# Complete Reference

Schildt's classic Java reference, updated and expanded for Java SE 6

# Java Seventh Edition

 Comprehensive guide to the entire Java language



- Includes coverage of applets, servlets, Swing,
   JavaBeans, the AWT, and collections
- Hundreds of examples and sample applications

# Herbert Schildt

Top-selling programming author with more than 3.5 million books sold worldwide



# Java<sup>™</sup>: The Complete Reference, Seventh Edition

### **About the Author**

Herbert Schildt is a leading authority on the Java, C, C++, and C# languages, and is a master Windows programmer. His programming books have sold more than 3.5 million copies worldwide and have been translated into all major foreign languages. He is the author of the best-selling The Art of Java, Java: A Beginner's Guide, and Swing: A Beginner's Guide. Among his other bestsellers are C++: The Complete Reference, C++: A Beginner's Guide, C#: The Complete Reference, and C#: A Beginner's Guide. Schildt holds both graduate and undergraduate degrees from the University of Illinois. He can be reached at his consulting office at (217) 586-4683. His Web site is www.HerbSchildt.com.

# Java<sup>™</sup>: The Complete Reference, Seventh Edition

Herbert Schildt



New York Chicago San Francisco Lisbon London Madrid Mexico City Milan New Delhi San Juan Seoul Singapore Sydney Toronto Copyright © 2007 by The McGraw-Hill Companies. All rights reserved. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

ISBN: 978-0-07-163177-8

MHID: 0-07-163177-1

The material in this eBook also appears in the print version of this title: ISBN: 978-0-07-226385-5.

MHID: 0-07-226385-7.

All trademarks are trademarks of their respective owners. Rather than put a trademark symbol after every occurrence of a trademarked name, we use names in an editorial fashion only, and to the benefit of the trademark owner, with no intention of infringement of the trademark. Where such designations appear in this book, they have been printed with initial caps.

McGraw-Hill eBooks are available at special quantity discounts to use as premiums and sales promotions, or for use in corporate training programs. To contact a representative please e-mail us at bulksales@mcgraw-hill.com.

Information has been obtained by McGraw-Hill from sources believed to be reliable. However, because of the possibility of human or mechanical error by our sources, McGraw-Hill, or others, McGraw-Hill does not guarantee the accuracy, adequacy, or completeness of any information and is not responsible for any errors or omissions or the results obtained from the use of such information.

### TERMS OF USE

This is a copyrighted work and The McGraw-Hill Companies, Inc. ("McGrawHill") and its licensors reserve all rights in and to the work. Use of this work is subject to these terms. Except as permitted under the Copyright Act of 1976 and the right to store and retrieve one copy of the work, you may not decompile, disassemble, reverse engineer, reproduce, modify, create derivative works based upon, transmit, distribute, disseminate, sell, publish or sublicense the work or any part of it without McGraw-Hill's prior consent. You may use the work for your own noncommercial and personal use; any other use of the work is strictly prohibited. Your right to use the work may be terminated if you fail to comply with these terms.

THE WORK IS PROVIDED "AS IS." McGRAW-HILL AND ITS LICENSORS MAKE NO GUARANTEES OR WARRANTIES AS TO THE ACCURACY, ADEQUACY OR COMPLETENESS OF OR RESULTS TO BE OBTAINED FROM USING THE WORK, INCLUDING ANY INFORMATION THAT CAN BE ACCESSED THROUGH THE WORK VIA HYPERLINK OR OTHERWISE, AND EXPRESSLY DISCLAIM ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. McGraw-Hill and its licensors do not warrant or guarantee that the functions contained in the work will meet your requirements or that its operation will be uninterrupted or error free. Neither McGraw-Hill nor its licensors shall be liable to you or anyone else for any inaccuracy, error or omission, regardless of cause, in the work or for any damages resulting therefrom. McGraw-Hill has no responsibility for the content of any information accessed through the work. Under no circumstances shall McGraw-Hill and/or its licensors be liable for any indirect, incidental, special, punitive, consequential or similar damages that result from the use of or inability to use the work, even if any of them has been advised of the possibility of such damages. This limitation of liability shall apply to any claim or cause whatsoever whether such claim or cause arises in contract, tort or otherwise.

