

Contents

Preface	xxxi	
Part I The Java Language		
Chapter 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 Impacted the Internet.....	8
	Java Applets.....	8
	Security	9
	Portability	9
	Java's Magic: The Bytecode	10
	Moving Beyond Applets.....	11
	A Faster Release Schedule	12
	Servlets: Java on the Server Side.....	12
	The Java Buzzwords	13
	Simple	13
	Object-Oriented.....	13
	Robust	13
	Multithreaded.....	14
	Architecture-Neutral	14
	Interpreted and High Performance	14
	Distributed	15
	Dynamic	15
	The Evolution of Java	15
	A Culture of Innovation.....	20
Chapter 2	An Overview of Java	21
	Object-Oriented Programming	21
	Two Paradigms.....	21
	Abstraction.....	22
	The Three OOP Principles.....	22

A First Simple Program	27
Entering the Program	27
Compiling the Program	27
A Closer Look at the First Sample Program	28
A Second Short Program.....	30
Two Control Statements	32
The if Statement.....	32
The for Loop	33
Using Blocks of Code	34
Lexical Issues	36
Whitespace	36
Identifiers	36
Literals	36
Comments.....	36
Separators	37
The Java Keywords.....	37
The Java Class Libraries	38
Chapter 3 Data Types, Variables, and Arrays.....	39
Java Is a Strongly Typed Language.....	39
The Primitive Types	39
Integers	40
byte.....	40
short.....	41
int	41
long.....	41
Floating-Point Types.....	42
float.....	42
double	42
Characters.....	43
Booleans	44
A Closer Look at Literals.....	45
Integer Literals	45
Floating-Point Literals	46
Boolean Literals	47
Character Literals	47
String Literals	47
Variables	48
Declaring a Variable	48
Dynamic Initialization	49
The Scope and Lifetime of Variables	49
Type Conversion and Casting.....	52
Java's Automatic Conversions	52
Casting Incompatible Types	52

Automatic Type Promotion in Expressions	54
The Type Promotion Rules.....	54
Arrays	55
One-Dimensional Arrays.....	55
Multidimensional Arrays	58
Alternative Array Declaration Syntax	62
Introducing Type Inference with Local Variables.....	62
Some var Restrictions.....	64
A Few Words About Strings	65
Chapter 4 Operators	67
Arithmetic Operators.....	67
The Basic Arithmetic Operators.....	68
The Modulus Operator.....	69
Arithmetic Compound Assignment Operators.....	69
Increment and Decrement.....	70
The Bitwise Operators	72
The Bitwise Logical Operators	73
The Left Shift	75
The Right Shift	77
The Unsigned Right Shift	78
Bitwise Operator Compound Assignments	79
Relational Operators.....	80
Boolean Logical Operators	81
Short-Circuit Logical Operators.....	83
The Assignment Operator.....	83
The ? Operator.....	84
Operator Precedence	85
Using Parentheses.....	85
Chapter 5 Control Statements.....	87
Java's Selection Statements	87
if	87
The Traditional switch	90
Iteration Statements	95
while.....	95
do-while.....	97
for	99
The For-Each Version of the for Loop	103
Local Variable Type Inference in a for Loop.....	108
Nested Loops	109
Jump Statements	109
Using break.....	109
Using continue.....	113
return.....	115

Chapter 6	Introducing Classes	117
	Class Fundamentals	117
	The General Form of a Class	117
	A Simple Class	118
	Declaring Objects	121
	A Closer Look at new	121
	Assigning Object Reference Variables.....	122
	Introducing Methods	123
	Adding a Method to the Box Class.....	124
	Returning a Value	126
	Adding a Method That Takes Parameters.....	127
	Constructors	129
	Parameterized Constructors	131
	The this Keyword	132
	Instance Variable Hiding	133
	Garbage Collection.....	133
	A Stack Class	134
Chapter 7	A Closer Look at Methods and Classes.....	137
	Overloading Methods.....	137
	Overloading Constructors	140
	Using Objects as Parameters.....	142
	A Closer Look at Argument Passing	144
	Returning Objects.....	146
	Recursion	147
	Introducing Access Control	149
	Understanding static.....	153
	Introducing final	154
	Arrays Revisited.....	155
	Introducing Nested and Inner Classes	157
	Exploring the String Class	160
	Using Command-Line Arguments.....	162
	Varargs: Variable-Length Arguments	163
	Overloading Vararg Methods	166
	Varargs and Ambiguity.....	167
	Local Variable Type Inference with Reference Types.....	168
Chapter 8	Inheritance	171
	Inheritance Basics	171
	Member Access and Inheritance	173
	A More Practical Example	174
	A Superclass Variable Can Reference a Subclass Object	176
	Using super.....	177
	Using super to Call Superclass Constructors	177
	A Second Use for super	180

