ConfirmationCallback implements Callback, Serializable {
// Public Constructors
     public ConfirmationCallback(int messageType, String[ ] options, int defaultOption)
     public ConfirmationCallback(int messageType, int optionType, int defaultOption);
     public ConfirmationCallback(String prompt, int messageType, String[ ] options,
        int defaultOption);
     public ConfirmationCallback(String prompt, int messageType, int optionType,
        int defaultOption);
// Public Constants
     public static final int CANCEL;                                         =2
     public static final int ERROR;                                          =2
     public static final int INFORMATION;                                    =0
     public static final int NO;                                             =1
     public static final int OK;                                             =3
     public static final int OK_CANCEL_OPTION;                               =2
     public static final int UNSPECIFIED_OPTION;                             =-1
     public static final int WARNING;                                        =1
     public static final int YES;                                            =0
     public static final int YES_NO_CANCEL_OPTION;                           =1
     public static final int YES_NO_OPTION;                                  =0
// Public Instance Methods
     public int getDefaultOption( );
     public int getMessageType( );
     public String[ ] getOptions( );
     public int getOptionType( );
     public String getPrompt( );
     public int getSelectedIndex( );
     public void setSelectedIndex(int selection);
}
```

LanguageCallback javax.security.auth.callback

Java 1.4 *serializable*

This `Callback` class represents a request for the user's preferred language (as represented by a `Locale` object), which a `LoginModule` can use to localize things such as prompts and error messages ir subsequent `Callback` objects. If a `CallbackHandler` already has knowledge of the user's preferred langauge, it is not required to prompt the user for this information and can simply pass an appropriate `Locale` object to `setLocale( )` .

Figure 19-8. javax.security.auth.callback.LanguageCallback


```
public class LanguageCallback implements Callback, Serializable {
// Public Constructors
     public LanguageCallback( );
// Public Instance Methods
     public java.util.Locale getLocale( );                              default:null
     public void setLocale(java.util.Locale locale);
}
```

NameCallback javax.security.auth.callback

Java 1.4 *serializable*

This Callback class represents a request for the username or other text that identifies the user to be authenticated. An interactive CallbackHandler should call getPrompt( ) and getdefaultName( ) and should display the returned prompt and optionally, the returned default name to the user. When the user has entered a name (or accepted the default name) the handler should pass the user's input to setName( ).

Figure 19-9. javax.security.auth.callback.NameCallback


```
public class NameCallback implements Callback, Serializable {
// Public Constructors
     public NameCallback(String prompt);
     public NameCallback(String prompt, String defaultName);
// Public Instance Methods
     public String getDefaultName( );
     public String getName( );
     public String getPrompt( );
     public void setName(String name);
}
```

PasswordCallback javax.security.auth.callback

Java 1.4 *serializable*

This `Callback` class represents a request for a password. A `CallbackHandler` should handle it by displaying the prompt returned by `getPrompt( )` and then allowing the user the enter a password. When the user has entered the password, it should pass the entered text to `setPassword( )` . If `isEchoOn( )` returns true, then the `Handler` should display the password as the user types it.

Figure 19-10. javax.security.auth.callback.PasswordCallback


```
public class PasswordCallback implements Callback, Serializable {
// Public Constructors
     public PasswordCallback(String prompt, boolean echoOn);
// Public Instance Methods
     public void clearPassword( );
     public char[ ] getPassword( );
     public String getPrompt( );
     public boolean isEchoOn( );
     public void setPassword(char[ ] password);
}
```

TextInputCallback javax.security.auth.callback

Java 1.4 *serializable*

A Callback of this type is a request to prompt the user for text input; it is essentially a generic version of NameCallback. A CallbackHandler should call getPrompt( ) and should display the returned prompt text to the user. It should then allow the user to enter text, and provide the option of selecting the default text returned by getdefaultText( ). When the user has entered text (or selected the default text) it should pass the user's input to setText( ).

Figure 19-11. javax.security.auth.callback.TextInputCallback


```
public class TextInputCallback implements Callback, Serializable {
// Public Constructors
     public TextInputCallback(String prompt);
     public TextInputCallback(String prompt, String defaultText);
// Public Instance Methods
     public String getDefaultText( );
     public String getPrompt( );
     public String getText( );
     public void setText(String text);
}
```

TextOutputCallback javax.security.auth.callback

Java 1.4 *serializable*

A `Callback` of this type represents a request to display text to the user. A callback handler should call `getMessage( )` and display the returned string to the user. It should also call `getMessageType( )` and use the returned value (which is one of the constants defined by the class) to indicate the type or severity of the information.

Figure 19-12. javax.security.auth.callback.TextOutputCallback


```
public class TextOutputCallback implements Callback, Serializable {
// Public Constructors
     public TextOutputCallback(int messageType, String message);
// Public Constants
     public static final int ERROR;                                    =2
     public static final int INFORMATION;                              =0
     public static final int WARNING;                                  =1
// Public Instance Methods
     public String getMessage( );
     public int getMessageType( );
}
```

UnsupportedCallbackException javax.security.auth.callback

Java 1.4 *serializable checked*

CallbackHandler implementations may throw exceptions of this type from their handle( ) method if a Callback object passed to that method is of an unrecognized or unsupported type. Note that the offending Callback object must be passed to the constructor method.

Figure 19-13. javax.security.auth.callback.UnsupportedCallbackException


```
public class UnsupportedCallbackException extends Exception {
// Public Constructors
     public UnsupportedCallbackException(Callback callback);
     public UnsupportedCallbackException(Callback callback, String msg);
// Public Instance Methods
     public Callback getCallback( );
}
```

Thrown By

CallbackHandler.handle( )

Team LiB

Package javax.security.auth.kerberos

Java 1.4

This package defines classes for use with Kerberos: a secure network authentication protocol. They are primarily of interest to system-level programmers writing Kerberos-based `javax.security.auth.spi.LoginModule` implementations. Developers writing Kerberos-enabled applications should use the `org.ietf.jgss` package. A full description of Kerberos is beyond the scope of this book; so it is assumed that the reader is familar with Kerberos authentication.

Classes

```
public final class DelegationPermission extends java.security.BasicPermission
        implements Serializable;
public class KerberosKey implements javax.security.auth.Destroyable,
        javax.crypto.SecretKey;
public final class KerberosPrincipal implements java.security.Principal,
        Serializable;
public class KerberosTicket implements javax.security.auth.Destroyable,
        javax.security.auth.Refreshable, Serializable;
public final class ServicePermission extends java.security.Permission
        implements Serializable;
```

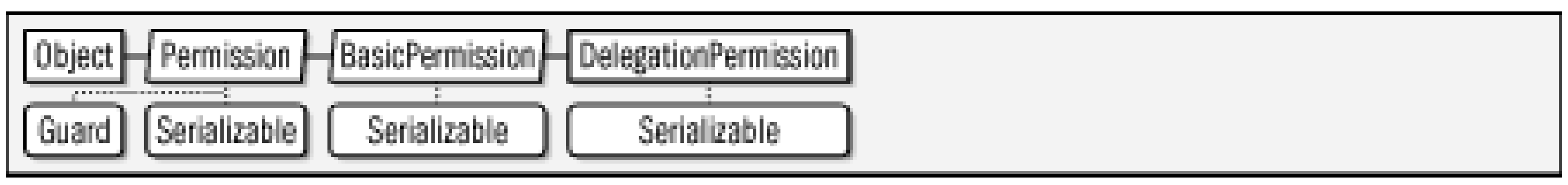
Team LiB

DelegationPermission javax.security.auth.kerberos

Java 1.4 *serializable permission*

This `java.security.Permission` class governs the delegation of Kerberos tickets from a Kerberos principal to a Kerberos service for use on behalf of the original principal. The target name of a `DelegationPermission` consists of the principal names of two Kerberos services. The first specifies the service that is being delegated to, and the second specifies the service that is to be used by the first on behalf of the original Kerberos principal.

Figure 19-14. javax.security.auth.kerberos.DelegationPermission




```
public final class DelegationPermission extends java.security.BasicPermission
        implements Serializable {
// Public Constructors
     public DelegationPermission(String principals);
     public DelegationPermission(String principals, String actions);
// Public Methods Overriding BasicPermission
     public boolean equals(Object obj);
     public int hashCode( );
     public boolean implies(java.security.Permission p);
     public java.security.PermissionCollection newPermissionCollection( );
}
```

Team LiB

KerberosKey javax.security.auth.kerberos

Java 1.4 *serializable*

This class is a `javax.crypto.SecretKey` implementation that represents the secret key of a Kerberos principal. A Kerberos-based `javax.security.auth.spi.LoginModule` implementation instantiates a `KerberosKey` object and stores it in the private credential set of the authenticated `Subject` it creates.

Figure 19-15. javax.security.auth.kerberos.KerberosKey


```
public class KerberosKey implements javax.security.auth.Destroyable,
        javax.crypto.SecretKey {
// Public Constructors
     public KerberosKey(KerberosPrincipal principal, char[ ] password,
        String algorithm);
     public KerberosKey(KerberosPrincipal principal, byte[ ] keyBytes, int keyType,
        int versionNum);
// Public Instance Methods
     public final int getKeyType( );
     public final KerberosPrincipal getPrincipal( );
     public final int getVersionNumber( );
// Methods Implementing Destroyable
     public void destroy( ) throws javax.security.auth.DestroyFailedException;
     public boolean isDestroyed( );
// Methods Implementing Key
     public final String getAlgorithm( );
     public final byte[ ] getEncoded( );
     public final String getFormat( );
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

KerberosPrincipal javax.security.auth.kerberos

Java 1.4 *serializable*

This class represents a Kerberos principal, specified as a principal name with an optional realm. If no realm is specified in the name, the default realm (from the *krb5.conf* configuration file or from the `java.security.krb5.realm` system property) is used.

Figure 19-16. javax.security.auth.kerberos.KerberosPrincipal


```
public final class KerberosPrincipal implements java.security.Principal, Serializable {
// Public Constructors
     public KerberosPrincipal(String name);
     public KerberosPrincipal(String name, int nameType);
// Public Constants
     public static final int KRB_NT_PRINCIPAL;                            =1
     public static final int KRB_NT_SRV_HST;                              =3
     public static final int KRB_NT_SRV_INST;                             =2
     public static final int KRB_NT_SRV_XHST;                             =4
     public static final int KRB_NT_UID;                                  =5
     public static final int KRB_NT_UNKNOWN;                              =0
// Public Instance Methods
     public int getNameType( );
     public String getRealm( );
// Methods Implementing Principal
     public boolean equals(Object other);
     public String getName( );
     public int hashCode( );
     public String toString( );
}
```

Passed To

`KerberosKey.KerberosKey( )` , `KerberosTicket.KerberosTicket( )`

Returned By

`KerberosKey.getPrincipal( )`, `KerberosTicket.{getClient( )`, `getServer( )}`

Team LiB

KerberosTicket javax.security.auth.kerberos

Java 1.4 *serializable*

This class represents a Kerberos ticket: a credential used to authenticate a Kerberos principal to some Kerberos-enabled network service. A Kerberos-based `javax.security.auth.spi.LoginModule` implementation will instantiate a `KerberosTicket` object and store it in the private credential set of the authenticated `Subject` it creates.

Figure 19-17. javax.security.auth.kerberos.KerberosTicket


```
public class KerberosTicket implements javax.security.auth.Destroyable,
        javax.security.auth.Refreshable, Serializable {
// Public Constructors
     public KerberosTicket(byte[ ] asn1Encoding, KerberosPrincipal client,
        KerberosPrincipal server, byte[ ] sessionKey,
        int keyType, boolean[ ] flags,
        java.util.Date authTime, java.util.Date startTime,
        java.util.Date endTime, java.util.Date renewTill,
        java.net.InetAddress[ ] clientAddresses);
// Public Instance Methods
     public final java.util.Date getAuthTime( );
     public final KerberosPrincipal getClient( );
     public final java.net.InetAddress[ ] getClientAddresses( );
     public final byte[ ] getEncoded( );
     public final java.util.Date getEndTime( );
     public final boolean[ ] getFlags( );
     public final java.util.Date getRenewTill( );
     public final KerberosPrincipal getServer( );
     public final javax.crypto.SecretKey getSessionKey( );
     public final int getSessionKeyType( );
     public final java.util.Date getStartTime( );
     public final boolean isForwardable( );
     public final boolean isForwarded( );
     public final boolean isInitial( );
     public final boolean isPostdated( );
     public final boolean isProxiable( );
     public final boolean isProxy( );
     public final boolean isRenewable( );
```

```
// Methods Implementing Destroyable
     public void destroy( ) throws javax.security.auth.DestroyFailedException;
     public boolean isDestroyed( );
// Methods Implementing Refreshable
     public boolean isCurrent( );
     public void refresh( ) throws javax.security.auth.RefreshFailedException;
// Public Methods Overriding Object
     public String toString( );
}
```

Team LiB

ServicePermission javax.security.auth.kerberos

Java 1.4 *serializable permission*

This java.security.Permission class protects access to the Kerberos tickets used to access a specifiec
The target name of of a ServicePermission is the Kerberos principal name of the service. The action fo
ServicePermission is either "initiate" for clients or "accept" for servers.

Figure 19-18. javax.security.auth.kerberos.ServicePermission


```
public final class ServicePermission extends java.security.Permission implements Serial:
// Public Constructors
     public ServicePermission(String servicePrincipal, String action);
// Public Methods Overriding Permission
     public boolean equals(Object obj);
     public String getActions( );
     public int hashCode( );
     public boolean implies(java.security.Permission p);
     public java.security.PermissionCollection newPermissionCollection( );
}
```

Team LiB

Package javax.security.auth.login

Java 1.4

This package defines the LoginContext class which is one of the primary JAAS classes used by application programmers. To authenticate a user, an application creates a LoginContext object, specifying the application name (used to lookup the type of authentication required for that application in the Configuration) and usually specifying a javax.security.auth.callback.CallbackHandler for communication between the user and the underlying login modules. Next, the application calls the login( ) method of the LoginContext to perform the actual login. If this method returns without throwing a LoginException, then the user was sucessfully authenticated, and the getSubject( ) method of LoginContext returns a javax.security.auth.Subject representing the user. The code might look like this:

```
import javax.security.auth.*;
import javax.security.auth.callback.*;
import javax.security.auth.login.*;
// Get a default GUI-based CallbackHandler
CallbackHandler h = new com.sun.security.auth.callback.DialogCallbackHandler( );
// Try to create a LoginContext for use with this application
LoginContext context;
try {
  context = new LoginContext("MyAppName", h);
}
catch(LoginException e) {
  System.err.println("LoginContext configuration error: " + e.getMessage( ));
  System.exit(-1);
}
// Now use that context to authenticate the user
try {
  context.login( );
}
catch(LoginException e) {
  System.err.println("Authentication failed: " + e.getMessage( ));
  System.exit(-1);  // Or we could allow them to try again.
}
// If we get here, authentication was successful, so get the Subject that
// represents the authenticated user.
Subject subject = context.getSubject( );
```

In order to make this kind of authentication work correctly, a fair bit of configuration is required in various files in the jre/lib/security directory of the Java installation and possibly elsewhere. In particular, a login configuration file is required to specify which login modules are required to authenticate users for a particular application (some applications may require more than one). A description of how to do this is beyond the scope of this reference. See the Configuration class for a run-time representation of the login configuration information, however.

Classes

```
public class AppConfigurationEntry;
public static class AppConfigurationEntry.LoginModuleControlFlag;
public abstract class Configuration;
public class LoginContext;
```

Exceptions

```
public class LoginException extends java.security.GeneralSecurityException;
   public class AccountException extends LoginException;
      public class AccountExpiredException extends AccountException;
      public class AccountLockedException extends AccountException;
      public class AccountNotFoundException extends AccountException;
   public class CredentialException extends LoginException;
      public class CredentialExpiredException extends CredentialException;
      public class CredentialNotFoundException extends CredentialException;
   public class FailedLoginException extends LoginException;
```

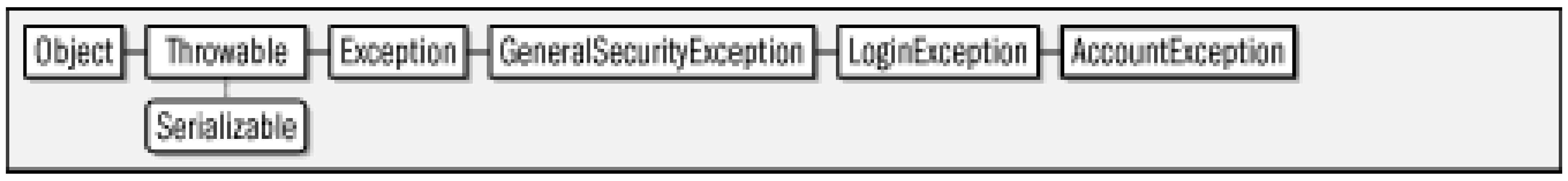
Team LiB

AccountException javax.security.auth.login

Java 5.0 *serializable checked*

A LoginException exception of this type signals a problem logging in to the specified account. Subclasses provide more detail.

Figure 19-19. javax.security.auth.login.AccountException




```
public class AccountException extends LoginException {
// Public Constructors
     public AccountException( );
     public AccountException(String msg);
}
```

Subclasses

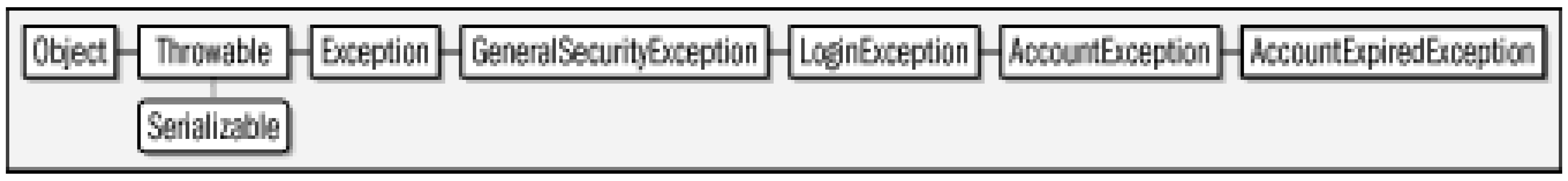
AccountExpiredException, AccountLockedException, AccountNotFoundException

AccountExpiredException javax.security.auth.login

Java 1.4 *serializable checked*

Signals that login failed because the user's account has expired. Prior to Java 5.0, this exception was a direct subclass of `LoginException`.

Figure 19-20. javax.security.auth.login.AccountExpiredException



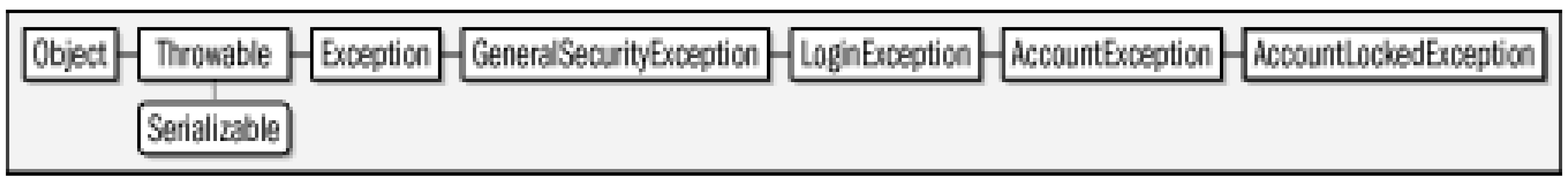

```
public class AccountExpiredException extends AccountException {
// Public Constructors
     public AccountExpiredException( );
     public AccountExpiredException(String msg);
}
```

AccountLockedException javax.security.auth.login

Java 5.0 *serializable checked*

An exception of this type indicates that the account for which login was attempted has been "locked" or otherwise made unavailable. See also `AccountExpiredException`.

Figure 19-21. javax.security.auth.login.AccountLockedException



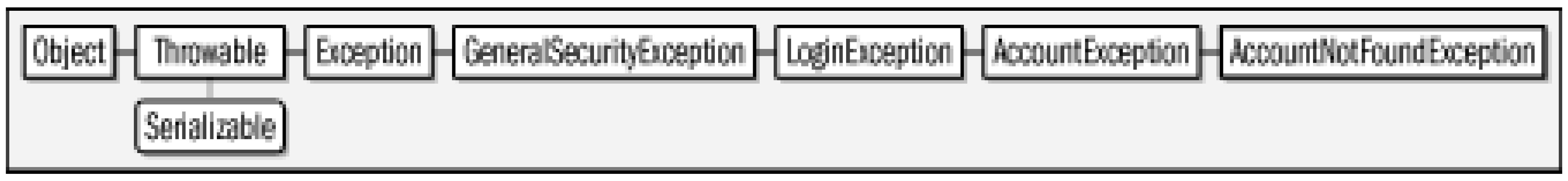

```
public class AccountLockedException extends AccountException {
// Public Constructors
     public AccountLockedException( );
     public AccountLockedException(String msg);
}
```

AccountNotFoundException javax.security.auth.login

Java 5.0 *serializable checked*

An exception of this type indicates that the account specified in a login attempt does not exist.

Figure 19-22. javax.security.auth.login.AccountNotFoundException




```
public class AccountNotFoundException extends AccountException {
// Public Constructors
     public AccountNotFoundException( );
     public AccountNotFoundException(String msg);
}
```

Team LiB

AppConfigurationEntry javax.security.auth.login

Java 1.4

An instance of this class represents a login module to be used for user authentication for a particular application. It encapsulates three pieces of information: the class name of the javax.security.auth.spi.LoginModule implementation that is to be used, a "control flag" that specifies whether authentication by that module is required or optional, and a java.util.Map of arbitrary string name/value pairs of options for the login module.

```
public class AppConfigurationEntry {
// Public Constructors
     public AppConfigurationEntry(String loginModuleName, AppConfigurationEntry.
        LoginModuleControlFlag controlFlag, java.util.Map<String,?> options);
// Nested Types
     public static class LoginModuleControlFlag;
// Public Instance Methods
     public AppConfigurationEntry.LoginModuleControlFlag getControlFlag( );
     public String getLoginModuleName( );
     public java.util.Map<String,?> getOptions( );
}
```

Returned By

Configuration.getAppConfigurationEntry( )

Team LiB

AppConfigurationEntry.LoginModuleControlFlag javax.security.

Java 1.4

This inner class defines a "control flag" type and four specific instances of that type. The constants defin
specify whether a login module is required or optional, and have the following meanings:

REQUIRED

Authentication by this module must be successful, or the overall login process will fail. However, e
authentication fails for this module, the LoginContext continues to attempt authentication with an
in the list. (This can server to disguise the source of the authentication failure from an attacker)

REQUSITE

Authentication by this module must be successful, or the overall login process will fail. If authentic
module, the LoginContext does not try any further login modules.

SUFFICIENT

Authentication by this module is not required, and the overall login process can still succeed if all R
REQUISITE modules successfully authenticate the user. However, if authentication by this module
LoginContext does not try any further login modules, but instead returns immediately.

OPTIONAL

Authentication by this module is not required. Whether or not it succeeds, the LoginContext conti
other modules on the list.

```
public static class AppConfigurationEntry.LoginModuleControlFlag {
// No Constructor
// Public Constants
     public static final AppConfigurationEntry.LoginModuleControlFlag OPTIONAL;
     public static final AppConfigurationEntry.LoginModuleControlFlag REQUIRED;
     public static final AppConfigurationEntry.LoginModuleControlFlag REQUISITE;
     public static final AppConfigurationEntry.LoginModuleControlFlag SUFFICIENT;
// Public Methods Overriding Object
     public String toString( );
```

```
}
```

Passed To

`AppConfigurationEntry.AppConfigurationEntry( )`

Returned By

`AppConfigurationEntry.getControlFlag( )`

Team LiB

Configuration javax.security.auth.login

Java 1.4

This abstract class is a representation of the system and user login configuration files. The static getConfiguration( ) method returns the global Configuration object, and the static setConfiguration( ) allows that global object to be replaced with some other implementation. The instance method refresh( ) causes a Configuration to re-read the underlying configuration files. getAppConfigurationEntry( ) is the key method: it returns an array of AppConfigurationEntry objects that represent the set of login modules to be used for applications with the specified name. LoginContext uses this class to determine which login modules to use to authenticate a user of the named application. Application programmers do not typically need to use this class themselves. See th documentation for your Java implementation for the syntax of the underlying login configuration files.

```
public abstract class Configuration {
// Protected Constructors
     protected Configuration( );
// Public Class Methods
     public static Configuration getConfiguration( );                    synchronized
     public static void setConfiguration(Configuration configuration);
// Public Instance Methods
     public abstract AppConfigurationEntry[ ] getAppConfigurationEntry(String name);
     public abstract void refresh( );
}
```

Passed To

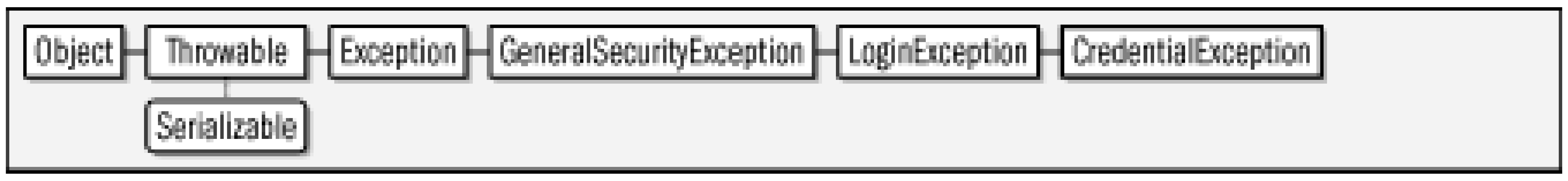
LoginContext.LoginContext( )

CredentialException javax.security.auth.login

Java 5.0 *serializable checked*

An exception of this type indicates a problem with the credential (e.g., the password) presented during the login attempt. Subclasses provide more detail.

Figure 19-23. javax.security.auth.login.CredentialException




```
public class CredentialException extends LoginException {
// Public Constructors
     public CredentialException( );
     public CredentialException(String msg);
}
```

Subclasses

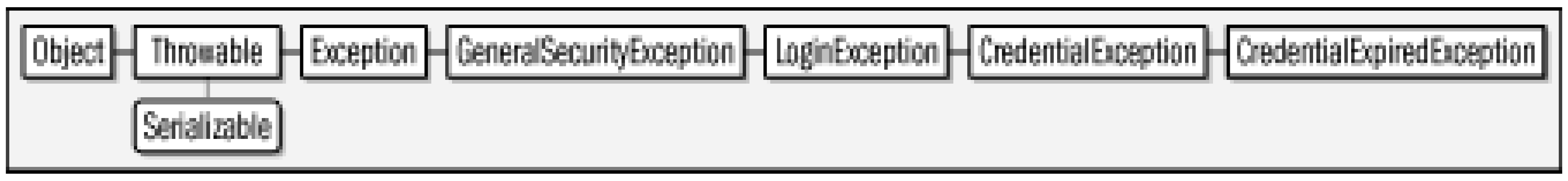
CredentialExpiredException, CredentialNotFoundException

CredentialExpiredException javax.security.auth.login

Java 1.4 *serializable checked*

Signals that a login failed because a credential (such as a password) hasexpired and is no longer valid. Prior to Java 5.0, this is a direct subclass of `LoginException`.

Figure 19-24. javax.security.auth.login.CredentialExpiredException




```
public class CredentialExpiredException extends CredentialException {
// Public Constructors
     public CredentialExpiredException( );
     public CredentialExpiredException(String msg);
}
```

CredentialNotFoundException javax.security.auth.login

Java 5.0 *serializable checked*

An exception of this type indicates that a credential (such as a Kerberos ticket) necessary for login could not be found. This is not the same as presenting an invalid credential, which results in a `FailedLoginException`.

Figure 19-25. javax.security.auth.login.CredentialNotFoundException


```
public class CredentialNotFoundException extends CredentialException {
// Public Constructors
     public CredentialNotFoundException( );
     public CredentialNotFoundException(String msg);
}
```

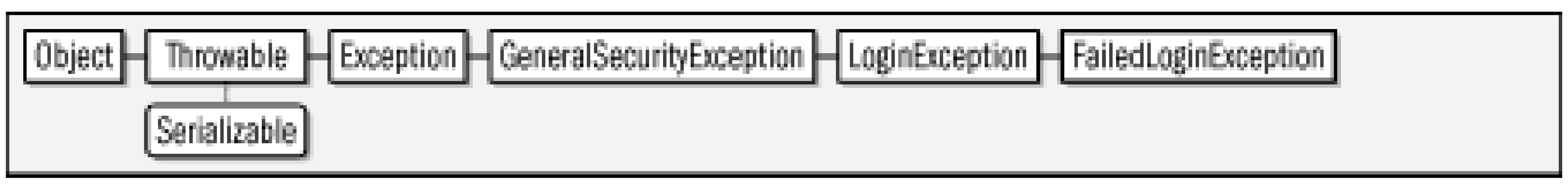
Team LiB

FailedLoginException javax.security.auth.login

Java 1.4 *serializable checked*

Signals that login failed. Typically this is because an incorrect username,password, or other information was presented. Login modules that throw this exception may provide human-readable details through the `getMessage( )` method.

Figure 19-26. javax.security.auth.login.FailedLoginException




```
public class FailedLoginException extends LoginException {
// Public Constructors
     public FailedLoginException( );
     public FailedLoginException(String msg);
}
```

Team LiB

LoginContext javax.security.auth.login

Java 1.4

This is one of the most important classes in the JAAS API for application programmers: it defines the `login( )` method (and the corresponding `logout( )` method) that allows an application to authenticate a user. Create a `LoginContext` object using one of the public constructors. The constructor expects to be passed the name of the application, and, optionally, the `javax.security.auth.Subject` that is to be authenticated and a `javax.security.auth.callback.CallbackHandler` that is to be used for communication between the underlying login module (or modules) and the user. If no `Subject` is specified, then the `LoginContext` will instantiate a new one to represent the authenticated user. If a `Subject` is supplied, then the `LoginContext` adds new entries to its sets of principals and credentials. If no `CallbackHandler` is specified, then the LoginContext attempts to instantiate one using the class name specified by the `auth.login.defaultCallbackHandler` property in the system's security properties file.

Once a `LoginContext` is successfully created, you can authenticate a user simply by calling the `login( )` method, and then calling `getSubject( )` to obtain the `Subject` object that represents the authenticated user. When this `Subject` is no longer required, you can log them out by calling the `logout( )` method.

```
public class LoginContext {
// Public Constructors
     public LoginContext(String name) throws LoginException;
     public LoginContext(String name, javax.security.auth.Subject subject)
        throws LoginException;
     public LoginContext(String name, javax.security.auth.callback.
        CallbackHandler callbackHandler) throws LoginException;
     public LoginContext(String name, javax.security.auth.Subject subject,
        javax.security.auth.callback.CallbackHandler callbackHandler)
        throws LoginException;
5.0  public LoginContext(String name, javax.security.auth.Subject subject,
        javax.security.auth.callback.CallbackHandler callbackHandler,
        Configuration config) throws LoginException;
// Public Instance Methods
     public javax.security.auth.Subject getSubject( );
     public void login( ) throws LoginException;
     public void logout( ) throws LoginException;
}
```

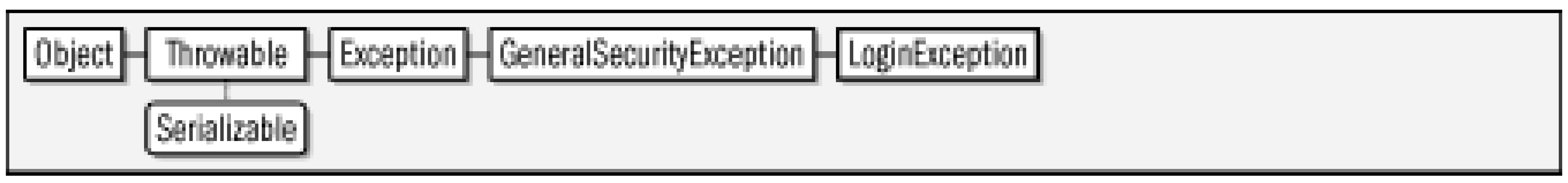
Team LiB

LoginException javax.security.auth.login

Java 1.4 *serializable checked*

Signals that something went wrong while creating a `LoginContext` or during the login or logout process. The subclasses of this class represent more specific exception types.

Figure 19-27. javax.security.auth.login.LoginException




```
public class LoginException extends java.security.GeneralSecurityException {
// Public Constructors
     public LoginException( );
     public LoginException(String msg);
}
```

Subclasses

`AccountException`, `CredentialException`, `FailedLoginException`

Thrown By

`java.security.AuthProvider.{login( ), logout( )}`, `LoginContext.{login( ), LoginContext( ), logout( )}`, `javax.security.auth.spi.LoginModule.{abort( ), commit( ), login( ), logout( )}`

Package javax.security.auth.spi

Java 1.4

This package defines the "service provider interface" for JAAS: itdefines a single `LoginModule` interface that must be implemented by developers of login modules.

Interfaces

```
public interface LoginModule;
```

Team LiB

LoginModule javax.security.auth.spi

Java 1.4

Developers of login modules to be used with the JAAS authentication API must implement this interface. Because this interface is not typically used by application developers, its methods are not documented here.

```
public interface LoginModule {
// Public Instance Methods
     boolean abort( ) throws javax.security.auth.login.LoginException;
     boolean commit( ) throws javax.security.auth.login.LoginException;
     void initialize(javax.security.auth.Subject subject, javax.security.
        auth.callback.CallbackHandler callbackHandler, java.util.Map<String,?>
        sharedState, java.util.Map<String,?> options);
     boolean login( ) throws javax.security.auth.login.LoginException;
     boolean logout( ) throws javax.security.auth.login.LoginException;
}
```

Team LiB

Package javax.security.auth.x500

Java 1.4

This package defines classes for use with authentication schemes for on X.500 principals. Instances of these classes are designed to be stored in the principals and private credentials sets of `Subject` objects, and although application programmers may occasionally find the `X500Principal` class useful, they are primarily of interest to system-level programmers writing X.500-based `javax.security.auth.spi.LoginModule` implementations See also the `java.security.cert` package which contains a class representing an X.509 certificate.

Classes

```
public final class X500Principal implements java.security.Principal, Serializable;
public final class X500PrivateCredential implements javax.security.auth.Destroyable;
```

Team LiB

X500Principal javax.security.auth.x500

Java 1.4 *serializable*

This class implements the `java.security.Principal` interface for entities represented by X.500 distinguished names (such as "CN=David,O=davidflanagan.com,C=US"). The constructor methods can accept the distinguished name in string form or in binary encoded form.`getName( )` returns the name in string form, using the format defined by one of the three consant values. The no-argument version of `getName( )` (the one defined by the `Principal` interface) returns the distinguished name formatted as specified by RFC 2253. Finally, `getEncoded( )` returns a binary-encoded form of the name.

Figure 19-28. javax.security.auth.x500.X500Principal

```
public final class X500Principal implements java.security.Principal, Serializable {
// Public Constructors
     public X500Principal(java.io.InputStream is);
     public X500Principal(String name);
     public X500Principal(byte[ ] name);
// Public Constants
     public static final String CANONICAL;                                        ="CANONICAL"
     public static final String RFC1779;                                          ="RFC1779"
     public static final String RFC2253;                                          ="RFC2253"
// Public Instance Methods
     public byte[ ] getEncoded( );
     public String getName(String format);
// Methods Implementing Principal
     public boolean equals(Object o);
     public String getName( );
     public int hashCode( );
     public String toString( );
}
```

Passed To

`java.security.cert.TrustAnchor.TrustAnchor( )` , `java.security.cert.X509CertSelector.{setIssuer( )` , `setSubject( )}` , `java.security.cert.X509CRLSelector.addIssuer( )`

Returned By

`java.security.cert.TrustAnchor.getCA( )`, `java.security.cert.X509Certificate.{getIssuerX500Principal( )`, `getSubjectX500Principal( )}`, `java.security.cert.X509CertSelector.{getIssuer( )`, `getSubject( )}`, `java.security.cert.X509CRL.getIssuerX500Principal( )`, `java.security.cert.X509CRLEntry.getCertificateIssuer( )`

X500PrivateCredential javax.security.auth.x500

Java 1.4

This class associates a `java.security.cert.X509Certificate` with a `java.security.PrivateKey` for that certificate, and, optionally, the keystore alias used to retrieve the certificate and key from a `java.security.KeyStore` . The class defines methods to retreive the certificate, key, and alias, and also implements the methods of the `javax.security.cert.Destroyable` interface.

Figure 19-29. javax.security.auth.x500.X500PrivateCredential


```
public final class X500PrivateCredential implements javax.security.auth.Destroyable {
// Public Constructors
     public X500PrivateCredential(java.security.cert.X509Certificate cert,
        java.security.PrivateKey key);
     public X500PrivateCredential(java.security.cert.X509Certificate cert,
        java.security.PrivateKey key, String alias);
// Public Instance Methods
     public String getAlias( );
     public java.security.cert.X509Certificate getCertificate( );
     public java.security.PrivateKey getPrivateKey( );
// Methods Implementing Destroyable
     public void destroy( );
     public boolean isDestroyed( );
}
```

Team LiB

Chapter 20. javax.xml and Subpackages

This chapter documents `javax.xml` and its subpackages:

`java.xml`

This simple package simply defines constants for use by its subpackages. Added inJava 5.0.

`javax.xml.datatype`

This package contains Java types corresponding to types defined by XML standards such as W3C XML Schema, XQuery, and XPath.

`javax.xml.namespace`

This package defines types for working with XML namespaces.

`javax.xml.parsers`

This package defines parser classes that serve as a wrapper around underlying DOM and SAX XML parsers, and also defines factory classes that are used to obtain instances of those parser classes.

`javax.xml.transform`

This package defines classes and interfaces for transforming the representation and content of an XML document with XSLT. It defines `Source` and `Result` interfaces to represent a source document and a result document. subpackages provide implementations of these classes that represent documents in different ways.

`javax.xml.transform.dom`

This package implements the `Source` and `Result` interfaces that represent documents as DOM document trees.

`javax.xml.transform.sax`

This package implements the `Source` and `Result` interfaces to represent documents as sequences of SAX parser events. It also defines other SAX-related transformation classes.

`javax.xml.transform.stream`

This package implements the `Source` and `Result` interfaces that represent documents as streams of text.

`javax.xml.validation`

This package contains classes for validating XML documents against a schema.

`javax.xml.xpath`

This package defines types for the evaluation of XPath expressions in the context of an XML document.

Package javax.xml

Java 5.0

This package has many important subpackages but defines only a single class`XMLConstants`, which, as its name implies, provides symbolic names for constants defined by various XML specifications.

Classes

```
public final class XMLConstants;
```

Team LiB

XMLConstants javax.xml

Java 5.0

This class is a repository for constants defined by various XML standards. Most areURIs that identify XMl namespaces.

```
public final class XMLConstants {
// No Constructor
// Public Constants
     public static final String DEFAULT_NS_PREFIX; =" "
     public static final String FEATURE_SECURE_PROCESSING;
      ="http://javax.xml.XMLConstants/feature/secure-processing"
     public static final String NULL_NS_URI;    =" "
     public static final String RELAXNG_NS_URI; ="http://relaxng.org/ns/structure/1.0"
     public static final String W3C_XML_SCHEMA_INSTANCE_NS_URI;
     ="http://www.w3.org/2001/XMLSchema-instance"
     public static final String W3C_XML_SCHEMA_NS_URI; ="http://www.w3.org/2001/XMLSche
     public static final String W3C_XPATH_DATATYPE_NS_URI;
      ="http://www.w3.org/2003/11/xpath-datatypes"
     public static final String XML_DTD_NS_URI;      ="http://www.w3.org/TR/REC-xml"
     public static final String XML_NS_PREFIX;       ="xml"
     public static final String XML_NS_URI;          ="http://www.w3.org/XML/1998/names
     public static final String XMLNS_ATTRIBUTE;     ="xmlns"
     public static final String XMLNS_ATTRIBUTE_NS_URI; ="http://www.w3.org/2000/xmlns/
}
```

Team LiB

Package javax.xml.datatype

Java 5.0

This package defines Java data types that correspond to certain time, date, and duration data types required by the W3C XML Schema, XQuery, and XPath standards. This package is of primary interest to those implementing schema validators and XPath evaluators and should not be required by applications that use schemas or XPath expressions.

Classes

```
public final class DatatypeConstants;
public static final class DatatypeConstants.Field;
public abstract class DatatypeFactory;
public abstract class Duration;
public abstract class XMLGregorianCalendar implements Cloneable;
```

Exceptions

```
public class DatatypeConfigurationException extends Exception;
```

Team LiB

DatatypeConfigurationException javax.xml.datatype

Java 5.0 *serializable checked*

An exception of this type is thrown by `DatatypeFactory.newInstance( )` to indicate a factory configuration error.

Figure 20-1. javax.xml.datatype.DatatypeConfigurationException


```
public class DatatypeConfigurationException extends Exception {
// Public Constructors
     public DatatypeConfigurationException( );
     public DatatypeConfigurationException(Throwable cause);
     public DatatypeConfigurationException(String message);
     public DatatypeConfigurationException(String message, Throwable cause);
}
```

Thrown By

`DatatypeFactory.newInstance( )`

DatatypeConstants javax.xml.datatype

Java 5.0

This class defines constants used in this package. Most of the constants are `int` values, but some are qualified names and some are instances of the `DatatypeConstants.Field` type.

```
public final class DatatypeConstants {
// No Constructor
// Public Constants
     public static final int APRIL;                                          =4
     public static final int AUGUST;                                         =8
     public static final javax.xml.namespace.QName DATE;
     public static final javax.xml.namespace.QName DATETIME;
     public static final DatatypeConstants.Field DAYS;
     public static final int DECEMBER;                                       =12
     public static final javax.xml.namespace.QName DURATION;
     public static final javax.xml.namespace.QName DURATION_DAYTIME;
     public static final javax.xml.namespace.QName DURATION_YEARMONTH;
     public static final int EQUAL;                                          =0
     public static final int FEBRUARY;                                       =2
     public static final int FIELD_UNDEFINED;                                =-2147483648
     public static final javax.xml.namespace.QName GDAY;
     public static final javax.xml.namespace.QName GMONTH;
     public static final javax.xml.namespace.QName GMONTHDAY;
     public static final int GREATER;                                        =1
     public static final javax.xml.namespace.QName GYEAR;
     public static final javax.xml.namespace.QName GYEARMONTH;
     public static final DatatypeConstants.Field HOURS;
     public static final int INDETERMINATE;                                  =2
     public static final int JANUARY;                                        =1
     public static final int JULY;                                           =7
     public static final int JUNE;                                           =6
     public static final int LESSER;                                         =-1
     public static final int MARCH;                                          =3
     public static final int MAX_TIMEZONE_OFFSET;                            =-840
     public static final int MAY;                                            =5
     public static final int MIN_TIMEZONE_OFFSET;                            =840
     public static final DatatypeConstants.Field MINUTES;
     public static final DatatypeConstants.Field MONTHS;
     public static final int NOVEMBER;                                       =11
     public static final int OCTOBER;                                        =10
     public static final DatatypeConstants.Field SECONDS;
     public static final int SEPTEMBER;                                      =9
     public static final javax.xml.namespace.QName TIME;
```

```
    public static final DatatypeConstants.Field YEARS;
// Nested Types
    public static final class Field;
}
```

DatatypeConstants.Field javax.xml.datatype

Java 5.0

This class defines a typesafe enumeration for some of the constants in DatatypeConstants. Note that it is a class, not a Java 5.0 enum type.

```
public static final class DatatypeConstants.Field {
// No Constructor
// Public Instance Methods
     public int getId( );
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

Duration.{getField( ), isSet( )}

Type Of

DatatypeConstants.{DAYS, HOURS, MINUTES, MONTHS, SECONDS, YEARS}

Team LiB

DatatypeFactory javax.xml.datatype

Java 5.0

This class defines factory methods for creating Duration and XMLGregorianCalendar objects.

```
public abstract class DatatypeFactory {
// Protected Constructors
     protected DatatypeFactory( );
// Public Constants
     public static final String DATATYPEFACTORY_IMPLEMENTATION_CLASS;
      ="com.sun.org.apache.xerces.internal.jaxp.datatype.DatatypeFactoryImpl"
     public static final String DATATYPEFACTORY_PROPERTY;
      ="javax.xml.datatype.DatatypeFactory"
// Public Class Methods
     public static DatatypeFactory newInstance( ) throws DatatypeConfigurationException;
// Public Instance Methods
     public abstract Duration newDuration(String lexicalRepresentation);
     public abstract Duration newDuration(long durationInMilliSeconds);
     public Duration newDuration(boolean isPositive, int years, int months,
        int days, int hours,
        int minutes, int seconds);
     public abstract Duration newDuration(boolean isPositive,
        java.math.BigInteger years, java.math.BigInteger months,
        java.math.BigInteger days, java.math.BigInteger hours,
        java.math.BigInteger minutes, java.math.BigDecimal seconds);
     public Duration newDurationDayTime(long durationInMilliseconds);
     public Duration newDurationDayTime(String lexicalRepresentation);
     public Duration newDurationDayTime(boolean isPositive, int day, int hour,
        int minute, int second);
     public Duration newDurationDayTime(boolean isPositive,
        java.math.BigInteger day, java.math.BigInteger hour,
        java.math.BigInteger minute, java.math.BigInteger second);
     public Duration newDurationYearMonth(long durationInMilliseconds);
     public Duration newDurationYearMonth(String lexicalRepresentation);
     public Duration newDurationYearMonth(boolean isPositive, int year, int month);
     public Duration newDurationYearMonth(boolean isPositive,
        java.math.BigInteger year, java.math.BigInteger month);
     public abstract XMLGregorianCalendar newXMLGregorianCalendar( );
     public abstract XMLGregorianCalendar newXMLGregorianCalendar
        (java.util.GregorianCalendar cal);
     public abstract XMLGregorianCalendar newXMLGregorianCalendar(String lexicalRepresen
     public XMLGregorianCalendar newXMLGregorianCalendar(int year, int month,
        int day, int hour,
```

```
            int minute, int second,
            int millisecond, int timezone);
        public abstract XMLGregorianCalendar newXMLGregorianCalendar
            (java.math.BigInteger year, int month,
            int day, int hour, int minute,
            int second,
            java.math.BigDecimal fractionalSecond,
            int timezone);
        public XMLGregorianCalendar newXMLGregorianCalendarDate(int year, int month,
            int day, int timezone);
        public XMLGregorianCalendar newXMLGregorianCalendarTime(int hours, int minutes,
            int seconds, int timezone);
        public XMLGregorianCalendar newXMLGregorianCalendarTime(int hours, int minutes,
            int seconds, int milliseconds,
            int timezone);
        public XMLGregorianCalendar newXMLGregorianCalendarTime(int hours, int minutes,
            int seconds, java.math.BigDecimal fractionalSecond,
            int timezone);
}
```

Duration javax.xml.datatype

Java 5.0

An instance of this class represents a length of time. Create Duration objects with DatatypeFactory.

```
public abstract class Duration {
// Public Constructors
     public Duration( );
// Public Instance Methods
     public abstract Duration add(Duration rhs);
     public abstract void addTo(java.util.Calendar calendar);
     public void addTo(java.util.Date date);
     public abstract int compare(Duration duration);
     public int getDays( );
     public abstract Number getField(DatatypeConstants.Field field);
     public int getHours( );
     public int getMinutes( );
     public int getMonths( );
     public int getSeconds( );
     public abstract int getSign( );
     public long getTimeInMillis(java.util.Date startInstant);
     public long getTimeInMillis(java.util.Calendar startInstant);
     public javax.xml.namespace.QName getXMLSchemaType( );
     public int getYears( );
     public boolean isLongerThan(Duration duration);
     public abstract boolean isSet(DatatypeConstants.Field field);
     public boolean isShorterThan(Duration duration);
     public Duration multiply(int factor);
     public abstract Duration multiply(java.math.BigDecimal factor);
     public abstract Duration negate( );
     public abstract Duration normalizeWith(java.util.Calendar startTimeInstant);
     public Duration subtract(Duration rhs);
// Public Methods Overriding Object
     public boolean equals(Object duration);
     public abstract int hashCode( );
     public String toString( );
}
```

Passed To

XMLGregorianCalendar.add( )

Returned By

`DatatypeFactory.{newDuration( )`, `newDurationDayTime( )`, `newDurationYearMonth( )}`

XMLGregorianCalendar javax.xml.datatype

Java 5.0 *cloneable*

Instances of this class represent a date or time. Create `XMLGregorianCalendar` objects with a `DatatypeFactory`.

Figure 20-2. javax.xml.datatype.XMLGregorianCalendar


```
public abstract class XMLGregorianCalendar implements Cloneable {
// Public Constructors
     public XMLGregorianCalendar( );
// Public Instance Methods
     public abstract void add(Duration duration);
     public abstract void clear( );
     public abstract int compare(XMLGregorianCalendar xmlGregorianCalendar);
     public abstract int getDay( );
     public abstract java.math.BigInteger getEon( );
     public abstract java.math.BigInteger getEonAndYear( );
     public abstract java.math.BigDecimal getFractionalSecond( );
     public abstract int getHour( );
     public int getMillisecond( );
     public abstract int getMinute( );
     public abstract int getMonth( );
     public abstract int getSecond( );
     public abstract int getTimezone( );
     public abstract java.util.TimeZone getTimeZone(int defaultZoneoffset);
     public abstract javax.xml.namespace.QName getXMLSchemaType( );
     public abstract int getYear( );
     public abstract boolean isValid( );
     public abstract XMLGregorianCalendar normalize( );
     public abstract void reset( );
     public abstract void setDay(int day);
     public abstract void setFractionalSecond(java.math.BigDecimal fractional);
     public abstract void setHour(int hour);
     public abstract void setMillisecond(int millisecond);
     public abstract void setMinute(int minute);
     public abstract void setMonth(int month);
     public abstract void setSecond(int second);
     public void setTime(int hour, int minute, int second);
```

```
    public void setTime(int hour, int minute, int second, int millisecond);
    public void setTime(int hour, int minute, int second,
       java.math.BigDecimal fractional);
    public abstract void setTimezone(int offset);
    public abstract void setYear(int year);
    public abstract void setYear(java.math.BigInteger year);
    public abstract java.util.GregorianCalendar toGregorianCalendar( );
    public abstract java.util.GregorianCalendar toGregorianCalendar
       (java.util.TimeZone timezone, java.util.Locale aLocale,
       XMLGregorianCalendar defaults);
    public abstract String toXMLFormat( );
// Public Methods Overriding Object
    public abstract Object clone( );
    public boolean equals(Object obj);
    public int hashCode( );
    public String toString( );
}
```

Returned By

`DatatypeFactory.{newXMLGregorianCalendar( )`, `newXMLGregorianCalendarDate( )`, `newXMLGregorianCalendarTime( )}`

Package javax.xml.namespace

Java 5.0

This small package defines types for working with XML namespaces.NamespaceContext represents a mapping between namespace URIs and namespace prefixes.QName represents a qualified name consisting of a local part and a namespace.

Interfaces

```
public interface NamespaceContext;
```

Classes

```
public class QName implements Serializable;
```

Team LiB

NamespaceContext javax.xml.namespace

Java 5.0

This interface represents a mapping between namespace URIs and the local prefixes that are bound to them. Use `getNamepaceURI( )` to obtain the URI that a prefix is bound to. Use `getPrefix( )` to do the reverse. More than one prefix can be bound to the same URI, and the `getPrefixes( )` method returns an `Iterator` that you can use to loop through all prefixes that have been associated with a given URI.

```
public interface NamespaceContext {
// Public Instance Methods
     String getNamespaceURI(String prefix);
     String getPrefix(String namespaceURI);
     java.util.Iterator getPrefixes(String namespaceURI);
}
```

Passed To

`javax.xml.xpath.XPath.setNamespaceContext( )`

Returned By

`javax.xml.xpath.XPath.getNamespaceContext( )`

Team LiB

QName javax.xml.namespace

Java 5.0 *serializable*

A `QName` represents an XML "qualified name," such as an XML element name that has both a local name and a namespace. `getLocalPart( )` returns the unqualified local part of the name. `getNamespaceURI( )` returns the canonical URI that formally identifies the namespace. `getPrefix( )` returns the locally declared namespace prefix. Note that a `QName` does not always have a prefix and that the prefix, if it exists, is ignored for the purposes of the `equals( )`, `hashCode( )`, and `toString( )` methods. The static `valueOf( )` method parses a `QName` from a string in the format of `toString( )`:

{namespaceURI}localPart

javax.xml.namespace.QName

```
public class QName implements Serializable {
// Public Constructors
     public QName(String localPart);
     public QName(String namespaceURI, String localPart);
     public QName(String namespaceURI, String localPart, String prefix);
// Public Class Methods
     public static QName valueOf(String qNameAsString);
// Public Instance Methods
     public String getLocalPart( );
     public String getNamespaceURI( );
     public String getPrefix( );
// Public Methods Overriding Object
     public final boolean equals(Object objectToTest);
     public final int hashCode( );
     public String toString( );
}
```

Passed To

`javax.xml.xpath.XPath.evaluate( )`, `javax.xml.xpath.XPathExpression.evaluate( )`, `javax.xml.xpath.XPathFunctionResolver.resolveFunction( )`, `javax.xml.xpath.XPathVariableResolver.resolveVariable( )`

Returned By

`javax.xml.datatype.Duration.getXMLSchemaType( )`,
`javax.xml.datatype.XMLGregorianCalendar.getXMLSchemaType( )`

Type Of

Too many fields to list.

Team LiB

Package javax.xml.parsers

Java 1.4

This package defines classes that represent XML parsers and factory classes for obtaining instances of those parser classes. `DocumentBuilder` is a DOM-based XML parser created from a `DocumentBuilderFactory`. `SAXParser` is a SAX-based XML parser created from a `SAXParserFactory`. In Java 5.0, you can configure either of the factory classes to create parsers that validate against a W3C XML Schema specified with a `javax.xml.validation.Schema` object. Note that this package does not include parser implementations. Instead, it is an implementation-independent layer that supports "pluggable" XML parsers. Furthermore, this package does not define a DOM or SAX API for working with XML documents. The DOM API is defined in `org.w3c.dom`, and the SAX API is defined in `org.xml.sax` and its subpackages.

Classes

```
public abstract class DocumentBuilder;
public abstract class DocumentBuilderFactory;
public abstract class SAXParser;
public abstract class SAXParserFactory;
```

Exceptions

```
public class ParserConfigurationException extends Exception;
```

Errors

```
public class FactoryConfigurationError extends Error;
```

Team LiB

DocumentBuilder javax.xml.parsers

Java 1.4

This class defines a high-level API to an underlying DOM parser implementation. Obtain a DocumentBuilder from a DocumentBuilderFactory. After obtaining a DocumentBuilder, you can provide org.xml.sax.ErrorHandler and org.xml.sax.EntityResolver objects, if desired. (These classes are defined by the SAX API but are useful for DOM parsers as well.) You may also want to cal isNamespaceAware( ), isXIncludeAware( ) and isValidating( ) to ensure that the parser is configured with the features your application requires. Finally, use one of the parse( ) methods to read an XML document from a stream, file, URL, or org.xml.sax.InputSource object, parse that document, and convert it into a org.w3c.dom.Document tree. Note that DocumentBuilder objects are not typically threadsafe. In Java 5.0, you can call reset( ) to restore the parser to its original state for reuse. Another Java 5.0 method, getSchema( ) returns the Schema object, if any, registered with the DocumentBuilderFactory that created this parser.

If you want to obtain an empty Document object (so that you can build the document tree from scratch, for example) call newDocument( ). Or use getdOMImplementation( ) to obtain a the org.w3c.dom.DOMImplementation object of the underlying DOM implementation from which you can also create an empty Document.

See the org.w3c.dom package for information on what you can do with a Document object once you have used a DocumentBuilder to create it.

```
public abstract class DocumentBuilder {
// Protected Constructors
     protected DocumentBuilder( );
// Public Instance Methods
     public abstract org.w3c.dom.DOMImplementation getDOMImplementation( );
5.0  public javax.xml.validation.Schema getSchema( );
     public abstract boolean isNamespaceAware( );
     public abstract boolean isValidating( );
5.0  public boolean isXIncludeAware( );
     public abstract org.w3c.dom.Document newDocument( );
     public org.w3c.dom.Document parse(java.io.InputStream is)
        throws org.xml.sax.SAXException, java.io.IOException;
     public org.w3c.dom.Document parse(String uri)
        throws org.xml.sax.SAXException, java.io.IOException;
     public abstract org.w3c.dom.Document parse(org.xml.sax.InputSource is)
throws org.xml.sax.SAXException, java.io.IOException;
     public org.w3c.dom.Document parse(java.io.File f)
        throws org.xml.sax.SAXException, java.io.IOException;
     public org.w3c.dom.Document parse(java.io.InputStream is, String systemId)
throws org.xml.sax.SAXException, java.io.IOException;
5.0  public void reset( );
     public abstract void setEntityResolver(org.xml.sax.EntityResolver er);
```

```
    public abstract void setErrorHandler(org.xml.sax.ErrorHandler eh);
}
```

Returned By

DocumentBuilderFactory.newDocumentBuilder( )

Team LiB

Team LiB

DocumentBuilderFactory javax.xml.parsers

Java 1.4

A `DocumentBuilderFactory` is a factory class for creating `DocumentBuilder` objects. You can obtain a `DocumentBuilderFactory` by instantiating an implementation-specific subclass provided by a parser vendor, but it is much more common to simply call `newInstance( )` to obtain an instance of the factory that has been configured as the default for the system. Once you have obtained a factory object, you can use the various `set` methods to configure the properties of the `DocumentBuilder` objects it will create. These methods allow you to specify whether the parsers created by the factory will:

- coalesce `CDATA` sections with adjacent text nodes;
- expand entity references or leave them unexpanded in the document tree;
- omit XML comments from the document tree;
- omit ignorable whitespace from the document tree;
- handle XML namespaces correctly; and
- validate XML documents against a DTD or other schema.

In Java 5.0, you can use `setSchema( )` to specify the `javax.xml.vaidation.Schema` object against which parsers should validate their documents. And you can use `setXIncludeAware( )` to indicate that parsers should process XInclude markup.

In addition to the various implementation-independent `set` methods, you can also use `setAttribute( )` pass an implementation-dependent named attribute to the underlying parser implementation. Once you have configured the factory object as desired, simply call `newDocumentBuilder( )` to create a `DocumentBuilder` object with the all of the attributes you have specified. Note that `DocumentBuilderFactory` objects are not typically threadsafe.

The `javax.xml.parsers` package allows parser implementations to be "plugged in." This pluggability is provided by the `getInstance( )` method, which follows the following steps to determine which `DocumentBuilderFactory` implementation to use:

- If the `javax.xml.parsers.DocumentBuilderFactory` system property is defined, then the class specified by that property is used.
- Otherwise, if the *jre/lib/jaxp.properties* file exists in the Java distribution and contains a definition for the `javax.xml.parsers.DocumentBuilderFactory` property, then the class specified by that property is used.
- Otherwise, if any of the JAR files on the classpath includes a file named *META-*

INF/services/javax.xml.parsers.DocumentBuilderFactory, then the class named in that file will be used.

- Otherwise, a default implementation provided by the Java implementation will be used.

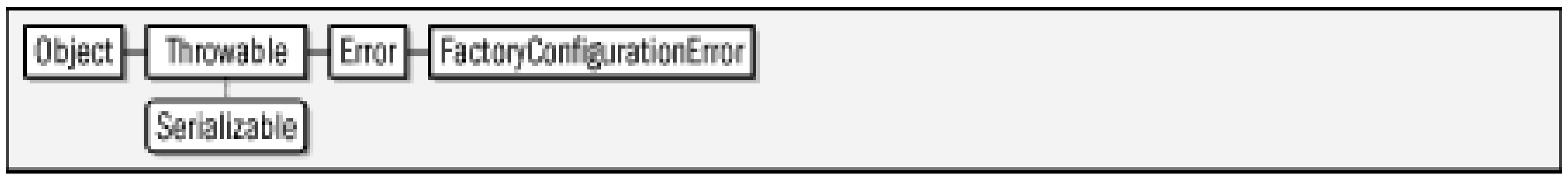
```
public abstract class DocumentBuilderFactory {
// Protected Constructors
     protected DocumentBuilderFactory( );
// Public Class Methods
     public static DocumentBuilderFactory newInstance( );
// Public Instance Methods
     public abstract Object getAttribute(String name)
        throws IllegalArgumentException;
5.0  public abstract boolean getFeature(String name)
        throws ParserConfigurationException;
5.0  public javax.xml.validation.Schema getSchema( );
     public boolean isCoalescing( );
     public boolean isExpandEntityReferences( );
     public boolean isIgnoringComments( );
     public boolean isIgnoringElementContentWhitespace( );
     public boolean isNamespaceAware( );
     public boolean isValidating( );
5.0  public boolean isXIncludeAware( );
     public abstract DocumentBuilder newDocumentBuilder( )
        throws ParserConfigurationException;
     public abstract void setAttribute(String name, Object value)
        throws IllegalArgumentException;
     public void setCoalescing(boolean coalescing);
     public void setExpandEntityReferences(boolean expandEntityRef);
5.0  public abstract void setFeature(String name, boolean value)
        throws ParserConfigurationException;
     public void setIgnoringComments(boolean ignoreComments);
     public void setIgnoringElementContentWhitespace(boolean whitespace);
     public void setNamespaceAware(boolean awareness);
5.0  public void setSchema(javax.xml.validation.Schema schema);
     public void setValidating(boolean validating);
5.0  public void setXIncludeAware(boolean state);
}
```

FactoryConfigurationError javax.xml.parsers

Java 1.4 *serializable error*

Signals a nonrecoverable problem instantiating a parser factory. This usually means that a pluggable parser implementation has been incorrectly plugged in and the`getInstance( )` method cannot locate the specified factory implementation class.

Figure 20-3. javax.xml.parsers.FactoryConfigurationError




```
public class FactoryConfigurationError extends Error {
// Public Constructors
     public FactoryConfigurationError( );
     public FactoryConfigurationError(Exception e);
     public FactoryConfigurationError(String msg);
     public FactoryConfigurationError(Exception e, String msg);
// Public Instance Methods
     public Exception getException( );                                       default:null
// Public Methods Overriding Throwable
     public String getMessage( );                                            default:null
}
```

ParserConfigurationException javax.xml.parsers

Java 1.4 *serializable checked*

Signals a parser configuration problem that prevents a parser factory object from creating a parser object.

Figure 20-4. javax.xml.parsers.ParserConfigurationException

```
public class ParserConfigurationException extends Exception {
// Public Constructors
     public ParserConfigurationException( );
     public ParserConfigurationException(String msg);
}
```

Thrown By

DocumentBuilderFactory.{getFeature( ), newDocumentBuilder( ), setFeature( )}, SAXParserFactory.{getFeature( ), newSAXParser( ), setFeature( )}

Team LiB

SAXParser javax.xml.parsers

Java 1.4

The SAXParser class is a wrapper around an org.xml.sax.XMLReader class and is used to parse XML dc
. Call setProperty( ) if desired to set a property on the underlying parser. (See www.saxproject.orgfor
parse( ) methods to parse an XML document from a stream, file, URL, or org.xml.sax.InputSource .
describe an XML document like a DOM parser does. Instead, it describes the XML document to your appl
of the org.xml.sax.helpers.DefaultHandler object that is passed to the parse( ) method: you subcl
those methods at appropriate times. For example, when the parser encounters an XML tag in a documer
when it finds a run of plain text, it passes that text to the characters( ) method. In Java 5.0, the rese

Instead of using one of the parse( ) methods of this class, you can also call getXMLReader( ) to obtain
document. SAXParser objects are not typically threadsafe.

Note that the getParser( ) method as well as the parse( ) methods that take an org.xml.sax.Handl

```
public abstract class SAXParser {
// Protected Constructors
     protected SAXParser( );
// Public Instance Methods
     public abstract org.xml.sax.Parser getParser( ) throws org.xml.sax.SAXException;
     public abstract Object getProperty(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
5.0  public javax.xml.validation.Schema getSchema( );
     public abstract org.xml.sax.XMLReader getXMLReader( ) throws org.xml.sax.SAXExcept
     public abstract boolean isNamespaceAware( );
     public abstract boolean isValidating( );
5.0  public boolean isXIncludeAware( );
     public void parse(org.xml.sax.InputSource is, org.xml.sax.HandlerBase hb)
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(org.xml.sax.InputSource is, org.xml.sax.helpers.DefaultHandler d
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(java.io.File f, org.xml.sax.helpers.DefaultHandler dh)
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(java.io.InputStream is, org.xml.sax.helpers.DefaultHandler dh)
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(java.io.InputStream is, org.xml.sax.HandlerBase hb)
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(String uri, org.xml.sax.HandlerBase hb) throws org.xml.sax.SAXEx
     public void parse(String uri, org.xml.sax.helpers.DefaultHandler dh)
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(java.io.File f, org.xml.sax.HandlerBase hb) throws org.xml.sax.S
     public void parse(java.io.InputStream is, org.xml.sax.HandlerBase hb, String syste
```

```
        throws org.xml.sax.SAXException, java.io.IOException;
     public void parse(java.io.InputStream is, org.xml.sax.helpers.DefaultHandler dh, S
5.0  public void reset( );
     public abstract void setProperty(String name, Object value)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
}
```

Returned By

SAXParserFactory.newSAXParser( )

Team LiB

SAXParserFactory javax.xml.parsers

Java 1.4

This class is a factory for SAXParser objects. Obtain a SAXParserFactory by calling the newInstance( ) method which instantiates the default SAXParserFactory subclass provided with your Java implementation, or instantiates some other SAXParserFactory that has been "plugged in".

Once you have a SAXParserFactory object, you can use setValidating( ) and setNamespaceAware( ) to specify whether the parsers it creates will be validating parsers or not and whether they will know how to handle XML namespaces. You may also call setFeature( ) to set a feature of the underlying parser implementation. See http://www.saxproject.org for the names of standard parser features that can be enabled and disabled with this method. In Java 5.0, call setXIncludeAware( ) to specify that created parsers will recognize XInclude markup. Use setSchema( ) to specify a W3C XML Schema against which parsers should validate the document.

Once you have created and configured your factory object, simply call newSAXParser( ) to create a SAXParser object. Note that SAXParserFactory implementations are not typically threadsafe.

The javax.xml.parsers package allows parser implementations to be "plugged in". This pluggability is provided by the getInstance( ) method, which follows the following steps to determine which SAXBuilderFactory subclass to use:

- If the javax.xml.parsers.SAXParserFactory system property is defined, then the class specified by that property is used.
- Otherwise, if the *jre/lib/jaxp.properties* file exists in the Java distribution and contains a definition for the javax.xml.parsers.SAXParserFactory property, then the class specified by that property is used.
- Otherwise, if any of the JAR files on the classpath includes a file named *META-INF/services/javax.xml.parsers.SAXParserFactory*, then the class named in that file will be used
- Otherwise, a default implementation provided by the Java platform will be used.

```
public abstract class SAXParserFactory {
// Protected Constructors
     protected SAXParserFactory( );
// Public Class Methods
     public static SAXParserFactory newInstance( );
// Public Instance Methods
     public abstract boolean getFeature(String name)
        throws ParserConfigurationException,
        org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
5.0  public javax.xml.validation.Schema getSchema( );
```

```
     public boolean isNamespaceAware( );
     public boolean isValidating( );
5.0  public boolean isXIncludeAware( );
     public abstract SAXParser newSAXParser( )
        throws ParserConfigurationException,
        org.xml.sax.SAXException;
     public abstract void setFeature(String name, boolean value)
        throws ParserConfigurationException,
        org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public void setNamespaceAware(boolean awareness);
5.0  public void setSchema(javax.xml.validation.Schema schema);
     public void setValidating(boolean validating);
5.0  public void setXIncludeAware(boolean state);
}
```

Package javax.xml.transform

Java 1.4

This package defines an high-level implementation-independent API for using an XSLT engine or other document transformation system for transforming XML document content, and also for transforming XML documents from one form (such as a stream of text in a file) to anther form (such as a tree of DOM nodes). The `Source` interface is a very generic description of a document source. Three concrete implementations that represent documents in text form, as DOM trees, and as sequences of SAX parser events are defined in the three subpackages of this package. The `Result` interface is a similarly high-level description of what form the source document should be transformed into. The three subpackages define three `Result` implementations that represent XML documents as streams or files, as DOM trees, and as sequnces of SAX parser events.

The `TRansformerFactory` class represents the document transformation engine. The implementation provides a default factory that represents an XSLT engine. A `transformerFactory` can be used to produce `Templates` objects that represent compiled XSL stylesheets (or other implementation-dependent forms of transformation instructions). Documents are actually transfomed from `Soruce` to `Result` with a `transformer` object, which is obtained from a `Templates` object, or directly from a `TRansformerFactory`.

Interfaces

```
public interface ErrorListener;
public interface Result;
public interface Source;
public interface SourceLocator;
public interface Templates;
public interface URIResolver;
```

Classes

```
public class OutputKeys;
public abstract class Transformer;
public abstract class TransformerFactory;
```

Exceptions

```
public class TransformerException extends Exception;
   public class TransformerConfigurationException extends TransformerException;
```

Errors

```
public class TransformerFactoryConfigurationError extends Error;
```

Team LiB

ErrorListener javax.xml.transform

Java 1.4

This interface defines methods that transformer and TRansformerFactory use for reporting warnings, errors, and fatal errors to an application. To use an ErrorListener, an application must implement this interface and pass an implementing object to the setErrorListener( ) method of transformer or transformerFactory. The argument to each method of this interface is a TRansformerException object, and the implementation of these methods can throw that exception if it chooses, or it can simply log the warning or error in some way and return. A transformer or transformerFactory is not required to continue processing after reporting a nonrecoverable error with an invocation of the fatalError( ) method.

If you are familiar with the SAX API for parsing XML documents, you'll recognize that this interface is very similar to org.xml.sax.ErrorHandler.

```
public interface ErrorListener {
// Public Instance Methods
     void error(TransformerException exception) throws TransformerException;
     void fatalError(TransformerException exception) throws TransformerException;
     void warning(TransformerException exception) throws TransformerException;
}
```

Passed To

transformer.setErrorListener( ), transformerFactory.setErrorListener( )

Returned By

transformer.getErrorListener( ), transformerFactory.getErrorListener( )

Team LiB

OutputKeys javax.xml.transform

Java 1.4

This class defines string constants that hold the names of the attributes of an`<xsl:output>` tag in an XSLT stylesheet. These are also legal key values for the`Properties` object returned by `Templates.getOutputProperties( )` and passed to `transformer.setOutputProperties( )` .

```
public class OutputKeys {
// No Constructor
// Public Constants
     public static final String CDATA_SECTION_ELEMENTS;      ="cdata-section-elements"
     public static final String DOCTYPE_PUBLIC;              ="doctype-public"
     public static final String DOCTYPE_SYSTEM;              ="doctype-system"
     public static final String ENCODING;                    ="encoding"
     public static final String INDENT;                      ="indent"
     public static final String MEDIA_TYPE;                  ="media-type"
     public static final String METHOD;                      ="method"
     public static final String OMIT_XML_DECLARATION; ="omit-xml-declaration"
     public static final String STANDALONE; ="standalone"
     public static final String VERSION;                     ="version"
}
```

Team LiB

Result javax.xml.transform

Java 1.4

This interface represents, in a very general way, the result of an XML transformation.`setSystemId( )` specifies a the system identifier of the result as a URL. This is useful when the result is to be writte as a file, but it can also be useful for error reporting and for resolution of relative URLs even when th `Result` object does not represent a file. All other methods related to the result are the responsibility of the concrete implementation of this interface. See the`DOMResult`, `SAXResult` and `StreamResult` implementations in the three subpackages of this package.

```
public interface Result {
// Public Constants
     public static final String PI_DISABLE_OUTPUT_ESCAPING;
         ="javax.xml.transform.disable-output-escaping"
     public static final String PI_ENABLE_OUTPUT_ESCAPING;
         ="javax.xml.transform.enable-output-escaping"
// Public Instance Methods
     String getSystemId( );
     void setSystemId(String systemId);
}
```

Implementations

`javax.xml.transform.dom.DOMResult`, `javax.xml.transform.sax.SAXResult`, `javax.xml.transform.stream.StreamResult`

Passed To

`transformer.transform( )`, `javax.xml.transform.sax.TransformerHandler.setResult( )`, `javax.xml.validation.Validator.validate( )`

Source javax.xml.transform

Java 1.4

This interface represents, in a very general way, the source of an XML document.setSystemId( ) specifies a the system identifier of the document in the form of a URL. This is useful for resolving relative URLs and for error reporting even when the document is not read directly from a URL. All other methods related to the document source are the responsibility of the concrete implementation of this interface. See the DOMSource, SAXSource and StreamSource implementations in the three subpackages of this package.

```
public interface Source {
// Public Instance Methods
     String getSystemId( );
     void setSystemId(String systemId);
}
```

Implementations

javax.xml.transform.dom.DOMSource, javax.xml.transform.sax.SAXSource, javax.xml.transform.stream.StreamSource

Passed To

TRansformer.transform( ), transformerFactory.{getAssociatedStylesheet( ), newTemplates( ), newtransformer( )}, javax.xml.transform.sax.SAXSource.sourceToInputSource( ), javax.xml.transform.sax.SAXTransformerFactory.{newTransformerHandler( ), newXMLFilter( )}, javax.xml.validation.SchemaFactory.newSchema( ), javax.xml.validation.Validator.validate( )

Returned By

transformerFactory.getAssociatedStylesheet( ), URIResolver.resolve( )

Team LiB

SourceLocator javax.xml.transform

Java 1.4

This interface defines methods that return the system and public identifiers of an XML document, anc return a line number and column number within that document.`SourceLocator` objects are used with `transformerException` and `TRansformerConfigurationException` objects to specify the location in an XML file at which the exception occurred. Note, however that system and public identifiers are not always available for a document, and so`getSystemId( )` and `getPublicId( )` may return `null`. Also, a `tranformer` is not required to track line and column numbers precisely, or at all, so `getLineNumber( )` and `getColumnNumber( )` may return -1 to indicate that line and column number information is not available. If they return a value other than -1, it should be considered an approximation to the actual value. Note that lines and columns within a document are numbered starting with 1, not with 0.

If you are familiar with the SAX API for parsing XML, you'll recognize this interface as a renamed version of `org.xml.sax.Locator`.

```
public interface SourceLocator {
// Public Instance Methods
     int getColumnNumber( );
     int getLineNumber( );
     String getPublicId( );
     String getSystemId( );
}
```

Implementations

`javax.xml.transform.dom.DOMLocator`

Passed To

`transformerConfigurationException.TransformerConfigurationException( )`, `transformerException.{setLocator( )`, `transformerException( )}`

Returned By

`transformerException.getLocator( )`

Templates javax.xml.transform

Java 1.4

This interface represents a set of transformation instructions for transforming a Source document into a Result document. The javax.xml.transform package is nominally independent of type of transformation, but in practice, an object of this type always represents the compiled form of an XSLT stylesheet. Obtain a Templates object from a transformerFactory object, or with a javax.xml.transform.sax.TemplatesHandler. Once you have a Templates object, you can use the newTRansformer( ) method to create a transformer object for applying the templates to a Source to produce a Result document.

getOutputProperties( ) returns a java.util.Properties object that defines name/value pairs specifying details about how a textual version of the Result document should be produced. These properties are specified in an XSLT stylesheet with the <xsl:output> element. The constants defined by the OutputKeys are legal output property names. The returned Properties object contains explicitly properties directly, and contains default values in a parent Properties object. This means that if you query a property value with getProperty( ), you'll get an explicitly specified value of a default value. On the other hand, if you query a property with the get( ) method (inherited by Properties from its superclass) you'll get a property value if it was explictly specified in the stylesheet, or null if it was not specified. The returned Properties object is a clone of the internal value, so you can modify it (before passing it to the setOutputProperties( ) method of a TRansformer object, for example) without affecting the Templates object.

Templates implementations are required to be threadsafe. A Templates object can be used to create any number of transformer objects.

```
public interface Templates {
// Public Instance Methods
     java.util.Properties getOutputProperties( );
     Transformer newTransformer( ) throws TransformerConfigurationException;
}
```

Passed To

javax.xml.transform.sax.SAXTransformerFactory.{newTransformerHandler( ), newXMLFilter( )}

Returned By

transformerFactory.newTemplates( ), javax.xml.transform.sax.TemplatesHandler.getTemplates( )

Team LiB

Transformer javax.xml.transform

Java 1.4

Objects of this type are used to transform a Source document into a Result document. Obtain a transformer object from a TRansformerFactory object, from a Templates object created by a transformerFactory, or from a transformerHandler object created by a SAXTransformerFactory (these last two types are from the javax.xml.transform.sax package).

Once you have a transformer object, you may need to configure it before using it to transform documents. setErrorListener( ) and setURIResolver( ) allow you to specify ErrorListener and URLResolver object that the transformer can use. setOutputProperty( ) and setOutputProperties( ) allow you to specify name/value pairs that affect the text formatting of the Result document (if that document is written out in text format). OutputKeys defines constants that represent the set of standard output property names. The output properties you specify with these methods override any output properties specified (with an <xsl:output> tag) in the Templates object. Use setParameter( ) to supply values for any top-level parameters defined (with <xsl:param> tags) in the stylesheet. Note that if the name of any such parameter is a qualified name, then it appears in the stylesheet with a namespace prefix. You can't use the prefix with the setParameter( ) method, however, and you must instead specify the parameter name using the URI of the namespace within curly braces followed by the local name. If no namespace is involved, then you can just use the simple name of the parameter with no curly braces or URIs.

Once you have created and configured a TRansformer object, use the TRansform( ) method to perform a document transformation. This method transforms the specified Source document and creates the transformed document specified by the Result object. In Java 5.0, you can reset( ) a transformer to restore it to its original state and prepare it for reuse.

transformer implementations are not typically threadsafe. You can reuse a transformer object and call transform( ) any number of times (just not concurrently). The output properties and parameters you specify are not changed by calling the transform( ) method, and can be reused.