# **Contents at a Glance**

Part I	The Java Language	
1	The History and Evolution of Java	3
2	An Overview of Java	15
3	Data Types, Variables, and Arrays	33
4	Operators	57
5	Control Statements	77
6	Introducing Classes	105
7	A Closer Look at Methods and Classes	125
8	Inheritance	157
9	Packages and Interfaces	183
10	Exception Handling	205
11	Multithreaded Programming	223
12	Enumerations, Autoboxing, and Annotations (Metadata)	255
13	I/O, Applets, and Other Topics	285
14	Generics	315
	Ocherics	010
Dort II	The love Library	
Part II	The Java Library	
Part II	· ·	359
	String Handling	359 385
15	String Handling	
15 16 17	String Handling	385 437
15 16 17 18	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes	385 437 503
15 16 17 18 19	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io	385 437 503 555
15 16 17 18 19 20	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking	385 437 503 555 599
15 16 17 18 19 20 21	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class	385 437 503 555 599 617
15 16 17 18 19 20 21 22	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class Event Handling	385 437 503 555 599 617 637
15 16 17 18 19 20 21 22 23	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class Event Handling Introducing the AWT: Working with Windows, Graphics, and Text	385 437 503 555 599 617 637 663
15 16 17 18 19 20 21 22 23 24	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class Event Handling Introducing the AWT: Working with Windows, Graphics, and Text Using AWT Controls, Layout Managers, and Menus	385 437 503 555 599 617 637 663 701
15 16 17 18 19 20 21 22 23 24 25	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class Event Handling Introducing the AWT: Working with Windows, Graphics, and Text Using AWT Controls, Layout Managers, and Menus Images	385 437 503 555 599 617 637 663 701 755
15 16 17 18 19 20 21 22 23 24	String Handling Exploring java.lang java.util Part 1: The Collections Framework java.util Part 2: More Utility Classes Input/Output: Exploring java.io Networking The Applet Class Event Handling Introducing the AWT: Working with Windows, Graphics, and Text Using AWT Controls, Layout Managers, and Menus	385 437 503 555 599 617 637 663 701

# vi Java: The Complete Reference

Part III	Software Development Using Java	
29 30	Java Beans Introducing Swing Exploring Swing Servlets	847 859 879 907
Part IV	Applying Java	
33	Financial Applets and Servlets	931 965 991
	Index	997

# **Contents**

	Preface	XX1X
Part I	The Java Language	
1	The History and Evolution of Java	3
	Java's Lineage	3
	The Birth of Modern Programming: C	4
	C++: The Next Step	5
	The Stage Is Set for Java	6
	The Creation of Java	6
	The C# Connection	8
	How Java Changed the Internet	8
	Java Applets	8
	Security	9
	Portability	9
	Java's Magic: The Bytecode	9
	Servlets: Java on the Server Side	10
	The Java Buzzwords	10
	Simple	11
	Object-Oriented	11
	Robust	11
	Multithreaded	12
	Architecture-Neutral	12
	Interpreted and High Performance	12
	Distributed	12
	Dynamic	13
	The Evolution of Java	13
	Java SE 6	14
	A Culture of Innovation	14
2	An Overview of Java	15
	Object-Oriented Programming	15
	Two Paradigms	15
	Abstraction	16
	The Three OOP Principles	16
	A First Simple Program	21
	Entering the Program	21
	Compiling the Program	22
	A Closer Look at the First Sample Program	22

	A Second Short Program	24
	Two Control Statements	26
	The if Statement	26
	The for Loop	27
	Using Blocks of Code	29
	Lexical Issues	30
	Whitespace	30
	Identifiers	30
	Literals	31
	Comments	31
	Separators	31
	The Java Keywords	31
	The Java Class Libraries	32
3	Data Types, Variables, and Arrays	33
	Java Is a Strongly Typed Language	33
	The Primitive Types	33
	Integers	34
	byte	35
	short	35
	int	35
	long	35
	Floating-Point Types	36
	float	36
	double	36
	Characters	37
	Booleans	38
	A Closer Look at Literals	39
	Integer Literals	39
	Floating-Point Literals	40
	Boolean Literals	40
	Character Literals	40
	String Literals	40
	Variables	41
	Declaring a Variable	41
	Dynamic Initialization	42
	The Scope and Lifetime of Variables	42
	Type Conversion and Casting	45
	Java's Automatic Conversions	45
	Casting Incompatible Types	45
	Automatic Type Promotion in Expressions	47
	The Type Promotion Rules	47
	Arrays	48
	One-Dimensional Arrays	48
	Multidimensional Arrays	51
	Alternative Array Declaration Syntax	55