Creating a Multilevel Hierarchy	181
When Constructors Are Executed.....	184
Method Overriding.....	185
Dynamic Method Dispatch.....	188
Why Overridden Methods?.....	189
Applying Method Overriding	190
Using Abstract Classes.....	191
Using final with Inheritance	194
Using final to Prevent Overriding.....	194
Using final to Prevent Inheritance	195
Local Variable Type Inference and Inheritance.....	195
The Object Class	197
Chapter 9 Packages and Interfaces.....	199
Packages	199
Defining a Package.....	200
Finding Packages and CLASSPATH.....	200
A Short Package Example.....	201
Packages and Member Access	202
An Access Example	203
Importing Packages.....	206
Interfaces	208
Defining an Interface.....	209
Implementing Interfaces	210
Nested Interfaces.....	212
Applying Interfaces	213
Variables in Interfaces.....	216
Interfaces Can Be Extended.....	218
Default Interface Methods.....	219
Default Method Fundamentals	220
A More Practical Example	222
Multiple Inheritance Issues	222
Use static Methods in an Interface.....	223
Private Interface Methods	224
Final Thoughts on Packages and Interfaces	225
Chapter 10 Exception Handling	227
Exception-Handling Fundamentals	227
Exception Types.....	228
Uncaught Exceptions	229
Using try and catch.....	230
Displaying a Description of an Exception.....	232
Multiple catch Clauses	232
Nested try Statements	234
throw	236
throws	237

finally.....	238
Java's Built-in Exceptions.....	240
Creating Your Own Exception Subclasses.....	241
Chained Exceptions.....	244
Three Additional Exception Features.....	245
Using Exceptions.....	246
Chapter 11 Multithreaded Programming.....	247
The Java Thread Model.....	248
Thread Priorities.....	249
Synchronization.....	249
Messaging.....	250
The Thread Class and the Runnable Interface.....	250
The Main Thread.....	251
Creating a Thread.....	252
Implementing Runnable.....	253
Extending Thread.....	255
Choosing an Approach.....	256
Creating Multiple Threads.....	256
Using isAlive() and join().....	258
Thread Priorities.....	260
Synchronization.....	261
Using Synchronized Methods.....	261
The synchronized Statement.....	263
Interthread Communication.....	265
Deadlock.....	270
Suspending, Resuming, and Stopping Threads.....	272
Obtaining a Thread's State.....	274
Using a Factory Method to Create and Start a Thread.....	275
Using Multithreading.....	276
Chapter 12 Enumerations, Autoboxing, and Annotations	277
Enumerations.....	277
Enumeration Fundamentals.....	278
The values() and valueOf() Methods.....	280
Java Enumerations Are Class Types.....	281
Enumerations Inherit Enum.....	283
Another Enumeration Example.....	285
Type Wrappers.....	286
Character.....	287
Boolean.....	287
The Numeric Type Wrappers.....	288
Autoboxing.....	289
Autoboxing and Methods.....	290
Autoboxing/Unboxing Occurs in Expressions.....	291
Autoboxing/Unboxing Boolean and Character Values.....	292