```
public abstract class Transformer {
// Protected Constructors
     protected Transformer( );
// Public Instance Methods
     public abstract void clearParameters( );
     public abstract ErrorListener getErrorListener( );
     public abstract java.util.Properties getOutputProperties( );
     public abstract String getOutputProperty(String name)
        throws IllegalArgumentException;
     public abstract Object getParameter(String name);
     public abstract URIResolver getURIResolver( );
5.0  public void reset( );
     public abstract void setErrorListener(ErrorListener listener)
        throws IllegalArgumentException;
```

```
    public abstract void setOutputProperties(java.util.Properties oformat);
    public abstract void setOutputProperty(String name, String value)
       throws IllegalArgumentException;
    public abstract void setParameter(String name, Object value);
    public abstract void setURIResolver(URIResolver resolver);
    public abstract void transform(Source xmlSource, Result outputTarget)
       throws TransformerException;
}
```

Returned By

Templates.newTransformer( ), TRansformerFactory.newTransformer( ), javax.xml.transform.sax.TransformerHandler.getTransformer( )

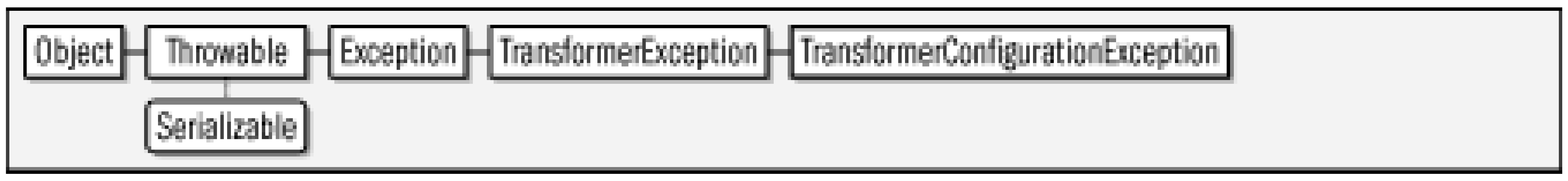
Team LiB

TransformerConfigurationException javax.xml.transform

Java 1.4 *serializable checked*

Signals a problem creating a `transformer` object. This may occur, for exmaple, if there is a syntax error in the XSL stylesheet that contains the transformation instructions. Use the inherited `getLocator( )` method to obtain a `SourceLocator` that describes the document location at which the exception occurred.

Figure 20-5. javax.xml.transform.TransformerConfigurationException




```
public class TransformerConfigurationException extends TransformerException {
// Public Constructors
     public TransformerConfigurationException( );
     public TransformerConfigurationException(Throwable e);
     public TransformerConfigurationException(String msg);
     public TransformerConfigurationException(String message, SourceLocator locator);
     public TransformerConfigurationException(String msg, Throwable e);
     public TransformerConfigurationException(String message, SourceLocator locator,
        Throwable e);
}
```

Thrown By

`Templates.newTransformer( )`, `transformerFactory.{getAssociatedStylesheet( )`, `newTemplates( )`, `newtransformer( )`, `setFeature( )}`, `javax.xml.transform.sax.SAXTransformerFactory.{newTemplatesHandler( )`, `newtransformerHandler( )`, `newXMLFilter( )}`

TransformerException javax.xml.transform

Java 1.4 *serializable checked*

Signals a problem while reading or transforming a document. Call `getLocator( )` to obtain a `SourceLocator` object that describes the document location at which the exception occured.

Figure 20-6. javax.xml.transform.TransformerException


```
public class TransformerException extends Exception {
// Public Constructors
     public TransformerException(String message);
     public TransformerException(Throwable e);
     public TransformerException(String message, Throwable e);
     public TransformerException(String message, SourceLocator locator);
     public TransformerException(String message, SourceLocator locator, Throwable e);
// Public Instance Methods
     public Throwable getException( );
     public String getLocationAsString( );
     public SourceLocator getLocator( );
     public String getMessageAndLocation( );
     public void setLocator(SourceLocator location);
// Public Methods Overriding Throwable
     public Throwable getCause( );
     public Throwable initCause(Throwable cause);                synchronized
     public void printStackTrace( );
     public void printStackTrace(java.io.PrintStream s);
     public void printStackTrace(java.io.PrintWriter s);
}
```

Subclasses

`transformerConfigurationException`

Passed To

`ErrorListener.{error( ) , fatalError( ) , warning( )}`

Thrown By

ErrorListener.{error( ) , fatalError( ) , warning( )} , TRansformer.transform( ) , URIResolver.resolve( )

Team LiB

Team LiB

TransformerFactory javax.xml.transform

Java 1.4

An instance of this abstract class represents a document "transformation engine" such as an XSLT proce transformerFactory is used to create TRansformer objects that perform document transformations, an also be used to process transformation instructions (such as XSLT stylesheets) into compiled Templates

Obtain a transformerFactory instance by calling the static newInstance( ) method. newInstance( ) r an instance of the default implementation for your Java installation, or, if the system property javax.xml.transform.TransformerFactory is set, then it returns an instance of the implementation cl named by that property. The default TRansformerFactory implementation provided with the Java distrib transforms XML documents using XSL stylesheets.

You can configure a transformerFactory instance by calling setErrorListener( ) and setURIResolve specify an ErrorListener object and a URIResolver object to be used by the factory when reading and XSL stylesheets. The setAttribute( ) and getAttribute( ) methods can be used to set and query implementation-dependent attributes of the transformation engine. The default engine supplied by Sun define any attributes. The getFeature( ) method is used to test whether the factory supports a given fe For uniqueness, feature names are expressed as URIs, and each of the Source and Result implementati defined in the three subpackages of this package define a FEATURE constant that specifies a URL that you use to test whether a transformerFactory supports that particular Source or Result type.

Once you have obtained and configured your TRansformerFactory object, you can use it in several ways call the newtransformer( ) method that takes no arguments, you'll obtain a transformer object that transforms the format or representation of an XML document without transforming its content. For exam could use a transformer created in this way to transform a DOM tree (represented by a javax.xml.transform.dom.DOMSource object) to a stream of XML text stored in a file named by a javax.xml.transform.stream.StreamResult .

Another way to use a transformerFactory is to call the newTemplates( ) method, passing in a Source that represents an XSL stylesheet. This produces a Templates object, which you can use to obtain a transformer object that applies the stylesheet to transform document content. Alternatively, if you do r to create more than one transformer object from the Templates object, you can combine the two steps simply pass the Source object representing the stylesheet to the one-argument version of newtransform

XML documents may include references to XSL stylesheets in the form of an xml-stylesheet processing instruction. The getAssociatedStylesheet( ) method reads the XML document represented by a Sourc object and returns a new Source object that represents the stylesheet (or the concatenation of all the stylesheets) contained in that document that match the media, title, and charset constraints defined by other three parameters (which may be null). If you want to process an XML document using the styleshe it defines itself, use this method to obtain a Source object that you can pass to newtransformer( ) to c the transformer object that you can use to transform the document.

transformerFactory implementations are not typically threadsafe.

```
public abstract class TransformerFactory {
```

```
// Protected Constructors
     protected TransformerFactory( );
// Public Class Methods
     public static TransformerFactory newInstance( )
        throws TransformerFactoryConfigurationError;
// Public Instance Methods
     public abstract Source getAssociatedStylesheet(Source source, String media,
        String title, String charset)
        throws TransformerConfigurationException;
     public abstract Object getAttribute(String name);
     public abstract ErrorListener getErrorListener( );
     public abstract boolean getFeature(String name);
     public abstract URIResolver getURIResolver( );
     public abstract Templates newTemplates(Source source)
        throws TransformerConfigurationException;
     public abstract Transformer newTransformer( ) throws TransformerConfigurationExcep
     public abstract Transformer newTransformer(Source source)
        throws TransformerConfigurationException;
     public abstract void setAttribute(String name, Object value);
     public abstract void setErrorListener(ErrorListener listener);
5.0  public abstract void setFeature(String name, boolean value)
        throws TransformerConfigurationException;
     public abstract void setURIResolver(URIResolver resolver);
}
```

Subclasses

javax.xml.transform.sax.SAXTransformerFactory

TransformerFactoryConfigurationError javax.xml.transform

Java 1.4 *serializable error*

This error class signals a fatal problem while creating a `transformerFactory` . It usually signals a configuration problem, such as the system property `javax.xml.transform.TransformerFactory` has a value that is not a valid classname, or that the class path does not contain the specified factory implementation class.

Figure 20-7. javax.xml.transform.TransformerFactoryConfigurationError


```
public class TransformerFactoryConfigurationError extends Error {
// Public Constructors
     public TransformerFactoryConfigurationError( );
     public TransformerFactoryConfigurationError(String msg);
     public TransformerFactoryConfigurationError(Exception e);
     public TransformerFactoryConfigurationError(Exception e, String msg);
// Public Instance Methods
     public Exception getException( );                                   default:null
// Public Methods Overriding Throwable
     public String getMessage( );                                        default:null
}
```

Thrown By

`transformerFactory.newInstance( )`

URIResolver javax.xml.transform

Java 1.4

This interface allows an application to tell a `transformer` how to resolve the URIs that appear in an XSLT stylesheet. If you pass a `URIResolver` to the `setURIResolver( )` method of a `TRansformer` or `transformerFactory` then when the `transformer` or `TRansformerFactory` encounters a URI, it first passes that URI, along with the base URI to the `resolve( )` method of the `URIResolver`. If `resolve( )` returns a `Source` object, then the `transformer` will use that `Source`. If a `transformer` or `transformerFactory` has no URIResolver registered, or if the `resolve( )` method returns `null`, then the tranformer or factory will attempt to resolve the URI itself.

```
public interface URIResolver {
// Public Instance Methods
     Source resolve(String href, String base) throws TransformerException;
}
```

Passed To

`transformer.setURIResolver( )`, `transformerFactory.setURIResolver( )`

Returned By

`transformer.getURIResolver( )`, `transformerFactory.getURIResolver( )`

Team LiB

Package javax.xml.transform.dom

Java 1.4

This package contains Source and Result implementations that work with DOM document trees and subtrees.

Interfaces

```
public interface DOMLocator extends javax.xml.transform.SourceLocator;
```

Classes

```
public class DOMResult implements javax.xml.transform.Result;
public class DOMSource implements javax.xml.transform.Source;
```

DOMLocator javax.xml.transform.dom

Java 1.4

This class extends SourceLocator to define a method for retrieving a DOM Node object, which is typically used to indicate the source of an error in the transformation process. See SourceLocator and transformerException.

Figure 20-8. javax.xml.transform.dom.DOMLocator


```
public interface DOMLocator extends javax.xml.transform.SourceLocator {
// Public Instance Methods
     org.w3c.dom.Node getOriginatingNode( );
}
```

Team LiB

DOMResult javax.xml.transform.dom

Java 1.4

This class is a Result implementation that writes XML content by generating a DOM tree to represent th content. If you pass an org.w3c.dom.Node to the constructor or to setNode( ), the DOMResult will crea result tree as a child of the specified node (which should typically be a Document or Element node). If yo specify a node, the DOMResult will create a new Document node when it creates the result tree. You can this Document with getNode( ). In Java 5.0, you can also pass two Node objects to the constructor: the specify the parent node of the result tree and the child of that parent before which the result tree shoulc inserted. See also setNextSibling( ).

Figure 20-9. javax.xml.transform.dom.DOMResult

```
public class DOMResult implements javax.xml.transform.Result {
// Public Constructors
     public DOMResult( );
     public DOMResult(org.w3c.dom.Node node);
5.0  public DOMResult(org.w3c.dom.Node node, org.w3c.dom.Node nextSibling);
     public DOMResult(org.w3c.dom.Node node, String systemId);
5.0  public DOMResult(org.w3c.dom.Node node, org.w3c.dom.Node nextSibling,
       String systemId);
// Public Constants
     public static final String FEATURE;  ="http://javax.xml.transform.dom.DOMResult/fe
// Public Instance Methods
5.0  public org.w3c.dom.Node getNextSibling( );           default:null
     public org.w3c.dom.Node getNode( );            default:null
5.0  public void setNextSibling(org.w3c.dom.Node nextSibling);
     public void setNode(org.w3c.dom.Node node);
// Methods Implementing Result
     public String getSystemId( );                      default:null
     public void setSystemId(String systemId);
}
```

DOMSource javax.xml.transform.dom

Java 1.4

This class is a `Source` implementation that reads an XML document from a DOM document tree or subtre the `org.w3c.dom.Node` object that represents the root of the tree or subtree to the constructor or to `set` When possible, it is also useful to provide a system id (a filename or URL) for use in error messages anc resolving relative URLs contained in the document.

Figure 20-10. javax.xml.transform.dom.DOMSource


```
public class DOMSource implements javax.xml.transform.Source {
// Public Constructors
     public DOMSource( );
     public DOMSource(org.w3c.dom.Node n);
     public DOMSource(org.w3c.dom.Node node, String systemID);
// Public Constants
     public static final String FEATURE;    ="http://javax.xml.transform.dom.DOMSource/
// Public Instance Methods
     public org.w3c.dom.Node getNode( );                default:null
     public void setNode(org.w3c.dom.Node node);
// Methods Implementing Source
     public String getSystemId( );                      default:null
     public void setSystemId(String systemID);
}
```

Package javax.xml.transform.sax

Java 1.4

This package defines Source and Result implementations that work with SAX events. In addition, it includes an extension to the transformerFactory class that has additional methods for returning TemplatesHandler and TRansformerHandler objects. These objects implement SAX handler interfaces and are able to work with a SAX parser object to turn a series of SAX parse events into a Templates object or into a Result document. SAXSource and SAXResult adapt the org.xml.sax framework for use in the javax.xml.transform framework. By contrast, SAXTransformerFactory, TemplatesHandler, and transfomerHandler adapt the javax.xml.transform framework for use within the org.xml.sax parsing framework.

Interfaces

```
public interface TemplatesHandler extends org.xml.sax.ContentHandler;
public interface TransformerHandler extends org.xml.sax.ContentHandler,
   org.xml.sax.DTDHandler, org.xml.sax.ext.LexicalHandler;
```

Classes

```
public class SAXResult implements javax.xml.transform.Result;
public class SAXSource implements javax.xml.transform.Source;
public abstract class SAXTransformerFactory
   extends javax.xml.transform.TransformerFactory;
```

SAXResult javax.xml.transform.sax

Java 1.4

This class is a Result implementation that describes the content of a transformed document by triggerir methods of the specified ContentHandler . That is, a SAXResult acts like a org.xml.sax.SAXReader ob invoking the methods of the specified org.xml.sax.ContentHandler object as it parses the transformed document. You may also provide a org.xml.sax.ext.LexicalHandler object whose methods will be inv the SAXResult by calling setLexicalHandler , or by suppling a ContentHandler object that also implen the LexicalHandler interface.

Figure 20-11. javax.xml.transform.sax.SAXResult


```
public class SAXResult implements javax.xml.transform.Result {
// Public Constructors
     public SAXResult( );
     public SAXResult(org.xml.sax.ContentHandler handler);
// Public Constants
     public static final String FEATURE;  ="http://javax.xml.transform.sax.SAXResult/fea
// Public Instance Methods
     public org.xml.sax.ContentHandler getHandler( );              default:null
     public org.xml.sax.ext.LexicalHandler getLexicalHandler( );   default:null
     public void setHandler(org.xml.sax.ContentHandler handler);
     public void setLexicalHandler(org.xml.sax.ext.LexicalHandler handler);
// Methods Implementing Result
     public String getSystemId( );                                 default:null
     public void setSystemId(String systemId);
}
```

Team LiB

SAXSource javax.xml.transform.sax

Java 1.4

This class is a Source implementation that describes a document represented as a series of SAX event n SAXSource requires an org.xml.sax.InputSource object that describes the stream to parse, and may c specify the org.xml.sax.XMLReader or org.xml.sax.XMLFilter that generates the SAX events. (If no X XMLFilter is specified, then the transformer object will a default XMLReader .) Note that since an Input required, a SAXSource does not behave significantly differently than a StreamSource unless an XMLFilte

SAXSource also has one static method, sourceToInputSource( ) which returns a SAX InputSource me from the specified Source object, or null if the specified Source cannot be converted to an InputSource

Figure 20-12. javax.xml.transform.sax.SAXSource

```
public class SAXSource implements javax.xml.transform.Source {
// Public Constructors
     public SAXSource( );
     public SAXSource(org.xml.sax.InputSource inputSource);
     public SAXSource(org.xml.sax.XMLReader reader, org.xml.sax.InputSource inputSource
// Public Constants
     public static final String FEATURE;    ="http://javax.xml.transform.sax.SAXSource/f
// Public Class Methods
     public static org.xml.sax.InputSource sourceToInputSource(javax.xml.transform.Sour
// Public Instance Methods
     public org.xml.sax.InputSource getInputSource( );        default:null
     public org.xml.sax.XMLReader getXMLReader( );            default:null
     public void setInputSource(org.xml.sax.InputSource inputSource);
     public void setXMLReader(org.xml.sax.XMLReader reader);
// Methods Implementing Source
     public String getSystemId( );                            default:null
     public void setSystemId(String systemId);
}
```

Team LiB

SAXTransformerFactory javax.xml.transform.sax

Java 1.4

This class extends transformerFactory to define additional factory methods that are useful when worki are represented as sequences of SAX events. Pass the FEATURE constant to the getFeature( ) method TRansformerFactory object to determine whether the newTemplatesHandler( ) and newtransformerH supported and whether it is safe to cast your transformerFactory object to a SAXTransformerFactory FEATURE_XMLFILTER constant with getFeature( ) to determine if the newXMLFilter( ) methods are al:

newTemplatesHandler( ) returns a TemplatesHandler object that you can use as an org.xml.sax.Con receive SAX events generated by a SAX parser and transform those events into a Templates object.

The newtransformerHandler( ) methods are similar: they return a transformerHandler object that ca and representing a source document and transform them into a Result document. The no-argument ver newTRansformerHandler( ) creates a TRansformerHandler that simply modifies the form of the docum stylesheet to its content. The other two versions of newtransformerHandler( ) use a stylesheet specifi Templates object.

The newXMLFilter( ) methods, if supported, return an org.xml.sax.XMLFilter object that can acts as source of SAX events and filters those events by applying the transformation instructions specified by th objects.

Figure 20-13. javax.xml.transform.sax.SAXTransformerFact

```
public abstract class SAXTransformerFactory extends javax.xml.transform.TransformerFact
// Protected Constructors
     protected SAXTransformerFactory( );
// Public Constants
     public static final String FEATURE;    ="http://javax.xml.transform.sax.SAXTransfor
     public static final String FEATURE_XMLFILTER;
         ="http://javax.xml.transform.sax.SAXTransformerFactory/feature/xmlfilter"
// Public Instance Methods
     public abstract TemplatesHandler newTemplatesHandler( )
        throws javax.xml.transform.TransformerConfigurationException;
     public abstract TransformerHandler newTransformerHandler( )
        throws javax.xml.transform.TransformerConfigurationException;
     public abstract TransformerHandler newTransformerHandler
        (javax.xml.transform.Source src)
        throws javax.xml.transform.TransformerConfigurationException;
     public abstract TransformerHandler newTransformerHandler
        (javax.xml.transform.Templates templates)
```

```
        throws javax.xml.transform.TransformerConfigurationException;
    public abstract org.xml.sax.XMLFilter newXMLFilter
        (javax.xml.transform.Source src)
        throws javax.xml.transform.TransformerConfigurationException;
    public abstract org.xml.sax.XMLFilter newXMLFilter
        (javax.xml.transform.Templates templates)
        throws javax.xml.transform.TransformerConfigurationException;
}
```

Team LiB

TemplatesHandler javax.xml.transform.sax

Java 1.4

This interface extends `org.xml.sax.ContentHandler` and adds a `getTemplates( )` method. An object that implements this interface can be used to receive method calls from some source of SAX events and process those events (as a XSL stylesheet) into a`Templates` object. Obtain a `TemplatesHandler` from a `SAXTransformerFactory`. Register it with the `setContentHandler( )` method of an `org.xml.sax.XMLReader` and invoke the `parse( )` method of the reader. When `parse( )` returns, call the `getTemplates( )` method to obtain the `Templates` object.

Figure 20-14. javax.xml.transform.sax.TemplatesHandler


```
public interface TemplatesHandler extends org.xml.sax.ContentHandler {
// Public Instance Methods
     String getSystemId( );
     javax.xml.transform.Templates getTemplates( );
     void setSystemId(String systemID);
}
```

Returned By

`SAXTransformerFactory.newTemplatesHandler( )`

Team LiB

TransformerHandler javax.xml.transform.sax

Java 1.4

This interface extends `org.xml.sax.ContentHandler` and related interfaces so that it can consume SAX events generated by a `org.xml.sax.SAXReader` or `org.xml.sax.SAXFilter`. Create a `transformerHandler` by calling one of the `newTRansformerHandler( )` methods of a `SAXTransformerFactory`.

Next, call the `setResult( )` method to specify a `Result` object that describes the result document you'd like the transformation to produce. You may also call `gettransformer( )` to get the `TRansformer` object associated with this `transformerHandler` if you need to set output properties or parameter values for the transformation.

Now, register the `transformerHandler` with the `SAXReader` or `SAXFilter` object by calling `setContentHandler( )`, `setDTDHandler( )`, and `setProperty( )`. `Then you use the property name "http://www.xml.org/sax/properties/lexical-handler" in the call to `setProperties( )` to register the `TRansformerHandler` as a `org.xml.sax.ext.LexicalHandler` for the parser or filter.

Finally, invoke one of the `parse( )` methods on your `XMLReader` or `XMLFilter` object. This will cause the reader or filter to start parsing the source document and translating it into method calls on the `transformerHandler`. The `transformerHandler` will transform those calls as specified in the `Templates` or `Source` object (if any) that was passed to the original call to `newtransformerHandler( )` and generate a result document as directed by the `Result` object that was passed to `setResult( )`.

Figure 20-15. javax.xml.transform.sax.TransformerHandler

```
public interface TransformerHandler extends org.xml.sax.ContentHandler,
        org.xml.sax.DTDHandler, org.xml.sax.ext.LexicalHandler {
// Public Instance Methods
     String getSystemId( );
     javax.xml.transform.Transformer getTransformer( );
     void setResult(javax.xml.transform.Result result)
        throws IllegalArgumentException;
     void setSystemId(String systemID);
}
```

Returned By

`SAXTransformerFactory.newTransformerHandler( )`

Package javax.xml.transform.stream

Java 1.4

This package contains `Source` and `Result` implementations that work with files and streams.

Classes

```
public class StreamResult implements javax.xml.transform.Result;
public class StreamSource implements javax.xml.transform.Source;
```

StreamResult javax.xml.transform.stream

Java 1.4

This class is a `Result` implementation that writes a textual representation of a transformed document to stream or file. Because XML documents define their own encoding, it is usually preferable to construct a `StreamResult` using a `File` or `OutputStream` instead of a character-based `Writer` which may use a different encoding than that specified within the document.

Figure 20-16. javax.xml.transform.stream.StreamResult


```
public class StreamResult implements javax.xml.transform.Result {
// Public Constructors
     public StreamResult( );
     public StreamResult(java.io.File f);
     public StreamResult(String systemId);
     public StreamResult(java.io.Writer writer);
     public StreamResult(java.io.OutputStream outputStream);
// Public Constants
     public static final String FEATURE;
         ="http://javax.xml.transform.stream.StreamResult/feature"
// Public Instance Methods
     public java.io.OutputStream getOutputStream( );                default:null
     public java.io.Writer getWriter( );                            default:null
     public void setOutputStream(java.io.OutputStream outputStream);
     public void setSystemId(java.io.File f);
     public void setWriter(java.io.Writer writer);
// Methods Implementing Result
     public String getSystemId( );                                  default:null
     public void setSystemId(String systemId);
}
```

Team LiB

StreamSource javax.xml.transform.stream

Java 1.4

This class is a Source implementation that reads the textual format of an XML document from a file, byte stream, or character stream. Because XML documents declare their own encoding, it is preferable to create a StreamSource object from an InputStream instead of from a Reader , so that the XML processor can correctly handle the declared encoding. When creating a StreamSource from a byte stream or character stream, you should provide the "system id" (i.e. the filename or URL) by using one of the two-argument constructors or by caling setSystemId( ) . The system id is required if the XML file to be processed includes relative URLs to be resolved.

Figure 20-17. javax.xml.transform.stream.StreamSource

```
public class StreamSource implements javax.xml.transform.Source {
// Public Constructors
     public StreamSource( );
     public StreamSource(java.io.InputStream inputStream);
     public StreamSource(java.io.Reader reader);
     public StreamSource(java.io.File f);
     public StreamSource(String systemId);
     public StreamSource(java.io.Reader reader, String systemId);
     public StreamSource(java.io.InputStream inputStream, String systemId);
// Public Constants
     public static final String FEATURE;
         ="http://javax.xml.transform.stream.StreamSource/feature"
// Public Instance Methods
     public java.io.InputStream getInputStream( );                  default:null
     public String getPublicId( );                                  default:null
     public java.io.Reader getReader( );                            default:null
     public void setInputStream(java.io.InputStream inputStream);
     public void setPublicId(String publicId);
     public void setReader(java.io.Reader reader);
     public void setSystemId(java.io.File f);
// Methods Implementing Source
     public String getSystemId( );                                  default:null
     public void setSystemId(String systemId);
}
```

Team LiB

Package javax.xml.validation

Java 5.0

This package contains classes for validating XML documents against W3C XML Schema definitions. Implementations may also support additional schema types, such as RELAX NG. Typical usage begins with the `SchemaFactory` class, which parses schema specifications into immutable `Schema` objects. Next, the `Schema` object is used to create a `Validator` with which a document may be validated.

Classes

```
public abstract class Schema;
public abstract class SchemaFactory;
public abstract class SchemaFactoryLoader;
public abstract class TypeInfoProvider;
public abstract class Validator;
public abstract class ValidatorHandler implements org.xml.sax.ContentHandler;
```

Schema javax.xml.validation

Java 5.0

A Schema is an immutable opaque parsed representation of a schema. Schema objects don't perform validation themselves; instead, they are factories for Validator and ValidatorHandler objects that can be used to validate individual documents.

```
public abstract class Schema {
// Protected Constructors
     protected Schema( );
// Public Instance Methods
     public abstract Validator newValidator( );
     public abstract ValidatorHandler newValidatorHandler( );
}
```

Passed To

javax.xml.parsers.DocumentBuilderFactory.setSchema( ), javax.xml.parsers.SAXParserFactory.setSchema( )

Returned By

javax.xml.parsers.DocumentBuilder.getSchema( ), javax.xml.parsers.DocumentBuilderFactory.getSchema( ), javax.xml.parsers.SAXParser.getSchema( ), javax.xml.parsers.SAXParserFactory.getSchema( ), SchemaFactory.newSchema( )

Team LiB

SchemaFactory javax.xml.validation

Java 5.0

A SchemaFactory parses the textual representation of a schema into a Schema object. Obtain a SchemaFactory with the newInstance( ) method, passing a string that identifies the type of schema you want to parse. All implementations are required to support the W3C XML Schema language, which is identified by XMLConstants.W3C_XML_SCHEMA_NS_URL . Other schema types may also be supported, such as RELAX NG schemas, identified by XMLConstants.RELAXNG_NS_URL .

To parse a schema, call the newSchema( ) method, passing the File or javax.xml.transform.Source object that identifies the schema contents. For schemas in the W3C XML Schema language, you may also specify an array of Source objects that contain the schema definition. If you call newSchema( ) with no arguments, a special Schema object is returned that expects the document to specify the location of its own W3C XML Schema.

You can configure a SchemaFactory before calling newSchema( ) with setErrorHandler( ) , setResourceResolver( ) , setProperty( ) , and setFeature( ) .

```
public abstract class SchemaFactory {
// Protected Constructors
     protected SchemaFactory( );
// Public Class Methods
     public static final SchemaFactory newInstance(String schemaLanguage);
// Public Instance Methods
     public abstract org.xml.sax.ErrorHandler getErrorHandler( );
     public boolean getFeature(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public Object getProperty(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public abstract org.w3c.dom.ls.LSResourceResolver getResourceResolver( );
     public abstract boolean isSchemaLanguageSupported(String schemaLanguage);
     public abstract Schema newSchema( ) throws org.xml.sax.SAXException;
     public Schema newSchema(javax.xml.transform.Source schema)
        throws org.xml.sax.SAXException;
     public Schema newSchema(java.io.File schema) throws org.xml.sax.SAXException;
     public abstract Schema newSchema(javax.xml.transform.Source[ ] schemas)
        throws org.xml.sax.SAXException;
     public Schema newSchema(java.net.URL schema) throws org.xml.sax.SAXException;
     public abstract void setErrorHandler(org.xml.sax.ErrorHandler errorHandler);
     public void setFeature(String name, boolean value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public void setProperty(String name, Object object)
```

```
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public abstract void setResourceResolver(org.w3c.dom.ls.LSResourceResolver
        resourceResolver);
}
```

Returned By

`SchemaFactoryLoader.newFactory( )`

SchemaFactoryLoader javax.xml.validation

Java 5.0

This class is used by implementations of the validation API to produce a SchemaFactory object for a specified schema type. Applications that use the javax.xml.validation package do not need to use this class.

```
public abstract class SchemaFactoryLoader {
// Protected Constructors
     protected SchemaFactoryLoader( );
// Public Instance Methods
     public abstract SchemaFactory newFactory(String schemaLanguage);
}
```

Team LiB

TypeInfoProvider javax.xml.validation

Java 5.0

A TypeInfoProvider provides information about the type of the element or attribute currently being processed by a ValidatorHandler. This type information is obtained by validating document content against a schema and may be useful to the ContentHandler to which the ValidatorHandler dispatches its method calls.

```
public abstract class TypeInfoProvider {
// Protected Constructors
     protected TypeInfoProvider( );
// Public Instance Methods
     public abstract org.w3c.dom.TypeInfo getAttributeTypeInfo(int index);
     public abstract org.w3c.dom.TypeInfo getElementTypeInfo( );
     public abstract boolean isIdAttribute(int index);
     public abstract boolean isSpecified(int index);
}
```

Returned By

ValidatorHandler.getTypeInfoProvider( )

Team LiB

Validator javax.xml.validation

Java 5.0

A Validator object validates an XML document against the Schema from which the Validator was created. The validate( ) method performs validation. Specify the document to be validated with a DOMSource or SAXSource object (from the javax.xml.transform.dom or javax.xml.transform.sax packages). The validate( ) method accepts any javax.xml.transform.Source object as an argument, but SAXSource and DOMSource are the only two supported implementations.

The document validation process can also be used to augment the source document by adding the default values of unspecified attributes. If you want to capture this augmented form of the document pass a Result object to the two-argument version of validate( ). If the source is a SAXSource, the result must be a SAXResult, and if the source is a DOMSource, the result must be a DOMResult object.

If the document is valid, the validate( ) method returns normally. If the document is not valid, validate( ) throws an org.xml.sax.SAXException. You can alter this somewhat by passing a custom org.xml.sax.ErrorHandler to setErrorHandler( ). Validation exceptions are first passed to the error handler methods, which may throw the exception or handle them in some other way, such as printing a message. If the error handler does not throw an exception, the validate( ) method attempts to continue validation. The default error handler ignores exceptions passed to its warn( ) method but throws exceptions passed to its error( ) and fatalError( ) methods.

Before calling validate( ), a Validator may also be configured with setResourceResolver( ), setFeature( ), and setProperty( ).

```
public abstract class Validator {
// Protected Constructors
     protected Validator( );
// Public Instance Methods
     public abstract org.xml.sax.ErrorHandler getErrorHandler( );
     public boolean getFeature(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public Object getProperty(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public abstract org.w3c.dom.ls.LSResourceResolver getResourceResolver( );
     public abstract void reset( );
     public abstract void setErrorHandler(org.xml.sax.ErrorHandler errorHandler);
     public void setFeature(String name, boolean value)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public void setProperty(String name, Object object)
        throws org.xml.sax.SAXNotRecognizedException,
```

```
        org.xml.sax.SAXNotSupportedException;
     public abstract void setResourceResolver(org.w3c.dom.ls.LSResourceResolver
        resourceResolver);
     public void validate(javax.xml.transform.Source source)
        throws org.xml.sax.SAXException, java.io.IOException;
     public abstract void validate(javax.xml.transform.Source source,
        javax.xml.transform.Result result)
        throws org.xml.sax.SAXException, java.io.IOException;
}
```

Returned By

`Schema.newValidator( )`

Team LiB

ValidatorHandler javax.xml.validation

Java 5.0

A ValidatorHandler is an org.xml.sax.ContentHandler that uses the streaming SAX API to validate an XML document against the Schema from which the ValidatorHandler was derived. The Validator class can be used to validate a SAXSource , but ValidatorHandler provides lower-level access to the SAX API.

If the document is not valid, one of the ContentHandler methods throws a SAXException that propagates up to your code. As with the Validator class, you can alter this by specifying a custom org.xml.sax.ErrorHandler class.

ValidatorHandler can be used as a filter for SAX parsing events. If you pass a ContentHandler to setContentHandler( ) , the ValidatorHandler augments the source document with attribute defaults from the schema and invokes the appropriate callback methods on the ContentHandler you supply. If you are interested in attribute and element type information provided by the schema, your ContentHandler can use the TypeInfoProvider obtained from the ValidatorHandler getTypeInfoProvider( ) .

Figure 20-18. javax.xml.validation.ValidatorHandler

```
public abstract class ValidatorHandler implements org.xml.sax.ContentHandler {
// Protected Constructors
     protected ValidatorHandler( );
// Public Instance Methods
     public abstract org.xml.sax.ContentHandler getContentHandler( );
     public abstract org.xml.sax.ErrorHandler getErrorHandler( );
     public boolean getFeature(String name)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public Object getProperty(String name)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public abstract org.w3c.dom.ls.LSResourceResolver getResourceResolver( );
     public abstract TypeInfoProvider getTypeInfoProvider( );
     public abstract void setContentHandler(org.xml.sax.ContentHandler receiver);
     public abstract void setErrorHandler(org.xml.sax.ErrorHandler errorHandler);
     public void setFeature(String name, boolean value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public void setProperty(String name, Object object)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public abstract void setResourceResolver(org.w3c.dom.ls.LSResourceResolver
```

```
        resourceResolver);
}
```

Returned By

`Schema.newValidatorHandler( )`

Package javax.xml.xpath

Java 5.0

This package defines types for the evaluation of XPath expressions in the context of an XML document. XPath is a language for describing a "path" to a node or set of nodes within an XML document. Details of the XPath grammar are beyond the scope of this reference.

A typical use of this package begins with the `XPathFactory`, an instance of which is used to create an `XPath` object. After configuring the `XPath` object as desired, you can use it to evaluate XPath expressions directly or to compile XPath expressions into `XPathExpression` objects for later use.

Interfaces

```
public interface XPath;
public interface XPathExpression;
public interface XPathFunction;
public interface XPathFunctionResolver;
public interface XPathVariableResolver;
```

Classes

```
public class XPathConstants;
public abstract class XPathFactory;
```

Exceptions

```
public class XPathException extends Exception;
   public class XPathExpressionException extends XPathException;
      public class XPathFunctionException extends XPathExpressionException;
   public class XPathFactoryConfigurationException extends XPathException;
```

XPath javax.xml.xpath

Java 5.0

An XPath object is used to compile or evaluate an XPath expression. Create an XPath object through an XPathFactory . Configuration methods of XPath allow you to specify an XPathVariableResolver and an XPathFunctionResolver to resolve variable and function references in XPath expressions. You may also specify the javax.xml.namespace.NamespaceContext with which the XPath can resolve qualified names.

After creating and configuring an XPath object, you can use the compile( ) method to compile an XPath expression for later evaluation, or you can use one of the evaluate( ) methods to compile and evaluate an expression directly. There are four versions of evaluate( ) . All expect a String containing an XPath expression as their first argument. The second argument is the document or portion of a document to evaluate the expression against. Two versions of evaluate( ) expect an org.xml.sax.InputSource for this second argument. These versions of the method first parse the document and build a DOM (or other object model) tree. The other two versions of evaluate( ) expect an Object as the second argument. The object passed should be a DOM (or other object model) object representing the document or some portion of it. For the org.w3c.dom object model, this might be a Document , DocumentFragment , Node , or NodeList object.

The final difference between evaluate( ) methods is the presence or absence of a third argument. The two-argument versions of evaluate( ) return the result of the expression evaluation as a String . The three-argument versions expect a third argument that specifies the desired return type and return an Object of an appropriate type. The valid types are the QName objects defined in the XPathConstants class, such as XPathConstants.NODE and XPathConstants.NODESET . With the DOM object model, evaluate( ) returns org.w3c.dom.Node and org.w3c.dom.NodeList objects for these types.

```
public interface XPath {
// Public Instance Methods
     XPathExpression compile(String expression) throws XPathExpressionException;
     String evaluate(String expression, Object item) throws XPathExpressionException;
     String evaluate(String expression, org.xml.sax.InputSource source)
        throws XPathExpressionException;
     Object evaluate(String expression, org.xml.sax.InputSource source,
        javax.xml.namespace.QName returnType)
        throws XPathExpressionException;
     Object evaluate(String expression, Object item, javax.xml.namespace.
        QName returnType) throws XPathExpressionException;
     javax.xml.namespace.NamespaceContext getNamespaceContext( );
     XPathFunctionResolver getXPathFunctionResolver( );
     XPathVariableResolver getXPathVariableResolver( );
     void reset( );
     void setNamespaceContext(javax.xml.namespace.NamespaceContext nsContext);
     void setXPathFunctionResolver(XPathFunctionResolver resolver);
     void setXPathVariableResolver(XPathVariableResolver resolver);
```

```
}
```

Returned By

`XPathFactory.newXPath( )`

downloaded from: lib.ommolketab.ir

XPathConstants javax.xml.xpath

Java 5.0

This class defines javax.xml.namespace.QName constants that represent the possible return types of the evaluate( ) methods of XPath and XPathExpression. It also defines the DOM_OBJECT_MODEL constant that can be passed to XPathFactory.newInstance( ) to specify that the resulting XPathFactory should be for the org.w3c.dom object model.

```
public class XPathConstants {
// No Constructor
// Public Constants
     public static final javax.xml.namespace.QName BOOLEAN;
     public static final String DOM_OBJECT_MODEL;
           ="http://java.sun.com/jaxp/xpath/dom"
     public static final javax.xml.namespace.QName NODE;
     public static final javax.xml.namespace.QName NODESET;
     public static final javax.xml.namespace.QName NUMBER;
     public static final javax.xml.namespace.QName STRING;
}
```

XPathException javax.xml.xpath

Java 5.0 *serializable checked*

This is the common superclass of all XPath-related exception types.

Figure 20-19. javax.xml.xpath.XPathException


```
public class XPathException extends Exception {
// Public Constructors
     public XPathException(Throwable cause);
     public XPathException(String message);
// Public Methods Overriding Throwable
     public Throwable getCause( );
     public void printStackTrace( );
     public void printStackTrace(java.io.PrintWriter s);
     public void printStackTrace(java.io.PrintStream s);
}
```

Subclasses

XPathExpressionException, XPathFactoryConfigurationException

XPathExpression javax.xml.xpath

Java 5.0

If an XPath expression is to be evaluated more than once, it is not efficient to call the `XPath.evaluate( )` method repeatedly. Instead, compile the expression to an `XPathExpression` using the `XPath.compile( )` method and then evaluate it using one of the `evaluate( )` methods of `XPathExpression`. The `evaluate( )` methods of `XPathExpression` behave just like the corresponding methods of `XPath`. See `XPath` for details.

```
public interface XPathExpression {
// Public Instance Methods
     String evaluate(org.xml.sax.InputSource source)
        throws XPathExpressionException;
     String evaluate(Object item) throws XPathExpressionException;
     Object evaluate(Object item, javax.xml.namespace.QName returnType)
        throws XPathExpressionException;
     Object evaluate(org.xml.sax.InputSource source, javax.xml.namespace.
        QName returnType) throws XPathExpressionException;
}
```

Returned By

`XPath.compile( )`

XPathExpressionException javax.xml.xpath

Java 5.0 *serializable checked*

Exceptions of this type indicate an error while compiling or evaluating an XPath expression. See the `compile( )` and `evaluate( )` methods of `XPath` and `XPathExpression`.

Figure 20-20. javax.xml.xpath.XPathExpressionException

```
public class XPathExpressionException extends XPathException {
// Public Constructors
     public XPathExpressionException(Throwable cause);
     public XPathExpressionException(String message);
}
```

Subclasses

`XPathFunctionException`

Thrown By

`XPath.{compile( )`, `evaluate( )}`, `XPathExpression.evaluate( )`

XPathFactory javax.xml.xpath

Java 5.0

The XPathFactory class is a factory for creating XPath expression evaluators. Call the no-argument vers newInstance( ) to obtain an XPathFactory object that creates XPath object to work with DOM docume javax.xml.xpath package is nominally object-model independent, however, and you can specify the na different object model by calling the one-argument version of newInstance( ) .

Once you have created an XPathFactory object, you can set default function and variable resolvers with setXPathFunctionResolver( ) and setXPathVariableResolver( ) . You can configure implementatio dependent features of an XPathFactory with setFeature( ) . All implementations are required to suppo XMLConstants.FEATURE_SECURE_PROCESSING feature. When this feature is set to true, external function allowed in XPath expressions, and the XPathFunctionResolver is not used.

After creating and configuring an XPathFactory object, use the newXPath( ) method to create one or m objects for actually evaluating XPath expressions.

```
public abstract class XPathFactory {
// Protected Constructors
     protected XPathFactory( );
// Public Constants
     public static final String DEFAULT_OBJECT_MODEL_URI;   ="http://java.sun.com/jaxp/
     public static final String DEFAULT_PROPERTY_NAME;      ="javax.xml.xpath.XPathFact
// Public Class Methods
     public static final XPathFactory newInstance( );
     public static final XPathFactory newInstance(String uri)
         throws XPathFactoryConfigurationException;
// Public Instance Methods
     public abstract boolean getFeature(String name)
        throws XPathFactoryConfigurationException;
     public abstract boolean isObjectModelSupported(String objectModel);
     public abstract XPath newXPath( );
     public abstract void setFeature(String name, boolean value)
        throws XPathFactoryConfigurationException;
     public abstract void setXPathFunctionResolver(XPathFunctionResolver resolver);
     public abstract void setXPathVariableResolver(XPathVariableResolver resolver);
}
```

Team LiB

XPathFactoryConfigurationException javax.xml.xpath

Java 5.0 *serializable checked*

This exception is thrown by methods of XPathFactory to indicate that a specified object model or feature is not supported.

Figure 20-21. javax.xml.xpath.XPathFactoryConfigurationException

```
public class XPathFactoryConfigurationException extends XPathException {
// Public Constructors
     public XPathFactoryConfigurationException(Throwable cause);
     public XPathFactoryConfigurationException(String message);
}
```

Thrown By

XPathFactory.{getFeature( ), newInstance( ), setFeature( )}

Team LiB

XPathFunction javax.xml.xpath

Java 5.0

This interface defines the invocation API for user-defined XPath functions. Arguments are passed to the `evaluate( )` method as a `java.util.List` and the return value should be an `Object`. `evaluate( )` may throw an `XPathFunctionException`. See also `XPathFunctionResolver`.

```
public interface XPathFunction {
// Public Instance Methods
     Object evaluate(java.util.List args) throws XPathFunctionException;
}
```

Returned By

`XPathFunctionResolver.resolveFunction( )`

XPathFunctionException javax.xml.xpath

Java 5.0 *serializable checked*

Exceptions of this type may be thrown by user-defined `XPathFunction` implementations. Note that this is a subclass of `XPathExpressionException`.

Figure 20-22. javax.xml.xpath.XPathFunctionException

```
public class XPathFunctionException extends XPathExpressionException {
// Public Constructors
     public XPathFunctionException(Throwable cause);
     public XPathFunctionException(String message);
}
```

Thrown By

`XPathFunction.evaluate( )`

Team LiB

XPathFunctionResolver javax.xml.xpath

Java 5.0

This interface defines a single method to return the `XPathFunction` with the specified qualified name and specified arity (number of arguments). Objects that implement this interface may be passed to the `setXPathFunctionResolver( )` methods of `XPath` or `XPathFactory` .

Note that the function resolvers are invoked only for functions defined in an external namespace, so they cannot be used to override the meaning of XPath's built-in functions or to add new core functions to the XPath language. Also, if the `XMLConstants.FEATURE_SECURE_PROCESSING` feature has been enabled on a `XPathFactory` , user-defined functions are not allowed in XPath expressions, and the `XPathFunctionResolver` is never called.

```
public interface XPathFunctionResolver {
// Public Instance Methods
     XPathFunction resolveFunction(javax.xml.namespace.QName functionName, int arity);
}
```

Passed To

`XPath.setXPathFunctionResolver( )` , `XPathFactory.setXPathFunctionResolver( )`

Returned By

`XPath.getXPathFunctionResolver( )`

XPathVariableResolver javax.xml.xpath

Java 5.0

This interface defines a single method to return the `Object` value of a variable identified by a qualified name. The value of a named variable is allowed to change between XPath evaluations, but implementations of this interface must ensure that no variable changes *during* the evaluation of an expression. Objects that implement this interface may be passed to the `setXPathVariableResolver( )` methods of `XPath` or `XPathFactory`.

```
public interface XPathVariableResolver {
// Public Instance Methods
     Object resolveVariable(javax.xml.namespace.QName variableName);
}
```

Passed To

`XPath.setXPathVariableResolver( )`, `XPathFactory.setXPathVariableResolver( )`

Returned By

`XPath.getXPathVariableResolver( )`

Team LiB

Chapter 21. org.w3c.dom

Package org.w3c.dom

Attr

CDATASection

CharacterData

Comment

Document

DocumentFragment

DocumentType

DOMConfiguration

DOMError

DOMErrorHandler

DOMException

DOMImplementation

DOMImplementationList

DOMImplementationSource

DOMLocator

DOMStringList

Element

Entity

EntityReference

NamedNodeMap

NameList

Node

NodeList

Notation

ProcessingInstruction

Text

TypeInfo

UserDataHandler

Package org.w3c.dom

Java 1.4

This package defines the Java binding to the core and XML modules of the DOM API defined by the World Wide Web Consortium (W3C). DOM stands for Document Object Model, and the DOM API defines a way to represent an XML document as a tree of nodes. Java 1.4 supports the Level 2 DOM, and Java 5.0 adds support for Level 3.

This package includes methods that allow document trees to be traversed, examined, modified, and built from scratch. `Node` is the central interface of the package. All nodes in a document tree implement this interface, and it defines the basic methods for traversing and modifying the tree of nodes. Most of the other interfaces in the package are extensions of `Node` that represent specific types of XML content. The most important and commonly used of these subinterfaces are `Document`, `Element`, and `Text`. A `Document` object serves as the root of the document tree and defines methods for searching the tree for elements with a specified tag name or `ID` attribute. The `Element` interface represents an XML element or tag and has methods for manipulating the element's attributes. The `Text` interface represents a run of plain text within an `Element` and has methods for querying or altering that text. `NodeList` and `DOMImplementation` do not extend `Node` but are also important interfaces.

This package is an endorsed standard, which means that it is defined outside of Sun Microsystems and the Java Community Process but has been adopted as part of the Java platform. Full documentation is available at http://www.w3.org/TR/DOM-Level-3-Core/. Note that Java 5.0 also adopts the `bootstrap`, `events`, and `ls` (load/save) subpackages. Those subpackages are not documented in this book because they are only tangentially used by the rest of the Java platform.

Interfaces

```
public interface Attr extends Node;
public interface CDATASection extends Text;
public interface CharacterData extends Node;
public interface Comment extends CharacterData;
public interface Document extends Node;
public interface DocumentFragment extends Node;
public interface DocumentType extends Node;
public interface DOMConfiguration;
public interface DOMError;
public interface DOMErrorHandler;
public interface DOMImplementation;
public interface DOMImplementationList;
public interface DOMImplementationSource;
public interface DOMLocator;
public interface DOMStringList;
public interface Element extends Node;
```

```
public interface Entity extends Node;
public interface EntityReference extends Node;
public interface NamedNodeMap;
public interface NameList;
public interface Node;
public interface NodeList;
public interface Notation extends Node;
public interface ProcessingInstruction extends Node;
public interface Text extends CharacterData;
public interface TypeInfo;
public interface UserDataHandler;
```

Exceptions

```
public class DOMException extends RuntimeException;
```

Team LiB

Attr org.w3c.dom

Java 1.4

An Attr object represents an attribute of an Element node. Attr objects are associated with Element nodes, but are not directly part of the document tree: the getParentNode( ) method of an Attr object always returns null. Use getOwnerElement( ) to deterine which Element an Attr is part of. You can obtain an Attr object by calling the getAttributeNode( ) method of Element, or you can obtain a NamedNodeMap of all Attr objects for an element with the getAttributes( ) method of Node.

getName( ) returns the name of the attribute. getValue( ) returns the attribute value as a string. getSpecified( ) returns TRue if the attribute was explicitly specified in the source document through a call to setValue( ), and returns false if the attribute represents a default obtained from a DTD or other schema.

XML allows attributes to contain text and entity references. The getValue( ) method returns the attribute value as a single string. If you want to know the precise composition of the attribute however, you can examine the children of the Attr node: they may consist of Text and/or EntityReference nodes.

In most cases the easiest way to work with attributes is with the getAttribute( ) and setAttribute( ) methods of the Element interface. These methods avoid the use of Attr nodes altogether.

Figure 21-1. org.w3c.dom.Attr

```
public interface Attr extends Node {
// Public Instance Methods
     String getName( );
     Element getOwnerElement( );
5.0  TypeInfo getSchemaTypeInfo( );
     boolean getSpecified( );
     String getValue( );
5.0  boolean isId( );
     void setValue(String value) throws DOMException;
}
```

Passed To

Element.{removeAttributeNode( ), setAttributeNode( ), setAttributeNodeNS( ), setIdAttributeNode( )}

Returned By

Document.{createAttribute( ), createAttributeNS( )}, Element.{getAttributeNode( ), getAttributeNodeNS( ), removeAttributeNode( ), setAttributeNode( ), setAttributeNodeNS( )}

CDATASection org.w3c.dom

Java 1.4

This interface represents a CDATA section in an XML document. `CDATASection` is a subinterface of `Text` and does not define any methods of its own. The content of the CDATA section is available through the `getNodeValue( )` method inherited from Node, or through the `getdata( )` method inherited from `CharacterData`. Although `CDATASection` nodes can often be treated in the same way as `Text` nodes, note that the `Node.normalize( )` method does not merge adjacent CDATA sections.

Figure 21-2. org.w3c.dom.CDATASection

```
public interface CDATASection extends Text {
}
```

Returned By

`Document.createCDATASection( )`

CharacterData org.w3c.dom

Java 1.4

This interface is a generic one that is extended by `Text`, `CDATASection` (which extends `Text`) and `Comment`. Any node in a document tree that implements `CharacterData` also implements one of these more specific types. This interface exists simply to group the string manipulation methods that these text-related node types all share.

The `CharacterData` interface defines a mutable string. `geTData( )` returns the "character data" as a `String` object, and `setData( )` allows it to be set from a `String` object. `getLength( )` returns the number of characters of character data, and `substringData( )` returns just the specified portion of the data as a string. The `appendData( )`, `deleteData( )`, `insertData( )`, and `replaceData( )` methods mutate the data by appending a string to the end, deleting region, inserting a string at the specified location, and replacing a region with a specified string.

Figure 21-3. org.w3c.dom.CharacterData

```
public interface CharacterData extends Node {
// Public Instance Methods
     void appendData(String arg) throws DOMException;
     void deleteData(int offset, int count) throws DOMException;
     String getData( ) throws DOMException;
     int getLength( );
     void insertData(int offset, String arg) throws DOMException;
     void replaceData(int offset, int count, String arg) throws DOMException;
     void setData(String data) throws DOMException;
     String substringData(int offset, int count) throws DOMException;
}
```

Implementations

`Comment`, `Text`

Team LiB

Comment org.w3c.dom

Java 1.4

A `Comment` node represents a comment in an XML document. The content of the comment (i.e. the text between `<!--` and `-->`) is available with the `getdata( )` method inherited from `CharacterData`, or through the `getNodeValue( )` method inherited from `Node`. This content may be manipulated using the various methods inherited from `CharacterData`

Figure 21-4. org.w3c.dom.Comment


```
public interface Comment extends CharacterData {
}
```

Returned By

`Document.createComment( )`

Team LiB

Document org.w3c.dom

Java 1.4

This interface represents a DOM document, and an object that implements this interface serves as the root of a DOM document tree. Most of the methods defined by the Document interface are "factory methods" that are used to create various types of nodes that can be inserted into this document. Note that there are two versions of the methods for creating attributes and elements. The methods with "NS" in their name are namespace-aware and require the attribute or element name to be specified as a combination of a namespace URI and a local name. You'll notice that throughout the DOM API, methods with "NS" in their names are namespace-aware. Other important methods include the following:

getElementsByTagName( ) and its namespace-aware variant getElementsByTagNameNS( ) search the document tree for Element nodes that have the specified tag name and return a NodeList containing those matching nodes. The Element interface defines methods by the same names that search only within the subtree defined by an Element.

getElementById( ) is a related method that searches the document tree for a single element with the specified unique value for an ID attribute. This is useful when you use an ID attribute to uniquely identify certain tags within an XML document. Note that this method does not search for attributes that are named "id" or "ID". It searches for attributes whose XML type (as declared in the document's DTD) is ID. Such attributes are often named "id", but this is not required.

An XML document must have a single root element. getdocumentElement( ) returns this Element object. Note, however that this does not mean that a Document node has only one child. It must have exactly one child that is an Element, but it can also have other children such as Comment and ProcessingInstruction nodes. The geTDoctype( ) method returns the DocumentType object (or null if there isn't one) that represents the document's DTD. getImplementation( ) returns the the DOMImplementation object that represents the DOM implementation that created this document tree.

Figure 21-5. org.w3c.dom.Document

```
public interface Document extends Node {
// Public Instance Methods
5.0  Node adoptNode(Node source) throws DOMException;
     Attr createAttribute(String name) throws DOMException;
     Attr createAttributeNS(String namespaceURI, String qualifiedName)
        throws DOMException;
     CDATASection createCDATASection(String data) throws DOMException;
```

```
     Comment createComment(String data);
     DocumentFragment createDocumentFragment( );
     Element createElement(String tagName) throws DOMException;
     Element createElementNS(String namespaceURI, String qualifiedName)
        throws DOMException;
     EntityReference createEntityReference(String name) throws DOMException;
     ProcessingInstruction createProcessingInstruction(String target,
        String data) throws DOMException;
     Text createTextNode(String data);
     DocumentType getDoctype( );
     Element getDocumentElement( );
5.0  String getDocumentURI( );
5.0  DOMConfiguration getDomConfig( );
     Element getElementById(String elementId);
     NodeList getElementsByTagName(String tagname);
     NodeList getElementsByTagNameNS(String namespaceURI, String localName);
     DOMImplementation getImplementation( );
5.0  String getInputEncoding( );
5.0  boolean getStrictErrorChecking( );
5.0  String getXmlEncoding( );
5.0  boolean getXmlStandalone( );
5.0  String getXmlVersion( );
     Node importNode(Node importedNode, boolean deep) throws DOMException;
5.0  void normalizeDocument( );
5.0  Node renameNode(Node n, String namespaceURI, String qualifiedName)
        throws DOMException;
5.0  void setDocumentURI(String documentURI);
5.0  void setStrictErrorChecking(boolean strictErrorChecking);
5.0  void setXmlStandalone(boolean xmlStandalone) throws DOMException;
5.0  void setXmlVersion(String xmlVersion) throws DOMException;
}
```

Returned By

javax.xml.parsers.DocumentBuilder.{newDocument( ), parse( )}, DOMImplementation.createDocument( ), Node.getOwnerDocument( )

DocumentFragment org.w3c.dom

Java 1.4

The `DocumentFragment` interface represents a portionor fragmentof a document. More specifically, it represents one or more adjacent document nodes, and all of the descendants of each. `DocumentFragment` nodes are never part of a document tree, and `getParentNode( )` always returns `null`. Although a `DocumentFragment` does not have a parent, it can have children, and you can use the inherited `Node` methods to add child nodes (or delete or replace them) to a `DocumentFragment`.

`DocumentFragment` nodes exhibit a special behavior that makes them quite useful: when a request is made to insert a `DocumentFragment` into a document tree, it is not the `DocumentFragment` node itself that is inserted, but each of the children of the `DocumentFragment` instead. This makes `DocumentFragment` useful as a temporary placeholder for a sequence of nodes that you wish to insert, all at once, into a document.

You can create a new, empty, `DocumentFragment` to work with by calling the `createDocumentFragment( )` method of the desired `Document`.

Figure 21-6. org.w3c.dom.DocumentFragment

```
public interface DocumentFragment extends Node {
}
```

Returned By

`Document.createDocumentFragment( )`

Team LiB

DocumentType org.w3c.dom

Java 1.4

This interface represents the Document Type Declaration, or DTD of a document. Because the DTD is not part of the document itself, a DocumentType object is not part of DOM document tree, even though it extends the Node interface. If a Document has a DTD, then you may obtain the DocumentType object that represents it by calling the getdoctype( ) method of the Document object.

getName( ), getPublicId( ), getSystemId( ), and getInternalSubset( ) all return strings (or null) that contain the name, public identifier, system identifier, and internal subset of the document type. getEntities( ) returns a read-only NamedNodeMap that represents the a name-to-value mapping for all internal and external general entities declared by the DTD. You can use this NamedNodeMap to lookup an Entity object by name. Similarly, getNotations( ) returns a read-only NamedNodeMap that allows you to look up a Notation object declared in the DTD by name.

DocumentType does not provide access to the bulk of a DTD, which usually consists of element and attribute delcarations. Future versions of the DOM API may provide more details.

Figure 21-7. org.w3c.dom.DocumentType

```
public interface DocumentType extends Node {
// Public Instance Methods
     NamedNodeMap getEntities( );
     String getInternalSubset( );
     String getName( );
     NamedNodeMap getNotations( );
     String getPublicId( );
     String getSystemId( );
}
```

Passed To

DOMImplementation.createDocument( )

Returned By

Document.getDoctype( ), DOMImplementation.createDocumentType( )

DOMConfiguration org.w3c.dom

Java 5.0

This Level 3 interface defines methods for querying and setting the values of named parameters. The `DOMConfiguration` object obtained with the `Document.getDomConfig( )` method allows you to specify parameters that affect the behavior of the `Document.normalizeDocument( )` method. You can also obtain a `DOMConfiguration` object from the `LSParser` and `LSSerializer` interfaces of the `org.w3c.dom.ls` package. Those configuration objects affect the way documents are loaded and saved, but the package is beyond the scope of this book. See the DOM specification for details on the available parameters.

```
public interface DOMConfiguration {
// Public Instance Methods
     boolean canSetParameter(String name, Object value);
     Object getParameter(String name) throws DOMException;
     DOMStringList getParameterNames( );
     void setParameter(String name, Object value) throws DOMException;
}
```

Returned By

`Document.getDomConfig( )`

DOMError org.w3c.dom

Java 5.0

This Level 3 interface describes an error that occurs while processing a document (such as when loading, saving, validating or normalizing it). An object that implements this interface is passed to the registered `DOMErrorHandler`, if any. The constants defined by this interface represent error severity levels.

Note that this interface is unrelated to `DOMException` class or to the `java.lang.Error` and `java.lang.Exception` classes.

```
public interface DOMError {
// Public Constants
     public static final short SEVERITY_ERROR;                    =2
     public static final short SEVERITY_FATAL_ERROR;              =3
     public static final short SEVERITY_WARNING;                  =1
// Public Instance Methods
     org.w3c.dom.DOMLocator getLocation( );
     String getMessage( );
     Object getRelatedData( );
     Object getRelatedException( );
     short getSeverity( );
     String getType( );
}
```

Passed To

`DOMErrorHandler.handleError( )`

Team LiB

DOMErrorHandler org.w3c.dom

Java 5.0

This Level 3 interface defines a handler for DOMError objects that represent errors while processing an XML document. Register an object that implements this interface by setting it as the value of the "error-handler" property through the DOMConfiguration interface.

```
public interface DOMErrorHandler {
// Public Instance Methods
     boolean handleError(DOMError error);
}
```

Team LiB

Team LiB

DOMException org.w3c.dom

Java 1.4 *serializable unchecked*

An instance of this class is thrown whenever an exception is raised by the DOM API. Unlike many Java APIs, the DOM API does not define specialized subclasses to define different categories of exceptions. Instead, a more specific exception type is specified by the public field `code`. The value of this field will be one of the constants defined by this class, which have the following meanings:

`INDEX_SIZE_ERR`

Indicates an out-of-bounds error for an array or string index.

`DOMSTRING_SIZE_ERR`

Indicates that a requested text is too big to fit into a `String` object. Exceptions of this type are intended for DOM implementations for other languages and should not occur in Java.

`HIERARCHY_REQUEST_ERR`

Indicates that an attempt was made to place a node somewhere illegal in the document tree hierarchy.

`WRONG_DOCUMENT_ERR`

Indicates an attempt to use a node with a document that is different than the document that created the node.

`INVALID_CHARACTER_ERR`

Indicates that an illegal character is used (in an element name, for example) .

`NO_DATA_ALLOWED_ERR`

Not currently used.

NO_MODIFICATION_ALLOWED_ERR

Indicates that an attempt was made to modify a node that is read-only and does not allow modifications. Entity, EntityReference, and Notation nodes, and all of their descendants are read-only.

NOT_FOUND_ERR

Indicates that a node was not found where it was expected.

NOT_SUPPORTED_ERR

Indicates that a method or property is not supported in the current DOM implementation.

INUSE_ATTRIBUTE_ERR

Indicates that an attempt was made to associate an Attr with an Element when that Attr node was already associated with a different Element node.

INVALID_STATE_ERR

Indicates an attempt to use an object that is not yet, or is no longer, in a state that allows such use.

SYNTAX_ERR

Indicates that a specified string contains a syntax error. Exceptions of this type are not raised by the core module of the DOM API described here.

INVALID_MODIFICATION_ERR

Exceptions of this type are not raised by the core module of the DOM API described here.

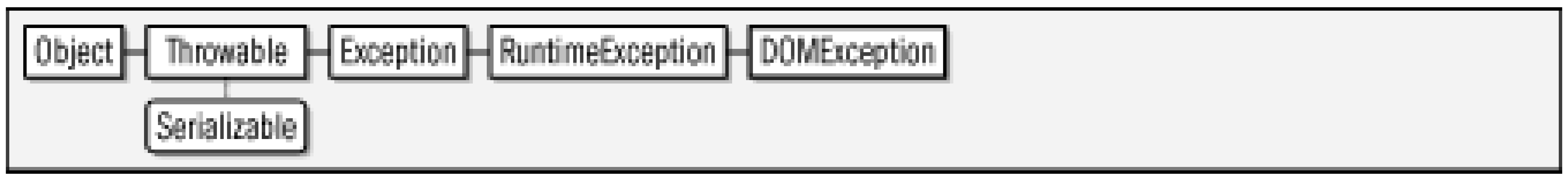
NAMESPACE_ERR

Indicates an error involving element or attribute namespaces.

INVALID_ACCESS_ERR

Indicates an attempt to access an object in a way that is not supported by the implementation.

Figure 21-8. org.w3c.dom.DOMException




```
public class DOMException extends RuntimeException {
// Public Constructors
     public DOMException(short code, String message);
// Public Constants
     public static final short DOMSTRING_SIZE_ERR;                    =2
     public static final short HIERARCHY_REQUEST_ERR;                 =3
     public static final short INDEX_SIZE_ERR;                        =1
     public static final short INUSE_ATTRIBUTE_ERR;                   =10
     public static final short INVALID_ACCESS_ERR;                    =15
     public static final short INVALID_CHARACTER_ERR;                 =5
     public static final short INVALID_MODIFICATION_ERR;              =13
     public static final short INVALID_STATE_ERR;                     =11
     public static final short NAMESPACE_ERR;                         =14
     public static final short NO_DATA_ALLOWED_ERR;                   =6
     public static final short NO_MODIFICATION_ALLOWED_ERR;           =7
     public static final short NOT_FOUND_ERR;                         =8
     public static final short NOT_SUPPORTED_ERR;                     =9
     public static final short SYNTAX_ERR;                            =12
5.0  public static final short TYPE_MISMATCH_ERR;                 =17
5.0  public static final short VALIDATION_ERR;                    =16
     public static final short WRONG_DOCUMENT_ERR;                    =4
// Public Instance Fields
     public short code;
}
```

Thrown By

Too many methods to list.

DOMImplementation org.w3c.dom

Java 1.4

This interface defines methods that are global to an implementation of the DOM rather than specific to a particular Document object. Obtain a reference to the DOMImplementation object that represents your implementation by calling the getImplementation( ) method of any Document object. createDocument( ) returns a new, empty Document object which you can populate with nodes that you create using the create methods defined by the Document interface.

hasFeature( ) allows you to test whether your DOM implementation supports a specified version of a named feature, or module, of the DOM standard. This method should return TRue when you pass the feature name "core" and the verion "1.0", or when you pass the feature names "core" or "xml" and the version "2.0". The DOM standard includes a number of optional modules, but the Java platform has not adopted the subpackages of this package that define the API for those optional modules, and therefore the DOM implementation bundled with a Java implementation is not likely to support those modules.

The javax.xml.parsers.DocumentBuilder class provides another way to obtain the DOMImplementation object by calling its getdOMImplementation( ) object. It also defines a shortcut newDocument( ) method for creating empty Document objects to populate.

```
public interface DOMImplementation {
// Public Instance Methods
     Document createDocument(String namespaceURI, String qualifiedName,
        DocumentType doctype) throws DOMException;
     DocumentType createDocumentType(String qualifiedName, String publicId,
        String systemId) throws DOMException;
5.0  Object getFeature(String feature, String version);
     boolean hasFeature(String feature, String version);
}
```

Returned By

javax.xml.parsers.DocumentBuilder.getDOMImplementation( ), Document.getImplementation( ), DOMImplementationList.item( ), DOMImplementationSource.getDOMImplementation( )

DOMImplementationList org.w3c.dom

Java 5.0

This Level 3 interface represents a fixed-size, read-only list (or array) of `DOMImplementation` objects. `getLength( )` returns the list length, and `item( )` returns the `DOMImplementation` at the specified index.

```
public interface DOMImplementationList {
// Public Instance Methods
     int getLength( );
     DOMImplementation item(int index);
}
```

Returned By

`DOMImplementationSource.getDOMImplementationList( )`

DOMImplementationSource org.w3c.dom

Java 5.0

This Level 3 interface is designed for use by DOM implementors. It is also used in the `org.w3c.dom.bootstrap` package, which is beyond the scope of this book.

```
public interface DOMImplementationSource {
// Public Instance Methods
     DOMImplementation getDOMImplementation(String features);
     DOMImplementationList getDOMImplementationList(String features);
}
```

DOMLocator org.w3c.dom

Java 5.0

This Level 3 interface represents the location at which a `DOMError` occurred. The methods return the location of the error as measured by various metrics (byte offset, line and column number, etc.) and return `-1` or `null` if location information is not available.

```
public interface DOMLocator {
// Public Instance Methods
     int getByteOffset( );
     int getColumnNumber( );
     int getLineNumber( );
     Node getRelatedNode( );
     String getUri( );
     int getUtf16Offset( );
}
```

Returned By

`DOMError.getLocation( )`

DOMStringList org.w3c.dom

Java 5.0

This Level 3 interface represents a fixed-size, read-only list ofstrings. `getLength( )` returns the length of the list, and `item( )` returns the `String` at the specified index. `contains( )` tests whether the specified `String` is contained in the list. An object of this type is returned by `DOMConfiguration.getParameterNames( )`.

```
public interface DOMStringList {
// Public Instance Methods
     boolean contains(String str);
     int getLength( );
     String item(int index);
}
```

Returned By

`DOMConfiguration.getParameterNames( )`

Element org.w3c.dom

Java 1.4

This interface represents an element (or tag) in an XML document. `getTagName( )` returns the tagname of the element, including the namespace prefix if there is one. When working with namespaces, you will probably prefer to use the namespace-aware methods defined by the `Node` interface. Use `getNamespaceURI( )` to get the namespace URI of the element, and use `getLocalName( )` to the local name of the element within that namespace. You can also use `getPrefix( )` to query the namespace prefix, or `setPrefix( )` to change the namespace prefix (this does not change the namespace URI).

`Element` defines a `getElementsByTagName( )` method and a corresponding namespace-aware `getElementsByTagNameNS( )` method, which behave just like the methods of the same names on the `Document` object, except that they search for named elements only within the subtree rooted at this `Element`.

The remaining methods of the `Element` interface are for querying and setting attribute values, testing the existence of an attribute, and removing an attribute from the `Element`. There are a confusing number of methods to perform these four basic attribute operations. If an attribute-related method has "NS" in its name, then it is namespace-aware. If it has "Node" in its name, then it works with `Attr` objects rather than with the simpler string representation of the attribute value. Attributes in XML documents may contain entity references. If your document may include entity references in attribute values, then you may need to use the `Attr` interface because the expansion of such an entity reference can result in a subtree of nodes beneath the `Attr` object. Whenver possible, however, it is much easier to work with the methods that treat attribute values as plain strings. Note also that in addition to the attribute methods defined by the `Element` interface you can also obtain a `NamedNodeMap` of `Attr` objects with the `getAttributes( )` method of the `Node` interface.

Finally, note also that `getAttribute( )` and related methods and `hasAttribute( )` and related methods return the value of or test for the existance of both explicitly specified attributes, and also attributes for which a default value is specified in the document DTD. If you need to determine whether an attribute was explicitly specified in the document, obtain its `Attr` object, and use its `getSpecified( )` method.

Figure 21-9. org.w3c.dom.Element

```
public interface Element extends Node {
// Public Instance Methods
     String getAttribute(String name);
     Attr getAttributeNode(String name);
```

```
     Attr getAttributeNodeNS(String namespaceURI, String localName)
        throws DOMException;
     String getAttributeNS(String namespaceURI, String localName)
        throws DOMException;
     NodeList getElementsByTagName(String name);
     NodeList getElementsByTagNameNS(String namespaceURI, String localName)
        throws DOMException;
5.0  TypeInfo getSchemaTypeInfo( );
     String getTagName( );
     boolean hasAttribute(String name);
     boolean hasAttributeNS(String namespaceURI, String localName)
        throws DOMException;
     void removeAttribute(String name) throws DOMException;
     Attr removeAttributeNode(Attr oldAttr) throws DOMException;
     void removeAttributeNS(String namespaceURI, String localName)
        throws DOMException;
     void setAttribute(String name, String value) throws DOMException;
     Attr setAttributeNode(Attr newAttr) throws DOMException;
     Attr setAttributeNodeNS(Attr newAttr) throws DOMException;
     void setAttributeNS(String namespaceURI, String qualifiedName, String value)
        throws DOMException;
5.0  void setIdAttribute(String name, boolean isId) throws DOMException;
5.0  void setIdAttributeNode(Attr idAttr, boolean isId) throws DOMException;
5.0  void setIdAttributeNS(String namespaceURI, String localName, boolean isId)
        throws DOMException;
}
```

Returned By

Attr.getOwnerElement( ), Document.{createElement( ), createElementNS( ), getdocumentElement( ), getElementById( )}

Team LiB

Entity org.w3c.dom

Java 1.4

This interface represents an entity defined in an XML DTD. The name of the entity is specified by the getNodeName( ) method inherited from the Node interface. The entity content is represented by the child nodes of the Entity node. The methods defined by this interface return the public identifier and system identifier for external entities, and the notation name for unparsed entities. Note that Entity nodes and their children are not part of the document tree (and the getParentNode( ) method of an Entity always returns null). Instead a document may contain one or more references to an entity: see the EntityReference interface.

Entities are defined in the DTD (document type definition) of a document, either as part of an external DTD file, or as part of an "internal subset" that defines local entities that are specific to the current document. The DocumentType interface has a getEntities( ) method that returns a NamedNodeMap mapping entity names to Entity nodes. This is the only way to obtain an Entity object: because they are part of the DTD, Entity nodes never appear within the document tree itself. Entity nodes and all descendants of an Entity node are read-only and cannot be edited or modified in any way.

Figure 21-10. org.w3c.dom.Entity

```
public interface Entity extends Node {
// Public Instance Methods
5.0  String getInputEncoding( );
     String getNotationName( );
     String getPublicId( );
     String getSystemId( );
5.0  String getXmlEncoding( );
5.0  String getXmlVersion( );
}
```

EntityReference org.w3c.dom

Java 1.4

This interface represents a reference from an XML document to an entity defined in the document's DTD. Character entities and predefined entities such as `<` are always expanded in XML documents and do not create `EntityReference` nodes. Note also that some XML parsers expand all entity references. Documents created by such parsers do not contain `EntityReference` nodes.

This interface defines no methods of its own. The `getNodeName( )` method of the `Node` interface provides the name of the referenced entity. The `getEntities( )` method of the `DocumentType` interface provides a way to look up the `Entity` object associated with that name. Note however, that the `DocumentType` may not contain an `Entity` with the specified name (because, for example, nonvalidating XML parsers are not required to parse the external subset of the DTD.) In this case, the `EntityReference` is a reference to a named entity whose content is not known, and it has no children. On the other hand, if the `DocumentType` does contain an `Entity` node with the specified name, then the child nodes of the `EntityReference` are a copy of the child nodes of the `Entity`, and represent the expansion of the entity. (The children of an `EntityReference` may not be an exact copy of the children of an `Entity` if the entity's expansion includes namespace prefixes that are not bound to namespace URIs.)

Like `Entity` nodes, `EntityReference` nodes and their descendants are read-only and cannot be edited or modified.

Figure 21-11. org.w3c.dom.EntityReference

```
public interface EntityReference extends Node {
}
```

Returned By

`Document.createEntityReference( )`

Team LiB

NamedNodeMap org.w3c.dom

Java 1.4

The NamedNodeMap interface defines a collection of nodes that may be looked up by name or by namespa URI and local name. It is unrelated to the java.util.Map interface. Use getNamedItem( ) to look for an return a node whose getNodeName( ) method returns the specified value. Use getNamedItemNS( ) to lo for and return a node whose getNamespaceURI( ) and getLocalName( ) methods return the specified values. A NamedNodeMap is a mapping from names to nodes, and does not order the nodes in any particu way. Nevertheless, it does impose an arbitrary ordering on the nodes and allow them to be looked up by index. Use getLength( ) to find out how many nodes are contained in the NamedNodeMap , and use item( ) to obtain the Node object at a specified index.

If a NamedNodeMap is not read-only, you can use removeNamedItem( ) and removeNamedItemNS( ) to remove a named node from the map, and you can use setNamedItem( ) and setNamedItemNS( ) to ad a node to the map, mapping to it from its name or its namespace URI and local name.

NamedNodeMap objects are "live," which means that they immediately reflect any changes to the docume tree. For example, if you obtain a NamedNodeMap that represents the attributes of an element, and then add a new attribute to that element, the new attribute is automatically available through the NamedNodeMap : you do not need to obtain a new NamedNodeMap to get the modified set of attributes.

NamedNodeMap is returned only by relatively obscure methods of the DOM API. The most notable use is a the return value of the getAttributes( ) method of Node . It is usually easier to work with attributes through the methods of the Element interface, however. Two methods of DocumentType also return read only NamedNodeMap objects.

```
public interface NamedNodeMap {
// Public Instance Methods
     int getLength( );
     Node getNamedItem(String name);
     Node getNamedItemNS(String namespaceURI, String localName) throws DOMException;
     Node item(int index);
     Node removeNamedItem(String name) throws DOMException;
     Node removeNamedItemNS(String namespaceURI, String localName) throws DOMException;
     Node setNamedItem(Node arg) throws DOMException;
     Node setNamedItemNS(Node arg) throws DOMException;
}
```

Returned By

DocumentType.{getEntities( ) , getNotations( )} , Node.getAttributes( )

Team LiB

NameList org.w3c.dom

Java 5.0

This Level 3 interface represnts a fixed-size, read-only list of element or attribute names and their namespace URI. `getLength( )` returns the length of the list. `getName( )` and `getNamespaceURI( )` return the name and namespace at the specified index. `contains( )` and `containsNS( )` test for membership in the list.

This interface is unused within the `org.w3c.dom` package.

```
public interface NameList {
// Public Instance Methods
     boolean contains(String str);
     boolean containsNS(String namespaceURI, String name);
     int getLength( );
     String getName(int index);
     String getNamespaceURI(int index);
}
```

Team LiB

Node org.w3c.dom

Java 1.4

All objects in a DOM document tree (including the Document object itself) implement the Node interface, which provides basic methods for traversing and manipulating the tree.

getParentNode( ) and getChildNodes( ) allow you to traverse up and down the document tree. You can enumerate the children of a given node by looping through the elements of the NodeList returned by getChildNodes( ), or by using getFirstChild( ) and getNextSibling( ) (or getLastChild( ) and getPreviousSibling( ) to loop backwards). It is sometimes useful to call hasChildNodes( ) to determine whether a node has children or not. getOwnerDocument( ) returns the Document node of which the node is a descendant or with which it is associated. It provides a quick way to jump to the root of the document tree.

Several methods allow you to add children to a tree or alter the list of children. appendChild( ) adds a new child node at the end of this nodes list of children. insertChild( ) inserts a node into this nodes list of children, placing it immediately before a specified child node. removeChild( ) removes the specified node from this node's list of children. replaceChild( ) replaces one child node of this node with another node. For all of these methods, if the node to be appended or inserted is already part of the document tree, it is first removed from its current parent. Use cloneNode( ) to produce a copy of this node. Pass true if you want all descendants of this node to be cloned as well.

Every object in a document tree implements the Node interface, but also implements a more specialized subinterface, such as Element or Text. The getNodeType( ) method provides an easy way to determine which subinterface a node implements: the return value is one of the _NODE constants defined by this class. You might use the return value of getNodeType( ) in a switch statement, for exmaple, to determine how to process a node of unknown type.

getNodeName( ) and getNodeValue( ) provide additional information about a node, but the interpretation of the strings they return depends on the node type as shown in the table below. Note that subinterfaces typically define specialized methods (such as the getTagName( ) method of Element and the getdata( ) method of Text) for obtaining this same information. Note also that unless a node is read-only, you can use setNodeValue( ) to alter the value associated with the node.

Node type	Node name	Node value
ELEMENT_NODE	The element s tag name	null
ATTRIBUTE_NODE	The attribute name	The attribute value
TEXT_NODE	#text	The text of the node
CDATA_SECTION_NODE	#cdata-section	The text of the node

Node type	Node name	Node value
ENTITY_REFERENCE_NODE	The name of the referenced entity	null
ENTITY_NODE	The entity name	null
PROCESSING_INSTRUCTION_NODE	The target of the PI	The remainder of the PI
COMMENT_NODE	#comment	The text of the comment
DOCUMENT_NODE	#document	null
DOCUMENT_TYPE_NODE	The document type name	null
DOCUMENT_FRAGMENT_NODE	#document-fragment	null
NOTATION_NODE	The notation name	null

In documents that use namespaces, the getNodeName( ) method of a Element or Attr node returns the qualified node name, which may include a namespace prefix. In documents that use namespaces you may prefer to use the namespace-aware methods getNamespaceURI( ), getLocalName( ) and getPrefix( ).

Element nodes may have a list of attributes, and the Element interface defines a number of methods for working with these attributes. In addition, however, Node defines the hasAttributes( ) method to determine if a node has any attributes. If it does, they can be retrieved with getAttributes( ).

Text content in an XML document is represented by Text nodes, which have methods for manipulating that textual content. The Node interface defines a normalize( ) method which has the specialized purpose of normalizing all descendants of a node by deleting empty Text nodes and coalescing adjacent Text nodes into a single combined node. Document trees usually start off in this normalized form, but modifications to the tree may result in non-normalized documents.

Most of the other interfaces in this package extend Node. Document, Element and Text are the most commonly used.

```
public interface Node {
// Public Constants
     public static final short ATTRIBUTE_NODE;                          =2
     public static final short CDATA_SECTION_NODE;                      =4
     public static final short COMMENT_NODE;                            =8
     public static final short DOCUMENT_FRAGMENT_NODE;                  =11
     public static final short DOCUMENT_NODE;                           =9
5.0  public static final short DOCUMENT_POSITION_CONTAINED_BY;      =16
5.0  public static final short DOCUMENT_POSITION_CONTAINS;          =8
5.0  public static final short DOCUMENT_POSITION_DISCONNECTED;      =1
5.0  public static final short DOCUMENT_POSITION_FOLLOWING;         =4
5.0  public static final short DOCUMENT_POSITION_IMPLEMENTATION_SPECIFIC;     =32
5.0  public static final short DOCUMENT_POSITION_PRECEDING;         =2
     public static final short DOCUMENT_TYPE_NODE;                      =10
     public static final short ELEMENT_NODE;                            =1
     public static final short ENTITY_NODE;                             =6
     public static final short ENTITY_REFERENCE_NODE;                   =5
```

```
     public static final short NOTATION_NODE;                          =12
     public static final short PROCESSING_INSTRUCTION_NODE;            =7
     public static final short TEXT_NODE;                              =3
// Public Instance Methods
     Node appendChild(Node newChild) throws DOMException;
     Node cloneNode(boolean deep);
5.0  short compareDocumentPosition(Node other) throws DOMException;
     NamedNodeMap getAttributes( );
5.0  String getBaseURI( );
     NodeList getChildNodes( );
5.0  Object getFeature(String feature, String version);
     Node getFirstChild( );
     Node getLastChild( );
     String getLocalName( );
     String getNamespaceURI( );
     Node getNextSibling( );
     String getNodeName( );
     short getNodeType( );
     String getNodeValue( ) throws DOMException;
     Document getOwnerDocument( );
     Node getParentNode( );
     String getPrefix( );
     Node getPreviousSibling( );
5.0  String getTextContent( ) throws DOMException;
5.0  Object getUserData(String key);
     boolean hasAttributes( );
     boolean hasChildNodes( );
     Node insertBefore(Node newChild, Node refChild) throws DOMException;
5.0  boolean isDefaultNamespace(String namespaceURI);
5.0  boolean isEqualNode(Node arg);
5.0  boolean isSameNode(Node other);
     boolean isSupported(String feature, String version);
5.0  String lookupNamespaceURI(String prefix);
5.0  String lookupPrefix(String namespaceURI);
     void normalize( );
     Node removeChild(Node oldChild) throws DOMException;
     Node replaceChild(Node newChild, Node oldChild) throws DOMException;
     void setNodeValue(String nodeValue) throws DOMException;
     void setPrefix(String prefix) throws DOMException;
5.0  void setTextContent(String textContent) throws DOMException;
5.0  Object setUserData(String key, Object data, UserDataHandler handler);
}
```

Implementations

Attr, CharacterData, Document, DocumentFragment, DocumentType, Element, Entity, EntityReference, Notation, ProcessingInstruction

Passed To

Too many methods to list.

Returned By

Too many methods to list.

Team LiB

Team LiB

NodeList org.w3c.dom

Java 1.4

This interface represents a read-only ordered collection of nodes that can be interated through. getLength( ) returns the number of nodes in the list, and item( ) returns the Node at a specified index in the list (the index of the first node is 0). The elements of a NodeList are always valid Node objects: a NodeList never contains null elements.

Note that NodeList objects are "live"they are not static but immediately reflect changes to the document tree. For example, if you have a NodeList that represents the children of a specific node, and you then delete one of those children, the child will be removed from your NodeList. Be careful when looping through the elements of a NodeList if the body of your loop makes changes to the document tree (such as deleting nodes) that may affect the contents of the NodeList!