	A Few Words About Strings	55 56
4	·	57
4	Operators	57 57
	Arithmetic Operators	
	The Basic Arithmetic Operators	58
	The Modulus Operator	59
	Arithmetic Compound Assignment Operators	59
	Increment and Decrement	60
	The Bitwise Operators	62
	The Bitwise Logical Operators	63
	The Left Shift	65
	The Right Shift	66
	The Unsigned Right Shift	68
	Bitwise Operator Compound Assignments	69
	Relational Operators	70
	Regional Operators	71
	Boolean Logical Operators	71
	Short-Circuit Logical Operators	
	The Assignment Operator	73
	The? Operator	73
	Operator Precedence	74
	Using Parentheses	74
5	Control Statements	77
J		77
	Java's Selection Statements	77 77
	if	
	switch	80
	Iteration Statements	84
	while	84
	do-while	86
	for	88
	The For-Each Version of the for Loop	92
	Nested Loops	97
	Jump Statements	98
	Using break	98
	Using continue	102
	return	103
	ictuiii	100
6	Introducing Classes	105
	Class Fundamentals	105
	The General Form of a Class	105
	A Simple Class	106
	Declaring Objects	100
	A Closer Look at new	109
	Assigning Object Reference Variables	111
	Introducing Methods	111
	Adding a Mothod to the Koy ( Tage	112

# X Java: The Complete Reference

	Returning a Value	114
	Adding a Method That Takes Parameters	115
	Constructors	117
	Parameterized Constructors	119
	The this Keyword	120
	Instance Variable Hiding	121
	Garbage Collection	121
	The finalize() Method	121
	A Stack Class	122
7	A Closer Look at Methods and Classes	125
•	Overloading Methods	125
	Overloading Constructors	128
	Using Objects as Parameters	130
	A Closer Look at Argument Passing	132
	Returning Objects	134
	Recursion	135
	Introducing Access Control	138
	Understanding static	141
	Introducing final	143
	Arrays Revisited	143
	Introducing Nested and Inner Classes	145
	Exploring the String Class	148
	Using Command-Line Arguments	150
	Varargs: Variable-Length Arguments	151
	Overloading Vararg Methods	154
	Varargs and Ambiguity	155
		155
8	Inheritance	157
	Inheritance Basics	157
	Member Access and Inheritance	159
	A More Practical Example	160
	A Superclass Variable Can Reference a Subclass Object	162
	Using super	163
	Using super to Call Superclass Constructors	163
	A Second Use for super	166
	Creating a Multilevel Hierarchy	167
	When Constructors Are Called	170
	Method Overriding	171
	Dynamic Method Dispatch	174
	Why Overridden Methods?	175
	Applying Method Overriding	176
	Using Abstract Classes	177
	Using final with Inheritance	180
	Using final to Prevent Overriding	180
	Using final to Prevent Inheritance	181
	The Object Class	181

9	Packages and Interfaces
	Packages
	Defining a Package
	Finding Packages and CLASSPATH
	A Short Package Example
	Access Protection
	An Access Example
	Importing Packages
	Interfaces
	Defining an Interface
	Implementing Interfaces
	Nested Interfaces
	Applying Interfaces
	Variables in Interfaces
	Interfaces Can Be Extended
	Interfaces can be Extended
10	Exception Handling
-	Exception-Handling Fundamentals
	Exception Types
	Uncaught Exceptions
	Using try and catch
	Displaying a Description of an Exception
	Multiple catch Clauses
	Nested try Statements
	throw
	throws
	finally
	Java's Built-in Exceptions
	Creating Your Own Exception Subclasses
	Chained Exceptions
	Using Exceptions
11	Multithreaded Programming
	The Java Thread Model
	Thread Priorities
	Synchronization
	Messaging
	The Thread Class and the Runnable Interface
	The Main Thread
	Creating a Thread
	Implementing Runnable
	Extending Thread
	Choosing an Approach
	Creating Multiple Threads
	Using isAlive() and join()
	Throad Priorities

	Synchronization	238
	Using Synchronized Methods	239
	The synchronized Statement	241
	Interthread Communication	242
	Deadlock	247
	Suspending, Resuming, and Stopping Threads	249
	Suspending, Resuming, and Stopping Threads	21)
	Using Java 1.1 and Earlier	249
	The Modern Way of Suspending, Resuming,	247
		251
	and Stopping Threads	251
	Using Multithreading	254
12	Enumerations, Autoboxing, and Annotations (Metadata)	255
	Enumerations	255
	Enumeration Fundamentals	255
	The values() and valueOf() Methods	258
	Java Enumerations Are Class Types	259
	Enumerations Inherit Enum	261
	Another Enumeration Example	263
	Type Wrappers	264
	Autoboxing	266
	Autoboxing and Methods	267
	Autoboxing/Unboxing Occurs in Expressions	268
	Autoboxing/Unboxing Boolean and Character Values	270
	Autoboxing/Unboxing Helps Prevent Errors	271
	A Word of Warning	271
	Annotations (Metadata)	272
	Annotation Basics	272
	Specifying a Retention Policy	273
	Obtaining Annotations at Run Time by Use of Reflection	273
	The AnnotatedElement Interface	278
	Using Default Values	279
	Marker Annotations	280
		281
	Single-Member Annotations	282
	Some Restrictions	284
13	I/O, Applets, and Other Topics	285
	I/O Basics	285
	Streams	286
	Byte Streams and Character Streams	286
	The Predefined Streams	288
	Reading Console Input	288
	Reading Characters	289
	Reading Strings	290

