

Contents

Preface

Part I The Java Language

Chapter 1 The History and Evolution of Java

Java's Lineage

The Birth of Modern Programming: C

C++: The Next Step

The Stage Is Set for Java

The Creation of Java

The C# Connection

How Java Impacted the Internet

Java Applets

Security

Portability

Java's Magic: The Bytecode

Moving Beyond Applets

A Faster Release Schedule

Servlets: Java on the Server Side

The Java Buzzwords

Simple

Object-Oriented

Robust

Multithreaded

Architecture-Neutral

Interpreted and High Performance

Distributed

Dynamic

The Evolution of Java

A Culture of Innovation

Chapter 2 An Overview of Java

Object-Oriented Programming

Two Paradigms

Abstraction

The Three OOP Principles

A First Simple Program

Entering the Program

Compiling the Program

A Closer Look at the First Sample Program

A Second Short Program

Two Control Statements

The if Statement

The for Loop

Using Blocks of Code

Lexical Issues

Whitespace

Identifiers

Literals

Comments

Separators

The Java Keywords

The Java Class Libraries

Chapter 3 Data Types, Variables, and Arrays

Java Is a Strongly Typed Language

The Primitive Types

Integers

byte

short

int

long

Floating-Point Types

float

double

Characters

Booleans

A Closer Look at Literals

Integer Literals

Floating-Point Literals

Boolean Literals

Character Literals

String Literals

Variables

Declaring a Variable

Dynamic Initialization

The Scope and Lifetime of Variables

Type Conversion and Casting

Java's Automatic Conversions

Casting Incompatible Types

Automatic Type Promotion in Expressions

The Type Promotion Rules

Arrays

One-Dimensional Arrays

Multidimensional Arrays

Alternative Array Declaration Syntax

Introducing Type Inference with Local Variables

Some var Restrictions

A Few Words About Strings

Chapter 4 Operators

Arithmetic Operators

The Basic Arithmetic Operators

The Modulus Operator

Arithmetic Compound Assignment Operators

Increment and Decrement

The Bitwise Operators

The Bitwise Logical Operators

The Left Shift

The Right Shift

The Unsigned Right Shift

Bitwise Operator Compound Assignments

Relational Operators

Boolean Logical Operators

Short-Circuit Logical Operators

The Assignment Operator

The ? Operator

Operator Precedence

Using Parentheses

Chapter 5 Control Statements

Java's Selection Statements

if

The Traditional switch

Iteration Statements

- while
- do-while
- for
- The For-Each Version of the for Loop
- Local Variable Type Inference in a for Loop
- Nested Loops
- Jump Statements
- Using break
- Using continue
- return

Chapter 6 Introducing Classes

- Class Fundamentals
 - The General Form of a Class
 - A Simple Class
- Declaring Objects
 - A Closer Look at new
- Assigning Object Reference Variables
- Introducing Methods
 - Adding a Method to the Box Class
 - Returning a Value
 - Adding a Method That Takes Parameters
- Constructors
 - Parameterized Constructors
- The this Keyword
 - Instance Variable Hiding
- Garbage Collection
- A Stack Class

Chapter 7 A Closer Look at Methods and Classes

- Overloading Methods
 - Overloading Constructors
- Using Objects as Parameters
- A Closer Look at Argument Passing
- Returning Objects
- Recursion
- Introducing Access Control
- Understanding static
- Introducing final
- Arrays Revisited
- Introducing Nested and Inner Classes
- Exploring the String Class
- Using Command-Line Arguments
- Varargs: Variable-Length Arguments
 - Overloading Vararg Methods
 - Varargs and Ambiguity
- Local Variable Type Inference with Reference Types

Chapter 8 Inheritance

- Inheritance Basics
 - Member Access and Inheritance
 - A More Practical Example
 - A Superclass Variable Can Reference a Subclass Object
- Using super
 - Using super to Call Superclass Constructors
 - A Second Use for super
- Creating a Multilevel Hierarchy
- When Constructors Are Executed
- Method Overriding
- Dynamic Method Dispatch
 - Why Overridden Methods?

- Applying Method Overriding
- Using Abstract Classes
- Using final with Inheritance
 - Using final to Prevent Overriding
 - Using final to Prevent Inheritance
- Local Variable Type Inference and Inheritance
- The Object Class

Chapter 9 Packages and Interfaces

- Packages
 - Defining a Package
 - Finding Packages and CLASSPATH
 - A Short Package Example
- Packages and Member Access
 - An Access Example
- Importing Packages
- Interfaces
 - Defining an Interface
 - Implementing Interfaces
 - Nested Interfaces
 - Applying Interfaces
 - Variables in Interfaces
 - Interfaces Can Be Extended
- Default Interface Methods
 - Default Method Fundamentals
 - A More Practical Example
- Multiple Inheritance Issues
- Use static Methods in an Interface
- Private Interface Methods
- Final Thoughts on Packages and Interfaces

Chapter 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
- Three Additional Exception Features
- Using Exceptions

Chapter 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()

- Thread Priorities
- Synchronization
 - Using Synchronized Methods
 - The synchronized Statement
- Interthread Communication
- Deadlock
- Suspending, Resuming, and Stopping Threads
- Obtaining a Thread's State
- Using a Factory Method to Create and Start a Thread
- Using Multithreading

Chapter 12 Enumerations, Autoboxing, and Annotations

- Enumerations
 - Enumeration Fundamentals
 - The values() and valueOf() Methods
 - Java Enumerations Are Class Types
 - Enumerations Inherit Enum
 - Another Enumeration Example
- Type Wrappers
 - Character
 - Boolean
 - The Numeric Type Wrappers
- Autoboxing
 - Autoboxing and Methods
 - Autoboxing/Unboxing Occurs in Expressions
 - Autoboxing/Unboxing Boolean and Character Values
 - Autoboxing/Unboxing Helps Prevent Errors
 - A Word of Warning
- Annotations
 - Annotation Basics
 - Specifying a Retention Policy
 - Obtaining Annotations at Run Time by Use of Reflection
 - The AnnotatedElement Interface
 - Using Default Values
 - Marker Annotations
 - Single-Member Annotations
 - The Built-In Annotations
- Type Annotations
- Repeating Annotations
- Some Restrictions

Chapter 13 I/O, Try-with-Resources, and Other Topics

- I/O Basics
 - Streams
 - Byte Streams and Character Streams
 - The Predefined Streams
- Reading Console Input
 - Reading Characters
 - Reading Strings
- Writing Console Output
 - The PrintWriter Class
- Reading and Writing Files
 - Automatically Closing a File
- The transient and volatile Modifiers
- Introducing instanceof
- strictfp
- Native Methods
- Using assert
 - Assertion Enabling and Disabling Options
- Static Import
- Invoking Overloaded Constructors Through this()

- Applying Method Overriding
- Using Abstract Classes
- Using final with Inheritance
 - Using final to Prevent Overriding
 - Using final to Prevent Inheritance
- Local Variable Type Inference and Inheritance
- The Object Class

Chapter 9 Packages and Interfaces

- Packages
 - Defining a Package
 - Finding Packages and CLASSPATH
 - A Short Package Example
- Packages and Member Access
 - An Access Example
- Importing Packages
- Interfaces
 - Defining an Interface
 - Implementing Interfaces
 - Nested Interfaces
 - Applying Interfaces
 - Variables in Interfaces
 - Interfaces Can Be Extended
- Default Interface Methods
 - Default Method Fundamentals
 - A More Practical Example
 - Multiple Inheritance Issues
- Use static Methods in an Interface
- Private Interface Methods
- Final Thoughts on Packages and Interfaces

Chapter 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
- Three Additional Exception Features
- Using Exceptions

Chapter 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()

- Thread Priorities
- Synchronization
 - Using Synchronized Methods
 - The synchronized Statement
- Interthread Communication
- Deadlock
- Suspending, Resuming, and Stopping Threads
- Obtaining a Thread's State
- Using a Factory Method to Create and Start a Thread
- Using Multithreading

Chapter 12 Enumerations, Autoboxing, and Annotations

- Enumerations
 - Enumeration Fundamentals
 - The values() and valueOf() Methods
 - Java Enumerations Are Class Types
 - Enumerations Inherit Enum
 - Another Enumeration Example
- Type Wrappers
 - Character
 - Boolean
 - The Numeric Type Wrappers
- Autoboxing
 - Autoboxing and Methods
 - Autoboxing/Unboxing Occurs in Expressions
 - Autoboxing/Unboxing Boolean and Character Values
 - Autoboxing/Unboxing Helps Prevent Errors
 - A Word of Warning
- Annotations
 - Annotation Basics
 - Specifying a Retention Policy
 - Obtaining Annotations at Run Time by Use of Reflection
 - The AnnotatedElement Interface
 - Using Default Values
 - Marker Annotations
 - Single-Member Annotations
 - The Built-In Annotations
- Type Annotations
- Repeating Annotations
- Some Restrictions

Chapter 13 I/O, Try-with-Resources, and Other Topics

- I/O Basics
 - Streams
 - Byte Streams and Character Streams
 - The Predefined Streams
- Reading Console Input
 - Reading Characters
 - Reading Strings
- Writing Console Output
 - The PrintWriter Class
- Reading and Writing Files
 - Automatically Closing a File
 - The transient and volatile Modifiers
- Introducing instanceof
- strictfp
- Native Methods
- Using assert
 - Assertion Enabling and Disabling Options
- Static Import
- Invoking Overloaded Constructors Through this()

A Word About Value-Based Classes

Chapter 14 Generics

What Are Generics?