Autoboxing/Unboxing Helps Prevent Errors	293
A Word of Warning	294
Annotations	294
Annotation Basics	295
Specifying a Retention Policy	295
Obtaining Annotations at Run Time by Use of Reflection	296
The AnnotatedElement Interface	301
Using Default Values	302
Marker Annotations	303
Single-Member Annotations	304
The Built-In Annotations	305
Type Annotations	307
Repeating Annotations	312
Some Restrictions	314
Chapter 13 I/O, Try-with-Resources, and Other Topics	315
I/O Basics	315
Streams	316
Byte Streams and Character Streams	316
The Predefined Streams	318
Reading Console Input	319
Reading Characters	320
Reading Strings	321
Writing Console Output	322
The PrintWriter Class	323
Reading and Writing Files	324
Automatically Closing a File	330
The transient and volatile Modifiers	333
Introducing instanceof	334
strictfp	336
Native Methods	337
Using assert	337
Assertion Enabling and Disabling Options	339
Static Import	340
Invoking Overloaded Constructors Through this()	342
A Word About Value-Based Classes	345
Chapter 14 Generics	347
What Are Generics?	348
A Simple Generics Example	348
Generics Work Only with Reference Types	352
Generic Types Differ Based on Their Type Arguments	352
How Generics Improve Type Safety	352
A Generic Class with Two Type Parameters	355
The General Form of a Generic Class	356
Bounded Types	356

Using Wildcard Arguments.....	359
Bounded Wildcards.....	362
Creating a Generic Method.....	366
Generic Constructors	369
Generic Interfaces.....	370
Raw Types and Legacy Code.....	372
Generic Class Hierarchies	374
Using a Generic Superclass	375
A Generic Subclass	377
Run-Time Type Comparisons Within a Generic Hierarchy	378
Casting.....	380
Overriding Methods in a Generic Class	380
Type Inference with Generics.....	382
Local Variable Type Inference and Generics	383
Erasure	383
Bridge Methods	384
Ambiguity Errors.....	386
Some Generic Restrictions	387
Type Parameters Can't Be Instantiated	387
Restrictions on Static Members	387
Generic Array Restrictions	388
Generic Exception Restriction	389
Chapter 15 Lambda Expressions.....	391
Introducing Lambda Expressions.....	391
Lambda Expression Fundamentals.....	392
Functional Interfaces.....	393
Some Lambda Expression Examples	394
Block Lambda Expressions	397
Generic Functional Interfaces.....	399
Passing Lambda Expressions as Arguments.....	401
Lambda Expressions and Exceptions.....	404
Lambda Expressions and Variable Capture	405
Method References.....	406
Method References to static Methods	406
Method References to Instance Methods	407
Method References with Generics	411
Constructor References	414
Predefined Functional Interfaces	418
Chapter 16 Modules.....	421
Module Basics	421
A Simple Module Example.....	422
Compile and Run the First Module Example	426
A Closer Look at requires and exports	428

Chapter 19	java.base and the Platform Modules	429
	Legacy Code and the Unnamed Module.....	429
	Exporting to a Specific Module	430
	Using requires transitive	432
	Use Services	436
	Service and Service Provider Basics.....	436
	The Service-Based Keywords	437
	A Module-Based Service Example.....	437
	Module Graphs	444
	Three Specialized Module Features.....	445
	Open Modules	445
	The opens Statement.....	445
	requires static	446
	Introducing jlink and Module JAR Files	446
	Linking Files in an Exploded Directory.....	446
	Linking Modular JAR Files.....	447
	JMOD Files	447
	A Brief Word About Layers and Automatic Modules	448
	Final Thoughts on Modules.....	448
Chapter 17	Switch Expressions, Records, and Other Recently Added Features	449
	Enhancements to switch	450
	Use a List of case Constants.....	451
	Introducing the switch Expression and the yield Statement	452
	Introducing the Arrow in a case Statement	454
	A Closer Look at the Arrow case	456
	Another switch Expression Example	459
	Text Blocks	459
	Text Block Fundamentals.....	459
	Understanding Leading Whitespace	460
	Use Double Quotes in a Text Block	462
	Escape Sequences in Text Blocks	463
	Records	464
	Record Basics	464
	Create Record Constructors	466
	Another Record Constructor Example	470
	Create Record Getter Methods.....	472
	Pattern Matching with instanceof	473
	Pattern Variables in a Logical AND Expression.....	474
	Pattern Matching in Other Statements	475
	Sealed Classes and Interfaces	476
	Sealed Classes.....	477
	Sealed Interfaces	478
	Future Directions	480