```
public interface NodeList {
// Public Instance Methods
     int getLength( );
     Node item(int index);
}
```

Returned By

Document.{getElementsByTagName( ), getElementsByTagNameNS( )}, Element.{getElementsByTagName( ), getElementsByTagNameNS( )}, Node.getChildNodes( )

Notation org.w3c.dom

Java 1.4

This interface represents a notation declared in the DTD of an XML document. In XML notations are used to specify the format of an unparsed entity or to formally declare a processing instruction target.

The getNodeName( ) method of the Node interface returns the name of the notation. getSystemId( ) and getPublicId( ) return the system identifier and the public identifier specified in the notation declaration. The getNotations( ) method of the DocumentType interface returns a NamedNodeMap of Notation objects declared in the DTD and provides a way to look up Notation objects by notation name.

Because notations appear in the DTD and not the document itself, Notation nodes are never part of the document tree, and the getParentNode( ) method always returns null. Similarly, since XML notation declarations never have any content, a Notation node never has children and getChildNodes( ) always returns null. Notation objects are read-only and cannot be modified in any way.

Figure 21-12. org.w3c.dom.Notation

```
public interface Notation extends Node {
// Public Instance Methods
     String getPublicId( );
     String getSystemId( );
}
```

ProcessingInstruction org.w3c.dom

Java 1.4

This interface represents an XML processing instruction (or PI) which specifies an arbitrary string of data to a named target processor. The `getTarget( )` and `getdata( )` methods return the target and data portions of a PI, and these values can also be obtained using the `getNodeName( )` and `getNodeValue( )` methods of the `Node` interface. You can alter the data portion of a PI with `setData( )` or with the `setNodeValue( )` method of `Node`. `ProcessingInstruction` nodes never have children.

Figure 21-13. org.w3c.dom.ProcessingInstruction


```
public interface ProcessingInstruction extends Node {
// Public Instance Methods
     String getData( );
     String getTarget( );
     void setData(String data) throws DOMException;
}
```

Returned By

`Document.createProcessingInstruction( )`

Team LiB

Text org.w3c.dom

Java 1.4

A Text node represents a run of plain text that does not contain any XML markup. Plain text appears within XML elements and attributes, and Text nodes typically appear as children of Element and Attr nodes. Text nodes inherit from CharacterData, and the textual content of a Text node is available through the getdata( ) method inherited from CharacterData or through the getNodeValue( ) method inherited from Node.

Text nodes may be manipulated using any of the methods inherited from CharacterData. The Text interface defines one method of its own: splitText( ) splits a Text node at the specified character position. The method changes the original node so that it contains only the text up to the specified position. Then it creates a new Text node that contains the text from the specified position on and inserts that new node into the document tree immediately after the original one. The Node.normalize( ) method reverses this process by deleting emty Text nodes and merging adjacent Text nodes into a single node.

Text nodes never have children.

Figure 21-14. org.w3c.dom.Text

```
public interface Text extends CharacterData {
// Public Instance Methods
5.0  String getWholeText( );
5.0  boolean isElementContentWhitespace( );
5.0  Text replaceWholeText(String content) throws DOMException;
     Text splitText(int offset) throws DOMException;
}
```

Implementations

CDATASection

Returned By

Document.createTextNode( )

Team LiB

TypeInfo org.w3c.dom

Java 5.0

This Level 3 interface represents information about the type of an Element or Attr node. Obtain a TypeI by calling the getSchemaTypeInfo( ) method of an Element or Attr . Note that TypeInfo information is available if the document has been validated against a W3C XML Schema.

The methods of TypeInfo return the name and namespace of the element or attribute type. isDerivedF determines if the type is a derivative of another named type. The constants defined by the interface spe different derivation techniques for types.

See also java.xml.validation.TypeInfoProvider .

```
public interface TypeInfo {
// Public Constants
     public static final int DERIVATION_EXTENSION;                       =2
     public static final int DERIVATION_LIST;                            =8
     public static final int DERIVATION_RESTRICTION;                     =1
     public static final int DERIVATION_UNION;                           =4
// Public Instance Methods
     String getTypeName( );
     String getTypeNamespace( );
     boolean isDerivedFrom(String typeNamespaceArg, String typeNameArg, int derivationM
}
```

Returned By

javax.xml.validation.TypeInfoProvider.{getAttributeTypeInfo( ) , getElementTypeInfo( )} , Attr.getSchemaTypeInfo( ) , Element.getSchemaTypeInfo( )

UserDataHandler org.w3c.dom

Java 5.0

This Level 3 interface defines a handler that is invoked when a node on which user-specified data has been registered is adopted, cloned, deleted, imported or renamed. Register an object that implements this interface in the call to Node.setUserData( ).

```
public interface UserDataHandler {
// Public Constants
     public static final short NODE_ADOPTED;                          =5
     public static final short NODE_CLONED;                           =1
     public static final short NODE_DELETED;                          =3
     public static final short NODE_IMPORTED;                         =2
     public static final short NODE_RENAMED;                          =4
// Public Instance Methods
     void handle(short operation, String key, Object data, Node src, Node dst);
}
```

Passed To

Node.setUserData( )

Chapter 22. org.xml.sax and Subpackages

This chapter documents the `org.xml.sax` package and its subpackages. `org.xml.sax` defines the Simplified API for XML, or SAX, a de facto standard for parsing XML documents. The `org.xml.sax.ext` package defines optional extensions to the SAX API, and the `org.xml.sax.helpers` package defines helper classes that are often useful with SAX.

These packages were added in Java 1.4 as "endorsed standards." This means that they are part of the Java platform, but are not defined by Sun, which is why they have the "org.xml" prefix.

Team LiB

downloaded from: lib.ommolketab.ir

Team LiB

Package org.xml.sax

Java 1.4

This is the core package for SAX (Simple API for XML) parsing of XML documents. SAX is an "event-driv
a SAX parser reads an XML document and generates a stream of "SAX events" to describe the content o
document. These "events" are actually method calls made on one or more handler objects that the appli
has registered with the parser. The `XMLReader` interface defines the API that must be implemented by a
parser. `ContentHandler` , `ErrorHandler` , `EntityResolver` , and `DTDHandler` are interfaces that define
objects. An application registers objects that implement one or more of these interfaces with the `XMLRea`

This package defines both the SAX1 and SAX2 interfaces. The `AttributesList` , `DocumentHandler` and
interfaces, as well as the `HandlerBase` class are part of the SAX1 API and are now deprecated in favor o
`Attributes` , `ContentHandler` , `XMLReader` , and `org.xml.sax.helpers.DefaultHandler` .

Interfaces

```
public interface AttributeList;
public interface Attributes;
public interface ContentHandler;
public interface DocumentHandler;
public interface DTDHandler;
public interface EntityResolver;
public interface ErrorHandler;
public interface Locator;
public interface Parser;
public interface XMLFilter extends XMLReader;
public interface XMLReader;
```

Classes

```
public class HandlerBase implements DocumentHandler, DTDHandler, EntityResolver, ErrorHa
public class InputSource;
```

Exceptions

```
public class SAXException extends Exception;
   public class SAXNotRecognizedException extends SAXException;
   public class SAXNotSupportedException extends SAXException;
   public class SAXParseException extends SAXException;
```

Team LiB

AttributeList org.xml.sax

Java 1.4; Deprecated in 1.4

This interface is part of the SAX1 API and has been deprecated in favor of the SAX2`Attributes` interface, which supports XML namespaces.

```
public interface AttributeList {
// Public Instance Methods
     int getLength( );
     String getName(int i);
     String getType(String name);
     String getType(int i);
     String getValue(String name);
     String getValue(int i);
}
```

Implementations

`org.xml.sax.helpers.AttributeListImpl`

Passed To

`DocumentHandler.startElement( )`, `HandlerBase.startElement( )`, `org.xml.sax.helpers.AttributeListImpl.{AttributeListImpl( )`, `setAttributeList( )}`, `org.xml.sax.helpers.ParserAdapter.startElement( )`

Attributes org.xml.sax

Java 1.4

This interface represents a list of attributes of an XML element and includes information about the attribute names, types, and values. If the SAX parser has read a DTD or schema for the document, this list of attributes will include attributes that are not explicitly specified in the document but which have a default value specified in the DTD or schema.

The most commonly used method is `getValue( )` which returns the value of a named attribute (there is also a version of this method that returns the value of a numbered attribute; it is discussed later). If the SAX parser is not processing namespaces, you can use the one-argument version of `getValue( )`. Otherwise, use the two argument version to specify the URI that uniquely identifies the namespace, and the "local name" of the desired attribute within that namespace . The `getType( )` methods are similar, except that they return the type of the named attribute, rather than its value. Note that `getType( )` can only return useful information if the parser has read a DTD or schema for the document and knows the type of each attribute.

In XML documents the attributes of a tag can appear in any order. `Attributes` objects make no attempt to preserve the document source order of the tags. Nevertheless, it does impose an ordering on the attributes so that you can loop through them. `getLength( )` returns the number of elements in the list. There are versions of `getValue( )` and `getType( )` that return the value and type of the attribute at a specified position in the list. You can also query the name of the attribute at a specified position, although the way you do this depends on whether the parser handles namespaces or not. If it does not process namespaces, use `getQName( )` to get the name at a specified position. Otherwise, use `getURI( )` and `getLocalName( )` to obtain the URI and local name pair for the numbered attribute. Note that `getQName( )` may return the empty string when namespace processing is on, and `getLocalName( )` may return the empty string if namespace processing is off.

```
public interface Attributes {
// Public Instance Methods
     int getIndex(String qName);
     int getIndex(String uri, String localName);
     int getLength( );
     String getLocalName(int index);
     String getQName(int index);
     String getType(String qName);
     String getType(int index);
     String getType(String uri, String localName);
     String getURI(int index);
     String getValue(String qName);
     String getValue(int index);
     String getValue(String uri, String localName);
}
```

Implementations

`org.xml.sax.ext.Attributes2`, `org.xml.sax.helpers.AttributesImpl`

Passed To

`org.xml.sax.ContentHandler.startElement( )`,
`org.xml.sax.ext.Attributes2Impl.{Attributes2Impl( )`, `setAttributes( )}`,
`org.xml.sax.helpers.AttributesImpl.{AttributesImpl( )`, `setAttributes( )}`,
`org.xml.sax.helpers.DefaultHandler.startElement( )`,
`org.xml.sax.helpers.XMLFilterImpl.startElement( )`,
`org.xml.sax.helpers.XMLReaderAdapter.startElement( )`

Team LiB

ContentHandler org.xml.sax

Java 1.4

This interface is the key one for XML parsing with the SAX API. An `XMLReader` tells your application about the content of the XML document it is parsing by invoking the various methods of the `ContentHandler` interface. In order to parse documents with SAX, you must implement this interface to define methods that take whatever actions are necessary when they are invoked by the parser. Because this interface is so critical to the SAX API, the methods are explained individually below:

`setDocumentLocator( )`

> The parser usually calls this method (but is not required to do so) before calling any others to pass a `Locator` object to the `ContentHandler`. `Locator` defines methods that return the current line and column number of the document being parsed, and if the parser supplies a `Locator` object, it guarantees that its methods will return valid values during any other `ContentHandler` invocations that follow. A `ContentHandler` can call the methods of this object when printing error messages, for example.

`startDocument( ), endDocument( )`

> The parser calls these methods once, at the beginning and end of parsing. `startDocument( )` is the first method called except for the optional `setDocumentLocator( )` call, and `endDocument( )` is always the last method call on a `ContentHandler`.

`startElement( ), endElement( )`

> The parser calls these methods for each start tag and end tag it encounters. Both are passed three arguments describing the name of the tag: if the parser is doing namespace processing, then the first two arguments of both methods return the URI that uniquely identifies the namespace, and the local name of the tag within that namespace. If the parser is not doing namespace parsing, then the third argument provides the full name of the tag. In addition to these tag name arguments, `startElement( )` is also passed an `Attributes` object that describes the attributes of the tag.

`characters( )`

> This method is invoked to tell the application that the parser has found a string of text in the

XML document. The text is contained within the specified character array, at the specified start position, and continuing for the specified number of characters.

`ignorableWhitespace( )`

This method is like `characters( )`, but parsers may use it to tell the application about "ignorable whitespace" in XML element content.

`processingInstruction( )`

The parser calls this method to tell the application that it has encountered an XML Processing Instruction (or PI) with the specified target and data strings.

`skippedEntity( )`

If the XML parser does encounters an entity in the document, but does not expand and parse its content, then it tells the application about it by passing the name of the entity to this method.

`startPrefixMapping( ), endPrefixMapping( )`

These methods to tell the application about a namespace mapping from the specified prefix to the specified namespace URI.

`DTDHandler` is another interface like `ContentHandler`. An application can implement this interface to receive notification of DTD-related events from the parser. Similarly, the`org.xml.sax.ext` package defines two "extension" interfaces that can be used (if the parser supports these extensions) to obtain even more information about the document (such as comments and CDATA sections) and about the DTD (including the full set of element, attribute and entity declarations). The `org.xml.sax.helpers.DefaultHandler` class is a useful one. It implements `ContentHandler` and three other interfaces that are commonly used with the `XMLReader` class and provides empty implementations of all their methods. Applications can subclass`DefaultHandler` only need to override the methods they care about. This is usually more convenient that implementing the interfaces directly.

```
public interface ContentHandler {
// Public Instance Methods
     void characters(char[ ] ch, int start, int length)
       throws SAXException;
     void endDocument( ) throws SAXException;
     void endElement(String uri, String localName, String qName)
        throws SAXException;
     void endPrefixMapping(String prefix) throws SAXException;
     void ignorableWhitespace(char[ ] ch, int start, int length)
        throws SAXException;
```

```
    void processingInstruction(String target, String data)
       throws SAXException;
    void setDocumentLocator(Locator locator);
    void skippedEntity(String name) throws SAXException;
    void startDocument( ) throws SAXException;
    void startElement(String uri, String localName, String qName,
       org.xml.sax.Attributes atts) throws SAXException;
    void startPrefixMapping(String prefix, String uri)
       throws SAXException;
}
```

Implementations

javax.xml.transform.sax.TemplatesHandler, javax.xml.transform.sax.TransformerHandler, javax.xml.validation.ValidatorHandler, org.xml.sax.helpers.DefaultHandler, org.xml.sax.helpers.XMLFilterImpl, org.xml.sax.helpers.XMLReaderAdapter

Passed To

javax.xml.transform.sax.SAXResult.{SAXResult( ), setHandler( )}, javax.xml.validation.ValidatorHandler.setContentHandler( ), XMLReader.setContentHandler( ), org.xml.sax.helpers.ParserAdapter.setContentHandler( ), org.xml.sax.helpers.XMLFilterImpl.setContentHandler( )

Returned By

javax.xml.transform.sax.SAXResult.getHandler( ), javax.xml.validation.ValidatorHandler.getContentHandler( ), XMLReader.getContentHandler( ), org.xml.sax.helpers.ParserAdapter.getContentHandler( ), org.xml.sax.helpers.XMLFilterImpl.getContentHandler( )

Team LiB

DocumentHandler org.xml.sax

Java 1.4; Deprecated in 1.4

This interface is part of the SAX1 API and has been deprecated in favor of the SAX2 `ContentHandler` interface, which supports XML namespaces.

```
public interface DocumentHandler {
// Public Instance Methods
     void characters(char[ ] ch, int start, int length) throws SAXException;
     void endDocument( ) throws SAXException;
     void endElement(String name) throws SAXException;
     void ignorableWhitespace(char[ ] ch, int start, int length) throws SAXException;
     void processingInstruction(String target, String data) throws SAXException;
     void setDocumentLocator(Locator locator);
     void startDocument( ) throws SAXException;
     void startElement(String name, AttributeList atts) throws SAXException;
}
```

Implementations

`HandlerBase` , `org.xml.sax.helpers.ParserAdapter`

Passed To

`Parser.setDocumentHandler( )` , `org.xml.sax.helpers.XMLReaderAdapter.setDocumentHandler( )`

DTDHandler org.xml.sax

Java 1.4

This interface defines methods that an application can implement in order to receive notification from a `XMLReader` about notation and unparsed entity declarations in the DTD of an XML document. Notations and unparsed entities are two of the most obscure features of XML, and they (and this interface) are not frequently used. To use a `DTDHandler`, define a class that implements the interface, (or simply subclass the helper class `org.xml.sax.helpers.DefaultHandler`) and pass an instance of that class to the `setDTDHandler( )` method of an `XMLReader`. Then, if the parser encounters any notation or unparsed entity declarations in the DTD of the document, it will invoke the `notationDecl( )` or `unparsedEntityDecl( )` method that you have supplied. Unparsed entities can appear later in a document as the value of an attribute, so if your application cares about them, it should somehow make a note of the entity name and system id for use later.

```
public interface DTDHandler {
// Public Instance Methods
     void notationDecl(String name, String publicId, String systemId)
        throws SAXException;
     void unparsedEntityDecl(String name, String publicId, String systemId,
        String notationName) throws SAXException;
}
```

Implementations

`javax.xml.transform.sax.TransformerHandler`, `HandlerBase`, `org.xml.sax.helpers.DefaultHandler`, `org.xml.sax.helpers.XMLFilterImpl`

Passed To

`Parser.setDTDHandler( )`, `XMLReader.setDTDHandler( )`, `org.xml.sax.helpers.ParserAdapter.setDTDHandler( )`, `org.xml.sax.helpers.XMLFilterImpl.setDTDHandler( )`, `org.xml.sax.helpers.XMLReaderAdapter.setDTDHandler( )`

Returned By

`XMLReader.getDTDHandler( )`, `org.xml.sax.helpers.ParserAdapter.getDTDHandler( )`, `org.xml.sax.helpers.XMLFilterImpl.getDTDHandler( )`

EntityResolver org.xml.sax

Java 1.4

An application can implement this interface to help the parser resolve external entities, if required. If you pass an EntityResolver instance to the setEntityResolver( ) method of an XMLReader, then the parser will call the resolveEntity( ) method whenever it needs to read an external entity. This method should use the public identifier or system identifier to return an InputSource that the parser can use to read the content of the external entity. If the external entity includes a valid system identifier, then the parser can read it directly without the need for an EntityResolver, but this interface is still useful for mapping network URLs to locally cached copies, or for mapping public identifiers to local files, for example. The helper class org.xml.sax.helpers.DefaultHandler includes a stub implementation of this interface, so if you subclass DefaultHandler you can override its resolveEntity( ) method.

```
public interface EntityResolver {
// Public Instance Methods
     InputSource resolveEntity(String publicId, String systemId)
        throws SAXException, java.io.IOException;
}
```

Implementations

HandlerBase, org.xml.sax.ext.EntityResolver2, org.xml.sax.helpers.DefaultHandler, org.xml.sax.helpers.XMLFilterImpl

Passed To

javax.xml.parsers.DocumentBuilder.setEntityResolver( ), Parser.setEntityResolver( ), XMLReader.setEntityResolver( ), org.xml.sax.helpers.ParserAdapter.setEntityResolver( ), org.xml.sax.helpers.XMLFilterImpl.setEntityResolver( ), org.xml.sax.helpers.XMLReaderAdapter.setEntityResolver( )

Returned By

XMLReader.getEntityResolver( ), org.xml.sax.helpers.ParserAdapter.getEntityResolver( ), org.xml.sax.helpers.XMLFilterImpl.getEntityResolver( )

Team LiB

ErrorHandler org.xml.sax

Java 1.4

Before parsing an XML document, an application should provide an implementation of this interface to the XMLReader by calling the setErrorHandler( ) method of the XMLReader. If the reader needs to issue a warning or report an error or fatal error, it will call the appropriate method of the ErrorHandler object you supplied. The error( ) method is used to report recoverable errors, such as document validity problems. The parser continues parsing after calling error( ). The fatalError( ) method is used to report nonrecoverable errors, such as well-formedness problems. The parser may not continue parsing after calling fatalError( ). An ErrorHandler object may respond to warnings, errors, and fatal errors however it likes, and may throw exceptions from these methods.

Instead of implementing this interface directly, you may also subclass the helper class org.xml.sax.helpers.DefaultHandler and override the error reporting methods it provides. The warning( ) and error( ) methods of a DefaultHandler do nothing, and the fatalError( ) method throws the SAXParseException object that was passed to it.

```
public interface ErrorHandler {
// Public Instance Methods
     void error(SAXParseException exception) throws SAXException;
     void fatalError(SAXParseException exception) throws SAXException;
     void warning(SAXParseException exception) throws SAXException;
}
```

Implementations

HandlerBase, org.xml.sax.helpers.DefaultHandler, org.xml.sax.helpers.XMLFilterImpl

Passed To

javax.xml.parsers.DocumentBuilder.setErrorHandler( ), javax.xml.validation.SchemaFactory.setErrorHandler( ), javax.xml.validation.Validator.setErrorHandler( ), javax.xml.validation.ValidatorHandler.setErrorHandler( ), Parser.setErrorHandler( ), XMLReader.setErrorHandler( ), org.xml.sax.helpers.ParserAdapter.setErrorHandler( ), org.xml.sax.helpers.XMLFilterImpl.setErrorHandler( ), org.xml.sax.helpers.XMLReaderAdapter.setErrorHandler( )

Returned By

javax.xml.validation.SchemaFactory.getErrorHandler( ), javax.xml.validation.Validator.getErrorHandler( ), javax.xml.validation.ValidatorHandler.getErrorHandler( ), XMLReader.getErrorHandler( ), org.xml.sax.helpers.ParserAdapter.getErrorHandler( ), org.xml.sax.helpers.XMLFilterImpl.getErrorHandler( )

HandlerBase org.xml.sax

Java 1.4; Deprecated in 1.4

This class is part of the SAX1 API and has been deprecated in favor of the SAX2 `org.xml.sax.helpers.DefaultHandler` class.

Figure 22-1. org.xml.sax.HandlerBase


```
public class HandlerBase implements DocumentHandler, DTDHandler, EntityResolver, ErrorHa
// Public Constructors
     public HandlerBase( );
// Methods Implementing DocumentHandler
     public void characters(char[ ] ch, int start, int length)
        throws SAXException;     empty
     public void endDocument( ) throws SAXException;                    empty
     public void endElement(String name) throws SAXException;           empty
     public void ignorableWhitespace(char[ ] ch, int start, int length)
        throws SAXException;     empty
     public void processingInstruction(String target, String data)
        throws SAXException;     empty
     public void setDocumentLocator(Locator locator);                   empty
     public void startDocument( ) throws SAXException;                  empty
     public void startElement(String name, AttributeList attributes)
        throws SAXException;     empty
// Methods Implementing DTDHandler
     public void notationDecl(String name, String publicId, String systemId);     empty
     public void unparsedEntityDecl(String name, String publicId, String systemId,
        String notationName);     empty
// Methods Implementing EntityResolver
     public InputSource resolveEntity(String publicId, String systemId)
        throws SAXException;     constant
// Methods Implementing ErrorHandler
     public void error(SAXParseException e) throws SAXException;        empty
     public void fatalError(SAXParseException e) throws SAXException;
     public void warning(SAXParseException e) throws SAXException;      empty
}
```

Passed To

`javax.xml.parsers.SAXParser.parse( )`

Team LiB

InputSource org.xml.sax

Java 1.4

This simple class describes a source of input for an XMLReader . An InputSource object can be passed to the parse( ) method of XMLReader , and is also the return value of the EntityResolver.resolveEntity( ) method.

Create an InputSource( ) with one of the constructor methods, specifying the system identifier (a URL) of the file to be parsed, or specifying a byte or character stream that the parser should read the document from. In addition to calling the constructor, you may also want to call setSystemId( ) to specify and/or setPublicId( ) to provide identifiers for the document being parsed. Having a filename or URL is useful if an error arises, and your ErrorHandler object needs to print an error message, for example. If you specify the document to parse as a URL or as a byte stream, you can also call setEncoding( ) to specify the character encoding of the document. The parser will use this encoding value if you supply it, but XML documents are supposed to describe their own encoding in the <?xml?> declaration, so the parser ought to be able to determine the encoding of the document even if you do not call setEncoding( ) .

This class allows you to specify more than one input source. The XMLReader will first call getCharacterStream( ) and use the returned Reader if there is one. If that method returns false , then it calls getByteStream( ) and uses the InputStream it returns. Finally, if no character or byte stream is found, then the parser will call getSystemId( ) and will attempt to read an XML document from the returned URL.

An XMLReader will never use any of the set( ) methods to modify the state of an InputSource object.

```
public class InputSource {
// Public Constructors
     public InputSource( );
     public InputSource(java.io.Reader characterStream);
     public InputSource(java.io.InputStream byteStream);
     public InputSource(String systemId);
// Public Instance Methods
     public java.io.InputStream getByteStream( );                          default:null
     public java.io.Reader getCharacterStream( );                          default:null
     public String getEncoding( );                                         default:null
     public String getPublicId( );                                         default:null
     public String getSystemId( );                                         default:null
     public void setByteStream(java.io.InputStream byteStream);
     public void setCharacterStream(java.io.Reader characterStream);
     public void setEncoding(String encoding);
     public void setPublicId(String publicId);
     public void setSystemId(String systemId);
}
```

Passed To

javax.xml.parsers.DocumentBuilder.parse( ) , javax.xml.parsers.SAXParser.parse( ) , javax.xml.transform.sax.SAXSource.{SAXSource( ) , setInputSource( )} , javax.xml.xpath.XPath.evaluate( ) , javax.xml.xpath.XPathExpression.evaluate( ) , Parser.parse( ) , XMLReader.parse( ) , org.xml.sax.helpers.ParserAdapter.parse( ) , org.xml.sax.helpers.XMLFilterImpl.parse( ) , org.xml.sax.helpers.XMLReaderAdapter.parse( )

Returned By

javax.xml.transform.sax.SAXSource.{getInputSource( ) , sourceToInputSource( )} , EntityResolver.resolveEntity( ) , HandlerBase.resolveEntity( ) , org.xml.sax.ext.DefaultHandler2.{getExternalSubset( ) , resolveEntity( )} , org.xml.sax.ext.EntityResolver2.{getExternalSubset( ) , resolveEntity( )} , org.xml.sax.helpers.DefaultHandler.resolveEntity( ) , org.xml.sax.helpers.XMLFilterImpl.resolveEntity( )

Team LiB

Locator org.xml.sax

Java 1.4

A XMLReader may pass an object that implements this interface to the application by calling the setDocumentLocator( ) method of the application's ContentHandler object before it invokes any other methods of that ContentHandler. The ContentHandler can use methods of this Locator object from within any of the other methods called by the parser in order to determine what document the parser is parsing and what line number and column number it is parsing at. This information is particularly useful when displaying error or warning messages, for example. getSystemId( ) and getPublicId( ) return the system and public identifiers of the document being parsed, if this information is available to the parser, and otherwise returnnull. getLineNumber( ) and getColumnNumber( ) return the line number and column number of the next character that the parser will read (line and column numbers are numbered starting at 1, not at 0). The parser is allowed to return an approximate value from these methods, or to return -1 if it does not track line and column numbers.

```
public interface Locator {
// Public Instance Methods
     int getColumnNumber( );
     int getLineNumber( );
     String getPublicId( );
     String getSystemId( );
}
```

Implementations

org.xml.sax.ext.Locator2, org.xml.sax.helpers.LocatorImpl

Passed To

org.xml.sax.ContentHandler.setDocumentLocator( ), DocumentHandler.setDocumentLocator( ), HandlerBase.setDocumentLocator( ), SAXParseException.SAXParseException( ), org.xml.sax.ext.Locator2Impl.Locator2Impl( ), org.xml.sax.helpers.DefaultHandler.setDocumentLocator( ), org.xml.sax.helpers.LocatorImpl.LocatorImpl( ), org.xml.sax.helpers.ParserAdapter.setDocumentLocator( ), org.xml.sax.helpers.XMLFilterImpl.setDocumentLocator( ), org.xml.sax.helpers.XMLReaderAdapter.setDocumentLocator( )

Team LiB

Parser org.xml.sax

Java 1.4; Deprecated in 1.4

This interface is part of the SAX1 API and has been deprecated in favor of the SAX2XMLReader interface, which supports XML namespaces.

```
public interface Parser {
// Public Instance Methods
     void parse(InputSource source) throws SAXException, java.io.IOException;
     void parse(String systemId) throws SAXException, java.io.IOException;
     void setDocumentHandler(DocumentHandler handler);
     void setDTDHandler(DTDHandler handler);
     void setEntityResolver(EntityResolver resolver);
     void setErrorHandler(ErrorHandler handler);
     void setLocale(java.util.Locale locale) throws SAXException;
}
```

Implementations

org.xml.sax.helpers.XMLReaderAdapter

Passed To

org.xml.sax.helpers.ParserAdapter.ParserAdapter( )

Returned By

javax.xml.parsers.SAXParser.getParser( ),
org.xml.sax.helpers.ParserFactory.makeParser( )

SAXException org.xml.sax

Java 1.4 *serializable checked*

Signals a problem while parsing an XML document. This class serves as the general superclass for more specific types of SAX exceptions. The `parse( )` method of an `XMLReader` can throw an exception of this type. The application can also throw a `SAXException` from any of the handler methods (of `ContentHandler` and `ErrorHandler` for example) invoked by the parser.

Figure 22-2. org.xml.sax.SAXException


```
public class SAXException extends Exception {
// Public Constructors
5.0  public SAXException( );
     public SAXException(String message);
     public SAXException(Exception e);
     public SAXException(String message, Exception e);
// Public Instance Methods
     public Exception getException( );                                     default:null
// Public Methods Overriding Throwable
     public String getMessage( );                                          default:null
     public String toString( );
}
```

Subclasses

`SAXNotRecognizedException` , `SAXNotSupportedException` , `SAXParseException`

Thrown By

Too many methods to list.

SAXNotRecognizedException org.xml.sax

Java 1.4 *serializable checked*

Signals that the parser does not recognize a feature or property name. See the `setFeature( )` and `setProperty( )` methods of `XMLReader`.

Figure 22-3. org.xml.sax.SAXNotRecognizedException


```
public class SAXNotRecognizedException extends SAXException {
// Public Constructors
5.0  public SAXNotRecognizedException( );
     public SAXNotRecognizedException(String message);
}
```

Thrown By

Too many methods to list.

SAXNotSupportedException org.xml.sax

Java 1.4 *serializable checked*

Signals that the parser does recognizes, but does not support a named feature or property. The property or feature may be entirely unsupported, or it may be read-only, in which case this exception will be thrown by the `setFeature( )` or `setProperty( )` method, but not by the corresponding `getFeature( )` or `getProperty( )` method of `XMLReader`.

Figure 22-4. org.xml.sax.SAXNotSupportedException


```
public class SAXNotSupportedException extends SAXException {
// Public Constructors
5.0  public SAXNotSupportedException( );
     public SAXNotSupportedException(String message);
}
```

Thrown By

Too many methods to list.

SAXParseException org.xml.sax

Java 1.4 *serializable checked*

An exception of this type signals an XML parsing error or warning. `SAXParseException` includes methods to return the system and public identifiers of the document in which the error or warning occurred, as well as methods to return the approximate line number and column number at which it occurred. A parser is not required to obtain or track all of this information, and the methods may return `null` or -1 if the information is not available. (See `Locator` for more information.)

Exceptions of this type are usually thrown by the application from the methods of the `ErrorHandler` interface. The parser never throws a `SAXParseException` itself, but does pass an appropriately initialized instance of this class to each of the `ErrorHandler` methods. It is up to the application's `ErrorHandler` object to decide whether to actually throw the exception, however.

Figure 22-5. org.xml.sax.SAXParseException

```
public class SAXParseException extends SAXException {
// Public Constructors
     public SAXParseException(String message, Locator locator);
     public SAXParseException(String message, Locator locator, Exception e);
     public SAXParseException(String message, String publicId, String systemId,
        int lineNumber, int columnNumber);
     public SAXParseException(String message, String publicId, String systemId,
        int lineNumber, int columnNumber,
        Exception e);
// Public Instance Methods
     public int getColumnNumber( );
     public int getLineNumber( );
     public String getPublicId( );
     public String getSystemId( );
}
```

Passed To

`ErrorHandler.{error( ), fatalError( ), warning( )}`, `HandlerBase.{error( ), fatalError( ), warning( )}`, `org.xml.sax.helpers.DefaultHandler.{error( ), fatalError( ), warning(`

)}, org.xml.sax.helpers.XMLFilterImpl.{error( ), fatalError( ), warning( )}

Team LiB

XMLFilter org.xml.sax

Java 1.4

An XMLFilter extends XMLReader and behaves like an XMLReader except that instead of parsing a document itself, it filters the SAX events provided by a "parent"XMLReader object. Use the setParent( ) method to link an XMLFilter object to the XMLReader that it is to serve as a filter for.

An XMLFilter serves as both a source of SAX events, and also as a receipient of those events, so an implementation must implement ContentHandler and related interfaces so that it can obtain events from the parent object, filter them, and then pass the filtered events on to theContentHandler object that was registered on the filter. See the helper classorg.xml.sax.helpers.XMLFilterImpl for a bare-bones implementation of an XMLFilter that implements the XMLReader interface and the ContentHandler and related handler interfaces. XMLFilterImpl does no filteringit simply passes passes all of its method invocations through. You can subclass it and override only the methods that need filtering.

Figure 22-6. org.xml.sax.XMLFilter

```
public interface XMLFilter extends XMLReader {
// Public Instance Methods
     XMLReader getParent( );
     void setParent(XMLReader parent);
}
```

Implementations

org.xml.sax.helpers.XMLFilterImpl

Returned By

javax.xml.transform.sax.SAXTransformerFactory.newXMLFilter( )

XMLReader org.xml.sax

Java 1.4

This interface defines the methods that must be implemented by a SAX2 XML parser. Since it is an interface, `XMLReader` cannot define a constructor for creating an `XMLReader`. To obtain an `XMLReader`, object, you can instantiate some implementation-specific class that implements this interface. Alternatively, you can keep your code independent of any specific parser implementation by using the `SAXParserFactory` and `SAXParser` classes of the `javax.xml.parsers` package. See those classes for more details. Note that the `XMLReader` interface has no relationship to the `java.io.Reader` class or any other character stream classes.

Once you have obtained an `XMLReader` instance, you must register handler objects on it, so that it can invoke methods on those handlers to notify your application of the results of its parsing. All applications should register a `ContentHandler` and an `ErrorHandler` with `setContentHandler( )` and `setErrorHandler( )`. Some applications may also want to register an `EntityResolver` and/or a `DTDHandler`. Applications can also register `DeclHandler` and `LexicalHandler` objects from the `org.xml.sax.ext` package, if the parser implementation supports these extension handler interfaces `DeclHandler` and `LexicalHandler` objects are registered with `setProperty( )`, as explained below.

In addition to registering handler objects for an XMLReader, you may also want to configure the behavior of the parser using `setFeature( )` and `setProperty( )`. Features and properties are both name/value pairs. For uniqueness, the names of features and properties are expressed as URLs (the URLs usually do not have any web content associated with them: they are merely unique identifiers). Features have boolean values, and properties have arbitrary object values. Features and properties are an extension mechanism, allowing an application to specify implementation-specific details about how the parser should behave. But there are also several "standard" features and properties that are supported by many (or all) SAX parsers. They are listed below. If a parser does not recognize the name of a feature or property, the `setFeature( )` and `setProperty( )` methods (as well as the corresponding `getFeature( )` and `getProperty( )` query methods) throw a `SAXNotRecognizedException`. If the parser recognizes the name of a feature or property, but does not support the feature or property, the methods instead throw a `SAXNotSupportedException`. This exception is also thrown by the `set` methods when the parser allows the feature or property to be queried but not set.

The standard features are the following. Their names are all URLs that begin with the prefix "http://www.xml.org/sax/features/". For brevity, this prefix has been omitted below. Note that only two of these features must be supported by all parsers. The others may or may not be supported in any given implementation:

`namespaces`

If `true` (the default), then the parser supports namespaces and provides the namespace URI and localname for element and attribute names. Support for this feature is required in all parser implementations .

`namespace-prefixes`

If `true`, then the parser provides the qualified name (or "qName") that for element and attribute names. A qName consists of a namespace prefix, a colon, and the local name. The default value of this feature is `false`, and support for the feature is required in all parser implementations.

`validation`

If `true`, then the parser will validate XML documents, and will read all external entities.

`external-general-entities`

If `true`, then the parser handles external general entities. This is always `TRue` if the `validation` feature is `TRue`.

`external-parameter-entities`

If `true`, then the parser handles external parameter entities. This is always `TRue` if the `validation` feature is `true`.

`lexical-handler/parameter-entities`

If `true`, then the parser will report the begining and end of parameter entities to the `LexicalHandler` extension interface.

`string-interning`

If `TRue`, then the parser will use the `String.intern( )` method for all strings (element, attribute, entity and notation names, and namespace prefixes and URIs) it returns. If the application does the same, it can use `= =` equality testing for these strings rather than using the more expensive `equals( )` method.

The standard properties are the following. Like the features, their names are all URLs that begin with the prefix (omitted below) "http://www.xml.org/sax/properties/". Note that support for all of these properties is optional.

`declaration-handler`

An `org.xml.sax.ext.DeclHandler` object to which the parser will report the contents of the DTD.

`lexical-handler`

An `org.xml.sax.ext.LexicalHandler` object on which the parser will make method calls to describe the lexical structure (such as comments and CDATA sections) of the XML document.

`xml-string`

This is a read-only property, and can only be queried from within a handler method invoked by the parser. The value of this property is a `String` that contains the document content that triggered the current handler invocation.

`dom-node`

An `XMLReader` that "parses" a DOM tree rather than the textual form of an XML document uses the value of this property as the `org.w3c.dom.Node` object at which it should begin parsing.

Finally, after you have obtained an `XMLReader` object, have queried and configured its features and properties, and have set a `ContentHandler`, `ErrorHandler`, and any other required handler objects, you are ready to parse an XML document. Do this by calling one of the `parse( )` methods, specifying the document to parse either as a system identifier (a URL) or as an `InputSource` object (which allows the use of streams as well).

```
public interface XMLReader {
// Public Instance Methods
     org.xml.sax.ContentHandler getContentHandler( );
     DTDHandler getDTDHandler( );
     EntityResolver getEntityResolver( );
     ErrorHandler getErrorHandler( );
     boolean getFeature(String name) throws SAXNotRecognizedException,
        SAXNotSupportedException;
     Object getProperty(String name) throws SAXNotRecognizedException,
        SAXNotSupportedException;
     void parse(String systemId) throws java.io.IOException, SAXException;
     void parse(InputSource input) throws java.io.IOException, SAXException;
     void setContentHandler(org.xml.sax.ContentHandler handler);
     void setDTDHandler(DTDHandler handler);
     void setEntityResolver(EntityResolver resolver);
     void setErrorHandler(ErrorHandler handler);
     void setFeature(String name, boolean value)
        throws SAXNotRecognizedException, SAXNotSupportedException;
     void setProperty(String name, Object value)
        throws SAXNotRecognizedException, SAXNotSupportedException;
}
```

Implementations

XMLFilter, org.xml.sax.helpers.ParserAdapter

Passed To

javax.xml.transform.sax.SAXSource.{SAXSource( ), setXMLReader( )}, XMLFilter.setParent( ), org.xml.sax.helpers.XMLFilterImpl.{setParent( ), XMLFilterImpl( )}, org.xml.sax.helpers.XMLReaderAdapter.XMLReaderAdapter( )

Returned By

javax.xml.parsers.SAXParser.getXMLReader( ), javax.xml.transform.sax.SAXSource.getXMLReader( ), XMLFilter.getParent( ), org.xml.sax.helpers.XMLFilterImpl.getParent( ), org.xml.sax.helpers.XMLReaderFactory.createXMLReader( )

Team LiB

Package org.xml.sax.ext

Java 1.4

This package defines extensions to the basic SAX2 API. Neither SAX parsers nor SAX applications are required to support these extensions, but when they do, the interfaces defined here provide a standard way for the parser to provide additional information about an XML document to the application. `DeclHandler` defines methods for reporting the content of a DTD, and `LexicalHandler` defines methods for reporting the lexical structure of an XML document.

In Java 5.0 adopts "SAX2 Extensions 1.1" and adds three new interfaces to this package: `Attributes2`, `EntityResolver2`, and `Locator2`. Each extends a similarly named interface from the core `org.xml.sax` package.

Interfaces

```
public interface Attributes2 extends org.xml.sax.Attributes;
public interface DeclHandler;
public interface EntityResolver2 extends org.xml.sax.EntityResolver;
public interface LexicalHandler;
public interface Locator2 extends org.xml.sax.Locator;
```

Classes

```
public class Attributes2Impl extends org.xml.sax.helpers.AttributesImpl
        implements Attributes2;
public class DefaultHandler2 extends org.xml.sax.helpers.DefaultHandler
        implements DeclHandler, EntityResolver2, LexicalHandler;
public class Locator2Impl extends org.xml.sax.helpers.LocatorImpl
        implements Locator2;
```

Attributes2 org.xml.sax.ext

Java 5.0

This interface extends `org.xml.sax.Attributes` and adds methods for determining if an attribute was declared in the DTD and whether an attribute value was explicitly specified in the document or whether a default value from the DTD was used. If the SAX implementation supports this interface, the `Attributes` object passed to the `startElement( )` method of the `ContentHandler` implements this interface. You can also test for support by querying the feature named "http://xml.org/sax/features/use-attributes2" with `XMLReader.getFeature( )`.

Figure 22-7. org.xml.sax.ext.Attributes2


```
public interface Attributes2 extends org.xml.sax.Attributes {
// Public Instance Methods
     boolean isDeclared(String qName);
     boolean isDeclared(int index);
     boolean isDeclared(String uri, String localName);
     boolean isSpecified(String qName);
     boolean isSpecified(int index);
     boolean isSpecified(String uri, String localName);
}
```

Implementations

`Attributes2Impl`

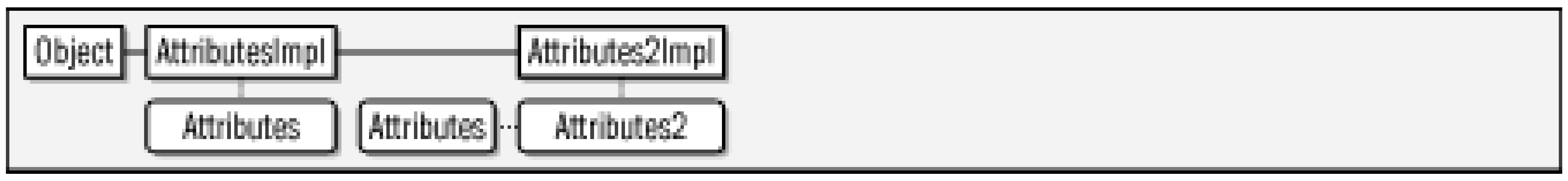
Team LiB

Attributes2Impl org.xml.sax.ext

Java 5.0

This extension helper class extends the `org.xml.sax.helpers.AttributesImpl` class to make it implement the `Attributes2` interface.

Figure 22-8. org.xml.sax.ext.Attributes2Impl




```
public class Attributes2Impl extends org.xml.sax.helpers.AttributesImpl
        implements Attributes2 {
// Public Constructors
     public Attributes2Impl( );
     public Attributes2Impl(org.xml.sax.Attributes atts);
// Public Instance Methods
     public void setDeclared(int index, boolean value);
     public void setSpecified(int index, boolean value);
// Methods Implementing Attributes2
     public boolean isDeclared(String qName);
     public boolean isDeclared(int index);
     public boolean isDeclared(String uri, String localName);
     public boolean isSpecified(String qName);
     public boolean isSpecified(int index);
     public boolean isSpecified(String uri, String localName);
// Public Methods Overriding AttributesImpl
     public void addAttribute(String uri, String localName, String qName, String type,
        String value);
     public void removeAttribute(int index);
     public void setAttributes(org.xml.sax.Attributes atts);
}
```

Team LiB

DeclHandler org.xml.sax.ext

Java 1.4

This extension interface defines methods that a SAX parser can call to notify an application about element, attribute, and entity declarations in a DTD. If your application requires this information about a DTD, then pass an object that implements this interface to the setProperty( ) method of an XMLReader, using the property name "http://www.xml.org/sax/properties/declaration-handler". Because this is an extension handler, SAX parsers are not required to support it, and may throw a SAXNotRecognizedException or a SAXNotSupportedException when you attempt to register a DeclHandler.

```
public interface DeclHandler {
// Public Instance Methods
     void attributeDecl(String eName, String aName, String type,
        String mode, String value) throws org.xml.sax.SAXException;
     void elementDecl(String name, String model)
        throws org.xml.sax.SAXException;
     void externalEntityDecl(String name, String publicId,
        String systemId) throws org.xml.sax.SAXException;
     void internalEntityDecl(String name, String value)
        throws org.xml.sax.SAXException;
}
```

Implementations

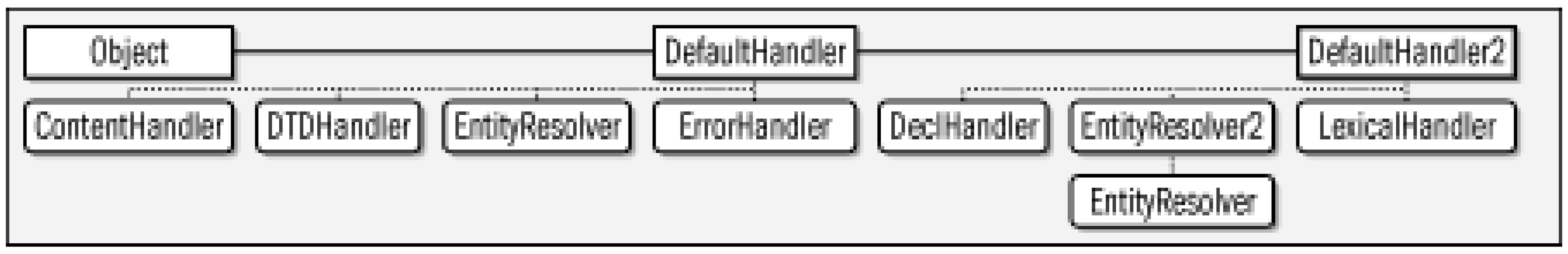
DefaultHandler2

DefaultHandler2 org.xml.sax.ext

Java 5.0

This class extends `org.xml.sax.helpers.DefaultHandler` to add no-op methods that implement the `LexicalHandler`, `DeclHandler`, and `EntityResolver2` methods. It overrides the two-argument version of `resolveEntity` from the core `EntityResolver` interface to invoke the four-argument version from the `EntityResolver2` interface.

Figure 22-9. org.xml.sax.ext.DefaultHandler2




```
public class DefaultHandler2 extends org.xml.sax.helpers.DefaultHandler
 implements DeclHandler, EntityResolver2, LexicalHandler {
// Public Constructors
     public DefaultHandler2( );
// Methods Implementing DeclHandler
     public void attributeDecl(String eName, String aName, String type,
        String mode, String value)
        throws org.xml.sax.SAXException;      emDpty
     public void elementDecl(String name, String model)
        throws org.xml.sax.SAXException;      empty
     public void externalEntityDecl(String name, String publicId, String systemId)
        throws org.xml.sax.SAXException;      empty
     public void internalEntityDecl(String name, String value)
        throws org.xml.sax.SAXException;      empty
// Methods Implementing EntityResolver
     public org.xml.sax.InputSource resolveEntity(String publicId, String systemId)
        throws org.xml.sax.SAXException, java.io.IOException;
// Methods Implementing EntityResolver2
     public org.xml.sax.InputSource getExternalSubset(String name, String baseURI)
        throws org.xml.sax.SAXException, java.io.IOException;      constant
     public org.xml.sax.InputSource resolveEntity(String name, String publicId,
        String baseURI, String systemId)
        throws org.xml.sax.SAXException,
        java.io.IOException;      constant
// Methods Implementing LexicalHandler
     public void comment(char[ ] ch, int start, int length)
```

```
        throws org.xml.sax.SAXException;     empty
     public void endCDATA( ) throws org.xml.sax.SAXException;             empty
     public void endDTD( ) throws org.xml.sax.SAXException;               empty
     public void endEntity(String name) throws org.xml.sax.SAXException;     empty
     public void startCDATA( ) throws org.xml.sax.SAXException;           empty
     public void startDTD(String name, String publicId, String systemId)
        throws org.xml.sax.SAXException;     empty
     public void startEntity(String name) throws org.xml.sax.SAXException;     empty
}
```

EntityResolver2 org.xml.sax.ext

Java 5.0

This extension interface provides alternative entity resolver methods. If you register an entity resolver that implements this interface, if the SAX implementation supports this interface, and you set the feature "http://xml.org/sax/features/use-entity-resolver2" to `true`, then the implementation will use the methods defined by this interface instead of the method defined by the super-interface.

Figure 22-10. org.xml.sax.ext.EntityResolver2


```
public interface EntityResolver2 extends org.xml.sax.EntityResolver {
// Public Instance Methods
     org.xml.sax.InputSource getExternalSubset(String name, String baseURI)
throws org.xml.sax.SAXException, java.io.IOException;
     org.xml.sax.InputSource resolveEntity(String name, String publicId,
        String baseURI, String systemId)
        throws org.xml.sax.SAXException, java.io.IOException;
}
```

Implementations

`DefaultHandler2`

LexicalHandler org.xml.sax.ext

Java 1.4

This extension interface defines methods that a SAX parser can call to notify an application about the lexical structure of an XML document. If your application requires this kind of information (for example if it wants to create a new document that has a similar structure to the one it reads), then pass an object that implements this interface to the `setProperty( )` method of an `XMLReader`, using the property name "http://www.xml.org/sax/properties/lexical-handler". Because this is an extension handler, SAX parsers are not required to support it, and may throw a `SAXNotRecognizedException` or a `SAXNotSupportedException` when you attempt to register a `DeclHandler`.

If a `LexicalHandler` is successfully registered on an `XMLReader`, then the parser will call `startDTD( )` and `endDTD( )` to report the beginning and end of the document's DTD. It will call `startCDATA( )` and `endCDATA( )` to report the start and end of a `CDATA` section. The content of the `CDATA` section will be reported through the `characters( )` method of the `ContentHandler` interface. When the parser expands an entity, it first calls `startEntity( )` to specify the name of the entity it is about to expand, and then calls `endEntity( )` when the entity expansion is complete. Finally, whenever the parser encounters an XML comment, it calls the `comment( )` method.

```
public interface LexicalHandler {
// Public Instance Methods
     void comment(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     void endCDATA( ) throws org.xml.sax.SAXException;
     void endDTD( ) throws org.xml.sax.SAXException;
     void endEntity(String name) throws org.xml.sax.SAXException;
     void startCDATA( ) throws org.xml.sax.SAXException;
     void startDTD(String name, String publicId, String systemId)
        throws org.xml.sax.SAXException;
     void startEntity(String name) throws org.xml.sax.SAXException;
}
```

Implementations

`javax.xml.transform.sax.TransformerHandler`, `DefaultHandler2`

Passed To

`javax.xml.transform.sax.SAXResult.setLexicalHandler( )`

Returned By

`javax.xml.transform.sax.SAXResult.getLexicalHandler( )`

Locator2 org.xml.sax.ext

Java 5.0

This interface defines an extension to the core `Locator` interface. If the implementation supports it, then the `Locator` object passed to `ContentHandler.setDocumentLocator( )` will implement this interface. You can also test for support by querying the feature named "http://xml.org/sax/features/use-locator2".

Figure 22-11. org.xml.sax.ext.Locator2


```
public interface Locator2 extends org.xml.sax.Locator {
// Public Instance Methods
     String getEncoding( );
     String getXMLVersion( );
}
```

Implementations

`Locator2Impl`

Locator2Impl org.xml.sax.ext

Java 5.0

This class extends the `org.xml.sax.helpers.LocatorImpl` class to make it implement the `Locator2` interface.

Figure 22-12. org.xml.sax.ext.Locator2Impl


```
public class Locator2Impl extends org.xml.sax.helpers.LocatorImpl implements Locator2 {
// Public Constructors
     public Locator2Impl( );
     public Locator2Impl(org.xml.sax.Locator locator);
// Public Instance Methods
     public void setEncoding(String encoding);
     public void setXMLVersion(String version);
// Methods Implementing Locator2
     public String getEncoding( );                                        default:null
     public String getXMLVersion( );                                      default:null
}
```

Package org.xml.sax.helpers

Java 1.4

This package contains utility classes that are useful for programmers working with SAX parsers. DefaultHandler is the most commonly used: it is a default implementation of the four standard handler interfaces, suitable for easy subclassing by an application. XMLReaderFactory provides a layer implementation-independence, allowing an application to use an XMLReader implementation specified in a system property. XMLFilterImpl is a no-op implementation of the XMLFilter interface that also implements the various handler interfaces necessary to connect the filter to its "parent" XMLReader . It does no filtering of its own, but is easy to subclass to add filtering. If you need to work with legacy APIs that expect or return SAX1 Parser objects, you can use ParserAdapter to make a Parser object behav like a SAX2 XMLReader object, or use an XMLReaderAdapter to make an XMLReader behave like a Parser .

Classes

```
public class AttributeListImpl implements org.xml.sax.AttributeList;
public class AttributesImpl implements org.xml.sax.Attributes;
public class DefaultHandler implements org.xml.sax.ContentHandler,
  org.xml.sax.DTDHandler, org.xml.sax.EntityResolver, org.xml.sax.ErrorHandler;
public class LocatorImpl implements org.xml.sax.Locator;
public class NamespaceSupport;
public class ParserAdapter implements org.xml.sax.DocumentHandler,
  org.xml.sax.XMLReader;
public class ParserFactory;
public class XMLFilterImpl implements org.xml.sax.ContentHandler,
  org.xml.sax.DTDHandler, org.xml.sax.EntityResolver, org.xml.sax.ErrorHandler,
  org.xml.sax.XMLFilter;
public class XMLReaderAdapter implements org.xml.sax.ContentHandler, org.xml.sax.Parser
public final class XMLReaderFactory;
```

AttributeListImpl org.xml.sax.helpers

Java 1.4; Deprecated in 1.4

This deprecated class is an implementation of the deprecated SAX1 `org.xml.sax.AttributeList` interface. They have been deprecated in favor of the `AttributesImpl` implementation of the SAX2 `org.xml.sax.Attributes` interface.

Figure 22-13. org.xml.sax.helpers.AttributeListImpl


```
public class AttributeListImpl implements org.xml.sax.AttributeList {
// Public Constructors
     public AttributeListImpl( );
     public AttributeListImpl(org.xml.sax.AttributeList atts);
// Public Instance Methods
     public void addAttribute(String name, String type, String value);
     public void clear( );
     public void removeAttribute(String name);
     public void setAttributeList(org.xml.sax.AttributeList atts);
// Methods Implementing AttributeList
     public int getLength( );                           default:0
     public String getName(int i);
     public String getType(int i);
     public String getType(String name);
     public String getValue(String name);
     public String getValue(int i);
}
```

Team LiB

AttributesImpl org.xml.sax.helpers

Java 1.4

This utility class is a general-purpose implementation of the Attributes interface. In addition to implementing all the methods of Attributes, it also defines various set methods for setting attribute names, values, and types, an addAttribute( ) method for adding a new attribute to the end of the list, a removeAttribute( ) method for removing an attribute from the list, and a clear( ) method for removing all attributes. Also, there is an AttributesImpl( ) constructor that initializes the new AttributesImpl object with a copy of a specified Attributes object. This class is useful for XMLFilter implementations that want to filter the attributes of an element, or for ContentHandler implementations that need to make and save a copy of an Attributes object for later use.

Figure 22-14. org.xml.sax.helpers.AttributesImpl

```
public class AttributesImpl implements org.xml.sax.Attributes {
// Public Constructors
     public AttributesImpl( );
     public AttributesImpl(org.xml.sax.Attributes atts);
// Public Instance Methods
     public void addAttribute(String uri, String localName, String qName,
        String type, String value);
     public void clear( );
     public void removeAttribute(int index);
     public void setAttribute(int index, String uri, String localName,
        String qName, String type, String value);
     public void setAttributes(org.xml.sax.Attributes atts);
     public void setLocalName(int index, String localName);
     public void setQName(int index, String qName);
     public void setType(int index, String type);
     public void setURI(int index, String uri);
     public void setValue(int index, String value);
// Methods Implementing Attributes
     public int getIndex(String qName);
     public int getIndex(String uri, String localName);
     public int getLength( );                          default:0
     public String getLocalName(int index);
     public String getQName(int index);
     public String getType(String qName);
```

```
    public String getType(int index);
    public String getType(String uri, String localName);
    public String getURI(int index);
    public String getValue(int index);
    public String getValue(String qName);
    public String getValue(String uri, String localName);
}
```

Subclasses

org.xml.sax.ext.Attributes2Impl

Team LiB

DefaultHandler org.xml.sax.helpers

Java 1.4

This helper class implements the four commonly-used SAX handler interfaces from the `org.xml.sax` pacl and defines stub implementations for all of their methods. It is usually easier to subclass `DefaultHandle` and override the desired methods than it is to implement all of the interfaces (and all of their methods) scratch. `DefaultHandler` implements `ContentHandler` , `ErrorHandler` , `EntityResolver` and `DTDHand` so you can pass an instance of this class, (or of a subclass you define) to the `setContentHandler( )` , `setErrorHandler( )` , `setEntityResolver( )` , and `setDTDHandler( )` methods of an `XMLReader` . Yo can also pass an instance of a `DefaultHandler` subclass directly to one of the `parse( )` methods of a `javax.xml.parsers.SAXParser` . The `SAXParser` will take care of calling the four relevant methods of it internal `XMLReader` .

All but two of the methods of `DefaultHandler` have empty bodies and do nothing. The exceptions are `resolveEntity( )` which simply returns `null` to tell the parser to resolve the entity itself, and `fatalErr )` which throws the `SAXParseException` object that is passed to it.

Figure 22-15. org.xml.sax.helpers.DefaultHandler

```
public class DefaultHandler implements org.xml.sax.ContentHandler,
        org.xml.sax.DTDHandler, org.xml.sax.EntityResolver,
        org.xml.sax.ErrorHandler {
// Public Constructors
     public DefaultHandler( );
// Methods Implementing ContentHandler
     public void characters(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;     empty
     public void endDocument( ) throws org.xml.sax.SAXException;          empty
     public void endElement(String uri, String localName, String qName)
        throws org.xml.sax.SAXException;     empty
     public void endPrefixMapping(String prefix) throws org.xml.sax.SAXException;     e
     public void ignorableWhitespace(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;     empty
     public void processingInstruction(String target, String data)
        throws org.xml.sax.SAXException;     empty
     public void setDocumentLocator(org.xml.sax.Locator locator);       empty
     public void skippedEntity(String name) throws org.xml.sax.SAXException;     empty
     public void startDocument( ) throws org.xml.sax.SAXException;        empty
```

```
     public void startElement(String uri, String localName, String qName,
        org.xml.sax.Attributes attributes)
        throws org.xml.sax.SAXException;     empty
     public void startPrefixMapping(String prefix, String uri)
        throws org.xml.sax.SAXException;     empty
// Methods Implementing DTDHandler
     public void notationDecl(String name, String publicId, String systemId)
        throws org.xml.sax.SAXException;     empty
     public void unparsedEntityDecl(String name, String publicId, String systemId,
        String notationName)
        throws org.xml.sax.SAXException;     empty
// Methods Implementing EntityResolver
     public org.xml.sax.InputSource resolveEntity(String publicId, String systemId)
throws java.io.IOException, org.xml.sax.SAXException;     constant
// Methods Implementing ErrorHandler
     public void error(org.xml.sax.SAXParseException e)
        throws org.xml.sax.SAXException;     empty
     public void fatalError(org.xml.sax.SAXParseException e)
        throws org.xml.sax.SAXException;
     public void warning(org.xml.sax.SAXParseException e)
        throws org.xml.sax.SAXException;     empty
}
```

Subclasses

`org.xml.sax.ext.DefaultHandler2`

Passed To

`javax.xml.parsers.SAXParser.parse( )`

LocatorImpl org.xml.sax.helpers

Java 1.4

This helper class is a very simple implementation of the Locator interface. It defines a copy constructor that create a new LocatorImpl object that copies the state of a specified Locator object. This constructor is useful because it allows applications to copy the state of a Locator and save it for later use.

Figure 22-16. org.xml.sax.helpers.LocatorImpl


```
public class LocatorImpl implements org.xml.sax.Locator {
// Public Constructors
     public LocatorImpl( );
     public LocatorImpl(org.xml.sax.Locator locator);
// Public Instance Methods
     public void setColumnNumber(int columnNumber);
     public void setLineNumber(int lineNumber);
     public void setPublicId(String publicId);
     public void setSystemId(String systemId);
// Methods Implementing Locator
     public int getColumnNumber( );                                    default:0
     public int getLineNumber( );                                      default:0
     public String getPublicId( );                                     default:null
     public String getSystemId( );                                     default:null
}
```

Subclasses

org.xml.sax.ext.Locator2Impl

NamespaceSupport org.xml.sax.helpers

Java 1.4

This utility class exists to help SAX parser implementors handle XML namespaces. It is not commonly us applications.

```
public class NamespaceSupport {
// Public Constructors
     public NamespaceSupport( );
// Public Constants
5.0  public static final String NSDECL;  ="http://www.w3.org/xmlns/2000/"
     public static final String XMLNS;                   ="http://www.w3.org/XML/1998/na
// Public Instance Methods
     public boolean declarePrefix(String prefix, String uri);
     public java.util.Enumeration getDeclaredPrefixes( );
     public String getPrefix(String uri);
     public java.util.Enumeration getPrefixes( );
     public java.util.Enumeration getPrefixes(String uri);
     public String getURI(String prefix);
5.0  public boolean isNamespaceDeclUris( );                          default:false
     public void popContext( );
     public String[ ] processName(String qName, String[ ] parts, boolean isAttribute);
     public void pushContext( );
     public void reset( );
5.0  public void setNamespaceDeclUris(boolean value);
}
```

Team LiB

ParserAdapter org.xml.sax.helpers

Java 1.4

This adapter class behaves like a SAX2 XMLReader object, but gets its input from the SAX1 Parser objec passed to the constructor. In order to make this work, it implements the deprecated SAX1DocumentHanc interface so that it can receive events from the Parser . ParserAdapter provides its own layer of names processing to convert a namespace-unaware Parser into a namespace-aware XMLReader . This class is u working you are working with a legacy API that supplies a SAX1Parser object, but want to work with th using the SAX2 XMLReader API: to use it, simply pass the Parser object to the ParserAdapter( ) const use the resulting object as you would use any other XMLReader object.

There is not perfect congruence between the SAX1 and SAX2 APIs, and a Parser cannot be perfectly ada XMLReader . In particular, a ParserAdapter will never call the skippedEntity( ) handler method becau SAX1 Parser API does not provide notification of skipped entities. Also, it does not attempt to determine two namespace-prefixed attributes of an element actually resolve to the same attribute.

See also XMLReaderAdapter , an adapter that works in the reverse direction to make a SAX2 parser beh SAX1 parser.

Figure 22-17. org.xml.sax.helpers.ParserAdapter

```
public class ParserAdapter implements org.xml.sax.DocumentHandler,
        org.xml.sax.XMLReader {
// Public Constructors
     public ParserAdapter( ) throws org.xml.sax.SAXException;
     public ParserAdapter(org.xml.sax.Parser parser);
// Methods Implementing DocumentHandler
     public void characters(char[ ] ch, int start, int length) throws org.xml.sax.SAXEx
     public void endDocument( )
        throws org.xml.sax.SAXException;
     public void endElement(String qName) throws org.xml.sax.SAXException;
     public void ignorableWhitespace(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     public void processingInstruction(String target, String data)
        throws org.xml.sax.SAXException;
     public void setDocumentLocator(org.xml.sax.Locator locator);
     public void startDocument( ) throws org.xml.sax.SAXException;
     public void startElement(String qName, org.xml.sax.AttributeList qAtts)
        throws org.xml.sax.SAXException;
```

```
// Methods Implementing XMLReader
     public org.xml.sax.ContentHandler getContentHandler( );
     public org.xml.sax.DTDHandler getDTDHandler( );
     public org.xml.sax.EntityResolver getEntityResolver( );
     public org.xml.sax.ErrorHandler getErrorHandler( );
     public boolean getFeature(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public Object getProperty(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
     public void parse(String systemId) throws java.io.IOException,
        org.xml.sax.SAXException;
     public void parse(org.xml.sax.InputSource input) throws java.io.IOException,
        org.xml.sax.SAXException;
     public void setContentHandler(org.xml.sax.ContentHandler handler);
     public void setDTDHandler(org.xml.sax.DTDHandler handler);
     public void setEntityResolver(org.xml.sax.EntityResolver resolver);
     public void setErrorHandler(org.xml.sax.ErrorHandler handler);
     public void setFeature(String name, boolean value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
     public void setProperty(String name, Object value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
}
```

Team LiB

ParserFactory org.xml.sax.helpers

Java 1.4; Deprecated in 1.4

This deprecated SAX1 class is a factory for deprecated SAX1 `Parser` objects. New applications should use the SAX2 `XMLReaderFactory` as a factory for SAX2 `XMLReader` objects.

```
public class ParserFactory {
// No Constructor
// Public Class Methods
     public static org.xml.sax.Parser makeParser( )
        throws ClassNotFoundException, IllegalAccessException,
        InstantiationException,
NullPointerException, ClassCastException;
     public static org.xml.sax.Parser makeParser(String className)
        throws ClassNotFoundException, IllegalAccessException,
        InstantiationException, ClassCastException;
}
```

XMLFilterImpl org.xml.sax.helpers

Java 1.4

This class is implements an XMLFilter that does no filtering. You can subclass it to override whatever methods are required to perform the type of filtering you desire.

XMLFilterImpl implements ContentHandler , ErrorHandler , EntityResolver , and DTDHandler so th can receive SAX events from the "parent" XMLReader object. But it also implements the XMLFilter inter which is an extension of XMLReader , so that it acts as an XMLReader itself, and can send SAX events to handler objects that are registered on it. Each of the handler methods of this class simply invoke the corresponding method of the corresponding handler that was registered on the filter. The XMLReader me for getting and setting features and properties simply invoke the corresponding method of the parent XMLReader object. The parse( ) methods do the same thing: they pass their argument to the correspo parse( ) method of the parent reader to start the parsing process.

Figure 22-18. org.xml.sax.helpers.XMLFilterImpl

```
public class XMLFilterImpl
implements org.xml.sax.ContentHandler, org.xml.sax.DTDHandler,
        org.xml.sax.EntityResolver, org.xml.sax.ErrorHandler, org.xml.sax.XMLFilter {
// Public Constructors
     public XMLFilterImpl( );
     public XMLFilterImpl(org.xml.sax.XMLReader parent);
// Methods Implementing ContentHandler
     public void characters(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     public void endDocument( ) throws org.xml.sax.SAXException;
     public void endElement(String uri, String localName, String qName)
        throws org.xml.sax.SAXException;
     public void endPrefixMapping(String prefix) throws org.xml.sax.SAXException;
     public void ignorableWhitespace(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     public void processingInstruction(String target, String data)
        throws org.xml.sax.SAXException;
     public void setDocumentLocator(org.xml.sax.Locator locator);
     public void skippedEntity(String name) throws org.xml.sax.SAXException;
     public void startDocument( ) throws org.xml.sax.SAXException;
     public void startElement(String uri, String localName, String qName,
        org.xml.sax.Attributes atts) throws org.xml.sax.SAXException;
```

```
    public void startPrefixMapping(String prefix, String uri)
        throws org.xml.sax.SAXException;
// Methods Implementing DTDHandler
    public void notationDecl(String name, String publicId, String systemId)
        throws org.xml.sax.SAXException;
    public void unparsedEntityDecl(String name, String publicId, String systemId,
        String notationName) throws org.xml.sax.SAXException;
// Methods Implementing EntityResolver
    public org.xml.sax.InputSource resolveEntity(String publicId, String systemId)
        throws org.xml.sax.SAXException, java.io.IOException;
// Methods Implementing ErrorHandler
    public void error(org.xml.sax.SAXParseException e)
       throws org.xml.sax.SAXException;
    public void fatalError(org.xml.sax.SAXParseException e)
        throws org.xml.sax.SAXException;
    public void warning(org.xml.sax.SAXParseException e) throws org.xml.sax.SAXExcepti
// Methods Implementing XMLFilter
    public org.xml.sax.XMLReader getParent( );                          default:null
    public void setParent(org.xml.sax.XMLReader parent);
// Methods Implementing XMLReader
    public org.xml.sax.ContentHandler getContentHandler( );             default:null
    public org.xml.sax.DTDHandler getDTDHandler( );                     default:null
    public org.xml.sax.EntityResolver getEntityResolver( );             default:null
    public org.xml.sax.ErrorHandler getErrorHandler( );                 default:null
    public boolean getFeature(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
    public Object getProperty(String name)
        throws org.xml.sax.SAXNotRecognizedException,
        org.xml.sax.SAXNotSupportedException;
    public void parse(String systemId) throws org.xml.sax.SAXException,
        java.io.IOException;
    public void parse(org.xml.sax.InputSource input) throws org.xml.sax.SAXException,
        java.io.IOException;
    public void setContentHandler(org.xml.sax.ContentHandler handler);
    public void setDTDHandler(org.xml.sax.DTDHandler handler);
    public void setEntityResolver(org.xml.sax.EntityResolver resolver);
    public void setErrorHandler(org.xml.sax.ErrorHandler handler);
    public void setFeature(String name, boolean value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
    public void setProperty(String name, Object value)
throws org.xml.sax.SAXNotRecognizedException, org.xml.sax.SAXNotSupportedException;
}
```

Team LiB

XMLReaderAdapter org.xml.sax.helpers

Java 1.4

This adapter class wraps a SAX2 XMLReader object and makes it behave like a SAX1 Parser object. It is when working with a legacy API that requires a deprecated Parser object. Create an XMLReaderAdapter passing an XMLReader to the XMLReaderAdapter( ) constructor. Then use the resulting object exactly a would use any other SAX1 Parser object. This class implements ContentHandler so that it can receive S events from the XMLReader . But it also implements the Parser interface so that it can have a SAX1 DocumentHandler registered on it. The methods of ContentHandler are implemented to invoke the corr methods of the registered DocumentHandler .

Figure 22-19. org.xml.sax.helpers.XMLReaderAdapter

```
public class XMLReaderAdapter implements org.xml.sax.ContentHandler, org.xml.sax.Parser
// Public Constructors
     public XMLReaderAdapter( ) throws org.xml.sax.SAXException;
     public XMLReaderAdapter(org.xml.sax.XMLReader xmlReader);
// Methods Implementing ContentHandler
     public void characters(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     public void endDocument( ) throws org.xml.sax.SAXException;
     public void endElement(String uri, String localName, String qName)
        throws org.xml.sax.SAXException;
     public void endPrefixMapping(String prefix);           empty
     public void ignorableWhitespace(char[ ] ch, int start, int length)
        throws org.xml.sax.SAXException;
     public void processingInstruction(String target, String data)
        throws org.xml.sax.SAXException;
     public void setDocumentLocator(org.xml.sax.Locator locator);
     public void skippedEntity(String name) throws org.xml.sax.SAXException;     empty
     public void startDocument( ) throws org.xml.sax.SAXException;
     public void startElement(String uri, String localName, String qName,
        org.xml.sax.Attributes atts)
        throws org.xml.sax.SAXException;
     public void startPrefixMapping(String prefix, String uri);         empty
// Methods Implementing Parser
     public void parse(String systemId) throws java.io.IOException, org.xml.sax.SAXExce
     public void parse(org.xml.sax.InputSource input) throws java.io.IOException,
```

```
            org.xml.sax.SAXException;
        public void setDocumentHandler(org.xml.sax.DocumentHandler handler);
        public void setDTDHandler(org.xml.sax.DTDHandler handler);
        public void setEntityResolver(org.xml.sax.EntityResolver resolver);
        public void setErrorHandler(org.xml.sax.ErrorHandler handler);
        public void setLocale(java.util.Locale locale) throws org.xml.sax.SAXException;
}
```

XMLReaderFactory org.xml.sax.helpers

Java 1.4

This factory class defines two static factory methods for creating `XMLReader` objects. One method takes the name of a class as its argument. It dynamically loads and instantiates the class, then casts it to an `XMLReader` object. The second factory method takes no arguments; it reads the system property named "*org.xml.sax.driver*" and uses the value of that property as the name of the class `XMLReader` implementation class to load and instantiate. An application that instantiates its SAX parser using the no-argument method of `XMLReaderFactory` gains a layer of independence from the underlying parser implementation. The end user or system administrator of the system on which the application is deployed can change the parser implementation simply by setting a system property. Note that the `javax.xml.parsers` package provides a similar, but somewhat more useful `SAXParserFactory`.