A Simple Generics Example

- Generics Work Only with Reference Types

- Generic Types Differ Based on Their Type Arguments

- How Generics Improve Type Safety

A Generic Class with Two Type Parameters

The General Form of a Generic Class

Bounded Types

Using Wildcard Arguments

- Bounded Wildcards

Creating a Generic Method

- Generic Constructors

Generic Interfaces

Raw Types and Legacy Code

Generic Class Hierarchies

- Using a Generic Superclass

- A Generic Subclass

- Run-Time Type Comparisons Within a Generic Hierarchy

- Casting

- Overriding Methods in a Generic Class

Type Inference with Generics

Local Variable Type Inference and Generics

Erasure

- Bridge Methods

Ambiguity Errors

Some Generic Restrictions

- Type Parameters Can't Be Instantiated

- Restrictions on Static Members

- Generic Array Restrictions

- Generic Exception Restriction

Chapter 15 Lambda Expressions

Introducing Lambda Expressions

- Lambda Expression Fundamentals

- Functional Interfaces

- Some Lambda Expression Examples

Block Lambda Expressions

Generic Functional Interfaces

Passing Lambda Expressions as Arguments

Lambda Expressions and Exceptions

Lambda Expressions and Variable Capture

Method References

- Method References to static Methods

- Method References to Instance Methods

- Method References with Generics

Constructor References

Predefined Functional Interfaces

Chapter 16 Modules

Module Basics

- A Simple Module Example

- Compile and Run the First Module Example

- A Closer Look at requires and exports

java.base and the Platform Modules

Legacy Code and the Unnamed Module

Exporting to a Specific Module

Using requires transitive

Use Services

- Service and Service Provider Basics
- The Service-Based Keywords
- A Module-Based Service Example
- Module Graphs
- Three Specialized Module Features
 - Open Modules
 - The opens Statement
 - requires static
- Introducing jlink and Module JAR Files
 - Linking Files in an Exploded Directory
 - Linking Modular JAR Files
 - JMOD Files
- A Brief Word About Layers and Automatic Modules
- Final Thoughts on Modules

Chapter 17 Switch Expressions, Records, and Other Recently Added Features

- Enhancements to switch
 - Use a List of case Constants
 - Introducing the switch Expression and the yield Statement
 - Introducing the Arrow in a case Statement
 - A Closer Look at the Arrow case
 - Another switch Expression Example
- Text Blocks
 - Text Block Fundamentals
 - Understanding Leading Whitespace
 - Use Double Quotes in a Text Block
 - Escape Sequences in Text Blocks
- Records
 - Record Basics
 - Create Record Constructors
 - Another Record Constructor Example
 - Create Record Getter Methods
- Pattern Matching with instanceof
 - Pattern Variables in a Logical AND Expression
 - Pattern Matching in Other Statements
- Sealed Classes and Interfaces
 - Sealed Classes
 - Sealed Interfaces
- Future Directions

Part II The Java Library

Chapter 18 String Handling

- The String Constructors
- String Length
- Special String Operations
 - String Literals
 - String Concatenation
 - String Concatenation with Other Data Types
 - String Conversion and toString()
- Character Extraction
 - charAt()
 - getChars()
 - getBytes()
 - toCharArray()
- String Comparison
 - equals() and equalsIgnoreCase()
 - regionMatches()
 - startsWith() and endsWith()
 - equals() Versus ==
 - compareTo()

- Searching Strings
- Modifying a String
 - substring()
 - concat()
 - replace()
 - trim() and strip()
- Data Conversion Using valueOf()
- Changing the Case of Characters Within a String
- Joining Strings
- Additional String Methods
- StringBuffer
 - StringBuffer Constructors
 - length() and capacity()
 - ensureCapacity()
 - setLength()
 - charAt() and setCharAt()
 - getChars()
 - append()
 - insert()
 - reverse()
 - delete() and deleteCharAt()
 - replace()
 - substring()
 - Additional StringBuffer Methods
- StringBuilder

Chapter 19 Exploring java.lang

- Primitive Type Wrappers
 - Number
 - Double and Float
 - Understanding isInfinite() and isNaN()
 - Byte, Short, Integer, and Long
 - Character
 - Additions to Character for Unicode Code Point Support
 - Boolean
- Void
- Process
- Runtime
 - Executing Other Programs
- Runtime.Version
- ProcessBuilder
- System
 - Using currentTimeMillis() to Time Program Execution
 - Using arraycopy()
 - Environment Properties
- System.Logger and System.LoggerFinder
- Object
 - Using clone() and the Cloneable Interface
- Class
- ClassLoader
- Math
 - Trigonometric Functions
 - Exponential Functions
 - Rounding Functions
 - Miscellaneous Math Methods
- StrictMath
- Compiler
- Thread, ThreadGroup, and Runnable
 - The Runnable Interface
 - Thread
 - ThreadGroup

- ThreadLocal and InheritableThreadLocal
- Package
- Module
- ModuleLayer
- RuntimePermission
- Throwable
- SecurityManager
- StackTraceElement
- StackWalker and StackWalker.StackFrame
- Enum
- Record
- ClassValue
- The CharSequence Interface
- The Comparable Interface
- The Appendable Interface
- The Iterable Interface
- The Readable Interface
- The AutoCloseable Interface
- The Thread.UncaughtExceptionHandler Interface
- The java.lang Subpackages
 - java.lang.annotation
 - java.lang.constant
 - java.lang.instrument
 - java.lang.invoke
 - java.lang.management
 - java.lang.module
 - java.lang.ref
 - java.lang.reflect

Chapter 20 java.util Part 1: The Collections Framework

- Collections Overview
- 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 PriorityQueue Class
 - The ArrayDeque Class
 - The EnumSet Class
- Accessing a Collection via an Iterator
 - Using an Iterator
 - The For-Each Alternative to Iterators
- Spliterators
- Storing User-Defined Classes in Collections
- The RandomAccess Interface
- Working with Maps
 - The Map Interfaces
 - The Map Classes
- Comparators
 - Using a Comparator
- The Collection Algorithms
- Arrays

- The Legacy Classes and Interfaces
 - The Enumeration Interface
 - Vector
 - Stack
 - Dictionary
 - Hashtable
 - Properties
 - Using store() and load()

- Parting Thoughts on Collections

Chapter 21 java.util Part 2: More Utility Classes

- StringTokenizer
- BitSet
- Optional, OptionalDouble, OptionalInt, and OptionalLong
- Date
- Calendar
- GregorianCalendar
- TimeZone
- SimpleTimeZone
- Locale
- Random
- Timer and TimerTask
- Currency
- Formatter

- The Formatter Constructors
 - The Formatter Methods
 - Formatting Basics
 - Formatting Strings and Characters
 - Formatting Numbers
 - Formatting Time and Date
 - The %n and %% Specifiers
 - Specifying a Minimum Field Width
 - Specifying Precision
 - Using the Format Flags
 - Justifying Output
 - The Space, +, 0, and (Flags
 - The Comma Flag
 - The # Flag
 - The Uppercase Option
 - Using an Argument Index
 - Closing a Formatter
 - The Java printf() Connection

Scanner

- The Scanner Constructors
 - Scanning Basics
 - Some Scanner Examples
 - Setting Delimiters
 - Other Scanner Features

- The ResourceBundle, ListResourceBundle, and PropertyResourceBundle Classes

- Miscellaneous Utility Classes and Interfaces

- The java.util Subpackages

- java.util.concurrent, java.util.concurrent.atomic, and java.util.concurrent.locks
 - java.util.function
 - java.util.jar
 - java.util.logging
 - java.util.prefs
 - java.util.random
 - java.util.regex
 - java.util.spi
 - java.util.stream
 - java.util.zip

Chapter 22 Input/Output: Exploring java.io

The I/O Classes and Interfaces

File

Directories

Using FilenameFilter

The listFiles() Alternative

Creating Directories

The AutoCloseable, Closeable, and Flushable Interfaces

I/O Exceptions

Two Ways to Close a Stream

The Stream Classes

The Byte Streams

InputStream

OutputStream

FileInputStream

FileOutputStream

ByteArrayInputStream

ByteArrayOutputStream

Filtered Byte Streams

Buffered Byte Streams

SequenceInputStream

PrintStream

DataOutputStream and DataInputStream

RandomAccessFile

The Character Streams

Reader

Writer

FileReader

FileWriter

CharArrayReader

CharArrayWriter

BufferedReader

BufferedWriter

PushbackReader

PrintWriter

The Console Class

Serialization

Serializable

Externalizable

ObjectOutput

ObjectOutputStream

ObjectInput

ObjectInputStream

A Serialization Example

Stream Benefits

Chapter 23 Exploring NIO

The NIO Classes

NIO Fundamentals

Buffers

Channels

Charsets and Selectors

Enhancements Added by NIO.2

The Path Interface

The Files Class

The Paths Class

The File Attribute Interfaces

The Filesystem, FileSystems, and FileStore Classes

Using the NIO System

Use NIO for Channel-Based I/O

Use NIO for Stream-Based I/O

Chapter 24 Networking

Networking Basics

The java.net Networking Classes and Interfaces

InetAddress

Factory Methods

Instance Methods

InetSocketAddress and Inet6Address

TCP/IP Client Sockets

URL

URLConnection

HttpURLConnection

The URI Class

Cookies

TCP/IP Server Sockets

Datagrams

DatagramSocket

DatagramPacket

A Datagram Example

Introducing java.net.http

Three Key Elements

A Simple HTTP Client Example

Things to Explore in java.net.http

Chapter 25 Event Handling

Two Event Handling Mechanisms

The Delegation Event Model

Events

Event Sources

Event Listeners

Event Classes

The ActionEvent Class

The AdjustmentEvent Class

The ComponentEvent Class

The ContainerEvent Class

The FocusEvent Class

The InputEvent Class

The ItemEvent Class

The KeyEvent Class

The MouseEvent Class

The MouseWheelEvent Class

The TextEvent Class

The WindowEvent Class

Sources of Events

Event Listener Interfaces

The ActionListener Interface

The AdjustmentListener Interface

The ComponentListener Interface

The ContainerListener Interface

The FocusListener Interface

The ItemListener Interface

The KeyListener Interface

The MouseListener Interface

The MouseMotionListener Interface

The MouseWheelListener Interface

The TextListener Interface

The WindowFocusListener Interface

The WindowListener Interface

Using the Delegation Event Model

Some Key AWT GUI Concepts

- Handling Mouse Events
- Handling Keyboard Events
- Adapter Classes
- Inner Classes
- Anonymous Inner Classes

Chapter 26 Introducing the AWT: Working with Windows, Graphics, and Text

- AWT Classes
- Window Fundamentals
 - Component
 - Container
 - Panel
 - Window
 - Frame
 - Canvas

- Working with Frame Windows
 - Setting the Window's Dimensions
 - Hiding and Showing a Window
 - Setting a Window's Title
 - Closing a Frame Window
 - The `paint()` Method
 - Displaying a String
 - Setting the Foreground and Background Colors
 - Requesting Repainting
 - Creating a Frame-Based Application

- Introducing Graphics
 - Drawing Lines
 - Drawing Rectangles
 - Drawing Ellipses and Circles
 - Drawing Arcs
 - Drawing Polygons
 - Demonstrating the Drawing Methods
 - Sizing Graphics

- Working with Color
 - Color Methods
 - Setting the Current Graphics Color
 - A Color Demonstration Program

- Setting the Paint Mode

- Working with Fonts
 - Determining the Available Fonts
 - Creating and Selecting a Font
 - Obtaining Font Information
- Managing Text Output Using `FontMetrics`

Chapter 27 Using AWT Controls, Layout Managers, and Menus

- AWT Control Fundamentals
 - Adding and Removing Controls
 - Responding to Controls
 - The `HeadlessException`