	Writing Console Output	292
		292
		<b>2</b> 93
	Applet Fundamentals	296
	The transient and volatile Modifiers	299
		300
		302
		302
	Problems with Native Methods	306
	Using assert	306
		309
		309
		312
14		315
		316
	1	316
	j ,	320
		320
	1 11	320
		322
		324
	J 1	324
	0	327
		329
		334
		336
		337
		339
		342
		342
		344
		345
	0	348
	O .	348
		349
	0	351
		353
		354
		354
		354
		355
	1	356
	Final Thoughts on Congrice	356

Part II	The Java Library	
15	String Handling	359
	The String Constructors	359
	String Length	362
	Special String Operations	362
	String Literals	362
	String Concatenation	362
	String Concatenation with Other Data Types	363
	String Conversion and toString()	364
	Character Extraction	365
	charAt( )	365
	getChars()	365
	getBytes()	366
	toCharArray()	366
	String Comparison	366
	equals() and equalsIgnoreCase()	366
	regionMatches()	367
	startsWith() and endsWith()	368
	equals() Versus ==	368
	compareTo()	369
	Searching Strings	370
	Modifying a String	372
	substring()	372
	concat()	373
	replace()	373
	trim()	373
	Data Conversion Using valueOf()	374
	Changing the Case of Characters Within a String	375
	Additional String Methods	376
	StringBuffer	377
	StringBuffer Constructors	377
	length() and capacity()	378
	ensureCapacity()	378
	setLength()	378
	charAt() and setCharAt()	379
	getChars()	379
	append()	380
	insert()	381
	reverse()	381
	delete() and deleteCharAt()	382
	replace()	382
	substring()	383
	Additional StringBuffer Methods	383
	StringBuilder	384
	Junizpunder	004

16	Exploring java.lang
	Primitive Type Wrappers
	Number
	Double and Float
	Byte, Short, Integer, and Long
	Character
	Recent Additions to Character for Unicode Code
	Point Support
	Boolean
	Void
	Process
	Runtime
	Memory Management
	Executing Other Programs
	ProcessBuilder
	System
	Using currentTimeMillis() to Time Program Execution
	Using arraycopy()
	Environment Properties
	Object
	Using clone() and the Cloneable Interface
	Class
	ClassLoader
	Math
	Transcendental Functions
	Exponential Functions
	Rounding Functions
	Miscellaneous Math Methods
	StrictMath
	Compiler
	Thread, ThreadGroup, and Runnable
	The Runnable Interface
	Thread
	ThreadGroup
	ThreadLocal and InheritableThreadLocal
	Package
	RuntimePermission
	Throwable
	SecurityManager
	StackTraceElement
	Enum
	The CharSequence Interface
	The Comparable Interface
	The Appendable Interface

	The Iterable Interface
	The Readable Interface
	The java.lang Subpackages
	java.lang.annotation
	java.lang.instrument
	java.lang.management
	java.lang.ref
	java.lang.reflect
17	java.util Part 1: The Collections Framework
	Collections Overview
	Recent Changes to Collections
	Generics Fundamentally Change the Collections
	Framework
	Autoboxing Facilitates the Use of Primitive Types
	The For-Each Style for Loop
	The Collection Interfaces
	The Collection Interface
	The List Interface
	The Set Interface
	The SortedSet Interface
	The NavigableSet Interface
	The Queue Interface
	The Deque Interface
	The Collection Classes
	The ArrayList Class
	The LinkedList Class
	The HashSet Class
	The LinkedHashSet Class
	The TreeSet Class
	The Priority Queue Class
	The Array Deque Class
	The EnumSet Class
	Accessing a Collection via an Iterator
	Using an Iterator
	The For-Each Alternative to Iterators
	Storing User-Defined Classes in Collections
	The RandomAccess Interface
	Working with Maps
	The Map Interfaces
	The NavigableMap Interface
	The Map Classes
	Comparators
	Using a Comparator
	The Collection Algorithms