Part II The Java Library

Chapter 18	String Handling	483
	The String Constructors	484
	String Length	486
	Special String Operations	486
	String Literals	486
	String Concatenation	487
	String Concatenation with Other Data Types	487
	String Conversion and <code>toString()</code>	488
	Character Extraction	489
	<code>charAt()</code>	489
	<code>getChars()</code>	489
	<code>getBytes()</code>	490
	<code>toCharArray()</code>	490
	String Comparison	490
	<code>equals()</code> and <code>equalsIgnoreCase()</code>	491
	<code>regionMatches()</code>	491
	<code>startsWith()</code> and <code>endsWith()</code>	492
	<code>equals()</code> Versus <code>==</code>	492
	<code>compareTo()</code>	493
	Searching Strings	494
	Modifying a String	496
	<code>substring()</code>	496
	<code>concat()</code>	497
	<code>replace()</code>	497
	<code>trim()</code> and <code>strip()</code>	498
	Data Conversion Using <code>valueOf()</code>	499
	Changing the Case of Characters Within a String	499
	Joining Strings	500
	Additional String Methods	501
	<code>StringBuffer</code>	502
	<code>StringBuffer</code> Constructors	503
	<code>length()</code> and <code>capacity()</code>	503
	<code>ensureCapacity()</code>	504
	<code>setLength()</code>	504
	<code>charAt()</code> and <code>setCharAt()</code>	504
	<code>getChars()</code>	505
	<code>append()</code>	505
	<code>insert()</code>	506
	<code>reverse()</code>	506
	<code>delete()</code> and <code>deleteCharAt()</code>	507
	<code>replace()</code>	507
	<code>substring()</code>	508
	Additional <code>StringBuffer</code> Methods	508
	<code>StringBuilder</code>	509

Chapter 19 Exploring <code>java.lang</code>	511
Primitive Type Wrappers	512
Number	512
Double and Float	512
Understanding <code>isInfinite()</code> and <code>isNaN()</code>	516
Byte, Short, Integer, and Long	517
Character	526
Additions to Character for Unicode Code Point Support	528
Boolean	529
Void	529
Process	529
Runtime	532
Executing Other Programs	534
Runtime.Version	535
ProcessBuilder	536
System	538
Using <code>currentTimeMillis()</code> to Time Program Execution	540
Using <code>arraycopy()</code>	541
Environment Properties	542
System.Logger and System.LoggerFinder	542
Object	542
Using <code>clone()</code> and the Cloneable Interface	542
Class	545
ClassLoader	548
Math	548
Trigonometric Functions	549
Exponential Functions	549
Rounding Functions	550
Miscellaneous Math Methods	551
StrictMath	553
Compiler	553
Thread, ThreadGroup, and Runnable	553
The Runnable Interface	553
Thread	553
ThreadGroup	556
ThreadLocal and InheritableThreadLocal	560
Package	560
Module	561
ModuleLayer	562
RuntimePermission	562
Throwable	562
SecurityManager	562
StackTraceElement	563
StackWalker and StackWalker.StackFrame	564
Enum	564
Record	565

Chapter 19	java.util	Part II	ClassValue	565
	The CharSequence Interface.....	565		
	The Comparable Interface.....	566		
	The Appendable Interface.....	566		
	The Iterable Interface.....	566		
	The Readable Interface.....	567		
	The AutoCloseable Interface.....	567		
	The Thread.UncaughtExceptionHandler Interface.....	567		
	The <code>java.lang</code> Subpackages.....	568		
	<code>java.lang.annotation</code>	568		
	<code>java.lang.constant</code>	568		
	<code>java.lang.instrument</code>	568		
	<code>java.lang.invoke</code>	568		
	<code>java.lang.management</code>	568		
	<code>java.lang.module</code>	569		
	<code>java.lang.ref</code>	569		
	<code>java.lang.reflect</code>	569		
Chapter 20	java.util Part 1: The Collections Framework	571		
	Collections Overview.....	572		
	The Collection Interfaces.....	573		
	The Collection Interface.....	574		
	The List Interface.....	577		
	The Set Interface.....	579		
	The SortedSet Interface.....	580		
	The NavigableSet Interface.....	581		
	The Queue Interface.....	582		
	The Deque Interface.....	583		
	The Collection Classes.....	584		
	The ArrayList Class.....	585		
	The LinkedList Class.....	589		
	The HashSet Class.....	590		
	The LinkedHashSet Class.....	591		
	The TreeSet Class.....	592		
	The PriorityQueue Class.....	593		
	The ArrayDeque Class.....	594		
	The EnumSet Class.....	595		
	Accessing a Collection via an Iterator.....	595		
	Using an Iterator.....	597		
	The For-Each Alternative to Iterators.....	599		
	Spliterators.....	600		
	Storing User-Defined Classes in Collections.....	602		
	The RandomAccess Interface.....	604		
	Working with Maps.....	604		
	The Map Interfaces.....	605		
	The Map Classes.....	612		