- Labels

- Using Buttons

- Handling Buttons

- Applying Check Boxes

- Handling Check Boxes

- `CheckboxGroup`

- Choice Controls

- Handling Choice Lists

- Using Lists

- Handling Lists

- Managing Scroll Bars

- Handling Scroll Bars

- Using a TextField
 - Handling a TextField
- Using a TextArea
- Understanding Layout Managers
 - FlowLayout
 - BorderLayout
 - Using Insets
 - GridLayout
 - CardLayout
 - GridBagLayout
- Menu Bars and Menus
- Dialog Boxes
- A Word About Overriding paint()

Chapter 28 Images

- File Formats
- Image Fundamentals: Creating, Loading, and Displaying
 - Creating an Image Object
 - Loading an Image
 - Displaying an Image
- Double Buffering
- ImageProducer
 - MemoryImageSource
- ImageConsumer
 - PixelGrabber
- ImageFilter
 - CropImageFilter
 - RGBImageFilter
- Additional Imaging Classes

Chapter 29 The Concurrency Utilities

- The Concurrent API Packages
 - java.util.concurrent
 - java.util.concurrent.atomic
 - java.util.concurrent.locks
- Using Synchronization Objects
 - Semaphore
 - CountDownLatch
 - CyclicBarrier
 - Exchanger
 - Phaser
- Using an Executor
 - A Simple Executor Example
 - Using Callable and Future
- The TimeUnit Enumeration
- The Concurrent Collections
- Locks
- Atomic Operations
- Parallel Programming via the Fork/Join Framework
 - The Main Fork/Join Classes
 - The Divide-and-Conquer Strategy
 - A Simple First Fork/Join Example
 - Understanding the Impact of the Level of Parallelism
 - An Example that Uses RecursiveTask<V>
 - Executing a Task Asynchronously
 - Cancelling a Task
 - Determining a Task's Completion Status
 - Restarting a Task
 - Things to Explore
 - Some Fork/Join Tips
- The Concurrency Utilities Versus Java's Traditional Approach

Chapter 30 The Stream API

Stream Basics

Stream Interfaces

How to Obtain a Stream

A Simple Stream Example

Reduction Operations

Using Parallel Streams

Mapping

Collecting

Iterators and Streams

Use an Iterator with a Stream

Use Spliterator

More to Explore in the Stream API

Chapter 31 Regular Expressions and Other Packages

Regular Expression Processing

Pattern

Matcher

Regular Expression Syntax

Demonstrating Pattern Matching

Two Pattern-Matching Options

Exploring Regular Expressions

Reflection

Remote Method Invocation (RMI)

A Simple Client/Server Application Using RMI

Formatting Date and Time with java.text

DateFormat Class

SimpleDateFormat Class

The java.time Time and Date API

Time and Date Fundamentals

Formatting Date and Time

Parsing Date and Time Strings

Other Things to Explore in java.time

Part III Introducing GUI Programming with Swing

Chapter 32 Introducing Swing

The Origins of Swing

Swing Is Built on the AWT

Two Key Swing Features

Swing Components Are Lightweight

Swing Supports a Pluggable Look and Feel

The MVC Connection

Components and Containers

Components

Containers

The Top-Level Container Panes

The Swing Packages

A Simple Swing Application

Event Handling

Painting in Swing

Painting Fundamentals

Compute the Paintable Area

A Paint Example

Chapter 33 Exploring Swing

JLabel and ImageIcon

TextField

The Swing Buttons

JButton

JToggleButton

- Check Boxes
- Radio Buttons
- JTabbedPane
- JScrollPane
- JList
- JComboBox
- Trees
- JTable

Chapter 34 Introducing Swing Menus

- Menu Basics
 - An Overview of JMenuBar, JMenu, and JMenuItem
 - JMenuBar
 - JMenu
 - JMenuItem
 - Create a Main Menu
 - Add Mnemonics and Accelerators to Menu Items
 - Add Images and Tooltips to Menu Items
 - Use JRadioButtonMenuItem and JCheckBoxMenuItem
 - Create a Popup Menu
 - Create a Toolbar
 - Use Actions
 - Put the Entire MenuDemo Program Together
 - Continuing Your Exploration of Swing

Part IV Applying Java

Chapter 35 Java Beans

- What Is a Java Bean?
- Advantages of Beans
- Introspection
 - Design Patterns for Properties
 - Design Patterns for Events
 - Methods and Design Patterns
 - Using the BeanInfo Interface
- Bound and Constrained Properties
- Persistence
- Customizers
- The JavaBeans API
 - Introspector
 - PropertyDescriptor
 - EventSetDescriptor
 - MethodDescriptor
- A Bean Example

Chapter 36 Introducing Servlets

- Background
- The Life Cycle of a Servlet
- Servlet Development Options
- Using Tomcat
- A Simple Servlet
 - Create and Compile the Servlet Source Code
 - Start Tomcat
 - Start a Web Browser and Request the Servlet
- The Servlet API
- The jakarta.servlet Package
 - The Servlet Interface
 - The ServletConfig Interface
 - The ServletContext Interface
 - The ServletRequest Interface
 - The ServletResponse Interface
 - The GenericServlet Class

- The ServletInputStream Class
- The ServletOutputStream Class
- The Servlet Exception Classes
- Reading Servlet Parameters
- The jakarta.servlet.http Package
- The HttpServletResponse Interface
- The HttpSession Interface
- The Cookie Class
- The HttpServlet Class
- Handling HTTP Requests and Responses
- Handling HTTP GET Requests
- Handling HTTP POST Requests
- Using Cookies
- Session Tracking

Part V Appendices

Appendix A Using Java's Documentation Comments

The javadoc Tags

- @author
- @code
- @deprecated
- @docRoot
- @exception
- @hidden
- @index
- @inheritDoc
- @link
- @linkplain
- @literal
- @param
- @provides
- @return
- @see
- @serial
- @serialData
- @serialField
- @since
- @summary
- @systemProperty
- @throws
- @uses
- @value
- @version

The General Form of a Documentation Comment

What javadoc Outputs

An Example that Uses Documentation Comments

Appendix B Introducing JShell

- JShell Basics
- List, Edit, and Rerun Code
- Add a Method
- Create a Class
- Use an Interface
- Evaluate Expressions and Use Built-in Variables
- Importing Packages
- Exceptions
- Some More JShell Commands
- Exploring JShell Further

Appendix C Compile and Run Simple Single-File Programs in One Step

Table of Contents

Preface.....	xii
1. Preliminaries.....	1
1.1 What Is This Book About?	1
What Kinds of Data?	1
1.2 Why Python for Data Analysis?	2
Python as Glue	2
Solving the “Two-Language” Problem	3
Why Not Python?	3
1.3 Essential Python Libraries	4
NumPy	4
pandas	4
matplotlib	5
IPython and Jupyter	6
SciPy	6
scikit-learn	7
statsmodels	8
1.4 Installation and Setup	8
Windows	9
Apple (OS X, macOS)	9
GNU/Linux	9
Installing or Updating Python Packages	10
Python 2 and Python 3	11
Integrated Development Environments (IDEs) and Text Editors	11
1.5 Community and Conferences	12
1.6 Navigating This Book	12
Code Examples	13
Data for Examples	13

Import Conventions	14
Jargon	14
2. Python Language Basics, IPython, and Jupyter Notebooks.....	15
2.1 The Python Interpreter	16
2.2 IPython Basics	17
Running the IPython Shell	17
Running the Jupyter Notebook	18
Tab Completion	21
Introspection	23
The %run Command	25
Executing Code from the Clipboard	26
Terminal Keyboard Shortcuts	27
About Magic Commands	28
Matplotlib Integration	29
2.3 Python Language Basics	30
Language Semantics	38
Scalar Types	46
Control Flow	
3. Built-in Data Structures, Functions, and Files.....	51
3.1 Data Structures and Sequences	51
Tuple	54
List	59
Built-in Sequence Functions	61
dict	65
set	67
List, Set, and Dict Comprehensions	69
3.2 Functions	70
Namespaces, Scope, and Local Functions	71
Returning Multiple Values	72
Functions Are Objects	73
Anonymous (Lambda) Functions	74
Currying: Partial Argument Application	75
Generators	77
Errors and Exception Handling	80
3.3 Files and the Operating System	83
Bytes and Unicode with Files	84
3.4 Conclusion	
4. NumPy Basics: Arrays and Vectorized Computation.....	85
4.1 The NumPy ndarray: A Multidimensional Array Object	87

Creating ndarrays	88
Data Types for ndarrays	90
Arithmetic with NumPy Arrays	93
Basic Indexing and Slicing	94
Boolean Indexing	99
Fancy Indexing	102
Transposing Arrays and Swapping Axes	103
4.2 Universal Functions: Fast Element-Wise Array Functions	105
4.3 Array-Oriented Programming with Arrays	108
Expressing Conditional Logic as Array Operations	109
Mathematical and Statistical Methods	111
Methods for Boolean Arrays	113
Sorting	113
Unique and Other Set Logic	114
4.4 File Input and Output with Arrays	115
4.5 Linear Algebra	116
4.6 Pseudorandom Number Generation	118
4.7 Example: Random Walks	119
Simulating Many Random Walks at Once	121
4.8 Conclusion	122
5. Getting Started with pandas.....	123
5.1 Introduction to pandas Data Structures	124
Series	124
DataFrame	128
Index Objects	134
5.2 Essential Functionality	136
Reindexing	136
Dropping Entries from an Axis	138
Indexing, Selection, and Filtering	140
Integer Indexes	145
Arithmetic and Data Alignment	146
Function Application and Mapping	151
Sorting and Ranking	153
Axis Indexes with Duplicate Labels	157
5.3 Summarizing and Computing Descriptive Statistics	158
Correlation and Covariance	160
Unique Values, Value Counts, and Membership	162
5.4 Conclusion	165
6. Data Loading, Storage, and File Formats.....	167
6.1 Reading and Writing Data in Text Format	167

Reading Text Files in Pieces	173
Writing Data to Text Format	175
Working with Delimited Formats	176
JSON Data	178
XML and HTML: Web Scraping	180
6.2 Binary Data Formats	183
Using HDFS Format	184
Reading Microsoft Excel Files	186
6.3 Interacting with Web APIs	187
6.4 Interacting with Databases	188
6.5 Conclusion	190
7. Data Cleaning and Preparation.	191
7.1 Handling Missing Data	191
Filtering Out Missing Data	193
Filling In Missing Data	195
7.2 Data Transformation	197
Removing Duplicates	198
Transforming Data Using a Function or Mapping	200
Replacing Values	201
Renaming Axis Indexes	203
Discretization and Binning	205
Detecting and Filtering Outliers	206
Permutation and Random Sampling	208
Computing Indicator/Dummy Variables	211
7.3 String Manipulation	211
String Object Methods	213
Regular Expressions	216
Vectorized String Functions in pandas	219
7.4 Conclusion	
8. Data Wrangling: Join, Combine, and Reshape.	221
8.1 Hierarchical Indexing	224
Reordering and Sorting Levels	225
Summary Statistics by Level	225
Indexing with a DataFrame's columns	227
8.2 Combining and Merging Datasets	227
Database-Style DataFrame Joins	232
Merging on Index	236
Concatenating Along an Axis	241
Combining Data with Overlap	242
8.3 Reshaping and Pivoting	