```
public final class XMLReaderFactory {
// No Constructor
// Public Class Methods
     public static org.xml.sax.XMLReader createXMLReader( )
        throws org.xml.sax.SAXException;
     public static org.xml.sax.XMLReader createXMLReader(String className)
        throws org.xml.sax.SAXException;
}
```

Team LiB

Chapter 23. Class, Method, and Field Index

Section 23.1. A

Section 23.2. B

Section 23.3. C

Section 23.4. D

Section 23.5. E

Section 23.6. F

Section 23.7. G

Section 23.8. H

Section 23.9. I

Section 23.10. J

Section 23.11. K

Section 23.12. L

Section 23.13. M

Section 23.14. N

Section 23.15. O

Section 23.16. P

Section 23.17. Q

Section 23.18. R

Section 23.19. S

Section 23.20. T

Section 23.21. U

Section 23.22. V

Section 23.23. W

Section 23.24. X

Section 23.25. Y

Section 23.26. Z

23.1. A

abort( ):

CacheRequest, LoginModule

AbortPolicy:

java.util.concurrent.ThreadPoolExecutor

abs( ):

BigDecimal, BigInteger, Math, StrictMath

absolutePath( ):

AbstractPreferences, Preferences

ABSTRACT:

Modifier

AbstractCollection:

java.util

AbstractExecutorService:

java.util.concurrent

AbstractInterruptibleChannel:

java.nio.channels.spi

AbstractList:

java.util

AbstractMap:

java.util

AbstractMethodError:

java.lang

AbstractPreferences:

java.util.prefs

AbstractQueue:

java.util

AbstractQueuedSynchronizer:

java.util.concurrent.locks

AbstractQueuedSynchronizer.ConditionObject:

java.util.concurrent.locks

AbstractSelectableChannel:

java.nio.channels.spi

AbstractSelectionKey:

java.nio.channels.spi

AbstractSelector:

java.nio.channels.spi

AbstractSequentialList:

java.util

AbstractSet:

java.util

accept( ):

FileFilter, FilenameFilter, ServerSocket, ServerSocketChannel, SocketImpl

AccessControlContext:

java.security

AccessControlException:

java.security

AccessController:

java.security

AccessibleObject:

java.lang.reflect

AccountException:

javax.security.auth.login

AccountExpiredException:

javax.security.auth.login

AccountLockedException:

javax.security.auth.login

AccountNotFoundException:

javax.security.auth.login

acos( ):

Math, StrictMath

acquire( ):

AbstractQueuedSynchronizer, Semaphore

acquireInterruptibly( ):

AbstractQueuedSynchronizer

acquireShared( ):

AbstractQueuedSynchronizer

acquireSharedInterruptibly( ):

AbstractQueuedSynchronizer

acquireUninterruptibly( ):

Semaphore

activeCount( ):

Thread, ThreadGroup

activeGroupCount( ):

ThreadGroup

AD:

GregorianCalendar

add( ):

AbstractCollection, AbstractList, AbstractQueue, AbstractSequentialList, ArrayList, BigDecimal, BigInteger, BlockingQueue, Calendar, Collection, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, DelayQueue, Duration, GregorianCalendar, HashSet, LinkedList, List, ListIterator, PermissionCollection, Permissions, PriorityBlockingQueue, PriorityQueue, Set, TreeSet, Vector, XMLGregorianCalendar

addAll( ):

AbstractCollection, AbstractList, AbstractQueue, AbstractSequentialList, ArrayList, Collection, Collections, CopyOnWriteArrayList, CopyOnWriteArraySet, LinkedList, List, Set, TreeSet, Vecto

addAllAbsent( ):

CopyOnWriteArrayList

addAndGet( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

addAttribute( ):

AttributedString, AttributeListImpl, Attributes2Impl, AttributesImpl

addAttributes( ):

AttributedString

addCertificate( ):

Identity

addCertPathChecker( ):

PKIXParameters

addCertStore( ):

PKIXParameters

addElement( ):

Vector

addFirst( ):

LinkedList

addHandler( ):

Logger

addHandshakeCompletedListener( ):

SSLSocket

addIdentity( ):

IdentityScope

addIfAbsent( ):

CopyOnWriteArrayList

addIssuer( ):

X509CRLSelector

addIssuerName( ):

X509CRLSelector

addLast( ):

LinkedList

addLogger( ):

LogManager

addNodeChangeListener( ):

AbstractPreferences, Preferences

addObserver( ):

Observable

addPathToName( ):

X509CertSelector

addPreferenceChangeListener( ):

AbstractPreferences, Preferences

addPropertyChangeListener( ):

LogManager, Packer, Unpacker

addProvider( ):

Security

addRequestProperty( ):

URLConnection

address:

SocketImpl

address( ):

Proxy

addShutdownHook( ):

Runtime

addSubjectAlternativeName( ):

X509CertSelector

addTo( ):

Duration

addTransformer( ):

Instrumentation

addURL( ):

URLClassLoader

Adler32:

java.util.zip

adoptNode( ):

Document

AEGEAN_NUMBERS:

UnicodeBlock

after( ):

Calendar, Date

afterExecute( ):

ThreadPoolExecutor

AlgorithmParameterGenerator:

java.security

AlgorithmParameterGeneratorSpi:

java.security

AlgorithmParameters:

java.security

AlgorithmParameterSpec:

java.security.spec

AlgorithmParametersSpi:

java.security

aliases( ):

Charset, KeyStore

ALL:

Level

allocate( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

allocateDirect( ):

ByteBuffer

allOf( ):

EnumSet

allowMultipleSelections( ):

ChoiceCallback

allowThreadSuspension( ):

ThreadGroup

allowUserInteraction:

URLConnection

AllPermission:

java.security

ALPHABETIC_PRESENTATION_FORMS:

UnicodeBlock

AlreadyConnectedException:

java.nio.channels

ALTERNATE:

FormattableFlags

AM:

Calendar

AM_PM:

Calendar, Field

AM_PM_FIELD:

DateFormat

and( ):

BigInteger, BitSet

andNot( ):

BigInteger, BitSet

annotateClass( ):

ObjectOutputStream

AnnotatedElement:

java.lang.reflect

annotateProxyClass( ):

ObjectOutputStream

Annotation:

java.lang.annotation, java.text

ANNOTATION_TYPE:

ElementType

AnnotationFormatError:

java.lang.annotation

annotationType( ):

Annotation, IncompleteAnnotationException

AnnotationTypeMismatchException:

java.lang.annotation

AppConfigurationEntry:

javax.security.auth.login

AppConfigurationEntry.LoginModuleControlFlag:

javax.security.auth.login

append( ):

Appendable, CharArrayWriter, CharBuffer, PrintStream, PrintWriter, StringBuffer, StringBuilder StringWriter, Writer

Appendable:

java.lang

appendChild( ):

Node

appendCodePoint( ):

StringBuffer, StringBuilder

appendData( ):

CharacterData

appendReplacement( ):

Matcher

appendTail( ):

Matcher

applyLocalizedPattern( ):

DecimalFormat, SimpleDateFormat

applyPattern( ):

ChoiceFormat, DecimalFormat, MessageFormat, SimpleDateFormat

appRandom:

SignatureSpi

APRIL:

Calendar, DatatypeConstants

ARABIC:

UnicodeBlock

ARABIC_PRESENTATION_FORMS_A:

UnicodeBlock

ARABIC_PRESENTATION_FORMS_B:

UnicodeBlock

areFieldsSet:

Calendar

ARGUMENT:

Field

ArithmeticException:

java.lang

ARMENIAN:

UnicodeBlock

Array:

java.lang.reflect

array( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

ArrayBlockingQueue:

java.util.concurrent

arraycopy( ):

System

ArrayIndexOutOfBoundsException:

java.lang

ArrayList:

java.util

arrayOffset( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

Arrays:

java.util

ArrayStoreException:

java.lang

ARROWS:

UnicodeBlock

asCharBuffer( ):

ByteBuffer

asDoubleBuffer( ):

ByteBuffer

asFloatBuffer( ):

ByteBuffer

asin( ):

Math, StrictMath

asIntBuffer( ):

ByteBuffer

asList( ):

Arrays

asLongBuffer( ):

ByteBuffer

asReadOnlyBuffer( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

AssertionError:

java.lang

asShortBuffer( ):

ByteBuffer

asSubclass( ):

Class

AsynchronousCloseException:

java.nio.channels

atan( ):

Math, StrictMath

atan2( ):

Math, StrictMath

AtomicBoolean:

java.util.concurrent.atomic

AtomicInteger:

java.util.concurrent.atomic

AtomicIntegerArray:

java.util.concurrent.atomic

AtomicIntegerFieldUpdater:

java.util.concurrent.atomic

AtomicLong:

java.util.concurrent.atomic

AtomicLongArray:

java.util.concurrent.atomic

AtomicLongFieldUpdater:

java.util.concurrent.atomic

AtomicMarkableReference:

java.util.concurrent.atomic

AtomicReference:

java.util.concurrent.atomic

AtomicReferenceArray:

java.util.concurrent.atomic

AtomicReferenceFieldUpdater:

java.util.concurrent.atomic

AtomicStampedReference:

java.util.concurrent.atomic

attach( ):

SelectionKey

attachment( ):

SelectionKey

attemptMark( ):

AtomicMarkableReference

attemptStamp( ):

AtomicStampedReference

Attr:

org.w3c.dom

Attribute:

java.text.AttributedCharacterIterator

ATTRIBUTE_NODE:

Node

AttributedCharacterIterator:

java.text

AttributedCharacterIterator.Attribute:

java.text

attributeDecl( ):

DeclHandler, DefaultHandler2

AttributedString:

java.text

AttributeList:

org.xml.sax

AttributeListImpl:

org.xml.sax.helpers

Attributes:

java.util.jar, org.xml.sax

Attributes.Name:

java.util.jar

Attributes2:

org.xml.sax.ext

Attributes2Impl:

org.xml.sax.ext

AttributesImpl:

org.xml.sax.helpers

AUGUST:

Calendar, DatatypeConstants

Authenticator:

java.net

Authenticator.RequestorType:

java.net

AuthPermission:

javax.security.auth

AuthProvider:

java.security

available( ):

BufferedInputStream, ByteArrayInputStream, CipherInputStream, FileInputStream, FilterInputStream, InflaterInputStream, InputStream, LineNumberInputStream, ObjectInput, ObjectInputStream, PipedInputStream, PushbackInputStream, SequenceInputStream, SocketImpl, StringBufferInputStream, ZipInputStream

availableCharsets( ):

Charset

availablePermits( ):

Semaphore

availableProcessors( ):

Runtime

averageBytesPerChar( ):

CharsetEncoder

averageCharsPerByte( ):

CharsetDecoder

await( ):

Condition, ConditionObject, CountDownLatch, CyclicBarrier

awaitNanos( ):

Condition, ConditionObject

awaitTermination( ):

ExecutorService, ThreadPoolExecutor

awaitUninterruptibly( ):

Condition, ConditionObject

awaitUntil( ):

Condition, ConditionObject

Team LiB

23.2. B

BackingStoreException:

java.util.prefs

BadPaddingException:

javax.crypto

baseIsLeftToRight( ):

Bidi

baseWireHandle:

ObjectStreamConstants

BASIC_LATIN:

UnicodeBlock

BasicPermission:

java.security

BC:

GregorianCalendar

before( ):

Calendar, Date

beforeExecute( ):

ThreadPoolExecutor

begin( ):

AbstractInterruptibleChannel, AbstractSelector

beginHandshake( ):

SSLEngine

BENGALI:

UnicodeBlock

BEST_COMPRESSION:

Deflater

BEST_SPEED:

Deflater

Bidi:

java.text

BIG_ENDIAN:

ByteOrder

BigDecimal:

java.math

BigDecimalLayoutForm:

java.util.Formatter

BigInteger:

java.math

binarySearch( ):

Arrays, Collections

bind( ):

DatagramSocket, DatagramSocketImpl, ServerSocket, Socket, SocketImpl

BindException:

java.net

bitCount( ):

BigInteger, Integer, Long

bitLength( ):

BigInteger

BitSet:

java.util

BLOCK_ELEMENTS:

UnicodeBlock

downloaded from: lib.ommolketab.ir

BLOCKED:

State

blockingLock( ):

AbstractSelectableChannel, SelectableChannel

BlockingQueue:

java.util.concurrent

BOOLEAN:

XPathConstants

Boolean:

java.lang

booleanValue( ):

Boolean

BOPOMOFO:

UnicodeBlock

BOPOMOFO_EXTENDED:

UnicodeBlock

BOX_DRAWING:

UnicodeBlock

BRAILLE_PATTERNS:

UnicodeBlock

BreakIterator:

java.text

BrokenBarrierException:

java.util.concurrent

buf:

BufferedInputStream, BufferedOutputStream, ByteArrayInputStream, ByteArrayOutputStream, CharArrayReader, CharArrayWriter, DeflaterOutputStream, InflaterInputStream, PushbackInputStream

Buffer:

java.nio

buffer:

PipedInputStream, StringBufferInputStream

BUFFER_OVERFLOW:

Status

BUFFER_UNDERFLOW:

Status

BufferedInputStream:

java.io

BufferedOutputStream:

java.io

BufferedReader:

java.io

BufferedWriter:

java.io

BufferOverflowException:

java.nio

BufferUnderflowException:

java.nio

BUHID:

UnicodeBlock

build( ):

CertPathBuilder

Builder:

java.security.KeyStore

Byte:

java.lang

ByteArrayInputStream:

java.io

ByteArrayOutputStream:

java.io

ByteBuffer:

java.nio

ByteChannel:

java.nio.channels

ByteOrder:

java.nio

bytesConsumed( ):

SSLEngineResult

bytesProduced( ):

SSLEngineResult

bytesTransferred:

InterruptedIOException

byteValue( ):

Byte, Double, Float, Integer, Long, Number, Short

byteValueExact( ):

BigDecimal

BYZANTINE_MUSICAL_SYMBOLS:

UnicodeBlock

Team LiB

Team LiB

23.3. C

cachedChildren( ):

AbstractPreferences

CacheRequest:

java.net

CacheResponse:

java.net

Calendar:

java.util

calendar:

DateFormat

call( ):

Callable

Callable:

java.util.concurrent

callable( ):

Executors

Callback:

javax.security.auth.callback

CallbackHandler:

javax.security.auth.callback

CallbackHandlerProtection:

java.security.KeyStore

CallerRunsPolicy:

java.util.concurrent.ThreadPoolExecutor

CANADA:

Locale

CANADA_FRENCH:

Locale

CANCEL:

ConfirmationCallback

cancel( ):

AbstractSelectionKey, Future, FutureTask, SelectionKey, Timer, TimerTask

CancellationException:

java.util.concurrent

CancelledKeyException:

java.nio.channels

cancelledKeys( ):

AbstractSelector

canEncode( ):

Charset, CharsetEncoder

CANON_EQ:

Pattern

CANONICAL:

X500Principal

CANONICAL_DECOMPOSITION:

Collator

canRead( ):

File

canSetParameter( ):

DOMConfiguration

canWrite( ):

File

capacity( ):

Buffer, StringBuffer, Vector

capacityIncrement:

Vector

cardinality( ):

BitSet

CASE_INSENSITIVE:

Pattern

CASE_INSENSITIVE_ORDER:

String

cast( ):

Class

cbrt( ):

Math, StrictMath

CDATA_SECTION_ELEMENTS:

OutputKeys

CDATA_SECTION_NODE:

Node

CDATASection:

org.w3c.dom

ceil( ):

Math, StrictMath

CEILING:

RoundingMode

Certificate:

java.security, java.security.cert

Certificate.CertificateRep:

java.security.cert

CertificateEncodingException:

java.security.cert

CertificateException:

java.security.cert

CertificateExpiredException:

java.security.cert

CertificateFactory:

java.security.cert

CertificateFactorySpi:

java.security.cert

CertificateNotYetValidException:

java.security.cert

CertificateParsingException:

java.security.cert

CertificateRep:

java.security.cert.Certificate

certificates( ):

Identity

CertPath:

java.security.cert

CertPath.CertPathRep:

java.security.cert

CertPathBuilder:

java.security.cert

CertPathBuilderException:

java.security.cert

CertPathBuilderResult:

java.security.cert

CertPathBuilderSpi:

java.security.cert

CertPathParameters:

java.security.cert

CertPathRep:

java.security.cert.CertPath

CertPathTrustManagerParameters:

javax.net.ssl

CertPathValidator:

java.security.cert

CertPathValidatorException:

java.security.cert

CertPathValidatorResult:

java.security.cert

CertPathValidatorSpi:

java.security.cert

CertSelector:

java.security.cert

CertStore:

java.security.cert

CertStoreException:

java.security.cert

CertStoreParameters:

java.security.cert

CertStoreSpi:

java.security.cert

Channel:

java.nio.channels

channel( ):

FileLock, SelectionKey

Channels:

java.nio.channels

Character:

java.lang

Character.Subset:

java.lang

Character.UnicodeBlock:

java.lang

CharacterCodingException:

java.nio.charset

CharacterData:

org.w3c.dom

CharacterIterator:

java.text

characters( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

CharArrayReader:

java.io

CharArrayWriter:

java.io

charAt( ):

CharBuffer, CharSequence, String, StringBuffer

CharBuffer:

java.nio

CharConversionException:

java.io

charCount( ):

Character

CharSequence:

java.lang

Charset:

java.nio.charset

charset( ):

CharsetDecoder, CharsetEncoder

CharsetDecoder:

java.nio.charset

CharsetEncoder:

java.nio.charset

charsetForName( ):

CharsetProvider

CharsetProvider:

java.nio.charset.spi

charsets( ):

CharsetProvider

charValue( ):

Character

check( ):

PKIXCertPathChecker

checkAccept( ):

SecurityManager

checkAccess( ):

LogManager, SecurityManager, Thread, ThreadGroup

checkAwtEventQueueAccess( ):

SecurityManager

checkClientTrusted( ):

X509TrustManager

checkConnect( ):

SecurityManager

checkCreateClassLoader( ):

SecurityManager

checkDelete( ):

SecurityManager

checkedCollection( ):

Collections

CheckedInputStream:

java.util.zip

checkedList( ):

Collections

checkedMap( ):

Collections

CheckedOutputStream:

java.util.zip

checkedSet( ):

Collections

checkedSortedMap( ):

Collections

checkedSortedSet( ):

Collections

checkError( ):

PrintStream, PrintWriter

checkExec( ):

SecurityManager

checkExit( ):

SecurityManager

checkGuard( ):

Guard, Permission

checkLink( ):

SecurityManager

checkListen( ):

SecurityManager

checkMemberAccess( ):

SecurityManager

checkMulticast( ):

SecurityManager

checkPackageAccess( ):

SecurityManager

checkPackageDefinition( ):

SecurityManager

checkPermission( ):

AccessControlContext, AccessController, SecurityManager *checkPrintJobAccess( ):*

SecurityManager

checkPropertiesAccess( ):

SecurityManager

checkPropertyAccess( ):

SecurityManager

checkRead( ):

SecurityManager

checkSecurityAccess( ):

SecurityManager

checkServerTrusted( ):

X509TrustManager

checkSetFactory( ):

SecurityManager

Checksum:

java.util.zip

checkSystemClipboardAccess( ):

SecurityManager

checkTopLevelWindow( ):

SecurityManager

checkValidity( ):

X509Certificate

checkWrite( ):

SecurityManager

CHEROKEE:

UnicodeBlock

childAdded( ):

NodeChangeListener

childRemoved( ):

NodeChangeListener

childrenNames( ):

AbstractPreferences, Preferences

childrenNamesSpi( ):

AbstractPreferences

childSpi( ):

AbstractPreferences

childValue( ):

InheritableThreadLocal

CHINA:

Locale

CHINESE:

Locale

ChoiceCallback:

javax.security.auth.callback

ChoiceFormat:

java.text

chooseClientAlias( ):

X509KeyManager

chooseEngineClientAlias( ):

X509ExtendedKeyManager

chooseEngineServerAlias( ):

X509ExtendedKeyManager

chooseServerAlias( ):

X509KeyManager

chunkLength:

HttpURLConnection

Cipher:

javax.crypto

CipherInputStream:

javax.crypto

CipherOutputStream:

javax.crypto

CipherSpi:

javax.crypto

CJK_COMPATIBILITY:

UnicodeBlock

CJK_COMPATIBILITY_FORMS:

UnicodeBlock

CJK_COMPATIBILITY_IDEOGRAPHS:

UnicodeBlock

CJK_COMPATIBILITY_IDEOGRAPHS_SUPPLEMENT:

UnicodeBlock

CJK_RADICALS_SUPPLEMENT:

UnicodeBlock

CJK_SYMBOLS_AND_PUNCTUATION:

UnicodeBlock

CJK_UNIFIED_IDEOGRAPHS:

UnicodeBlock

CJK_UNIFIED_IDEOGRAPHS_EXTENSION_A:

UnicodeBlock

CJK_UNIFIED_IDEOGRAPHS_EXTENSION_B:

UnicodeBlock

Class:

java.lang

CLASS:

RetentionPolicy

CLASS_ATTRIBUTE_PFX:

Packer

CLASS_LOADING_MXBEAN_NAME:

ManagementFactory

CLASS_PATH:

Name

ClassCastException:

java.lang

ClassCircularityError:

java.lang

ClassDefinition:

java.lang.instrument

classDepth( ):

SecurityManager

ClassFileTransformer:

java.lang.instrument

ClassFormatError:

java.lang

ClassLoader:

java.lang

classLoaderDepth( ):

SecurityManager

ClassLoadingMXBean:

java.lang.management

classname:

InvalidClassException

ClassNotFoundException:

java.lang

clear( ):

AbstractCollection, AbstractList, AbstractMap, AbstractPreferences, AbstractQueue, ArrayBlockingQueue, ArrayList, AttributeListImpl, Attributes, AttributesImpl, BitSet, Buffer, Calendar, Collection, ConcurrentHashMap, CopyOnWriteArrayList, CopyOnWriteArraySet, DelayQueue, EnumMap, HashMap, HashSet, Hashtable, IdentityHashMap, LinkedBlockingQueue, LinkedHashMap, LinkedList, List, Manifest, Map, Preferences, PriorityBlockingQueue, PriorityQueue, Provider, Reference, Set, SynchronousQueue, TreeMap, TreeSet, Vector, WeakHashMap, XMLGregorianCalendar

clearAssertionStatus( ):

ClassLoader

clearBit( ):

BigInteger

clearChanged( ):

Observable

clearParameters( ):

Transformer

clearPassword( ):

PasswordCallback, PBEKeySpec

clearProperty( ):

System

clockSequence( ):

UUID

clone( ):

AbstractMap, ArrayList, Attributes, BitSet, BreakIterator, Calendar, CertPathBuilderResult, CertPathParameters, CertPathValidatorResult, CertSelector, CertStoreParameters, CharacterIterator, ChoiceFormat, Collator, CollectionCertStoreParameters, CopyOnWriteArrayList, CRLSelector, Date, DateFormat, DateFormatSymbols, DecimalFormat, DecimalFormatSymbols, Enum, EnumMap, EnumSet, Format, GregorianCalendar, HashMap, HashSet, Hashtable, IdentityHashMap, LDAPCertStoreParameters, LinkedList, Locale, Mac, MacSpi, Manifest, MessageDigest, MessageDigestSpi, MessageFormat, NumberFormat, Object, PKIXCertPathChecker, PKIXCertPathValidatorResult, PKIXParameters, RuleBasedCollator, Signature, SignatureSpi, SimpleDateFormat, SimpleTimeZone, StringCharacterIterator, TimeZone, TreeMap, TreeSet, Vector, X509CertSelector, X509CRLSelector, XMLGregorianCalendar, ZipEntry

Cloneable:

java.lang

cloneNode( ):

Node

CloneNotSupportedException:

java.lang

close( ):

AbstractInterruptibleChannel, AbstractSelector, BufferedInputStream, BufferedReader, BufferedWriter, ByteArrayInputStream, ByteArrayOutputStream, Channel, CharArrayReader, CharArrayWriter, CipherInputStream, CipherOutputStream, Closeable, ConsoleHandler, DatagramSocket, DatagramSocketImpl, DeflaterOutputStream, FileHandler, FileInputStream, FileOutputStream, FilterInputStream, FilterOutputStream, FilterReader, FilterWriter, Formatter, GZIPInputStream, Handler, InflaterInputStream, InputStream, InputStreamReader, InterruptibleChannel, MemoryHandler, ObjectInput, ObjectInputStream, ObjectOutput, ObjectOutputStream, OutputStream, OutputStreamWriter, PipedInputStream,

PipedOutputStream, PipedReader, PipedWriter, PrintStream, PrintWriter, PushbackInputStream, PushbackReader, RandomAccessFile, Reader, Scanner, Selector, SequenceInputStream, ServerSocket, Socket, SocketHandler, SocketImpl, StreamHandler, StringReader, StringWriter, Writer, ZipFile, ZipInputStream, ZipOutputStream

CLOSE_FAILURE:

ErrorManager

Closeable:

java.io

CLOSED:

Status

ClosedByInterruptException:

java.nio.channels

ClosedChannelException:

java.nio.channels

ClosedSelectorException:

java.nio.channels

closeEntry( ):

ZipInputStream, ZipOutputStream

closeInbound( ):

SSLEngine

closeOutbound( ):

SSLEngine

code:

DOMException

CODE_ATTRIBUTE_PFX:

Packer

codePointAt( ):

Character, String, StringBuffer

codePointBefore( ):

Character, String, StringBuffer

codePointCount( ):

Character, String, StringBuffer

CoderMalfunctionError:

java.nio.charset

CoderResult:

java.nio.charset

CodeSigner:

java.security

CodeSource:

java.security

CodingErrorAction:

java.nio.charset

CollationElementIterator:

java.text

CollationKey:

java.text

Collator:

java.text

Collection:

java.util

CollectionCertStoreParameters:

java.security.cert

Collections:

java.util

combine( ):

DomainCombiner, SubjectDomainCombiner

COMBINING_DIACRITICAL_MARKS:

UnicodeBlock

COMBINING_HALF_MARKS:

UnicodeBlock

COMBINING_MARKS_FOR_SYMBOLS:

UnicodeBlock

COMBINING_SPACING_MARK:

Character

command( ):

Compiler, ProcessBuilder

Comment:

org.w3c.dom

comment( ):

DefaultHandler2, LexicalHandler

COMMENT_NODE:

Node

commentChar( ):

StreamTokenizer

COMMENTS:

Pattern

commit( ):

LoginModule

compact( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

Comparable:

java.lang

Comparator:

java.util

comparator( ):

PriorityBlockingQueue, PriorityQueue, SortedMap, SortedSet, TreeMap, TreeSet

compare( ):

Collator, Comparator, Double, Duration, Float, RuleBasedCollator, XMLGregorianCalendar

compareAndSet( ):

AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater, AtomicMarkableReference, AtomicReference, AtomicReferenceArray, AtomicReferenceFieldUpdater, AtomicStampedReference

compareAndSetState( ):

AbstractQueuedSynchronizer

compareDocumentPosition( ):

Node

compareTo( ):

BigDecimal, BigInteger, Boolean, Byte, ByteBuffer, Calendar, Character, CharBuffer, Charset, CollationKey, Comparable, Date, Double, DoubleBuffer, Enum, File, Float, FloatBuffer, IntBuffer, Integer, Long, LongBuffer, ObjectStreamField, Short, ShortBuffer, String, URI, UUID

compareToIgnoreCase( ):

String

COMPILATION_MXBEAN_NAME:

ManagementFactory

CompilationMXBean:

java.lang.management

compile( ):

Pattern, XPath

compileClass( ):

Compiler

compileClasses( ):

Compiler

Compiler:

java.lang

complementOf( ):

EnumSet

complete( ):

Calendar

CompletionService:

java.util.concurrent

computeFields( ):

Calendar, GregorianCalendar

computeTime( ):

Calendar, GregorianCalendar

concat( ):

String

ConcurrentHashMap:

java.util.concurrent

ConcurrentLinkedQueue:

java.util.concurrent

ConcurrentMap:

java.util.concurrent

ConcurrentModificationException:

java.util

Condition:

java.util.concurrent.locks

ConditionObject:

java.util.concurrent.locks.AbstractQueuedSynchronizer

CONFIG:

Level

config( ):

Logger

Configuration:

javax.security.auth.login

configureBlocking( ):

AbstractSelectableChannel, SelectableChannel

ConfirmationCallback:

javax.security.auth.callback

connect( ):

DatagramChannel, DatagramSocket, DatagramSocketImpl, PipedInputStream, PipedOutputStream, PipedReader, PipedWriter, Socket, SocketChannel, SocketImpl, URLConnection

connected:

URLConnection

ConnectException:

java.net

connectFailed( ):

ProxySelector

ConnectionPendingException:

java.nio.channels

CONNECTOR_PUNCTUATION:

Character

ConsoleHandler:

java.util.logging

constantName( ):

EnumConstantNotPresentException

Constructor:

java.lang.reflect

CONSTRUCTOR:

ElementType

contains( ):

AbstractCollection, ArrayBlockingQueue, ArrayList, Charset, Collection, ConcurrentHashMap, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, DOMStringList, HashSet, Hashtable, LinkedList, List, NameList, PriorityBlockingQueue, Set, String, SynchronousQueue, TreeSet, Vector

containsAlias( ):

KeyStore

containsAll( ):

AbstractCollection, Collection, CopyOnWriteArrayList, CopyOnWriteArraySet, List, Set, SynchronousQueue, Vector

containsKey( ):

AbstractMap, Attributes, ConcurrentHashMap, EnumMap, HashMap, Hashtable, IdentityHashMap, Map, TreeMap, WeakHashMap

containsNS( ):

NameList

containsValue( ):

AbstractMap, Attributes, ConcurrentHashMap, EnumMap, HashMap, Hashtable, IdentityHashMap, LinkedHashMap, Map, TreeMap, WeakHashMap

CONTENT_TYPE:

Name

contentEquals( ):

String

ContentHandler:

java.net, org.xml.sax

ContentHandlerFactory:

java.net

CONTROL:

Character

CONTROL_PICTURES:

UnicodeBlock

convert( ):

TimeUnit

CookieHandler:

java.net

copy( ):

Collections

copyInto( ):

Vector

copyOf( ):

EnumSet

CopyOnWriteArrayList:

java.util.concurrent

CopyOnWriteArraySet:

java.util.concurrent

copyValueOf( ):

String

cos( ):

Math, StrictMath

cosh( ):

Math, StrictMath

count:

BufferedInputStream, BufferedOutputStream, ByteArrayInputStream, ByteArrayOutputStream, CharArrayReader, CharArrayWriter, StringBufferInputStream

countDown( ):

CountDownLatch

CountDownLatch:

java.util.concurrent

countObservers( ):

Observable

countStackFrames( ):

Thread

countTokens( ):

StringTokenizer

crc:

GZIPInputStream, GZIPOutputStream

CRC32:

java.util.zip

create( ):

DatagramSocketImpl, SocketImpl, URI

createAttribute( ):

Document

createAttributeNS( ):

Document

createCDATASection( ):

Document

createComment( ):

Document

createContentHandler( ):

ContentHandlerFactory

createDatagramSocketImpl( ):

DatagramSocketImplFactory

createDocument( ):

DOMImplementation

createDocumentFragment( ):

Document

createDocumentType( ):

DOMImplementation

createElement( ):

Document

createElementNS( ):

Document

createEntityReference( ):

Document

createLineBidi( ):

Bidi

createNewFile( ):

File

createProcessingInstruction( ):

Document

createServerSocket( ):

ServerSocketFactory

createSocket( ):

SocketFactory, SSLSocketFactory

createSocketImpl( ):

SocketImplFactory

createSSLEngine( ):

SSLContext

createTempFile( ):

File

createTextNode( ):

Document

createUnresolved( ):

InetSocketAddress

createURLStreamHandler( ):

URLStreamHandlerFactory

createXMLReader( ):

XMLReaderFactory

createZipEntry( ):

JarInputStream, ZipInputStream

CredentialException:

javax.security.auth.login

CredentialExpiredException:

javax.security.auth.login

CredentialNotFoundException:

javax.security.auth.login

CRL:

java.security.cert

CRLException:

java.security.cert

CRLSelector:

java.security.cert

Currency:

java.util

CURRENCY:

Field

CURRENCY_SYMBOL:

Character

CURRENCY_SYMBOLS:

UnicodeBlock

current( ):

BreakIterator, CharacterIterator, StringCharacterIterator

currentClassLoader( ):

SecurityManager

currentLoadedClass( ):

SecurityManager

currentThread( ):

Thread

currentTimeMillis( ):

System

CyclicBarrier:

java.util.concurrent

CYPRIOT_SYLLABARY:

UnicodeBlock

CYRILLIC:

UnicodeBlock

CYRILLIC_SUPPLEMENTARY:

UnicodeBlock

Team LiB

23.4. D

DASH_PUNCTUATION:

Character

DataFormatException:

java.util.zip

DatagramChannel:

java.nio.channels

DatagramPacket:

java.net

DatagramSocket:

java.net

DatagramSocketImpl:

java.net

DatagramSocketImplFactory:

java.net

DataInput:

java.io

DataInputStream:

java.io

DataOutput:

java.io

DataOutputStream:

java.io

DatatypeConfigurationException:

javax.xml.datatype

DatatypeConstants:

javax.xml.datatype

DatatypeConstants.Field:

javax.xml.datatype

DatatypeFactory:

javax.xml.datatype

DATATYPEFACTORY_IMPLEMENTATION_CLASS:

DatatypeFactory

DATATYPEFACTORY_PROPERTY:

DatatypeFactory

downloaded from: lib.ommolketab.ir

DATE:

Calendar, DatatypeConstants

Date:

java.util

DATE_FIELD:

DateFormat

DateFormat:

java.text

DateFormat.Field:

java.text

DateFormatSymbols:

java.text

DATETIME:

DatatypeConstants

DAY_OF_MONTH:

Calendar, Field

DAY_OF_WEEK:

Calendar, Field

DAY_OF_WEEK_FIELD:

DateFormat

DAY_OF_WEEK_IN_MONTH:

Calendar, Field

DAY_OF_WEEK_IN_MONTH_FIELD:

DateFormat

DAY_OF_YEAR:

Calendar, Field

DAY_OF_YEAR_FIELD:

DateFormat

DAYS:

DatatypeConstants

DECEMBER:

Calendar, DatatypeConstants

DECIMAL128:

MathContext

DECIMAL32:

MathContext

DECIMAL64:

MathContext

DECIMAL_DIGIT_NUMBER:

Character

DECIMAL_FLOAT:

BigDecimalLayoutForm

DECIMAL_SEPARATOR:

Field

DecimalFormat:

java.text

DecimalFormatSymbols:

java.text

DECLARED:

Member

declarePrefix( ):

NamespaceSupport

DeclHandler:

org.xml.sax.ext

decode( ):

Byte, Certificate, Charset, CharsetDecoder, Integer, Long, Short, URLDecoder

decodeLoop( ):

CharsetDecoder

decrementAndGet( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

DECRYPT_MODE:

Cipher

deepEquals( ):

Arrays

deepHashCode( ):

Arrays

deepToString( ):

Arrays

def:

DeflaterOutputStream

DEFAULT:

DateFormat, OAEPParameterSpec, PSpecified, PSSParameterSpec

DEFAULT_COMPRESSION:

Deflater

DEFAULT_NS_PREFIX:

XMLConstants

DEFAULT_OBJECT_MODEL_URI:

XPathFactory

DEFAULT_PROPERTY_NAME:

XPathFactory

DEFAULT_STRATEGY:

Deflater

defaultCharset( ):

Charset

defaulted( ):

GetField

DefaultHandler:

org.xml.sax.helpers

DefaultHandler2:

org.xml.sax.ext

defaultReadObject( ):

ObjectInputStream

defaults:

Properties

defaultThreadFactory( ):

Executors

defaultWriteObject( ):

ObjectOutputStream

defineClass( ):

ClassLoader, SecureClassLoader

definePackage( ):

ClassLoader, URLClassLoader

deflate( ):

Deflater, DeflaterOutputStream

DEFLATE_HINT:

Packer, Unpacker

DEFLATED:

Deflater, ZipEntry, ZipOutputStream

Deflater:

java.util.zip

DeflaterOutputStream:

java.util.zip

Delayed:

java.util.concurrent

DelayQueue:

java.util.concurrent

DelegationPermission:

javax.security.auth.kerberos

delete( ):

File, StringBuffer, StringBuilder

deleteCharAt( ):

StringBuffer, StringBuilder

deleteData( ):

CharacterData

deleteEntry( ):

KeyStore

deleteObserver( ):

Observable

deleteObservers( ):

Observable

deleteOnExit( ):

File

delimiter( ):

Scanner

Deprecated:

java.lang

deregister( ):

AbstractSelector

DERIVATION_EXTENSION:

TypeInfo

DERIVATION_LIST:

TypeInfo

DERIVATION_RESTRICTION:

TypeInfo

DERIVATION_UNION:

TypeInfo

DES_EDE_KEY_LEN:

DESedeKeySpec

DES_KEY_LEN:

DESKeySpec

DESedeKeySpec:

javax.crypto.spec

DESERET:

UnicodeBlock

desiredAssertionStatus( ):

Class

DESKeySpec:

javax.crypto.spec

destroy( ):

Destroyable, KerberosKey, KerberosTicket, PasswordProtection, Process, Thread, ThreadGroup, X500PrivateCredential

Destroyable:

javax.security.auth

DestroyFailedException:

javax.security.auth

detail:

WriteAbortedException

detectedCharset( ):

CharsetDecoder

DEVANAGARI:

UnicodeBlock

DHGenParameterSpec:

javax.crypto.spec

DHKey:

javax.crypto.interfaces

DHParameterSpec:

javax.crypto.spec

DHPrivateKey:

javax.crypto.interfaces

DHPrivateKeySpec:

javax.crypto.spec

DHPublicKey:

javax.crypto.interfaces

DHPublicKeySpec:

javax.crypto.spec

Dictionary:

java.util

digest:

DigestInputStream, DigestOutputStream

digest( ):

MessageDigest

DigestException:

java.security

DigestInputStream:

java.security

DigestOutputStream:

java.security

digit( ):

Character

DINGBATS:

UnicodeBlock

DIRECT:

Type

DIRECTION_DEFAULT_LEFT_TO_RIGHT:

Bidi

DIRECTION_DEFAULT_RIGHT_TO_LEFT:

Bidi

DIRECTION_LEFT_TO_RIGHT:

Bidi

DIRECTION_RIGHT_TO_LEFT:

Bidi

DIRECTIONALITY_ARABIC_NUMBER:

Character

DIRECTIONALITY_BOUNDARY_NEUTRAL:

Character

DIRECTIONALITY_COMMON_NUMBER_SEPARATOR:

Character

DIRECTIONALITY_EUROPEAN_NUMBER:

Character

DIRECTIONALITY_EUROPEAN_NUMBER_SEPARATOR:

Character

DIRECTIONALITY_EUROPEAN_NUMBER_TERMINATOR:

Character

DIRECTIONALITY_LEFT_TO_RIGHT:

Character

DIRECTIONALITY_LEFT_TO_RIGHT_EMBEDDING:

Character

DIRECTIONALITY_LEFT_TO_RIGHT_OVERRIDE:

Character

DIRECTIONALITY_NONSPACING_MARK:

Character

DIRECTIONALITY_OTHER_NEUTRALS:

Character

DIRECTIONALITY_PARAGRAPH_SEPARATOR:

Character

DIRECTIONALITY_POP_DIRECTIONAL_FORMAT:

Character

DIRECTIONALITY_RIGHT_TO_LEFT:

Character

DIRECTIONALITY_RIGHT_TO_LEFT_ARABIC:

Character

DIRECTIONALITY_RIGHT_TO_LEFT_EMBEDDING:

Character

DIRECTIONALITY_RIGHT_TO_LEFT_OVERRIDE:

Character

DIRECTIONALITY_SEGMENT_SEPARATOR:

Character

DIRECTIONALITY_UNDEFINED:

Character

DIRECTIONALITY_WHITESPACE:

Character

directory( ):

ProcessBuilder

disable( ):

Compiler

DiscardOldestPolicy:

java.util.concurrent.ThreadPoolExecutor

DiscardPolicy:

java.util.concurrent.ThreadPoolExecutor

disconnect( ):

DatagramChannel, DatagramSocket, DatagramSocketImpl, HttpURLConnection

disjoint( ):

Collections

displayName( ):

Charset

divide( ):

BigDecimal, BigInteger

divideAndRemainder( ):

BigDecimal, BigInteger

divideToIntegralValue( ):

BigDecimal

doAs( ):

Subject

doAsPrivileged( ):

Subject

DOCTYPE_PUBLIC:

OutputKeys

DOCTYPE_SYSTEM:

OutputKeys

Document:

org.w3c.dom

DOCUMENT_FRAGMENT_NODE:

Node

DOCUMENT_NODE:

Node

DOCUMENT_POSITION_CONTAINED_BY:

Node

DOCUMENT_POSITION_CONTAINS:

Node

DOCUMENT_POSITION_DISCONNECTED:

Node

DOCUMENT_POSITION_FOLLOWING:

Node

DOCUMENT_POSITION_IMPLEMENTATION_SPECIFIC:

Node

DOCUMENT_POSITION_PRECEDING:

Node

DOCUMENT_TYPE_NODE:

Node

DocumentBuilder:

javax.xml.parsers

DocumentBuilderFactory:

javax.xml.parsers

Documented:

java.lang.annotation

DocumentFragment:

org.w3c.dom

DocumentHandler:

org.xml.sax

DocumentType:

org.w3c.dom

doFinal( ):

Cipher, Mac

doInput:

URLConnection

DOM_OBJECT_MODEL:

XPathConstants

DomainCombiner:

java.security

DOMConfiguration:

org.w3c.dom

DOMError:

org.w3c.dom

DOMErrorHandler:

org.w3c.dom

DOMException:

org.w3c.dom

DOMImplementation:

org.w3c.dom

DOMImplementationList:

org.w3c.dom

DOMImplementationSource:

org.w3c.dom

DOMLocator:

javax.xml.transform.dom, org.w3c.dom

DOMResult:

javax.xml.transform.dom

DOMSource:

javax.xml.transform.dom

DOMSTRING_SIZE_ERR:

DOMException

DOMStringList:

org.w3c.dom

DONE:

BreakIterator, CharacterIterator

done( ):

FutureTask

doOutput:

URLConnection

doPhase( ):

KeyAgreement

doPrivileged( ):

AccessController

DOTALL:

Pattern

Double:

java.lang

DoubleBuffer:

java.nio

doubleToLongBits( ):

Double

doubleToRawLongBits( ):

Double

doubleValue( ):

AtomicInteger, AtomicLong, BigDecimal, BigInteger, Byte, Double, Float, Integer, Long, Number, Short

DOWN:

RoundingMode

drain( ):

ObjectOutputStream

drainPermits( ):

Semaphore

drainTo( ):

ArrayBlockingQueue, BlockingQueue, DelayQueue, LinkedBlockingQueue, PriorityBlockingQueue, SynchronousQueue

DSAKey:

java.security.interfaces

DSAKeyPairGenerator:

java.security.interfaces

DSAParameterSpec:

java.security.spec

DSAParams:

java.security.interfaces

DSAPrivateKey:

java.security.interfaces

DSAPrivateKeySpec:

java.security.spec

DSAPublicKey:

java.security.interfaces

DSAPublicKeySpec:

java.security.spec

DST_OFFSET:

Calendar

DTDHandler:

org.xml.sax

dumpStack( ):

Thread

duplicate( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

DuplicateFormatFlagsException:

java.util

DURATION:

DatatypeConstants

Duration:

javax.xml.datatype

DURATION_DAYTIME:

DatatypeConstants

DURATION_YEARMONTH:

DatatypeConstants

23.5. E

E:

Math, StrictMath

ECField:

java.security.spec

ECFieldF2m:

java.security.spec

ECFieldFp:

java.security.spec

ECGenParameterSpec:

java.security.spec

ECKey:

java.security.interfaces

ECParameterSpec:

java.security.spec

ECPoint:

java.security.spec

ECPrivateKey:

java.security.interfaces

ECPrivateKeySpec:

java.security.spec

ECPublicKey:

java.security.interfaces

ECPublicKeySpec:

java.security.spec

EFFORT:

Packer

Element:

org.w3c.dom

element( ):

AbstractQueue, AnnotationTypeMismatchException, LinkedList, Queue

ELEMENT_NODE:

Node

elementAt( ):

Vector

elementCount:

Vector

elementData:

Vector

elementDecl( ):

DeclHandler, DefaultHandler2

elementName( ):

IncompleteAnnotationException

elements( ):

ConcurrentHashMap, Dictionary, Hashtable, PermissionCollection, Permissions, Vector

ElementType:

java.lang.annotation

EllipticCurve:

java.security.spec

empty( ):

Stack

EMPTY_LIST:

Collections

EMPTY_MAP:

Collections

EMPTY_SET:

Collections

emptyList( ):

Collections

emptyMap( ):

Collections

emptySet( ):

Collections

EmptyStackException:

java.util

enable( ):

Compiler

enableReplaceObject( ):

ObjectOutputStream

enableResolveObject( ):

ObjectInputStream

ENCLOSED_ALPHANUMERICS:

UnicodeBlock

ENCLOSED_CJK_LETTERS_AND_MONTHS:

UnicodeBlock

ENCLOSING_MARK:

Character

encode( ):

Certificate, Charset, CharsetEncoder, URLEncoder

EncodedKeySpec:

java.security.spec

encodedParams:

SealedObject

encodeLoop( ):

CharsetEncoder

ENCODING:

OutputKeys

ENCRYPT_MODE:

Cipher

EncryptedPrivateKeyInfo:

javax.crypto

end( ):

AbstractInterruptibleChannel, AbstractSelector, Deflater, Inflater, Matcher, MatchResult

END_PUNCTUATION:

Character

endCDATA( ):

DefaultHandler2, LexicalHandler

endDocument( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

endDTD( ):

DefaultHandler2, LexicalHandler

endElement( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

endEntity( ):

DefaultHandler2, LexicalHandler

endPrefixMapping( ):

ContentHandler, DefaultHandler, XMLFilterImpl, XMLReaderAdapter

endsWith( ):

String

engineAliases( ):

KeyStoreSpi

engineBuild( ):

CertPathBuilderSpi

engineContainsAlias( ):

KeyStoreSpi

engineCreateSSLEngine( ):

SSLContextSpi

engineDeleteEntry( ):

KeyStoreSpi

engineDigest( ):

MessageDigestSpi

engineDoFinal( ):

CipherSpi, MacSpi

engineDoPhase( ):

KeyAgreementSpi

engineEntryInstanceOf( ):

KeyStoreSpi

downloaded from: lib.ommolketab.ir

engineGenerateCertificate( ):

CertificateFactorySpi

engineGenerateCertificates( ):

CertificateFactorySpi

engineGenerateCertPath( ):

CertificateFactorySpi

engineGenerateCRL( ):

CertificateFactorySpi

engineGenerateCRLs( ):

CertificateFactorySpi

engineGenerateKey( ):

KeyGeneratorSpi

engineGenerateParameters( ):

AlgorithmParameterGeneratorSpi

engineGeneratePrivate( ):

KeyFactorySpi

engineGeneratePublic( ):

KeyFactorySpi

engineGenerateSecret( ):

KeyAgreementSpi, SecretKeyFactorySpi

engineGenerateSeed( ):

SecureRandomSpi

engineGenExemptionBlob( ):

ExemptionMechanismSpi

engineGetBlockSize( ):

CipherSpi

engineGetCertificate( ):

KeyStoreSpi

engineGetCertificateAlias( ):

KeyStoreSpi

engineGetCertificateChain( ):

KeyStoreSpi

engineGetCertificates( ):

CertStoreSpi

engineGetCertPathEncodings( ):

CertificateFactorySpi

engineGetClientSessionContext( ):

SSLContextSpi

engineGetCreationDate( ):

KeyStoreSpi

engineGetCRLs( ):

CertStoreSpi

engineGetDigestLength( ):

MessageDigestSpi

engineGetEncoded( ):

AlgorithmParametersSpi

engineGetEntry( ):

KeyStoreSpi

engineGetIV( ):

CipherSpi

engineGetKey( ):

KeyStoreSpi

engineGetKeyManagers( ):

KeyManagerFactorySpi

engineGetKeySize( ):

CipherSpi

engineGetKeySpec( ):

KeyFactorySpi, SecretKeyFactorySpi

engineGetMacLength( ):

MacSpi

engineGetOutputSize( ):

CipherSpi, ExemptionMechanismSpi

engineGetParameter( ):

SignatureSpi

engineGetParameters( ):

CipherSpi, SignatureSpi

engineGetParameterSpec( ):

AlgorithmParametersSpi

engineGetServerSessionContext( ):

SSLContextSpi

engineGetServerSocketFactory( ):

SSLContextSpi

engineGetSocketFactory( ):

SSLContextSpi

engineGetTrustManagers( ):

TrustManagerFactorySpi

engineInit( ):

AlgorithmParameterGeneratorSpi, AlgorithmParametersSpi, CipherSpi, ExemptionMechanismSpi, KeyAgreementSpi, KeyGeneratorSpi, KeyManagerFactorySpi, MacSpi, SSLContextSpi, TrustManagerFactorySpi

engineInitSign( ):

SignatureSpi

engineInitVerify( ):

SignatureSpi

engineIsCertificateEntry( ):

KeyStoreSpi

engineIsKeyEntry( ):

KeyStoreSpi

engineLoad( ):

KeyStoreSpi

engineNextBytes( ):

SecureRandomSpi

engineReset( ):

MacSpi, MessageDigestSpi

engineSetCertificateEntry( ):

KeyStoreSpi

engineSetEntry( ):

KeyStoreSpi

engineSetKeyEntry( ):

KeyStoreSpi

engineSetMode( ):

CipherSpi

engineSetPadding( ):

CipherSpi

engineSetParameter( ):

SignatureSpi

engineSetSeed( ):

SecureRandomSpi

engineSign( ):

SignatureSpi

engineSize( ):

KeyStoreSpi

engineStore( ):

KeyStoreSpi

engineToString( ):

AlgorithmParametersSpi

engineTranslateKey( ):

KeyFactorySpi, SecretKeyFactorySpi

engineUnwrap( ):

CipherSpi

engineUpdate( ):

CipherSpi, MacSpi, MessageDigestSpi, SignatureSpi

engineValidate( ):

CertPathValidatorSpi

engineVerify( ):

SignatureSpi

engineWrap( ):

CipherSpi

ENGLISH:

Locale

enqueue( ):

Reference

ensureCapacity( ):

ArrayList, StringBuffer, Vector

entering( ):

Logger

Entity:

org.w3c.dom

ENTITY_NODE:

Node

ENTITY_REFERENCE_NODE:

Node

EntityReference:

org.w3c.dom

EntityResolver:

org.xml.sax

EntityResolver2:

org.xml.sax.ext

entries( ):

JarFile, ZipFile

Entry:

java.security.KeyStore, java.util.Map

entryInstanceOf( ):

KeyStore

entrySet( ):

AbstractMap, Attributes, ConcurrentHashMap, EnumMap, HashMap, Hashtable, IdentityHashMap, Map, Provider, TreeMap, WeakHashMap

Enum:

java.lang

EnumConstantNotPresentException:

java.lang

enumerate( ):

Thread, ThreadGroup

Enumeration:

java.util

enumeration( ):

Collections

EnumMap:

java.util

EnumSet:

java.util

enumType( ):

EnumConstantNotPresentException

environment( ):

ProcessBuilder

eof:

OptionalDataException

EOFException:

java.io

eolIsSignificant( ):

StreamTokenizer

eos:

GZIPInputStream

EQUAL:

DatatypeConstants

equals( ):

AbstractList, AbstractMap, AbstractSet, AccessControlContext, AllPermission, Annotation, Arrays, Attribute, Attributes, BasicPermission, BigDecimal, BigInteger, BitSet, Boolean, Byte, ByteBuffer, Calendar, Certificate, CertPath, Character, CharBuffer, Charset, ChoiceFormat, CodeSigner, CodeSource, CollationKey, Collator, Collection, Comparator, Constructor, CopyOnWriteArrayList, Date, DateFormat, DateFormatSymbols, DecimalFormat, DecimalFormatSymbols, DelegationPermission, Double, DoubleBuffer, Duration, ECFieldF2m, ECFieldFp, ECPoint, EllipticCurve, Entry, Enum, EnumMap, Field, FieldPosition, File, FilePermission, Float, FloatBuffer, GregorianCalendar, Hashtable, Identity, IdentityHashMap, Inet4Address, Inet6Address, InetAddress, InetSocketAddress, IntBuffer, Integer, KerberosPrincipal, Level, List, Locale, Long, LongBuffer, Manifest, Map, MathContext, MessageFormat, Method, Name, NetworkInterface, NumberFormat, Object, ParsePosition, Permission, Principal, PrivateCredentialPermission, PropertyPermission, Proxy, QName, RC2ParameterSpec, RC5ParameterSpec, RuleBasedCollator, SecretKeySpec, ServicePermission, Set, Short, ShortBuffer, SimpleDateFormat, SimpleTimeZone, SocketPermission, StackTraceElement, String, StringCharacterIterator, Subject, Subset, Timestamp, UnresolvedPermission, URI, URL, URLStreamHandler, UUID, Vector, X500Principal, X509CRL, X509CRLEntry, XMLGregorianCalendar

equalsIgnoreCase( ):

String

ERA:

Calendar, Field

ERA_FIELD:

DateFormat

err:

FileDescriptor, System

Error:

java.lang

ERROR:

ConfirmationCallback, Packer, TextOutputCallback

error( ):

DefaultHandler, ErrorHandler, ErrorListener, ErrorManager, HandlerBase, XMLFilterImpl

ErrorHandler:

org.xml.sax

ErrorListener:

javax.xml.transform

ErrorManager:

java.util.logging

ETHIOPIC:

UnicodeBlock

evaluate( ):

XPath, XPathExpression, XPathFunction

EventListener:

java.util

EventListenerProxy:

java.util

EventObject:

java.util

Exception:

java.lang

ExceptionInInitializerError:

java.lang

exchange( ):

Exchanger

Exchanger:

java.util.concurrent

exec( ):

Runtime

execute( ):

Executor, ScheduledThreadPoolExecutor, ThreadPoolExecutor

ExecutionException:

java.util.concurrent

Executor:

java.util.concurrent

ExecutorCompletionService:

java.util.concurrent

Executors:

java.util.concurrent

ExecutorService:

java.util.concurrent

ExemptionMechanism:

javax.crypto

ExemptionMechanismException:

javax.crypto

ExemptionMechanismSpi:

javax.crypto

exists( ):

File

exit( ):

Runtime, System

exiting( ):

Logger

exitValue( ):

Process

exp( ):

Math, StrictMath

expm1( ):

Math, StrictMath

EXPONENT:

Field

EXPONENT_SIGN:

Field

EXPONENT_SYMBOL:

Field

exportNode( ):

AbstractPreferences, Preferences

exportSubtree( ):

AbstractPreferences, Preferences

EXTENSION_INSTALLATION:

Name

EXTENSION_LIST:

Name

EXTENSION_NAME:

Name

externalEntityDecl( ):

DeclHandler, DefaultHandler2

Externalizable:

java.io

Team LiB

Team LiB

23.6. F

F0:

RSAKeyGenParameterSpec

F4:

RSAKeyGenParameterSpec

FactoryConfigurationError:

javax.xml.parsers

FailedLoginException:

javax.security.auth.login

FALSE:

Boolean, Packer, Unpacker

fatalError( ):

DefaultHandler, ErrorHandler, ErrorListener, HandlerBase, XMLFilterImpl

fd:

DatagramSocketImpl, SocketImpl

FEATURE:

DOMResult, DOMSource, SAXResult, SAXSource, SAXTransformerFactory, StreamResult, StreamSource

FEATURE_SECURE_PROCESSING:

XMLConstants

FEATURE_XMLFILTER:

SAXTransformerFactory

FEBRUARY:

Calendar, DatatypeConstants

Field:

java.lang.reflect, java.text.DateFormat, java.text.Format, java.text.MessageFormat, java.text.NumberFormat, javax.xml.datatype.DatatypeConstants

FIELD:

ElementType

FIELD_ATTRIBUTE_PFX:

Packer

FIELD_COUNT:

Calendar

FIELD_UNDEFINED:

DatatypeConstants

FieldPosition:

java.text

fields:

Calendar

File:

java.io

FileChannel:

java.nio.channels

FileChannel.MapMode:

java.nio.channels

FileDescriptor:

java.io

FileFilter:

java.io

FileHandler:

java.util.logging

FileInputStream:

java.io

FileLock:

java.nio.channels

FileLockInterruptionException:

java.nio.channels

FilenameFilter:

java.io

FileNameMap:

java.net

FileNotFoundException:

java.io

FileOutputStream:

java.io

FilePermission:

java.io

FileReader:

java.io

FileWriter:

java.io

fill( ):

Arrays, Collections, InflaterInputStream

fillInStackTrace( ):

Throwable

Filter:

java.util.logging

FILTERED:

Deflater

FilterInputStream:

java.io

FilterOutputStream:

java.io

FilterReader:

java.io

FilterWriter:

java.io

FINAL:

Modifier

FINAL_QUOTE_PUNCTUATION:

Character

finalize( ):

Deflater, ExemptionMechanism, FileInputStream, FileOutputStream, Inflater, Object, ThreadPoolExecutor, ZipFile

find( ):

Matcher

findClass( ):

ClassLoader, URLClassLoader

findInLine( ):

Scanner

findLibrary( ):

ClassLoader

findLoadedClass( ):

ClassLoader

findMonitorDeadlockedThreads( ):

ThreadMXBean

findResource( ):

ClassLoader, URLClassLoader

findResources( ):

ClassLoader, URLClassLoader

findSystemClass( ):

ClassLoader

findWithinHorizon( ):

Scanner

FINE:

Level

fine( ):

Logger

FINER:

Level

finer( ):

Logger

FINEST:

Level

finest( ):

Logger

finish( ):

Deflater, DeflaterOutputStream, GZIPOutputStream, ZipOutputStream

finishConnect( ):

SocketChannel

FINISHED:

HandshakeStatus

finished( ):

Deflater, Inflater

first( ):

BreakIterator, CharacterIterator, SortedSet, StringCharacterIterator, TreeSet

firstElement( ):

Vector

firstKey( ):

SortedMap, TreeMap

fixedContentLength:

HttpURLConnection

flags( ):

Pattern

flip( ):

BitSet, Buffer

flipBit( ):

BigInteger

Float:

java.lang

FloatBuffer:

java.nio

floatToIntBits( ):

Float

floatToRawIntBits( ):

Float

floatValue( ):

AtomicInteger, AtomicLong, BigDecimal, BigInteger, Byte, Double, Float, Integer, Long, Number, Short

FLOOR:

RoundingMode

floor( ):

Math, StrictMath

flush( ):

AbstractPreferences, BufferedOutputStream, BufferedWriter, CharArrayWriter, CharsetDecoder, CharsetEncoder, CipherOutputStream, DataOutputStream, FilterOutputStream, FilterWriter, Flushable, Formatter, Handler, MemoryHandler, ObjectOutput ObjectOutputStream, OutputStream, OutputStreamWriter, PipedOutputStream, PipedWriter, Preferences, PrintStream, PrintWriter, StreamHandler, StringWriter, Writer

FLUSH_FAILURE:

ErrorManager

Flushable:

java.io

flushSpi( ):

AbstractPreferences

following( ):

BreakIterator

force( ):

FileChannel, MappedByteBuffer

forClass( ):

ObjectStreamClass

forDigit( ):

Character

Format:

java.text

FORMAT:

Character

format( ):

ChoiceFormat, DateFormat, DecimalFormat, Format, Formatter, MessageFormat,

NumberFormat, PrintStream, PrintWriter, SimpleDateFormat, SimpleFormatter, String, XMLFormatter

Format.Field:

java.text

FORMAT_FAILURE:

ErrorManager

FormatFlagsConversionMismatchException:

java.util

formatMessage( ):

Formatter

Formattable:

java.util

FormattableFlags:

java.util

Formatter:

java.util, java.util.logging

Formatter.BigDecimalLayoutForm:

java.util

FormatterClosedException:

java.util

formatTo( ):

Formattable

formatToCharacterIterator( ):

DecimalFormat, Format, MessageFormat, SimpleDateFormat

forName( ):

Charset, Class, UnicodeBlock

foundType( ):

AnnotationTypeMismatchException

FRACTION:

Field

FRACTION_FIELD:

NumberFormat

FRANCE:

Locale

freeMemory( ):

Runtime

FRENCH:

Locale

frequency( ):

Collections

FRIDAY:

Calendar

from( ):

MemoryNotificationInfo, MemoryUsage, ThreadInfo

fromString( ):

UUID

FULL:

DateFormat

FULL_DECOMPOSITION:

Collator

Future:

java.util.concurrent

FutureTask:

java.util.concurrent

Team LiB

23.7. G

GARBAGE_COLLECTOR_MXBEAN_DOMAIN_TYPE:

ManagementFactory

GarbageCollectorMXBean:

java.lang.management

GatheringByteChannel:

java.nio.channels

gc( ):

MemoryMXBean, Runtime, System

gcd( ):

BigInteger

GDAY:

DatatypeConstants

GENERAL_PUNCTUATION:

UnicodeBlock

GeneralSecurityException:

java.security

generateCertificate( ):

CertificateFactory

generateCertificates( ):

CertificateFactory

generateCertPath( ):

CertificateFactory

generateCRL( ):

CertificateFactory

generateCRLs( ):

CertificateFactory

generateKey( ):

KeyGenerator

generateKeyPair( ):

KeyPairGenerator, KeyPairGeneratorSpi

generateParameters( ):

AlgorithmParameterGenerator

generatePrivate( ):

KeyFactory

generatePublic( ):

KeyFactory

generateSecret( ):

KeyAgreement, SecretKeyFactory

generateSeed( ):

SecureRandom

GENERIC_FAILURE:

ErrorManager

GenericArrayType:

java.lang.reflect

GenericDeclaration:

java.lang.reflect

GenericSignatureFormatError:

java.lang.reflect

genExemptionBlob( ):

ExemptionMechanism

genKeyPair( ):

KeyPairGenerator

GEOMETRIC_SHAPES:

UnicodeBlock

GEORGIAN:

UnicodeBlock

GERMAN:

Locale

GERMANY:

Locale

get( ):

AbstractList, AbstractMap, AbstractPreferences, AbstractSequentialList, Array, ArrayList, AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater, AtomicMarkableReference, AtomicReference, AtomicReferenceArray, AtomicReferenceFieldUpdater, AtomicStampedReference, Attributes, BitSet, ByteBuffer, Calendar, CharBuffer, ConcurrentHashMap, CookieHandler, CopyOnWriteArrayList, Dictionary, DoubleBuffer, EnumMap, Field, FloatBuffer, Future, FutureTask, GetField, HashMap, Hashtable, IdentityHashMap, IntBuffer, LinkedHashMap, LinkedList, List, LongBuffer, Map, PhantomReference, Preferences, Reference, ResponseCache, ShortBuffer, SoftReference, ThreadLocal, TreeMap, Vector, WeakHashMap

get2DigitYearStart( ):

SimpleDateFormat

getA( ):

EllipticCurve

getAbsoluteFile( ):

File

getAbsolutePath( ):

File

getAcceptedIssuers( ):

X509TrustManager

getActions( ):

AllPermission, BasicPermission, FilePermission, Permission, PrivateCredentialPermission, PropertyPermission, ServicePermission, SocketPermission, UnresolvedPermission

getActiveCount( ):

ThreadPoolExecutor

getActualMaximum( ):

Calendar, GregorianCalendar

getActualMinimum( ):

Calendar, GregorianCalendar

getActualTypeArguments( ):

ParameterizedType

getAddress( ):

DatagramPacket, Inet4Address, Inet6Address, InetAddress, InetSocketAddress

getAdler( ):

Deflater, Inflater

getAffineX( ):

ECPoint

getAffineY( ):

ECPoint

getAlgName( ):

EncryptedPrivateKeyInfo

getAlgorithm( ):

AlgorithmParameterGenerator, AlgorithmParameters, CertPathBuilder, CertPathValidator, Cipher, KerberosKey, Key, KeyAgreement, KeyFactory, KeyGenerator, KeyManagerFactory, KeyPairGenerator, Mac, MessageDigest, PSource, SealedObject, SecretKeyFactory, SecretKeySpec, SecureRandom, Service, Signature, SignedObject, TrustManagerFactory

getAlgorithmProperty( ):

Security

getAlgorithms( ):

Security

getAlgParameters( ):

EncryptedPrivateKeyInfo

getAlias( ):

X500PrivateCredential

getAllAttributeKeys( ):

AttributedCharacterIterator

getAllByName( ):

InetAddress

getAllLoadedClasses( ):

Instrumentation

getAllowUserInteraction( ):

URLConnection

getAllStackTraces( ):

Thread

getAllThreadIds( ):

ThreadMXBean

getAmPmStrings( ):

DateFormatSymbols

getAndAdd( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

getAndDecrement( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

getAndIncrement( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

getAndSet( ):

AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater, AtomicReference, AtomicReferenceArray, AtomicReferenceFieldUpdater

getAnnotation( ):

AccessibleObject, AnnotatedElement, Class, Constructor, Field, Method, Package

getAnnotations( ):

AccessibleObject, AnnotatedElement, Class, Package

getAnonymousLogger( ):

Logger

getAppConfigurationEntry( ):

Configuration

getApplicationBufferSize( ):

SSLSession

getArch( ):

OperatingSystemMXBean

getArgumentClass( ):

IllegalFormatConversionException

getAssociatedStylesheet( ):

TransformerFactory

getAttribute( ):

AttributedCharacterIterator, DocumentBuilderFactory, Element, Service, TransformerFactory

getAttributeNode( ):

Element

getAttributeNodeNS( ):

Element

getAttributeNS( ):

Element

getAttributes( ):

AttributedCharacterIterator, JarEntry, JarURLConnection, Manifest, Node

getAttributeTypeInfo( ):

TypeInfoProvider

getAuthority( ):

URI, URL

getAuthorityKeyIdentifier( ):

X509CertSelector

getAuthTime( ):

KerberosTicket

getAvailableIDs( ):

TimeZone

getAvailableLocales( ):

BreakIterator, Calendar, Collator, DateFormat, Locale, NumberFormat

getAvailableProcessors( ):

OperatingSystemMXBean

getB( ):

EllipticCurve

getBaseLevel( ):

Bidi

getBaseURI( ):

Node

getBasicConstraints( ):

X509Certificate, X509CertSelector

getBeginIndex( ):

CharacterIterator, FieldPosition, StringCharacterIterator

getBlockedCount( ):

ThreadInfo

getBlockedTime( ):

ThreadInfo

getBlockSize( ):

Cipher

getBody( ):

CacheRequest, CacheResponse

getBoolean( ):

AbstractPreferences, Array, Boolean, Field, Preferences

getBootClassPath( ):

RuntimeMXBean

getBounds( ):

TypeVariable

getBroadcast( ):

DatagramSocket

getBuffer( ):

StringWriter

getBundle( ):

ResourceBundle

getByAddress( ):

Inet6Address, InetAddress

getByInetAddress( ):

NetworkInterface

getByName( ):

InetAddress, NetworkInterface

getByte( ):

Array, Field

getByteArray( ):

AbstractPreferences, Preferences

getByteOffset( ):

DOMLocator

getBytes( ):

String

getBytesRead( ):

Deflater, Inflater

getByteStream( ):

InputSource

getBytesWritten( ):

Deflater, Inflater

getCA( ):

TrustAnchor

getCalendar( ):

DateFormat

getCalendarField( ):

Field

getCallback( ):

UnsupportedCallbackException

getCallbackHandler( ):

CallbackHandlerProtection

getCAName( ):

TrustAnchor

getCanonicalFile( ):

File

getCanonicalHostName( ):

InetAddress

getCanonicalName( ):

Class

getCanonicalPath( ):

File

getCAPublicKey( ):

TrustAnchor

getCause( ):

ClassNotFoundException, ExceptionInInitializerError, InvocationTargetException, PrivilegedActionException, Throwable, TransformerException, UndeclaredThrowableException, WriteAbortedException, XPathException

getCertificate( ):

KeyStore, PrivateKeyEntry, X500PrivateCredential, X509CertSelector

getCertificateAlias( ):

KeyStore

getCertificateChain( ):

KeyStore, PrivateKeyEntry, X509KeyManager

getCertificateChecking( ):

X509CRLSelector

getCertificateIssuer( ):

X509CRLEntry

getCertificates( ):

CertPath, CertStore, CodeSource, JarEntry, JarURLConnection *getCertificateValid( ):*

X509CertSelector

getCertPath( ):

CertPathBuilderResult, CertPathValidatorException, PKIXCertPathBuilderResult

getCertPathCheckers( ):

PKIXParameters

getCertPathEncodings( ):

CertificateFactory

getCertStoreParameters( ):

CertStore

getCertStores( ):

PKIXParameters

getChannel( ):

DatagramSocket, FileInputStream, FileOutputStream, RandomAccessFile, ServerSocket, Socke

getChar( ):

Array, ByteBuffer, Field

getCharacterInstance( ):

BreakIterator

getCharacterStream( ):

InputSource

getChars( ):

String, StringBuffer

getCharsetName( ):

IllegalCharsetNameException, UnsupportedCharsetException

getChecksum( ):

CheckedInputStream, CheckedOutputStream

getChild( ):

AbstractPreferences, NodeChangeEvent

getChildNodes( ):

Node

getChildren( ):

PolicyNode

getChoices( ):

ChoiceCallback

getCipherSuite( ):

HandshakeCompletedEvent, HttpsURLConnection, SecureCacheResponse, SSLSession

getClass( ):

Object

getClassContext( ):

SecurityManager

getClasses( ):

Class

getClassLoader( ):

Class, ProtectionDomain

getClassLoadingMXBean( ):

ManagementFactory

getClassName( ):

MissingResourceException, Service, StackTraceElement

getClassPath( ):

RuntimeMXBean

getClient( ):

KerberosTicket

getClientAddresses( ):

KerberosTicket

getClientAliases( ):

X509KeyManager

getClientSessionContext( ):

SSLContext

getCodePoint( ):

IllegalFormatCodePointException

getCodeSigners( ):

CodeSource, JarEntry

getCodeSource( ):

ProtectionDomain

getCofactor( ):

ECParameterSpec

getCollationElementIterator( ):

RuleBasedCollator

getCollationKey( ):

Collator, RuleBasedCollator

getCollection( ):

CollectionCertStoreParameters

getCollectionCount( ):

GarbageCollectorMXBean

getCollectionTime( ):

GarbageCollectorMXBean

getCollectionUsage( ):

MemoryPoolMXBean

getCollectionUsageThreshold( ):

MemoryPoolMXBean

getCollectionUsageThresholdCount( ):

MemoryPoolMXBean

getColumnNumber( ):

DOMLocator, Locator, LocatorImpl, SAXParseException, SourceLocator

getComment( ):

ZipEntry

getCommitted( ):

MemoryUsage

getCompilationMXBean( ):

ManagementFactory

getCompletedTaskCount( ):

ThreadPoolExecutor

getComponentType( ):

Class

getCompressedSize( ):

ZipEntry

getConfiguration( ):

Configuration

getConnectTimeout( ):

URLConnection

getConstructor( ):

Class

getConstructors( ):

Class

getContent( ):

ContentHandler, URL, URLConnection

getContentEncoding( ):

URLConnection

getContentHandler( ):

ParserAdapter, ValidatorHandler, XMLFilterImpl, XMLReader

getContentLength( ):

URLConnection

getContents( ):

ListResourceBundle

getContentType( ):

URLConnection

getContentTypeFor( ):

FileNameMap

getContext( ):

AccessController

getContextClassLoader( ):

Thread

getContinueExistingPeriodicTasksAfterShutdownPolicy( ):

ScheduledThreadPoolExecutor

getControlFlag( ):

AppConfigurationEntry

getConversion( ):

FormatFlagsConversionMismatchException, IllegalFormatConversionException, UnknownFormatConversionException

getCorePoolSize( ):

ThreadPoolExecutor

getCount( ):

CountDownLatch, MemoryNotificationInfo

getCountry( ):

Locale

getCrc( ):

ZipEntry

getCreationDate( ):

KeyStore

getCreationTime( ):

SSLSession

getCredentialClass( ):

PrivateCredentialPermission

getCriticalExtensionOIDs( ):

X509Extension

getCRLs( ):

CertStore

getCrtCoefficient( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAOtherPrimeInfo, RSAPrivateCrtKey, RSAPrivateCrtKeySpec

getCurrency( ):

DecimalFormat, DecimalFormatSymbols, NumberFormat

getCurrencyCode( ):

Currency

getCurrencyInstance( ):

NumberFormat

getCurrencySymbol( ):

DecimalFormatSymbols

getCurrentThreadCpuTime( ):

ThreadMXBean

getCurrentThreadUserTime( ):

ThreadMXBean

getCurve( ):

ECParameterSpec

getDaemonThreadCount( ):

ThreadMXBean

getData( ):

CharacterData, DatagramPacket, ProcessingInstruction *getDate( ):*

Date, PKIXParameters, URLConnection

getDateAndTime( ):

X509CRLSelector

getDateFormatSymbols( ):

SimpleDateFormat

getDateInstance( ):

DateFormat

getDateTimeInstance( ):

DateFormat

getDay( ):

Date, XMLGregorianCalendar

getDays( ):

Duration

getDecimalFormatSymbols( ):

DecimalFormat

getDecimalSeparator( ):

DecimalFormatSymbols

getDeclaredAnnotations( ):

AccessibleObject, AnnotatedElement, Class, Constructor, Field, Method, Package

getDeclaredClasses( ):

Class

getDeclaredConstructor( ):

Class

getDeclaredConstructors( ):

Class

getDeclaredField( ):

Class

getDeclaredFields( ):

Class

getDeclaredMethod( ):

Class

getDeclaredMethods( ):

Class

getDeclaredPrefixes( ):

NamespaceSupport

getDeclaringClass( ):

Class, Constructor, Enum, Field, Member, Method

getDecomposition( ):

Collator

getDefault( ):

CookieHandler, Locale, ProxySelector, ResponseCache, ServerSocketFactory, SocketFactory, SSLServerSocketFactory, SSLSocketFactory, TimeZone

getDefaultAlgorithm( ):

KeyManagerFactory, TrustManagerFactory

getDefaultAllowUserInteraction( ):

URLConnection

getDefaultChoice( ):

ChoiceCallback

getDefaultCipherSuites( ):

SSLServerSocketFactory, SSLSocketFactory

getDefaultFractionDigits( ):

Currency

getDefaultHostnameVerifier( ):

HttpsURLConnection

getDefaultName( ):

NameCallback

getDefaultOption( ):

ConfirmationCallback

getDefaultPort( ):

URL, URLStreamHandler

getDefaultRequestProperty( ):

URLConnection

getDefaultSSLSocketFactory( ):

HttpsURLConnection

getDefaultText( ):

TextInputCallback

getDefaultType( ):

CertPathBuilder, CertPathValidator, CertStore, KeyStore

getDefaultUncaughtExceptionHandler( ):

Thread

getDefaultUseCaches( ):

URLConnection

getDefaultValue( ):

Method

getDefinitionClass( ):

ClassDefinition

getDefinitionClassFile( ):

ClassDefinition

getDelay( ):

Delayed

getDelegatedTask( ):

SSLEngine

getDepth( ):

PolicyNode

getDescription( ):

PatternSyntaxException

getDigestAlgorithm( ):

MGF1ParameterSpec, OAEPParameterSpec, PSSParameterSpec

getDigestLength( ):

MessageDigest

getDigit( ):

DecimalFormatSymbols

getDirectionality( ):

Character

getDisplayCountry( ):

Locale

getDisplayLanguage( ):

Locale

getDisplayName( ):

Locale, NetworkInterface, TimeZone

getDisplayVariant( ):

Locale

getDoctype( ):

Document

getDocumentElement( ):

Document

getDocumentURI( ):

Document

getDoInput( ):

URLConnection

getDomainCombiner( ):

AccessControlContext

getDomConfig( ):

Document

getDOMImplementation( ):

DocumentBuilder, DOMImplementationSource

getDOMImplementationList( ):

DOMImplementationSource

getDoOutput( ):

URLConnection

getDouble( ):

AbstractPreferences, Array, ByteBuffer, Field, Preferences

getDSTSavings( ):

SimpleTimeZone, TimeZone

getDTDHandler( ):

ParserAdapter, XMLFilterImpl, XMLReader

getEffectiveKeyBits( ):

RC2ParameterSpec

getElementById( ):

Document

getElementsByTagName( ):

Document, Element

getElementsByTagNameNS( ):

Document, Element

getElementTypeInfo( ):

TypeInfoProvider

getEnabledCipherSuites( ):

SSLEngine, SSLServerSocket, SSLSocket

getEnabledProtocols( ):

SSLEngine, SSLServerSocket, SSLSocket

getEnableSessionCreation( ):

SSLEngine, SSLServerSocket, SSLSocket

getEnclosingClass( ):

Class

getEnclosingConstructor( ):

Class

getEnclosingMethod( ):

Class

getEncoded( ):

AlgorithmParameters, Certificate, CertPath, EncodedKeySpec, EncryptedPrivateKeyInfo, KerberosKey, KerberosTicket, Key, PKCS8EncodedKeySpec, PolicyQualifierInfo, SecretKeySpec, X500Principal, X509CRL, X509CRLEntry, X509EncodedKeySpec

getEncoding( ):

Handler, InputSource, InputStreamReader, Locator2, Locator2Impl, OutputStreamWriter

getEncodings( ):

CertPath

getEncryptedData( ):

EncryptedPrivateKeyInfo

getEndIndex( ):

CharacterIterator, FieldPosition, StringCharacterIterator

getEndTime( ):

KerberosTicket

getEntities( ):

DocumentType

getEntityResolver( ):

ParserAdapter, XMLFilterImpl, XMLReader

getEntries( ):

Manifest

getEntry( ):

JarFile, KeyStore, ZipFile

getEntryName( ):

JarURLConnection

getEnumConstants( ):

Class

getenv( ):

System

getEon( ):

XMLGregorianCalendar

getEonAndYear( ):

XMLGregorianCalendar

getEras( ):

DateFormatSymbols

getErrorHandler( ):

ParserAdapter, SchemaFactory, Validator, ValidatorHandler, XMLFilterImpl, XMLReader

getErrorIndex( ):

ParsePosition

getErrorListener( ):

Transformer, TransformerFactory

getErrorManager( ):

Handler

getErrorOffset( ):

ParseException

getErrorStream( ):

HttpURLConnection, Process

getException( ):

ClassNotFoundException, ExceptionInInitializerError, FactoryConfigurationError, PrivilegedActionException, SAXException, TransformerException, TransformerFactoryConfigurationError

getExceptionTypes( ):

Constructor, Method

getExclusiveQueuedThreads( ):

AbstractQueuedSynchronizer

getExecuteExistingDelayedTasksAfterShutdownPolicy( ):

ScheduledThreadPoolExecutor

getExemptionMechanism( ):

Cipher

getExpectedPolicies( ):

PolicyNode

getExpiration( ):

URLConnection

getExponent( ):

RSAOtherPrimeInfo

getExponentSize( ):

DHGenParameterSpec

getExtendedKeyUsage( ):

X509Certificate, X509CertSelector

getExtensionValue( ):

X509Extension

getExternalSubset( ):

DefaultHandler2, EntityResolver2

getExtra( ):

ZipEntry

getFD( ):

FileInputStream, FileOutputStream, RandomAccessFile *getFeature( ):*

DocumentBuilderFactory, DOMImplementation, Node, ParserAdapter, SAXParserFactory, SchemaFactory, TransformerFactory, Validator, ValidatorHandler, XMLFilterImpl, XMLReader, XPathFactory

GetField:

java.io.ObjectInputStream

getField( ):

Class, Duration, EllipticCurve, FieldPosition, ObjectStreamClass

getFieldAttribute( ):

FieldPosition

getFields( ):

Class, ObjectStreamClass

getFieldSize( ):

ECField, ECFieldF2m, ECFieldFp

getFile( ):

URL

getFileDescriptor( ):

DatagramSocketImpl, SocketImpl

getFileName( ):

StackTraceElement

getFileNameMap( ):

URLConnection

getFilePointer( ):

RandomAccessFile

getFilter( ):

Handler, Logger

getFirst( ):

LinkedList

getFirstChild( ):

Node

getFirstDayOfWeek( ):

Calendar

getFirstQueuedThread( ):

AbstractQueuedSynchronizer

getFlags( ):

DuplicateFormatFlagsException, FormatFlagsConversionMismatchException, IllegalFormatFlagsException, KerberosTicket, UnknownFormatFlagsException

getFloat( ):

AbstractPreferences, Array, ByteBuffer, Field, Preferences *getFollowRedirects( ):*

HttpURLConnection

getFormat( ):

Certificate, EncodedKeySpec, KerberosKey, Key, PKCS8EncodedKeySpec, SecretKeySpec, X509EncodedKeySpec

getFormats( ):

ChoiceFormat, MessageFormat

getFormatsByArgumentIndex( ):

MessageFormat

getFormatSpecifier( ):

MissingFormatArgumentException, MissingFormatWidthException

getFormatter( ):

Handler

getFractionalSecond( ):

XMLGregorianCalendar

getFragment( ):

URI

getG( ):

DHParameterSpec, DHPrivateKeySpec, DHPublicKeySpec, DSAParameterSpec, DSAParams, DSAPrivateKeySpec, DSAPublicKeySpec *getGarbageCollectorMXBeans( ):*

ManagementFactory

getGenerator( ):

ECParameterSpec

getGenericComponentType( ):

GenericArrayType

getGenericDeclaration( ):

TypeVariable

getGenericExceptionTypes( ):

Constructor, Method

getGenericInterfaces( ):

Class

getGenericParameterTypes( ):

Constructor, Method

getGenericReturnType( ):

Method

getGenericSuperclass( ):

Class

getGenericType( ):

Field

getGreatestMinimum( ):

Calendar, GregorianCalendar

getGregorianChange( ):

GregorianCalendar

getGroupingSeparator( ):

DecimalFormatSymbols

getGroupingSize( ):

DecimalFormat

getGuarantor( ):

Certificate

getHandler( ):

SAXResult

getHandlers( ):

Logger

getHandshakeStatus( ):

SSLEngine, SSLEngineResult

getHead( ):

Formatter, XMLFormatter

getHeaderField( ):

HttpURLConnection, URLConnection

getHeaderFieldDate( ):

HttpURLConnection, URLConnection

getHeaderFieldInt( ):

URLConnection

getHeaderFieldKey( ):

HttpURLConnection, URLConnection

getHeaderFields( ):

URLConnection

getHeaders( ):

CacheResponse

getHeapMemoryUsage( ):

MemoryMXBean

getHoldCount( ):

ReentrantLock

getHost( ):

URI, URL

getHostAddress( ):

Inet4Address, Inet6Address, InetAddress, URLStreamHandler

getHostName( ):

InetAddress, InetSocketAddress

getHostnameVerifier( ):

HttpsURLConnection

getHour( ):

XMLGregorianCalendar

getHours( ):

Date, Duration

getID( ):

TimeZone

getId( ):

Field, SSLSession, Thread

getIdentity( ):

IdentityScope

getIds( ):

SSLSessionContext

downloaded from: lib.ommolketab.ir

getIfModifiedSince( ):

URLConnection

getImplementation( ):

Document

getImplementationTitle( ):

Package

getImplementationVendor( ):

Package

getImplementationVersion( ):

Package

getInCheck( ):

SecurityManager

getIndex( ):

Attributes, AttributesImpl, CertPathValidatorException, CharacterIterator, ParsePosition, PatternSyntaxException, StringCharacterIterator, URISyntaxException

getInetAddress( ):

DatagramSocket, ServerSocket, Socket, SocketImpl

getInetAddresses( ):

NetworkInterface

getInfinity( ):

DecimalFormatSymbols

getInfo( ):

Identity, Provider

getInit( ):

MemoryUsage

getInitialPolicies( ):

PKIXParameters

getInitiatedClasses( ):

Instrumentation

getInput( ):

URISyntaxException

getInputArguments( ):

RuntimeMXBean

getInputEncoding( ):

Document, Entity

getInputLength( ):

MalformedInputException, UnmappableCharacterException

getInputSource( ):

SAXSource

getInputStream( ):

JarFile, Process, Socket, SocketImpl, StreamSource, URLConnection, ZipFile

getInstance( ):

AlgorithmParameterGenerator, AlgorithmParameters, Calendar, CertificateFactory, CertPathBuilder, CertPathValidator, CertStore, Cipher, Collator, Currency, DateFormat, ExemptionMechanism, KeyAgreement, KeyFactory, KeyGenerator, KeyManagerFactory, KeyPairGenerator, KeyStore, Mac, MessageDigest, NumberFormat, SecretKeyFactory, SecureRandom, Signature, SSLContext, TrustManagerFactory

getInstanceFollowRedirects( ):

HttpURLConnection

getInt( ):

AbstractPreferences, Array, BreakIterator, ByteBuffer, Field, Preferences

getInteger( ):

Integer

getIntegerInstance( ):

NumberFormat

getInterface( ):

MulticastSocket

getInterfaces( ):

Class

getInternalSubset( ):

DocumentType

getInternationalCurrencySymbol( ):

DecimalFormatSymbols

getInvocationHandler( ):

Proxy

getISO3Country( ):

Locale

getISO3Language( ):

Locale

getISOCountries( ):

Locale

getISOLanguages( ):

Locale

getIssuer( ):

X509CertSelector

getIssuerAlternativeNames( ):

X509Certificate

getIssuerAsBytes( ):

X509CertSelector

getIssuerAsString( ):

X509CertSelector

getIssuerDN( ):

X509Certificate, X509CRL

getIssuerNames( ):

X509CRLSelector

getIssuers( ):

X509CRLSelector

getIssuerUniqueID( ):

X509Certificate

getIssuerX500Principal( ):

X509Certificate, X509CRL

getIterationCount( ):

PBEKey, PBEKeySpec, PBEParameterSpec

getIterator( ):

AttributedString

getIV( ):

Cipher, IvParameterSpec, RC2ParameterSpec, RC5ParameterSpec

getJarEntry( ):

JarFile, JarURLConnection

getJarFile( ):

JarURLConnection

getJarFileURL( ):

JarURLConnection

getKeepAlive( ):

Socket

getKeepAliveTime( ):

ThreadPoolExecutor

getKey( ):

DESedeKeySpec, DESKeySpec, Entry, KeyStore, MissingResourceException, PreferenceChangeEvent

getKeyLength( ):

PBEKeySpec

getKeyManagers( ):

KeyManagerFactory

getKeys( ):

ListResourceBundle, PropertyResourceBundle, ResourceBundle

getKeysize( ):

RSAKeyGenParameterSpec

getKeySpec( ):

EncryptedPrivateKeyInfo, KeyFactory, SecretKeyFactory

getKeyStore( ):

Builder

getKeyType( ):

KerberosKey

getKeyUsage( ):

X509Certificate, X509CertSelector

getL( ):

DHParameterSpec

getLanguage( ):

Locale

getLargestPoolSize( ):

ThreadPoolExecutor

getLast( ):

LinkedList

getLastAccessedTime( ):

SSLSession

getLastChild( ):

Node

getLastModified( ):

URLConnection

getLeastMaximum( ):

Calendar, GregorianCalendar

getLeastSignificantBits( ):