Comparators	616
Using a Comparator	619
The Collection Algorithms	625
Arrays	631
The Legacy Classes and Interfaces.....	636
The Enumeration Interface	636
Vector.....	637
Stack.....	641
Dictionary.....	643
Hashtable.....	644
Properties	647
Using store() and load()	650
Parting Thoughts on Collections	652
Chapter 21 java.util Part 2: More Utility Classes.....	653
StringTokenizer	653
BitSet.....	655
Optional, OptionalDouble, OptionalInt, and OptionalLong	658
Date	660
Calendar	662
GregorianCalendar	665
TimeZone	667
SimpleTimeZone.....	668
Locale	669
Random.....	670
Timer and TimerTask.....	672
Currency.....	675
Formatter	676
The Formatter Constructors	676
The Formatter Methods	677
Formatting Basics	677
Formatting Strings and Characters.....	679
Formatting Numbers.....	679
Formatting Time and Date.....	681
The %n and %% Specifiers	683
Specifying a Minimum Field Width.....	683
Specifying Precision	685
Using the Format Flags.....	686
Justifying Output	686
The Space, +, 0, and (Flags	687
The Comma Flag	688
The # Flag	688
The Uppercase Option	688
Using an Argument Index	689
Closing a Formatter.....	690
The Java printf() Connection	691

Scanner	691
The Scanner Constructors	691
Scanning Basics	691
Some Scanner Examples.....	695
Setting Delimiters	699
Other Scanner Features	700
The ResourceBundle, ListResourceBundle, and PropertyResourceBundle Classes.....	701
Miscellaneous Utility Classes and Interfaces.....	706
The java.util Subpackages	707
java.util.concurrent, java.util.concurrent.atomic, and java.util.concurrent.locks	707
java.util.function	707
java.util.jar.....	707
java.util.logging	710
java.util.prefs.....	710
java.util.random.....	711
java.util.regex	711
java.util.spi	711
java.util.stream.....	711
java.util.zip	711
Chapter 22 Input/Output: Exploring java.io.....	713
The I/O Classes and Interfaces	714
File	715
Directories.....	717
Using FilenameFilter	718
The listFiles() Alternative	719
Creating Directories	720
The AutoCloseable, Closeable, and Flushable Interfaces.....	720
I/O Exceptions.....	721
Two Ways to Close a Stream.....	721
The Stream Classes	722
The Byte Streams.....	723
InputStream	723
OutputStream.....	723
FileInputStream	723
FileOutputStream	727
ByteArrayInputStream	729
ByteArrayOutputStream	730
Filtered Byte Streams	732
Buffered Byte Streams.....	732
SequenceInputStream.....	736
PrintStream.....	737
DataOutputStream and DataInputStream	740
RandomAccessFile.....	742