Reshaping with Hierarchical Indexing	243
Pivoting "Long" to "Wide" Format	246
Pivoting "Wide" to "Long" Format	249
8.4 Conclusion	251
9. Plotting and Visualization.....	253
9.1 A Brief matplotlib API Primer	253
Figures and Subplots	255
Colors, Markers, and Line Styles	259
Ticks, Labels, and Legends	261
Annotations and Drawing on a Subplot	265
Saving Plots to File	267
matplotlib Configuration	268
9.2 Plotting with pandas and seaborn	268
Line Plots	269
Bar Plots	272
Histograms and Density Plots	277
Scatter or Point Plots	280
Facet Grids and Categorical Data	283
9.3 Other Python Visualization Tools	285
9.4 Conclusion	286
10. Data Aggregation and Group Operations.....	287
10.1 GroupBy Mechanics	288
Iterating Over Groups	291
Selecting a Column or Subset of Columns	293
Grouping with Dicts and Series	294
Grouping with Functions	295
Grouping by Index Levels	295
10.2 Data Aggregation	296
Column-Wise and Multiple Function Application	298
Returning Aggregated Data Without Row Indexes	301
10.3 Apply: General split-apply-combine	302
Suppressing the Group Keys	304
Quantile and Bucket Analysis	305
Example: Filling Missing Values with Group-Specific Values	306
Example: Random Sampling and Permutation	308
Example: Group Weighted Average and Correlation	310
Example: Group-Wise Linear Regression	312
10.4 Pivot Tables and Cross-Tabulation	313
Cross-Tabulations: Crosstab	315
10.5 Conclusion	316

Reshaping with Hierarchical Indexing	243
Pivoting "Long" to "Wide" Format	246
Pivoting "Wide" to "Long" Format	249
8.4 Conclusion	251
9. Plotting and Visualization	253
9.1 A Brief matplotlib API Primer	253
Figures and Subplots	255
Colors, Markers, and Line Styles	259
Ticks, Labels, and Legends	261
Annotations and Drawing on a Subplot	265
Saving Plots to File	267
matplotlib Configuration	268
9.2 Plotting with pandas and seaborn	268
Line Plots	269
Bar Plots	272
Histograms and Density Plots	277
Scatter or Point Plots	280
Facet Grids and Categorical Data	283
9.3 Other Python Visualization Tools	285
9.4 Conclusion	286
10. Data Aggregation and Group Operations	287
10.1 GroupBy Mechanics	288
Iterating Over Groups	291
Selecting a Column or Subset of Columns	293
Grouping with Dicts and Series	294
Grouping with Functions	295
Grouping by Index Levels	295
10.2 Data Aggregation	296
Column-Wise and Multiple Function Application	298
Returning Aggregated Data Without Row Indexes	301
10.3 Apply: General split-apply-combine	302
Suppressing the Group Keys	304
Quantile and Bucket Analysis	305
Example: Filling Missing Values with Group-Specific Values	306
Example: Random Sampling and Permutation	308
Example: Group Weighted Average and Correlation	310
Example: Group-Wise Linear Regression	312
10.4 Pivot Tables and Cross-Tabulation	313
Cross-Tabulations: Crosstab	315
10.5 Conclusion	316

11. Time Series.....	311
11.1 Date and Time Data Types and Tools	311
Converting Between String and Datetime	311
11.2 Time Series Basics	321
Indexing, Selection, Subsetting	321
Time Series with Duplicate Indices	321
11.3 Date Ranges, Frequencies, and Shifting	324
Generating Date Ranges	327
Frequencies and Date Offsets	328
Shifting (Leading and Lagging) Data	330
11.4 Time Zone Handling	332
Time Zone Localization and Conversion	335
Operations with Time Zone-Aware Timestamp Objects	335
Operations Between Different Time Zones	338
11.5 Periods and Period Arithmetic	339
Period Frequency Conversion	340
Quarterly Period Frequencies	342
Converting Timestamps to Periods (and Back)	344
Creating a PeriodIndex from Arrays	345
11.6 Resampling and Frequency Conversion	348
Downsampling	349
Upsampling and Interpolation	352
Resampling with Periods	353
11.7 Moving Window Functions	354
Exponentially Weighted Functions	358
Binary Moving Window Functions	359
User-Defined Moving Window Functions	361
11.8 Conclusion	362
12. Advanced pandas.....	363
12.1 Categorical Data	363
Background and Motivation	363
Categorical Type in pandas	365
Computations with Categoricals	367
Categorical Methods	370
12.2 Advanced GroupBy Use	373
Group Transforms and “Unwrapped” GroupBys	373
Grouped Time Resampling	377
12.3 Techniques for Method Chaining	378
The pipe Method	380
12.4 Conclusion	381

13. Introduction to Modeling Libraries in Python.....	383
13.1 Interfacing Between pandas and Model Code	383
13.2 Creating Model Descriptions with Patsy	386
Data Transformations in Patsy Formulas	389
Categorical Data and Patsy	390
13.3 Introduction to statsmodels	393
Estimating Linear Models	393
Estimating Time Series Processes	396
13.4 Introduction to scikit-learn	397
13.5 Continuing Your Education	401
14. Data Analysis Examples.....	403
14.1 1.USA.gov Data from Bitly	403
Counting Time Zones in Pure Python	404
Counting Time Zones with pandas	406
14.2 MovieLens 1M Dataset	413
Measuring Rating Disagreement	418
14.3 US Baby Names 1880–2010	419
Analyzing Naming Trends	425
14.4 USDA Food Database	434
14.5 2012 Federal Election Commission Database	440
Donation Statistics by Occupation and Employer	442
Bucketing Donation Amounts	445
Donation Statistics by State	447
14.6 Conclusion	448
A. Advanced NumPy.....	449
A.1 ndarray Object Internals	449
NumPy dtype Hierarchy	450
A.2 Advanced Array Manipulation	451
Reshaping Arrays	452
C Versus Fortran Order	454
Concatenating and Splitting Arrays	454
Repeating Elements: tile and repeat	457
Fancy Indexing Equivalents: take and put	459
A.3 Broadcasting	460
Broadcasting Over Other Axes	462
Setting Array Values by Broadcasting	465
A.4 Advanced ufunc Usage	466
ufunc Instance Methods	466
Writing New ufuncs in Python	468
A.5 Structured and Record Arrays	469

Nested dtypes and Multidimensional Fields	469
Why Use Structured Arrays?	470
A.6 More About Sorting	471
Indirect Sorts: argsort and lexsort	472
Alternative Sort Algorithms	474
Partially Sorting Arrays	474
numpy.searchsorted: Finding Elements in a Sorted Array	475
A.7 Writing Fast NumPy Functions with Numba	476
Creating Custom numpy.ufunc Objects with Numba	478
A.8 Advanced Array Input and Output	478
Memory-Mapped Files	478
HDF5 and Other Array Storage Options	480
A.9 Performance Tips	480
The Importance of Contiguous Memory	480
B. More on the IPython System.....	483
B.1 Using the Command History	483
Searching and Reusing the Command History	483
Input and Output Variables	484
B.2 Interacting with the Operating System	485
Shell Commands and Aliases	486
Directory Bookmark System	487
B.3 Software Development Tools	487
Interactive Debugger	488
Timing Code: %time and %timeit	492
Basic Profiling: %prun and %run -p	494
Profiling a Function Line by Line	496
B.4 Tips for Productive Code Development Using IPython	498
Reloading Module Dependencies	498
Code Design Tips	499
B.5 Advanced IPython Features	500
Making Your Own Classes IPython-Friendly	500
Profiles and Configuration	501
B.6 Conclusion	503
Index.....	505

CONTENTS

INTRODUCTION

xxxi

CHAPTER 1: HELLO, ANDROID

1

Android Application Development

1

A Little Background

2

The Not-So-Distant Past

3

Living in the Future

3

The Android Ecosystem

3

Pre-installed Android Applications

4

Android SDK Features

5

What Does Android Run On?

6

Why Develop for Mobile?

6

Why Develop for Android?

7

Introducing the Development Framework

7

What Comes in the Box

8

Understanding the Android Software Stack

8

The Android Run Time

10

Android Application Architecture

11

Android Libraries

12

CHAPTER 2: GETTING STARTED

13

Getting Started Developing Android Apps

14

Developing for Android

15

What You Need to Begin

15

Creating Your First Android Application

20

Getting Started Writing Android Apps Using Kotlin

35

Using the Android Support Library Package

36

Developing for Mobile and Embedded Devices

39

Hardware-Imposed Design Considerations

39

Considering the User's Environment

43

Developing for Android

44

Android Development Tools

48

Android Studio

49

The Android Virtual Device Manager

51

The Android Emulator

51

Android Profiler	52
The Android Debug Bridge	54
APK Analyzer	54
The Lint Tool	55
Monkey, Monkey Runner, and Espresso UI Testing	55
Gradle	56
CHAPTER 3: APPLICATIONS AND ACTIVITIES AND FRAGMENTS, OH MY!	57
Applications, Activities, and Fragments	58
The Components of an Android Application	58
The Android Application Life Cycle, Priority, and Process States	59
Introducing the Android Application Class	61
A Closer Look at Android Activities	61
Creating Activities	62
Using the AppCompatActivity	63
The Activity Life Cycle	64
Responding to Memory Pressure	71
Introducing Fragments	73
Creating New Fragments	73
The Fragment Life Cycle	74
Introducing the Fragment Manager	79
Adding Fragments to Activities	79
Communicating Between Fragments and Activities	85
Fragments Without User Interfaces	86
Building an Earthquake Viewer Application	87
CHAPTER 4: DEFINING THE ANDROID MANIFEST AND GRADLE BUILD FILES, AND EXTERNALIZING RESOURCES	95
The Manifest, Build Files, and Resources	96
Introducing the Android Manifest	96
Configuring the Gradle Build	101
Gradle Settings File	101
Project Gradle Build File	102
Module Gradle Build Files	102
Externalizing Resources	107
Creating Resources	108
Using Resources	119
Creating Resources for Different Languages and Hardware	122
Runtime Configuration Changes	126