	Arrays	480
	Why Generic Collections?	484
	The Legacy Classes and Interfaces	487
	The Enumeration Interface	487
	Vector	487
	Stack	491
	Dictionary	493
	Hashtable	494
	Properties	497
	Using store() and load()	500
	Parting Thoughts on Collections	501
	Tarting Thoughts on Conections	501
18	java.util Part 2: More Utility Classes	503
	String Tokenizer	503
	BitSet	505
	Date	507
	Calendar	509
	GregorianCalendar	512
	TimeZone	513
	SimpleTimeZone	514
	Locale	515
	Random	516
	Observable	518
	The Observer Interface	519
		519
	An Observer Example	522
	Timer and TimerTask	
	Currency	524
	Formatter	525
	The Formatter Constructors	526
	The Formatter Methods	526
	Formatting Basics	526
	Formatting Strings and Characters	529
	Formatting Numbers	529
	Formatting Time and Date	530
	The %n and %% Specifiers	532
	Specifying a Minimum Field Width	533
	Specifying Precision	534
	Using the Format Flags	535
	Justifying Output	535
	The Space, +, 0, and ( Flags	536
	The Comma Flag	537
	The # Flag	537
	The Uppercase Option	537
	Using an Argument Index	538
	The Java printf() Connection	530

# XVIII Java: The Complete Reference

	Scanner	540
	The Scanner Constructors	540
	Scanning Basics	541
	Some Scanner Examples	544
	Setting Delimiters	547
	Other Scanner Features	548
	The ResourceBundle, ListResourceBundle,	
	and PropertyResourceBundle Classes	549
	Miscellaneous Utility Classes and Interfaces	553
	The java.util Subpackages	554
	java.util.concurrent, java.util.concurrent.atomic, and	551
	java.util.concurrent.locks	554
	java.util.jar	554
		554
	java.util.logging	
	java.util.prefs	554
	java.util.regex	554
	java.util.spi	554
	java.util.zip	554
19	Input/Output: Exploring java.io	555
13	The Java I/O Classes and Interfaces	555
	File	556
		559
	Directories	560
	Using FilenameFilter	
	The listFiles() Alternative	561
	Creating Directories	561
	The Closeable and Flushable Interfaces	561
	The Stream Classes	562
	The Byte Streams	562
	InputStream	562
	OutputStream	562
	FileInputStream	564
	FileOutputStream	565
	ByteArrayInputStream	567
	ByteArrayOutputStream	568
	Filtered Byte Streams	569
	Buffered Byte Streams	569
	SequenceInputStream	573
	PrintStream	574
	DataOutputStream and DataInputStream	576
	RandomAccessFile	578
	The Character Streams	578
	Reader	579
	Writer	579
	FileReader	579
	FileWriter	579

	CharArrayReader	582
	CharArrayWriter	582
	BufferedReader	583
	BufferedWriter	585
	PushbackReader	585
	PrintWriter	586
	The Console Class	587
	Using Stream I/O	589
	Improving wc() Using a StreamTokenizer	590
	Serialization	592
	Serializable	593
	Externalizable	593
	ObjectOutput	593
	ObjectOutputStream	593
	ObjectInput	595
	ObjectInputStream	595
	A Serialization Example	595
	Stream Benefits	598
	oreant benefits	370
20	Networking	599
	Networking Basics	599
	The Networking Classes and Interfaces	600
	InetAddress	601
	Factory Methods	601
	Instance Methods	602
	Inet4Address and Inet6Address	603
	TCP/IP Client Sockets	603
	URL	605
	URLConnection	607
	HttpURLConnection	610
	The URI Class	612
	Cookies	612
	TCP/IP Server Sockets	612
	Datagrams	613
	DatagramSocket	613
	DatagramPacket	614
	A Datagram Example	615
	A Datagram Example	015
21	The Applet Class	617
	Two Types of Applets	617
	Applet Basics	617
	The Applet Class	618
	Applet Architecture	620
	An Applet Skeleton	621
	Applet Initialization and Termination	622
	Overriding undate()	623

	Simple Applet Display Methods	623
	Requesting Repainting	625
	A Simple Banner Applet	626
	Using the Status Window	628
	The HTML APPLET Tag	629
	Passing Parameters to Applets	630
	Improving the Banner Applet	631
	getDocumentBase() and getCodeBase()	633
	AppletContext and showDocument()	634
	The AudioClip Interface	635
	The AppletStub Interface	635
	Outputting to the Console	636
22	Event Handling	637
	Two Event Handling Mechanisms	637
	The Delegation Event Model	638
	Events	638
	Event Sources	638
	Event Listeners	639
	Event Classes	639
	The ActionEvent Class	640
	The AdjustmentEvent Class	641
	The ComponentEvent Class	642
	The ContainerEvent Class	642
	The FocusEvent Class	643
	The InputEvent Class	643
	The ItemEvent Class	644
	The KeyEvent Class	645
	The MouseEvent Class	646
	The MouseWheelEvent Class	647
	The TextEvent Class	648
	The WindowEvent Class	648
	Sources of Events	649
	Event Listener Interfaces	650
	The ActionListener Interface	650
	The AdjustmentListener Interface	651
	The ComponentListener Interface	651
	The ContainerListener Interface	651
	The FocusListener Interface	651
	The ItemListener Interface	651
	The KeyListener Interface	651
	The MouseListener Interface	652
	The MouseMotionListener Interface	652
	The MouseWheelListener Interface	652
	The TextListener Interface	652
	The Window Focus Listener Interface	652