UUID

getLength( ):

Array, AttributeList, AttributeListImpl, Attributes, AttributesImpl, Bidi, CharacterData, DatagramPacket, DOMImplementationList, DOMStringList, NamedNodeMap, NameList, NodeList

getLevel( ):

Handler, Logger, LogRecord

getLevelAt( ):

Bidi

getLexicalHandler( ):

SAXResult

getLibraryPath( ):

RuntimeMXBean

getLimits( ):

ChoiceFormat

getLineInstance( ):

BreakIterator

getLineNumber( ):

DOMLocator, LineNumberInputStream, LineNumberReader, Locator, LocatorImpl, SAXParseException, SourceLocator, StackTraceElement

getListener( ):

EventListenerProxy

getLoadedClassCount( ):

ClassLoadingMXBean

getLocalAddress( ):

DatagramSocket, Socket

getLocalCertificateChain( ):

SecureCacheResponse

getLocalCertificates( ):

HandshakeCompletedEvent, HttpsURLConnection, SSLSession *getLocale( ):*

LanguageCallback, MessageFormat, ResourceBundle

getLocalHost( ):

InetAddress

getLocalizedInputStream( ):

Runtime

getLocalizedMessage( ):

Throwable

getLocalizedName( ):

Level

getLocalizedOutputStream( ):

Runtime

getLocalName( ):

Attributes, AttributesImpl, Node

getLocalPart( ):

QName

getLocalPatternChars( ):

DateFormatSymbols

getLocalPort( ):

DatagramSocket, DatagramSocketImpl, ServerSocket, Socket, SocketImpl

getLocalPrincipal( ):

HandshakeCompletedEvent, HttpsURLConnection, SecureCacheResponse, SSLSession

getLocalSocketAddress( ):

DatagramSocket, ServerSocket, Socket

getLocation( ):

CodeSource, DOMError, HttpRetryException

getLocationAsString( ):

TransformerException

getLocator( ):

TransformerException

getLockName( ):

ThreadInfo

getLockOwnerId( ):

ThreadInfo

getLockOwnerName( ):

ThreadInfo

getLogger( ):

Logger, LogManager

getLoggerLevel( ):

LoggingMXBean

getLoggerName( ):

LogRecord

getLoggerNames( ):

LoggingMXBean, LogManager

getLoggingMXBean( ):

LogManager

getLoginModuleName( ):

AppConfigurationEntry

getLogManager( ):

LogManager

getLong( ):

AbstractPreferences, Array, BreakIterator, ByteBuffer, Field, Long, Preferences

getLoopbackMode( ):

MulticastSocket

getLowerBounds( ):

WildcardType

getLowestSetBit( ):

BigInteger

getM( ):

ECFieldF2m

getMacLength( ):

Mac

getMainAttributes( ):

JarURLConnection, Manifest

getManagementSpecVersion( ):

RuntimeMXBean

getManifest( ):

JarFile, JarInputStream, JarURLConnection

getMatchAllSubjectAltNames( ):

X509CertSelector

getMax( ):

MemoryUsage

getMaxAllowedKeyLength( ):

Cipher

getMaxAllowedParameterSpec( ):

Cipher

getMaxCRL( ):

X509CRLSelector

getMaxExpansion( ):

CollationElementIterator

getMaximum( ):

Calendar, GregorianCalendar

getMaximumFractionDigits( ):

DecimalFormat, NumberFormat

getMaximumIntegerDigits( ):

DecimalFormat, NumberFormat

getMaximumPoolSize( ):

ThreadPoolExecutor

getMaxPathLength( ):

PKIXBuilderParameters

getMaxPriority( ):

ThreadGroup

getMemoryManagerMXBeans( ):

ManagementFactory

getMemoryManagerNames( ):

MemoryPoolMXBean

getMemoryMXBean( ):

ManagementFactory

getMemoryPoolMXBeans( ):

ManagementFactory

getMemoryPoolNames( ):

MemoryManagerMXBean

getMessage( ):

DOMError, DuplicateFormatFlagsException, FactoryConfigurationError, FormatFlagsConversionMismatchException, IllegalFormatCodePointException, IllegalFormatConversionException, IllegalFormatFlagsException, IllegalFormatPrecisionException, IllegalFormatWidthException, InvalidClassException, LogRecord, MalformedInputException, MissingFormatArgumentException, MissingFormatWidthException, PatternSyntaxException, SAXException, TextOutputCallback, Throwable, TransformerFactoryConfigurationError, UnknownFormatConversionException, UnknownFormatFlagsException, UnmappableCharacterException, URISyntaxException, WriteAbortedException

getMessageAndLocation( ):

TransformerException

getMessageDigest( ):

DigestInputStream, DigestOutputStream

getMessageType( ):

ConfirmationCallback, TextOutputCallback

getMethod( ):

Class, ZipEntry

getMethodName( ):

StackTraceElement

getMethods( ):

Class

getMGFAlgorithm( ):

OAEPParameterSpec, PSSParameterSpec

getMGFParameters( ):

OAEPParameterSpec, PSSParameterSpec

getMidTermsOfReductionPolynomial( ):

ECFieldF2m

getMillis( ):

LogRecord

getMillisecond( ):

XMLGregorianCalendar

getMinCRL( ):

X509CRLSelector

getMinimalDaysInFirstWeek( ):

Calendar

getMinimum( ):

Calendar, GregorianCalendar

getMinimumFractionDigits( ):

DecimalFormat, NumberFormat

getMinimumIntegerDigits( ):

DecimalFormat, NumberFormat

getMinusSign( ):

DecimalFormatSymbols

getMinute( ):

XMLGregorianCalendar

getMinutes( ):

Date, Duration

getModifiers( ):

Class, Constructor, Field, Member, Method

getModulus( ):

RSAKey, RSAPrivateKeySpec, RSAPublicKeySpec

getMonetaryDecimalSeparator( ):

DecimalFormatSymbols

getMonth( ):

Date, XMLGregorianCalendar

getMonths( ):

DateFormatSymbols, Duration

getMostSignificantBits( ):

UUID

getMultiplier( ):

DecimalFormat

getName( ):

Attr, Attribute, AttributeList, AttributeListImpl, Class, CompilationMXBean, Constructor, DocumentType, ECGenParameterSpec, ExemptionMechanism, Field, File, Identity, KerberosPrincipal, Level, Logger, Member, MemoryManagerMXBean, MemoryPoolMXBean, Method, NameCallback, NameList, NetworkInterface, ObjectStreamClass, ObjectStreamField, OperatingSystemMXBean, Package, Permission, Principal, Provider, RuntimeMXBean, SSLSessionBindingEvent, Thread, ThreadGroup, TypeVariable, X500Principal, ZipEntry, ZipFile

getNameConstraints( ):

TrustAnchor, X509CertSelector

getNamedItem( ):

NamedNodeMap

getNamedItemNS( ):

NamedNodeMap

getNamespaceContext( ):

XPath

getNamespaceURI( ):

NameList, NamespaceContext, Node, QName

getNameType( ):

KerberosPrincipal

getNaN( ):

DecimalFormatSymbols

getNeedClientAuth( ):

SSLEngine, SSLServerSocket, SSLSocket

getNegativePrefix( ):

DecimalFormat

getNegativeSuffix( ):

DecimalFormat

getNetworkInterface( ):

MulticastSocket

getNetworkInterfaces( ):

NetworkInterface

getNewValue( ):

PreferenceChangeEvent

getNextEntry( ):

JarInputStream, ZipInputStream

getNextJarEntry( ):

JarInputStream

getNextSibling( ):

DOMResult, Node

getNextUpdate( ):

X509CRL

getNode( ):

DOMResult, DOMSource, PreferenceChangeEvent

getNodeName( ):

Node

getNodeType( ):

Node

getNodeValue( ):

Node

getNonCriticalExtensionOIDs( ):

X509Extension

getNonHeapMemoryUsage( ):

MemoryMXBean

getNotAfter( ):

X509Certificate

getNotationName( ):

Entity

getNotations( ):

DocumentType

getNotBefore( ):

X509Certificate

getNumberFormat( ):

DateFormat

getNumberInstance( ):

NumberFormat

getNumberWaiting( ):

CyclicBarrier

getNumericValue( ):

Character

getObject( ):

GuardedObject, ResourceBundle, SealedObject, SignedObject

getObjectPendingFinalizationCount( ):

MemoryMXBean

getObjectSize( ):

Instrumentation

getObjectStreamClass( ):

GetField

getOffset( ):

CollationElementIterator, DatagramPacket, ObjectStreamField, SimpleTimeZone, TimeZone

getOOBInline( ):

Socket

getOperatingSystemMXBean( ):

ManagementFactory

getOption( ):

SocketOptions

getOptions( ):

AppConfigurationEntry, ConfirmationCallback

getOptionType( ):

ConfirmationCallback

getOrder( ):

ECParameterSpec

getOriginatingNode( ):

DOMLocator

getOtherPrimeInfo( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec

getOutputProperties( ):

Templates, Transformer

getOutputProperty( ):

Transformer

getOutputSize( ):

Cipher, ExemptionMechanism

getOutputStream( ):

Process, Socket, SocketImpl, StreamResult, URLConnection *getOwner( ):*

ReentrantLock, ReentrantReadWriteLock

getOwnerDocument( ):

Node

getOwnerElement( ):

Attr

getOwnerType( ):

ParameterizedType

getP( ):

DHParameterSpec, DHPrivateKeySpec, DHPublicKeySpec, DSAParameterSpec, DSAParams, DSAPrivateKeySpec, DSAPublicKeySpec, ECFieldFp

getPackage( ):

Class, ClassLoader, Package

getPackages( ):

ClassLoader, Package

getPacketBufferSize( ):

SSLSession

getParameter( ):

DOMConfiguration, Signature, Transformer *getParameterAnnotations( ):*

Constructor, Method

getParameterNames( ):

DOMConfiguration

getParameters( ):

CertPathTrustManagerParameters, Cipher, KeyStoreBuilderParameters, LogRecord, Signature

getParameterSpec( ):

AlgorithmParameters

getParameterTypes( ):

Constructor, Method

getParams( ):

DHKey, DSAKey, ECKey, ECPrivateKeySpec, ECPublicKeySpec

getParent( ):

ClassLoader, File, Logger, NodeChangeEvent, PolicyNode, ThreadGroup, XMLFilter, XMLFilterImpl

getParentFile( ):

File

getParentLoggerName( ):

LoggingMXBean

getParentNode( ):

Node

getParser( ):

SAXParser

getParties( ):

CyclicBarrier

getPassword( ):

PasswordAuthentication, PasswordCallback, PasswordProtection, PBEKey, PBEKeySpec

getPasswordAuthentication( ):

Authenticator

getPath( ):

File, URI, URL

getPathToNames( ):

X509CertSelector

getPattern( ):

PatternSyntaxException

getPatternSeparator( ):

DecimalFormatSymbols

getPeakThreadCount( ):

ThreadMXBean

getPeakUsage( ):

MemoryPoolMXBean

getPeerCertificateChain( ):

HandshakeCompletedEvent, SSLSession

getPeerCertificates( ):

HandshakeCompletedEvent, SSLSession

getPeerHost( ):

SSLEngine, SSLSession

getPeerPort( ):

SSLEngine, SSLSession

getPeerPrincipal( ):

HandshakeCompletedEvent, HttpsURLConnection, SecureCacheResponse, SSLSession

getPercent( ):

DecimalFormatSymbols

getPercentInstance( ):

NumberFormat

getPerMill( ):

DecimalFormatSymbols

getPermission( ):

AccessControlException, HttpURLConnection, URLConnection

getPermissions( ):

Policy, ProtectionDomain, SecureClassLoader, URLClassLoader

getPlatformMBeanServer( ):

ManagementFactory

getPolicy( ):

Policy, X509CertSelector

getPolicyQualifier( ):

PolicyQualifierInfo

getPolicyQualifierId( ):

PolicyQualifierInfo

getPolicyQualifiers( ):

PolicyNode

getPolicyQualifiersRejected( ):

PKIXParameters

getPolicyTree( ):

PKIXCertPathValidatorResult

getPoolName( ):

MemoryNotificationInfo

getPoolSize( ):

ThreadPoolExecutor

getPort( ):

DatagramPacket, DatagramSocket, InetSocketAddress, LDAPCertStoreParameters, Socket, SocketImpl, URI, URL

getPositivePrefix( ):

DecimalFormat

getPositiveSuffix( ):

DecimalFormat

getPrecision( ):

IllegalFormatPrecisionException, MathContext

getPrefix( ):

NamespaceContext, NamespaceSupport, Node, QName

getPrefixes( ):

NamespaceContext, NamespaceSupport

getPreviousSibling( ):

Node

getPrime( ):

RSAOtherPrimeInfo

getPrimeExponentP( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKey, RSAPrivateCrtKeySpec

getPrimeExponentQ( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKey, RSAPrivateCrtKeySpec

getPrimeP( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKey, RSAPrivateCrtKeySpec

getPrimeQ( ):

RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKey, RSAPrivateCrtKeySpec

getPrimeSize( ):

DHGenParameterSpec

getPrincipal( ):

Certificate, KerberosKey

getPrincipals( ):

PrivateCredentialPermission, ProtectionDomain, Subject

getPriority( ):

Thread

getPrivate( ):

KeyPair

getPrivateCredentials( ):

Subject

getPrivateExponent( ):

RSAPrivateKey, RSAPrivateKeySpec

getPrivateKey( ):

PrivateKeyEntry, Signer, X500PrivateCredential, X509KeyManager

getPrivateKeyValid( ):

X509CertSelector

getPrompt( ):

ChoiceCallback, ConfirmationCallback, NameCallback, PasswordCallback, TextInputCallback

getProperties( ):

System

getProperty( ):

LogManager, ParserAdapter, Properties, SAXParser, SchemaFactory, Security, System, Validator, ValidatorHandler, XMLFilterImpl, XMLReader

getProtectionDomain( ):

Class

getProtectionParameter( ):

Builder, LoadStoreParameter

getProtocol( ):

SSLContext, SSLSession, URL

getProvider( ):

AlgorithmParameterGenerator, AlgorithmParameters, CertificateFactory, CertPathBuilder, CertPathValidator, CertStore, Cipher, ExemptionMechanism, KeyAgreement, KeyFactory, KeyGenerator, KeyManagerFactory, KeyPairGenerator, KeyStore, Mac, MessageDigest, SecretKeyFactory, SecureRandom, Security, Service, Signature, SSLContext, TrustManagerFactory

getProviders( ):

Security

getProxyClass( ):

Proxy

getPSource( ):

OAEPParameterSpec

getPublic( ):

KeyPair

getPublicCredentials( ):

Subject

getPublicExponent( ):

RSAKeyGenParameterSpec, RSAMultiPrimePrivateCrtKey, RSAMultiPrimePrivateCrtKeySpec, RSAPrivateCrtKey, RSAPrivateCrtKeySpec, RSAPublicKey, RSAPublicKeySpec

getPublicId( ):

DocumentType, Entity, InputSource, Locator, LocatorImpl, Notation, SAXParseException, SourceLocator, StreamSource

getPublicKey( ):

Certificate, Identity, PKIXCertPathValidatorResult

getPushLevel( ):

MemoryHandler

getQ( ):

DSAParameterSpec, DSAParams, DSAPrivateKeySpec, DSAPublicKeySpec

getQName( ):

Attributes, AttributesImpl

getQuery( ):

URI, URL

getQueue( ):

ScheduledThreadPoolExecutor, ThreadPoolExecutor

getQueuedReaderThreads( ):

ReentrantReadWriteLock

getQueuedThreads( ):

AbstractQueuedSynchronizer, ReentrantLock, ReentrantReadWriteLock, Semaphore

getQueuedWriterThreads( ):

ReentrantReadWriteLock

getQueueLength( ):

AbstractQueuedSynchronizer, ReentrantLock, ReentrantReadWriteLock, Semaphore

getRawAuthority( ):

URI

getRawFragment( ):

URI

getRawOffset( ):

SimpleTimeZone, TimeZone

getRawPath( ):

URI

getRawQuery( ):

URI

getRawSchemeSpecificPart( ):

URI

getRawType( ):

ParameterizedType

getRawUserInfo( ):

URI

getReader( ):

StreamSource

getReadLockCount( ):

ReentrantReadWriteLock

getReadTimeout( ):

URLConnection

getRealm( ):

KerberosPrincipal

getReason( ):

HttpRetryException, URISyntaxException

getReceiveBufferSize( ):

DatagramSocket, ServerSocket, Socket

getReductionPolynomial( ):

ECFieldF2m

getRef( ):

URL

getReference( ):

AtomicMarkableReference, AtomicStampedReference

getRejectedExecutionHandler( ):

ThreadPoolExecutor

getRelatedData( ):

DOMError

getRelatedException( ):

DOMError

getRelatedNode( ):

DOMLocator

getRemaining( ):

Inflater

getRemoteSocketAddress( ):

DatagramSocket, Socket

getRenewTill( ):

KerberosTicket

getRequestingHost( ):

Authenticator

getRequestingPort( ):

Authenticator

getRequestingPrompt( ):

Authenticator

getRequestingProtocol( ):

Authenticator

getRequestingScheme( ):

Authenticator

getRequestingSite( ):

Authenticator

getRequestingURL( ):

Authenticator

getRequestMethod( ):

HttpURLConnection

getRequestorType( ):

Authenticator

getRequestProperties( ):

URLConnection

getRequestProperty( ):

URLConnection

getResource( ):

Class, ClassLoader

getResourceAsStream( ):

Class, ClassLoader

getResourceBundle( ):

Logger, LogRecord

getResourceBundleName( ):

Level, Logger, LogRecord

getResourceResolver( ):

SchemaFactory, Validator, ValidatorHandler

getResources( ):

ClassLoader

getResponseCode( ):

HttpURLConnection

getResponseMessage( ):

HttpURLConnection

getReturnType( ):

Method

getReuseAddress( ):

DatagramSocket, ServerSocket, Socket

getRevocationDate( ):

X509CRLEntry

getRevokedCertificate( ):

X509CRL

getRevokedCertificates( ):

X509CRL

getRoundingMode( ):

MathContext

getRounds( ):

RC5ParameterSpec

getRules( ):

RuleBasedCollator

getRunCount( ):

Bidi

getRunLevel( ):

Bidi

getRunLimit( ):

AttributedCharacterIterator, Bidi

getRunStart( ):

AttributedCharacterIterator, Bidi

getRuntime( ):

Runtime

getRuntimeMXBean( ):

ManagementFactory

getS( ):

ECPrivateKey, ECPrivateKeySpec

getSalt( ):

PBEKey, PBEKeySpec, PBEParameterSpec

getSaltLength( ):

PSSParameterSpec

getSchema( ):

DocumentBuilder, DocumentBuilderFactory, SAXParser, SAXParserFactory

getSchemaTypeInfo( ):

Attr, Element

getScheme( ):

URI

getSchemeSpecificPart( ):

URI

getScope( ):

Identity

getScopedInterface( ):

Inet6Address

getScopeId( ):

Inet6Address

getSecond( ):

XMLGregorianCalendar

getSeconds( ):

Date, Duration

getSecretKey( ):

SecretKeyEntry

getSecurityContext( ):

SecurityManager

getSecurityManager( ):

System

getSeed( ):

EllipticCurve, SecureRandom

getSelectedIndex( ):

ConfirmationCallback

getSelectedIndexes( ):

ChoiceCallback

getSendBufferSize( ):

DatagramSocket, Socket

getSentenceInstance( ):

BreakIterator

getSequenceNumber( ):

LogRecord

getSerialNumber( ):

X509Certificate, X509CertSelector, X509CRLEntry

getSerialVersionUID( ):

ObjectStreamClass

getServer( ):

KerberosTicket

getServerAliases( ):

X509KeyManager

getServerCertificateChain( ):

SecureCacheResponse

getServerCertificates( ):

HttpsURLConnection

getServerName( ):

LDAPCertStoreParameters

getServerSessionContext( ):

SSLContext

getServerSocketFactory( ):

SSLContext

getService( ):

Provider

getServices( ):

Provider

getSession( ):

HandshakeCompletedEvent, SSLEngine, SSLSessionBindingEvent, SSLSessionContext, SSLSocket *getSessionCacheSize( ):*

SSLSessionContext

getSessionContext( ):

SSLSession

getSessionKey( ):

KerberosTicket

getSessionKeyType( ):

KerberosTicket

getSessionTimeout( ):

SSLSessionContext

getSeverity( ):

DOMError

getSharedQueuedThreads( ):

AbstractQueuedSynchronizer

getShort( ):

Array, BreakIterator, ByteBuffer, Field

getShortMonths( ):

DateFormatSymbols

getShortWeekdays( ):

DateFormatSymbols

getSigAlgName( ):

X509Certificate, X509CRL

getSigAlgOID( ):

X509Certificate, X509CRL

getSigAlgParams( ):

X509Certificate, X509CRL

getSign( ):

Duration

getSignature( ):

SignedObject, X509Certificate, X509CRL

getSignerCertPath( ):

CodeSigner, Timestamp

getSigners( ):

Class

getSigProvider( ):

PKIXParameters

getSimpleName( ):

Class

getSize( ):

ZipEntry

getSocket( ):

HandshakeCompletedEvent

getSocketAddress( ):

DatagramPacket

getSocketFactory( ):

SSLContext

getSoLinger( ):

Socket

getSoTimeout( ):

DatagramSocket, ServerSocket, Socket

getSource( ):

EventObject

getSourceClassName( ):

LogRecord

getSourceMethodName( ):

LogRecord

getSourceString( ):

CollationKey

getSpecificationTitle( ):

Package

getSpecificationVendor( ):

Package

getSpecificationVersion( ):

Package

getSpecified( ):

Attr

getSpecName( ):

RuntimeMXBean

getSpecVendor( ):

RuntimeMXBean

getSpecVersion( ):

RuntimeMXBean

getSpi( ):

AbstractPreferences

getSSLSocketFactory( ):

HttpsURLConnection

getStackTrace( ):

Thread, ThreadInfo, Throwable

getStamp( ):

AtomicStampedReference

getStartTime( ):

KerberosTicket, RuntimeMXBean

getState( ):

AbstractQueuedSynchronizer, Thread

getStatus( ):

SSLEngineResult

getStrength( ):

Collator

getStrictErrorChecking( ):

Document

getString( ):

ResourceBundle

getStringArray( ):

ResourceBundle

getSubject( ):

LoginContext, Subject, SubjectDomainCombiner, X509CertSelector

getSubjectAlternativeNames( ):

X509Certificate, X509CertSelector

getSubjectAsBytes( ):

X509CertSelector

getSubjectAsString( ):

X509CertSelector

getSubjectDN( ):

X509Certificate

getSubjectKeyIdentifier( ):

X509CertSelector

getSubjectPublicKey( ):

X509CertSelector

getSubjectPublicKeyAlgID( ):

X509CertSelector

getSubjectUniqueID( ):

X509Certificate

getSubjectX500Principal( ):

X509Certificate

getSuperclass( ):

Class

getSupportedCipherSuites( ):

SSLEngine, SSLServerSocket, SSLServerSocketFactory, SSLSocket, SSLSocketFactory

getSupportedExtensions( ):

PKIXCertPathChecker

getSupportedProtocols( ):

SSLEngine, SSLServerSocket, SSLSocket

getSymbol( ):

Currency

getSystemClassLoader( ):

ClassLoader

getSystemId( ):

DocumentType, DOMResult, DOMSource, Entity, InputSource, Locator, LocatorImpl, Notation, Result, SAXParseException, SAXResult, SAXSource, Source, SourceLocator, StreamResult, StreamSource, TemplatesHandler, TransformerHandler

getSystemProperties( ):

RuntimeMXBean

getSystemResource( ):

ClassLoader

getSystemResourceAsStream( ):

ClassLoader

getSystemResources( ):

ClassLoader

getSystemScope( ):

IdentityScope

getTagName( ):

Element

getTail( ):

Formatter, XMLFormatter

getTarget( ):

ProcessingInstruction

getTargetCertConstraints( ):

PKIXParameters

getTargetException( ):

InvocationTargetException

getTaskCount( ):

ThreadPoolExecutor

getTBSCertificate( ):

X509Certificate

getTBSCertList( ):

X509CRL

getTcpNoDelay( ):

Socket

getTemplates( ):

TemplatesHandler

getText( ):

BreakIterator, TextInputCallback

getTextContent( ):

Node

getThisUpdate( ):

X509CRL

getThreadCount( ):

ThreadMXBean

getThreadCpuTime( ):

ThreadMXBean

getThreadFactory( ):

ThreadPoolExecutor

getThreadGroup( ):

SecurityManager, Thread

getThreadId( ):

ThreadInfo

getThreadID( ):

LogRecord

getThreadInfo( ):

ThreadMXBean

getThreadMXBean( ):

ManagementFactory

getThreadName( ):

ThreadInfo

getThreadState( ):

ThreadInfo

getThreadUserTime( ):

ThreadMXBean

getThrown( ):

LogRecord

getTime( ):

Calendar, Date, ZipEntry

getTimeInMillis( ):

Calendar, Duration

getTimeInstance( ):

DateFormat

getTimestamp( ):

CodeSigner, Timestamp

getTimeToLive( ):

DatagramSocketImpl, MulticastSocket

getTimeZone( ):

Calendar, DateFormat, GregorianCalendar, TimeZone, XMLGregorianCalendar

getTimezone( ):

XMLGregorianCalendar

getTimezoneOffset( ):

Date

getTotalCompilationTime( ):

CompilationMXBean

getTotalIn( ):

Deflater, Inflater

getTotalLoadedClassCount( ):

ClassLoadingMXBean

getTotalOut( ):

Deflater, Inflater

getTotalStartedThreadCount( ):

ThreadMXBean

getTrafficClass( ):

DatagramSocket, Socket

getTrailerField( ):

PSSParameterSpec

getTransformer( ):

TransformerHandler

getTrustAnchor( ):

PKIXCertPathValidatorResult

getTrustAnchors( ):

PKIXParameters

getTrustedCert( ):

TrustAnchor

getTrustedCertificate( ):

TrustedCertificateEntry

getTrustManagers( ):

TrustManagerFactory

getTTL( ):

DatagramSocketImpl, MulticastSocket

getType( ):

AttributeList, AttributeListImpl, Attributes, AttributesImpl, Certificate, CertificateFactory, CertPath, CertStore, Character, CRL, DOMError, Field, KeyStore, MemoryPoolMXBean, ObjectStreamField, Service

getTypeCode( ):

ObjectStreamField

getTypeInfoProvider( ):

ValidatorHandler

getTypeName( ):

TypeInfo

getTypeNamespace( ):

TypeInfo

getTypeParameters( ):

Class, Constructor, GenericDeclaration, Method

getTypeString( ):

ObjectStreamField

getUncaughtExceptionHandler( ):

Thread

getUndeclaredThrowable( ):

UndeclaredThrowableException

getUnloadedClassCount( ):

ClassLoadingMXBean

getUnresolvedActions( ):

UnresolvedPermission

getUnresolvedCerts( ):

UnresolvedPermission

getUnresolvedName( ):

UnresolvedPermission

getUnresolvedType( ):

UnresolvedPermission

getUpperBounds( ):

WildcardType

getUptime( ):

RuntimeMXBean

getURI( ):

Attributes, AttributesImpl, NamespaceSupport

getUri( ):

DOMLocator

getURIResolver( ):

Transformer, TransformerFactory

getURL( ):

URLConnection

getURLs( ):

URLClassLoader

getUsage( ):

MemoryNotificationInfo, MemoryPoolMXBean *getUsageThreshold( ):*

MemoryPoolMXBean

getUsageThresholdCount( ):

MemoryPoolMXBean

getUseCaches( ):

URLConnection

getUseClientMode( ):

SSLEngine, SSLServerSocket, SSLSocket

getUsed( ):

MemoryUsage

getUseParentHandlers( ):

Logger

getUserData( ):

Node

getUserInfo( ):

URI, URL

getUserName( ):

PasswordAuthentication

getUtf16Offset( ):

DOMLocator

getValidPolicy( ):

PolicyNode

getValue( ):

Adler32, Annotation, Attr, AttributeList, AttributeListImpl, Attributes, AttributesImpl, Checksum, CRC32, Entry, PSpecified, SSLSession

getValueNames( ):

SSLSession

getVariant( ):

Locale

getVersion( ):

OperatingSystemMXBean, Provider, RC5ParameterSpec, X509Certificate, X509CRL

getVersionNumber( ):

KerberosKey

getVmName( ):

RuntimeMXBean

getVmVendor( ):

RuntimeMXBean

getVmVersion( ):

RuntimeMXBean

getW( ):

ECPublicKey, ECPublicKeySpec

getWaitedCount( ):

ThreadInfo

getWaitedTime( ):

ThreadInfo

getWaitingThreads( ):

AbstractQueuedSynchronizer, ConditionObject, ReentrantLock, ReentrantReadWriteLock

getWaitQueueLength( ):

AbstractQueuedSynchronizer, ConditionObject, ReentrantLock, ReentrantReadWriteLock

getWantClientAuth( ):

SSLEngine, SSLServerSocket, SSLSocket

getWeekdays( ):

DateFormatSymbols

getWholeText( ):

Text

getWidth( ):

IllegalFormatWidthException

getWordInstance( ):

BreakIterator

getWordSize( ):

RC5ParameterSpec

getWriteHoldCount( ):

ReentrantReadWriteLock

getWriter( ):

StreamResult

getX( ):

DHPrivateKey, DHPrivateKeySpec, DSAPrivateKey, DSAPrivateKeySpec

getXmlEncoding( ):

Document, Entity

getXMLReader( ):

SAXParser, SAXSource

getXMLSchemaType( ):

Duration, XMLGregorianCalendar

getXmlStandalone( ):

Document

getXmlVersion( ):

Document, Entity

getXMLVersion( ):

Locator2, Locator2Impl

getXPathFunctionResolver( ):

XPath

getXPathVariableResolver( ):

XPath

getY( ):

DHPublicKey, DHPublicKeySpec, DSAPublicKey, DSAPublicKeySpec

getYear( ):

Date, XMLGregorianCalendar

getYears( ):

Duration

getZeroDigit( ):

DecimalFormatSymbols

getZoneStrings( ):

DateFormatSymbols

global:

Logger

GMONTH:

DatatypeConstants

GMONTHDAY:

DatatypeConstants

GOTHIC:

UnicodeBlock

GREATER:

DatatypeConstants

GREEK:

UnicodeBlock

GREEK_EXTENDED:

UnicodeBlock

GregorianCalendar:

java.util

group( ):

Matcher, MatchResult

groupCount( ):

Matcher, MatchResult

GROUPING_SEPARATOR:

Field

Guard:

java.security

GuardedObject:

java.security

guessContentTypeFromName( ):

URLConnection

guessContentTypeFromStream( ):

URLConnection

GUJARATI:

UnicodeBlock

GURMUKHI:

UnicodeBlock

GYEAR:

DatatypeConstants

GYEARMONTH:

DatatypeConstants

GZIP_MAGIC:

GZIPInputStream

GZIPInputStream:

java.util.zip

GZIPOutputStream:

java.util.zip

Team LiB

Team LiB

23.8. H

h:

Proxy

HALF_DOWN:

RoundingMode

HALF_EVEN:

RoundingMode

HALF_UP:

RoundingMode

HALFWIDTH_AND_FULLWIDTH_FORMS:

UnicodeBlock

halt( ):

Runtime

handle( ):

CallbackHandler, UserDataHandler

handleError( ):

DOMErrorHandler

handleGetObject( ):

ListResourceBundle, PropertyResourceBundle, ResourceBundle

Handler:

java.util.logging

HandlerBase:

org.xml.sax

handshakeCompleted( ):

HandshakeCompletedListener

HandshakeCompletedEvent:

javax.net.ssl

HandshakeCompletedListener:

javax.net.ssl

HandshakeStatus:

javax.net.ssl.SSLEngineResult

HANGUL_COMPATIBILITY_JAMO:

UnicodeBlock

HANGUL_JAMO:

UnicodeBlock

HANGUL_SYLLABLES:

UnicodeBlock

HANUNOO:

UnicodeBlock

hasAnchoringBounds( ):

Matcher

hasArray( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

hasAttribute( ):

Element

hasAttributeNS( ):

Element

hasAttributes( ):

Node

hasChanged( ):

Observable

hasChildNodes( ):

Node

hasContended( ):

AbstractQueuedSynchronizer

hasExtensions( ):

X509CRLEntry

hasFeature( ):

DOMImplementation

hashCode( ):

AbstractList, AbstractMap, AbstractSet, AccessControlContext, AllPermission, Annotation, Arrays, Attribute, Attributes, BasicPermission, BigDecimal, BigInteger, BitSet, Boolean, Byte, ByteBuffer, Calendar, Certificate, CertPath, Character, CharBuffer, Charset, ChoiceFormat, CodeSigner, CodeSource, CollationKey, Collator, Collection, Constructor, CopyOnWriteArrayList, Date, DateFormat, DateFormatSymbols, DecimalFormat, DecimalFormatSymbols, DelegationPermission, Double, DoubleBuffer, Duration, ECFieldF2m, ECFieldFp, ECPoint, EllipticCurve, Entry, Enum, Field, FieldPosition, File, FilePermission, Float, FloatBuffer, GregorianCalendar, Hashtable, Identity, IdentityHashMap, Inet4Address, Inet6Address, InetAddress, InetSocketAddress, IntBuffer, Integer, KerberosPrincipal, Level, List, Locale, Long, LongBuffer, Manifest, Map, MathContext, MessageFormat, Method, Name, NetworkInterface, NumberFormat, Object, Package, ParsePosition, Permission, Principal, PrivateCredentialPermission, PropertyPermission, Proxy, QName, RC2ParameterSpec, RC5ParameterSpec, RuleBasedCollator, SecretKeySpec, ServicePermission, Set, Short, ShortBuffer, SimpleDateFormat, SimpleTimeZone, SocketPermission, StackTraceElement, String, StringCharacterIterator, Subject, Subset, Timestamp, UnresolvedPermission, URI, URL, URLStreamHandler, UUID, Vector, X500Principal, X509CRL, X509CRLEntry, XMLGregorianCalendar, ZipEntry

HashMap:

java.util

HashSet:

java.util

Hashtable:

java.util

hasMoreElements( ):

Enumeration, StringTokenizer

hasMoreTokens( ):

StringTokenizer

hasNext( ):

Iterator, ListIterator, Scanner

hasNextBigDecimal( ):

Scanner

hasNextBigInteger( ):

Scanner

hasNextBoolean( ):

Scanner

hasNextByte( ):

Scanner

hasNextDouble( ):

Scanner

hasNextFloat( ):

Scanner

hasNextInt( ):

Scanner

hasNextLine( ):

Scanner

hasNextLong( ):

Scanner

hasNextShort( ):

Scanner

hasPrevious( ):

ListIterator

hasQueuedThread( ):

ReentrantLock, ReentrantReadWriteLock

hasQueuedThreads( ):

AbstractQueuedSynchronizer, ReentrantLock, ReentrantReadWriteLock, Semaphore

hasRemaining( ):

Buffer

hasSameRules( ):

SimpleTimeZone, TimeZone

hasTransparentBounds( ):

Matcher

hasUnsupportedCriticalExtension( ):

X509Extension

hasWaiters( ):

AbstractQueuedSynchronizer, ConditionObject, ReentrantLock, ReentrantReadWriteLock

headMap( ):

SortedMap, TreeMap

headSet( ):

SortedSet, TreeSet

HEAP:

MemoryType

HEBREW:

UnicodeBlock

HIERARCHY_REQUEST_ERR:

DOMException

HIGH_PRIVATE_USE_SURROGATES:

UnicodeBlock

HIGH_SURROGATES:

UnicodeBlock

highestOneBit( ):

Integer, Long

HIRAGANA:

UnicodeBlock

hitEnd( ):

Matcher

holdsLock( ):

Thread

hostnameVerifier:

HttpsURLConnection

HostnameVerifier:

javax.net.ssl

hostsEqual( ):

URLStreamHandler

HOUR:

Calendar

HOUR0:

Field

HOUR0_FIELD:

DateFormat

HOUR1:

Field

HOUR1_FIELD:

DateFormat

HOUR_OF_DAY:

Calendar

HOUR_OF_DAY0:

Field

HOUR_OF_DAY0_FIELD:

DateFormat

HOUR_OF_DAY1:

Field

HOUR_OF_DAY1_FIELD:

DateFormat

HOURS:

DatatypeConstants

HTTP:

Type

HTTP_ACCEPTED:

HttpURLConnection

HTTP_BAD_GATEWAY:

HttpURLConnection

HTTP_BAD_METHOD:

HttpURLConnection

HTTP_BAD_REQUEST:

HttpURLConnection

HTTP_CLIENT_TIMEOUT:

HttpURLConnection

HTTP_CONFLICT:

HttpURLConnection

HTTP_CREATED:

HttpURLConnection

HTTP_ENTITY_TOO_LARGE:

HttpURLConnection

HTTP_FORBIDDEN:

HttpURLConnection

HTTP_GATEWAY_TIMEOUT:

HttpURLConnection

HTTP_GONE:

HttpURLConnection

HTTP_INTERNAL_ERROR:

HttpURLConnection

HTTP_LENGTH_REQUIRED:

HttpURLConnection

HTTP_MOVED_PERM:

HttpURLConnection

HTTP_MOVED_TEMP:

HttpURLConnection

HTTP_MULT_CHOICE:

HttpURLConnection

HTTP_NO_CONTENT:

HttpURLConnection

HTTP_NOT_ACCEPTABLE:

HttpURLConnection

HTTP_NOT_AUTHORITATIVE:

HttpURLConnection

HTTP_NOT_FOUND:

HttpURLConnection

HTTP_NOT_IMPLEMENTED:

HttpURLConnection

HTTP_NOT_MODIFIED:

HttpURLConnection

HTTP_OK:

HttpURLConnection

HTTP_PARTIAL:

HttpURLConnection

HTTP_PAYMENT_REQUIRED:

HttpURLConnection

HTTP_PRECON_FAILED:

HttpURLConnection

HTTP_PROXY_AUTH:

HttpURLConnection

HTTP_REQ_TOO_LONG:

HttpURLConnection

HTTP_RESET:

HttpURLConnection

HTTP_SEE_OTHER:

HttpURLConnection

HTTP_SERVER_ERROR:

HttpURLConnection

HTTP_UNAUTHORIZED:

HttpURLConnection

HTTP_UNAVAILABLE:

HttpURLConnection

HTTP_UNSUPPORTED_TYPE:

HttpURLConnection

HTTP_USE_PROXY:

HttpURLConnection

HTTP_VERSION:

HttpURLConnection

HttpRetryException:

java.net

HttpsURLConnection:

javax.net.ssl

HttpURLConnection:

java.net

HUFFMAN_ONLY:

Deflater

hypot( ):

Math, StrictMath

Team LiB

23.9. I

IDENTICAL:

Collator

identities( ):

IdentityScope

Identity:

java.security

identityEquals( ):

Identity

identityHashCode( ):

System

IdentityHashMap:

java.util

IdentityScope:

java.security

IDEOGRAPHIC_DESCRIPTION_CHARACTERS:

UnicodeBlock

IEEEremainder( ):

Math, StrictMath

ifModifiedSince:

URLConnection

ignorableWhitespace( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

IGNORE:

CodingErrorAction

IllegalAccessError:

java.lang

IllegalAccessException:

java.lang

IllegalArgumentException:

java.lang

IllegalBlockingModeException:

java.nio.channels

IllegalBlockSizeException:

javax.crypto

IllegalCharsetNameException:

java.nio.charset

IllegalClassFormatException:

java.lang.instrument

IllegalFormatCodePointException:

java.util

IllegalFormatConversionException:

java.util

IllegalFormatException:

java.util

IllegalFormatFlagsException:

java.util

IllegalFormatPrecisionException:

java.util

IllegalFormatWidthException:

java.util

IllegalMonitorStateException:

java.lang

IllegalSelectorException:

java.nio.channels

IllegalStateException:

java.lang

IllegalThreadStateException:

java.lang

implAccept( ):

ServerSocket

implCloseChannel( ):

AbstractInterruptibleChannel, AbstractSelectableChannel

implCloseSelectableChannel( ):

AbstractSelectableChannel

implCloseSelector( ):

AbstractSelector

implConfigureBlocking( ):

AbstractSelectableChannel

IMPLEMENTATION_TITLE:

Name

IMPLEMENTATION_URL:

Name

IMPLEMENTATION_VENDOR:

Name

IMPLEMENTATION_VENDOR_ID:

Name

IMPLEMENTATION_VERSION:

Name

implFlush( ):

CharsetDecoder, CharsetEncoder

implies( ):

AllPermission, BasicPermission, CodeSource, DelegationPermission, FilePermission, Permission, PermissionCollection, Permissions, Policy, PrivateCredentialPermission, PropertyPermission, ProtectionDomain, ServicePermission, SocketPermission, UnresolvedPermission

implOnMalformedInput( ):

CharsetDecoder, CharsetEncoder

implOnUnmappableCharacter( ):

CharsetDecoder, CharsetEncoder

implReplaceWith( ):

CharsetDecoder, CharsetEncoder

implReset( ):

CharsetDecoder, CharsetEncoder

importNode( ):

Document

importPreferences( ):

Preferences

in:

FileDescriptor, FilterInputStream, FilterReader, PipedInputStream, System

inCheck:

SecurityManager

inClass( ):

SecurityManager

inClassLoader( ):

SecurityManager

IncompatibleClassChangeError:

java.lang

IncompleteAnnotationException:

java.lang.annotation

incrementAndGet( ):

AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater

inDaylightTime( ):

SimpleTimeZone, TimeZone

INDENT:

OutputKeys

INDETERMINATE:

DatatypeConstants

INDEX_SIZE_ERR:

DOMException

indexOf( ):

AbstractList, ArrayList, CopyOnWriteArrayList, LinkedList, List, String, StringBuffer, StringBuilder, Vector

indexOfSubList( ):

Collections

IndexOutOfBoundsException:

java.lang

Inet4Address:

java.net

Inet6Address:

java.net

InetAddress:

java.net

InetSocketAddress:

java.net

inf:

InflaterInputStream

inflate( ):

Inflater

Inflater:

java.util.zip

InflaterInputStream:

java.util.zip

INFO:

Level

info( ):

Logger

INFORMATION:

ConfirmationCallback, TextOutputCallback

InheritableThreadLocal:

java.lang

Inherited:

java.lang.annotation

inheritedChannel( ):

SelectorProvider, System

init( ):

AlgorithmParameterGenerator, AlgorithmParameters, Cipher, ExemptionMechanism, KeyAgreement, KeyGenerator, KeyManagerFactory, Mac, PKIXCertPathChecker, SSLContext, TrustManagerFactory

initCause( ):

Throwable, TransformerException

INITIAL_QUOTE_PUNCTUATION:

Character

initialize( ):

DSAKeyPairGenerator, KeyPairGenerator, KeyPairGeneratorSpi, LoginModule

initialValue( ):

ThreadLocal

initSign( ):

Signature

initVerify( ):

Signature

INPUT_METHOD_SEGMENT:

Attribute

InputMismatchException:

java.util

InputSource:

org.xml.sax

InputStream:

java.io

InputStreamReader:

java.io

insert( ):

StringBuffer, StringBuilder

insertBefore( ):

Node

insertData( ):

CharacterData

insertElementAt( ):

Vector

insertProviderAt( ):

Security

instanceFollowRedirects:

HttpURLConnection

InstantiationError:

java.lang

InstantiationException:

java.lang

Instrumentation:

java.lang.instrument

intBitsToFloat( ):

Float

IntBuffer:

java.nio

INTEGER:

Field

Integer:

java.lang

INTEGER_FIELD:

NumberFormat

interestOps( ):

SelectionKey

INTERFACE:

Modifier

intern( ):

String

internalEntityDecl( ):

DeclHandler, DefaultHandler2

InternalError:

java.lang

internalGet( ):

Calendar

interrupt( ):

Thread, ThreadGroup

interrupted( ):

Thread

InterruptedException:

java.lang

InterruptedIOException:

java.io

InterruptibleChannel:

java.nio.channels

intersects( ):

BitSet

intValue( ):

AtomicInteger, AtomicLong, BigDecimal, BigInteger, Byte, Double, Float, Integer, Level, Long, Number, Short

intValueExact( ):

BigDecimal

INUSE_ATTRIBUTE_ERR:

DOMException

INVALID_ACCESS_ERR:

DOMException

INVALID_CHARACTER_ERR:

DOMException

INVALID_MODIFICATION_ERR:

DOMException

INVALID_STATE_ERR:

DOMException

InvalidAlgorithmParameterException:

java.security

invalidate( ):

SSLSession

InvalidClassException:

java.io

InvalidKeyException:

java.security

InvalidKeySpecException:

java.security.spec

InvalidMarkException:

java.nio

InvalidObjectException:

java.io

InvalidParameterException:

java.security

InvalidParameterSpecException:

java.security.spec

InvalidPreferencesFormatException:

java.util.prefs

InvalidPropertiesFormatException:

java.util

InvocationHandler:

java.lang.reflect

InvocationTargetException:

java.lang.reflect

invoke( ):

InvocationHandler, Method

invokeAll( ):

AbstractExecutorService, ExecutorService

invokeAny( ):

AbstractExecutorService, ExecutorService

IOException:

java.io

ioException( ):

Formatter, Scanner

IP_MULTICAST_IF:

SocketOptions

IP_MULTICAST_IF2:

SocketOptions

IP_MULTICAST_LOOP:

SocketOptions

IP_TOS:

SocketOptions

IPA_EXTENSIONS:

UnicodeBlock

isAbsolute( ):

File, URI

isAbstract( ):

Modifier

isAcceptable( ):

SelectionKey

isAccessible( ):

AccessibleObject

isAlive( ):

Thread

isAnnotation( ):

Class

isAnnotationPresent( ):

AccessibleObject, AnnotatedElement, Class, Package

isAnonymousClass( ):

Class

isAnyLocalAddress( ):

Inet4Address, Inet6Address, InetAddress

isAnyPolicyInhibited( ):

PKIXParameters

isArray( ):

Class

isAssignableFrom( ):

Class

isAutoDetecting( ):

CharsetDecoder

isBlocking( ):

AbstractSelectableChannel, SelectableChannel

isBootClassPathSupported( ):

RuntimeMXBean

isBound( ):

DatagramSocket, ServerSocket, Socket

isBoundary( ):

BreakIterator

isBridge( ):

Method

isBroken( ):

CyclicBarrier

isCancelled( ):

Future, FutureTask

isCertificateEntry( ):

KeyStore

isCharsetDetected( ):

CharsetDecoder

isClosed( ):

DatagramSocket, ServerSocket, Socket

isCoalescing( ):

DocumentBuilderFactory

isCollectionUsageThresholdExceeded( ):

MemoryPoolMXBean

isCollectionUsageThresholdSupported( ):

MemoryPoolMXBean

isCompatibleWith( ):

Package

isCompilationTimeMonitoringSupported( ):

CompilationMXBean

isConnectable( ):

SelectionKey

isConnected( ):

DatagramChannel, DatagramSocket, Socket, SocketChannel *isConnectionPending( ):*

SocketChannel

isCritical( ):

PolicyNode

isCryptoAllowed( ):

ExemptionMechanism

isCurrent( ):

KerberosTicket, Refreshable

isCurrentThreadCpuTimeSupported( ):

ThreadMXBean

isDaemon( ):

Thread, ThreadGroup

isDecimalSeparatorAlwaysShown( ):

DecimalFormat

isDeclared( ):

Attributes2, Attributes2Impl

isDefaultNamespace( ):

Node

isDefined( ):

Character

isDerivedFrom( ):

TypeInfo

isDestroyed( ):

Destroyable, KerberosKey, KerberosTicket, PasswordProtection, ThreadGroup, X500PrivateCredential

isDigit( ):

Character

isDirect( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

isDirectory( ):

File, ZipEntry

isDone( ):

Future, FutureTask

isEchoOn( ):

PasswordCallback

isElementContentWhitespace( ):

Text

isEmpty( ):

AbstractCollection, AbstractMap, ArrayList, Attributes, BitSet, Collection, ConcurrentHashMap, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, Dictionary, HashMap, HashSet, Hashtable, IdentityHashMap, List, Map, Set, SynchronousQueue, TreeSet, Vector, WeakHashMap

isEnqueued( ):

Reference

isEnum( ):

Class

isEnumConstant( ):

Field

isEqual( ):

MessageDigest

isEqualNode( ):

Node

isError( ):

CoderResult

isExpandEntityReferences( ):

DocumentBuilderFactory

isExplicitPolicyRequired( ):

PKIXParameters

isFair( ):

ReentrantLock, ReentrantReadWriteLock, Semaphore

isFile( ):

File

isFinal( ):

Modifier

isForwardable( ):

KerberosTicket

isForwardCheckingSupported( ):

PKIXCertPathChecker

isForwarded( ):

KerberosTicket

isGroupingUsed( ):

NumberFormat

isHeldByCurrentThread( ):

ReentrantLock

isHeldExclusively( ):

AbstractQueuedSynchronizer

isHidden( ):

File

isHighSurrogate( ):

Character

isId( ):

Attr

isIdAttribute( ):

TypeInfoProvider

isIdentifierIgnorable( ):

Character

isIgnoringComments( ):

DocumentBuilderFactory

isIgnoringElementContentWhitespace( ):

DocumentBuilderFactory

isInboundDone( ):

SSLEngine

isInfinite( ):

Double, Float

isInitial( ):

KerberosTicket

isInNative( ):

ThreadInfo

isInputShutdown( ):

Socket

isInstance( ):

Class

isInterface( ):

Class, Modifier

isInterrupted( ):

Thread

isIPv4CompatibleAddress( ):

Inet6Address

isISOControl( ):

Character

isJavaIdentifierPart( ):

Character

isJavaIdentifierStart( ):

Character

isJavaLetter( ):

Character

isJavaLetterOrDigit( ):

Character

isKeyEntry( ):

KeyStore

isLeapYear( ):

GregorianCalendar

isLeftToRight( ):

Bidi

isLegalReplacement( ):

CharsetEncoder

isLenient( ):

Calendar, DateFormat

isLetter( ):

Character

isLetterOrDigit( ):

Character

isLinkLocalAddress( ):

Inet4Address, Inet6Address, InetAddress

isLoaded( ):

MappedByteBuffer

isLocalClass( ):

Class

isLocked( ):

ReentrantLock

isLoggable( ):

Filter, Handler, Logger, MemoryHandler, StreamHandler

isLongerThan( ):

Duration

isLoopbackAddress( ):

Inet4Address, Inet6Address, InetAddress

isLowerCase( ):

Character

isLowSurrogate( ):

Character

isMalformed( ):

CoderResult

isMarked( ):

AtomicMarkableReference

isMCGlobal( ):

Inet4Address, Inet6Address, InetAddress

isMCLinkLocal( ):

Inet4Address, Inet6Address, InetAddress

isMCNodeLocal( ):

Inet4Address, Inet6Address, InetAddress

isMCOrgLocal( ):

Inet4Address, Inet6Address, InetAddress

isMCSiteLocal( ):

Inet4Address, Inet6Address, InetAddress

isMemberClass( ):

Class

isMirrored( ):

Character

isMixed( ):

Bidi

isMulticastAddress( ):

Inet4Address, Inet6Address, InetAddress

isNamespaceAware( ):

DocumentBuilder, DocumentBuilderFactory, SAXParser, SAXParserFactory

isNamespaceDeclUris( ):

NamespaceSupport

isNaN( ):

Double, Float

isNative( ):

Modifier

isNativeMethod( ):

StackTraceElement

isObjectModelSupported( ):

XPathFactory

isOpaque( ):

URI

isOpen( ):

AbstractInterruptibleChannel, AbstractSelector, Channel, Selector *isOutboundDone( ):*

SSLEngine

isOutputShutdown( ):

Socket

isOverflow( ):

CoderResult

isParityAdjusted( ):

DESedeKeySpec, DESKeySpec

isParseBigDecimal( ):

DecimalFormat

isParseIntegerOnly( ):

NumberFormat

isPolicyMappingInhibited( ):

PKIXParameters

isPostdated( ):

KerberosTicket

isPrimitive( ):

Class, ObjectStreamField

isPrivate( ):

Modifier

isProbablePrime( ):

BigInteger

isProtected( ):

Modifier

isProxiable( ):

KerberosTicket

isProxy( ):

KerberosTicket

isProxyClass( ):

Proxy

isPublic( ):

Modifier

isQueued( ):

AbstractQueuedSynchronizer

isReachable( ):

InetAddress

isReadable( ):

SelectionKey

isReadOnly( ):

Buffer, PermissionCollection, Subject

isRedefineClassesSupported( ):

Instrumentation

isRegistered( ):

AbstractSelectableChannel, Charset, SelectableChannel

isRemoved( ):

AbstractPreferences

isRenewable( ):

KerberosTicket

isRevocationEnabled( ):

PKIXParameters

isRevoked( ):

CRL

isRightToLeft( ):

Bidi

isSameNode( ):

Node

isSchemaLanguageSupported( ):

SchemaFactory

isSealed( ):

Package

isSet:

Calendar

isSet( ):

Calendar, Duration

isShared( ):

FileLock

isShorterThan( ):

Duration

isShutdown( ):

ExecutorService, ThreadPoolExecutor

isSiteLocalAddress( ):

Inet4Address, Inet6Address, InetAddress

isSpace( ):

Character

isSpaceChar( ):

Character

isSpecified( ):

Attributes2, Attributes2Impl, TypeInfoProvider

isStatic( ):

Modifier

isStrict( ):

Modifier

isSupplementaryCodePoint( ):

Character

isSupported( ):

Charset, Node

isSurrogatePair( ):

Character

isSuspended( ):

ThreadInfo

isSynchronized( ):

Modifier

isSynthetic( ):

Class, Constructor, Field, Member, Method

isTerminated( ):

ExecutorService, ThreadPoolExecutor

isTerminating( ):

ThreadPoolExecutor

isThreadContentionMonitoringEnabled( ):

ThreadMXBean

isThreadContentionMonitoringSupported( ):

ThreadMXBean

isThreadCpuTimeEnabled( ):

ThreadMXBean

isThreadCpuTimeSupported( ):

ThreadMXBean

isTimeSet:

Calendar

isTitleCase( ):

Character

isTransient( ):

Modifier

isUnderflow( ):

CoderResult

isUnicodeIdentifierPart( ):

Character

isUnicodeIdentifierStart( ):

Character

isUnmappable( ):

CoderResult

isUnresolved( ):

InetSocketAddress

isUnshared( ):

ObjectStreamField

isUpperCase( ):

Character

isUsageThresholdExceeded( ):

MemoryPoolMXBean

isUsageThresholdSupported( ):

MemoryPoolMXBean

isUserNode( ):

AbstractPreferences, Preferences

isValid( ):

AbstractSelectionKey, FileLock, MemoryManagerMXBean, MemoryPoolMXBean, SelectionKey, SSLSession, XMLGregorianCalendar

isValidating( ):

DocumentBuilder, DocumentBuilderFactory, SAXParser, SAXParserFactory

isValidCodePoint( ):

Character

isVarArgs( ):

Constructor, Method

isVerbose( ):

ClassLoadingMXBean, MemoryMXBean

isVolatile( ):

Modifier

isWeak( ):

DESKeySpec

isWhitespace( ):

Character

isWritable( ):

SelectionKey

isWriteLocked( ):

ReentrantReadWriteLock

isWriteLockedByCurrentThread( ):

ReentrantReadWriteLock

isXIncludeAware( ):

DocumentBuilder, DocumentBuilderFactory, SAXParser, SAXParserFactory

ITALIAN:

Locale

ITALY:

Locale

item( ):

DOMImplementationList, DOMStringList, NamedNodeMap, NodeList

Iterable:

java.lang

Iterator:

java.util

iterator( ):

AbstractCollection, AbstractList, AbstractSequentialList, ArrayBlockingQueue, Collection, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, DelayQueue, HashSet, Iterable, LinkedBlockingQueue, List, PriorityBlockingQueue, PriorityQueue, Set, SynchronousQueue, TreeSet

IvParameterSpec:

javax.crypto.spec

Team LiB

23.10. J

JANUARY:

Calendar, DatatypeConstants

JAPAN:

Locale

JAPANESE:

Locale

JarEntry:

java.util.jar

JarException:

java.util.jar

JarFile:

java.util.jar

jarFileURLConnection:

JarURLConnection

JarInputStream:

java.util.jar

JarOutputStream:

java.util.jar

JarURLConnection:

java.net

join( ):

DatagramSocketImpl, Thread

joinGroup( ):

DatagramSocketImpl, MulticastSocket

JULY:

Calendar, DatatypeConstants

JUNE:

Calendar, DatatypeConstants

Team LiB

23.11. K

KANBUN:

UnicodeBlock

KANGXI_RADICALS:

UnicodeBlock

KANNADA:

UnicodeBlock

KATAKANA:

UnicodeBlock

KATAKANA_PHONETIC_EXTENSIONS:

UnicodeBlock

KEEP:

Packer, Unpacker

KEEP_FILE_ORDER:

Packer

KerberosKey:

javax.security.auth.kerberos

KerberosPrincipal:

javax.security.auth.kerberos

KerberosTicket:

javax.security.auth.kerberos

Key:

java.security

KeyAgreement:

javax.crypto

KeyAgreementSpi:

javax.crypto

KeyException:

java.security

KeyFactory:

java.security

KeyFactorySpi:

java.security

keyFor( ):

AbstractSelectableChannel, SelectableChannel

KeyGenerator:

javax.crypto

KeyGeneratorSpi:

javax.crypto

KeyManagementException:

java.security

KeyManager:

javax.net.ssl

KeyManagerFactory:

javax.net.ssl

KeyManagerFactorySpi:

javax.net.ssl

KeyPair:

java.security

KeyPairGenerator:

java.security

KeyPairGeneratorSpi:

java.security

KeyRep:

java.security

KeyRep.Type:

java.security

keys( ):

AbstractPreferences, ConcurrentHashMap, Dictionary, Hashtable, Preferences, Selector

keySet( ):

AbstractMap, Attributes, ConcurrentHashMap, EnumMap, HashMap, Hashtable, IdentityHashMap, Map, Provider, TreeMap, WeakHashMap

KeySpec:

java.security.spec

keysSpi( ):

AbstractPreferences

KeyStore:

java.security

KeyStore.Builder:

java.security

KeyStore.CallbackHandlerProtection:

java.security

KeyStore.Entry:

java.security

KeyStore.LoadStoreParameter:

java.security

KeyStore.PasswordProtection:

java.security

KeyStore.PrivateKeyEntry:

java.security

KeyStore.ProtectionParameter:

java.security

KeyStore.SecretKeyEntry:

java.security

KeyStore.TrustedCertificateEntry:

java.security

KeyStoreBuilderParameters:

javax.net.ssl

KeyStoreException:

java.security

KeyStoreSpi:

java.security

KHMER:

UnicodeBlock

KHMER_SYMBOLS:

UnicodeBlock

KOREA:

Locale

KOREAN:

Locale

KRB_NT_PRINCIPAL:

KerberosPrincipal

KRB_NT_SRV_HST:

KerberosPrincipal

KRB_NT_SRV_INST:

KerberosPrincipal

KRB_NT_SRV_XHST:

KerberosPrincipal

KRB_NT_UID:

KerberosPrincipal

KRB_NT_UNKNOWN:

KerberosPrincipal

Team LiB

23.12. L

LANGUAGE:

Attribute

LanguageCallback:

javax.security.auth.callback

LAO:

UnicodeBlock

last( ):

BreakIterator, CharacterIterator, SortedSet, StringCharacterIterator, TreeSet

lastElement( ):

Vector

lastIndexOf( ):

AbstractList, ArrayList, CopyOnWriteArrayList, LinkedList, List, String, StringBuffer, StringBuilder, Vector

lastIndexOfSubList( ):

Collections

lastKey( ):

SortedMap, TreeMap

lastModified( ):

File

LATEST:

Packer

LATIN_1_SUPPLEMENT:

UnicodeBlock

LATIN_EXTENDED_A:

UnicodeBlock

LATIN_EXTENDED_ADDITIONAL:

UnicodeBlock

LATIN_EXTENDED_B:

UnicodeBlock

LDAPCertStoreParameters:

java.security.cert

leave( ):

DatagramSocketImpl

leaveGroup( ):

DatagramSocketImpl, MulticastSocket

LEFT_JUSTIFY:

FormattableFlags

len:

InflaterInputStream

length:

OptionalDataException

length( ):

AtomicIntegerArray, AtomicLongArray, AtomicReferenceArray, BitSet, CharBuffer, CharSequence, CoderResult, File, RandomAccessFile, String, StringBuffer

LESSER:

DatatypeConstants

LETTER_NUMBER:

Character

LETTERLIKE_SYMBOLS:

UnicodeBlock

Level:

java.util.logging

LexicalHandler:

org.xml.sax.ext

LIMBU:

UnicodeBlock

limit( ):

Buffer

LINE_SEPARATOR:

Character

LINEAR_B_IDEOGRAMS:

UnicodeBlock

LINEAR_B_SYLLABARY:

UnicodeBlock

lineno( ):

StreamTokenizer

LineNumberInputStream:

java.io

LineNumberReader:

java.io

LinkageError:

java.lang

LinkedBlockingQueue:

java.util.concurrent

LinkedHashMap:

java.util

LinkedHashSet:

java.util

LinkedList:

java.util

List:

java.util

list( ):

Collections, File, Properties, ThreadGroup

listen( ):

SocketImpl

listFiles( ):

File

ListIterator:

java.util

listIterator( ):

AbstractList, AbstractSequentialList, CopyOnWriteArrayList, LinkedList, List

ListResourceBundle:

java.util

listRoots( ):

File

LITERAL:

Pattern

LITTLE_ENDIAN:

ByteOrder

load( ):

KeyStore, MappedByteBuffer, Properties, Provider, Runtime, System

loadClass( ):

ClassLoader

loadFromXML( ):

Properties

loadLibrary( ):

Runtime, System

LoadStoreParameter:

java.security.KeyStore

LOCAL_VARIABLE:

ElementType

Locale:

java.util

locale( ):

Formatter, Scanner

localPort:

DatagramSocketImpl

localport:

SocketImpl

Locator:

org.xml.sax

Locator2:

org.xml.sax.ext

Locator2Impl:

org.xml.sax.ext

LocatorImpl:

org.xml.sax.helpers

Lock:

java.util.concurrent.locks

lock:

AbstractPreferences, Reader, Writer

lock( ):

FileChannel, Lock, ReadLock, ReentrantLock, WriteLock

lockInterruptibly( ):

Lock, ReadLock, ReentrantLock, WriteLock

LockSupport:

java.util.concurrent.locks

log( ):

Logger, Math, StrictMath

log10( ):

Math, StrictMath

log1p( ):

Math, StrictMath

Logger:

java.util.logging

LOGGING_MXBEAN_NAME:

LogManager

LoggingMXBean:

java.util.logging

LoggingPermission:

java.util.logging

login( ):

AuthProvider, LoginContext, LoginModule

LoginContext:

javax.security.auth.login

LoginException:

javax.security.auth.login

LoginModule:

javax.security.auth.spi

LoginModuleControlFlag:

javax.security.auth.login.AppConfigurationEntry

LogManager:

java.util.logging

logout( ):

AuthProvider, LoginContext, LoginModule

logp( ):

Logger

logrb( ):

Logger

LogRecord:

java.util.logging

Long:

java.lang

LONG:

DateFormat, TimeZone

longBitsToDouble( ):

Double

LongBuffer:

java.nio

longValue( ):

AtomicInteger, AtomicLong, BigDecimal, BigInteger, Byte, Double, Float, Integer, Long, Number, Short

longValueExact( ):

BigDecimal

lookingAt( ):

Matcher

lookup( ):

ObjectStreamClass

lookupNamespaceURI( ):

Node

lookupPrefix( ):

Node

LOW_SURROGATES:

UnicodeBlock

LOWERCASE_LETTER:

Character

lowerCaseMode( ):

StreamTokenizer

lowestOneBit( ):

Integer, Long

Team LiB

23.13. M

Mac:

javax.crypto

MacSpi:

javax.crypto

MAIN_CLASS:

Name

makeParser( ):

ParserFactory

MALAYALAM:

UnicodeBlock

malformedForLength( ):

CoderResult

malformedInputAction( ):

CharsetDecoder, CharsetEncoder

MalformedInputException:

java.nio.charset

MalformedParameterizedTypeException:

java.lang.reflect

MalformedURLException:

java.net

ManagementFactory:

java.lang.management

ManagementPermission:

java.lang.management

ManagerFactoryParameters:

javax.net.ssl

Manifest:

java.util.jar

MANIFEST_NAME:

JarFile

MANIFEST_VERSION:

Name

map:

Attributes

Map:

java.util

map( ):

FileChannel

Map.Entry:

java.util

mapLibraryName( ):

System

MapMode:

java.nio.channels.FileChannel

MappedByteBuffer:

java.nio

MARCH:

Calendar, DatatypeConstants

mark:

ByteArrayInputStream

mark( ):

Buffer, BufferedInputStream, BufferedReader, ByteArrayInputStream, CharArrayReader, FilterInputStream, FilterReader, InflaterInputStream, InputStream, LineNumberInputStream, LineNumberReader, PushbackInputStream, PushbackReader, Reader, StringReader *markedPos:*

CharArrayReader

marklimit:

BufferedInputStream

markpos:

BufferedInputStream

markSupported( ):

BufferedInputStream, BufferedReader, ByteArrayInputStream, CharArrayReader, CipherInputStream, FilterInputStream, FilterReader, InflaterInputStream, InputStream, PushbackInputStream, PushbackReader, Reader, StringReader

match( ):

CertSelector, CRLSelector, Scanner, X509CertSelector, X509CRLSelector

Matcher:

java.util.regex

matcher( ):

Pattern

matches( ):

Matcher, Pattern, String

MatchResult:

java.util.regex

Math:

java.lang

MATH_SYMBOL:

Character

MathContext:

java.math

MATHEMATICAL_ALPHANUMERIC_SYMBOLS:

UnicodeBlock

MATHEMATICAL_OPERATORS:

UnicodeBlock

max( ):

BigDecimal, BigInteger, Collections, Math, StrictMath

MAX_CODE_POINT:

Character

MAX_HIGH_SURROGATE:

Character

MAX_KEY_LENGTH:

Preferences

MAX_LOW_SURROGATE:

Character

MAX_NAME_LENGTH:

Preferences

MAX_PRIORITY:

Thread

MAX_RADIX:

Character

MAX_SURROGATE:

Character

MAX_TIMEZONE_OFFSET:

DatatypeConstants

MAX_VALUE:

Byte, Character, Double, Float, Integer, Long, Short

MAX_VALUE_LENGTH:

Preferences

maxBytesPerChar( ):

CharsetEncoder

maxCharsPerByte( ):

CharsetDecoder

maxMemory( ):

Runtime

MAY:

Calendar, DatatypeConstants

MEDIA_TYPE:

OutputKeys

MEDIUM:

DateFormat

Member:

java.lang.reflect

MEMORY_COLLECTION_THRESHOLD_EXCEEDED:

MemoryNotificationInfo

MEMORY_MANAGER_MXBEAN_DOMAIN_TYPE:

ManagementFactory

MEMORY_MXBEAN_NAME:

ManagementFactory

MEMORY_POOL_MXBEAN_DOMAIN_TYPE:

ManagementFactory

MEMORY_THRESHOLD_EXCEEDED:

MemoryNotificationInfo

MemoryHandler:

java.util.logging

MemoryManagerMXBean:

java.lang.management

MemoryMXBean:

java.lang.management

MemoryNotificationInfo:

java.lang.management

MemoryPoolMXBean:

java.lang.management

MemoryType:

java.lang.management

MemoryUsage:

java.lang.management

MessageDigest:

java.security

MessageDigestSpi:

java.security

MessageFormat:

java.text

MessageFormat.Field:

java.text

method:

HttpURLConnection

METHOD:

ElementType, OutputKeys

Method:

java.lang.reflect

METHOD_ATTRIBUTE_PFX:

Packer

MGF1ParameterSpec:

java.security.spec

MICROSECONDS:

TimeUnit

MILLISECOND:

Calendar, Field

MILLISECOND_FIELD:

DateFormat

MILLISECONDS:

TimeUnit

min( ):

BigDecimal, BigInteger, Collections, Math, StrictMath

MIN_CODE_POINT:

Character

MIN_HIGH_SURROGATE:

Character

MIN_LOW_SURROGATE:

Character

MIN_PRIORITY:

Thread

MIN_RADIX:

Character

MIN_SUPPLEMENTARY_CODE_POINT:

Character

MIN_SURROGATE:

Character

MIN_TIMEZONE_OFFSET:

DatatypeConstants

MIN_VALUE:

Byte, Character, Double, Float, Integer, Long, Short

MINUTE:

Calendar, Field

MINUTE_FIELD:

DateFormat

MINUTES:

DatatypeConstants

MISCELLANEOUS_MATHEMATICAL_SYMBOLS_A:

UnicodeBlock

MISCELLANEOUS_MATHEMATICAL_SYMBOLS_B:

UnicodeBlock

MISCELLANEOUS_SYMBOLS:

UnicodeBlock

MISCELLANEOUS_SYMBOLS_AND_ARROWS:

UnicodeBlock

MISCELLANEOUS_TECHNICAL:

UnicodeBlock

MissingFormatArgumentException:

java.util

MissingFormatWidthException:

java.util

MissingResourceException:

java.util

mkdir( ):

File

mkdirs( ):

File

mod( ):

BigInteger

modCount:

AbstractList

MODIFICATION_TIME:

Packer

Modifier:

java.lang.reflect

MODIFIER_LETTER:

Character

MODIFIER_SYMBOL:

Character

modInverse( ):

BigInteger

modPow( ):

BigInteger

MONDAY:

Calendar

MONGOLIAN:

UnicodeBlock

MONTH:

Calendar, Field

MONTH_FIELD:

DateFormat

MONTHS:

DatatypeConstants

movePointLeft( ):

BigDecimal

movePointRight( ):

BigDecimal

MulticastSocket:

java.net

MULTILINE:

Pattern

multiply( ):

BigDecimal, BigInteger, Duration

MUSICAL_SYMBOLS:

UnicodeBlock

MYANMAR:

UnicodeBlock

Team LiB

23.14. N

Name:

java.util.jar.Attributes

name( ):

AbstractPreferences, Charset, Enum, Preferences

NameCallback:

javax.security.auth.callback

NamedNodeMap:

org.w3c.dom

NameList:

org.w3c.dom

NAMESPACE_ERR:

DOMException

NamespaceContext:

javax.xml.namespace

NamespaceSupport:

org.xml.sax.helpers

nameUUIDFromBytes( ):

UUID

NaN:

Double, Float

NANOSECONDS:

TimeUnit

nanoTime( ):

System

NATIVE:

Modifier

nativeOrder( ):

ByteOrder

nCopies( ):

Collections

NEED_TASK:

HandshakeStatus

NEED_UNWRAP:

HandshakeStatus

NEED_WRAP:

HandshakeStatus

needsDictionary( ):

Inflater

needsInput( ):

Deflater, Inflater

negate( ):

BigDecimal, BigInteger, Duration

NEGATIVE_INFINITY:

Double, Float

NegativeArraySizeException:

java.lang

NetPermission:

java.net

NetworkInterface:

java.net

NEW:

State

newCachedThreadPool( ):

Executors

newChannel( ):

Channels

newCondition( ):

Lock, ReadLock, ReentrantLock, WriteLock

newDecoder( ):

Charset

newDocument( ):

DocumentBuilder

newDocumentBuilder( ):

DocumentBuilderFactory

newDuration( ):

DatatypeFactory

newDurationDayTime( ):

DatatypeFactory

newDurationYearMonth( ):

DatatypeFactory

newEncoder( ):

Charset

newFactory( ):

SchemaFactoryLoader

newFixedThreadPool( ):

Executors

newInputStream( ):

Channels

newInstance( ):

Array, Builder, Class, Constructor, DatatypeFactory, DocumentBuilderFactory, SAXParserFactory, SchemaFactory, Service, TransformerFactory, URLClassLoader, XPathFactory

newLine( ):

BufferedWriter

newNode:

AbstractPreferences

newOutputStream( ):

Channels

newPacker( ):

Pack200

newPermissionCollection( ):

AllPermission, BasicPermission, DelegationPermission, FilePermission, Permission, PrivateCredentialPermission, PropertyPermission, ServicePermission, SocketPermission, UnresolvedPermission

newPlatformMXBeanProxy( ):

ManagementFactory

newProxyInstance( ):

Proxy

newReader( ):

Channels

newSAXParser( ):

SAXParserFactory

newScheduledThreadPool( ):

Executors

newSchema( ):

SchemaFactory

newSingleThreadExecutor( ):

Executors

newSingleThreadScheduledExecutor( ):

Executors

newTemplates( ):

TransformerFactory

newTemplatesHandler( ):

SAXTransformerFactory

newThread( ):

ThreadFactory

newTransformer( ):

Templates, TransformerFactory

newTransformerHandler( ):

SAXTransformerFactory

newUnpacker( ):

Pack200

newUpdater( ):

AtomicIntegerFieldUpdater, AtomicLongFieldUpdater, AtomicReferenceFieldUpdater

newValidator( ):

Schema

newValidatorHandler( ):

Schema

newWriter( ):

Channels

newXMLFilter( ):

SAXTransformerFactory

newXMLGregorianCalendar( ):

DatatypeFactory

newXMLGregorianCalendarDate( ):

DatatypeFactory

newXMLGregorianCalendarTime( ):

DatatypeFactory

newXPath( ):

XPathFactory

next( ):

BreakIterator, CharacterIterator, CollationElementIterator, Iterator, ListIterator, Random, Scanner, SecureRandom, StringCharacterIterator

nextBigDecimal( ):

Scanner

nextBigInteger( ):

Scanner

nextBoolean( ):

Random, Scanner

nextByte( ):

Scanner

nextBytes( ):

Random, SecureRandom

nextClearBit( ):

BitSet

nextDouble( ):

ChoiceFormat, Random, Scanner

nextElement( ):

Enumeration, StringTokenizer

nextFloat( ):

Random, Scanner

nextGaussian( ):

Random

nextIndex( ):

ListIterator

nextInt( ):

Random, Scanner

nextLine( ):

Scanner

nextLong( ):

Random, Scanner

nextProbablePrime( ):

BigInteger

nextSetBit( ):

BitSet

nextShort( ):

Scanner

nextToken( ):

StreamTokenizer, StringTokenizer

NO:

ConfirmationCallback

NO_COMPRESSION:

Deflater

NO_DATA_ALLOWED_ERR:

DOMException

NO_DECOMPOSITION:

Collator

NO_FIELDS:

ObjectStreamClass

NO_MODIFICATION_ALLOWED_ERR:

DOMException

NO_PROXY:

Proxy

NoClassDefFoundError:

java.lang

NoConnectionPendingException:

java.nio.channels

Node:

org.w3c.dom

NODE:

XPathConstants

node( ):

AbstractPreferences, Preferences, UUID

NODE_ADOPTED:

UserDataHandler

NODE_CLONED:

UserDataHandler

NODE_DELETED:

UserDataHandler

NODE_IMPORTED:

UserDataHandler

NODE_RENAMED:

UserDataHandler

NodeChangeEvent:

java.util.prefs

NodeChangeListener:

java.util.prefs

nodeExists( ):

AbstractPreferences, Preferences

NodeList:

org.w3c.dom

NODESET:

XPathConstants

NON_HEAP:

MemoryType

NON_SPACING_MARK:

Character

noneOf( ):

EnumSet

NonReadableChannelException:

java.nio.channels

NonWritableChannelException:

java.nio.channels

NORM_PRIORITY:

Thread

normalize( ):

Node, URI, XMLGregorianCalendar

normalizeDocument( ):

Document

normalizeWith( ):

Duration

NoRouteToHostException:

java.net

NoSuchAlgorithmException:

java.security

NoSuchElementException:

java.util

NoSuchFieldError:

java.lang

NoSuchFieldException:

java.lang

NoSuchMethodError:

java.lang

NoSuchMethodException:

java.lang

NoSuchPaddingException:

javax.crypto

NoSuchProviderException:

java.security

not( ):

BigInteger

NOT_FOUND_ERR:

DOMException

NOT_HANDSHAKING:

HandshakeStatus

NOT_SUPPORTED_ERR:

DOMException

NotActiveException:

java.io

Notation:

org.w3c.dom

NOTATION_NODE:

Node

notationDecl( ):

DefaultHandler, DTDHandler, HandlerBase, XMLFilterImpl

notify( ):

Object

notifyAll( ):

Object

notifyObservers( ):

Observable

NotSerializableException:

java.io

NotYetBoundException:

java.nio.channels

NotYetConnectedException:

java.nio.channels

NOVEMBER:

Calendar, DatatypeConstants

NSDECL:

NamespaceSupport

NULL_NS_URI:

XMLConstants

NullCipher:

javax.crypto

NULLORDER:

CollationElementIterator

NullPointerException:

java.lang

Number:

java.lang

NUMBER:

XPathConstants

NUMBER_FORMS:

UnicodeBlock

NumberFormat:

java.text

numberFormat:

DateFormat

NumberFormat.Field:

java.text

NumberFormatException:

java.lang

numberOfLeadingZeros( ):

Integer, Long

numberOfTrailingZeros( ):

Integer, Long

nval:

StreamTokenizer

Team LiB

Team LiB

23.15. O

OAEPParameterSpec:

javax.crypto.spec

Object:

java.lang

ObjectInput:

java.io

ObjectInputStream:

java.io

ObjectInputStream.GetField:

java.io

ObjectInputValidation:

java.io

ObjectOutput:

java.io

ObjectOutputStream:

java.io

downloaded from: lib.ommolketab.ir

ObjectOutputStream.PutField:

java.io

ObjectStreamClass:

java.io

ObjectStreamConstants:

java.io

ObjectStreamException:

java.io

ObjectStreamField:

java.io

Observable:

java.util

Observer:

java.util

OCTOBER:

Calendar, DatatypeConstants

of( ):

EnumSet, UnicodeBlock

ofCalendarField( ):

Field

OFF:

Level

offer( ):

ArrayBlockingQueue, BlockingQueue, ConcurrentLinkedQueue, DelayQueue, LinkedBlockingQueue, LinkedList, PriorityBlockingQueue, PriorityQueue, Queue, SynchronousQueue

offsetByCodePoints( ):

Character, String, StringBuffer

OGHAM:

UnicodeBlock

OK:

ConfirmationCallback, Status

OK_CANCEL_OPTION:

ConfirmationCallback

OLD_ITALIC:

UnicodeBlock

OMIT_XML_DECLARATION:

OutputKeys

on( ):

DigestInputStream, DigestOutputStream

ONE:

BigDecimal, BigInteger

onMalformedInput( ):

CharsetDecoder, CharsetEncoder

onUnmappableCharacter( ):

CharsetDecoder, CharsetEncoder

OP_ACCEPT:

SelectionKey

OP_CONNECT:

SelectionKey

OP_READ:

SelectionKey

OP_WRITE:

SelectionKey

open( ):

DatagramChannel, Pipe, Selector, ServerSocketChannel, SocketChannel

OPEN_DELETE:

ZipFile

OPEN_FAILURE:

ErrorManager

OPEN_READ:

ZipFile

openConnection( ):

URL, URLStreamHandler

openDatagramChannel( ):

SelectorProvider

openPipe( ):

SelectorProvider

openSelector( ):

SelectorProvider

openServerSocketChannel( ):

SelectorProvider

openSocketChannel( ):

SelectorProvider

openStream( ):

URL

OPERATING_SYSTEM_MXBEAN_NAME:

ManagementFactory

OperatingSystemMXBean:

java.lang.management

OPTICAL_CHARACTER_RECOGNITION:

UnicodeBlock

OPTIONAL:

LoginModuleControlFlag

OptionalDataException:

java.io

or( ):

BigInteger, BitSet

order( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

ordinal( ):

Enum

ordinaryChar( ):

StreamTokenizer

ordinaryChars( ):

StreamTokenizer

ORIYA:

UnicodeBlock

OSMANYA:

UnicodeBlock

OTHER_LETTER:

Character

OTHER_NUMBER:

Character

OTHER_PUNCTUATION:

Character

OTHER_SYMBOL:

Character

out:

FileDescriptor, FilterOutputStream, FilterWriter, PipedInputStream, PrintWriter, System

out( ):

Formatter

OutOfMemoryError:

java.lang

OutputKeys:

javax.xml.transform

OutputStream:

java.io

OutputStreamWriter:

java.io

OVERFLOW:

CoderResult

OverlappingFileLockException:

java.nio.channels

overlaps( ):

FileLock

Override:

java.lang

owns( ):

AbstractQueuedSynchronizer

23.16. P

pack( ):

Packer

Pack200:

java.util.jar

Pack200.Packer:

java.util.jar

Pack200.Unpacker:

java.util.jar

PACKAGE:

ElementType

Package:

java.lang

Packer:

java.util.jar.Pack200

PARAGRAPH_SEPARATOR:

Character

PARAMETER:

ElementType

ParameterizedType:

java.lang.reflect

parent:

ResourceBundle

parent( ):

AbstractPreferences, Preferences

parentOf( ):

ThreadGroup

park( ):

LockSupport

parkNanos( ):

LockSupport

parkUntil( ):

LockSupport

parse( ):

ChoiceFormat, Date, DateFormat, DecimalFormat, DocumentBuilder, Level, MessageFormat, NumberFormat, Parser, ParserAdapter, SAXParser, SimpleDateFormat, XMLFilterImpl, XMLReader, XMLReaderAdapter

parseBoolean( ):

Boolean

parseByte( ):

Byte

parseDouble( ):

Double

ParseException:

java.text

parseFloat( ):

Float

parseInt( ):

Integer

parseLong( ):

Long

parseNumbers( ):

StreamTokenizer

parseObject( ):

DateFormat, Format, MessageFormat, NumberFormat

ParsePosition:

java.text

Parser:

org.xml.sax

ParserAdapter:

org.xml.sax.helpers

ParserConfigurationException:

javax.xml.parsers

ParserFactory:

org.xml.sax.helpers

parseServerAuthority( ):

URI

parseShort( ):

Short

parseURL( ):

URLStreamHandler

PASS:

Packer

PASS_FILE_PFX:

Packer

PasswordAuthentication:

java.net

PasswordCallback:

javax.security.auth.callback

PasswordProtection:

java.security.KeyStore

pathSeparator:

File

pathSeparatorChar:

File

Pattern:

java.util.regex

pattern( ):

Matcher, Pattern

PatternSyntaxException:

java.util.regex

PBEKey:

javax.crypto.interfaces

PBEKeySpec:

javax.crypto.spec

PBEParameterSpec:

javax.crypto.spec

peek( ):

ArrayBlockingQueue, ConcurrentLinkedQueue, DatagramSocketImpl, DelayQueue, LinkedBlockingQueue, LinkedList, PriorityBlockingQueue, PriorityQueue, Queue, Stack, SynchronousQueue

peekData( ):

DatagramSocketImpl

PERCENT:

Field

PERMILLE:

Field

Permission:

java.security

PermissionCollection:

java.security

Permissions:

java.security

PhantomReference:

java.lang.ref

PHONETIC_EXTENSIONS:

UnicodeBlock

PI:

Math, StrictMath

PI_DISABLE_OUTPUT_ESCAPING:

Result

PI_ENABLE_OUTPUT_ESCAPING:

Result

Pipe:

java.nio.channels

Pipe.SinkChannel:

java.nio.channels

Pipe.SourceChannel:

java.nio.channels

PIPE_SIZE:

downloaded from: lib.ommolketab.ir

PipedInputStream

PipedInputStream:

java.io

PipedOutputStream:

java.io

PipedReader:

java.io

PipedWriter:

java.io

PKCS8EncodedKeySpec:

java.security.spec

PKIXBuilderParameters:

java.security.cert

PKIXCertPathBuilderResult:

java.security.cert

PKIXCertPathChecker:

java.security.cert

PKIXCertPathValidatorResult:

java.security.cert

PKIXParameters:

java.security.cert

plus( ):

BigDecimal

PM:

Calendar

POINT_INFINITY:

ECPoint

Policy:

java.security, javax.security.auth

PolicyNode:

java.security.cert

PolicyQualifierInfo:

java.security.cert

poll( ):

ArrayBlockingQueue, BlockingQueue, CompletionService, ConcurrentLinkedQueue, DelayQueue, ExecutorCompletionService, LinkedBlockingQueue, LinkedList, PriorityBlockingQueue, PriorityQueue, Queue, ReferenceQueue, SynchronousQueue

pop( ):

Stack

popContext( ):

NamespaceSupport

port:

SocketImpl

PortUnreachableException:

java.net

pos:

BufferedInputStream, ByteArrayInputStream, CharArrayReader, PushbackInputStream, StringBufferInputStream

position( ):

Buffer, FileChannel, FileLock

POSITIVE_INFINITY:

Double, Float

pow( ):

BigDecimal, BigInteger, Math, StrictMath

PRC:

Locale

preceding( ):

BreakIterator

precision( ):

BigDecimal

preferenceChange( ):

PreferenceChangeListener

PreferenceChangeEvent:

java.util.prefs

PreferenceChangeListener:

java.util.prefs

Preferences:

java.util.prefs

PreferencesFactory:

java.util.prefs

prestartAllCoreThreads( ):

ThreadPoolExecutor

prestartCoreThread( ):

ThreadPoolExecutor

previous( ):

BreakIterator, CharacterIterator, CollationElementIterator, ListIterator, StringCharacterIterator

previousDouble( ):

ChoiceFormat

previousIndex( ):

ListIterator

PRIMARY:

Collator

primaryOrder( ):

CollationElementIterator

Principal:

java.security

print( ):

PrintStream, PrintWriter

printf( ):

PrintStream, PrintWriter

println( ):

PrintStream, PrintWriter

printStackTrace( ):

Throwable, TransformerException, XPathException

PrintStream:

java.io

PrintWriter:

java.io

PriorityBlockingQueue:

java.util.concurrent

PriorityQueue:

java.util

PRIVATE:

MapMode, Modifier, Type

PRIVATE_KEY:

Cipher

PRIVATE_USE:

Character

PRIVATE_USE_AREA:

UnicodeBlock

PrivateCredentialPermission:

javax.security.auth

PrivateKey:

java.security

PrivateKeyEntry:

java.security.KeyStore

PrivilegedAction:

java.security

PrivilegedActionException:

java.security

privilegedCallable( ):

Executors

privilegedCallableUsingCurrentClassLoader( ):

Executors

PrivilegedExceptionAction:

java.security

privilegedThreadFactory( ):

Executors

probablePrime( ):

BigInteger

Process:

java.lang

ProcessBuilder:

java.lang

PROCESSING_INSTRUCTION_NODE:

Node

ProcessingInstruction:

org.w3c.dom

processingInstruction( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

processName( ):

NamespaceSupport

PROGRESS:

Packer, Unpacker

Properties:

java.util

properties( ):

Packer, Unpacker

propertyNames( ):

Properties

PropertyPermission:

java.util

PropertyResourceBundle:

java.util

PROTECTED:

Modifier

ProtectionDomain:

java.security

ProtectionParameter:

java.security.KeyStore

PROTOCOL_VERSION_1:

ObjectStreamConstants

PROTOCOL_VERSION_2:

ObjectStreamConstants

ProtocolException:

java.net

Provider:

java.security

provider( ):

AbstractSelectableChannel, AbstractSelector, SelectableChannel, Selector, SelectorProvider

Provider.Service:

java.security

ProviderException:

java.security

PROXY:

RequestorType

Proxy:

java.lang.reflect, java.net

Proxy.Type:

java.net

ProxySelector:

java.net

PSource:

javax.crypto.spec

PSource.PSpecified:

javax.crypto.spec

PSpecified:

javax.crypto.spec.PSource

PSSParameterSpec:

java.security.spec

PUBLIC:

Member, Modifier, Type

PUBLIC_KEY:

Cipher

PublicKey:

java.security

publish( ):

ConsoleHandler, FileHandler, Handler, MemoryHandler, SocketHandler, StreamHandler

purge( ):

ThreadPoolExecutor, Timer

push( ):

MemoryHandler, Stack

pushBack( ):

StreamTokenizer

PushbackInputStream:

java.io

PushbackReader:

java.io

pushContext( ):

NamespaceSupport

put( ):

AbstractMap, AbstractPreferences, ArrayBlockingQueue, Attributes, BlockingQueue, ByteBuffer, CharBuffer, ConcurrentHashMap, CookieHandler, DelayQueue, Dictionary, DoubleBuffer, EnumMap, FloatBuffer, HashMap, Hashtable, IdentityHashMap, IntBuffer, LinkedBlockingQueue, LongBuffer, Map, Preferences, PriorityBlockingQueue, Provider, PutField, ResponseCache, ShortBuffer, SynchronousQueue, TreeMap, WeakHashMap

putAll( ):

AbstractMap, Attributes, ConcurrentHashMap, EnumMap, HashMap, Hashtable, IdentityHashMap, Map, Provider, TreeMap, WeakHashMap

putBoolean( ):

AbstractPreferences, Preferences

putByteArray( ):

AbstractPreferences, Preferences

putChar( ):

ByteBuffer

putDouble( ):

AbstractPreferences, ByteBuffer, Preferences

PutField:

java.io.ObjectOutputStream

putFields( ):

ObjectOutputStream

putFloat( ):

AbstractPreferences, ByteBuffer, Preferences

putIfAbsent( ):

ConcurrentHashMap, ConcurrentMap

putInt( ):

AbstractPreferences, ByteBuffer, Preferences

putLong( ):

AbstractPreferences, ByteBuffer, Preferences

putNextEntry( ):

JarOutputStream, ZipOutputStream

putService( ):

Provider

putShort( ):

ByteBuffer

putSpi( ):

AbstractPreferences