CHAPTER 5: BUILDING USER INTERFACES	129
Fundamental Android Design	130
Density-Independent Design	130
Android User Interface Fundamentals	131
Assigning User Interfaces to Activities	132
Introducing Layouts	132
Defining Layouts	134
Using Layouts to Create Device-Independent User Interfaces	136
Optimizing Layouts	139
The Android Widget Toolbox	143
Working with Lists and Grids	144
Recycler View and Layout Managers	145
Introducing Adapters	146
Returning to the Earthquake Viewer Application	149
Introducing Data Binding	150
Enabling Data Binding	151
Variables in Data Binding	152
Data Binding for the Earthquake Viewer Application	153
Creating New Views	155
Modifying Existing Views	155
Creating Compound Controls	159
Creating Simple Compound Controls as a Layout	161
Creating Custom Views	162
Using Custom Controls	176
CHAPTER 6: INTENTS AND BROADCAST RECEIVERS	177
Using Intents and Broadcast Receivers	178
Using Intents to Launch Activities	178
Explicitly Starting New Activities	179
Implicit Intents and Late Runtime Binding	179
Determining If an Intent Will Resolve	180
Returning Results from Activities	181
Using Platform-Native Actions to Launch Activities	184
Creating Intent Filters to Receive Implicit Intents	186
Defining an Intent Filter	186
Using Intent Filters for Plug-Ins and Extensibility	194
Introducing Linkify	198
Native Linkify Link Types	198
Creating Custom Link Strings	199

CONTENTS

Using the Match Filter	200
Using the Transform Filter	200
Using Intents to Broadcast Events	200
Broadcasting Events with Intents	201
Listening for Intent Broadcasts with Broadcast Receivers	202
Registering Broadcast Receivers in Code	203
Registering Broadcast Receivers in Your Application Manifest	204
Managing Manifest Receivers at Run Time	204
Monitoring Device State Changes Through Broadcast Intents	205
Introducing the Local Broadcast Manager	207
Introducing Pending Intents	208
CHAPTER 7: USING INTERNET RESOURCES	211
Connecting to the Internet	211
Connecting, Downloading, and Parsing Internet Resources	212
Why Build a Native Internet App?	212
Connecting to an Internet Resource	213
Performing Network Operations on Background Threads Using View Models, Live Data, and Asynchronous Tasks	214
Parsing XML Using the XML Pull Parser	219
Connecting the Earthquake Viewer to the Internet	220
Parsing JSON Using the JSON Parser	228
Using the Download Manager	233
Downloading Files	233
Customizing Download Manager Notifications	235
Specifying a Download Location	237
Canceling and Removing Downloads	238
Querying the Download Manager	238
Best Practices for Downloading Data Without Draining the Battery	241
An Introduction to Internet Services and Cloud Computing	242
CHAPTER 8: FILES, SAVING STATE, AND USER PREFERENCES	245
Saving Files, States, and Preferences	246
Saving and Restoring Activity and Fragment Instance State Using the Lifecycle Handlers	246
Retaining Instance State with Headless Fragments and View Models	248
View Models and Live Data	248
Headless Fragments	251
Creating and Saving Shared Preferences	252
Retrieving Shared Preferences	253

Introducing On Shared Preference Change Listeners	254
Configuring Auto Backup of Application Files and Shared Preferences	254
Building a Preference UI	256
Using the Preference Support Library	256
Defining a Preference Screen Layout in XML	257
Introducing the Preference Fragment	260
Creating a Settings Activity for the Earthquake Monitor	261
Including Static Files as Resources	267
Working with the Filesystem	267
File-Management Tools	267
Creating Files on Application-Specific Internal Storage	268
Creating Files on Application-Specific External Storage	268
Accessing Public Directories Using Scoped Directory Access	270
Sharing Files Using File Provider	274
Creating a File Provider	274
Sharing a File Using a File Provider	275
Receiving a File from a File Provider	275
Accessing Files from Other Applications Using the Storage Access Framework	275
Requesting Temporary Access to Files	276
Requesting Persistent Access to Files	277
Requesting Access to Directories	277
Creating New Files	278
Using URI-Based Permissions	278
CHAPTER 9: CREATING AND USING DATABASES	281
Introducing Structured Data Storage in Android	282
Storing Data Using the Room Persistence Library	282
Adding the Room Persistence Library	283
Defining a Room Database	284
Persisting Complex Objects Using Type Convertors	286
Defining Room Database Interactions Using Data Access Objects	288
Performing Room Database Interactions	291
Monitoring Query Result Changes with Live Data	292
Persisting Earthquakes to a Database with Room	294
Working with SQLite Databases	298
Input Validation and SQL Injection	299
Cursors and Content Values	299
Defining a Database Contract	300
Introducing the SQLiteOpenHelper	300

Opening Databases with the SQLite Open Helper	302
Opening and Creating Databases Without the SQLite Open Helper	303
Adding, Updating, and Deleting Rows	303
Querying a Database	305
Extracting Values from a Cursor	307
Introducing the Firebase Realtime Database	308
Adding Firebase to Your App	309
Defining a Firebase Database and Defining Access Rules	311
Adding, Modifying, Deleting, and Querying Data from a Firebase Realtime Database	313
CHAPTER 10: CONTENT PROVIDERS AND SEARCH	317
Introducing Content Providers	318
Why Should I Use Content Providers?	318
Creating Content Providers	319
Creating the Content Provider's Database	320
Registering Content Providers	321
Publishing Your Content Provider's URI Address	321
Implementing Content Provider Queries	322
Content Provider Transactions	325
Sharing Files Using a Content Provider	327
Adding Permission Requirements to Content Providers	328
Accessing Content Providers with Content Resolvers	330
Querying Content Providers	330
Cancelling Queries	333
Querying for Content Asynchronously with a Cursor Loader	333
Adding, Deleting, and Updating Content	336
Accessing Files Stored in Content Providers	338
Accessing Permission-Restricted Content Providers	339
Using Native Android Content Providers	341
Accessing the Call Log	341
Using the Media Store Content Provider	342
Using the Contacts Content Provider	344
Using the Calendar Content Provider	351
Adding Search to Your Application	354
Defining Your Search Metadata	354
Creating a Search Results Activity	355
Searching a Content Provider	357
Using the Search View Widget	360
Providing Search Suggestions Using a Content Provider	362
Searching the Earthquake Monitor Database	366

CHAPTER 11: WORKING IN THE BACKGROUND	377
Working in the Background	378
Using Background Threads	379
Using Asynchronous Tasks to Run Tasks Asynchronously	379
Manual Thread Creation Using Handler Threads	383
Scheduling Background Jobs	385
Creating a Job Service for the Job Scheduler	386
Scheduling Jobs with the Job Scheduler	388
Scheduling Jobs with the Firebase Job Dispatcher	391
Scheduling Work with the Work Manager	393
An Earthquake-Monitoring Job Service Example	396
Using Notifications to Notify Users	401
Introducing the Notification Manager	401
Working with Notification Channels	402
Creating Notifications	403
Setting a Notification's Priority	407
Adding Notification Actions	411
Adding Direct Reply Actions	412
Grouping Multiple Notifications	413
Adding Notifications to the Earthquake Monitor	414
Using Firebase Cloud Messaging	417
Triggering Notifications Remotely with Firebase Notifications	418
Receiving Data with Firebase Cloud Messaging	421
Using Alarms	422
Creating, Setting, and Canceling Alarms	423
Setting an Alarm Clock	424
Introducing Services	424
Using Bound Services	425
Creating a Started Service	427
CHAPTER 12: IMPLEMENTING THE ANDROID DESIGN PHILOSOPHY	433
Introducing the Android Design Philosophy	434
Designing for Every Screen	434
Resolution Independence	435
Supporting and Optimizing for Different Screen Sizes	436
Creating Scalable Graphics Assets	439
Introducing Material Design	445
Thinking in Terms of Paper and Ink	446
Using Color and Keylines as Guides	447
Continuity Through Motion	449

Material Design UI Elements	452
The App Bar	452
Applying Material Design to the Earthquake Monitor	455
Using Cards to Display Content	456
Floating Action Buttons	460
CHAPTER 13: IMPLEMENTING A MODERN ANDROID USER EXPERIENCE	463
The Modern Android UI	464
Creating Consistent, Modern User Interfaces Using AppCompatActivity	464
Creating and Applying Themes Using AppCompatActivity	465
Creating Theme Overlays for Specific Views	466
Adding a Menu and Actions to the App Bar	467
Defining a Menu Resource	467
Adding a Menu to an Activity	468
Adding a Menu to a Fragment	469
Updating Menu Items Dynamically	469
Handling Menu Selections	470
Adding Action Views and Action Providers	470
Going Beyond the Default App Bar	472
Replacing Your App Bar with a Toolbar	472
Advanced Scrolling Techniques for the Toolbar	473
Incorporating Menus Without the App Bar	476
Improving the Earthquake Monitor's App Bar	477
App Navigation Patterns	479
Navigating with Tabs	479
Implementing a Bottom Navigation Bar	482
Using a Navigation Drawer	485
Combining Navigation Patterns	491
Adding Tabs to the Earthquake Monitor	492
Choosing the Right Level of Interruption	496
Initiating a Dialog	497
Let's Make a Toast	498
Inline Interruptions with Snackbars	499
CHAPTER 14: ADVANCED CUSTOMIZATION OF YOUR USER INTERFACE	501
Expanding the User Experience	502
Supporting Accessibility	502

Supporting Navigation Without a Touch Screen	502
Providing a Textual Description of Each View	503
Introducing Android Text-to-Speech	503
Using Speech Recognition	505
Using Speech Recognition for Voice Input	506
Using Speech Recognition for Search	507
Controlling Device Vibration	508
Going Full Screen	508
Working with Property Animations	510
Enhancing Your Views	513
Advanced Canvas Drawing	514
Creating Interactive Controls	530
Composite Drawable Resources	536
Transformative Drawables	536
Layer Drawables	537
State List Drawables	537
Level List Drawables	538
Copy, Paste, and the Clipboard	539
Copying Data to the Clipboard	539
Pasting Clipboard Data	539

CHAPTER 15: LOCATION, CONTEXTUAL AWARENESS, AND MAPPING	541
--	------------

Adding Location, Maps, and Contextual Awareness to Your Applications	542
Introducing Google Play Services	542
Adding Google Play Services to Your Application	543
Determining the Availability of Google Play Services	545
Finding Device Location Using Google Location Services	546
Using the Emulator to Test Location-Based Functionality	548
Finding the Last Known Location	549
"Where Am I" Example	551
Requesting Location Change Updates	555
Changing Device Location Settings	560
Updating the Location in the "Where Am I" Example	563
Best Practices When Using Location	566
Setting and Managing Geofences	567
Using the Legacy Platform Location-Based Services	571
Selecting a Location Provider	572
Finding the Last Known Location	574