	The WindowListener Interface	653
	Using the Delegation Event Model	653
	Handling Mouse Events	653
	Handling Keyboard Events	656
	Adapter Classes	659
	Inner Classes	660
	Anonymous Inner Classes	662
	Allonymous liner Classes	002
23	Introducing the AWT: Working with Windows, Graphics,	
	and Text	663
	AWT Classes	664
	Window Fundamentals	666
	Component	666
	Container	666
	Panel	667
	Window	667
	Frame	667
	Canvas	667
	Working with Frame Windows	667
	Setting the Window's Dimensions	668
	Hiding and Showing a Window	668
	Setting a Window's Title	668
	Closing a Frame Window	668
	Creating a Frame Window in an Applet	668
	Handling Events in a Frame Window	670
	Creating a Windowed Program	674
	Displaying Information Within a Window	676
	Working with Graphics	676
	Drawing Lines	677
	Drawing Rectangles	677
	Drawing Ellipses and Circles	678
	Drawing Arcs	679
	Drawing Polygons	680
	Sizing Graphics	681
	Working with Color	682
	Color Methods	683
	Setting the Current Graphics Color	684
	A Color Demonstration Applet	684
	Setting the Paint Mode	685
	Working with Fonts	686
	Determining the Available Fonts	687
	Creating and Selecting a Font	689
	Obtaining Font Information	690
	Managing Text Output Using FontMetrics	691
	Displaying Multiple Lines of Text	693

# XXII Java: The Complete Reference

	Centering Text	694
	Multiline Text Alignment	695
24	Using AWT Controls, Layout Managers, and Menus	701
	Control Fundamentals	701
	Adding and Removing Controls	702
	Responding to Controls	702
	The HeadlessException	702
	Labels	702
	Using Buttons	704
	Handling Buttons	704
	Applying Check Boxes	707
	Handling Check Boxes	707
	CheckboxGroup	709
	Choice Controls	711
	Handling Choice Lists	711
	Using Lists	713
	Handling Lists	714
	Managing Scroll Bars	716
	Handling Scroll Bars	717
	Using a TextField	719
	Handling a TextField	720
	Using a TextArea	721
	Understanding Layout Managers	723
	FlowLayout	724
	BorderLayout	725
	Using Insets	727
	GridLayout	728
	CardLayout	730
	GridBagLayout	732
	Menu Bars and Menus	737
	Dialog Boxes	742
	FileDialog	747
	Handling Events by Extending AWT Components	748
	Extending Button	749
	Extending Checkbox	750
	Extending a Check Box Group	751
	Extending Choice	752
	Extending List	752
	Extending Scrollbar	753
	Exterioring octorion	100
25	Images	755
	File Formats	755
	Image Fundamentals: Creating, Loading, and Displaying	756
	Creating an Image Object	756
	2-2	

	Loading an Image	756
	Displaying an Image	757
	ImageObserver	758
	Double Buffering	759
	MediaTracker	762
	ImageProducer	765
	MemoryImageSource	766
	ImageConsumer	767
	PixelGrabber	767
	ImageFilter	770
	CropImageFilter	770
	RGBImageFilter	772
	Cell Animation	783
	Additional Imaging Classes	786
26	The Concurrency Utilities	787
20	The Concurrent API Packages	788
	java.util.concurrent	788
	java.util.concurrent.atomic	789
	java.util.concurrent.locks	789
	,	789
	Using Synchronization Objects	789 789
	Semaphore	709 795
	CountDownLatch	793 796
	CyclicBarrier	790 799
	Exchanger	
	Using an Executor	801
	A Simple Executor Example	802
	Using Callable and Future	804
	The TimeUnit Enumeration	806
	The Concurrent Collections	808
	Locks	808
	Atomic Operations	811
	The Concurrency Utilities Versus Java's Traditional Approach	812
27	NIO, Regular Expressions, and Other Packages	813
	The Core Java API Packages	813
	NIO	815
	NIO Fundamentals	815
	Charsets and Selectors	818
	Using the NIO System	819
	Is NIO the Future of I/O Handling?	825
	Regular Expression Processing	825
	Pattern	825
	Matcher	826
	Regular Expression Syntax	827
	Demonstrating Pattern Matching	827