The Character Streams.....	742
Reader	743
Writer.....	743
FileReader	744
FileWriter	745
CharArrayReader.....	746
CharArrayWriter.....	747
BufferedReader.....	748
BufferedWriter.....	750
PushbackReader.....	750
PrintWriter	751
The Console Class.....	752
Serialization	754
Serializable	755
Externalizable.....	755
ObjectOutput.....	755
ObjectOutputStream	756
ObjectInput.....	757
ObjectInputStream	757
A Serialization Example.....	759
Stream Benefits	762
Chapter 23 Exploring NIO	763
The NIO Classes	763
NIO Fundamentals	764
Buffers	764
Channels	767
Charsets and Selectors	768
Enhancements Added by NIO.2.....	768
The Path Interface	769
The Files Class	770
The Paths Class.....	772
The File Attribute Interfaces	773
The FileSystem, FileSystems, and FileStore Classes.....	775
Using the NIO System	775
Use NIO for Channel-Based I/O.....	776
Use NIO for Stream-Based I/O.....	785
Use NIO for Path and File System Operations.....	787
Chapter 24 Networking.....	795
Networking Basics.....	795
The java.net Networking Classes and Interfaces.....	796
InetAddress	797
Factory Methods	797
Instance Methods	798
Inet4Address and Inet6Address.....	799
TCP/IP Client Sockets	799

URL	802
URLConnection.....	804
HttpURLConnection	806
The URI Class.....	808
Cookies	808
TCP/IP Server Sockets.....	809
Datagrams.....	809
DatagramSocket.....	810
DatagramPacket.....	811
A Datagram Example	811
Introducing java.net.http	813
Three Key Elements.....	813
A Simple HTTP Client Example.....	816
Things to Explore in java.net.http.....	818
Chapter 25 Event Handling	819
Two Event Handling Mechanisms	819
The Delegation Event Model.....	820
Events.....	820
Event Sources.....	820
Event Listeners.....	821
Event Classes	821
The ActionEvent Class	822
The AdjustmentEvent Class.....	824
The ComponentEvent Class.....	824
The ContainerEvent Class	825
The FocusEvent Class	825
The InputEvent Class	826
The ItemEvent Class	827
The KeyEvent Class.....	828
The MouseEvent Class	829
The MouseWheelEvent Class	830
The TextEvent Class	831
The WindowEvent Class.....	831
Sources of Events.....	832
Event Listener Interfaces	833
The ActionListener Interface.....	833
The AdjustmentListener Interface	834
The ComponentListener Interface	834
The ContainerListener Interface.....	834
The FocusListener Interface.....	834
The ItemListener Interface.....	834
The KeyListener Interface	834
The MouseListener Interface.....	835

The MouseMotionListener Interface.....	835
The MouseWheelListener Interface.....	835
The TextListener Interface.....	835
The WindowFocusListener Interface.....	835
The WindowListener Interface	836
Using the Delegation Event Model.....	836
Some Key AWT GUI Concepts.....	836
Handling Mouse Events	837
Handling Keyboard Events.....	840
Adapter Classes	844
Inner Classes	846
Anonymous Inner Classes	848
Chapter 26 Introducing the AWT: Working with Windows, Graphics, and Text	851
AWT Classes	852
Window Fundamentals	854
Component.....	854
Container.....	855
Panel.....	855
Window.....	855
Frame.....	855
Canvas	855
Working with Frame Windows.....	855
Setting the Window's Dimensions	856
Hiding and Showing a Window.....	856
Setting a Window's Title.....	856
Closing a Frame Window.....	856
The paint() Method	857
Displaying a String.....	857
Setting the Foreground and Background Colors	857
Requesting Repainting	858
Creating a Frame-Based Application.....	859
Introducing Graphics	860
Drawing Lines.....	860
Drawing Rectangles.....	860
Drawing Ellipses and Circles	861
Drawing Arcs	861
Drawing Polygons	861
Demonstrating the Drawing Methods.....	862
Sizing Graphics	863
Working with Color	865
Color Methods.....	865
Setting the Current Graphics Color	866
A Color Demonstration Program.....	866