Requesting Location Change Updates	575
Best Practice for Using the Legacy Location-Based Services	577
Using the Geocoder	580
Reverse Geocoding	581
Forward Geocoding	582
Geocoding Where Am I	583
Creating Map-Based Activities	585
Getting Your Maps API Key	586
Creating a Map-Based Activity	586
Configuring Google Maps	589
Changing the Camera Position with Camera Updates	590
Mapping Where Am I	592
Displaying the Current Location with the My Location Layer	596
Displaying Interactive Map Markers	596
Adding Shapes to Google Maps	599
Adding Image Overlays to Google Maps	602
Adding Markers and Shapes to Where Am I	602
Mapping the Earthquake Example	605
Adding Contextual Awareness	609
Connecting to the Google Play Services API Client and Obtaining API Keys	610
Using Awareness Snapshots	612
Setting and Monitoring Awareness Fences	613
Awareness Best Practices	617
CHAPTER 16: HARDWARE SENSORS	619
Introducing Android Sensors	620
Using the Sensor Manager	620
Understanding the Android Sensors	621
Discovering and Identifying Sensors	623
Determining Sensor Capabilities	625
Wakeup and Non-Wakeup Sensors	627
Monitoring Sensor Results	627
Interpreting Sensor Values	632
Testing Sensors with the Android Virtual Device and Emulator	635
Best Practices for Working with Sensors	637
Monitoring a Device's Movement and Orientation	637
Determining the Natural Orientation of a Device	638
Introducing Accelerometers	639
Detecting Acceleration Changes	640
Creating a Gravitational Force Meter	642
Determining a Device's Orientation	645
Creating a Compass and Artificial Horizon	650

Using the Environmental Sensors	654
Using the Barometer Sensor	654
Creating a Weather Station	655
Using Body Sensors	659
User Activity Recognition	662
CHAPTER 17: AUDIO, VIDEO, AND USING THE CAMERA	665
Playing Audio and Video, and Using the Camera	666
Playing Audio and Video	666
Introducing the Media Player	667
Using Media Player for Video Playback	669
Using ExoPlayer for Video Playback	672
Requesting and Managing Audio Focus	674
Pausing Playback When the Output Changes	676
Responding to the Volume Controls	677
Working with a Media Session	678
Using the Media Router and Cast Application Framework	682
Background Audio Playback	686
Building an Audio Playback Service	686
Using a Media Browser to Connect Your Activity to a Media Browser Service	688
Life Cycle of a Media Browser Service	690
Playing Audio as a Foreground Service	691
Creating Media Style Notifications	693
Using the Media Recorder to Record Audio	695
Using the Camera for Taking Pictures	697
Using Intents to Take Pictures	697
Controlling the Camera Directly	699
Reading and Writing JPEG EXIF Image Details	706
Recording Video	706
Using Intents to Record Video	707
Using the Media Recorder to Record Video	707
Adding Media to the Media Store	710
Inserting Media Using the Media Scanner	710
Inserting Media Manually	711
CHAPTER 18: COMMUNICATING WITH BLUETOOTH, NFC, AND WI-FI PEER-TO-PEER	713
Networking and Peer-to-Peer Communication	713
Transferring Data Using Bluetooth	714
Managing the Local Bluetooth Device Adapter	714
Being Discoverable and Remote Device Discovery	716

Bluetooth Communications	720
Bluetooth Profiles	725
Bluetooth Low Energy	726
Transferring Data Using Wi-Fi Peer-to-Peer	728
Initializing the Wi-Fi Peer-to-Peer Framework	729
Discovering Peers	731
Connecting with Peers	732
Transferring Data Between Peers	733
Using Near Field Communication	735
Reading NFC Tags	735
Using the Foreground Dispatch System	736
Using Android Beam	738
Creating Android Beam Messages	739
Assigning the Android Beam Payload	740
Receiving Android Beam Messages	742
CHAPTER 19: INVADING THE HOME SCREEN	743
Customizing the Home Screen	743
Introducing Home Screen Widgets	744
Defining the Widget Layout	745
Defining Your Widget Size and Other Metadata	746
Implementing Your Widget	748
Updating the Widget UI Using the App Widget Manager and Remote Views	749
Forcing Refreshes of Your Widget Data and UI	753
Creating and Using a Widget Configuration Activity	756
Creating an Earthquake Widget	757
Introducing Collection View Widgets	763
Creating Collection View Widget Layouts	764
Updating Collection View Items with a Remote Views Factory	765
Updating Collection View Items with a Remote Views Service	767
Populating Collection View Widgets Using a Remote Views Service	768
Adding Interactivity to the Items Within a Collection View Widget	769
Refreshing Your Collection View Widgets	770
Creating an Earthquake Collection View Widget	770
Creating Live Wallpaper	777
Creating a Live Wallpaper Definition Resource	778
Creating a Wallpaper Service Engine	778
Creating a Wallpaper Service	780

Creating App Shortcuts	781
Static Shortcuts	783
Dynamic Shortcuts	784
Tracking App Shortcut Use	785

CHAPTER 20: ADVANCED ANDROID DEVELOPMENT	787
---	------------

Advanced Android	788
Paranoid Android	788
Linux Kernel Security	788
Re-introducing Permissions	789
Storing Keys in the Android Keystore	792
Using the Fingerprint Sensor	792
Dealing with Different Hardware and Software Availability	793
Specifying Required Hardware	794
Confirming Hardware Availability	795
Building Backward-Compatible Applications	795
Optimizing UI Performance with Strict Mode	797
Telephony and SMS	798
Telephony	799
Sending and Receiving SMS Messages	806

CHAPTER 21: RELEASING, DISTRIBUTING, AND MONITORING APPLICATIONS	825
---	------------

Preparing for Release	826
Preparing Release Support Material	826
Preparing Your Code for a Release Build	827
Updating Application Metadata in Your Application Manifest	828
Reviewing Application Installation Restrictions	828
Application Versioning	830
Signing Production Builds of Your Application	830
Creating a Keystore and Signing Key with Android Studio	832
Obtaining API Keys Based on Your Private Release Key	833
Building and Signing a Production Release	834
Distributing Your Application on the Google Play Store	835
Introducing the Google Play Store	835
Getting Started with the Google Play Store	836
Creating an Application on the Google Play Store	837
Publishing Your Application	845
Monitoring Your Application in Production	848

Creating App Shortcuts	781
Static Shortcuts	783
Dynamic Shortcuts	784
Tracking App Shortcut Use	785
CHAPTER 20: ADVANCED ANDROID DEVELOPMENT	787
Advanced Android	788
Paranoid Android	788
Linux Kernel Security	788
Re-introducing Permissions	789
Storing Keys in the Android Keystore	792
Using the Fingerprint Sensor	792
Dealing with Different Hardware and Software Availability	793
Specifying Required Hardware	794
Confirming Hardware Availability	795
Building Backward-Compatible Applications	795
Optimizing UI Performance with Strict Mode	797
Telephony and SMS	798
Telephony	799
Sending and Receiving SMS Messages	806
CHAPTER 21: RELEASING, DISTRIBUTING, AND MONITORING APPLICATIONS	825
Preparing for Release	826
Preparing Release Support Material	826
Preparing Your Code for a Release Build	827
Updating Application Metadata in Your Application Manifest	828
Reviewing Application Installation Restrictions	828
Application Versioning	830
Signing Production Builds of Your Application	830
Creating a Keystore and Signing Key with Android Studio	832
Obtaining API Keys Based on Your Private Release Key	833
Building and Signing a Production Release	834
Distributing Your Application on the Google Play Store	835
Introducing the Google Play Store	835
Getting Started with the Google Play Store	836
Creating an Application on the Google Play Store	837
Publishing Your Application	845
Monitoring Your Application in Production	848

CONTENTS

An Introduction to Monetizing Applications	853
Application Marketing, Promotion, and Distribution Strategies	854
Application Launch Strategies	854
Internationalization	855
Using Firebase to Monitor Your Application	856
Adding Firebase to Your Application	856
Using Firebase Analytics	857
Firebase Performance Monitoring	860
INDEX	863

Contents

About the Author

Preface

1 Information Systems and People

Learning Objectives

Introduction

Information Systems in Action

Managing Operations

Supporting Customer Interactions

Making Decisions

Collaborating on Teams

Gaining Competitive Advantage

Improving Individual Productivity

The Nature of Information

Data, Information, and Knowledge

What Makes Information Valuable?

The Components of an Information System

People

Technology

Processes

Data

Information Systems, the Discipline

Information Systems Throughout the Organization

Information Systems in Business

Information Systems in Nonprofits and Government

Inside the IT Department

Collaborating on Information Systems

Improving Your Own Productivity

Promises, Perils, and Ethical Issues

THE ETHICAL FACTOR: *Ethical Issues Surrounding Information Systems*

INTERACTIVE SIMULATION: THE WORLD OF MAMMALS A Role-Playing

Simulation on Choosing a New CIO for an Animal Preserve

Chapter 1 Summary

Key Terms and Concepts

Chapter Review Questions

Projects and Discussion Questions

Application Exercises

Excel: Staff Planning Spreadsheet

Access: Information Systems in Business

Case Studies

1. Trading at the Speed of Light: Nasdaq's Information Challenges

2. Breaking News: Twitter's Growing Role in Emergencies and Disaster Communications

E-Projects

1. Analyzing the May 6 "Flash Crash" with Excel Charts

2. Gathering, Visualizing, and Evaluating Reports from Twitter and Other Sources During a Disaster

Endnotes

vii

xix

2 Information Systems and Strategy

Learning Objectives

1 Introduction

1 Porter's Five Competitive Forces

1 Threat of New Entrants

2 Power of Buyers

2 Power of Suppliers

4 Threat of Substitutes

4 Rivalry among Existing Competitors

5 Factors That Affect How the Five Forces Operate

6 Disruptive Technology and Innovations

6 Government Policies and Actions

7 Complementary Services and Products in the Ecosystem

8 Environmental Events and "Wildcards"

9 The Value Chain and Strategic Thinking

9 Extending the Value Chain: from Suppliers to the Firm to Customers

9 Benchmarking Components of the Value Chain

10 IT Benchmarks

12 Competitive Strategies in Business

13 The Role of Information Systems in Strategy

15 Information Systems: Run, Grow, and Transform the Business

16 Information Strategies and Nonprofit Organizations

17 Fund-Raising

17 Volunteering

19 Information Strategies and Government

19 INCREASING ACCESS AND ENHANCING SERVICES TO THE PUBLIC 49 • FUNDING RESEARCH FOR TECHNOLOGICAL INNOVATION 50

21 Does IT Matter?

Spending on Running, Growing, and Transforming

Leveling UP!: A Strategic Analysis

21 THE ETHICAL FACTOR: *Ethical Responsibility in an Extended Value Chain*

21 INTERACTIVE SIMULATION: LEVELING UP! A Role-Playing Simulation on Business Strategy for a New Smartphone App

Chapter 2 Summary

Key Terms and Concepts

Chapter Review Questions

Projects and Discussion Questions

Application Exercises

Excel: IT Benchmarks

Access: Telethon Call Reports

Case Studies

1. Can GameStop Survive with Its Brick-and-Mortar Stores?

2. The Battle over Net Neutrality

30

30

31

32

33

34

34

35

36

36

38

39

39

40

40

42

42

44

45

46

48

48

48

49

49

50

51

51

42

52

52

53

53

54

55

55

56

57

xi

E-Projects	
1. Identifying Company Strategy with Online Financial Chart Tools	58
2. Analyzing Media Download Times with Excel	58
Endnotes	58