# XXIV Java: The Complete Reference

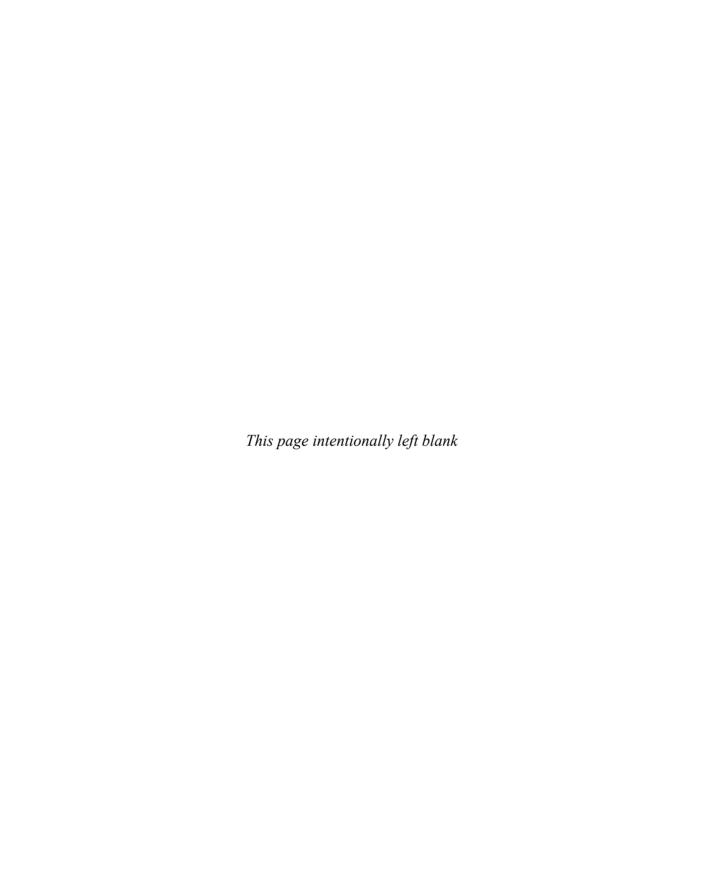
	Two Pattern-Matching Options	833
	Exploring Regular Expressions	833
	Reflection	833
	Remote Method Invocation (RMI)	837
	A Simple Client/Server Application Using RMI	837
	Text Formatting	840
	DateFormat Class	840
	SimpleDateFormat Class	842
	ompreduct office class	012
Part III	Software Development Using Java	
28	Java Beans	847
	What Is a Java Bean?	847
	Advantages of Java Beans	848
	Introspection	848
	Design Patterns for Properties	848
	Design Patterns for Events	849
	Design Patterns for Events	850
	Methods and Design Patterns	
	Using the BeanInfo Interface	850
	Bound and Constrained Properties	850
	Persistence	851
	Customizers	851
	The Java Beans API	851
	Introspector	853
	PropertyDescriptor	854
	EventSetDescriptor	854
	MethodDescriptor	854
	A Bean Example	854
	•	
29	Introducing Swing	859
	The Origins of Swing	859
	Swing Is Built on the AWT	860
	Two Key Swing Features	860
	Swing Components Are Lightweight	860
	Swing Supports a Pluggable Look and Feel	860
	The MVC Connection	861
	Components and Containers	862
	Components	862
	Containers	863
	The Top-Level Container Panes	863
	The Swing Packages	863
	A Simple Swing Application	864
		868
	Event Handling	871
	Create a Swing Applet	
	Painting in Swing	873

	Painting Fundamentals	874
	Compute the Paintable Area	875
	A Paint Example	875
30	Fundamina Craina	970
30	Exploring Swing	879
	JLabel and ImageIcon	879
	JTextField	881
	The Swing Buttons	883
	JButton	883
	JToggleButton	885
	Check Boxes	887
	Radio Buttons	889
	JTabbedPane	891
	JScrollPane	893
	JList	895
	JComboBox	898
	Trees	900
	JTable	904
	Continuing Your Exploration of Swing	906
31	Servlets	907
-	Background	907
	The Life Cycle of a Servlet	908
	Using Tomcat for Servlet Development	908
	A Simple Servlet	910
	Create and Compile the Servlet Source Code	910
	Start Tomcat	911
	Start tollicat  Start a Web Browser and Request the Servlet	911
	*	911
	The Servlet API	
	The javax.servlet Package	911
	The Servlet Interface	912
	The ServletConfig Interface	912
	The ServletContext Interface	912
	The ServletRequest Interface	913
	The ServletResponse Interface	913
	The GenericServlet Class	914
	The ServletInputStream Class	915
	The ServletOutputStream Class	915
	The Servlet Exception Classes	915
	Reading Servlet Parameters	915
	The javax.servlet.http Package	917
	The HttpServletRequest Interface	917
	The HttpServletResponse Interface	917
	The HttpSession Interface	917
	The HttpSessionBindingListener Interface	919
	The Cookie Class	010