Setting the Paint Mode.....	868
Working with Fonts	869
Determining the Available Fonts	871
Creating and Selecting a Font	872
Obtaining Font Information	874
Managing Text Output Using FontMetrics	875
Chapter 27 Using AWT Controls, Layout Managers, and Menus.....	879
AWT Control Fundamentals.....	880
Adding and Removing Controls	880
Responding to Controls	880
The HeadlessException.....	881
Labels.....	881
Using Buttons.....	883
Handling Buttons.....	883
Applying Check Boxes	887
Handling Check Boxes	888
CheckboxGroup	889
Choice Controls.....	891
Handling Choice Lists.....	892
Using Lists	894
Handling Lists	895
Managing Scroll Bars	897
Handling Scroll Bars	898
Using a TextField.....	900
Handling a TextField	901
Using a TextArea	903
Understanding Layout Managers.....	904
FlowLayout	905
BorderLayout	906
Using Insets.....	908
GridLayout	910
CardLayout	911
GridBagLayout	914
Menu Bars and Menus	919
Dialog Boxes.....	924
A Word About Overriding paint().....	928
Chapter 28 Images	929
File Formats	929
Image Fundamentals: Creating, Loading, and Displaying	930
Creating an Image Object	930
Loading an Image.....	930
Displaying an Image	931
Double Buffering	932
ImageProducer.....	935
MemoryImageSource	935

Chapter 28	ImageConsumer	937
	PixelGrabber.....	937
	ImageFilter	940
	CropImageFilter.....	940
	RGBImageFilter	942
	Additional Imaging Classes.....	954
Chapter 29	The Concurrency Utilities	955
	The Concurrent API Packages	956
	java.util.concurrent	956
	java.util.concurrent.atomic	957
	java.util.concurrent.locks.....	957
	Using Synchronization Objects	958
	Semaphore	958
	CountDownLatch	963
	CyclicBarrier.....	965
	Exchanger	967
	Phaser.....	970
	Using an Executor.....	977
	A Simple Executor Example	978
	Using Callable and Future	979
	The TimeUnit Enumeration	982
	The Concurrent Collections	983
	Locks	984
	Atomic Operations	986
	Parallel Programming via the Fork/Join Framework	988
	The Main Fork/Join Classes.....	988
	The Divide-and-Conquer Strategy	992
	A Simple First Fork/Join Example.....	993
	Understanding the Impact of the Level of Parallelism	995
	An Example that Uses RecursiveTask<V>.....	998
	Executing a Task Asynchronously	1001
	Cancelling a Task	1001
	Determining a Task's Completion Status	1002
	Restarting a Task	1002
	Things to Explore.....	1002
	Some Fork/Join Tips	1004
	The Concurrency Utilities Versus Java's Traditional Approach	1004
Chapter 30	The Stream API	1005
	Stream Basics.....	1005
	Stream Interfaces.....	1006
	How to Obtain a Stream.....	1009
	A Simple Stream Example	1009
	Reduction Operations	1013
	Using Parallel Streams	1015
	Mapping	1018

Collecting	1022
Iterators and Streams	1026
Use an Iterator with a Stream	1026
Use Spliterator	1027
More to Explore in the Stream API	1030
Chapter 31 Regular Expressions and Other Packages	1031
Regular Expression Processing	1031
Pattern	1032
Matcher	1032
Regular Expression Syntax	1033
Demonstrating Pattern Matching	1033
Two Pattern-Matching Options	1039
Exploring Regular Expressions	1039
Reflection	1040
Remote Method Invocation (RMI)	1044
A Simple Client/Server Application Using RMI	1044
Formatting Date and Time with java.text	1047
DateFormat Class	1047
SimpleDateFormat Class	1049
The java.time Time and Date API	1051
Time and Date Fundamentals	1052
Formatting Date and Time	1053
Parsing Date and Time Strings	1056
Other Things to Explore in java.time	1057

Part III Introducing GUI Programming with Swing

Chapter 32 Introducing Swing	1061
The Origins of Swing	1061
Swing Is Built on the AWT	1062
Two Key Swing Features	1062
Swing Components Are Lightweight	1062
Swing Supports a Pluggable Look and Feel	1062
The MVC Connection	1063
Components and Containers	1064
Components	1064
Containers	1065
The Top-Level Container Panes	1065
The Swing Packages	1066
A Simple Swing Application	1066
Event Handling	1071
Painting in Swing	1074
Painting Fundamentals	1074
Compute the Paintable Area	1075
A Paint Example	1076