3 Information and Communications Technologies: The Enterprise Architecture

Learning Objectives	
Introduction	
The Hardware	
Input and Output	
HUMAN INPUT 61 • SCANNERS AND SENSORS 63 • OUTPUT DEVICES 64	
Processing	
Storage	
PRIMARY STORAGE 66 • SECONDARY STORAGE 66	
The Software	
Types of Software	
How Is Software Created?	
PROGRAMMING LANGUAGES AND DEVELOPMENT ENVIRONMENTS 69 • SOFTWARE DEVELOPMENT AND DEPLOYMENT STRATEGIES 70 • OPEN SOURCE SOFTWARE 70	
Networks and Telecommunications	
Transmission Media and Protocols	
WIRED MEDIA 71 • WIRELESS MEDIA 72	
Networking Basics	
PACKET SWITCHING 73 • CLIENT-SERVER AND PEER-TO-PEER NETWORKS 74	
Network Protocols	
ETHERNET 75 • TCP/IP AND THE INTERNET'S HOURGLASS ARCHITECTURE 76 • WIRELESS PROTOCOLS 76	
Strategy and Competition in Telecommunications	
THE WIRELESS SPECTRUM AS OCEANFRONT PROPERTY 77 • THE LAST MILE 77 • CORD CUTTING 77	
The Enterprise Architecture	
Trends in Enterprise Architectures	
FROM MAINFRAMES TO MICROCOMPUTERS 78 • CLIENT SERVER ARCHITECTURES 78 • THIN CLIENTS 79 • VIRTUALIZATION 79 • INTEGRATION OF VOICE AND DATA 80 • CLOUD COMPUTING 80	
Guiding the Enterprise Architecture	
THE ETHICAL FACTOR: Ethical Implications of Big Data	
INTERACTIVE SIMULATION: RIVERSIDE LODGE A Role-Playing Simulation on Enterprise Architecture for a River Resort	
Chapter 3 Summary	84
Key Terms and Concepts	85
Chapter Review Questions	85
Projects and Discussion Questions	86
Application Exercises	
Excel: Analyzing Growth in Computer Storage Capacities	87
Access: Managing ICT Assets with a Database	87
Case Studies	
1. Dropbox and the Personal Cloud	87
2. The Race to 5G	88

E-Projects

1. Voluntary Distributed Computing	89
2. Analyzing Costs for Software as a Service (SaaS)	90
Endnotes	90

4 Databases and Data Warehouses

Learning Objectives	
Introduction	
The Nature of Information Resources	
Structured, Unstructured, and Semistructured Information	
Metadata	
THE QUALITY OF INFORMATION 94	
Managing Information: from Filing Cabinets to the Database	
Tables, Records, and Fields	
The Rise and Fall of File Processing Systems	
DATA REDUNDANCY AND INCONSISTENCY 97 • LACK OF DATA INTEGRATION 98 • INCONSISTENT DATA DEFINITIONS 98 • DATA DEPENDENCE 99	
Databases and Database Management Systems	
DATABASE ARCHITECTURE 99	
• THE RELATIONAL DATABASE 100	
Developing and Managing a Relational Database	
Planning the Data Model	
ENTITIES AND ATTRIBUTES 101 • PRIMARY KEYS AND UNIQUENESS 101 • NORMALIZING THE DATA MODEL 102 • RELATIONSHIPS AND FOREIGN KEYS 103 • HANDLING COMPLEX RELATIONSHIPS 104	
Accessing the Database and Retrieving Information	
SQL: STRUCTURED QUERY LANGUAGE 106 • OTHER ACCESS AND RETRIEVAL TOOLS 107 • NATURAL LANGUAGE INTERFACES 107	
Managing and Maintaining the Database	
PERFORMANCE TUNING AND SCALABILITY 108 • INTEGRITY, SECURITY, AND RECOVERY 109 • DOCUMENTATION 109	
Data Warehouses and Big Data	
Integrating Information with a Data Warehouse	
SOURCES OF DATA FOR THE DATA WAREHOUSE 110 • BUILDING THE DATA WAREHOUSE 111	
The Challenge of Big Data	
WHAT IS BIG DATA? 112 • BIG DATA TECHNOLOGIES 113	
Distributed Databases and Blockchain	
Distributed Database Architectures	
Blockchain	
The Challenges of Information Management:	
The Human Element	
Ownership Issues	
Shadow Systems	
Master Data Management	
Databases without Boundaries	
Balancing Stakeholders' Information Needs	
THE ETHICAL FACTOR: Ethical Issues in Database Design: The Case of Race and Ethnicity	
INTERACTIVE SIMULATION: VOLUNTEER NOW! A Role-Playing Simulation on Designing the Database for a Volunteer-Matching Service	

Chapter 4 Summary	117
Key Terms and Concepts	118
Chapter Review Questions	119
Projects and Discussion Questions	119
Application Exercises	
Excel: Managing Catering Supplies	120
Access: GO! Designs	121
Case Studies	
1. UK Police Track Suspicious Vehicles in Real Time with Cameras and the License Plate Database	122
2. Walmart Deploys Blockchain for Food Safety	122
E-Projects	
1. Identifying Suspects with a License Plate Database: Constructing Queries with Access	124
2. Building a Database for Customer Records	124
Endnotes	125

5 Information Systems for the Enterprise

Learning Objectives	127
Introduction	127
Finance Management	128
Components of Financial Information Systems	128
INTEGRATING THE COMPONENTS 128 • FINANCIAL WORKFLOWS 129	
Financial Reporting, Compliance, and Transparency	130
EXCEPTION REPORTING 131 • COMPLIANCE REPORTING 131 • XBRL 131 • IMPROVING TRANSPARENCY 131	
Human Capital Management	132
Components of Human Capital Management Systems	132
HUMAN RESOURCES MANAGEMENT 132 • WORKFORCE MANAGEMENT 132 • TALENT MANAGEMENT 132 • SOCIAL NETWORKING AND HCM 132	
HCM Metrics	133
Managing the Supply Chain	134
Supply Chain Fundamentals	134
THE PLANNING STEP 134 • CHOOSING SOURCES 135 • MAKE/DELIVER/RETURN 135	
Measuring Performance in Supply Chains	136
SUPPLY CHAIN VISIBILITY 136 • SUPPLY CHAIN METRICS 136 • REDUCING SUPPLY CHAIN COSTS 137 • SUPPLY CHAIN DISRUPTIONS 137	
Information Systems and Technology for Supply Chain Management	138
SUPPLY CHAIN COLLABORATION: ELECTRONIC DATA INTERCHANGE AND BLOCKCHAIN 138 • SUPPLY CHAIN AND THE INTERNET OF THINGS 139	
Customer Relationship Management	141
CRM Goals and Metrics	142
IMPROVING CUSTOMER RETENTION 142 • IMPROVING PROFITABILITY 142 • GROWING REVENUE 142 • LISTENING TO CUSTOMERS 143	
CRM Strategies and Technologies	143
MARKETING 144 • SALES FORCE AUTOMATION 145 • CUSTOMER SERVICE AND SUPPORT 145 • MOBILE CRM 146	

Enterprise Resource Planning (ERP): Bringing It All Together	147
ERP Components	147
STUDENT'S VIEW OF THE ERP 147 • THE FACULTY'S VIEW OF THE ERP 148	
ERP Integration Strategies	149
MAKING CONNECTIONS WITH MIDDLEWARE 150 • PROS AND CONS OF DIFFERENT INTEGRATION STRATEGIES 150	
Implementation Issues	150
ERP AND SOFTWARE AS A SERVICE (SaaS) 151 • ERP PROS AND CONS 151	
THE ETHICAL FACTOR: Ethics and Talent Management	152
INTERACTIVE SIMULATION: CUSTOM CAKES: A Role-Playing Simulation on Enterprise Information Systems and the Supply Chain	152
Chapter 5 Summary	152
Key Terms and Concepts	153
Chapter Review Questions	153
Projects and Discussion Questions	154
Application Exercises	
Excel: Performance Bicycle Parts	154
Access: VSI Consultants	155
Case Studies	
1. Salesforce.com: Taking CRM to the Cloud	156
2. Meeting Demands of Global Growth, Netflix Migrates to Integrated ERP	157
E-Projects	
1. CRM for Human Services Agencies	158
2. Evaluating Employment and Recruitment Websites	159
Endnotes	159

6 Developing a Digital Presence: Websites, Social Media, and Mobile Apps

Learning Objectives	161
Introduction	161
Developing a Digital Strategy	162
Choosing a Goal	162
INFORM OR ENTERTAIN THE AUDIENCE 162 • INFLUENCE THE AUDIENCE 163 • SELL PRODUCTS AND SERVICES 163 • FACILITATE OFFLINE RELATIONSHIPS 163	
Social Media Goals	164
Building the Website	164
The Website's Name and Virtual Address	165
COMPONENTS OF A URL 165 • MANAGING DOMAIN NAMES AND VIRTUAL REAL ESTATE 166 • DISPUTES OVER DOMAIN NAMES 166	
Website Design	167
WEBSITE INFORMATION ARCHITECTURE AND NAVIGATION 167 • USABILITY AND USER INTERFACE DESIGN 168 • WEB ACCESSIBILITY FOR PEOPLE WITH DISABILITIES 168	
Software Development Strategies for the Web	171
HTML AND HTML 5 172 • CREATING INTERACTIVE, MEDIA-RICH WEBSITES 173 • CONTENT MANAGEMENT SYSTEMS 174	
E-Commerce	175
The Online Transaction and E-Commerce Software	175

10 Ethics, Privacy, and Security

Learning Objectives

Introduction

Ethics

Ethical Frameworks

Ethics and the Law

Ethical Issues and Information and Communications Technologies

Information Ethics

Intellectual Property and Digital Rights Management

ENFORCING IP LAWS 293 • PIRACY 293 • PROTECTING IP WITH TECHNOLOGY 294

Plagiarism

Privacy

Trading Privacy for Convenience and Freebies

Anonymity

Surveillance

"The Right to Be Forgotten"