# XXVI Java: The Complete Reference

	The HttpServlet Class	921
	The HttpSessionEvent Class	921
	The HttpSessionBindingEvent Class	922
	Handling HTTP Requests and Responses	922
	Handling HTTP GET Requests	922
	Handling HTTP POST Requests	924
	Using Cookies	925
	Session Tracking	927
Part IV	Applying Java	
32	Financial Applets and Servlets	931
	Finding the Payments for a Loan	932
	The RegPay Fields	935
	The init() Method	936
	The makeGUI() Method	936
	The actionPerformed() Method	938
	The compute() Method	939
	Finding the Future Value of an Investment	940
	Finding the Initial Investment Required to Achieve a Future Value	943
	Finding the Initial Investment Needed for a Desired Annuity	947
	Finding the Maximum Annuity for a Given Investment	951
	Finding the Remaining Balance on a Loan	955
	Creating Financial Servlets	959
	Converting the RegPay Applet into a Servlet	960
	The RegPayS Servlet	960
	Some Things to Try	963
	6	
33	Creating a Download Manager in Java	965
	Understanding Internet Downloads	966
	An Overview of the Download Manager	966
	The Download Class	967
	The Download Variables	971
	The Download Constructor	971
	The download() Method	971
	The run() Method	971
	The stateChanged() Method	975
	Action and Accessor Methods	975
	The ProgressRenderer Class	975
	The DownloadsTableModel Class	976
	The addDownload() Method	978
	The clearDownload() Method	979
	The getColumnClass() Method	979
32	The getValueAt() Method	979
	The update() Method	980

	The DownloadManager Class	98
	The DownloadManager Variables	98
	The DownloadManager Constructor	98
	The verifyUrl() Method	98
	The tableSelectionChanged() Method	98
	The updateButtons() Method	98
	Handling Action Events	98
	Compiling and Running the Download Manager	98
	Enhancing the Download Manager	99
Α	Using Java's Documentation Comments	99
	The javadoc Tags	99
	@author	99
	{@code}	99
	@deprecated	99
	{@docRoot}	99
	@exception	99
	{@inheritDoc}	99
	{@link}	99
	{@linkplain}	99
	{@literal}	99
	@param	99
	@return	99
	@see	99
	@serial	99
	@serialData	99
	@serialField	99
	@since	99
	@throws	99
	{@value}	99
	@version	99
	The General Form of a Documentation Comment	99
	What javadoc Outputs	99
	An Example that Uses Documentation Comments	99
		00
	Indox	0



# **Preface**

s I write this, Java is just beginning its second decade. Unlike many other computer languages whose influence begins to wane over the years, Java's has grown stronger with the passage of time. Java leapt to the forefront of Internet programming with its first release. Each subsequent version has solidified that position. Today, Java is still the first and best choice for developing web-based applications.

One reason for Java's success is its agility. Java has rapidly adapted to changes in the programming environment and to changes in the way that programmers program. Most importantly, it has not just followed the trends, it has helped create them. Unlike some other languages that have a revision cycle of approximately 10 years, Java's release cycle averages about 1.5 years! Java's ability to accommodate the fast rate of change in the computing world is a crucial part of why it has stayed at the forefront of computer language design. With the release of Java SE 6, Java's leadership remains unchallenged. If you are programming for the Internet, you have chosen the right language. Java has been and continues to be the preeminent language of the Internet.

As many readers will know, this is the seventh edition of the book, which was first published in 1996. This edition has been updated for Java SE 6. It has also been expanded in several key areas. Here are two examples: it now includes twice as much coverage of Swing and a more detailed discussion of resource bundles. Throughout are many other additions and improvements. In all, dozens of pages of new material have been incorporated.

# **A Book for All Programmers**

This book is for all programmers, whether you are a novice or an experienced pro. The beginner will find its carefully paced discussions and many examples especially helpful. Its in-depth coverage of Java's more advanced features and libraries will appeal to the pro. For both, it offers a lasting resource and handy reference.

### What's Inside

This book is a comprehensive guide to the Java language, describing its syntax, keywords, and fundamental programming principles. Significant portions of the Java API library are also examined. The book is divided into four parts, each focusing on a different aspect of the Java programming environment.