putValue( ):

Attributes, SSLSession

Team LiB

23.17. Q

QName:

javax.xml.namespace

Queue:

java.util

quote( ):

Pattern

quoteChar( ):

StreamTokenizer

quoteReplacement( ):

Matcher

Team LiB

23.18. R

radix( ):

Scanner

Random:

java.util

random( ):

Math, StrictMath

RandomAccess:

java.util

RandomAccessFile:

java.io

randomUUID( ):

UUID

range( ):

EnumSet

RC2ParameterSpec:

javax.crypto.spec

RC5ParameterSpec:

javax.crypto.spec

read( ):

BufferedInputStream, BufferedReader, ByteArrayInputStream, CharArrayReader, CharBuffer, CheckedInputStream, CipherInputStream, DatagramChannel, DataInputStream, DigestInputStream, FileChannel, FileInputStream, FilterInputStream, FilterReader, GZIPInputStream, InflaterInputStream, InputStream, InputStreamReader, JarInputStream, LineNumberInputStream, LineNumberReader, Manifest, ObjectInput, ObjectInputStream, PipedInputStream, PipedReader, PushbackInputStream, PushbackReader, RandomAccessFile, Readable, ReadableByteChannel, Reader, ScatteringByteChannel, SequenceInputStream, SocketChannel, StringBufferInputStream, StringReader, ZipInputStream

READ_ONLY:

MapMode

READ_WRITE:

MapMode

Readable:

java.lang

ReadableByteChannel:

java.nio.channels

readBoolean( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readByte( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile *readChar( ):*

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readClassDescriptor( ):

ObjectInputStream

readConfiguration( ):

LogManager

readDouble( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

Reader:

java.io

readExternal( ):

Externalizable

readFields( ):

ObjectInputStream

readFloat( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readFully( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

READING:

Attribute

readInt( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readLine( ):

BufferedReader, DataInput, DataInputStream, LineNumberReader, ObjectInputStream, RandomAccessFile

ReadLock:

java.util.concurrent.locks.ReentrantReadWriteLock

readLock( ):

ReadWriteLock, ReentrantReadWriteLock

readLong( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readObject( ):

ObjectInput, ObjectInputStream

readObjectOverride( ):

ObjectInputStream

ReadOnlyBufferException:

java.nio

readResolve( ):

Attribute, CertificateRep, CertPathRep, Field, KeyRep

readShort( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readStreamHeader( ):

ObjectInputStream

readUnshared( ):

ObjectInputStream

readUnsignedByte( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readUnsignedShort( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

readUTF( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

ReadWriteLock:

java.util.concurrent.locks

ready( ):

BufferedReader, CharArrayReader, FilterReader, InputStreamReader, PipedReader, PushbackReader, Reader, StringReader *readyOps( ):*

SelectionKey

receive( ):

DatagramChannel, DatagramSocket, DatagramSocketImpl, PipedInputStream

redefineClasses( ):

Instrumentation

redirectErrorStream( ):

ProcessBuilder

reducePermits( ):

Semaphore

ReentrantLock:

java.util.concurrent.locks

ReentrantReadWriteLock:

java.util.concurrent.locks

ReentrantReadWriteLock.ReadLock:

java.util.concurrent.locks

ReentrantReadWriteLock.WriteLock:

java.util.concurrent.locks

Reference:

java.lang.ref

ReferenceQueue:

java.lang.ref

ReflectPermission:

java.lang.reflect

refresh( ):

Configuration, KerberosTicket, Policy, Refreshable

Refreshable:

javax.security.auth

RefreshFailedException:

javax.security.auth

region( ):

Matcher

regionEnd( ):

Matcher

regionMatches( ):

String

regionStart( ):

Matcher

register( ):

AbstractSelectableChannel, AbstractSelector, SelectableChannel

registerValidation( ):

ObjectInputStream

rehash( ):

Hashtable

rejectedExecution( ):

AbortPolicy, CallerRunsPolicy, DiscardOldestPolicy, DiscardPolicy, RejectedExecutionHandler

RejectedExecutionException:

java.util.concurrent

RejectedExecutionHandler:

java.util.concurrent

relativize( ):

URI

RELAXNG_NS_URI:

XMLConstants

release( ):

AbstractQueuedSynchronizer, FileLock, Semaphore *releaseShared( ):*

AbstractQueuedSynchronizer

remainder( ):

BigDecimal, BigInteger

remaining( ):

Buffer

remainingCapacity( ):

ArrayBlockingQueue, BlockingQueue, DelayQueue, LinkedBlockingQueue, PriorityBlockingQueue, SynchronousQueue

remove( ):

AbstractCollection, AbstractList, AbstractMap, AbstractPreferences, AbstractQueue, AbstractSequentialList, ArrayBlockingQueue, ArrayList, Attributes, Collection, ConcurrentHashMap, ConcurrentLinkedQueue, ConcurrentMap, CopyOnWriteArrayList, CopyOnWriteArraySet, DelayQueue, Dictionary, EnumMap, HashMap, HashSet, Hashtable, IdentityHashMap, Iterator, LinkedBlockingQueue, LinkedList, List, ListIterator, Map, Preferences, PriorityBlockingQueue, PriorityQueue, Provider, Queue, ReferenceQueue, Scanner ScheduledThreadPoolExecutor, Set, SynchronousQueue, ThreadLocal, ThreadPoolExecutor, TreeMap, TreeSet, Vector, WeakHashMap

removeAll( ):

AbstractCollection, AbstractSet, Collection, CopyOnWriteArrayList, CopyOnWriteArraySet, List, Set, SynchronousQueue, Vector

removeAllElements( ):

Vector

removeAttribute( ):

AttributeListImpl, Attributes2Impl, AttributesImpl, Element *removeAttributeNode( ):*

Element

removeAttributeNS( ):

Element

removeCertificate( ):

Identity

removeChild( ):

Node

removeEldestEntry( ):

LinkedHashMap

removeElement( ):

Vector

removeElementAt( ):

Vector

removeFirst( ):

LinkedList

removeHandler( ):

Logger

removeHandshakeCompletedListener( ):

SSLSocket

removeIdentity( ):

IdentityScope

removeLast( ):

LinkedList

removeNamedItem( ):

NamedNodeMap

removeNamedItemNS( ):

NamedNodeMap

removeNode( ):

AbstractPreferences, Preferences

removeNodeChangeListener( ):

AbstractPreferences, Preferences

removeNodeSpi( ):

AbstractPreferences

removePreferenceChangeListener( ):

AbstractPreferences, Preferences

removePropertyChangeListener( ):

LogManager, Packer, Unpacker

removeProvider( ):

Security

removeRange( ):

AbstractList, ArrayList, Vector

removeService( ):

Provider

removeShutdownHook( ):

Runtime

removeSpi( ):

AbstractPreferences

removeTransformer( ):

Instrumentation

removeValue( ):

SSLSession

renameNode( ):

Document

renameTo( ):

File

reorderVisually( ):

Bidi

REPLACE:

CodingErrorAction

replace( ):

ConcurrentHashMap, ConcurrentMap, String, StringBuffer, StringBuilder

replaceAll( ):

Collections, Matcher, String

replaceChild( ):

Node

replaceData( ):

CharacterData

replaceFirst( ):

Matcher, String

replacement( ):

CharsetDecoder, CharsetEncoder

replaceObject( ):

ObjectOutputStream

replaceWholeText( ):

Text

replaceWith( ):

CharsetDecoder, CharsetEncoder

REPORT:

CodingErrorAction

reportError( ):

Handler

RequestorType:

java.net.Authenticator

requestPasswordAuthentication( ):

Authenticator

REQUIRED:

LoginModuleControlFlag

requireEnd( ):

Matcher

requiresBidi( ):

Bidi

REQUISITE:

LoginModuleControlFlag

reset( ):

Adler32, Buffer, BufferedInputStream, BufferedReader, ByteArrayInputStream, ByteArrayOutputStream, CharArrayReader, CharArrayWriter, CharsetDecoder, CharsetEncoder, Checksum, CollationElementIterator, CRC32, CyclicBarrier, Deflater, DocumentBuilder, FilterInputStream, FilterReader, Inflater, InflaterInputStream, InputStream, LineNumberInputStream, LineNumberReader, LogManager, Mac, Matcher, MessageDigest, NamespaceSupport, ObjectOutputStream, PushbackInputStream, PushbackReader, Reader, SAXParser, StringBufferInputStream, StringReader, Transformer, Validator, XMLGregorianCalendar, XPath

resetPeakThreadCount( ):

ThreadMXBean

resetPeakUsage( ):

MemoryPoolMXBean

resetSyntax( ):

StreamTokenizer

resolve( ):

URI, URIResolver

resolveClass( ):

ClassLoader, ObjectInputStream

resolveEntity( ):

DefaultHandler, DefaultHandler2, EntityResolver, EntityResolver2, HandlerBase, XMLFilterImpl *resolveFunction( ):*

XPathFunctionResolver

resolveObject( ):

ObjectInputStream

resolveProxyClass( ):

ObjectInputStream

resolveVariable( ):

XPathVariableResolver

ResourceBundle:

java.util

ResponseCache:

java.net

responseCode:

HttpURLConnection

responseCode( ):

HttpRetryException

responseMessage:

HttpURLConnection

Result:

javax.xml.transform

resume( ):

Thread, ThreadGroup

retainAll( ):

AbstractCollection, Collection, CopyOnWriteArrayList, CopyOnWriteArraySet, List, Set, SynchronousQueue, Vector

Retention:

java.lang.annotation

RetentionPolicy:

java.lang.annotation

reverse( ):

Collections, Integer, Long, StringBuffer, StringBuilder

reverseBytes( ):

Character, Integer, Long, Short

reverseOrder( ):

Collections

rewind( ):

Buffer

RFC1779:

X500Principal

RFC2253:

X500Principal

rint( ):

Math, StrictMath

roll( ):

Calendar, GregorianCalendar

rotate( ):

Collections

rotateLeft( ):

Integer, Long

rotateRight( ):

Integer, Long

round( ):

BigDecimal, Math, StrictMath

ROUND_CEILING:

BigDecimal

ROUND_DOWN:

BigDecimal

ROUND_FLOOR:

BigDecimal

ROUND_HALF_DOWN:

BigDecimal

ROUND_HALF_EVEN:

BigDecimal

ROUND_HALF_UP:

BigDecimal

ROUND_UNNECESSARY:

BigDecimal

ROUND_UP:

BigDecimal

RoundingMode:

java.math

RSAKey:

java.security.interfaces

RSAKeyGenParameterSpec:

java.security.spec

RSAMultiPrimePrivateCrtKey:

java.security.interfaces

RSAMultiPrimePrivateCrtKeySpec:

java.security.spec

RSAOtherPrimeInfo:

java.security.spec

RSAPrivateCrtKey:

java.security.interfaces

RSAPrivateCrtKeySpec:

java.security.spec

RSAPrivateKey:

java.security.interfaces

RSAPrivateKeySpec:

java.security.spec

RSAPublicKey:

java.security.interfaces

RSAPublicKeySpec:

java.security.spec

RuleBasedCollator:

java.text

run( ):

FutureTask, PrivilegedAction, PrivilegedExceptionAction, Runnable, Thread, TimerTask

runAndReset( ):

FutureTask

runFinalization( ):

Runtime, System

runFinalizersOnExit( ):

Runtime, System

RUNIC:

UnicodeBlock

Runnable:

java.lang

RUNNABLE:

State

Runtime:

java.lang

RUNTIME:

RetentionPolicy

RUNTIME_MXBEAN_NAME:

ManagementFactory

RuntimeException:

java.lang

RuntimeMXBean:

java.lang.management

RuntimePermission:

java.lang

23.19. S

sameFile( ):

URL, URLStreamHandler

SATURDAY:

Calendar

save( ):

Properties

SAXException:

org.xml.sax

SAXNotRecognizedException:

org.xml.sax

SAXNotSupportedException:

org.xml.sax

SAXParseException:

org.xml.sax

SAXParser:

javax.xml.parsers

SAXParserFactory:

javax.xml.parsers

SAXResult:

javax.xml.transform.sax

SAXSource:

javax.xml.transform.sax

SAXTransformerFactory:

javax.xml.transform.sax

SC_BLOCK_DATA:

ObjectStreamConstants

SC_ENUM:

ObjectStreamConstants

SC_EXTERNALIZABLE:

ObjectStreamConstants

SC_SERIALIZABLE:

ObjectStreamConstants

SC_WRITE_METHOD:

ObjectStreamConstants

scale( ):

BigDecimal

scaleByPowerOfTen( ):

BigDecimal

Scanner:

java.util

ScatteringByteChannel:

java.nio.channels

schedule( ):

ScheduledExecutorService, ScheduledThreadPoolExecutor, Timer

scheduleAtFixedRate( ):

ScheduledExecutorService, ScheduledThreadPoolExecutor, Timer

scheduledExecutionTime( ):

TimerTask

ScheduledExecutorService:

java.util.concurrent

ScheduledFuture:

java.util.concurrent

ScheduledThreadPoolExecutor:

java.util.concurrent

scheduleWithFixedDelay( ):

ScheduledExecutorService, ScheduledThreadPoolExecutor

Schema:

javax.xml.validation

SchemaFactory:

javax.xml.validation

SchemaFactoryLoader:

javax.xml.validation

SCIENTIFIC:

BigDecimalLayoutForm

SEALED:

Name

SealedObject:

javax.crypto

search( ):

Stack

SECOND:

Calendar, Field

SECOND_FIELD:

DateFormat

SECONDARY:

Collator

secondaryOrder( ):

CollationElementIterator

SECONDS:

DatatypeConstants, TimeUnit

SECRET:

Type

SECRET_KEY:

Cipher

SecretKey:

javax.crypto

SecretKeyEntry:

java.security.KeyStore

SecretKeyFactory:

javax.crypto

SecretKeyFactorySpi:

javax.crypto

SecretKeySpec:

javax.crypto.spec

SecureCacheResponse:

java.net

SecureClassLoader:

java.security

SecureRandom:

java.security

SecureRandomSpi:

java.security

Security:

java.security

SecurityException:

java.lang

SecurityManager:

java.lang

SecurityPermission:

java.security

seek( ):

RandomAccessFile

SEGMENT_LIMIT:

Packer

select( ):

ProxySelector, Selector

SelectableChannel:

java.nio.channels

selectedKeys( ):

Selector

SelectionKey:

java.nio.channels

selectNow( ):

Selector

Selector:

java.nio.channels

selector( ):

SelectionKey

SelectorProvider:

java.nio.channels.spi

Semaphore:

java.util.concurrent

send( ):

DatagramChannel, DatagramSocket, DatagramSocketImpl, MulticastSocket

sendUrgentData( ):

Socket, SocketImpl

separator:

File

separatorChar:

File

SEPTEMBER:

Calendar, DatatypeConstants

SequenceInputStream:

java.io

Serializable:

java.io

SerializablePermission:

java.io

serialVersionUID:

DHPrivateKey, DHPublicKey, DSAPrivateKey, DSAPublicKey, ECPrivateKey, ECPublicKey, Key, PBEKey, PrivateKey, PublicKey, RSAMultiPrimePrivateCrtKey, RSAPrivateCrtKey, RSAPrivateKey, RSAPublicKey, SecretKey

SERVER:

RequestorType

ServerSocket:

java.net

ServerSocketChannel:

java.nio.channels

ServerSocketFactory:

javax.net

Service:

java.security.Provider

ServicePermission:

javax.security.auth.kerberos

Set:

java.util

set( ):

AbstractList, AbstractSequentialList, Array, ArrayList, AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater, AtomicMarkableReference, AtomicReference, AtomicReferenceArray, AtomicReferenceFieldUpdater, AtomicStampedReference, BitSet, Calendar, CopyOnWriteArrayList, Field, FutureTask, LinkedList, List, ListIterator, ThreadLocal, URL, Vector

set2DigitYearStart( ):

SimpleDateFormat

setAccessible( ):

AccessibleObject

setAddress( ):

DatagramPacket

setAllowUserInteraction( ):

URLConnection

setAmPmStrings( ):

DateFormatSymbols

setAnyPolicyInhibited( ):

PKIXParameters

setAttribute( ):

AttributesImpl, DocumentBuilderFactory, Element, TransformerFactory *setAttributeList( ):*

AttributeListImpl

setAttributeNode( ):

Element

setAttributeNodeNS( ):

Element

setAttributeNS( ):

Element

setAttributes( ):

Attributes2Impl, AttributesImpl

setAuthorityKeyIdentifier( ):

X509CertSelector

setBasicConstraints( ):

X509CertSelector

setBeginIndex( ):

FieldPosition

setBit( ):

BigInteger

setBoolean( ):

Array, Field

setBroadcast( ):

DatagramSocket

setByte( ):

Array, Field

setByteStream( ):

InputSource

setCalendar( ):

DateFormat

setCallbackHandler( ):

AuthProvider

setCertificate( ):

X509CertSelector

setCertificateChecking( ):

X509CRLSelector

setCertificateEntry( ):

KeyStore

setCertificateValid( ):

X509CertSelector

setCertPathCheckers( ):

PKIXParameters

setCertStores( ):

PKIXParameters

setChanged( ):

Observable

setChar( ):

Array, Field

setCharacterStream( ):

InputSource

setCharAt( ):

StringBuffer

setChoices( ):

ChoiceFormat

setChunkedStreamingMode( ):

HttpURLConnection

setClassAssertionStatus( ):

ClassLoader

setCoalescing( ):

DocumentBuilderFactory

setCollectionUsageThreshold( ):

MemoryPoolMXBean

setColumnNumber( ):

LocatorImpl

setComment( ):

ZipEntry, ZipOutputStream

setCompressedSize( ):

ZipEntry

setConfiguration( ):

Configuration

setConnectTimeout( ):

URLConnection

setContentHandler( ):

ParserAdapter, ValidatorHandler, XMLFilterImpl, XMLReader

setContentHandlerFactory( ):

URLConnection

setContextClassLoader( ):

Thread

setContinueExistingPeriodicTasksAfterShutdownPolicy( ):

ScheduledThreadPoolExecutor

setCorePoolSize( ):

ThreadPoolExecutor

setCrc( ):

ZipEntry

setCurrency( ):

DecimalFormat, DecimalFormatSymbols, NumberFormat

setCurrencySymbol( ):

DecimalFormatSymbols

setDaemon( ):

Thread, ThreadGroup

setData( ):

CharacterData, DatagramPacket, ProcessingInstruction

setDatagramSocketImplFactory( ):

DatagramSocket

setDate( ):

Date, PKIXParameters

setDateAndTime( ):

X509CRLSelector

setDateFormatSymbols( ):

SimpleDateFormat

setDay( ):

XMLGregorianCalendar

setDecimalFormatSymbols( ):

DecimalFormat

setDecimalSeparator( ):

DecimalFormatSymbols

setDecimalSeparatorAlwaysShown( ):

DecimalFormat

setDeclared( ):

Attributes2Impl

setDecomposition( ):

Collator

setDefault( ):

Authenticator, CookieHandler, Locale, ProxySelector, ResponseCache, TimeZone

setDefaultAllowUserInteraction( ):

URLConnection

setDefaultAssertionStatus( ):

ClassLoader

setDefaultHostnameVerifier( ):

HttpsURLConnection

setDefaultRequestProperty( ):

URLConnection

setDefaultSSLSocketFactory( ):

HttpsURLConnection

setDefaultUncaughtExceptionHandler( ):

Thread

setDefaultUseCaches( ):

URLConnection

setDictionary( ):

Deflater, Inflater

setDigit( ):

DecimalFormatSymbols

setDocumentHandler( ):

Parser, XMLReaderAdapter

setDocumentLocator( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

setDocumentURI( ):

Document

setDoInput( ):

URLConnection

setDoOutput( ):

URLConnection

setDouble( ):

Array, Field

setDSTSavings( ):

SimpleTimeZone

setDTDHandler( ):

Parser, ParserAdapter, XMLFilterImpl, XMLReader, XMLReaderAdapter

setElementAt( ):

Vector

setEnabledCipherSuites( ):

SSLEngine, SSLServerSocket, SSLSocket

setEnabledProtocols( ):

SSLEngine, SSLServerSocket, SSLSocket

setEnableSessionCreation( ):

SSLEngine, SSLServerSocket, SSLSocket

setEncoding( ):

Handler, InputSource, Locator2Impl, StreamHandler

setEndIndex( ):

FieldPosition

setEndRule( ):

SimpleTimeZone

setEntityResolver( ):

DocumentBuilder, Parser, ParserAdapter, XMLFilterImpl, XMLReader, XMLReaderAdapter

setEntry( ):

KeyStore

setEras( ):

DateFormatSymbols

setErr( ):

System

setError( ):

PrintStream, PrintWriter

setErrorHandler( ):

DocumentBuilder, Parser, ParserAdapter, SchemaFactory, Validator, ValidatorHandler, XMLFilterImpl, XMLReader, XMLReaderAdapter

setErrorIndex( ):

ParsePosition

setErrorListener( ):

Transformer, TransformerFactory

setErrorManager( ):

Handler

setException( ):

FutureTask

setExecuteExistingDelayedTasksAfterShutdownPolicy( ):

ScheduledThreadPoolExecutor

setExpandEntityReferences( ):

DocumentBuilderFactory

setExplicitPolicyRequired( ):

PKIXParameters

setExtendedKeyUsage( ):

X509CertSelector

setExtra( ):

ZipEntry

setFeature( ):

DocumentBuilderFactory, ParserAdapter, SAXParserFactory, SchemaFactory, TransformerFactory, Validator, ValidatorHandler, XMLFilterImpl, XMLReader, XPathFactory

setFileNameMap( ):

URLConnection

setFilter( ):

Handler, Logger

setFirstDayOfWeek( ):

Calendar

setFixedLengthStreamingMode( ):

HttpURLConnection

setFloat( ):

Array, Field

setFollowRedirects( ):

HttpURLConnection

setFormat( ):

MessageFormat

setFormatByArgumentIndex( ):

MessageFormat

setFormats( ):

MessageFormat

setFormatsByArgumentIndex( ):

MessageFormat

setFormatter( ):

Handler

setFractionalSecond( ):

XMLGregorianCalendar

setGregorianChange( ):

GregorianCalendar

setGroupingSeparator( ):

DecimalFormatSymbols

setGroupingSize( ):

DecimalFormat

setGroupingUsed( ):

NumberFormat

setHandler( ):

SAXResult

setHostnameVerifier( ):

HttpsURLConnection

setHour( ):

XMLGregorianCalendar

setHours( ):

Date

setID( ):

TimeZone

setIdAttribute( ):

Element

setIdAttributeNode( ):

Element

setIdAttributeNS( ):

Element

setIfModifiedSince( ):

URLConnection

setIgnoringComments( ):

DocumentBuilderFactory

setIgnoringElementContentWhitespace( ):

DocumentBuilderFactory

setIn( ):

System

setIndex( ):

CharacterIterator, ParsePosition, StringCharacterIterator

setInfinity( ):

DecimalFormatSymbols

setInfo( ):

Identity

setInitialPolicies( ):

PKIXParameters

setInput( ):

Deflater, Inflater

setInputSource( ):

SAXSource

setInputStream( ):

StreamSource

setInstanceFollowRedirects( ):

HttpURLConnection

setInt( ):

Array, Field

setInterface( ):

MulticastSocket

setInternationalCurrencySymbol( ):

DecimalFormatSymbols

setIssuer( ):

X509CertSelector

setIssuerNames( ):

X509CRLSelector

setIssuers( ):

X509CRLSelector

setKeepAlive( ):

Socket

setKeepAliveTime( ):

ThreadPoolExecutor

setKeyEntry( ):

KeyStore

setKeyPair( ):

Signer

setKeyUsage( ):

X509CertSelector

setLastModified( ):

File

setLength( ):

DatagramPacket, RandomAccessFile, StringBuffer

setLenient( ):

Calendar, DateFormat

setLevel( ):

Deflater, Handler, Logger, LogRecord, ZipOutputStream

setLexicalHandler( ):

SAXResult

setLineNumber( ):

LineNumberInputStream, LineNumberReader, LocatorImpl

setLocale( ):

LanguageCallback, MessageFormat, Parser, XMLReaderAdapter

setLocalName( ):

AttributesImpl

setLocalPatternChars( ):

DateFormatSymbols

setLocator( ):

TransformerException

setLoggerLevel( ):

LoggingMXBean

setLoggerName( ):

LogRecord

setLong( ):

Array, Field

setLoopbackMode( ):

MulticastSocket

setMatchAllSubjectAltNames( ):

X509CertSelector

setMaxCRLNumber( ):

X509CRLSelector

setMaximumFractionDigits( ):

DecimalFormat, NumberFormat

setMaximumIntegerDigits( ):

DecimalFormat, NumberFormat

setMaximumPoolSize( ):

ThreadPoolExecutor

setMaxPathLength( ):

PKIXBuilderParameters

setMaxPriority( ):

ThreadGroup

setMessage( ):

LogRecord

setMessageDigest( ):

DigestInputStream, DigestOutputStream

setMethod( ):

ZipEntry, ZipOutputStream

setMillis( ):

LogRecord

setMillisecond( ):

XMLGregorianCalendar

setMinCRLNumber( ):

X509CRLSelector

setMinimalDaysInFirstWeek( ):

Calendar

setMinimumFractionDigits( ):

DecimalFormat, NumberFormat

setMinimumIntegerDigits( ):

DecimalFormat, NumberFormat

setMinusSign( ):

DecimalFormatSymbols

setMinute( ):

XMLGregorianCalendar

setMinutes( ):

Date

setMonetaryDecimalSeparator( ):

DecimalFormatSymbols

setMonth( ):

Date, XMLGregorianCalendar

setMonths( ):

DateFormatSymbols

setMultiplier( ):

DecimalFormat

setName( ):

NameCallback, Thread

setNameConstraints( ):

X509CertSelector

setNamedItem( ):

NamedNodeMap

setNamedItemNS( ):

NamedNodeMap

setNamespaceAware( ):

DocumentBuilderFactory, SAXParserFactory

setNamespaceContext( ):

XPath

setNamespaceDeclUris( ):

NamespaceSupport

setNaN( ):

DecimalFormatSymbols

setNeedClientAuth( ):

SSLEngine, SSLServerSocket, SSLSocket

setNegativePrefix( ):

DecimalFormat

setNegativeSuffix( ):

DecimalFormat

setNetworkInterface( ):

MulticastSocket

setNextSibling( ):

DOMResult

setNode( ):

DOMResult, DOMSource

setNodeValue( ):

Node

setNumberFormat( ):

DateFormat

setOffset( ):

CollationElementIterator, ObjectStreamField

setOOBInline( ):

Socket

setOption( ):

SocketOptions

setOut( ):

System

setOutputProperties( ):

Transformer

setOutputProperty( ):

Transformer

setOutputStream( ):

StreamHandler, StreamResult

setPackageAssertionStatus( ):

ClassLoader

setParameter( ):

DOMConfiguration, Signature, Transformer

setParameters( ):

LogRecord

setParent( ):

Logger, ResourceBundle, XMLFilter, XMLFilterImpl

setParseBigDecimal( ):

DecimalFormat

setParseIntegerOnly( ):

NumberFormat

setPassword( ):

PasswordCallback

setPathToNames( ):

X509CertSelector

setPatternSeparator( ):

DecimalFormatSymbols

setPercent( ):

DecimalFormatSymbols

setPerformancePreferences( ):

ServerSocket, Socket, SocketImpl

setPerMill( ):

DecimalFormatSymbols

setPolicy( ):

Policy, X509CertSelector

setPolicyMappingInhibited( ):

PKIXParameters

setPolicyQualifiersRejected( ):

PKIXParameters

setPort( ):

DatagramPacket

setPositivePrefix( ):

DecimalFormat

setPositiveSuffix( ):

DecimalFormat

setPrefix( ):

Node

setPriority( ):

Thread

setPrivateKeyValid( ):

X509CertSelector

setProperties( ):

System

setProperty( ):

ParserAdapter, Properties, SAXParser, SchemaFactory, Security, System, Validator, ValidatorHandler, XMLFilterImpl, XMLReader

setPublicId( ):

InputSource, LocatorImpl, StreamSource

setPublicKey( ):

Identity

setPushLevel( ):

MemoryHandler

setQName( ):

AttributesImpl

setRawOffset( ):

SimpleTimeZone, TimeZone

setReader( ):

StreamSource

setReadOnly( ):

File, PermissionCollection, Subject

setReadTimeout( ):

URLConnection

setReceiveBufferSize( ):

DatagramSocket, ServerSocket, Socket

setRejectedExecutionHandler( ):

ThreadPoolExecutor

setRequestMethod( ):

HttpURLConnection

setRequestProperty( ):

URLConnection

setResourceBundle( ):

LogRecord

setResourceBundleName( ):

LogRecord

setResourceResolver( ):

SchemaFactory, Validator, ValidatorHandler

setResult( ):

TransformerHandler

setReuseAddress( ):

DatagramSocket, ServerSocket, Socket

setRevocationEnabled( ):

PKIXParameters

setScale( ):

BigDecimal

setSchema( ):

DocumentBuilderFactory, SAXParserFactory

setSecond( ):

XMLGregorianCalendar

setSeconds( ):

Date

setSecurityManager( ):

System

setSeed( ):

Random, SecureRandom

setSelectedIndex( ):

ChoiceCallback, ConfirmationCallback

setSelectedIndexes( ):

ChoiceCallback

setSendBufferSize( ):

DatagramSocket, Socket

setSequenceNumber( ):

LogRecord

setSerialNumber( ):

X509CertSelector

setSessionCacheSize( ):

SSLSessionContext

setSessionTimeout( ):

SSLSessionContext

setShort( ):

Array, Field

setShortMonths( ):

DateFormatSymbols

setShortWeekdays( ):

DateFormatSymbols

setSigners( ):

ClassLoader

setSigProvider( ):

PKIXParameters

setSize( ):

Vector, ZipEntry

setSocketAddress( ):

DatagramPacket

setSocketFactory( ):

ServerSocket

setSocketImplFactory( ):

Socket

setSoLinger( ):

Socket

setSoTimeout( ):

DatagramSocket, ServerSocket, Socket

setSourceClassName( ):

LogRecord

setSourceMethodName( ):

LogRecord

setSpecified( ):

Attributes2Impl

setSSLSocketFactory( ):

HttpsURLConnection

setStackTrace( ):

Throwable

setStartRule( ):

SimpleTimeZone

setStartYear( ):

SimpleTimeZone

setState( ):

AbstractQueuedSynchronizer

setStrategy( ):

Deflater

setStrength( ):

Collator

setStrictErrorChecking( ):

Document

setSubject( ):

X509CertSelector

setSubjectAlternativeNames( ):

X509CertSelector

setSubjectKeyIdentifier( ):

X509CertSelector

setSubjectPublicKey( ):

X509CertSelector

setSubjectPublicKeyAlgID( ):

X509CertSelector

setSystemId( ):

DOMResult, DOMSource, InputSource, LocatorImpl, Result, SAXResult, SAXSource, Source, StreamResult, StreamSource, TemplatesHandler, TransformerHandler

setSystemScope( ):

IdentityScope

setTargetCertConstraints( ):

PKIXParameters

setTcpNoDelay( ):

Socket

setText( ):

BreakIterator, CollationElementIterator, StringCharacterIterator, TextInputCallback

setTextContent( ):

Node

setThreadContentionMonitoringEnabled( ):

ThreadMXBean

setThreadCpuTimeEnabled( ):

ThreadMXBean

setThreadFactory( ):

ThreadPoolExecutor

setThreadID( ):

LogRecord

setThrown( ):

LogRecord

setTime( ):

Calendar, Date, XMLGregorianCalendar, ZipEntry

setTimeInMillis( ):

Calendar

setTimeToLive( ):

DatagramSocketImpl, MulticastSocket

setTimeZone( ):

Calendar, DateFormat, GregorianCalendar

setTimezone( ):

XMLGregorianCalendar

setTrafficClass( ):

DatagramSocket, Socket

setTrustAnchors( ):

PKIXParameters

setTTL( ):

DatagramSocketImpl, MulticastSocket

setType( ):

AttributesImpl

setUncaughtExceptionHandler( ):

Thread

setURI( ):

AttributesImpl

setURIResolver( ):

Transformer, TransformerFactory

setURL( ):

URLStreamHandler

setURLStreamHandlerFactory( ):

URL

setUsageThreshold( ):

MemoryPoolMXBean

setUseCaches( ):

URLConnection

setUseClientMode( ):

SSLEngine, SSLServerSocket, SSLSocket

setUseParentHandlers( ):

Logger

setUserData( ):

Node

setValidating( ):

DocumentBuilderFactory, SAXParserFactory

setValue( ):

Attr, AttributesImpl, Entry

setVerbose( ):

ClassLoadingMXBean, MemoryMXBean

setWantClientAuth( ):

SSLEngine, SSLServerSocket, SSLSocket

setWeekdays( ):

DateFormatSymbols

setWriter( ):

StreamResult

setXIncludeAware( ):

DocumentBuilderFactory, SAXParserFactory

setXMLReader( ):

SAXSource

setXmlStandalone( ):

Document

setXmlVersion( ):

Document

setXMLVersion( ):

Locator2Impl

setXPathFunctionResolver( ):

XPath, XPathFactory

setXPathVariableResolver( ):

XPath, XPathFactory

setYear( ):

Date, XMLGregorianCalendar

setZeroDigit( ):

DecimalFormatSymbols

setZoneStrings( ):

DateFormatSymbols

SEVERE:

Level

severe( ):

Logger

SEVERITY_ERROR:

DOMError

SEVERITY_FATAL_ERROR:

DOMError

SEVERITY_WARNING:

DOMError

SHA1:

MGF1ParameterSpec

SHA256:

MGF1ParameterSpec

SHA384:

MGF1ParameterSpec

SHA512:

MGF1ParameterSpec

SHAVIAN:

UnicodeBlock

shiftLeft( ):

BigInteger

shiftRight( ):

BigInteger

Short:

java.lang

SHORT:

DateFormat, TimeZone

ShortBuffer:

java.nio

ShortBufferException:

javax.crypto

shortValue( ):

Byte, Double, Float, Integer, Long, Number, Short

shortValueExact( ):

BigDecimal

shuffle( ):

Collections

shutdown( ):

ExecutorService, ScheduledThreadPoolExecutor, ThreadPoolExecutor

shutdownInput( ):

Socket, SocketImpl

shutdownNow( ):

ExecutorService, ScheduledThreadPoolExecutor, ThreadPoolExecutor

shutdownOutput( ):

Socket, SocketImpl

SIGN:

Field, Signature

sign( ):

Signature

signal( ):

Condition, ConditionObject

signalAll( ):

Condition, ConditionObject

Signature:

java.security

SIGNATURE_VERSION:

Name

SignatureException:

java.security

SignatureSpi:

java.security

SignedObject:

java.security

Signer:

java.security

signum( ):

BigDecimal, BigInteger, Integer, Long, Math, StrictMath

SimpleDateFormat:

java.text

SimpleFormatter:

java.util.logging

SimpleTimeZone:

java.util

SIMPLIFIED_CHINESE:

Locale

sin( ):

Math, StrictMath

singleton( ):

Collections

singletonList( ):

Collections

singletonMap( ):

Collections

sinh( ):

Math, StrictMath

SINHALA:

UnicodeBlock

sink( ):

Pipe

SinkChannel:

java.nio.channels.Pipe

SIZE:

Byte, Character, Double, Float, Integer, Long, Short

size( ):

AbstractCollection, AbstractMap, ArrayBlockingQueue, ArrayList, Attributes, BitSet, ByteArrayOutputStream, CharArrayWriter, Collection, ConcurrentHashMap, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, DataOutputStream, DelayQueue, Dictionary, EnumMap, FileChannel, FileLock, HashMap, HashSet, Hashtable, IdentityHashMap, IdentityScope, KeyStore, LinkedBlockingQueue, LinkedList, List, Map, PriorityBlockingQueue, PriorityQueue, Set, SynchronousQueue, TreeMap, TreeSet, Vector, WeakHashMap, ZipFile *skip( ):*

BufferedInputStream, BufferedReader, ByteArrayInputStream, CharArrayReader, CheckedInputStream, CipherInputStream, FileInputStream, FilterInputStream, FilterReader, InflaterInputStream, InputStream, LineNumberInputStream, LineNumberReader, ObjectInput, PushbackInputStream, PushbackReader, Reader, Scanner, StringBufferInputStream, StringReader, ZipInputStream

skipBytes( ):

DataInput, DataInputStream, ObjectInputStream, RandomAccessFile

skippedEntity( ):

ContentHandler, DefaultHandler, XMLFilterImpl, XMLReaderAdapter

slashSlashComments( ):

StreamTokenizer

slashStarComments( ):

StreamTokenizer

sleep( ):

Thread, TimeUnit

slice( ):

ByteBuffer, CharBuffer, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer

SMALL_FORM_VARIANTS:

UnicodeBlock

SO_BINDADDR:

SocketOptions

SO_BROADCAST:

SocketOptions

SO_KEEPALIVE:

SocketOptions

SO_LINGER:

SocketOptions

SO_OOBINLINE:

SocketOptions

SO_RCVBUF:

SocketOptions

SO_REUSEADDR:

SocketOptions

SO_SNDBUF:

SocketOptions

SO_TIMEOUT:

SocketOptions

Socket:

java.net

socket( ):

DatagramChannel, ServerSocketChannel, SocketChannel

SocketAddress:

java.net

SocketChannel:

java.nio.channels

SocketException:

java.net

SocketFactory:

javax.net

SocketHandler:

java.util.logging

SocketImpl:

java.net

SocketImplFactory:

java.net

SocketOptions:

java.net

SocketPermission:

java.net

SocketTimeoutException:

java.net

SOCKS:

Type

SoftReference:

java.lang.ref

sort( ):

Arrays, Collections

SortedMap:

java.util

SortedSet:

java.util

source:

EventObject

Source:

javax.xml.transform

SOURCE:

RetentionPolicy

source( ):

Pipe

SourceChannel:

java.nio.channels.Pipe

SourceLocator:

javax.xml.transform

sourceToInputSource( ):

SAXSource

SPACE_SEPARATOR:

Character

SPACING_MODIFIER_LETTERS:

UnicodeBlock

SPECIALS:

UnicodeBlock

SPECIFICATION_TITLE:

Name

SPECIFICATION_VENDOR:

Name

SPECIFICATION_VERSION:

Name

split( ):

Pattern, String

splitText( ):

Text

sqrt( ):

Math, StrictMath

SSLContext:

javax.net.ssl

SSLContextSpi:

javax.net.ssl

SSLEngine:

javax.net.ssl

SSLEngineResult:

javax.net.ssl

SSLEngineResult.HandshakeStatus:

javax.net.ssl

SSLEngineResult.Status:

javax.net.ssl

SSLException:

javax.net.ssl

SSLHandshakeException:

javax.net.ssl

SSLKeyException:

javax.net.ssl

SSLPeerUnverifiedException:

javax.net.ssl

SSLPermission:

javax.net.ssl

SSLProtocolException:

javax.net.ssl

SSLServerSocket:

javax.net.ssl

SSLServerSocketFactory:

javax.net.ssl

SSLSession:

javax.net.ssl

SSLSessionBindingEvent:

javax.net.ssl

SSLSessionBindingListener:

javax.net.ssl

SSLSessionContext:

javax.net.ssl

SSLSocket:

javax.net.ssl

SSLSocketFactory:

javax.net.ssl

Stack:

java.util

StackOverflowError:

java.lang

StackTraceElement:

java.lang

STANDALONE:

OutputKeys

STANDARD_TIME:

SimpleTimeZone

start( ):

Matcher, MatchResult, ProcessBuilder, Thread

START_PUNCTUATION:

Character

startCDATA( ):

DefaultHandler2, LexicalHandler

startDocument( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

startDTD( ):

DefaultHandler2, LexicalHandler

startElement( ):

ContentHandler, DefaultHandler, DocumentHandler, HandlerBase, ParserAdapter, XMLFilterImpl, XMLReaderAdapter

startEntity( ):

DefaultHandler2, LexicalHandler

startHandshake( ):

SSLSocket

startPrefixMapping( ):

ContentHandler, DefaultHandler, XMLFilterImpl, XMLReaderAdapter

startsWith( ):

String

state:

Signature

State:

java.lang.Thread

STATIC:

Modifier

Status:

javax.net.ssl.SSLEngineResult

stop( ):

Thread, ThreadGroup

store( ):

KeyStore, Properties

STORED:

ZipEntry, ZipOutputStream

storeToXML( ):

Properties

STREAM_MAGIC:

ObjectStreamConstants

STREAM_VERSION:

ObjectStreamConstants

StreamCorruptedException:

java.io

StreamHandler:

java.util.logging

StreamResult:

javax.xml.transform.stream

StreamSource:

javax.xml.transform.stream

StreamTokenizer:

java.io

STRICT:

Modifier

StrictMath:

java.lang

STRING:

XPathConstants

String:

java.lang

StringBuffer:

java.lang

StringBufferInputStream:

java.io

StringBuilder:

java.lang

StringCharacterIterator:

java.text

StringIndexOutOfBoundsException:

java.lang

StringReader:

java.io

StringTokenizer:

java.util

StringWriter:

java.io

STRIP:

Packer

stripTrailingZeros( ):

BigDecimal

SUBCLASS_IMPLEMENTATION_PERMISSION:

ObjectStreamConstants

Subject:

javax.security.auth

SubjectDomainCombiner:

javax.security.auth

subList( ):

AbstractList, CopyOnWriteArrayList, List, Vector

subMap( ):

SortedMap, TreeMap

submit( ):

AbstractExecutorService, CompletionService, ExecutorCompletionService, ExecutorService, ScheduledThreadPoolExecutor

subSequence( ):

CharBuffer, CharSequence, String, StringBuffer

Subset:

java.lang.Character

subSet( ):

SortedSet, TreeSet

SUBSTITUTION_PERMISSION:

ObjectStreamConstants

substring( ):

String, StringBuffer

substringData( ):

CharacterData

subtract( ):

BigDecimal, BigInteger, Duration

SUFFICIENT:

LoginModuleControlFlag

SUNDAY:

Calendar

SUPERSCRIPTS_AND_SUBSCRIPTS:

UnicodeBlock

SUPPLEMENTAL_ARROWS_A:

UnicodeBlock

SUPPLEMENTAL_ARROWS_B:

UnicodeBlock

SUPPLEMENTAL_MATHEMATICAL_OPERATORS:

UnicodeBlock

SUPPLEMENTARY_PRIVATE_USE_AREA_A:

UnicodeBlock

SUPPLEMENTARY_PRIVATE_USE_AREA_B:

UnicodeBlock

supportsParameter( ):

Service

supportsUrgentData( ):

SocketImpl

SuppressWarnings:

java.lang

SURROGATE:

Character

SURROGATES_AREA:

UnicodeBlock

suspend( ):

Thread, ThreadGroup

sval:

StreamTokenizer

swap( ):

Collections

sync( ):

AbstractPreferences, FileDescriptor, Preferences

SyncFailedException:

java.io

SYNCHRONIZED:

Modifier

synchronizedCollection( ):

Collections

synchronizedList( ):

Collections

synchronizedMap( ):

Collections

synchronizedSet( ):

Collections

synchronizedSortedMap( ):

Collections

synchronizedSortedSet( ):

Collections

SynchronousQueue:

java.util.concurrent

syncSpi( ):

AbstractPreferences

SYNTAX_ERR:

DOMException

SYRIAC:

UnicodeBlock

System:

java.lang

systemNodeForPackage( ):

Preferences

systemRoot( ):

Preferences, PreferencesFactory

Team LiB

23.20. T

TAGALOG:

UnicodeBlock

TAGBANWA:

UnicodeBlock

TAGS:

UnicodeBlock

TAI_LE:

UnicodeBlock

TAI_XUAN_JING_SYMBOLS:

UnicodeBlock

tailMap( ):

SortedMap, TreeMap

tailSet( ):

SortedSet, TreeSet

TAIWAN:

Locale

take( ):

ArrayBlockingQueue, BlockingQueue, CompletionService, DelayQueue, ExecutorCompletionService, LinkedBlockingQueue, PriorityBlockingQueue, SynchronousQueue

TAMIL:

UnicodeBlock

tan( ):

Math, StrictMath

tanh( ):

Math, StrictMath

Target:

java.lang.annotation

TC_ARRAY:

ObjectStreamConstants

TC_BASE:

ObjectStreamConstants

TC_BLOCKDATA:

ObjectStreamConstants

TC_BLOCKDATALONG:

ObjectStreamConstants

TC_CLASS:

ObjectStreamConstants

TC_CLASSDESC:

ObjectStreamConstants

TC_ENDBLOCKDATA:

ObjectStreamConstants

TC_ENUM:

ObjectStreamConstants

TC_EXCEPTION:

ObjectStreamConstants

TC_LONGSTRING:

ObjectStreamConstants

TC_MAX:

ObjectStreamConstants

TC_NULL:

ObjectStreamConstants

TC_OBJECT:

ObjectStreamConstants

TC_PROXYCLASSDESC:

ObjectStreamConstants

TC_REFERENCE:

ObjectStreamConstants

TC_RESET:

ObjectStreamConstants

TC_STRING:

ObjectStreamConstants

TCP_NODELAY:

SocketOptions

TELUGU:

UnicodeBlock

Templates:

javax.xml.transform

TemplatesHandler:

javax.xml.transform.sax

TEN:

BigDecimal, BigInteger

TERMINATED:

State

terminated( ):

ThreadPoolExecutor

TERTIARY:

Collator

tertiaryOrder( ):

CollationElementIterator

testBit( ):

BigInteger

Text:

org.w3c.dom

TEXT_NODE:

Node

TextInputCallback:

javax.security.auth.callback

TextOutputCallback:

javax.security.auth.callback

THAANA:

UnicodeBlock

THAI:

UnicodeBlock

Thread:

java.lang

Thread.State:

java.lang

Thread.UncaughtExceptionHandler:

java.lang

THREAD_MXBEAN_NAME:

ManagementFactory

ThreadDeath:

java.lang

ThreadFactory:

java.util.concurrent

ThreadGroup:

java.lang

ThreadInfo:

java.lang.management

ThreadLocal:

java.lang

ThreadMXBean:

java.lang.management

ThreadPoolExecutor:

java.util.concurrent

ThreadPoolExecutor.AbortPolicy:

java.util.concurrent

ThreadPoolExecutor.CallerRunsPolicy:

java.util.concurrent

ThreadPoolExecutor.DiscardOldestPolicy:

java.util.concurrent

ThreadPoolExecutor.DiscardPolicy:

java.util.concurrent

Throwable:

java.lang

throwException( ):

CoderResult

throwing( ):

Logger

THURSDAY:

Calendar

TIBETAN:

UnicodeBlock

time:

Calendar

TIME:

DatatypeConstants

TIME_ZONE:

Field

TIMED_WAITING:

State

timedJoin( ):

TimeUnit

timedWait( ):

TimeUnit

TimeoutException:

java.util.concurrent

Timer:

java.util

TimerTask:

java.util

Timestamp:

java.security

timestamp( ):

UUID

TimeUnit:

java.util.concurrent

TimeZone:

java.util

TIMEZONE_FIELD:

DateFormat

TITLECASE_LETTER:

Character

toArray( ):

AbstractCollection, ArrayBlockingQueue, ArrayList, Collection, ConcurrentLinkedQueue, CopyOnWriteArrayList, CopyOnWriteArraySet, DelayQueue, LinkedBlockingQueue, LinkedList, List, PriorityBlockingQueue, Set, SynchronousQueue, Vector

toASCIIString( ):

URI

toBigInteger( ):

BigDecimal

toBigIntegerExact( ):

BigDecimal

toBinaryString( ):

Integer, Long

toByteArray( ):

BigInteger, ByteArrayOutputStream, CollationKey

toCharArray( ):

CharArrayWriter, String

toChars( ):

Character

toCodePoint( ):

Character

toDegrees( ):

Math, StrictMath

toEngineeringString( ):

BigDecimal

toExternalForm( ):

URL, URLStreamHandler

toGenericString( ):

Constructor, Field, Method

toGMTString( ):

Date

toGregorianCalendar( ):

XMLGregorianCalendar

toHexString( ):

Double, Float, Integer, Long

toLocaleString( ):

Date

toLocalizedPattern( ):

DecimalFormat, SimpleDateFormat

toLowerCase( ):

Character, String

toMatchResult( ):

Matcher

toMicros( ):

TimeUnit

toMillis( ):

TimeUnit

toNanos( ):

TimeUnit

toOctalString( ):

Integer, Long

TooManyListenersException:

java.util

toPattern( ):

ChoiceFormat, DecimalFormat, MessageFormat, SimpleDateFormat

toPlainString( ):

BigDecimal

toRadians( ):

Math, StrictMath

toSeconds( ):

TimeUnit

toString( ):

AbstractCollection, AbstractMap, AbstractPreferences, AbstractQueuedSynchronizer, AlgorithmParameters, Annotation, ArrayBlockingQueue, Arrays, AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicLong, AtomicLongArray, AtomicReference, AtomicReferenceArray, Attribute, Bidi, BigDecimal, BigInteger, BitSet, Boolean, Byte, ByteArrayOutputStream, ByteBuffer, ByteOrder, Calendar, Certificate, CertPath, Character, CharArrayWriter, CharBuffer, CharSequence, Charset, Class, CoderResult, CodeSigner, CodeSource, CodingErrorAction, CollectionCertStoreParameters, Constructor, CopyOnWriteArrayList, CountDownLatch, CRL, Currency, Date, DigestInputStream, DigestOutputStream, Double, DoubleBuffer, Duration, Enum, EventObject, Field, FieldPosition, File, FileLock, Float, FloatBuffer, Formatter, Hashtable, Identity, IdentityScope, InetAddress, InetSocketAddress, IntBuffer, Integer, KerberosKey, KerberosPrincipal, KerberosTicket, LDAPCertStoreParameters, Level, LinkedBlockingQueue, Locale, LoginModuleControlFlag, Long, LongBuffer, MapMode, Matcher, MathContext, MemoryType, MemoryUsage, MessageDigest, Method, Modifier, Name, NetworkInterface, Object, ObjectStreamClass, ObjectStreamField, Package, ParsePosition, Pattern, Permission, PermissionCollection, PKIXBuilderParameters, PKIXCertPathBuilderResult, PKIXCertPathValidatorResult, PKIXParameters, PolicyQualifierInfo, Preferences, Principal, PriorityBlockingQueue, PrivateKeyEntry, PrivilegedActionException, ProtectionDomain, Provider, Proxy, QName, ReadLock, ReentrantLock, ReentrantReadWriteLock, SAXException, Scanner, SecretKeyEntry, Semaphore, ServerSocket, Service, Short, ShortBuffer, Signature, Signer, SimpleTimeZone, Socket, SocketImpl, SSLEngineResult, StackTraceElement, StreamTokenizer, String, StringBuffer, StringBuilder, StringWriter, Subject, Subset, Thread, ThreadGroup, ThreadInfo, Throwable, Timestamp, TrustAnchor, TrustedCertificateEntry, UnresolvedPermission, URI, URL, URLConnection, UUID, Vector, WriteLock, X500Principal, X509CertSelector, X509CRLEntry, X509CRLSelector, XMLGregorianCalendar, ZipEntry

totalMemory( ):

Runtime

toTitleCase( ):

Character

toUpperCase( ):

Character, String

toURI( ):

File, URL

toURL( ):

File, URI

toXMLFormat( ):

XMLGregorianCalendar

traceInstructions( ):

Runtime

traceMethodCalls( ):

Runtime

TRADITIONAL_CHINESE:

Locale

transferFrom( ):

FileChannel

transferTo( ):

FileChannel

transform( ):

ClassFileTransformer, Transformer

Transformer:

javax.xml.transform

TransformerConfigurationException:

javax.xml.transform

TransformerException:

javax.xml.transform

TransformerFactory:

javax.xml.transform

TransformerFactoryConfigurationError:

javax.xml.transform

TransformerHandler:

javax.xml.transform.sax

TRANSIENT:

Modifier

translateKey( ):

KeyFactory, SecretKeyFactory

TreeMap:

java.util

TreeSet:

java.util

trim( ):

String

trimToSize( ):

ArrayList, StringBuffer, Vector

TRUE:

Boolean, Packer, Unpacker

truncate( ):

FileChannel

TrustAnchor:

java.security.cert

TrustedCertificateEntry:

java.security.KeyStore

TrustManager:

javax.net.ssl

TrustManagerFactory:

javax.net.ssl

TrustManagerFactorySpi:

javax.net.ssl

tryAcquire( ):

AbstractQueuedSynchronizer, Semaphore

tryAcquireNanos( ):

AbstractQueuedSynchronizer

tryAcquireShared( ):

AbstractQueuedSynchronizer

tryAcquireSharedNanos( ):

AbstractQueuedSynchronizer

tryLock( ):

FileChannel, Lock, ReadLock, ReentrantLock, WriteLock

tryRelease( ):

AbstractQueuedSynchronizer

tryReleaseShared( ):

AbstractQueuedSynchronizer

TT_EOF:

StreamTokenizer

TT_EOL:

StreamTokenizer

TT_NUMBER:

StreamTokenizer

TT_WORD:

StreamTokenizer

ttype:

StreamTokenizer

TUESDAY:

Calendar

TYPE:

Boolean, Byte, Character, Double, ElementType, Float, Integer, Long, Short, Void

Type:

java.lang.reflect, java.net.Proxy, java.security.KeyRep

type( ):

Proxy

TYPE_MISMATCH_ERR:

DOMException

TypeInfo:

org.w3c.dom

TypeInfoProvider:

javax.xml.validation

typeName( ):

TypeNotPresentException

TypeNotPresentException:

java.lang

TypeVariable:

java.lang.reflect

Team LiB

Team LiB

23.21. U

UGARITIC:

UnicodeBlock

UK:

Locale

ulp( ):

BigDecimal, Math, StrictMath

UNASSIGNED:

Character

uncaughtException( ):

ThreadGroup, UncaughtExceptionHandler

UncaughtExceptionHandler:

java.lang.Thread

unconfigurableExecutorService( ):

Executors

unconfigurableScheduledExecutorService( ):

Executors

UNDECIMBER:

Calendar

UndeclaredThrowableException:

java.lang.reflect

UNDERFLOW:

CoderResult

UNICODE_CASE:

Pattern

UnicodeBlock:

java.lang.Character

UNIFIED_CANADIAN_ABORIGINAL_SYLLABICS:

UnicodeBlock

UNINITIALIZED:

Signature

UNIX_LINES:

Pattern

UNKNOWN_ATTRIBUTE:

Packer

UnknownError:

java.lang

UnknownFormatConversionException:

java.util

UnknownFormatFlagsException:

java.util

UnknownHostException:

java.net

UnknownServiceException:

java.net

UNLIMITED:

MathContext

unlock( ):

Lock, ReadLock, ReentrantLock, WriteLock

unmappableCharacterAction( ):

CharsetDecoder, CharsetEncoder

UnmappableCharacterException:

java.nio.charset

unmappableForLength( ):

CoderResult

UnmodifiableClassException:

java.lang.instrument

unmodifiableCollection( ):

Collections

unmodifiableList( ):

Collections

unmodifiableMap( ):

Collections

unmodifiableSet( ):

Collections

unmodifiableSortedMap( ):

Collections

unmodifiableSortedSet( ):

Collections

UNNECESSARY:

RoundingMode

unpack( ):

Unpacker

Unpacker:

java.util.jar.Pack200

unpark( ):

LockSupport

unparsedEntityDecl( ):

DefaultHandler, DTDHandler, HandlerBase, XMLFilterImpl

unread( ):

PushbackInputStream, PushbackReader

UnrecoverableEntryException:

java.security

UnrecoverableKeyException:

java.security

UnresolvedAddressException:

java.nio.channels

UnresolvedPermission:

java.security

UnsatisfiedLinkError:

java.lang

unscaledValue( ):

BigDecimal

UNSPECIFIED_OPTION:

ConfirmationCallback

UnsupportedAddressTypeException:

java.nio.channels

UnsupportedCallbackException:

javax.security.auth.callback

UnsupportedCharsetException:

java.nio.charset

UnsupportedClassVersionError:

java.lang

UnsupportedEncodingException:

java.io

UnsupportedOperationException:

java.lang

unwrap( ):

Cipher, SSLEngine

UNWRAP_MODE:

Cipher

UP:

RoundingMode

update( ):

Adler32, Checksum, Cipher, CRC32, Mac, MessageDigest, Observer, Signature

UPPERCASE:

FormattableFlags

UPPERCASE_LETTER:

Character

URI:

java.net

URIResolver:

javax.xml.transform

URISyntaxException:

java.net

URL:

java.net

url:

URLConnection

URLClassLoader:

java.net

URLConnection:

java.net

URLDecoder:

java.net

URLEncoder:

java.net

URLStreamHandler:

java.net

URLStreamHandlerFactory:

java.net

US:

Locale

useAnchoringBounds( ):

Matcher

useCaches:

URLConnection

useDaylightTime( ):

SimpleTimeZone, TimeZone

useDelimiter( ):

Scanner

useLocale( ):

Scanner

usePattern( ):

Matcher

useProtocolVersion( ):

ObjectOutputStream

useRadix( ):

Scanner

UserDataHandler:

org.w3c.dom

userNodeForPackage( ):

Preferences

userRoot( ):

Preferences, PreferencesFactory

useTransparentBounds( ):

Matcher

usingProxy( ):

HttpURLConnection

UTC( ):

Date

UTC_TIME:

SimpleTimeZone

UTFDataFormatException:

java.io

UUID:

java.util

Team LiB

23.22. V

valid( ):

FileDescriptor

validate( ):

CertPathValidator, Validator

validateObject( ):

ObjectInputValidation

VALIDATION_ERR:

DOMException

Validator:

javax.xml.validation

ValidatorHandler:

javax.xml.validation

validOps( ):

DatagramChannel, SelectableChannel, ServerSocketChannel, SinkChannel, SocketChannel, SourceChannel

value( ):

Retention, SuppressWarnings, Target

valueBound( ):

SSLSessionBindingListener

valueOf( ):

BigDecimal, BigDecimalLayoutForm, BigInteger, Boolean, Byte, Character, Double, ElementType, Enum, Float, HandshakeStatus, Integer, Long, MemoryType, QName, RequestorType, RetentionPolicy, RoundingMode, Short, State, Status, String, TimeUnit, Type

values( ):

AbstractMap, Attributes, BigDecimalLayoutForm, ConcurrentHashMap, ElementType, EnumMap, HandshakeStatus, HashMap, Hashtable, IdentityHashMap, Map, MemoryType, Provider, RequestorType, RetentionPolicy, RoundingMode, State, Status, TimeUnit, TreeMap, Type, WeakHashMap

valueUnbound( ):

SSLSessionBindingListener

variant( ):

UUID

VARIATION_SELECTORS:

UnicodeBlock

VARIATION_SELECTORS_SUPPLEMENT:

UnicodeBlock

Vector:

java.util

VERIFY:

Signature

verify( ):

Certificate, HostnameVerifier, Signature, SignedObject, X509CRL

VerifyError:

java.lang

VERSION:

OutputKeys

version( ):

UUID

VirtualMachineError:

java.lang

Void:

java.lang

VOLATILE:

Modifier

23.23. W

W3C_XML_SCHEMA_INSTANCE_NS_URI:

XMLConstants

W3C_XML_SCHEMA_NS_URI:

XMLConstants

W3C_XPATH_DATATYPE_NS_URI:

XMLConstants

wait( ):

Object

waitFor( ):

Process

WAITING:

State

wakeup( ):

Selector

WALL_TIME:

SimpleTimeZone

WARNING:

ConfirmationCallback, Level, TextOutputCallback

warning( ):

DefaultHandler, ErrorHandler, ErrorListener, HandlerBase, Logger, XMLFilterImpl

weakCompareAndSet( ):

AtomicBoolean, AtomicInteger, AtomicIntegerArray, AtomicIntegerFieldUpdater, AtomicLong, AtomicLongArray, AtomicLongFieldUpdater, AtomicMarkableReference, AtomicReference, AtomicReferenceArray, AtomicReferenceFieldUpdater, AtomicStampedReference

WeakHashMap:

java.util

WeakReference:

java.lang.ref

WEDNESDAY:

Calendar

WEEK_OF_MONTH:

Calendar, Field

WEEK_OF_MONTH_FIELD:

DateFormat

WEEK_OF_YEAR:

Calendar, Field

WEEK_OF_YEAR_FIELD:

DateFormat

whitespaceChars( ):

StreamTokenizer

WildcardType:

java.lang.reflect

wordChars( ):

StreamTokenizer

wrap( ):

ByteBuffer, CharBuffer, Cipher, DoubleBuffer, FloatBuffer, IntBuffer, LongBuffer, ShortBuffer, SSLEngine

WRAP_MODE:

Cipher

WritableByteChannel:

java.nio.channels

write( ):

BufferedOutputStream, BufferedWriter, ByteArrayOutputStream, CharArrayWriter, CheckedOutputStream, CipherOutputStream, DatagramChannel, DataOutput, DataOutputStream, DeflaterOutputStream, DigestOutputStream, FileChannel, FileOutputStream, FilterOutputStream, FilterWriter, GatheringByteChannel, GZIPOutputStream, Manifest, ObjectOutput, ObjectOutputStream, OutputStream, OutputStreamWriter, PipedOutputStream, PipedWriter, PrintStream, PrintWriter, PutField, RandomAccessFile, SocketChannel, StringWriter, WritableByteChannel, Writer, ZipOutputStream

WRITE_FAILURE:

ErrorManager

WriteAbortedException:

java.io

writeBoolean( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeByte( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeBytes( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeChar( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeChars( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeClassDescriptor( ):

ObjectOutputStream

writeDouble( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeExternal( ):

Externalizable

writeFields( ):

ObjectOutputStream

writeFloat( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeInt( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

WriteLock:

java.util.concurrent.locks.ReentrantReadWriteLock

writeLock( ):

ReadWriteLock, ReentrantReadWriteLock

writeLong( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeObject( ):

ObjectOutput, ObjectOutputStream

writeObjectOverride( ):

ObjectOutputStream

Writer:

java.io

writeReplace( ):

Certificate, CertPath

writeShort( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

writeStreamHeader( ):

ObjectOutputStream

writeTo( ):

ByteArrayOutputStream, CharArrayWriter

writeUnshared( ):

ObjectOutputStream

writeUTF( ):

DataOutput, DataOutputStream, ObjectOutputStream, RandomAccessFile

written:

DataOutputStream

WRONG_DOCUMENT_ERR:

DOMException

Team LiB

23.24. X

X500Principal:

javax.security.auth.x500

X500PrivateCredential:

javax.security.auth.x500

X509Certificate:

java.security.cert

X509CertSelector:

java.security.cert

X509CRL:

java.security.cert

X509CRLEntry:

java.security.cert

X509CRLSelector:

java.security.cert

X509EncodedKeySpec:

java.security.spec

X509ExtendedKeyManager:

javax.net.ssl

X509Extension:

java.security.cert

X509KeyManager:

javax.net.ssl

X509TrustManager:

javax.net.ssl

XML_DTD_NS_URI:

XMLConstants

XML_NS_PREFIX:

XMLConstants

XML_NS_URI:

XMLConstants

XMLConstants:

javax.xml

XMLFilter:

org.xml.sax

XMLFilterImpl:

org.xml.sax.helpers

XMLFormatter:

java.util.logging

XMLGregorianCalendar:

javax.xml.datatype

XMLNS:

NamespaceSupport

XMLNS_ATTRIBUTE:

XMLConstants

XMLNS_ATTRIBUTE_NS_URI:

XMLConstants

XMLReader:

org.xml.sax

XMLReaderAdapter:

org.xml.sax.helpers

XMLReaderFactory:

org.xml.sax.helpers

xor( ):

BigInteger, BitSet

XPath:

javax.xml.xpath

XPathConstants:

javax.xml.xpath

XPathException:

javax.xml.xpath

XPathExpression:

javax.xml.xpath

XPathExpressionException:

javax.xml.xpath

XPathFactory:

javax.xml.xpath

XPathFactoryConfigurationException:

javax.xml.xpath

XPathFunction:

javax.xml.xpath

XPathFunctionException:

javax.xml.xpath

XPathFunctionResolver:

javax.xml.xpath

XPathVariableResolver:

javax.xml.xpath

Team LiB

Team LiB

23.25. Y

YEAR:

Calendar, Field

YEAR_FIELD:

DateFormat

YEARS:

DatatypeConstants

YES:

ConfirmationCallback

YES_NO_CANCEL_OPTION:

ConfirmationCallback

YES_NO_OPTION:

ConfirmationCallback

YI_RADICALS:

UnicodeBlock

YI_SYLLABLES:

UnicodeBlock

yield( ):

Thread

YIJING_HEXAGRAM_SYMBOLS:

UnicodeBlock

Team LiB

23.26. Z

ZERO:

BigDecimal, BigInteger

ZipEntry:

java.util.zip

ZipException:

java.util.zip

ZipFile:

java.util.zip

ZipInputStream:

java.util.zip

ZipOutputStream:

java.util.zip

ZONE_OFFSET:

Calendar

Colophon

Our look is the result of reader comments, our own experimentation, and feedback from distribution channels. Distinctive covers complement our distinctive approach to technical topics, breathing personality and life into potentially dry subjects.

The animal on the cover of *Java in a Nutshell, Fifth Edition* is a Javan tiger, a subspecies unique to the island of Java. Although this tiger once offered unrivaled research opportunities due to its genetic isolation, these opportunities have been permanently lost due to human encroachment on the Javan tiger's habitat: in a worst-case scenario for the tiger, Java developed into the most densely populated island on earth, and awareness of the subspecies' precarious position came too late to secure the animals' survival even in captivity. The last known sighting of the tiger was in 1972, and it is now presumed extinct.

Jamie Peppard was the production editor and proofreader for *Java in a Nutshell, Fifth Edition*. Sarah Sherman, Darren Kelly, and Claire Cloutier provided quality control. Ellen Troutman Zaig wrote the index.

Edie Freedman designed the cover of this book. The cover image is a 19th-century engraving from the Dover Pictorial Archive. Emma Colby produced the cover layout with Adobe InDesign CS using Adobe's ITC Garamond font.

David Futato designed the interior layout. This book was converted by Andrew Savikas, Joe Wizda, and Ryan Grimm to FrameMaker 5.5.6 with a format conversion tool created by Erik Ray, Jason McIntosh, Neil Walls, and Mike Sierra that uses Perl and XML technologies. The text font is Linotype Birka; the heading font is Adobe Myriad Condensed; and the code font is LucasFont's TheSans Mono Condensed. The illustrations that appear in the book were produced by Robert Romano and Jessamyn Read using Macromedia FreeHand 9 and Adobe PhotoShop 6. Jamie Peppard wrote this colophon.

The online edition of this book was created by the Safari production group (John Chodacki, Becki Maisch, and Madeleine Newell) using a set of Frame-to-XML conversion and cleanup tools written and maintained by Erik Ray, Benn Salter, John Chodacki, and Jeff Liggett.

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

Team LiB

downloaded from: lib.ommolketab.ir

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

! (exclamation point)
 ! (boolean NOT) operator 2nd
 !! (jdb shorthand) command
 != (not equals) operator 2nd
 jar\: URL syntax
" (quotes, double)
 escaping in char literals
 in string literals
 string literals
$ (dollar sign)
 in identifiers 2nd
 in regular expressions
% (percent sign)
 % (modulo) operator 2nd
 %= (modulo assignment) operator 2nd
 in format specifiers
& (ampersand)
 & (bitwise AND) operator 2nd
 & (boolean AND) operator 2nd
 && (conditional AND) operator 2nd
 &= (bitwise AND assignment) operator 2nd
' (quotes, single)
 escape characters in char literals 2nd
( ) (parentheses)
 cast operator
 conditional operands, using with
 in expressions, order of evaluation and
 in method names
 in method parameters
 method invocation operator 2nd
  side effects
 operator precedence, overriding with
 separator characters (tokens)
 subexpressions within regular expressions
* (asterisk)
 *= (multiplication assignment) operator 2nd
 dereference operator (C/C++)
 in doc comments
 multiplication operator 2nd 3rd
+ (plus sign)
 + (addition) operator 2nd
 + (string concatenation) operator 2nd
 + (unary plus) operator

++ (increment) operator 2nd
side effects
+= (add assignment) operator 2nd 3rd
concatenating strings with
string concatenation operator
URL encoding
, (comma)
separating list of expressions
separating variable names and initializers
separator character (tokens)
- (minus sign)
- (subtraction) operator 2nd 3rd 4th
- (unary negation) operator 2nd 3rd
-- (decrement) operator 2nd
-= (subtract assignment) operator 2nd
integer literals and
-> (dereference) operator, C/C++
-source 1.4 (javac command-line argument)
. (dot)
dot operator in Java language and C/C++
object member access operator 2nd 3rd
separator character (tokens)
... (ellipsis) in variable-length argument lists
.java file extension
/ (division) operator 2nd
/= (divide assignment) operator 2nd
/ (slash)
/* */, in multiline comments 2nd
/** */, in doc comments 2nd
//, in single line comments 2nd
/= (division assignment) operator
0 (zero)
division by
negative and positive zero
represented by float and double types
0- and 1-based arrays
; (semicolon)
ending do loops
ending Java statements
compound statements and
for empty statements
separator character (tokens)
< > (angle brackets)
< (less than) operator 2nd
< and > relational operators, string comparison and
< and > separator characters (tokens)
<< (left shift) operator 2nd
<<= (left shift assignment) operator
<<= (signed left shift assignment) operator
<= (less than or equal) operator 2nd
> (greater than) operator 2nd 3rd
>= (greater than or equal) operator 2nd

>> (signed right shift) operator 2nd
>>= (signed right shift assignment) operator 2nd
>>> (unsigned right shift) operator 2nd
>>>= (unsigned right shift assignment) operator 2nd
generics, use in
<A> (hyperlink) tag, avoiding in doc comments
<Emphasis>Effective Java Programming Language Guide<Default Para Font> 2nd
<PRE> tag in doc comments
<xsl\:output> tag 2nd
<xsl\:param> tags
= (equal sign)
= (assignment) operator 2nd 3rd
combining with arithmetic, bitwise, and shift operators
== (equals) operator 2nd 3rd
comparing enum values
comparing hashtable key objects
comparing objects
string comparisons
string comparisons and
? (question mark)
?\: (conditional) operator 2nd
operand number and type
return type
jdb help command
wildcards
type parameters
@ (at sign)
filenames beginning with, Java compiler and
filenames preceded by
javadoc program
in doc comments
separator character (tokens)
@author doc comment tag
@Deprecated annotations 2nd 3rd
@deprecated javadoc tags 2nd
package.html file
@Documented annotations 2nd 3rd
@exception doc comment tag
@Inherited meta-annotation
@interface annotation
@link doc comment tag
@Override annotation 2nd 3rd 4th
@param doc comment tag
@Retention annotation 2nd 3rd
@return doc comment tag
@see doc comment tags 2nd
package.html file
@serial doc comment tag
@serialData doc comment tag
@serialField doc comment tag
@since doc comment tag
javadoc, ignoring in doc comments

  package.html file
@SuppressWarnings annotation 2nd 3rd 4th
@Target annotation 2nd
@throws doc comment tag
@version doc comment tag
[ ] (brackets)
  array access operator 2nd 3rd
  index operator 2nd
    in multidimensional arrays
  separator characters (tokens)
\ (backslash)
  character escapes in regular expressions
  escaping in char literals
\: (colon)
  assertion expressions, separating
  conditional operands, separating 2nd
  in statement labels
  separator character (tokens)
  superclass, indicating in C++
\b (escape sequence for backspace)
\f (form feed)
\n (newlines), escaping
\r (carriage return)
^ (caret)
  ^= (bitwise XOR assignment) operator 2nd
  bitwise XOR operator 2nd
  boolean XOR operator 2nd
_ (underscore), identifier names and
{ } (curly braces)
  anonymous class formatting
  enclosing body of loop
  enclosing statement blocks
  in classes
  inline doc comment tags
  method body, enclosing 2nd
  nested if statements, use with
  nesting arrays within arrays
  separator characters (tokens)
{@docRoot} doc comment tag
{@linkplain} doc comment tag 2nd
{@link} doc comment tag 2nd 3rd
{@value reference} doc comment tag
{@value} doc comment tag
  cross references
| (vertical bar)
  | (bitwise OR) operator 2nd
  | (boolean OR) operator 2nd
  |= (bitwise OR assignment) operator 2nd
  || (conditional OR) operator 2nd
~ (bitwise complement) operator
~ (tilde)
  bitwise compelemnt operator

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

AbortPolicy class
absolute filenames
abstract classes
 collections
 InstantiationError
 InstantiationException
 interfaces vs. 2nd 3rd
abstract methods
 AbstractMethodError
 dynamic method lookup
 interfaces 2nd
abstract modifier
 in class definitions
 enumerated types and
 methods
AbstractCollection class
AbstractExecutorService class
AbstractInterruptibleChannel class
AbstractList class 2nd
AbstractMap class
AbstractPreferences class
AbstractQueuedSynchronizer class
AbstractQueuedSynchronizer.ConditionObject
AbstractSelectableChannel class
AbstractSelectionKey class
AbstractSelector class
AbstractSequentialList class
AbstractSet class
AbstractStringBuilder class
accept( )
 FileFilter interface
 FilenameFilter interface
 ServerSocket class
 ServerSocketChannel class 2nd
access control 2nd 3rd
 class members
 classes 2nd
 digitally signed classes
 to files
 for packages
 IllegalAccessError
 inheritance and
 java.security package

packages for
permissions and policies
policies described in system, user, and java.security.policy policy files
sandbox
trusted vs. untrusted code, changes in Java 1.2
access modifiers 2nd [See also private modifier; protected modifier; public modifier]
class members
AccessControlContext class
AccessControlException
AccessController class 2nd 3rd
checkPermission( )
AccessibleObject class
setAccessible( )
accessor methods
bean properties 2nd
AccountException class
AccountExpiredException
AccountLockedException
AccountNotFoundException
acquire( ) (Semaphore)
action names, permissions
activeCount( ) (ThreadGroup)
activeGroupCount( )
adapter classes
add and remove methods for event listeners
add( )
AbstractCollection class
AbstractList class
BigDecimal class
Collection interface 2nd
HashSet class
LinkedList class
List interface 2nd 3rd
ListIterator interface
Permissions class
Queue interface
Set interface 2nd
TreeSet class
Vector class
addAll( )
Collection interface
List interface 2nd
Map interface
Set interface
addAllAbsent( )
CopyOnWriteArrayList
addAttribute( ) (AttributedString)
addAttributes( ) (AttributedString)
addCertPathChecker( )
addCertStore( )
addIfAbsent( )
CopyOnWriteArrayList

addition operator (+)
additive operators, associativity of
addObserver( ) (Observable)
addPreferenceChangeListener( )
addPropertyChangeListener( )
addProvider( ) (Security) 2nd
addShutdownHook( ) (Runtime) 2nd
addVetoableChangeListener
Adler32 class
after( )
agents 2nd 3rd
  instrumentation
  support for, in java.lang.instrument
AlgorithmParameterGenerator class
AlgorithmParameterGeneratorSpi class
AlgorithmParameters class
AlgorithmParameterSpec interface
AlgorithmParametersSpi class
algorithms, cryptographic
  digital signature algorithm for certificate
  RC2 encryption algorithm
  RC5 encryption algorithm
  specifying for keys
aliases for certificates and keys
aliases( ) (Charset)
allAll( ) (Set)
allocate( )
  ByteBuffer class
  CharBuffer class
  DoubleBuffer class
  FloatBuffer class
  IntBuffer class
  ShortBuffer class
allocateDirect( ) (ByteBuffer)
AllPermission class
AlreadyConnectedException
AND operator [See &, under Symbols]
animation, threads for
annotations 2nd 3rd 4th
  @Override 2nd
  @SuppressWarnings
  AnnotatedElement interface 2nd 3rd
  Annotation class
  Annotation interface 2nd 3rd
  annotation types 2nd 3rd 4th
    defined
    defining
    Deprecated 2nd
    Documented
    Inherited
    local scope and
    nonstatic member classes and

Override 2nd
Retention
SuppressWarnings 2nd
Target
AnnotationFormatError
AnnotationTypeMismatchException
apt processing tool
Class class methods
concepts and terminology
Constructor class support for
ElementType
Field class support of
IncompleteAnnotationException
java.lang.annotation package 2nd
meta-annotations
Method class, support for
reflection on 2nd
RetentionPolicy
standard
@Deprecated
@Override
@SuppressWarnings
syntax
defaults and
member types and values
targets
treated as modifiers
annotationType( )
anonymous array literals
anonymous classes 2nd
features of
implementation of
implementing adapter classes with
indentation and formatting
restrictions on
subclasses of enumerated types
syntax for defining and instantiating
when to use
APIs (application programming interfaces)
core Java APIs
extensions
platforms and operating systems
apostrophe [See ', under Symbols]
AppConfigurationEntry class
LoginModuleControlFlag
append( ) (StringBuffer)
Appendable interface 2nd 3rd 4th
formatting text for
implemented by PrintStream
applets
access control restrictions
java.applet package

security and
security restrictions on
application classes, default search path for
application programmers, security for
applyPattern( )
ChoiceFormat class
DecimalFormat class
MessageFormat class
SimpleDateFormat class
apt (annotation processing) tool
Arabic text
arbitrary-precision integers
arguments, method 2nd 3rd [See also variable-length argument lists]
IllegalArgumentsException
testing for legal values with assert statement
variable-length argument lists
arithmetic
BigDecimal class
pricision
integer arithmetic in Java
java.math package
arithmetic operators
combining with assignment (=) operator
listed
return type
ArithmeticException
array access operator ([ ]) 2nd 3rd
ArrayBlockingQueue 2nd
arraycopy( ) (System) 2nd 3rd
ArrayList class 2nd
arrays 2nd 3rd
accessing array elements
Array class 2nd
array types
widening conversions
ArrayIndexOutOfBoundsException 2nd 3rd 4th
Arrays class 2nd
equals( )
ArrayStoreException 2nd
as operand type
AtomicIntegerArray
bounds
of bytes
ByteArrayInputStream class
ByteArrayOutputStream class
reading from and writing to
of characters
comparing for equality
conversion rules
converting collections to and from
converting to strings
copying

creating and initializing
initializers
creating with new operator
generic methods and
GenericArrayType
indexed properties, JavaBeans
instanceof operator, using with
iterating
locks on
multidimensional
rectangular arrays
NegativeArraySizeException
as objects
ObjectStreamField objects
of parameterized type
streaming data to and from
of strings
utility methods
asCharBuffer( ) (ByteBuffer)
ASCII
7-bit character set
native2ascii tool
asDoubleBuffer( ) (ByteBuffer)
asFloatBuffer( ) (ByteBuffer)
asIntBuffer( ) (ByteBuffer)
asList( ) (Arrays)
asLongBuffer( ) (ByteBuffer)
assertions
AssertionError class 2nd
classes loaded through ClassLoader
compiling
disabling
enabling
errors in
options for Java interpreter
side effects
using
asShortBuffer( ) (ByteBuffer)
assignment in expression statements
assignment operators 2nd 3rd
combining with arithmetic, bitwise, and shift operators
return type
right-to-left associativity
side effects
associativity, operator 2nd
order of evaluation and
AsynchronousCloseException
atomic operations 2nd 3rd
createNewFile( ) (File)
AtomicBoolean class
AtomicInteger class 2nd
AtomicIntegerArray class

AtomicIntegerFieldUpdater class
AtomicLong class
AtomicLongArray class
AtomicLongFieldUpdater class
AtomicMarkableReference class
AtomicReference class
AtomicReferenceArray class
AtomicReferenceFieldUpdater class
AtomicStampedReference class
Attr interface (DOM)
Attribute class
AttributedCharacterIterator interface
AttributedString class 2nd
AttributeList interface (SAX)
AttributeListImpl class (SAX)
attributes (DOM Element node)
Attributes class
  Name class
Attributes interface (SAX)
Attributes2 interface (SAX)
Attributes2Impl interface (SAX)
AttributesImpl class (SAX)
authentication 2nd 3rd
  Authenticator.RequestorType
  classes
    implementing with
  MAC (message authentication code) 2nd 3rd
  messages transmitted with secret key
  packages for
  PasswordAuthentication class
  SSL client
Authenticator class
AuthPermission class
AuthProvider class
autoboxing and unboxing conversions 2nd 3rd 4th 5th
automatic imports
available( ) (InputStream)
availableCharsets( ) (Charset)
await( )
  Condition class
  CountDownLatch class
  CyclicBarrier class
AWT programming (java.awt.peer)

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

BackingStoreException
BadPaddingException
bag (unordered collection)
BasicPermission class
before( )
Bidi class
Bidirectional Algorithm (Unicode)
BIG_ENDIAN byte order
BigDecimal class 2nd
BigInteger class 2nd
  implementing Callable
binary data in files, reading from arbitrary locations
binary files, reading
binary numbers
  Integer type conversions
  Long type conversions
binary operators 2nd
binarySearch( )
  Arrays class 2nd 3rd
  Collections class 2nd
bind( )
  DatagramSocket class
  ServerSocket class
  Socket class
BindException
bitCount( ) (Integer)
bitfields (C language)
BitSet class
bitwise operators 2nd
  boolean operators as
  combining with assignment operator 2nd
  return type
blank lines in Java programs
Bloch, Joshua 2nd
BLOCKED thread 2nd
blocking queues
  ArrayBlockingQueue
  defined
  LinkedBlockingQueue
  PriorityBlockingQueue
blocking threads, waking
BlockingQueue interface 2nd 3rd
body (class definitions)

boolean operators
  listed
  return type
boolean type 2nd 3rd
  Boolean class 2nd
  conversion to other primitive types
  get methods and
  operator return values 2nd
bound properties 2nd
bounded wildcards 2nd 3rd
  in generic types
  in generic methods
bounds for type variables
boxing and unboxing conversions 2nd 3rd 4th
break statements
  labels, use of
  switch statements, stopping
BreakIterator class
breakpoints for jdb debugger 2nd
BrokenBarrierException
BufferedInputStream class 2nd
BufferedOutputStream class 2nd
BufferedReader class 2nd 3rd
BufferedWriter class 2nd
BufferOverflowException
buffers 2nd
  basic operations
  Buffer class
  byte order
  byte, views as other primitive types
  ByteBuffer class 2nd 3rd
  channels, using with
  CharBuffer 2nd 3rd
  DoubleBuffer
  FloatBuffer
  IntBuffer class
  InvalidMarkException
  LongBuffer
  MappedByteBuffer
  networking, size of
  pushback 2nd
  ReadOnlyBufferException
  ShortBuffer
  size, setting for sockets 2nd
  StringBuffer class
    using with StringWriter
BufferUnderflowException
bugs
  implementation-specific, portability and
  security-related
build( ) (CertPathBuilder) 2nd
by reference

byte code
 displaying for methods with javap tool
 verification of
byte streams 2nd [See also input/output]
 ByteArrayInputStream class class
 ByteArrayOutputStream class
 CharConversionException
 FileInputStream class
 FileOutputStream class
 InputStream class
 java.io classes
 PrintStream class
  implementing Appendable
 reading 2nd
byte type 2nd
 Byte class 2nd 3rd
 conversion to other primitive types
 unsigned values
byte-code verification
byte-code-to-native code JIT compilers
ByteArrayInputStream class 2nd 3rd
ByteArrayOutputStream class 2nd 3rd
ByteBuffer class 2nd 3rd
ByteChannel interface 2nd
ByteOrder class
bytes
 buffers of, converting to buffers of characters