Chapter 33	Exploring Swing.....	1079
JLabel and ImageIcon.....	1079	
JTextField	1081	
The Swing Buttons	1083	
JButton.....	1083	
JToggleButton.....	1085	
Check Boxes	1088	
Radio Buttons.....	1089	
JTabbedPane.....	1092	
JScrollPane	1094	
JList	1096	
JComboBox	1099	
Trees	1101	
JTable.....	1105	
Chapter 34	Introducing Swing Menus	1109
Menu Basics	1109	
An Overview of JMenuBar, JMenu, and JMenuItem	1111	
JMenuBar	1111	
JMenu.....	1112	
JMenuItem	1113	
Create a Main Menu.....	1114	
Add Mnemonics and Accelerators to Menu Items	1118	
Add Images and Tooltips to Menu Items	1120	
Use JRadioButtonMenuItem and JCheckBoxMenuItem	1121	
Create a Popup Menu.....	1123	
Create a Toolbar	1127	
Use Actions	1129	
Put the Entire MenuDemo Program Together	1135	
Continuing Your Exploration of Swing	1141	

Part IV **Applying Java**

Chapter 35	Java Beans	1145
What Is a Java Bean?.....	1145	
Advantages of Beans.....	1146	
Introspection	1146	
Design Patterns for Properties	1146	
Design Patterns for Events.....	1148	
Methods and Design Patterns	1148	
Using the BeanInfo Interface.....	1148	
Bound and Constrained Properties	1149	
Persistence	1149	
Customizers	1149	

The JavaBeans API	1150
Introspector	1152
PropertyDescriptor	1152
EventSetDescriptor	1152
MethodDescriptor	1152
A Bean Example	1152
Chapter 36 Introducing Servlets.....	1157
Background	1157
The Life Cycle of a Servlet	1158
Servlet Development Options.....	1158
Using Tomcat.....	1159
A Simple Servlet	1160
Create and Compile the Servlet Source Code	1161
Start Tomcat.....	1161
Start a Web Browser and Request the Servlet	1161
The Servlet API	1162
The jakarta.servlet Package	1162
The Servlet Interface	1163
The ServletConfig Interface.....	1164
The ServletContext Interface.....	1164
The ServletRequest Interface.....	1164
The ServletResponse Interface	1164
The GenericServlet Class	1166
The ServletInputStream Class.....	1166
The ServletOutputStream Class	1166
The Servlet Exception Classes.....	1166
Reading Servlet Parameters.....	1166
The jakarta.servlet.http Package.....	1168
The HttpServletRequest Interface	1168
The HttpServletResponse Interface	1168
The HttpSession Interface	1169
The Cookie Class	1170
The HttpServlet Class	1171
Handling HTTP Requests and Responses	1173
Handling HTTP GET Requests.....	1173
Handling HTTP POST Requests	1175
Using Cookies	1176
Session Tracking	1178

Part V Appendixes

Appendix A Using Java's Documentation Comments.....	1183
The javadoc Tags	1183
@author	1184
{@code}	1185
@deprecated	1185

{@docRoot}.....	1185
{@exception}	1185
{@hidden}	1185
{@index}	1185
{@inheritDoc}.....	1186
{@link}	1186
{@linkplain}.....	1186
{@literal}	1186
{@param}	1186
{@provides}	1186
{@return}	1187
{@see}	1187
{@serial}	1187
{@serialData}.....	1187
{@serialField}.....	1188
{@since}	1188
{@summary}	1188
{@systemProperty}	1188
{@throws}.....	1188
{@uses}	1188
{@value}.....	1188
{@version}	1189
The General Form of a Documentation Comment.....	1189
What javadoc Outputs	1189
An Example that Uses Documentation Comments	1189
Appendix B Introducing JShell	1191
JShell Basics	1191
List, Edit, and Rerun Code.....	1194
Add a Method	1195
Create a Class.....	1196
Use an Interface.....	1196
Evaluate Expressions and Use Built-in Variables.....	1198
Importing Packages.....	1198
Exceptions.....	1199
Some More JShell Commands	1199
Exploring JShell Further.....	1200
Appendix C Compile and Run Simple Single-File Programs in One Step	1201
Index	1203