 CharConversionException
 converting characters to
 converting objects to
 converting to characters
 input/output, filtering
 raw, reading from a stream
 transferring from FileChannel to another channel

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

C and C++
 array bounds
 boolean type, Java differences
 C++ features not found in Java
 comments, recognition by StreamTokenizer
 differences between C and Java
 extends keyword (Java) vs. \:
 finalization methods in Java vs. C++
 Java native methods, implementing in C
 memory allocation
  reclaiming
 multiple inheritance, interfaces as alternative to
 object-oriented programming in C++
 performance, Java vs.
 reference types
 unsigned keyword
 variable declarations
 virtual functions in C++
 vitrual functions in C++
 void methods
CA (certificate authority)
CacheRequest class
CacheResponse class
caching
 ResponseCache class
 SecureCacheResponse class
 SSL sessions
 URLs
calendar (XMLGregorianCalendar class)
Calendar class 2nd 3rd
 GregorianCalendar class
call( )
Callable interface 2nd
 scheduling Callable objects
CallbackHandlerProtection (KeyStore)
callbacks
 Callback interface
 CallbackHandler class
 CallbackHandler interface
 ChoiceCallback class
 ConfirmationCallback class
 javax.security.auth.callback
 LanguageCallback class

NameCallback class
PasswordCallback class
TextInputCallback class
TextOutputCallback class
UnsupportedCallbackException
CallerRunsPolicy class
calling methods
cancel( )
Timer class
TimerTask class
CanceledKeyException
CancellationException
canonical filenames
canRead( ) (File)
canWrite( ) (File)
capacity (buffers)
capacity( )
ArrayList class
Vector class
carriage return (\r)
case
capitalization, Java naming conventions
case-insensitive pattern matching
characters
charset names
conversions in strings
ignoring in string comparisons 2nd
case labels (switch statements)
for enumerated types
restrictions on
case-sensitivity in Java 2nd
casts 2nd [See also type conversions]
( ) (cast) operator 2nd
ClassCastException
hidden superclass field, accessing
narrowing conversions, reference types
objects to Object instance
super and this, using
catch clause
annotations on parameters
catching errors in assertions
catching exceptions
jdb debugger
try/catch/finally statement
cbrt( ) (Math)
CDATASection interface (DOM)
certificate authority (CA)
certificate revocation lists [See CRLs]
Certificate.CertificateRep class
CertificateException
CertificateExpiredException
CertificateFactory class

CertificateFactorySpi class
CertificateNotYetValidException
CertificateParsingException
certificates
 Certificate class
 Certificate interface 2nd 3rd 4th
 CertPathTrustManagerParameters class
 creating self-signed for public key associated with alias
 displaying contents with keytool
 in keystore file
 java.security.cert package
 management by keytool
 public key, associated with JAR file
 storing in keystore
 TrustedCertificateEntry (KeyStore)
 X.500, distinguished name
 X509Certificate, private key for
CertPath class
CertPath.CertPathRep
CertPathBuilder
CertPathBuilderException
CertPathBuilderResult
CertPathBuilderSpi
CertPathParamters
CertPathValidator
CertPathValidatorException
CertPathValidatorResult
CertPathValidatorSpi
CertSelector
CertStore class
CertStoreException
CertStoreParameters interface
CertStoreSpi class
chaining
 certificates
 constructors
 finalizers
 methods
  buffers
  overridden methods
channel( ) (FileLock)
channels 2nd
 avoiding explicit character encoding/decoding
 basic operations
 ByteChannel interface
 Channel interface 2nd
 Channels class
  charset encoder/decoder
 client-side networking with SocketChannel
 DatagramChannel 2nd
 FileChannel object, obtaining 2nd 3rd
 files, reading and writing 2nd

inheritedChannel( )
interrupted threads and
java.nio.channels package
nonblocking
ReadableByteChannel and WritableByteChannel
server-side networking
ServerSocketChannel 2nd
service provider interface
SocketChannel
streams and
char literals, quoting in Java code
char type 2nd
char values vs.
Character class 2nd
new methods in Java 5.0
static methods for working with characters
conversion to other primitive types
escape characters in char literals
surrogate pair, Unicode supplementary characters
character encoding
internationalization features
locale- and platform-dependent
native2ascii tool
OutputStreamWriter class
Unicode [See Unicode]
UnsupportedEncodingException
character sets [See charsets]
character encoding [See also charsets]
character streams 2nd [See also input/output; streams]
CharConversionException
filtering input streams
input and output
InputStreamReader class
LineNumberReader class
output, implementing Appendable interface 2nd
OutputStreamWriter class
PipedReader class
PipedWriter class
PrintWriter class
PushbackReader class
Readable interface, implementing
Reader (input stream superclass)
reading with BufferedReader
streaming data to and from arrays
StringReader class
superclass of output streams (Writer)
writing with BufferedWriter
CharacterCodingException
CharacterData interface (DOM)
characters
char data type
Character class 2nd 3rd

new methods in Java 5.0
Subset class
UnicodeBlock class
CharacterIterator interface
conventions for Java names
converting between byte buffers and character buffers
converting to bytes
encoding into and decoding from bytes
handling by StreamTokenizer
in identifiers
pattern matching with regular expressions
reading and writing streams of
string, CharSequence and CharBuffer interfaces
testing for different categories of
translating to bytes
CharArrayReader class 2nd
CharArrayWriter class 2nd
charAt( )
CharSequence interface
String class
StringBuffer class
CharBuffer class 2nd 3rd
CharSequence interface 2nd 3rd 4th
contentEquals( )
charsets 2nd 3rd
Charset class 2nd
CharsetDecoder class
CharsetEncoder class
CharsetProvider
conversions
decoding engine
encoding and decoding text with
EUC-JP (for Japanese text)
encoding engine
java.nio.charset package
required support by Java implementations
Unicode
charValue( ) (Character)
checkAccess( )
Thread class
ThreadGroup class
checked exceptions
methods throwing
CheckedInputStream class
checkedList( ) and checkedMap( ) (Collections)
CheckedOutputStream class
checkError( )
checkGuard( ) (Guard)
checkPermission( )
AccessControlContext class
AccessController class 2nd
SecurityManager class

checkRead( ) (SecurityManager) 2nd
Checksum interface
checksums 2nd [See also message digests]
checkValidity( ) (X509Certificate)
Chinese ideographs
ChoiceCallback class
ChoiceFormat class
Cipher class 2nd 3rd
  NullCipher class
cipher suites, SSL connections
  client/server disagreement on
  obtaining name of
  setting
  supported, getting full set of
CipherInputStream class 2nd
CipherOutputStream class 2nd
CipherSpi class
circular dependency
class body
  access to members 2nd
  anonymous classes 2nd
  enumerated types
    value-specific
Class class 2nd 3rd
  dynamic class loading
  dynamic instantiation with newInstance( )
  getMethod( )
  new methods, Java 5.0
class fields
  default initialization
  initializing
    static initializers, using
  superclass, hiding
  System.out.println( )
class files
  verification of
class hierarchy 2nd
  containment hierarchy vs.
  omitting tree diagram in javadoc documentation
class loading statistics (jstat)
class members
  access control
  access rules
  constructors and initializers
  hiding fields and methods
class methods
  choosing between class and instance methods
  example of
  interfaces and
  listing all for specified class with jdb debugger
  overriding not allowed
  static modifier

synchronized
System.out.println( ))
ClassCastException
ClassDefinition class
classes 2nd 3rd 4th 5th
abstract 2nd
collections
rules for
access to
anonymous 2nd
assertions 2nd
bean (JavaBeans)
byte-code verification, error
Class [See Class class]
ClassCastException 2nd
ClassCircularityError
ClassDefinition
ClassFormatError
ClassLoader class
enabling/disabling assertions
ClassNotFoundException
code source
constructors, fields, and methods
converting to strings
core, Java language
creating dynamically, with Proxy
defined
defining 2nd 3rd
modifiers
NoClassDefFoundError
static initializers
defining object types
deprecated (@deprecated javadoc tag)
digital signatures for
disassembler tool (javap)
documentation by javadoc, display of
dynamic loading
enumerated types
extending
final
garbage collection, disabling for
hiding (and encapsulating) data in
IllegalAccessError
IllegalAccessException
IllegalClassFormatException
implementing interfaces
IncompatibleClassChangeError
inner [See nested types]
InvalidClassException
Java platform
javap display, including or excluding from
LinkageError

- loading
  - dynamically, with Class
  - SecureClassLoader
  - URLClassLoader
- local 2nd
- members of
  - class fields
  - static and instance
- modifiers
- names, simple and fully qualified
- naming and capitalization conventions
- online documentation
- package, specifying for
- permission, summary of
- proxy
- public
  - in Java files
  - preventing insertion of public constructor
- reference index
- references to, in @see doc comment tag
- reflection and dynamic loading
- structs vs.
- system, code portability and
- undocumented, portability and
- UnsatisfiedLinkError
- UnsupportedClassVersionError
- version number

ClassFileTransformer interface
"Classic VM"
ClassLoadingMXBean interface
classpaths
- application classes, specifying for javap
- java 2nd
- javac compiler
- javadoc program
- javah tool
- javap, for classes named on command line
- jdb debugger
- serialver tool

clear( )
- Buffer class
- Collection interface 2nd
- List interface
- Map interface
- PhantomReference class
- Reference class

clearAssertionStatus( )
clearProperty( ) (System)
client applications
- -client option (HotSpot VM)

client-side networking, nonblocking I/O
Clock class

clone( ) 2nd 3rd 4th 5th
  Mac class
  MessageDigest class
  Object class 2nd
Cloneable interface 2nd 3rd
  arrays
  implemented by collections and maps
CloneNotSupportedException 2nd 3rd 4th
close( )
  OutputStream class
  Channel interface
  CharArrayWriter class
  Closeable interface 2nd
  DatagramSocket class
  FileInputStream class
  FileOutputStream class
  InputStream class
  JarOutputStream class
  PrintWriter class
  Reader class
  Selector class
  ServerSocket class
  Socket class
  SocketChannel class
  StringWriter class
  Writer class
Closeable interface 2nd
ClosedByInterruptException
ClosedByInterruptException class
ClosedChannelException
ClosedSelectorException
closeEntry( ) (ZipInputStream)
closeInbound( )
closeOutbound( )
code
  critical sections
  formatting and indenting
code blocks, synchronized
code libraries, reading into the system
codePointAt( )
  Character class
  String class
codePointBefore( ) (Character)
codePointCount( )
  Character class
  String class
codepoints
  illegal format exception
CoderMalfunctionError
CoderResult class
CodeSigner class
CodeSource class 2nd

CodingErrorAction class
CollationElementIterator class
CollationKey class
Collator class 2nd
  RuleBasedCollator class
CollectionCertStoreParameters
collections
  abstract classes to implement common collections
  AbstractCollection class
  AbstractList class
  AbstractMap class
  of certificates
  CertStoreParameters
  changes in Java 5.0
  classes in java.util package 2nd
  Collection interface 2nd 3rd 4th
    add( ) and addAll( )
  Collections class
    special-case collections
    utility methods
    wrapper methods
  Collections Framework
    generics in Java 5.0
  converting to and from arrays
  for/in loop
  Hashtables class
  immutable or unmodifiable, error
  implementing Cloneable or Serializable
  List interface
  Map interface
  packages for
  Permission objects
  primitive values, boxing and unboxing conversions
  queues
  RandomAccess interface 2nd
  runtime type safety
  Set interface
  typesafe [See generic typess]
com.sun.javadoc package
combination assignment operators
combine( ) (DomainCombiner)
command( ) (ProcessBuilder)
command-line tools
  enabling assertions
  Java interpreter, -classpath option
  javac compiler
Comment interface (DOM)
commentChar( )
comments 2nd
  doc
  single-line, enclosed with //
  StreamTokenizer and

compact( )
 ByteBuffer class
Comparable interface 2nd 3rd
 implementation by enumerated types
Comparator interface
compare( )
 Collator class
 Comparator interface
 Double class
compareTo( )
 BigDecimal class
 BigInteger class
 ByteBuffer class
 Character class
 Charset class
 CollationKey class
 Comparable interface 2nd
 Date class
 Double class
 Enum class
 enumerated types
 String class 2nd
compareToIgnoreCase( ) 2nd
comparing
 hashtable key objects
 strings
comparison operators
 listed
 precedence, boolean vs.
 return type
compilation units
compile( )
 Pattern class
 XPath class
compileClass( )
compileClasses( )
compiler (javac) 2nd
Compiler class
compiling
 assertions
 Java program (example)
 varargs methods
CompletionService interface
compound statements 2nd
compression
 JAR files
 java.util.zip package
 Pack200
 pack200 tool
 unpack200 tool
 ZIP files and gzip format
computed goto or jump table

concat( ) (String)
concatenating data from multiple input streams
concatenating strings 2nd 3rd
 + and += operators
 string literals
concrete subclass
concurrency
 atomic operations 2nd 3rd
 blocking queues
 BlockingQueue interface 2nd 3rd
  implementations
 ConcurrentHashMap class
 CopyOnWriteArrayList
 CopyOnWriteArraySet
 exclusion and locks
  deadlock
  Lock objects
 java.util.concurrent package 2nd 3rd 4th
 locks 2nd
  Condition objects
 running and scheduling tasks
  ExecutionException
  Executor interface
  ExecutorService
  Future object
  ScheduledExecutorService
  ThreadPoolEcecutor
  Timer and TimerTask
 synchronizer utilities
 TimeUnit class
ConcurrentHashMap class 2nd
ConcurrentLinkedQueue class 2nd
ConcurrentMap interface 2nd
ConcurrentModificationException 2nd 3rd
Condiiton interface
Condition objects
conditional AND operator (&&) 2nd
conditional operator (?\:) 2nd 3rd
 return type
conditional OR operator (||) 2nd
ConditionObject class
Configuration class
configuration files
 logging
 Properties class, using for
configureBlocking( )
 SelectableChannel class
 SocketChannel class
ConfirmationCallback class
connect( )
 DatagramChannel class
 DatagramSocket class 2nd

PipedInputStream class
PipedOutputStream class
PipedReader class
Socket class
SocketChannel class 2nd
ConnectException
ConnectionPendingException
console
displaying text on
input, reading
ConsoleHandler class
constants [See also enumerated types]
defined by an enumerated type
ElementType
enum
EnumConstantNotPresentException
HttpURLConnection
in interface definitions
inheritance of
Java object serialization
Modifier class
naming conventions 2nd
RetentionPolicy
RoundingMode
separator characters defined by File class
static and final
in anonymous classes
in local classes
static member import declarations
Thread.State
TimeUnit class
XML
DatatypeConstants
constrained properties 2nd
Constructor class
constructors 2nd
anonymous classes and
chaining, default constructor and
class
Constructor class
changes in Java 5.0
defined
defining
multiple 2nd
naming, declaring, and writing
enumerated types 2nd 3rd
field initialization code in
how they work
interfaces and
invoking from another constructor
local classes, enclosing instance passed to
member classes

references to, in @see doc comment tag
subclass
superclass
containing classes
associating instance with local class
instance, specifying for member class
containment hierarchy
contains( )
HashSet class
Collection interface
CopyOnWriteArraySet
Set interface
TreeSet class
containsAll( ) (Collection)
containsKey( )
Map interface 2nd
TreeMap class
containsValue( ) (Map)
contentEquals( )
CharSequence interface
String class
ContentHandler interface 2nd 3rd
ContentHandlerFactory interface
continue statements
for and while loops
labels, use of
control flags (login module)
conversion types, Formatter
conversions, type [See type conversions]
CookieHandler class
copy constructor
copy( ) (Collections)
CopyOnWriteArrayList class 2nd
CopyOnWriteArraySet class
core Java APIs
corrupted streams
cosh( ) (Math)
CountDownLatch class 2nd
counters for loops, incrementing 2nd
covariant returns 2nd 3rd
AbstractStringBuiilder class
CRC32 class
create( ) (URI)
createNewFile( ) (File)
createServerSocket( )
createSocket( )
SocketFactory class
SSLSocketFactory class
createSSLEngine( ) (SSLContext)
createTempFile( ) (File)
CredentialException
CredentialExpiredException

CredentialNotFoundException
credentials
  destroying or erasing
  KerberosKey
  KerberosTicket
  PrivateCredentialPermission
  refreshing
critical sections
CRLs (certificate revocation lists) 2nd 3rd
  CRL class
  CRLException
  CRLSelector
  X509CRL class
  X509CRLEntry
  X509CRLSelector
cross-references in doc comments
cryptographic checksums [See message digests]
cryptographic-strength random numbers
cryptography 2nd 3rd
  algorithms, parameters for
  arbitrary-precision integers, using
  BigInteger methods used for algorithms
  DSA, RSA, and EC public and private keys
  encrypted objects
  encrypting/decrypting streams
  encryption and decryption with Cipher
  Java Cryptography Extension (JCE)
  javax.crypto package
  javax.crypto.interfaces package
  javax.crypto.spec package
  keys, invalid
  private key
  public/private key
    in digital signatures
    key management
    keystore file for certificates
  PublicKey interface
  resources for further reading
  secret keys
  service provider, not available
  symmetric-key
cube root of a number
currency formats
currency symbols (Unicode), in identifiers
currentThread( ) (Thread)
currentTimeMillis( ) (System) 2nd
CyclicBarrier class 2nd

Team LiB

Index

daemon, specifying thread as
data
  acessor methods
  compressing and writing to file
  encapsulation of
  hiding and encapsulating
    access control
data types
  array
  buffer classes for
  classes as
  conditional operands
  conversions [See type conversions]
  declaring for variables
  element type (arrays)
  equality, testing
  fields, initializing
  getSimpleName( )
  interfaces as
  literals (Class class)
  method returns
  nested 2nd
  operand
  parameterized
  primitive 2nd [See also primitive data types]
    floating-point
    integer types
    wrapper classes for
  reference 2nd
  reflection and dynamic loading
  return, for operators
  specifying when added to API (@since doc comment)
  strings 2nd
    escape sequenes, string literals
  in switch statements
  switch statement with case labels
  Type interface
  vs. values represented by
  XML 2nd
DataFormatException
DatagramChannel class 2nd
DatagramPacket class 2nd
datagrams

defined
DatagramSocket class 2nd
channel associated with
DatagramSocketImpl class
DatagramSocketImplFactory interface
DataInput interface
DataInputStream class 2nd
DataOutput interface
DataOutputStream class 2nd
DatatypeConfigurationException
DatatypeConstants class
DatatypeConstants.Field class
DatatypeFactory class
newInstance( )
Date class
DateFormatSymbols class
dates and times
Calendar class
certificate validity checks
classes in java.util package
Date class 2nd 3rd
Duration class
formatting 2nd
DateFormat class
DateFormat.Field
locale-specific
formatting and parsing
locale-specific formats
milliseconds and nanoseconds
period of validity (in days) for certificates
System class
Timestamp class
TimeZone class
XMLGregorianCalendar class
deadlock (thread synchronization) 2nd
debugger for Java classes (jdb)
debugging
assertions, enabling for
HTTP clients
Java interpreter options for
java_g (debugging version of Java interpreter)
logging, using for
remote (jsadebugd tool)
decimal numbers
BigDecimal class
floating-point modes defined by IEEE 754R standard
fractions, representing
Short type conversions
specifying decimal places
DecimalFormat class
DecimalFormatSymbols class
declarations

class fields
constructors
exceptions
field
variable vs.
for/in loop variables
GenericDeclaration interface
methods
package
variables 2nd
local variables
placement of
DeclHandler interface (SAX)
decode( )
Charset class 2nd
CharsetDecoder class 2nd 3rd
CoderMalfunctionError
Integer class
Short class
URLDecoder class
decodeLoop( )
decoding byte sequences into character strings
decrement expression statements
decrement operator (--) 2nd
return type
decryption [See cryptography]
deep copy
deepEquals( ) (Arrays)
deepHashCode( ) (Arrays)
deepToString( ) (Arrays)
default constructor
default\: label
enumerated types
defaultCharset( )
defaulted( ) (GetField)
DefaultHandler class (SAX) 2nd
DefaultHandler2 interface (SAX)
defineClass( ) (SecureClassLoader)
definePackage( ) (ClassLoader)
defining
classes 2nd
simple (Circle class example)
static initializers
constructors, multiple
interfaces
Java programs
local classes
methods
packages
system classes, portability and
deflate( ) (Deflater)
Deflater class

DeflaterOutputStream class
Delay interface
Delayed interface
DelayQueue class 2nd
DelegationPermission class
delete permission
delete( )
 File class 2nd
 StringBuffer class
deleteCharAt( ) (StringBuffer)
deleteEntry( ) (KeyStore)
deleteOnExit( ) (File)
deleting temporary files
deprecated features, omitting from javadoc documentation
dereference operators (* and ->), C and C++
DESedeKeySpec class
deserializing objects [See serialization]
DESKeySpec class
destroy( )
 Destroyable interface
 KeyStore.PasswordProtection
 Process class
Destroyable interface 2nd
DestroyFailedException
DHGenParameterSpec class
DHKey interface
DHParameterSpec class
DHPrivateKey interface
DHPrivateKeySpec class
DHPublicKey interface
DHPublicKeySpec class
Dictionary class
Diffie-Hellman key-agreement algorithm
 public/private key pairs 2nd
 three-party agreement
digest( ) (MessageDigest) 2nd
DigestException
DigestInputStream class 2nd 3rd
DigestOutputStream class 2nd
digit( ) (Character)
digital signatures 2nd 3rd
 algorithm that signs a certificate
 jarsigner tool
 Signature class
 SignatureException
 SignatureSpi class
 SignedObject class 2nd
 Signer class
direct buffers 2nd
 MappedByteBuffer
directionality of a character
directories 2nd [See also files]

creating, renaming, and deleting
listing contents of 2nd
names of, platform-independent
naming, portability and
directory( ) (ProcessBuilder)
DiscardOldestPolicy class
DiscardPolicy class
disconnect( )
DatagramSocket class
HttpURLConnection class
displaying output
displaying text on the console
distinguished name
CRL issuer
X.500 certificate
distributed computing packages
divide( ) (BigDecimal)
division by zero 2nd
division operator (/)
do statements
continue, using
do/while statements
doAs( ) (Subject)
doAsPrivileged( ) (Subject)
doc comments 2nd
cross-references
defined
images in
in javadoc program output
overview, use by javadoc
for packages
spaces in
structure of
tags
custom
inline, within HTML text
listing of
doclet API (javadoc)
Document interface (DOM)
Document Type Definition (DTD)
documentation
doc comments
cross references
doc-comment tags
structure of
inheritance of, in doc comment tags
javadoc program
locale
undocumented classes, portability and
DocumentBuilder class
DocumentBuilderFactory class
DocumentFragment interface

DocumentHandler interface (SAX)
DocumentType interface (DOM)
DOM (Document Object Model)
  documentation
  DocumentBuilder class
  javax.xml.transform.dom package 2nd
  org.w3c.dom package
  parser for XML 2nd
  tree representation of XML documents
  validation of source documents
domain names, using in package naming
DomainCombiner interface 2nd
DOMConfiguration interface
DOMError interface
DOMErrorHandler interface
DOMException class
DOMImplementation interface
DOMImplementationList interface
DOMImplementationSource interface
DOMLocator interface 2nd
DOMResult class
DOMSource class 2nd
DOMStringList interface
double type 2nd 3rd 4th 5th
  conversion to other primitive types
  Double class 2nd
DoubleBuffer class
doubleToLongBits( )
doubleToRawBits( )
drainTo( ) (Queue)
DSA encryption algorithm
DSA, RSA and EC public and private keys 2nd
DSAKey interface
DSAKeyPairGenerator interface
DSAParameterSpec interface
DSAParams interface
DSAPrivateKey interface
DSAPrivateKeySpec interface
DSAPublicKey interface
DSAPublicKeySpec interface
DTD (Document Type Definition)
DTDHandler interface (SAX) 2nd
duplicate( ) (ByteBuffer)
Duration class
dynamic class creation
dynamic class instantiation
dynamic class loading
  security risks
dynamic method lookup 2nd
  abstract methods

Team LiB

Index

ECPublicKey interface
ECPublicKeySpec class
editors, text
Element interface (DOM) 2nd
element type
element( ) (Queue)
elementAt( ) (Vector)
elements of an array 2nd
 accessing
elements( )
 Hashtable class
 Permissions class
 Vector class
ellipsis (...), in variable-length argument lists
elliptic curve public keys
EllipticCurve class
else clause (if/else statements)
else if clause
emacs text editor
empty collections 2nd
empty interfaces
empty statements
emptyMap( )
EmptyStackException
encapsulation of data 2nd
 access control
  inheritance and
encode( )
 Charset class 2nd
 CharsetDecoder class
 CharsetEncoder class 2nd
 CoderMalfunctionError
EncodedKeySpec interface
encodeLoop( )
encoding and decoding text
encoding/decoding data [See also charsets]
 CertPath encodings
 charsets 2nd
  Unicode
 encoding of a certificate chain
 javadoc output
 tool for
 Unicode strings to/from bytes

URLDecoder class
URLEncoder class
EncryptedPrivateKeyInfo class
encryption/decryption of data [See cryptography SSL]
end users, security for
endorsed standards
endsWith( ) (String)
enforcing method preconditions
engineSetMode( ) (CipherSpi)
engineSetPadding( ) (CipherSpi)
enhanced for statement [See for/in statements]
enqueue( ) (Reference)
ensureCapacity( )
ArrayList class
Vector class
enterprise packages of Java
Entity interface (DOM)
EntityReference interface (DOM)
EntityResolver interface (SAX) 2nd
EntityResolver2 interface (SAX)
entries( )
JarFile class
entry in a keystore
private key
Entry interface (Map) 2nd 3rd
entrySet( )
AbstractMap class
Map interface 2nd
SortedMap interface
Enum class
enum constants
enum keyword
EnumConstantNotPresentException
enumerate( ) (ThreadGroup)
enumerated types 2nd 3rd
annotations and 2nd
as classes
Class methods supporting
DatatypeConstants.Field
DateFormat.Field
defined
ElementType
Enum class 2nd 3rd
enum syntax, advanced
class body
implementing an interface
restrictions on enum types
value-specific class bodies
EnumMap 2nd
EnumSet 2nd
features of
fields of

Formatter.BigDecimalLayoutForm 2nd
java.net package
KeyRep.Type
local scope and
MemoryType
nonstatic member classes and
NumberFormat.Field
Proxy.Type class
RetentionPolicy
RoundingMode class
SSLEngineResult.HandshakeStatus
SSLEngineResult.Status
static member import declarations
switch statement and
Thread.State 2nd
TimeUnit 2nd 3rd
typesafe enum pattern
enumerated values
enumeration implemented with anonymous class
Enumeration interface
Iterator interface vs.
EnumMap class 2nd 3rd 4th
enums [See enumerated types]
EnumSet class 2nd 3rd 4th
factory methods for initializing enumerted values
restrictions on
environment variables
CLASSPATH
java
javac compiler
javadoc
platform-dependent
environment( ) (ProcessBuilder)
EOFException 2nd
eolIsSignificant( )
epoch
equality operators 2nd
compaing objects with ==
return type
equals( ) 2nd 3rd 4th
Annotation interface
Arrays class 2nd 3rd
ByteBuffer class
Charset class
Collection interface
Comparator class
Date class
Enum class
enumerated types
Hashtable class
Object class 2nd
String class 2nd 3rd

string comparison
equalsIgnoreCase( ) (String)
Error class 2nd
unchecked exceptions
error messages
error streams, system 2nd
error( ) (Validator)
ErrorHandler interface (SAX) 2nd
ErrorListener interface
ErrorManager class
errors 2nd [See also exceptions]
assertion
in assertions
DOMErrorHandler
java.lang.annotation package
PrintWriter class
escape sequences
in char literals
in regular expressions
in string literals
in string and char literals
for Unicode characters
EUC-JP charset (Japanese text)
evaluate( ) (XPath)
evaluating expressions
operator associativity and
order of
EventListener interface
EventObject class
events
Event class
EventListener interface 2nd
EventObject class 2nd
JavaBeans model
conventions for
listeners for, registering
PropertyChangeEvent class
exceptions
bean property accessor methods
catching and handling with jdb debugger
causing run( ) method of a thread to exit
checked, declaring
classes
Exception class 2nd
ExceptionInInitializerError
finalizer methods
handlers for
handling with try/catch/finally statement
indexed property accessor methods
parameterized
subclasses of Error
subclasses of Exception

subclasses of RuntimeException
thread
Throwable interface 2nd
throwing 2nd
uncaught, in threads
unchecked
Exchanger class 2nd
exclusive locks 2nd
Exclusive OR [See XOR operator]
exec( ) (Runtime) 2nd 3rd
executable JAR files, running programs from
execute permission
ExecutionException 2nd
Executor interface 2nd
ExecutorCompletionService class
Executors class 2nd
ExecutorService interface 2nd
ExemptionMechanism class
ExemptionMechanismException
ExemptionMechanismSpi class
exists( ) (File)
exit( )
Runtime class
System class 2nd
exitValue( ) (Process)
exponential notation
exponentiation functions
expression statements
expressions 2nd 3rd
addition, combining with string concatenation
anonymous class definitions as
assertion 2nd
side effects of
comma-separated list
evaluating in loops 2nd
continue statement and
initializing and updating loop variables
jdb syntax
operators and [See also operators]
( ) (parentheses), use of
operator precedence
order of evaluation
summary of Java operators
extcheck utility
extending a class 2nd
enumerated types and
top-level class extending member class
extending interfaces
extensions
standard, portability and
external processes, communicating with
Externalizable interface 2nd

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

FactoryConfigurationError
FailedLoginException
false values (boolean)
fatalError( ) (Validator)
feature (doc comment cross-references)
Field class
  getGenericType( )
Field class (DatatypeConstants)
fields
  accessible to local classes
  atomic operations on (without locking)
  class 2nd
    hiding
    initializing
  DateFormat.Field class
  declaration syntax
  defaults and initializers
  deprecated (@deprecated javadoc tag)
  deserializing
  enumerated types
    initializers
  Field class
  FieldPosition class
  Format.Field class
  inheritance in subclassing
  inherited, initializing
  instance 2nd
    inheritance of
  MessageFormat.Field
  named fields read by ObjectInputStream
  naming and capitalization conventions
  NoSuchFieldError
  NoSuchFieldException
  NumberFormat.Field
  ObjectStreamField class
  PutField class
  reference index
  references to, in @see doc comment tag
  serialPersistentFields
  static modifier
  static, final, in interfaces
  superclass, hiding
    method overriding vs.

System.out.println( )
transient
volatile
File class 2nd
enhancement in Java 1.2
list( )
file compression [See compression]
file pointer
file separators
file structure
file\: protocol
FileChannel class 2nd
file locks, exclusive and shared
MapMode class
memory mapping a file
random access to file contents
FileDescriptor class
sync( )
FileFilter interface
FileHandler class
FileInputStream class 2nd 3rd
SecurityManager and
FileLock class
OverlappingFileLockException
FileLockInterruptedException
FilenameFilter interface 2nd 3rd
filenames
hardcoded, portability and
FileNotFoundException
FileOutputStream class 2nd
FilePermission class
FileReader class
files
associated with unused objects, closing or deleting
binary, reading
class
compressed, reading
compressing data
FileNameMap interface
FileNotFoundException
filtering a list of
filtering filenames
handle to open file
I/O
nonstream classes, java.io
not found
permission to access
RandomAccessFile class
reading binary data from arbitrary locations in
reading bytes from specified file
reading text from
reading to and writing from

text, reading
transforming to URIs
writing data to specified file
writing text to, using FileWriter
ZipFile class
FileWriter class
fill( )
Arrays class 2nd
Collections class
Filter interface
filtering
character input streams
input and output streams
FilterInputStream class 2nd 3rd
CheckedInputStream class
FilterOutputStream class 2nd 3rd
FilterReader class 2nd
FilterWriter class
final modifier
abstract modifier and
class fields
classes 2nd
enumerated types and 2nd
fields
for/in loop variables
in variable declarations
in local method definitions
local classes and
method lookup
methods
finalize( ) 2nd
finalizing objects
finalizers
chaining
finally clause
findClass( ) (ClassLoader)
findMonitorDeadlockedThreads( )
first( )
CharacterIterator interface
SortedSet interface
first-in, first-out (FIFO) queues
firstKey( )
SortedMap interface
TreeMap class
flags
format specifier
format, illegal combination of
format, mismatch with conversion specifier
FormattableFlags class
login module
flip( )
Buffer class

FloatBuffer class
floating-point types 2nd
 arbitrary-precision decimal arithmetic 2nd
 BigDecimal class
 comparing two operands of different types
 conversions
 decimal precision, IEEE 754R standard
 division
 double 2nd
 Double class 2nd 3rd
 float 2nd
  conversions
 Float class 2nd 3rd 4th
 formatting numbers
 Math class methods
 modulo (%) operator and
 strictfp methods
 strictfp modifier
 wrapper classes
floatValue( )
flow control statements 2nd
 return statement 2nd
flush( )
 BufferedOutputStream class
 CharArrayWriter class
 CipherOutputStream class
 DataOutputStream class
 Flushable interface 2nd
 OutputStream class
 PrintWriter class
 StringWriter class
 Writer class
Flushable interface 2nd
for each statement [See for/in statements]
for statements
 continue statement used in
 continue statement, starting new iteration
 empty loop body
 initializing, testing, and updating variables
 iterating arrays
for/in statements 2nd 3rd
 example
 Iterable and Iterator interfaces
 Iterable interface 2nd
  iterator( )
 iterating arrays
 limitations of
 syntax of
force( ) (FileChannel)
forClass( ) (ObjectStreamClass)
forDigit( ) (Character)
form feed (\f)

Format class
format specifiers
format( ) 2nd 3rd 4th
 Format class
 Formatter class 2nd
 formatting numbers 2nd
 MissingFormatArgumentException
 NumberFormat class
 PrintStream and PrintWriter classes
 String class 2nd
Format.Field class
FormatFlagsConversionMismatchException
Formattable interface 2nd
FormattableFlags class
Formatter class 2nd 3rd 4th 5th 6th 7th 8th
 argument specifier
 conversion exception
 flags
  illegal combination
 format string and format specifiers
 IllegalFormatException
 logging
 missing format arguments
 precision, format specifier
  exception
 printf( ) and format( )
 SimpleFormatter
 unknown conversion specifier
 unknown format flags
 width, format specifier
  illegal
  missing
 XMLFormatter
Formatter.BigDecimalLayoutForm
FormatterClosedException
formatToCharacterIterator( ) 2nd
forName( )
 Charset class
 Class class 2nd
 UnicodeBlock class
forward references
fractions, decimal representation of
freeMemory( )
from( ) (MemoryNotificationInfo)
ftp\: protocol
fully qualified class names 2nd
 importing types
functions
 mathematical
 XPath
Future interface 2nd
 CancellationException

ScheduledFuture
FutureTask class

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

garbage collection 2nd 3rd 4th [See also references]
 disabling for classes
 finalize( ) method
 incremental, interpreter option for
 jdb debugger
 OutOfMemoryError
 printing message upon occurrence
 statistics on (jstat)
 system
 WeakHashMap class
GarbageCollectorMXBean interface
GatheringByteChannel 2nd 3rd
gc( )
gcd( ) (BigInteger)
GeneralSecurityException
generateCertificate( ) 2nd
generateCertificates( )
generateCertPath( )
generateCRL( ) 2nd
generateKey( ) (KeyGenerator)
generateKeyPair( )
generateParameters( )
generatePrivate( )
generatePublic( )
generateSecret( )
 KeyAgreement class
 SecretKeyFactory class
generateSeed( ) (SecureRandom)
generic types 2nd 3rd
 annotation types and
 arrays of parameterized type
 bounded wildcards in parameterized types
 case study, Comparable and Enum
 Class class
 collection interfaces and classes
 compile-time type safety
 Constructor class
 covariant returns
 Enum class
 Exchanger 2nd
 Field class, support of
 FutureTask
 generic methods

GenericDeclaration
generics, defined
GenericSignatureFormatError
InheritableThreadLocal class
interfaces extending Type
MalformedParameterizedTypeException
Method class, support for
parameterized type hierarchy
parameterized types vs.
PhantomReference class
PrivilegedAction
raw types and unchecked warnings
Reference class
ReferenceQueue class
Reflection API, changes in
runtime type safety
SoftReference class
ThreadLocal class
type parameter wildcards
typesafe collections
TypeVariable interface
understanding
WeakReference class
writing
type variable bounds
wildcards
writing generic methods
arrays and
invoking methods
parameterized exceptions
GenericArrayType interface
GenericDeclaration interface 2nd
generics [See generic types]
genKeyPair( ) (KeyPairGenerator)
get and set accessor methods
data accessor methods
JavaBean properties
get( )
AbstractList class
Array class
ArrayList class
Buffer class
ByteBuffer class
Calendar class
Future class
GetField class
HashMap class
Hashtable class
LinkedList class
List interface 2nd
Map interface 2nd
PhantomReference class

Reference class
ReferenceQueue class
ThreadLocal class
TreeMap class
WeakHashMap class
getAbsoluteFile( ) (File)
getAbsolutePath( ) (File)
getActualTypeArguments( )
getAddress( ) (InetAddress)
getAlgorithm( ) (Key)
getAllAttributeKeys( )
getAllByName( ) (InetAddress)
getAllLoadedClasses( ) (Instrumentation)
getAllStackTraces( )
getAllThreadIds( )
getAnnotation( ) 2nd
getAnnotations( )
getAttribute( )
AttributedCharacterIterator
TransformerFactory class
getAttributes( )
AttributedCharacterIterator interface
JarEntry class
Manifest class
getBeginIndex( ) (FieldPosition)
getBlockedCount( ) (ThreadInfo)
getBlockedTime( ) (ThreadInfo)
getBody( )
CacheRequest class
CacheResponse class
getBounds( ) (TypeVariable)
getBuffer( ) (StringWriter)
getByAddress( ) (Inet6Address)
getByName( ) (InetAdress)
getCanonicalFile( ) (File)
getCanonicalPath( ) (File)
getCause( ) (Throwable) 2nd
getCertificate( ) (KeyStore)
getCertificateChain( ) (KeyStore)
getCertificates( )
CertPath class
JarEntry class
getCertPathEncoding( )
getChannel( ) 2nd 3rd 4th 5th
ServerSocket class
Socket class
getChars( )
StringBuffer class
getCipherSuite( ) (SSLSession)
getClass( )
Class class
Object class

getClassName( )
getClientSessionContext( )
getCollationElementIterator( )
getCollationKey( )
  Collator class
getColumnNumber( )
getCommitted( ) (MemoryUsage)
getConstructor( ) (Class)
getContent( )
  URL class 2nd
  URLConnection class
getContentEncoding( )
getContentLength( )
getContentType( )
getContext( ) (AccessController) 2nd
getDate( ) (URLConnection)
getDateInstance( ) (DateFormat)
getDeclaredAnnotations( )
getDeclaringClass( )
  Field class
  Member interface
  Method class
getDeclaringClass( ) (Enum)
getDefault( )
  CookieHandler class
  ResponseCache class
  ServerSocketFactory class
  SocketFactory class
  SSLServerSocketFactory class
getDefaultPort( ) (URL)
getDefaultText( )
getDelay( ) (ScheduledFuture)
getDelegatedTask( ) (Runnable)
getDirectionality( ) (Character)
getDisplayName( )
getEnclosingClass( )
getEnclosingConstructor( )
getEnclosingMethod( )
getEncoded( )
  AlgorithmParameters class
  Certificate class
  CertPath
  Key interface
getEncoding( ) 2nd
getEncodings( ) (CertPath)
getEndIndex( ) (FieldPosition)
getEntries( ) (Manifest)
getEntry( )
  KeyStore class
  ZipFile class
getEnumConstants( )
getenv( ) (System) 2nd

getErrorStream( ) (Process)
getException( )
PrivilegedActionException
getExceptionTypes( ) (Method)
getExpiration( )
getFD( )
GetField class
getField( )
Class class
ObjectStreamClass
getFields( ) (ObjectStreamClass)
getFile( ) (URL)
getFormat( )
Key interface
SecretKey interface
getGenericComponentType( )
getGenericDeclaration( )
getGenericExceptionTypes( )
getGenericParameterTypes( )
getGenericReturnType( )
getGenericType( ) (Field)
getHeaderField( )
getHeaderFieldDate( )
getHeaderFieldInt( )
getHeaderFields( )
getHeaders( )
getHost( ) (URL)
getHostAddress( ) (InetAddress)
getHostName( ) (InetAddress)
getId( ) (Thread)
getID( ) (TimeZone)
getIds( )
getInetAddress( )
DatagramSocket class
ServerSocket class
Socket class
getInetAddresses( )
getInfo( ) (Provider)
getInit( ) (MemoryUsage)
getInitiatedClasses( ) (Instrumentation)
getInputStream( )
JarFile class
Process class
Socket class
ZipFile class
getInstance( )
AlgorithmParameterGenerator
Calendar class
CertificateFactory class
CertStore class
Cipher class
Collator class 2nd

KeyAgreement class
KeyGenerator class 2nd
KeyManagerFactory class
KeyPairGenerator class 2nd
KeyStore class
Mac class
MessageDigest class
NumberFormat class
SecretKeyFactory class
SecureRandom class
Signature class
getInt( ) (Array)
getInteger( ) (Integer)
getInterfaces( ) (Class)
getInvocationHandler( ) (Proxy)
getIterator( ) (AttributedString)
getIV( ) (Cipher)
getJarEntry( ) (JarFile)
getKey( )
Entry interface
KeyStore class
getKeyManagers( )
getKeySpec( )
KeyFactory class
SecretKeyFactory class
getLineNumber( )
LineNumberReader class
SourceLocator
getLocalAddress( )
DatagramSocket class
Socket class
getLocalHost( ) (InetAddress)
getLocalPart( ) (QName)
getLocalPort( )
DatagramSocket class
ServerSocket class
Socket class
getLocalSocketAddress( )
DatagramSocket class
ServerSocket class
Socket class
getLocation( )
getLogger( ) (Logger)
getLong( ) (Long)
getLowerBounds( ) (WildcardType)
getMacLength( ) (Mac)
getMainAttributes( ) (Manifest)
getManifest( )
JarFile class
JarInputStream class
getMax( ) (MemoryUsage)
getMaxAllowedKeyLength( )

getMemoryPoolNames( )
getMessage( ) 2nd
  TextOutputCallback
  Throwable interface
  WriteAbortedException
getMessageType( ) (CallbackHandler)
getMethod( ) (Class)
getMethodName( )
getModifiers( )
  Field class
  Member interface
getModulus( ) (RSAKey)
getName( )
  Class class
  CompilationMXBean interface
  Field class
  File class
  Member interface
  MemoryPoolMXBean
  NetworkInterface class
  Provider class
  TypeVariable interface
getNamespaceURI( ) (QName)
getNetworkInterfaces( )
getNextEntry( )
getNextJarEntry( )
getNextUpdate( ) (X509CRL)
getNumericValue( ) (Character)
getObject( )
  GuardedObject class
  SealedObject class
  SignedObject class
getObjectSize( ) (Instrumentation)
getObjectStreamClass( ) (GetField)
getOffset( ) (TimeZone)
getOption( ) (SocketOptions)
getOutputProperties( )
getOutputSize( ) (Cipher)
getOutputStream( )
  Process classs
  Socket class
getOwnerType( ) (ParameterizedType)
getPackage( )
  ClassLoader class
  Package class
getPackages( ) (Package)
getParameterAnnotations( ) 2nd
getParameters( ) (Cipher)
getParameterTypes( ) (Method)
getParams( ) (DHKey)
getParent( )
  File class

ThreadGroup class
getParentFile( ) (File)
getPassword( )
KeyStore.PasswordProtection
PasswordAuthentication
getPasswordAuthentication( ) 2nd
getPath( ) (File)
getPeakUsage( )
getPeerCertificateChain( )
getPeerCertificates( ) 2nd
getPeerHost( ) 2nd
getPermissions( )
Policy class
SecureClassLoader class
getPolicy( ) (Policy) 2nd
getPort( )
DatagramSocket class
Socket class
URL class
getPrefix( ) (QName)
getPrivateKey( )
getPrompt( )
CallbackHandler class
NameCallback class
TextInputCallback class
getProperties( ) (System)
getProperty( )
Properties class
System class 2nd 3rd
getProtectionDomain( ) (Class)
getProtocol( )
SSLSession class
URL class
getProvider( ) (Security)
getProviders( ) (Security)
getProxyClass( ) (Proxy)
getPublicId( ) (SourceLocator)
getPublicKey( )
Certificate class
X509Certificate class
getRaw( ) (URI)
getRawType( ) (ParameterizedType)
getRemoteSocketAddress( )
getRequesting( )
getResource( ) (ClassLoader)
getResourceAsStream( )
getResources( ) (ClassLoader)
getResponseCode( )
getResponseMessage( )
getReturnType( ) (Method)
getRevokedCertificate( )
getRunLimit( )

getRunStart( )
getRuntime( )
getSecretKey( )
getSecurityManager( ) (System)
getSerialVersionUID( )
getServerSessionContext( )
getServerSocket( )
getServerSocketFactory( )
getSimpleName( ) (Class)
getSocketFactory( )
getSource( ) (EventObject)
getSpecificationVersion( )
getStackTrace( )
 Thread class
 Throwable interface
getState( ) (Thread) 2nd
getSubject( ) (LoginContext) 2nd 3rd
getSubjectDN( ) (X509Certificate) 2nd
getSuperclass( ) (Class)
getSupportedCipherSuite( )
getSupportedProtocols( )
getSystemId( ) (SourceLocator)
getTargetException( )
getThisUpdate( ) (X509CRL)
getThreadCPUTime( )
getThreadGroup( ) (Thread)
getThreadInfo( )
getThreadUserTime( )
getTime( )
getTimestamp( ) (Timestamp)
getTrustAnchor( )
getTrustedCertificate( )
getType( )
 CertPath class
 Character class
 Field class
 MemoryPoolMXBean
getTypeParameters( )
getUndeclaredThrowable( )
getUpperBounds( ) (WildcardType)
getUptime( ) (RuntimeMXBean)
getUsage( )
getUsed( ) (MemoryUsage)
getValue( )
 Entry interface
 SSLSocket
getVersion( ) (Provider)
getX( ) (DHPrivateKey)
getXMLReader( ) (SAXParser)
getY( ) (DHPublicKey)
global method or function, class methods as
global variables

C language vs. Java
public class fields as
GMT (Greenwich Mean Time)
goto statement
graphical Java process monitor
graphics
applet access control restrictions on facilities
packages for
greater than operator (>) 2nd
greater than or equal operator (>=)
green threads 2nd
Greenwich Mean Time (GMT)
Gregorian calendar
GregorianCalendar class
group of threads (ThreadGroup class)
groups (multicast), joining and leaving
Guard interface
GuardedObject class 2nd
GUI (graphical user interface)
applet access to, restrictions
packages for 2nd
gzip compression
pack200 tool
unpacking files with unpack200
GZIPInputStream class
GZIPOutputStream class

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

Han (Chinese) ideographs
hand-held devices
  Java 2 Platform, Micro Edition (J2ME)
  Java interpreter for
handle to an open file or socket
handle( ) (CallbackHandler) 2nd
Handler class
HandlerBase interface (SAX)
handlers for exceptions
  try/catch/finally statements
handshake, SSL connections
  status of the SSLEngine
handshakeCompleted( )
HandshakeCompletedEvent class
HandshakeCompletedListener interface
hardcoded filenames, code portability and
hashCode( )
  Annotation interface
  Enum class
  enumerated types
  Hashtable class
  Object class 2nd
HashMap class 2nd 3rd
HashSet class 2nd
hashtables
  causing memory leaks
  Hashtable class 2nd
    Properties subclass
  maps and sets based on
  WeakHashMap class
hasNext( )
  Iterator class
  Iterator interface 2nd
  ListIterator interface
hasPrevious( ) (ListIterator) 2nd
header and source files (C)
header files for use with JNI
headMap( ) (SortedMap) 2nd
headSet( ) (SortedSet)
heap
  memory allocation for
  memory usage information
Hebrew text

help
javadoc-generated documentation
javap tool
hexadecimal numbers
Integer type conversions
Long type conversions
Short type conversions
URL encoding
hiding data
access control
inheritance and
superclass fields
class fields
method overriding vs.
hierarchy, class
containment hierarchy vs.
parameterized types
superclasses, Object class and
highestOneBit( ) (Integer)
holdsLock( ) (Thread) 2nd
HostnameVerifier class
hosts
IP addresses
NoRouteToHostException
reachability of, testing 2nd
UnknownHostException
HotSpot VM
client and server versions
performace tuning options
HTML tags in doc comments 2nd
<A\\> (hyperlinks) tag, avoiding
<PRE\\> tag
HTTP server
http\: protocol
HttpRetryException
https\: protocol
https\: URLs
HttpsURLConnection class 2nd
hostname verifier
HttpURLConnection class
hyperbolic trigonometric functions
hyperlinks or cross-references in doc comments

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

IANA charset registry
identical objects
identifiers
 assert
 class version
 defined
 method names
 SSLSession
 thread
 TimeZone
 UUID (Universal Unique Identifier)
identity certificates [See certificates]
Identity class
identityHashCode( ) (System) 2nd
IdentityHashMap class 2nd 3rd
IdentityScope class
IEEE 754-1985 standard for floating-point types
if statements
 assertions in
if/else statements
 else if clause
 nested
IllegalAccessError
IllegalAccessException
IllegalArgumentException
IllegalBlockingModeException
IllegalBlockSizeException
IllegalCharsetNameException
IllegalClassFormatException
IllegalFormatCodePointException
IllegalFormatConversionException
IllegalFormatException
IllegalFormatFlagsException
IllegalMonitorStateException
IllegalSelectorException
IllegalStateException
IllegalThreadStateException
images in doc comments
immutability of String objects
implementation
 behavior specific to, portability and
 bugs specific to, portability and
 local and anonymous class

member class
of methods
portable Java code, conventions/rules for
static member types
implements (keyword) 2nd
implies( )
AllPermission class 2nd
BasicPermission class
CodeSource class
Permission class
PermissionCollection class
Permissions class
ProtectionDomain class
import declarations 2nd
naming conflicts and shadowing
static members
import static declaration 2nd 3rd
importPreferences( )
in, out, and err variables 2nd
IncompatibleClassChangeError
increment expression statements
increment operator (++) 2nd
return type
side effects
incrementing loop counter variable
inDaylightTime( ) (TimeZone)
indentation
anonymous class definitions
in doc comments, code examples and
nested statements 2nd
index operator ([ ])
index( )
indexed properties
conventions for
indexes
array 2nd
too small or too large
generating multiple index files, javadoc
javadoc, not generating
list
indexOf( )
CopyOnWriteArrayList
List interface 2nd
String class
StringBuffer class
indexOfSubList( ) (Collections)
IndexOutOfBoundsException
Inet4Address class
Inet6Address class
InetAddress class
isReachable( ) 2nd
InetSocketAddress class 2nd

infinite loops
for(;;)
infinity
% (modulo) operator and
Double, testing for
positive and negative
Inflater class
InflaterInputStream class
info( ) (Logger)
InheritableThreadLocal class
inheritance
@Inherited meta-annotation
access control and
interfaces
as alternative to multiple inheritance
constants in definitions
extending interfaces
scope vs., for member classes
subclass from superclass
subclasses and
class hierarchy
constructor chaining and the default constructor
fields and methods
hiding superclass fields
overriding superclass methods
subclass constructors
{@inheritDoc} doc comment tag
Inherited class
inheritedChannel( )
init( )
Cipher class
KeyAgreement class
KeyGenerator class
KeyManagerFactory class
Mac class
PKIXCertPathChecker class
initialization vectors (Cipher) 2nd
initialize( ) (KeyPairGenerator) 2nd
initializers
array
multidimensional arrays
defining a constructor
defining multiple constructors
enumerated types
ExceptionInInitializerError
field
IllegalAccessException
in variable declarations
inherited fields
instance
invoking one constructor from another
static 2nd

initializing loop variables
initialValue( ) (ThreadLocal)
initSign( ) (Signature)
initVerify( ) (Signature)
inline tags (doc comment)
inner classes [See nested types]
input/output
  appendability of text buffers and output streams
  binary file, reading
  character stream classes
  checksums for streams
  Closeable interface 2nd
  compressed files, reading
  compressing data
  console input, reading 2nd
  displaying output
  encrypting and decrypting streams
  files and directories
  files, working with
  filtering bytes
  Flushable interface 2nd
  GZIPInputStream class
  GZIPOutputStream class
  in, out, and err streams, system
  InflaterInputStream class
  input values, checking validity of
  JAR files, reading and writing 2nd
  Java program communicating with external process
  java.io package 2nd 3rd
  keytool program
  message digests 2nd
  message digests, computing 2nd
  New I/O API (see New I/O API
  nonstream classes
  processes
  profiling output, printing to standard output
  reading lines from a text file
  serializing/deserializing objects
  streaming data to and from arrays
  text file, reading lines from
  thread blocking during I/O operations
  thread communication with pipes
  writing text to a file 2nd
  XML, transformation classes for
  ZipInputStream class
  ZipOutputStream class
InputMismatchException
InputSource class (SAX)
InputStream class 2nd
  read( )
InputStreamReader class
insert( ) (StringBuffer)

insertProviderAt( ) (Security) 2nd
instance fields
 default initialization of
 interfaces and
 superclass, hiding
instance initializers
 substituting for constructors
instance members
 enumerated types, ordinal( )
 inheritance of
instance methods 2nd
 choosing between class and instance methods
 how they work
 interfaces
 overriding superclass methods
 synchronized
 System.out.println( )
instanceof operator 2nd 3rd
 marker interfaces, identifying with
instances, class
 comparing with Comparable.compareTo( )
 creating dynamically
 enumerated types
instantiating a class
InstantiationError
InstantiationException
instrumentation 2nd 3rd 4th
 ClassDefinition class
 ClassFileTransformer interface
 IllegalClassFormatException
 Instrumentation interface
 Java interpreter options
 java.lang.instrument package
 UnmodifiableClassException
int type 2nd
 32-bit int values
 bitwise and shift operator results
 conversion to other primitive types
 Integer class
  new methods in Java 5.0
IntBuffer class
integers
 % (modulo) operator and
 arbitrary-precision arithmetic 2nd
 BigInteger class 2nd
 converting floating-point values to, using casts
 converting strings to
 int data type
 Integer class 2nd 3rd 4th 5th
  new methods, Java 5.0
 integer literals
 integer types

array access ([ ]) operator and
wrapper classes
interest set of channel operations
interestOps( ) (SelectionKey)
interfaces
abstract classes vs.
abstract modifier in declarations
as static member types
classes implementing, definitions of
as data types
defined
defining
defining object types
deprecated (@deprecated javadoc tag)
dynamic proxies, implementing with
extending
implemented by enumerated types 2nd
implementing
multiple
InstantiationError
InstantiationException
local scope and
marker
member classes, inability to define as
modifiers
naming and capitalization conventions
network
references to, in @see doc comment tag
intern( ) (String) 2nd
InternalError
internationalization 2nd
applications, package for
comparing strings
date and time formatting
InputStreamReader, byte-to-character conversions
java.text package
LanguageCallback class
Locale class
locale, specifying for documentation
OutputStreamWriter class
Internet domain names, using in package naming
interpreted mode (JVM)
interrupt( )
Thread class 2nd 3rd
ThreadGroup class
interrupted( ) (Thread) 2nd
InterruptedException 2nd 3rd
InterruptedIOException 2nd 3rd
InterruptibleChannel interface 2nd
InvalidAlgorithmParameterException
invalidate( ) (SSLSession)
InvalidClassException 2nd

InvalidKeyException
InvalidKeySpecException
InvalidMarkException
InvalidObjectException 2nd
InvalidParameterException
InvalidParameterSpecException
InvalidPreferencesFormatException
InvalidPropertiesFormatException
InvocationHandler interface 2nd 3rd
 proxy class instances and
InvocationTargetException
invoke( )
 InvocationHandler 2nd 3rd
 Method class
invoking methods 2nd
 class methods
 constructors, from another constructor
 in expression statements
 instance methods
 overridden
IOException
IP (Internet Protocol) addresses
 combined with a port number
 enumerating for network interface
IPv4 (Internet Protocol version 4) addresses
IPv6 (Internet Protocol version 6) addresses
is prefix, data accessor methods
isAbsolute( ) (File)
isAbstract( ) (Modifier)
isAlive( ) (Thread)
isAnnotation( ) (Class)
isAnnotationPresent( ) (AnnotatedElement)
isAnonymousClass( )
isBound( )
 DatagramSocket class
 ServerSocket class
 Socket class
isCancelled( ) (Future)
isCompatibleWith( ) (Package)
isConnected( ) (Socket)
isCurrent( ) (Refreshable)
isDestroyed( ) (Destroyable)
isDigit( ) (Character) 2nd
isDirect( ) (ByteBuffer)
isDirectory( ) (File)
isDone( ) (Future)
isEchoOn( ) (PaswordCallback)
isEmpty( )
 Collection interface
 Map interface
isEnqueued( ) (Reference)
isEnum( ) (Class)

isEnumConstant( ) (Field)
isError( ) (CoderResult)
isFile( ) (File)
isHidden( ) (File)
isInfinite( ) (Double)
isInputShutdown( ) (Socket)
isInterrupted( ) (Thread) 2nd
isJavaIdentifierPart( ) (Character)
isJavaIdentifierStart( ) (Character)
isJavaLetter( ) (Character)
isLetter( ) (Character)
isLocalClass( )
isLowerCase( ) (Character) 2nd
isMalformed( ) (CoderResult)
isMemberClass( )
isNaN( )
  Double class 2nd 3rd
  Float class 2nd
isNativeMethod( ) (StackTraceElement)
ISO-8859-1 (Latin-1) charset 2nd
isOpen( ) (Channel)
isOutputShutdown( ) (Socket)
isProbablePrime( ) (BigInteger)
isProxyClass( ) (Proxy)
isPublic( ) (Modifier)
isReadOnly( ) (Buffer)
isRedefineClassesSupported( ) (Instrumentation)
isRegistered( )
  Charset class
  SelectableChannel interface
isRevoked( ) (CRL) 2nd
isSealed( ) (Package)
isShared( ) (FileLock)
isSupported( ) (Charset)
isSynthetic( ) (Member)
isThreadCPUTimeSupported( )
isUpperCase( ) (Character)
isUsageThresholdSupported( )
isValid( )
  FileLock class
  SSLSession class
isVarArgs( ) (Method)
isWhitespace( )
Iterable interface 2nd 3rd 4th 5th
iterations 2nd [See also statements]
  arrays
  for/in statement
  in loops, starting new with continue statement
  lists
Iterator interface 2nd 3rd 4th 5th
  getting Iterator objects
  implemented as an anonymous class

iterator( ) 2nd
AbstractCollection class
Iterable interface
List interface 2nd
Set interface
IvParameterSpec class

Team LiB

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

J2EE (Java 2 Platform, Enterprise Edition)
JAAS (Java Authentication and Authorization Service) 2nd 3rd
Japanese text (EUC-JP charset)
JAR (Java Archive) files
  classes for reading and writing
  compressed, unpacking with unpack200
  compression, pack200 tool
  digital signatures
  extcheck utility
  extension, checking whether installed
  java.util.jar package
  manifest, format of
  package for
  retrieving
  running programs 2nd
jar tool
  command options
  command syntax
  examples
  files
  modiifer options
JarEntry class 2nd
JarException
JarFile class 2nd
JarInputStream class 2nd
JarOutputStream class 2nd
jarsigner tool
JarURLConnection class 2nd
Java
  performance
  strong typing in
  versions
    1.1, security and
Java 2 Platform
  Enterprise Edition
  Micro Edition
Java 5.0 2nd 3rd
  annotation types
    Deprecated
    Override
    SuppressWarnings
  annotations 2nd 3rd
  Appendable interface 2nd 3rd 4th 5th

asList( ) (Arrays)
atomic operations
BigDecimal class, changes to
boxing and unboxing conversions
changes to the Java platform
CharSequence
Class class
Closeable interface 2nd
collections wrapper methods
ConcurrentHashMap class
Condition object
contentEquals( )
CopyOnWriteArrayList class
CountDownLatch class
cross-references in doc comments
cryptography
  algorithms supported, SunJCE
  Cipher class
  KeyGenerator algorithms
  MAC algorithms
  OAEPParameterSpec
  PSource
  PSource.PSpecified
  SecretKeyFactory
CyclicBarrier class
debugger to VM connections
DOM
  bootstrap, events, and ls subpackages
  Level 3
  NameList interface
  TypeInfo interface
  UserDataHandler interface
DOMConfiguration interface
DOMError interface
DOMErrorHandler interface
DOMImplementationList interface
DOMLocator interface
DOMStringList interface
enumerated types
  Enum class 2nd 3rd
  SSLEngineResult.HandshakeStatus
  SSLEngineResult.Status
executors framework
  Executor interface
  ExecutorService interface
  Future interface
  ScheduledExecutorService class
  ThreadPoolExecutor class
Flushable interface 2nd
format( ), creating String objects
Formattable interface
FormattableFlags class

Formatter class 2nd 3rd 4th
generic types 2nd
Class class
Exchanger
java.lang.ref
PrivilegedAction
InetAddress class, isReachable( )
inheritedChannel( )
instrumentation 2nd 3rd 4th
Integer class, methods added
Iterable interface 2nd 3rd
java.util package
java.util.concurrent package 2nd
jinfo
jmap
jsadebugd tool (remote debugging)
jstack tool
jstat tool
jstatd daemon
locks
Long class, additional methods
management package 2nd
JMX API
Matcher class, enchancements
Math class, new methods 2nd
math package, changes to
BigDecimal class
MathContext class
rounding mode
RoundingMode type
MissingFormatArgumentException
nanoTime( ) (System)
networking
Authenticator.RequestorType
CacheRequest
CacheResponse class
CookieHandler class
HttpRetryException
isReachable( ), InetAddress
Proxy.Type class
ProxySelector class
ResponseCache class
SecureCacheResponse
URLConnection, changes to
printf( ) and format( ) 2nd 3rd
formatting numbers
PrintStream class, changes to 2nd
PrintWriter class, changes to 2nd
PriorityQueue class
ProcessBuilder class 2nd 3rd
Queue and BlockingQueue interfaces 2nd
Queue interface 2nd

Readable interface 2nd 3rd
Reflection API, changes to
  AnnotatedElement
  Constructor class
  Field class
  generic type malformed
  GenericArrayType
  GenericDeclaration
  GenricSignatureFormatError
  Method class
  ParameterizedType
  Type interface
  TypeVariable interface
  WildcardType
replace( ), generalized versions of
SAX2 extensions
  Attributes2
  Attributes2Impl
  DefaultHandler2
  EntityResolver2
  Locator2
  Locator2Impl interface
Scanner class 2nd 3rd
  input mismatch
security
  CodeSigner class
  KeyRep class
  KeyRep.Type
  KeyStore class
  KeyStore nested classes
  Provider.Service class
  Timestamp class
  UnrecoverableEntryException
Semaphore class
SSLEngine class 2nd
StringBuilder class
System class, clearProperty( )
System.getenv( )
Thread class
  UncaughtExceptionHandler
Thread.State enumerated type
time in nanoseconds (System.nanoTime( ))
TimeUnit class 2nd
Unicode supplementary characters
  Character class methods
  String methods for
UnicodeBlock class
UUID class
Writer class, changes to
XML packages 2nd
  javax.xml
  javax.xml.datatype

javax.xml.namespace 2nd
javax.xml.validation 2nd
javax.xml.xpath
validation
XPath
XPathEvaluator class
Java Authentication and Authorization Service, [See JAAS]
java command 2nd 3rd [See also Java interpreter]
-javaagent argument
running a Java program
Java Cryptography Extension (JCE) 2nd 3rd
Java Development Kit [See JDK]
Java interpreter 2nd
advanced options
annotations, handling of
assertion options
assertions, enabling
break statements
classpaths, specifying for
common options
evaluating expressions 2nd
evaluation of operands
garbage collection
instrumentation options
InternalError
iterating through loops
java command-line program
jdb debugger
connection options
just-in-time (JIT) compiler, specifying
loading classes
main( ) method 2nd
OutOfMemoryError
performance tuning options
remote monitoring and management
running programs
StackOverflowError
threading system, specifying
versions 2nd
Java Keystore (JKS) type 2nd
Java language
case sensitivity
java.lang and subpackages
modifiers, summary of
new features, Java 5.0
pass by value
syntax
arrays
case-sensitivity and whitespace
classes and objects
comments
differences from C and C++

file structure
identifiers
literals
methods
packages and namespaces
parograms, defining and running
punctuation characters (tokens)
reference types
reserved words
statements
Unicode character set
Java Native Interface (JNI)
Java platform 2nd 3rd
arrays 2nd
collections
dates and times 2nd [See also dates and times]
extensions to, package names
files and directories
I/O and networking with java.nio
input/output 2nd [See also input/output]
management and instrumentation
Microsoft proprietary extension of
networking with java.net
numbers and math 2nd [See also math; numbers]
object persistence
packages (key), summary of
Preferences API
processes
properties
security
Standard Edition
text
threads and concurrency 2nd [See also threads]
types, reflection, and dynamic loading
"Write once, run anywhere"
XML processing
Java programming
conventions
naming and capitalization
conventions for JavaBeans
example program
compiling and running
network-centric
online tutorial
portability conventions
related book
Java Secure Sockets Extension (JSSE)
java, javax, and sun, package names beginning with
java.awt package
java.awt.peer package, portability and
java.io package 2nd 3rd 4th [See also input/output]
java.lang package 2nd

annotation types (standard)
primitive type wrapper classes
subpackages
new in Java 5.0
java.lang.annotation package [See annotations]
java.lang.instrument package [See instrumentation]
java.lang.management package 2nd
java.lang.ref package 2nd
java.lang.reflect package 2nd 3rd
annotation support
java.math package 2nd 3rd
java.net package 2nd 3rd 4th [See also networking]
java.nio package 2nd 3rd
java.nio.channels package 2nd 3rd 4th
server-side networking
java.nio.channels.spi package 2nd
java.nio.charset package 2nd 3rd 4th 5th
java.nio.charset.spi package
java.policy file
java.security package 2nd 3rd
message digests
subpackages, listed
java.security.auth package
java.security.cert package 2nd
java.security.interfaces package 2nd
java.security.manager system property
java.security.spec package 2nd
java.text package 2nd
java.util package 2nd 3rd 4th [See also collections; generic types]
additions in Java 5.0
collections classes
converted to generic types
use of type parameters
Formatter class
java.util.concurrent package 2nd [See also concurrency]
java.util.concurrent.atomic package 2nd
java.util.concurrent.locks package 2nd
Condition object
java.util.jar package 2nd 3rd 4th [See also JAR files]
java.util.logging package 2nd 3rd
java.util.prefs package 2nd 3rd
java.util.regex package
java.util.zip package 2nd 3rd 4th
JavaBeans 2nd
bean basics
bean classes
conventions
events
MXBean interfaces [See management package]
properties
bound
constrained

indexed
serialization mechanism for components
javac compiler 2nd
-xlint option
@SuppressWarnings annotation
apt (annotation processing tool)
assert statements, handling
classpath
common options
cross-compilation options
javadoc and
warning options
javadoc program 2nd
@deprecated tag
classpath
customizing documentation format
HTML documentation, creating
options
javah program
javakey program
javap tool
javaw interpreter
javaw_g interpreter
javax (package names)
javax.crypto package 2nd 3rd 4th
javax.crypto.interfaces package
javax.crypto.spec package
javax.net package 2nd
JSSE (Java Secure Sockets Extension)
javax.net.ssl package 2nd
JSSE (Java Secure Sockets Extension)
javax.security.auth package
javax.security.auth.callback package 2nd
javax.security.auth.kerberos package 2nd
javax.security.auth.login package 2nd
javax.security.auth.spi package 2nd
javax.security.auth.x500 package 2nd
javax.swing package
javax.xml package
new packages
javax.xml.datatype package 2nd
javax.xml.namespace package 2nd
javax.xml.parsers package 2nd 3rd 4th
javax.xml.transform package 2nd 3rd 4th
javax.xml.transform.dom package 2nd
javax.xml.transform.sax package
javax.xml.transform.stream package 2nd
javax.xml.validation package 2nd 3rd 4th
javax.xml.xpath package 2nd 3rd
JAXP (Java API for XML Processing)
SAX parser
transforming XML documents

JCE (Java Cryptography Extension) 2nd 3rd
 JCEKS keystore
JCEKS (Java Cryptography Extension Key Store)
jconsole tool
jdb debugger
 commands
 expression syntax
 interpreter-to-debugger connection options
 options
JDK (Java Development Kit) 2nd
 javac compiler
 Sun Microsystems, download site 5th [See also tools]
jinfo tool
JIT (just-in-time) compilers 2nd
 performance improvements with
 querying with CompilationMXBean
 specifying for Java interpreter
 using on frequently used methods
JKS (Java Keystore) type 2nd 3rd
jmap tool
JMX API [See management package]
join( ) (Thread) 2nd 3rd 4th
joinGroup( ) (MulticastSocket) 2nd
jps tool
JRE (Java Runtime Environment)
 JDK vs.
jsadebugd tool
JSSE (Java Secure Sockets Extension)
jstack tool
jstat tool
 options
jstatd tool
jump table
JVM (Java Virtual Machine) 2nd 3rd
 annotations and
 array initialization
 class loaded, statistics on
 debugger connection options (Java 5.0)
 deleting files on exit
 instrument package [See instrumentation]
 instrumentation options
 jdb debugger, connecting to
 JIT compiler [See JIT compilers]
 memory manager, monitoring
 monitoring and managment of
 monitoring garbage collections
 MXBean interfaces, obtaining
 performance tuning 2nd
 permission to monitor and manage
 process monitoring tool (jconsole)
 runtime configuration
 security

statistics on (jstat tool)
thread type, specifying for Classic VM
thread usage, monitoring
UnknownError
UnsupportedEncodingException
versions 2nd
VirtualMachineError
JVMTI (Java Virtual Machine Tool Interface)

Team LiB

Team LiB

Index

keepalive, setting for sockets
Kerberos authentication 2nd
  DelegationPermission
  KerberosKey class
  KerberosPrincipal class
  KerberosTicket class
  ServicePermission class
Key interface
key-agreement algorithms
key/value objects (Map)
KeyAgreement class
KeyAgreementSpi class
KeyException
KeyFactory class
KeyFactorySpi class
KeyGenerator class 2nd
KeyGeneratorSpi class
KeyManagementException
KeyManager interface
KeyManagerFactory class
KeyManagerFactorySpi class
KeyPair class
KeyPairGenerator class 2nd
KeyPairGeneratorSpi class
KeyRep class
KeyRep.Type class
keys( )
  Hashtable class
  Selector class
keys, cryptographic [See also cryptography]
  DES key
  KerberosKey
  Key interface
  management by keytool
  secret keys (symmetric), generating
  SecretKey interface
  SSLKeyException
  triple-DES key (DESede)
keySet( )
  Map interface 2nd
  SortedMap interface 2nd
KeySpec interface
KeyStore class 2nd 3rd 4th

KeyStore.Builder class
KeyStore.CallbackHandlerProtection
KeyStore.Entry interface
  UnrecoverableEntryException
KeyStore.LoadStoreParameter
KeyStore.PaswordProtection
KeyStore.PrivateKeyEntry
KeyStore.ProtectionParameter
KeyStore.SecretKeyEntry
KeyStore.TrustedCertificateEntry
KeyStoreBuilderParameters class
KeyStoreException
keystores 2nd 3rd [See also keytool program]
  management with keytool
  password, changing
  for policy files
  type, specifying
KeyStoreSpi class 2nd
keytool program 2nd
  commands
  options
keywords 2nd [See also modifiers]
  abstract
  access control
  assert 2nd 3rd
  break
  case
  class
  enum
  extends
  final
  if
  implements 2nd
  interface
  lines
  listing of
  lowercase used for
  new
  null
  package 2nd
  private
  public
  source
  static 2nd 3rd
  super 2nd 3rd 4th 5th
  switch
  synchronized
  throws
  vars
  void 2nd

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

labeled statements
 break statements, using with
 continue statement
LanguageCallback class
languages
 international, representing with Unicode
 pass-by-reference
 pass-by-value
last( )
 CharacterIterator interface
last in, first-out (LIFO) queues
last modified date (URLs)
last( )
 SortedSet interface
last-in-first-out (LIFO) stacks
lastIndexOf( )
 CharBuffer class
 CopyOnWriteArrayList
 List interface
 String class
lastIndexOfSubList( ) (Collections)
lastKey( ) (SortedMap) 2nd
lastModified( ) (File)
latch
Latin-1 character set 2nd 3rd
 encoding changed to UTF-8
 escaping in char literals
LDAPCertStoreParameters
leaveGroup( ) (MulticastSocket)
left shift assignment operator (<<=)
left shift operator (<<) 2nd
left-to-right associativity
length
 of arrays 2nd
 readable sequence of characters
length( )
 CharSequence interface
 CoderResult class
 File class
 String class
 StringBuffer
less than operator (<)
less than or equal operator (<=)

Level class
levels of severity, log messages
lexical scope 2nd
LexicalHandler interface (SAX)
lib/security/java.policy file
libraries, reading into the system
lifecycle of a thread
LIFO (last-in-first-out) stacks
limit (buffers) 2nd
line breaks in text
line separators, code portabilty and
LineNumberInputStream class (deprecated)
LineNumberReader class
lines keyword
lines, blank
LinkageError
LinkedBlockingQueue class 2nd
LinkedHashMap class 2nd 3rd 4th
LinkedHashSet class 2nd 3rd 4th
LinkedIterator class, implemented as anonymous class
LinkedList class 2nd
 implementing Queue
links, UnsatisfiedLinkError
"lint" in Java programs 2nd
Linux platforms
 Java interpreter
 JDK, downloading from Sun Microsystems
List class
 Collection interface methods
 java.util.List and java.awt.List
 methods, generic vs. nongeneric
 redefined as generic 2nd
 storing primitive values
list( ) (File) 2nd
Listener interface
listeners
 EventListener
 registering
  for constrained properties
  methods for
 TooManyListenersException
 for unicast events
listFiles( ) (File) 2nd
ListIterator interface 2nd 3rd
listIterator( )
 AbstractSequentialList class
 List interface
ListResourceBundle class
listRoots( ) (File)
lists
 AbstractList class
 AbstractSequentialList

element or attribute names (DOM)
immutable List objects
LinkedList class
List interface 2nd 3rd
implementations, general-purpose
random access to
literals 2nd
null reference
string 2nd
type
literals values
LITTLE_ENDIAN byte order
load( )
KeyStore class 2nd
MappedByteBuffer class
Properties class
Runtime class
System class
loadClass( )
ClassLoader class
URLClassLoader class
loadLibrary( )
Runtime class
System class
LoadStoreParameter (KeyStore)
local classes 2nd
defining and using (example)
features of
implementation of
local variables, lexical scoping, and closures
restrictions on
scope of
syntax
local variables
annotations
declaration statements
naming and capitalization conventions
scope of 2nd
Locale class
Locator interface (SAX)
Locator2 interface (SAX)
Locator2Impl interface (SAX)
LocatorImpl class (SAX)
locks 2nd
Condition objects
deadlock
file
FileChannel methods
FileLock class
file locks, overlapping
interrupted file locks
java.util.concurrent.locks package 2nd

listing waiting threads
Lock interface
synchronized methods 2nd
verifying for current thread 2nd
LockSupport class
log10( ) (Math)
logarithmic functions
Logger objects 2nd
logging
garbage collection events
java.util.logging package 2nd 3rd
LoggingMXBean interface
LoggingPermission class
login( )
AuthProvider class
LoginContext class 2nd 3rd
LoginModuleControlFlag class
logins
AccountException
AccountExpiredException
AccountLockedException
AccountNotFoundException
AppConfigurationEntry
AppConfigurationEntry.LoginModuleControlFlag
Configuration class
CredentialException
CredentialExpiredException
CredentialNotFoundException
FailedLoginException
javax.security.auth.login package
LoginContext class 2nd
LoginException
LoginModule interface
LogManager class
logout( ) (LoginContext)
LogRecord class
long type 2nd
64-bit long values
bitwise and shift operator results
conversion to other primitive types
dates and times
Long class 2nd 3rd 4th
unique identifier for threads
longBitsToDouble( )
LongBuffer class
lookup( ) (ObjectStreamClass)
loopback packets
loops 2nd [See also statements]
comparison operators, use in
continue statement in
for and while loops
counter, incrementing 2nd

- do vs. while
- empty loop body
- exiting with break statements
- infinite
- iterating through
- nested, creating and initializing multidimensional arrays

lower-bounded wildcards
lowerCaseMode( )
lunar calendars

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

MAC [See message authentication code]
Mac class 2nd
Macintosh platforms
MacSpi class
main( ) 2nd 3rd
  java interpreter and
  running with jdb debugger
MalformedInputException
MalformedParameterizedTypeException
MalformedURLException
management package 2nd 3rd 4th 5th
  ClassLoadingMXBean
  CompilationMXBean interface
  jconsole tool
  LoggingMXBean
ManagementFactory class
ManagementPermission class
ManagerFactoryParameters interface
Manifest class
manifest files, JAR
  creating with jar utility
Map interface 2nd 3rd
  ConcurrentMap interface
  Entry interface
  SortedMap interface
  TreeMap class
  WeakHashMap class
map( ) (FileChannel) 2nd 3rd
mapLibraryName( ) (System)
MapMode class (FileChannel)
MappedByteBuffer class 2nd
maps
  defined
  enumerated values
  hashtable-based 2nd
  immutable Map objects
  implementing Cloneable or Serializable
  Map interface
    implementations
    support for collection views
  memory mapping a file with FileChannel
mark (buffers) 2nd
  InvalidMarkException

mark( )
CharArrayReader class
InputStream class
Reader class
StringReader class
marker annotations
isAnnotationPresent( ), using
marker interfaces
markSupported( )
InputStream class
Reader class
mask generation function
match( )
CertSelector interface
CRLSelector interface
X509CRLSelector class
Matcher class 2nd 3rd
enchancements in Java 5.0
multiple matches with a regular expression
matches( ) (String) 2nd 3rd
MatchResult interface
math
java.math package
mathematical functions
Math class 2nd 3rd 4th [See also StrictMath class]
new functions in Java 5.0
pseudo-random numbers
static member import
MathContext class 2nd
max( ) (Collections)
MAX_VALUE constant
Float and Double classes
integral type wrapper classes
member classes
containing class instance, specifying for
features of
implementation
local classes vs.
restrictions on
scope vs. inheritance
syntax for
top-level class that extends
Member interface
members
annotation 2nd
class 2nd 3rd 4th
access control
access rules
constructors and initializers
hiding fields and methods
Member interface
nonstatic member classes as

constructors and initializers
deprecated (@deprecated javadoc tag)
importing static members
instance
modifiers
specifying when added to API (@since doc comment)
memory
managing with Runtime
OutOfMemoryError
required by a specified object
usage information for Java process or core file
memory allocation
garbage collection and 2nd
for the heap
for javadoc tool
reclaiming with garbage collection
memory leaks
memory mapping a file
MemoryHandler class
MemoryManagerMXBean interface
MemoryMXBean interface
MemoryNotificationInfo class
MemoryPoolMXBean interface
MemoryType class
MemoryUsage class
message authentication code (MAC) 2nd
MacSpi class
message digests 2nd 3rd
DigestException
DigestInputStream class
DigestOutputStream class
in digital signatures
MessageDigest class 2nd
MessageDigestSpi class
MessageFormat class 2nd
MessageFormat.Field class
messages, checking for tampering
meta-annotations 2nd
defining
Documented type
Inherited type
Retention type
Target type
metadata 2nd [See also annotations]
associating with program elements
Method class
changes in Java 5.0
getGenericParameterTypes( )
method invocation operator (( )) 2nd
side effects
methods 2nd [See also variable-length argument lists]
abstract 2nd

rules for
chaining
choosing between class and instance
class 2nd 3rd
hiding
listing with jdb debugger
Collections
covariant return types
data accessor
declaring checked exceptions
defining 2nd
examples
modifiers
name
parameters
return type
throws clause
deprecated (@deprecated javadoc tag)
displaying byte code for (javap tool)
end of
enforcing preconditions for
enumerated types
event listener interface
generic
invoking
IllegalAccessError
IllegalArgumentException
IllegalStateException
inheritance through subclassing
instance 2nd
inheritance of
interface, InvocationHandler
invoking
in expression statements
InvocationHandler
JavaBean
main( )
Method class 2nd
modifiers
naming and capitalization conventions
native
NoSuchMethodError
NoSuchMethodException
Object class
overloaded
references to
static member imports and
overloading 2nd
defining multiple constructors for a class
@Override annotation
overriding
dynamic method lookup

final and static method lookup
invoking overridden methods
overloading vs.
parameters 2nd
reference index
references to, in @see doc comment tag
side effects
static
synchronized 2nd 3rd
System.out.println( )
in type definitions
unsupported, error
void
MGF1ParameterSpec class
Micro Edition, Java 2 Platform (J2ME)
Microsoft
Java VM implementation, security flaws
proprietary extension of Java platform
milliseconds
MIME types 2nd
min( ) (Collections)
MIN_VALUE constant
Float and Double classes
integral type wrapper classes
MissingFormatArgumentException
MissingFormatWidthException
MissingResourceException
mkdir( ) (File)
mkdirs( ) (File)
modification time of a file
modifiers
access control
anonymous classes and
class
field
final
method 2nd
Modifier class 2nd
not allowed with local variable or class declarations
public, static and void
summary of
visibility
modInverse( ) (BigInteger)
modPow( ) (BigInteger)
modulo by zero
modulo operator (%) 2nd
%= (modulo assignment) operator 2nd
monitoring a running Java interpreter
MulticastSocket class
multidimensional arrays
copying, shallow and deep copies
multiline comments 2nd

multiple inheritance (C++)
multiple interfaces, implementing
multiplication operator (*) 2nd
multiplication table, representing with multidimensional array
multiply( ) (BigDecimal)
multithreaded programming
MXBean interfaces [See management package]

Team LiB

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

Name class
name( )
    Charset class
NameCallback class
NamedNodeMap interface (DOM)
NameList interface (DOM)
names
    anonymous classes
    classes
        fully qualified
        simple and fully qualified
    file and directory, platform-independent
    FilePermission
    library
    method
    package
        uniqueness of
    signer (digital signatures)
namespaces 2nd
    importing types
        naming conflicts and shadowing
        static members
    XML 2nd 3rd
        NamespaceContext
        QName class
        URIs for
NamespaceSupport class (SAX)
naming conflicts
    between superclass and containing class
naming conventions
    characters in names
    classes
    constants
    constructors
    fields and constants
    generic type variables
    images in doc comments
    interfaces
    local class and its enclosing classes
    local variables
    methods
    packages
    parameters, method

  reference types
NaN (not-a-number)
  % (modulo) operator, returning with
  Double, testing for
  floating point-values, testing for
  floating-point calculations, division by zero
  represented by float and double types
nanoseconds
nanoTime( ) (System) 2nd
narrowing conversions
  covariant returns
  reference types
native code, byte code vs.
native methods 2nd
  conventions/rules for
  Java, implemented in C
  javah tool for implementing in C
  printing message when called
  stack traces for errors or exceptions
native OS threads 2nd
native2ascii program
nativeOrder( ) (ByteOrder)
nCopies( ) (Collections)
negation, performing with - (unary minus) operator
negative infinity
  Double, testing for
negative integers, representing
negative zero 2nd
NegativeArraySizeException
nested types
  anonymous classes 2nd
    defining and instantiating
    features of
    indentation and formatting
    restrictions on
    when to use
  Class methods, Java 5.0
  how they work
  local classes 2nd
    features of
    local variables, lexical scoping, and closures
    restrictions on
    scope of
    syntax
  nonstatic member classes 2nd
    features of
    restrictions on
    scope vs. inheritance
    syntax for
  static member types 2nd
NetPermission class
network-centric programming

networking
 closing connections for unused objects
 datagrams
 getByAddress( ), Inet6Address
 host reachability
 java.net package 2nd
  Proxy class
 java.nio package [See New I/O API]
 javax.net package
 javax.net.ssl package
 Kerberos authentication
 packages for
 secure sockets (SSL)
 servers
 sockets 2nd [See also sockets]
NetworkInterface class
New I/O API 2nd 3rd
 buffer operations, basic
 channel operations, basic
 client-side networking
 encoding/decoding text with charsets
 files, working with
 java.nio.channels.spi package
 java.nio.charset package
 java.nio.charset.spi package
 nonblocking I/O
  SSL communication
 server-side networking
new operator 2nd 3rd
 anonymous class formatting
 creating arrays
 creating objects
 defining and implementing anonymous class
 member class, explicitly referring to containing instance
 multidimensional arrays, initializing
NEW thread 2nd
newDecoder( ) (CharsetDecoder)
newEncoder( ) (CharsetEncoder)
newInstance( )
 Array class
 Class class 2nd
 Constructor class 2nd
 DatatypeFactory class
 SchemaFactory class
 URLClassLoader class
newlines (\n), escaping
newPermissionCollection( )
newPlatformMXBeanProxy( ) (ManagementFactory)
newProxyInstance( ) (Proxy)
newReader( ) (Channels)
newSAXParser( )
newSchema( ) (SchemaFactory)

newTemplates( ) (TransformerFactory)
newTransformer( ) (TransformerFactory)
newWriter( ) (Channels)
next( )
 CharacterIterator interface
 Iterator class
 Iterator interface
 Iterator interface[
 ListIterator interface 2nd
nextBytes( ) (SecureRandom)
nextDouble( )
nextElement( ) (Enumeration)
nextFloat( )
nextIndex( ) (ListIterator)
nextInt( )
nextLong( )
nextToken( ) (StreamTokenizer)
NoClassDefFoundError
NoConnectionPendingException
Node interface
Node objects (DOM) 2nd 3rd
NodeChangeEvent class
NodeChangeListener interface
NodeList interface (DOM)
nonblocking I/O 2nd
 client-side networking
 socket connection (example)
 SocketChannel
 SSL communication using
nonheap memory, usage information
nonnative (green) threads 2nd
NonReadableChannelException
nonstatic member classes
 features of
 restrictions on
 scope vs. inheritance
 syntax for
nonstatic members
NonWritableChannelException
normalize( ) (URI)
NoRouteToHostException
NoSuchAlgorithmException
NoSuchElementException 2nd
NoSuchFieldError
NoSuchFieldException
NoSuchMethodError
NoSuchMethodException
NoSuchPaddingException
NoSuchProviderException
not equals operator (!=)
not equals operator (!=}
NOT operator

! (boolean NOT) 2nd
~ (bitwise NOT)
not-a-number [See NaN]
NotActiveException
Notation interface (DOM)
Notepad
notify( ) (Object) 2nd 3rd 4th
notifyAll( ) (Object) 2nd
notifying event listeners of events
bound property changes
constrained property changes
NotSerializableException
NotYetBoundException
NotYetConnectedException
null values
case labels and
collections
default, reference fields
LinkedList
NullCipher class
NullPointerException 2nd
numberOfTrailingZeros( ) (Integer)
numbers
BigInteger and BigDecimal classes
comparing (Comparator class)
converting from and to strings
DateFormat class
DecimalFormat class
Enumeration class
formatting 2nd
mathematical functions
Number class 2nd
number type (operands)
NumberFormat class 2nd 3rd
NumberFormatException
parsing by StreamTokenizer
random
SimpleDateFormat class

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

OAEP padding (PKCS#1 standard) 2nd
OAEPParameterSpec class
Object class
 class hierarchy root 2nd
 important methods
  clone( ) 2nd
  compareTo( )
  equals( )
  hashCode)
  toString( )
 notify( )
 wait( ) 2nd
object creation operator [See new operator]
object identifier (OID)
object literals
object member access operator (.) 2nd
object persistence
 JavaBeans
 serialization
object serialization [See serialization]
object-oriented classes
 nested types
  local classes
object-oriented programming
 abstract classes and methods
 class definitions
 classes
 creating and initializing objects
  defining a constructor
  defining multiple constructors
  field defaults and initializers
  invoking one constructor from another 2nd
 data hiding and encapsulation
  access control
  data accessor methods
 definitions of terms
 destroying and finalizing objects
  finalizers
  garbage collection
  memory leaks
 fields and methods
  class fields
  class methods

field declarations
instance fields
instance methods
System.out.println( )
interfaces
abstract classes vs.
constants and
implementing
marker
Java vs. C/C++
modifiers, summary of
nested types
anonymous classes
how they work
nonstatic member classes
Object methods
subclasses and inheritance
constructor chaining and the default constructor
extending a class
hiding superclass fields
overriding superclass methods
subclass constructors
superclasses, Object and class hierarchy
Object... variable length argument list
ObjectInput interface
ObjectInputStream class 2nd
enableResolveObject( )
readStreamHeader( )
ObjectInputValidation class 2nd
ObjectOutput interface
ObjectOutputStream class 2nd 3rd
enableReplaceObject( )
ObjectOutputStream.PutField class
objects 2nd [See also object-oriented programming]
AccessibleObject class
arrays as
as operand type
classes vs.
collections of
converting to and from arrays
comparing
converting arrays to
converting to strings
copying
creating and initializing 2nd
defining a constructor
expression statements, using
instance initializers
invoking one constructor from another
multiple constructors
new operator, using
defined

exception
information about, obtaining with instanceof
instanceof operator, using with
InvalidObjectException 2nd
locking 2nd
manipulating by reference
NullPointerException
Object class
serializing/deserializing [See serialization]
SignedObject class
state of, in instance fields
strings as
type defined by class or interface
using
waiting threads, list of
ObjectStreamClass class
ObjectStreamConstants interface
ObjectStreamException
ObjectStreamField class
Observable class
Observer interface
octal numbers
Integer type conversions
Long type conversions
Short type conversions
of( )
EnumSet class
UnicodeBlock class
offer( ) (Queue)
offsetByCodePoints( )
Character class
String class
OID (object identifier)
oldjava interpreter
oldjavaw interpreter
on( )
DigestInputStream class
DigestOutputStream class
on-demand type imports
naming conflicts and shadowing
onMalformedInput( )
onUnmappableCharacter( )
OO [See object-oriented programming]
open( )
connected SocketChannel, creating
DatagramChannel class
Pipe class
unconnected SocketChannel, creating
openConnection( )
URL class 2nd 3rd
openStream( ) (URL)
operands

evaluation by Java interpreter
list of
number and type
operating systems
OperatingSystemMXBean interface
operators 2nd
arithmetic
assignment
associativity
bitwise and shift
boolean
characters used as
comparison
relational operators
conditional
expressions, order of evaluation
increment and decrement
instanceof
listed
new
operand number and type
overloading
precedence of
return types
side effects of
combination assignment operators
special (language constructs)
string concatenation
ternary
OptionalDataException
OR operator
| (bitwise OR) 2nd
| (boolean OR) 2nd
|= (bitwise OR assignment) operator
|| (conditional OR) 2nd
order of evaluation
order( ) (ByteBuffer)
ordinal( ) 2nd
enumerated types
ordinaryChar( ) (StreamTokenizer)
ordinaryChars( ) (StreamTokenizer)
org.ietf.jgss package
org.w3c.dom package 2nd
org.xml.sax package 2nd
org.xml.sax.ext package
org.xml.sax.helpers package
out of band data, receiving
OutOfMemoryError 2nd
output [See input/output]
OutputKeys class
OutputStream class 2nd
write( )

OutputStreamWriter class 2nd
OverlappingFileLockException
overlaps( ) (FileLock)
overloaded methods, references to
overloading
methods
defining multiple constructors for class
overriding vs.
operators
overridden methods
chaining
superclass of a containing class
overriding methods 2nd
abstract
dynamic method lookup
field hiding vs.
final and static method lookup
inherited methods
invoking overridden methods
Object class methods
overview page, javadoc documentation 2nd
overview doc comment, using

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

Pack200 class
pack200 tool
 advanced options
 basic options
Pack200.Packer interface
Pack200.Unpacker interfce
package access 2nd
 class member accessibility
package annotations
Package class
package declarations
package directive
packages 2nd 3rd
 access to
 assertions enabling or disabling
 associated with classes
 declaring
 defined
 doc comments for
 enabling assertions in all classes and its subpackages
 globally unique names
 importing types
  naming conflicts and shadowing
  static members
 key, listing of
 naming and capitalization conventions
 not documented in this book
 omitting names in javadoc documentation
 references to, in @see doc comment tag
 unnamed
 visibility
packets of data
 loopback
padding schemes (cryptography)
PalmOS
parameterized types 2nd
 arrays
 bounded wildcards in
 conversion to nonparameterized
 exceptions and
 generic types vs.
 hierarchy
 malformed, exception

  Map
ParameterizedType interface
parameters
  <xsl\:param> tags
  arguments, assigning to
  certification path
  listing for methods
  naming and capitalization conventions
  this (keyword), for instance methods
  type parameters
    annotation types and
    specifying for generic methods
    wildcards
  as variables
parameters, method
  annotations
parse( )
parseByte( )
parseDouble( )
ParseException
parseInt( ) (Integer) 2nd
parseLong( ) (Long)
parseNumbers( ) (StreamTokenizer)
parseObject( ) 2nd
ParsePosition class
Parser interface (SAX)
ParserAdapter class (SAX)
ParserFactory class (SAX)
parsers 2nd
  DocumentBuilder class
  DocumentBuilderFactory class
  DOM (Document Object Model) 2nd
  FactoryConfigurationError
  javax.xml.parsers package
  ParserConfigurationError
  SAX (Simple API for XML)
  SAXParser class
  SAXParserFactory
parseShort( )
pass by reference
pass by value
password-based encryption (PBE) 2nd
PasswordAuthentication class
PasswordCallback class
passwords [See also logins]
  -keypass password option, jarsigner
  access control for /etc/passwd 2nd
  authenticating, Authenticator class
  expired
  incorrect
  keystore, changing
  PasswordProtection (KeyStore)

path separators
pathnames, JAR archive
paths
 CertPath
Pattern class 2nd 3rd
 multiple matches with a regular expression
 regular expression syntax
PatternSyntaxException 2nd 3rd
PBE (password-based encryption)
PBEKey interface
PBEKeySpec class
PBEParameterSpec class
PBEWithMD5AndDES algorithm
peek( )
 Queue interface 2nd
 Stack class
percentages
performance
 dynamic vs. static method lookup
 Java VM
performance tuning options, Java interpreter
Perl 5 programming language
Perl regular expressions
 matches, Java vs.
permissions
 AllPermission class
 AuthPermission class
 BasicPermission class
 checking with SecurityManager
 defining in policy file
 DelegationPermission
 FilePermission class
 guidelines for, web site information
 how they work
 jstatd daemon
 LoggingPermission
 ManagementPermission class
 NetPermission class
 Permission class 2nd
  subclasses for access control
  subclasses, summary of
 PermissionCollection class 2nd
 Permissions class 2nd
 PrivateCredentialPermission
 PropertyPermission class
 ReflectPermission class
 restricted
 RuntimePermission class
 SecurityPermission class
 SerializablePermission class
 ServicePermission
 SocketPermission class

SSLPermission class
UnresolvedPermission class
URLClassLoader class
persistence, object
JavaBeans
serialization
serialPersistentFields
PhantomReference class
ping utility
Pipe class 2nd
Pipe.SinkChannel class
Pipe.SourceChannel class
PipedInputStream class 2nd 3rd
PipedOutputStream class 2nd 3rd
PipedReader class 2nd
PipedWriter class 2nd
PKCS #1 standard, OAEP padding 2nd
PKCS#5 (password-based encryption algorithm)
PKCS8EncodedKeySpec interface
PKIXBuilderParameters class
PKIXCertPathBuilderResult class
PKIXCertPathChecker class
PKIXCertPathValidatorResult class
PKIXParameters class
platforms
defined
directory separator characters
line separators, differences in
pleaseStop( ) (example method)
Point class (example), defining
pointers (C language)
Java references vs.
method
Policy class 2nd 3rd 4th
modifying permissions to untrusted code
PolicyNode class
PolicyQualifierInfo class
policytool program 2nd 3rd
defining permissions
poll( )
Queue interface 2nd
ReferenceQueue class
pop( )
portability
conventions and rules
Java interpreter
ports, access restrictions for applets
PortUnreachableException
position (buffers) 2nd
position( )
FileChannel class
FileLock class

positive zero 2nd
post-decrement operator 2nd
post-increment expression statements
post-increment operator 2nd
pre-decrement expression statements
pre-decrement operator 2nd
pre-increment operator 2nd
precedence, operator 2nd
 ! (boolean NOT) operator
 boolean vs. comparison operators
 conditional (?\:) operator
 order of evaluation and
 overriding with parentheses
precision (format specifier)
 illegal
precision in BigDecimal arithmetic
predefined classes
preferences
 AbstractPreferences
 BackingStoreException
 InvalidPreferencesFormatException
 java.util.prefs package 2nd 3rd
 NodeChangeEvent
 NodeChangeListener
 PreferenceChangeEvent class
 PreferenceChangeListener 2nd
 Preferences class 2nd
 PreferencesFactory interface
 user, Properties class and
premain( )
preprocessor (C language)
prev( ) (CharacterIterator)
previous( ) (ListIterator) 2nd
previousIndex( ) (ListIterator)
primary expressions
prime numbers
 large, randomly generated
 RSA private key
primitive data types 2nd [See also listings under individual type names]
 array elements, returning as
 arrays of, conversions
 boolean 2nd
 buffers for
 byte
 byte buffers viewed as other types
 char
  Character class
 conversions
  boxing and unboxing
  listing of type conversions
 differences between Java and C
 double

encountered when object data is expected
equality, testing for
fields
float
floating-point types
int
Integer class
integer types 2nd
long 2nd
Long class
operand
reading in binary format with DataInput
reading in binary format with DataInputStream 2nd
reference types vs
short
Short class
textual representation of
wrapper classes 2nd
writing in binary format with DataOutput
writing in binary format with DataOutputStream 2nd
Principal interface 2nd
principals
KerberosPrincipal
X.500 2nd
print( )
PrintStream class
PrintWriter class
printf( ) 2nd 3rd
Formatter class 2nd
formatting numbers
formatting text
MissingFormatArgumentException
printList( )
println( )
PrintStream class
PrintStream or PrintWriter
PrintWriter class
PrintStream class
format( )
implementing Appendable interface
Java 5.0 enhancements
printf( )
println( )
PrintWriter class 2nd
format( )
Java 5.0 enhancements
printf( )
println( )
priority levels for threads 2nd
maximum priority in a ThreadGroup
priority queue
PriorityBlockingQueue class 2nd

PriorityQueue class 2nd 3rd
private keys
  -keypass password option, jarsigner
  EncryptedPrivateKeyInfo class
private modifier 2nd
  anonymous classes and
  class member visibility
  class members 2nd
  constructors
  fields
  local classes and
  member class, applying to
  methods
    abstract modifier and
    inheritance and
  static member types and
private-key encryption 2nd 3rd
  Diffie-Hellman private key
  DSA private key
  RSA private key
PrivateCredentialPermission class
PrivateKey interface
  DSA, casting to
  RSAPrivateCrtKey, casting to
PrivateKeyEntry class (KeyStore)
PrivilegedAction interface
PrivilegedActionException
PrivilegedExceptionAction
probablePrime( ) (BigInteger)
Process class 2nd 3rd
ProcessBuilder class 2nd 3rd
processes
  graphical interface to monitoring tools (jconsole)
  information about (jinfo)
  jdb connections to
  listing running Java processes
  local, providing information about (jstatd tool)
  spawning and executing on native system
  stack traces (jstack tool)
ProcessingInstruction interface (DOM)
profiling
  Java interpreter options
  printing output to standard output
programmers
  application, security for
  benefits of using Java
  system, security for
programming languages
  C and C++ [See C and C++]
  lexically scoped
  Perl, regular expressions in
  strongly typed

programs, Java
classes as fundamental unit
compiling
complete, portability of
defining and running
dynamic, extensible
lexical structure
case sensitivity and whitespace
comments
identifiers
literals
punctuation
Unicode
main( ) method
overview
running
propagating exceptions
properties
JavaBean
bound properties
constrained properties
conventions for
indexed properties
specialized subtypes
Properties class 2nd 3rd
invalid properties exception
PropertyPermission class
PropertyResourceBundle class
system, listed
XML transformation output
PropertyChangeEvent class
PropertyChangeListener interface
adding/removing listeners
PropertyChangeSupport class
propertyNames( )
PropertyVetoException class 2nd
protected modifier 2nd
anonymous classes and
class members 2nd 3rd
fields
finalizer methods
local classes and
member class, applying to
methods
Object.clone( )
ProtectionDomain class 2nd
ProtectionParameter (KeyStore)
protocol, serialization
ProtocolException
Provider class
provider( ) (SelectorProvider)
Provider.Service class

ProviderException class
Proxy class 2nd 3rd 4th
Proxy.Type class
ProxySelector class
pseudo-random numbers 2nd 3rd 4th
  Cipher class
  generating with Math class
  SecureRandom class
  SecureRandomSpi
PSource class
PSource.PSpecified class
PSSParameterSpec class
public modifier 2nd
  anonymous classes and
  in class definitions
  class fields
  class members 2nd 3rd
  classes
    in Java files
  constructors
  fields
  finalizer methods
  local classes and
  member class, applying to
  methods
    interface
    JavaBeans
public-key encryption 2nd [See also cryptography]
  Diffie-Hellman public key
  DSA public key
  RSA public key
PublicKey interface
  RSA, setting to
  RSAPublicKey, casting to
punctuation characters
  escaping
  identifier names and
  representing operators
  as tokens
push( )
PushbackInputStream class
PushbackReader class
put( )
  AbstractMap class
  Buffer class
  ByteBuffer class
  HashMap class
  Hashtable class
  Map interface 2nd
  Properties class
  Queue interface 2nd
  TreeMap class

putAll( ) (Map) 2nd
PutField class
putFields( )
putIfAbsent( ) (ConcurrentMap)
putValue( ) (SSLSocket)

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

QName class
QuadraticSequence class
qualified names (QName class)
queues
 BlockingQueue interface
  example of use
  implementations
 ConcurrentLinkedQueue
 DelayQueue class
 FIFO and LIFO
 insertion and removal operations
 LinkedBlockingQueue
 PriorityBlockingQueue
 PriorityQueue class
 Queue and BlockingQueue interfaces
  BlockingQueue
 Queue interface 2nd 3rd
  Collection methods
 ReferenceQueue
 SynchronousQueue
quick reference material, generation of
quoteChar( ) (StreamTokenizer)

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

radians
radiansToDegrees( ) (Circle)
random access to file contents
Random class 2nd
random numbers [See also pseudo-random numbers]
  SecureRandom class
  SecureRandomSpi
RandomAccess interface 2nd 3rd
RandomAccessFile class 2nd 3rd 4th
raw types
  using wildcard (?) instead of, for generics
RC2ParameterSpec class
RC5ParameterSpec class
read( )
  DataInputStream class
  DigestInputStream class
  FileChannel class 2nd
  FileInputStream class
  FilterReader class
  InputStream class 2nd
  Manifest class
  PushbackInputStream class
  ReadableByteChannel 2nd
  Reader class
  SelectableChannel interface
  Socket class
  SocketChannel class
read, write, delete, and execute permissions
read-only buffers 2nd
read-only collections
read-only files
Readable interface 2nd 3rd 4th
ReadableByteChannel interface 2nd 3rd
Reader class 2nd 3rd
  charset encoder/decoder
readExternal( ) (Externalizable)
readFields( ) (ObjectInputStream)
readFully( ) (DataInputStream)
reading [See also input/output]
  byte and character streams
  file contents
readLine( )
  BufferedReader class

DataInputStream class (deprecated method) 2nd
LineNumberReader class
ReadLock class
readObject( ) 2nd
ObjectInputStream class 2nd 3rd
ObjectOutputStream class
ReadOnlyBufferException
readUnsignedByte( )
readUnsignedShort( )
ReadWriteLock interface
ready( ) (Reader)
readyOps( ) (SelectionKey)
receive( )
DatagramChannel class
DatagramSocket class 2nd
rectangular arrays 2nd
red-black tree 2nd
redefineClasses( ) (Instrumentation)
redirectErrorStream( ) (ProcessBuilder)
redirection of system in, out, and err streams
ReentrantLock interface
ReentrantReadWriteLock class
ReentrantReadWriteLock.ReadLock
ReentrantReadWriteLock.WriteLock
reference types
boxing and unboxing conversions
C language pointers vs.
comparing objects
conversions
copying objects
defined by Java
definitions, in Java programs
enumerated [See enumerated types]
equality, testing for
in operands
instance of operator, using with
interface [See interfaces]
memory allocation and garbage collection
naming and capitalization conventions
pass by value
primitive types vs.
references
cross references in doc comments
cross-references in doc comments
java.lang.ref package
null
PhantomReference class
Reference class
ReferenceQueue class
SoftReference class
to objects
object member access (.) operator

restoring with this pointer
unused, causing memory leaks
weak references
WeakReference class
referent
reflection
Reflection API 2nd [See also Class class]
@Inherited annotation type
annotation support
applets, security restrictions on
changes in Java 5.0
Class class
Java 5.0 methods
dynamic proxies
java.lang.reflect package 2nd
ReflectPermission class
refresh( )
Policy class
Refreshable interface
Refreshable interface
RefreshFailedException
regionMatches( ) (String)
register( ) (SelectableChannel) 2nd
registering event listeners 2nd
for constrained properties
methods, conventions for
unicast event
registerValidation( ) 2nd
regular expressions 2nd
java.util.regex package 2nd
Matcher class
matches, Java vs. Perl
MatchResult interface
multiple matches
Pattern class
regular expression syntax
PatternSyntaxException
search-and-replace operations
strings, using with
RejectedExecutionException
RejectedExecutionHandler interface
relational operators
relativize( ) (URI)
RELAX NG (XML schema)
release of Java, specified for source files
release( ) (Semaphore)
remove methods, deregistering event listeners
remove( )
AbstractList class
AbstractMap class
Collection interface 2nd
HashSet class

Hashtable class
Iterator interface 2nd
LinkedList class
List interface 2nd
ListIterator interface
Map interface 2nd 3rd
Queue interface
ReferenceQueue class
Set interface
TreeMap class
TreeSet class
removeAll( )
Collection class
List interface
Map interface
removeElementAt( ) (Vector)
removePropertyChangeListener( )
removeProvider( ) (Security)
removeValue( ) (SSLSocket)
removeVetoableChangeListener( )
renameTo( ) (File)
repetitive tasks, threads for
replace( )
String class
StringBuffer class
replaceAll( ) (String) 2nd
replaceFirst( ) (String) 2nd
requestPasswordAuthentication( ) (Authenticator) 2nd
reserved words 2nd [See also keywords]
reset( )
ByteArrayOutputStream class
CharArrayReader class
CharArrayWriter class
InputStream class
MessageDigest class
Reader class
SAXParser class
StringReader class
Transformer class
resetSyntax( ) (StreamTokenizer)
resolve( ) (URI)
ResourceBundle class
resources associated with a class
resources for further information
examples in this book
quick reference material, generating
related books
ResponseCache class
Result interface 2nd
results, computing
resume( ) (Thread)
retainAll( )

Collection interface 2nd
List interface
Map interface
retention (of an annotation)
RetentionPolicy class
return statements 2nd 3rd
switch statements, stopping
return types
covariant
method overriding and
return values
comparison and relational operators
methods, data types for
reverse( ) (Collections)
reverseOrder( ) (Collections)
rewind( ) (Buffer)
right shift operator (>>), signed 2nd
>>= (signed right shift assignment) operator
right shift operator (>>>), unsigned
>>>= (unsigned right shift assignment) operator
right-to-left associativity
root directories, listing
root directory of generated documentation
rotate( ) (Collections)
rotateLeft( ) (Integer)
rotateRight( ) (Integer)
rounding numbers
BigDecimal class and
floating-point values when converting to integers
functions for
RoundingMode class 2nd
RSA and DSA public and private keys
RSA PSS encoding (PKCS#1 standard)
RSA-PSS signature (PKCS#1 standard)
RSAKey interface
RSAKeyGenParameterSpec interface
RSAMultiPrimePrivateCrtKeySpec
RSAOtherPrimeInfo class
RSAPrivateCrtKey interface
RSAPrivateCrtKeySpec interface
RSAPrivateKey interface
RSAPrivateKeySpec class
RSAPublicKey interface 2nd
RSAPublicKeySpec interface
RuleBasedCollator class
run( ) 2nd
call( ) vs.
PrivilegedAction interface
PrivilegedExceptionAction
Runnable interface
Thread class 2nd
TimerTask class

runFinalization( ) (System)
Runnable interface 2nd 3rd 4th 5th 6th
  getDelegatedTask( )
  scheduling Runnable objects
RUNNABLE thread 2nd
running Java programs 2nd
Runtime class 2nd
  addShutdownHook( ) 2nd
  exec( ), portability conventions and rules
runtime environment, Java 2nd 3rd
RuntimeException 2nd
RuntimeMXBean interface
RuntimePermission class

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

sameFile( ) (URL)
sandbox
SAX (Simple API for XML) 2nd
 javax.xml.transform package
 javax.xml.transform.sax package
 org.xml.sax package
 org.xml.sax.ext package
 org.xml.sax.helpers package
 parsing XML
 representing XML documents as method call sequences
 validation, source documents
 ValidatorHandler and
SAXException
SAXNotRecognizedException
SAXNotSupportedException
SAXParseException
SAXParser class 2nd
SAXParserFactory class
SAXResult class
SAXSource class 2nd
SAXTransformerFactory class
Scanner class 2nd 3rd 4th
 InputMismatchException
ScatteringByteChannel interface 2nd
schedule( ) (Timer)
scheduleAtFixedRate( ) (Timer)
scheduledExecutionTime( ) (TimerTask)
ScheduledExecutorService 2nd
ScheduledFuture interface 2nd
ScheduledThreadPoolExecutor
scheduling tasks
schemas, XML
 Schema class
 SchemaFactory class
 SchemaFactoryLoader class
 specifying for parser
scientific notation
scope 2nd
 inheritance vs., for member classes
 local classes
 local variables, local classes and
sealed packages
SealedObject class 2nd

search-and-replace operations, using regular expressions
searching
 arrays 2nd
 collections elements
SecretKey interface 2nd
SecretKeyEntry (KeyStore)
SecretKeyFactory class
SecretKeyFactorySpi class
SecretKeySpec class
Secure Hash Algorithm (SHA)
SecureCacheResponse class
SecureClassLoader class
SecureRandom class 2nd 3rd
SecureRandomSpi class
security 2nd 3rd 4th
 access control 2nd
  applets, restrictions on
  file access
  fine-tuning trust levels, policies, and permissions
  sandbox
 for application programmers
 architecture
 authentication and authorization 2nd
 authentication and cryptography
 cryptography
 digital signatures
  SignedObject class
 digitally signed classes
 for end users
 Java VM
  access restrictions
  byte-code verification
 java.security package 2nd
 java.security.cert package
 java.security.interfaces package
 java.security.spec package
 message digests 2nd
 packets, sending/receiving
 permissions and policies [See permissions security policies]
 risks
 secure HTTP (https\: protocol)
 SecurityException
 SecurityManager [See SecurityManager class]
 for system programmers
 for system administrators
 system properties, granting access to
 URLClassLoader class
Security class
security policies
 default, defined by system administrators
 file permissions
 how they work

implementation by SecurityManager
jstatd permissions
NetPermission class
Policy class 2nd
policytool
ReflectPermission class
RuntimePermission names
system, user, and java.security.policy policy files
user-defined, augmenting or replacing system policy
SecurityManager class 2nd
default, automatically installing
delegation of access requests to AccessController
getting and setting system SecurityManager
installing
restrictions on applets
use by FileInputStream class
SecurityPermission class
seek( ) (RandomAccessFile)
select( )
ProxySelector class
Selector class 2nd 3rd
SelectableChannel interface
selectedKeys( ) (Selector)
SelectionKey class
Selector class 2nd
IllegalSelectorException
selector classes
AbstractSelectionKey class
AbstractSelector class
SelectorProvider class
self-reflection
self-signed certificate authority certificates
Semaphore class 2nd
semicolon [See ; under Symbols]
send( )
DatagramChannel class
DatagramSocket class 2nd
sendUrgentData( ) (Socket)
separator characters
constants defined by File class
directory
line separators on different platforms
separators (tokens)
SequenceInputStream class
Serializable interface 2nd
arrays
implemented by collections and maps
SerializablePermission class
serialization 2nd [See also Serializable interface]
@serial doc comment tag
deserialization methods, ObjectInput interface
deserialization methods, ObjectInputStream

enumerated types
Externalizable interface, using
JavaBeans components
NotSerializableException
ObjectInputStream class
ObjectInputStream.GetField class
ObjectInputValidation class
ObjectOutput interface
ObjectOutputStream class 2nd
ObjectOutputStream.PutField class
ObjectStreamClass class
ObjectStreamConstants interface
ObjectStreamException
ObjectStreamField class
OptionalDataException
SealedObject class 2nd
SerializablePermission class
SignedObject class 2nd
StreamCorruptedException
warnings about inadequate documentation
writing data in addition to default
serialPersistentFields field 2nd 3rd
serialver program
serialVersionUID field
server sockets, factory classes for
server version of VM (Sun HotSpot)
server-side networking
servers
blocking I/O and
communicating directly with, using sockets
NonBlockingServer class (example)
ServerSocket class 2nd 3rd
ServerSocketChannel class
ServerSocketFactory class
Service class (Provider)
service provider interface
algorithm-parameter generation
AlgorithmParameters
CertificateFactory class
CertificateFactorySpi
CertPathBuilderSpi
CertPathValidatorSpi
CertStoreSpi
channel and selector implementations
channels and selectors
charset implementations
charsets
CipherSpi class
ExemptionMechanismSPI
for JAAS
javax.crypto package
KeyAgreementSpi class

KeyFactorySpi
KeyGeneratorSpi class
KeyManagerFactorySpi
KeyPairGeneratorSpi
KeyStoreSpi
KeyStoreSpi class
LoginModule, for JAAS
MacSpi class
message-digest algorithms
SecretKeyFactorySpi class
secure random number generation
SignatureSpi
SSLContextSpi
TrustManagerFactorySpi
ServicePermission class
servlets
session IDs, SSL
Set interface 2nd
AbstractSet class
Collection interface methods
SortedSet interface
set prefix, data accessor methods
set( )
AbstractList class
ArrayList class
Calendar class
Field class
LinkedList class
List interface
List interface[
ListIterator interface 2nd
ThreadLocal class
setAccessible( ) (AccessibleObject) 2nd
setAllowUserInteraction( )
setAttribute( ) (TransformerFactory)
setBroadcast( )
setCalendar( ) (DateFormat)
setCertificateEntry( ) (KeyStore)
setCertPathCheckers( )
setCertStores( )
setCharAt( ) (StringBuffer)
setClassAssertionStatus( )
setConnectTimeout( )
setContentHandler( )
setContentHandlerFactory( ) (URLConnection)
setContextClassLoader( ) (Thread)
setDaemon( ) (Thread)
setDatagramSocketImplFactory( )
setDefault( )
Authenticator class 2nd
CookieHandler class
ProxySelector class

ResponseCache class
setDefaultAllowUserInteraction( )
setDefaultAssertionStatus( )
setDefaultUncaughtExceptionHandler( ) 2nd
setDefaultUseCaches( ) 2nd
setDoInput( ) (URLConnection)
setDoOutput( ) (URLConnection)
setDTDHandler( )
setElementAt( ) (Vector)
setEnabledProtocols( ) (SSLSocket)
setEndRule( ) (SimpleTimeZone)
setEntry( ) (KeyStore)
setErr( ) (System)
setErrorHandler( )
setErrorListener( )
Transformer class
TransformerFactory class
setFeature( )
SAXParserFactory class
SchemaFactory class
Validator class
XPathFactory class
setGroupingUsed( )
setHostnameVerifier( )
setIfModifiedSince( )
setIn( ) (System)
setInput( ) (Deflater)
setInterface( ) (MulticastSocket)
setKeepAlive( ) (Socket)
setKeyEntry( ) (KeyStore) 2nd
setLastModified( ) (File)
setLevel( ) (ZipOutputStream) 2nd
setLineNumber( ) (LineNumberReader)
setLocale( ) (MessageFormat)
setLoopbackMode( ) (MulticastSocket)
setMaxCRLNumber( )
setMaximumFractionDigits( ) (NumberFormat)
setMaxPathLength( )
setMaxPriority( ) (ThreadGroup)
setMethod( )
ZipOutputStream class
setMinCRLNumber( )
setName( )
NameCallback class
Thread class
setNeedClientAuth( ) 2nd
setNetworkInterface( ) (MulticastSocket)
setNode( ) (DOMResult)
setOOBInline( ) (Socket)
setOption( ) (SocketOptions)
setOut( ) (System)
setOutputProperties( ) (Transformer)

setOutputProperty( ) (Transformer)
setPackageAssertionStatus( )
setParameter( ) (Transformer)
setPassword( )
setPolicy( ) (Policy) 2nd
setPriority( ) (Thread)
setProperties( )
 System class
 TransformerHandler interface
setProperty( )
 Properties class
 SAXParser class
 SchemaFactory class
 System class
 System interface
 TransformerHandler interface
 Validator class
setReadOnly( ) (File)
setReadTimeout( )
setReceiveBufferSize( )
 ServerSocket class
 Socket class
setRequestMethod( )
setResourceResolver( )
 Validator class
setReuseAddress( )
 ServerSocket class
 Socket class
sets
 defined
 enumerated values
 hashtable-based 2nd
 immutable Set objects
 Set interface
  implementations, listed
setSchema( )
setSecurityManager( ) (System)
setSeed( ) (SecureRandom)
setSendBufferSize( )
 DatagramSocket class
 Socket class
setSessionCacheSize( )
setSessionTimeout( )
setSoLinger( ) (Socket)
setSoTimeout( )
 DatagramSocket class
 ServerSocket class
 Socket class
setStartRule( ) (SimpleTimeZone)
setStrength( ) (Collator)
setTcpNoDelay( ) (Socket)
setText( ) (BreakIterator)

setThreadCPUTimeEnabled( )
setTime( )
  Calendar class
  Date class
setTimeToLive( )
setTimeZone( ) (DateFormat)
setTrafficClass( )
setTrafficClass( ) (Socket)
setTrustAnchors( )
setUncaughtExceptionHandler( ) 2nd
setURIResolver( )
  Transformer class 2nd
  TransformerFactory class
setUsageThreshold( )
setUseCaches( )
setValue( ) (Entry)
setVerbose( ) (CompilationMXBean)
setWantClientAuth( ) 2nd
setXIncludeAware( )
setXPathFunctionResolver( )
setXPathVariableResolver( )
severe( ) (Logger)
severity levels, log messages
SHA (Secure Hash Algorithm)
shadowing superclass fields
shallow copy
shared file locks
shared locks
shift operators
  << (left shift)
  >> (signed right shift) operator
  combining with assignment (=) operator
  listed
  return type
short type 2nd
  comparing to float type with == operator
  conversion to other primitive types
  Short class 2nd 3rd 4th
  unsigned values
ShortBuffer class
ShortBufferException
shuffle( ) (Collections)
shutdownInput( ) (Socket)
shutdownOutput( ) (Socket)
side effects
  expression
    in assertion expressions
    in expression statements
  of operators
  order of evaluation and
sign( ) (Signature)
signalAll( ) (Condition)

Signature class 2nd
signature, class definition
 GenericSignatureFormatError
SignatureException
signatures, digital [See digital signatures]
signatures, method
 generic, reflection on
 implicit this parameter
 varargs, converting
SignatureSpi class
signed numbers
signed right shift operator (>>) 2nd
SignedObject class 2nd 3rd
Signer class
signum( )
 Integer class
 Math class
simple class names
SimpleDateFormat class
SimpleFormatter class
SimpleTimeZone class
single-line comments
singleton( ) (Collections) 2nd
singletonList( ) (Collections) 2nd
singletonMap( ) (Collections) 2nd
sinh( ) (Math)
sink( ) (Pipe)
SinkChannel class (Pipe)
size( )
 AbstractCollection class
 AbstractList class
 CharArrayWriter class
 DataOutputStream class
 FileChannel class
 FileLock class
 Map interface
 Vector class
skip( )
 InputStream class
 Reader class
 Scanner class
 ZipInputStream class
skipBytes( ) (DataInputStream)
slashSlashComments( ) (StreamTokenizer)
slashStarComments( ) (StreamTokenizer)
sleep( ) (Thread) 2nd 3rd
socket( )
 DatagramChannel class
 SocketChannel class
SocketAddress class 2nd
 UnresolvedAddressException
SocketChannel class 2nd

SocketHandler class
sockets
 BindException 2nd
 client-side networking with SocketChannel
 ConnectException
 DatagramSocket class
 DatagramSocketImpl class
 DatagramSocketImplFactory
 factory classes for creating
 handle to open socket
 InetSocketAddress
 MulticastSocket class
 networking classes
 nonblocking connections
 ProtocolException
 server-side networking (New I/O API)
 ServerSocket class 2nd
 ServerSocketChannel
 ServerSocketFactory class
 Socket class 2nd 3rd
 SocketChannel
 SocketChannel class
 SocketException
 SocketFactory class
 SocketImpl class
 SocketImplFactory interface
 SocketOptions interface
 SocketPermission class
 SocketTimeoutException
 SSL (Secure Sockets Layer)
 unable to connect to remote host
SoftReference class
Solaris operating system
 Java interpreter
 JDK, download site (Sun)
 thread type for Java interpreter and Classic VM
sort( )
 Arrays class 2nd 3rd
 Collections class 2nd
 static member imports and
SortedMap interface 2nd
 TreeMap implementation
SortedSet interface 2nd
 interesting methods
 TreeSet class
sorting collections elements
source code
 CodeSource class
 converting to ASCII
source files
 C language, for Java native methods
 for classes being debugged, setting for jdb 2nd

path, specifying for javac compiler
release of Java, specifying for
search path for (javadoc)
specifying for javadoc to process
Source interface 2nd
source keyword
source( ) (Pipe) 2nd
SourceChannel class (Pipe)
SourceLocator interface
spaces in doc comments
special effects, threads for
SPI [See service provider interface]
split( ) (String) 2nd
SSL (Secure Sockets Layer) 2nd 3rd
SSLContext class 2nd
SSLContextSpi class
SSLEngine class 2nd
SSLEngineResult class
SSLEngineResult.HandshakeStatus
SSLException
SSLHandshakeException
SSLKeyException
SSLPeerUnverifiedException
SSLPermission class
SSLServerSocket class
SSLServerSocketFactory
SSLSession class
SSLSessionBindingEvent
SSLSessionBindingListener
SSLSessionContext
SSLSocket class 2nd
SSLSocketFactory
Stack class 2nd
EmptyStackException
stack traces
displaying for current or specified threads
for exceptions
for threads
jstack tool
StackOverflowError
stacks
LIFO queues
LinkedList, using
StackTraceElement class
standard extensions
additional information about
portability conventions and rules
standard input 2nd
standard output 2nd
profiling output, printing to
start( )
ProcessBuilder

Thread class 2nd
startElement( ) (SAXParser)
startsWith( ) (String)
state
beans
instance fields
threads 2nd
writing complete object state to serialization stream
State class
statements 2nd 3rd
assert
break
compound 2nd
continue
defined by Java, summary of
do/while
empty
expression
flow-control
return statement
for
for/in
if/else
else if clause
nested
labeled
local variable declaration
return
switch
synchronized
throw
exception types
try/catch/finally
while
static (keyword)
static initializers
static member types 2nd
features of
implementation
importing
restrictions on
static members 2nd
class fields
generic types
import static declaration
methods
static modifier
abstract modifier and
anonymous classes and
class fields
class methods
fields

interface methods and
local classes and
member classes and
method lookup
methods
statistics, JVM (jstat tool)
Status class (SSLEngineResult)
stop( ) (Thread) 2nd
store( )
KeyStore class
Properties class
StreamCorruptedException
StreamHandler class
streams [See also byte streams; character streams; input/output]
byte stream classes in java.io
channels and
character stream classes
CipherInputStream class
CipherOutputStream class
class resources
close( ) method and Closeable interface
corrupted
encrypting/decrypting
FileOutputStream class
filtering
implementing Appendable interface
in, out, and err 2nd
InputStream class
javax.xml.transform.stream package
LineNumberInputStream class (deprecated)
output, flush( ) and Flushable interface
OutputStream class
PipedInputStream class
PipedOutputStream class
reading primitive data types in binary format
SequenceInputStream class
WriteAbortedException
writing Java primitive types in portable binary format
writing serialized objects to
XML documents
StreamTokenizer class
strictfp methods
strictfp modifier 2nd
StrictMath class 2nd
string concatenation operator (+)
string literals 2nd
strings
arrays of
basic operations on
CharSequence and CharBuffer interfaces
comparing
concatenating 2nd 3rd 4th

converting characters to
converting numbers to/from
converting other data types to
converting Short values to and from
converting to a double
converting to and from bytes
converting to and from integers 2nd
converting to long or Long
DOMStringList
equality comparisons
escape sequences in string literals
formatting
instanceof operator, using with
manipulation methods, implemented in machine code
pattern matching with regular expressions
streaming data, reading from/writing to
String class 2nd 3rd
compareTo( ) and equals( )
format( ) 2nd 3rd 4th
intern( )
matches( )
split( )
Unicode supplementary characters
StringBuffer class 2nd
methods for CharSequence objects
StringBufferInputStream class
StringBuilder class
StringCharacterIterator class
StringIndexOutOfBoundsException
StringReader class
StringWriter class 2nd
tokenizing
Scanner class
StreamTokenizer
StringTokenizer 2nd
Unicode, converting to/from bytes
StringTokenizer class
strongly typed languages
structs (C language)
stub files for C language Java native method implementation
subclasses
of abstract classes
implementing abstract methods
partial implementation
concrete
constructors
inheritance and
access control
constructor chaining and the default constructor
hiding superclass fields
overriding superclass methods
superclasses and Object class

Thread class
subinterfaces
Subject class 2nd
SubjectDomainCombiner class
subList( ) (List) 2nd
subMap( ) (SortedMap) 2nd
submit( ) (ExecutorService)
subSequence( )
CharSequence interface
StringBuffer class
Subset class
subSet( ) (SortedSet)
substring( )
StringBuffer class
subtract( ) (BigDecimal)
subtraction operator (-) 2nd
Sun Microsystems
HotSpot VM
Java packages controlled by
java, javax and sun, package names beginning with
JDK download site
SunJCE cryptographic provider
Diffie-Hellman key-agreement algorithm
key-generation implementations
message authentication algorithms
SecretKeyFactory implementations, supporting
SunJSSE provider
SunX509 algorithm
super keyword 2nd
overridden methods, invoking
super( ) 2nd
vs. super keyword
superclasses 2nd
containing class members, accessing
fields, hiding in subclasses
inheritance by subclasses of method implementations
methods, overriding
Object, class hierarchy and
superinterfaces
supplementary characters (Unicode) 2nd 3rd
Character class methods for
String methods for
surrogate pairs (Unicode characters) 2nd 3rd 4th
suspend( ) (Thread)
swap( ) (Collections)
switch statements
assertions in
case labels
data types in
enumerated types and
restrictions on
symmetric keys 2nd

generating
SyncFailedException
synchronized methods
AtomicInteger vs.
collections
synchronized modifier 2nd 3rd
synchronized statements
verifying lock with assert statement
synchronizedList( ) (Collections) 2nd
synchronizedSet( ) (Collections) 2nd
synchronizer utilities
AbstractQueuedSynchronizer
CountDownLatch
CyclicBarrier
synchronizing threads
deadlock, avoiding
IllegalMonitorStateException
Object class methods, using
SynchronousQueue class 2nd
system administrators, security for
System class 2nd 3rd
arraycopy( ) 2nd
currentTimeMillis( )
exit( )
getenv( ), portability and
identityHashCode( )
nanoTime( ) 2nd
system classes
javap tool, specifying search path for
path to search for (javah)
portable Java code and
system preferences [See preferences]
system programmers, security for
system properties
access by applets, restrictions on
java.security.manager
Properties class, using for
read/write access control
system security policy, replacing with user-defined
System.err
System.out
System.out.println( ) 2nd
systemNodeForPackage( ) (Preferences)

Team LiB

Index

tabs
 \t escape sequence in char literals
taglet classes, classpath for
tags
 doc comment
  custom
  inline, within HTML text
  listing of
 HTML, in doc comments
tailMap( ) (SortedMap) 2nd
tailSet( ) (SortedSet)
take( )
 BlockingQueue interface
tanh( ) (Math)
target (of an annotation) 2nd
targets for permissions 2nd
 NetPermission
 SSLPermission
tasks
 running and scheduling
 scheduling
Templates interface 2nd
TemplatesHandler interface (SAX)
temporary files
 creating
 deleting
TERMINATED thread 2nd
terminating lines with platform-specific separators
ternary operator (?\:) 2nd 3rd
testing
 assertions as tool for
 loop variables
 method argument values with assert statement
text
 appendability of text buffers and output streams
 breaks in
 Character class
 CharSequence interface
 encoding/decoding with charsets [See charsets]
 formatting with printf( ) and format( )
 internationalized 2nd
 logging API
 outputting to file

 pattern matching with regular expressions
 reading from a file with FileReader
 reading lines from a file 2nd
 reading with FileInputStream
 representations of primitive data types
 String class
 string comparison
 string concatenation
 StringBuffer class
 supplementary characters
 tokenizing
  StringTokenizer
 writing to a file 2nd
 writing with FileOutputStream
text editors
Text interface (DOM) 2nd
TextInputCallback class
TextOutputCallback class
this (keyword)
 accessing hidden field through
  vs. invoking overridden method with super
 explicit reference to containing instance of this object
 invoking one constructor from another
 local classes
this( )
 calling one constructor from another
 field initialization code and
Thread class 2nd 3rd
 holdsLock( )
 interrupt( )
 interrupted( )
 new features in Java 5.0
 sleep( )
 stop( ) (deprecated method)
 UncaughtExceptionHandler 2nd
thread groups in debugging
thread safety, collections
Thread.State class 2nd
Thread.UncaughtExceptionHandler
ThreadFactory interface
ThreadInfo class
ThreadMXBean interface
ThreadPoolExecutor class 2nd
 AbortPolicy
 CallerRunsPolicy
 DiscardOldestPolicy
 DiscardPolicy
threads
 atomic variables
 blocking queues
 coordinating
  synchronizer utilities

wait( ) and notify( )
waiting for another to finish
waiting on a Condition
creating, running, and manipulating
handling uncaught exceptions
lifecycle
priority levels
deadlocked
exclusion and locking
deadlock
locks package
IllegalThreadStateException
inheritance
InterruptedException
interrupting
monitoring usage in the JVM
piped communication between 2nd 3rd 4th
running and scheduling tasks
Executor interface
ExecutorService interface
ScheduledExecutorService
safety
selecting system threading type 2nd
sleeping
stack size, setting for interpreter
stack traces, displaying with jdb
suspending execution with jdb
synchronized methods
synchronizing
CountDownLatch
CyclicBarrier
IllegalMonitorStateException
Object class methods
verifying lock with assert
terminating
Thread class [See Thread class]
ThreadDeath error
ThreadGroup class
ThreadInfo class
ThreadLocal class
throw statements
declaring exceptions
exception types
switch statements, stopping
Throwable interface 2nd 3rd
getCause( )
getStackTrace( )
throwing exceptions
throws clause
ticket (Kerberos)
time [See dates and times]
time-to-live value, packets sent through multicast sockets

TIMED_WAITING thread 2nd
TimeoutException
timeouts
 setting for ServerSocket
 SSL sessions
 URLConnection
Timer class 2nd
TimerTask class 2nd
Timestamp class
TimeUnit class 2nd 3rd 4th
TimeZone class
 SimpleTimeZone class
toArray( ) (Collection) 2nd
toBinaryString( )
 Integer class
 Long class
toByteArray( )
toCharArray( )
 CharArrayWriter class
toChars( ) (Character)
toCodePoint( ) (Character)
toHexString( )
 Integer class
 Long class
tokenizing text
 Scanner class
 specified input stream
 StringTokenizer, using
tokens
 literals and variables
 punctuation characters used as
toLowerCase( )
 Character class
toOctalString( )
 Integer class
 Long class
tools
 apt (annotation processing) tool
 extcheck
 jar
 jarsigner
 java
 javac
 javadoc
 javah
 javap (class disassembler)
 jconsole
 jdb debugger
 jinfo
 jmap
 jps
 jsadebugd

jstack
jstat
jstatd daemon
keytool
native2ascii tool
pack200
policytool
serialver
unpack200
TooManyListenersException 2nd
toPattern( ) (ChoiceFormat)
toString( )
Annotation interface
Arrays class
Byte class
ByteArrayOutputStream class
ByteBuffer class
ByteOrder class
Character class
CharArrayWriter class
CharSequence interface
Collection interface
Date class 2nd
Enum class
enumerated types
Integer class
Long class
Map interface
MessageFormat class
Object class 2nd
Short class
StringBuffer class
StringWriter class
Subset class
totalMemory( )
toUpperCase( )
Character class 2nd
String class
toURI( ) (File)
toURL( ) (URI)
traceInstructions( )
traceMethodCalls( )
traffic class for a socket
transferFrom( ) (FileChannel) 2nd
transferTo( ) (FileChannel) 2nd
transform( )
ClassFileTransformer
Transformer class
transformations [See XML]
Transformer class 2nd
TransformerConfigurationException
TransformerException

TransformerFactory class 2nd
TransformerFactoryConfigurationError
TransformerHandler interface (SAX)
transient fields, object serialization and
transient modifier
 fields
tree representation of XML documents 2nd
TreeMap class 2nd
trees (red-black tree structure)
TreeSet class 2nd
trigonometric functions 2nd
trim( ) (String)
trimToSize( ) (ArrayList)
triple-DES key
truncate( ) (FileChannel)
trust anchor 2nd
 PKIXParameters
trust manager, X509 certificates
trust, fine-grained levels in Java 1.2
TrustAnchor class
TrustedCertificateEntry (KeyStore)
TrustManager interface
TrustManagerFactory class
TrustManagerFactorySpi
truth values [See boolean type]
try clause
try/catch/finally statements
tryLock( ) (FileChannel)
TSA (Timestamping Authority)
tutorial, Java programming
twos-complement format, representing negative numbers
type conversions
 ( ) (cast) operator 2nd
 array type widening conversions
 boxing and unboxing 2nd 3rd 4th
 buffers of bytes to buffers of characters
 byte to character 2nd 3rd
 character to byte
  OutputStreamWriter
  PrintWriter class
 collections to/from arrays
 converting types to strings
 Formatter class
 inheritance and
 int to string or Integer
 numbers to/from strings
 objects to byte streams
 primitive types
  listing of
 reference types
 Short values to and from other types
 strings to and from longs

strings to char values
Unicode strings to/from bytes
type inference
Type interface 2nd
type literals
type parameters
access to
annotation types and
generic method, specification of
generics, using without
wildcards, using
type safety
enumerated types
runtime
typesafe enum pattern
type variables
typedef keyword (C language)
TypeInfo interface (DOM)
TypeInfoProvider class
typesafe collections [See generic types]
TypeVariable interface

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

unary operators
  ! (boolean NOT) operator
  - (negation) operator
  operand number and type
  right-to-left associativity
  ~ (bitwise complement)
unbounded wildcards
unboxing conversions [See boxing and unboxing conversions]
uncaught exceptions in threads 2nd 3rd
UncaughtExceptionHandler
unchecked exceptions
unchecked warnings, raw types and
UndeclaredThrowableException 2nd
unicast events
  registering listener for
Unicode 2nd
  byte-to-character conversions 2nd
  char data type
  characters in Java names
  CharBuffer class
  converting strings to/from bytes
  currency symbols in identifiers
  escape sequences
  escaping in char literals
  IllegalFormatCodePointException
  native2ascii tool and
  subsets of
    UnicodeBlock class
  supplementary characters
    Character class methods for
    String methods for
  UTF-8 encoding 2nd 3rd 4th
    converting Latin-1 to
    malformed strings
    writing with DataOutputStream
  UTFDataFormatException
  Version 3.0 Bidirectional Algorithm
  versions
union type (C language)
Universal Time (UTC)
Universal Unique Identifier (UUID)
Unix
  classpath, specifying

    emacs text editor
    file and path separators
    Java interpreter
    pipes
    root directory
    threads for Java interpreter and Classic VM
UnknownError
UnknownFormatConversionException
UnknownFormatFlagsException
UnknownHostException
UnknownServiceException
UnmappableCharsetException
unmodifiable methods (Collection)
UnmodifiableClassException
unnamed packages
unordered collection with duplicate elements (bag)
unpack200 tool
Unpacker interface (Pack200)
unread( )
    PushbackInputStream class
    PushbackReader class
UnrecoverableEntryException
UnrecoverableKeyException
UnresolvedAddressException
UnresolvedAddressTypeException
UnresolvedPermission class
UnsatisfiedLinkError
unsigned right shift operator (>>>) 2nd
unsigned values
    reading and returning as int values
UnsupportedCallbackException
UnsupportedCharsetException
UnsupportedClassVersionError
UnsupportedEncodingException
UnsupportedOperationException 2nd 3rd 4th
until loops
untrusted code
    access control
        fine-grained levels in Java 1.2
        sandbox (Java 1.0)
    application programming, use in
    byte-code verification of class files
unwrap( ) (SSLEngine) 2nd
update( )
    Checksum interface
    Cipher class
    MessageDigest class 2nd
    Observable class
    Observer interface
    Signature class
upper-bounded wildcards
URIs (Uniform Resource Identifiers)

URI class
URIs (Universal Resource Identifiers)
URIResolver interface
URISyntaxException
XML namespaces
URLConnection class
caching retrieved network resources
URLs (Uniform Resource Locators)
https\:
HttpsURLConnection
HttpURLConnection class
JarURLConnection
javadoc-generated documents
keystore file
MalformedURLException
URL class 2nd 3rd
caching retrieved network resources
URLClassLoader class 2nd
permissions to loaded code
URLConnection class 2nd
URLDecoder class
URLEncoder class
URLStreamHandler class
US-ASCII charset
useProtocolVersion( ) (ObjectOutputStream)
user preferences [See preferences]
UserDataHandler interface (DOM)
username and password, encapsulating
userNodeForPackage( ) (Preferences)
users, security for
UTC (Universal Time)
UTF-8 [See Unicode]
UTFDataFormatException
utility classes
packages
UUID class

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

validate( )
 CertPathValidator
 CertPathValidator class 2nd
 Validator class 2nd
validateObject( )
 ObjectInputValidation class
validation, XML documents 2nd 3rd 4th
 javax.xml.validation package
 Schema class
 SchemaFactory class
 SchemaFactoryLoader class
 TypeInfoProvider class
 Validator class
 ValidatorHandler class
validOps( )
 DatagramChannel class
 Pipe.SourceChannel class
 SelectableChannel class
value( ) (Target)
value-specific class bodies (enumerated types)
valueBound( )
valueOf( )
 Byte class
 Double class
 Enum class
 enumerated types 2nd
 Integer class
 Long class
 QName class
 Short class
values
 annotation
 enumerated
values( )
 Map interface 2nd
valueUnbound( )
varargs [See variable-length argument lists]
variable-length argument lists 2nd 3rd
 Constructor class support for
 Method class
 Object... parameter
variables 2nd
 accessible to local classes

assigning values to
declaring
C compatibility syntax
Java vs. C language
placement of
fields vs.
final modifier
IllegalAccessError
incrementing as side effect of ++ operator
initializing, field declarations vs.
local
naming and capitalization
local scope, local classes and
loop
for/in loops
initializing, testing, and updating
scope of 2nd
storing objects in
thread-local
type
variable type for operands
XPath
vars keyword
Vector class 2nd 3rd
verify( )
Certificate class
HostnameVerifier class
Signature class
SignedObject class
X509Certificate class
X509CRL class
VerifyError class
verifying byte code for untrusted classes
verifying digital signatures
jarsigner tool
versions
class or classes, displaying for
Java 2nd [See also Java 5.0]
1.2, security advances in
cross-compilation
Java interpreter 2nd
package specification and implementation
specifying in @since doc comment tag
VetoableChangeListener class 2nd
VetoableChangeSupport class
virtual functions (C++)
virtual method invocation
VirtualMachineError
visibility
class members
local classes
members, working with

visibility modifiers [See also private modifier; protected modifier; public modifier]
 nonstatic member classes
 rules for using
Void class
void keyword 2nd 3rd
volatile fields 2nd
volatile modifier

Team LiB

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

W3C (World Wide Web Consortium)
  DOM (Document Object Model)
  DOM API [See DOM]
W3C XML Schema 2nd 3rd
wait( ) 2nd
  Object class 2nd 3rd 4th
waitFor( )
WAITING thread 2nd
wakeup( ) (Selector)
waking threads
warning( ) (Logger)
warnings
  options for javac compiler
  turning off with @SuppressWarnings 2nd
  unchecked, raw types and
weak references, package for
WeakHashMap class 2nd 3rd
WeakReference class
while loops 2nd
  continue statement used in
  continue statement, starting new iteration
whitespace
  for readability in programs
whitespaceChars( ) (StreamTokenizer)
widening conversions
  among reference types
  array type
  reference types
width (format specifier)
  illegal
wildcards
  bounded
    in generic methods
    in parameterized types
  file permissions
  in generic types 2nd
  NetPermission targets
  on-demand type imports
  type parameter
WildcardType interface
Windows platforms
  classpath, setting
  file and path separators

 file permission wildcards
 Java interpreter 2nd
 JDK, downloading from Sun Microsystems
 Notepad and WordPad text editors
 root directories
wordChars( ) (StreamTokenizer)
WordPad
wrap( )
 ByteBuffer class
 CharBuffer class
 DoubleBuffer class
 FloatBuffer class
 IntBuffer class
 ShortBuffer class
 SSLEngine class
 SSLEngine) class
wrapper methods (collection)
WritableByteChannel interface 2nd 3rd 4th
"Write once, run anywhere" 2nd
write permission
write( )
 CharArrayWriter class
 DataOutputStream class
 DigestOutputStream class
 FileChannel class 2nd
 FileOutputStream class
 FilterWriter class
 GatheringByteChannel
 GatheringByteChannel class
 Manifest class
 OutputStream class 2nd
 PrintWriter class
 PutField class
 SelectableChannel interface
 SocketChannel class
 StringWriter class
 WritableByteChannel 2nd 3rd
 Writer class
WriteAbortedException
writeExternal( ) (Externalizable) 2nd
WriteLock class
writeObject( ) 2nd
 ObjectOutputStream class 2nd
Writer class 2nd 3rd
 charset encoder/decoder
writeReplace( ) (Certificate)
writeTo( ) (CharArrayWriter)
writeUTF( )
writing byte and character streams [See input/output]

Team LiB

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

X.500 certificates, distinguished name
X.500 principals 2nd
X500Principal class
X500PrivateCredential class
X509Certificate class 2nd
X509CRL class 2nd
X509CRLEntry class 2nd
X509CRLSelector class
X509EncodedKeySpec interface
X509ExtendedKeyManager class
X509Extension interface
X509KeyManager class
X509KeyManager interface
X509TrustManager interface
XInclude markup
XML 2nd 3rd [See also DOM; SAX]
  data types
    DatatypeConfigurationException
    DatatypeConstants
    DatatypeConstants.Field
    DatatypeFactory
    Duration class
    XMLGregorianCalendar
  DTD (Document Type Definition)
  invalid properties exception
  namespaces
    NamespaceContext
    QName class
  packages 2nd
    new, in Java 5.0
  parsers
  parsing with DOM
  parsing with SAX
  preference names and values as XML file
  transformations 2nd 3rd 4th
    DOM
    SAX
    streams
  validation 2nd
  XMLConstants class
  XPath expressions 2nd
XMLDecoder class
XMLEncoder class

XMLFilter interface (SAX)
XMLFilterImpl class (SAX)
XMLFormatter class
XMLReader class
XMLReader interface (SAX)
XMLReaderAdapter class (SAX)
XMLReaderFactory class (SAX)
XOR operator
 ^ (bitwise XOR) 2nd
 ^ (boolean XOR) 2nd
 ^= (bitwise XOR assignment) 2nd
XPath 2nd 3rd
 javax.xml.xpath package
 Xpath class
 XPathConstants class
 XPathException
 XPathExpression class
 XPathExpressionException
 XPathFactory class
 XPathFactoryConfigurationException
 XPathFunction interface
 XPathFunctionException
 XPathFunctionResolver interface
 XPathVariableResolver interface
XSLT
 java.xml.transform package
 stylesheets
  applying to XML document
  obtaining for XML documents
  Templates
 transformation engine
 transforming XML documents

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

yield( ) (Thread) 2nd

Index

[SYMBOL] [A] [B] [C] [D] [E] [F] [G] [H] [I] [J] [K] [L] [M] [N] [O] [P] [Q] [R] [S] [T] [U] [V] [W] [X] [Y] [Z]

zero (0)
  division by
  negative and positive zero
  represented by float and double types
zero extension technique
ZIP files 2nd 3rd 4th
  JAR files vs.
  reading