Information Security

Risk Management

Identifying Threats

MALWARE AND BOTNETS 301 • DISTRIBUTED DENIAL OF SERVICE 302 • PHISHING 302 • RANSOMWARE 304 • INFORMATION LEAKAGE 304

Assessing Vulnerability

Administrative Security Controls

Technical Security Controls

AUTHENTICATION STRATEGIES 307 • ENCRYPTION 308 • INTRUSION PREVENTION AND DETECTION SYSTEMS 308 • FIREWALLS 309 • BLOCKING SPAM 309

Information Security and Cloud Computing

The Human Element in Information Ethics, Security, and Privacy

Cognitive Issues and Productivity

AVOIDING WEAK PASSWORDS 311 • REDUCING COMPLEXITY 311

Social Engineering and Information Security

Security Awareness and Ethical Decision Making

THE ETHICAL FACTOR: *Ethical Dilemmas in a Distributed Denial of Service Attack*

INTERACTIVE SIMULATION: VAMPIRE LEGENDS A Role-Playing

Simulation on Ethics, Privacy, and Security in the

Multiplayer Online Game Business

Chapter 10 Chapter Summary 314

Key Terms and Concepts 315

Chapter Review Questions 315

Projects and Discussion Questions 316

Application Exercises

Excel: Citywide Community College 317

Access: Citywide Community College 317

Case Studies

1. Equifax: A Massive Data Breach at a Consumer Reporting Agency 318

2. Community Policing on the Internet: Spamhaus Targets Worldwide Spammers 319

289 E-Projects

1. Tracking the Trackers: Investigating How Third-Party Cookies Steer the Ads You See 320

2. Who Are the Spammers? 321

Endnotes 321

11 Systems Development and Procurement

Learning Objectives

Introduction

Systems Development Life Cycle

Planning

ASSESSING BUSINESS NEED 324 • FEASIBILITY STUDY 325

Analysis

PROCESS DIAGRAMS AND BUSINESS PROCESS IMPROVEMENT 325 • REQUIREMENTS DEFINITION DOCUMENT 326 • BUILD OR BUY? 327

Design Phase

ARCHITECTURAL DESIGN 327 • SERVICE-ORIENTED ARCHITECTURE 328 • APPLICATION PROGRAMMING INTERFACES (API) 328 • DATA MODELS AND DATABASE DESIGN 329

Development Phases

Testing Phase

Implementation

Maintenance

BUG FIXES AND CHANGE REQUESTS 333 • WHEN INFORMATION SYSTEMS GROW OLD 334

Software Development Strategies

Waterfall Software Development

Iterative Methods

Agile Methods

SCRUM 337 • EXTREME PROGRAMMING (XP) 337

311 Comparing Software Development Approaches

Type of Project

Organizational Culture

Is Waterfall Dead?

Global Software Development

Software Procurement: The "Buy" Strategy

Pros and Cons of Build and Buy

The Procurement Process

RFI AND RFP 340 • EVALUATING THE OPTIONS 341

Adaptation and Customization

The Human Element in Systems

Development and Procurement

Working in Teams

Working with Consultants

ADVANTAGES AND DISADVANTAGES 343 • CONTRACT MANAGEMENT 344

The Role of Senior Management

THE ETHICAL FACTOR: *Developing Systems That Promote Ethical Decision Making and Social Responsibility*

INTERACTIVE SIMULATION: GREEN WHEELING A Role-Playing

Simulation on Systems Development and Procurement

Chapter 11 Chapter Summary	345	FUNDING MODELS FOR IT	364 • ACCEPTABLE-USE AND SECURITY POLICIES	365 • RECORD RETENTION POLICIES	366 • ENTERPRISE ARCHITECTURE	367
Key Terms and Concepts	346	Project Portfolio Management				367
Chapter Review Questions	347	DECIDING WHICH PROJECTS TO PURSUE	367 • MANAGING THE PORTFOLIO			368
Projects and Discussion Questions	347	Disaster Recovery and Business Continuity Planning				369
Application Exercises		Technology and Industry Trends				370
Excel: Jay's Bikes	348	Planning for the Future: the Human Element				371
Access: Managing a Recipe Collection	348	Cognitive Biases and Strategic Planning				371
Case Studies		The Black Swan				373
1. Baby Steps toward Scrum: How BabyCenter.com Made the Cultural Transition to Agile Software Development	349	THE ETHICAL FACTOR: Code of Ethics for Project Managers				360
2. Extreme Programming at the US Strategic Command	350	INTERACTIVE SIMULATION: EXTREME VIRTUAL REALITY: A Role-Playing Simulation on Managing a Project to Open a New Business				374
E-Projects		Chapter 12 Chapter Summary				375
1. Watching Babycenter.com Change over Time with the Internet Archive	351	Key Terms and Concepts				376
2. Analyzing Software Defect Rates Using Excel	351	Chapter Review Questions				376
Endnotes	352	Projects and Discussion Questions				376
		Application Exercises				
		Excel: Creating a Gantt Chart with Excel				377
		Access: Apprentice Project Managers				378
		Case Studies				
		1. Predicting the Future: Gartner's Research Informs Strategic Planning				379
		2. JetBlue and WestJet: A Tale of Two Software Implementations				381
		E-Projects				
		1. Examining an IT Strategic Plan				382
		2. Analyzing Airline Performance with Excel Pivot Tables				382
		Endnotes				382
		Comprehensive Case Studies				
		1. Facebook's Privacy Challenges				384
		2. Enabling the Sharing Economy: The Case of Uber Technologies				388
		3. Apple: Can the Company Pull off Another Disruptive Innovation?				391
		4. Managing the Federal Government's IT Project Portfolio				394
		Case Studies				384
		Glossary				397
		Index				405

12 Information Systems Project Management and Strategic Planning

Learning Objectives

Introduction

What Is a Project?

Projects versus Processes

The Triple Constraint: Time, Cost, and Scope

Project Management

The Five Project Management Processes

INITIATING 358 • PLANNING 357 • EXECUTING 358 • MONITORING AND CONTROLLING 359 • CLOSING 359

The Role of the Project Manager

Project Management Software

Managing Time

Managing People and Resources

Managing Costs

Why Projects Succeed and Why They Fail

Why Do Projects Fail?

Success Factors for Project Management

Strategic Planning for Information Systems

Vision, Principles, and Policies

Brief Contents

- 1 Environmental Considerations 1
- 2 Invertebrate Classification and Relationships 5
- 3 The Protozoans 33
- 4 The Poriferans and Placozoans 75
- 5 Introduction to the Hydrostatic Skeleton 93
- 6 The Cnidarians 97
- 7 The Ctenophores 131
- 8 The Platyhelminths 143
- 9 The Mesozoans:
Possible Flatworm Relatives 173
- 10 The Rotifers and Acanthocephalans 177
- 11 The Nemertines 195
- 12 The Molluscs 207
- 13 The Annelids and Sipunculans 285
- 14 The Arthropods 329
- 15 Two Phyla of Likely Arthropod Relatives:
Tardigrades and Onychophorans 407
- 16 The Nematodes 417
- 17 Four Phyla of Likely Nematode Relatives:
Nematomorpha, Priapulida, Kinorhyncha,
and Loricifera 437
- 18 Five Phyla (Plus One Species) of Uncertain
Affiliation: Myxozoa, Gnathostomulida,
Gastrotricha, *Xenoturbella bocki*,
Chaetognatha, and Cyclophora 445
- 19 The Lophophorates (Phoronids,
Brachiopods, Bryozoans) and
Entoprocts 461
- 20 The Echinoderms 485
- 21 The Hemichordates 515
- 22 The Nonvertebrate Chordates 523
- 23 Invertebrate Reproduction
and Development—An Overview 539

Expanded Contents

<i>List of Research Focus Boxes</i>	<i>iv</i>
<i>Preface/Introduction</i>	<i>xi</i>
<i>Guide to the Major Animal Groups</i>	<i>xvi</i>
<i>The Geologic Time Scale</i>	<i>xvii</i>

1

Environmental Considerations 1

2

Invertebrate Classification and Relationships 5

Introduction	5
Classification by Cell Number, Embryology, and Body Symmetry	6
Classification by Developmental Pattern	7
Classification by Evolutionary Relationship	14
Deducing Evolutionary Relationships	17
Why Determine Evolutionary Trees?	21
How Evolutionary Relationships Are Determined	21
Uncertainty about Evolutionary Relationships	27
Time Machines: Help from the Fossil Record	27
Classification by Habitat and Lifestyle	28

3

The Protozoans 33

Introduction	33
General Characteristics	35

Protozoan Locomotory Systems	37
Structure and Function of Cilia	38
Structure and Function of Flagella	39
Structure and Function of Pseudopodia	39
Protozoan Reproduction	40
Protozoan Feeding	42
General Summary	42
The Alveolates	42
Phylum Ciliophora	42
Patterns of Ciliation	43
Other Morphological Features	43
Reproductive Characteristics	45
Ciliate Lifestyles	48
Phylum Dinozoa (= Dinoflagellata)	50
Phylum Apicomplexa ($\approx$ Sporozoa)	54
Phylum Microsporidea	57
Phylum Myxozoa (= Myxospora)	57
Amoeboid Protozoans	58
The Gymnamoebae (members of the Amoebozoa)	58
The Arcellanid and Other Test-bearing Amoebae (members of the Amoebozoa)	59
Phylum Granuloreticulosa (members of the Cercozoa)	59
Phylum Radiozoa (members of the Cercozoa)	61
Phylum Heliozoa (not members, but likely relatives of the Cercozoa)	61
Flagellated Protozoans	62
The Phytoflagellated Protozoans	63
The Zooflagellated Protozoans— Free-Living Forms	63
The Zooflagellated Protozoans— Parasitic Forms	63
Some Transitional Forms and Misfits	66

4

The Poriferans
and Placozoans 75

- Phylum Porifera 75
 - Introduction 75
 - General Characteristics 77
 - Poriferan Diversity 82
 - Other Features of Poriferan Biology:
 - Reproduction and Development 86
- Phylum Placozoa 87
 - Introduction 87
 - General Characteristics 87

5

Introduction to the
Hydrostatic Skeleton 93

6

The Cnidarians 97

- Introduction and General Characteristics 97
- Class Scyphozoa 100
- Class Cubozoa 105
- Class Hydrozoa 105
 - Order Hydroida 105
 - Order Siphonophora 110
 - The Hydrocorals 112
- Class Anthozoa 113
 - Subclass Hexacorallia (= Zoantharia) 116
 - Subclass Octocorallia (= Alcyonaria) 119

7

The Ctenophores 131

- Introduction and General Characteristics 131
- Ctenophore Diversity 137
 - Class Tentaculata 137
 - Class Nuda 140
- Other Features of Ctenophore Biology:
 - Reproduction 140

8

The Platyhelminths 143

- Introduction and General Characteristics 143
- Class Turbellaria 145
- Class Cestoda 149
- Class Monogenea 153
- Class Trematoda 153
 - The Digeneans 154
 - The Aspidogastrea (= Aspidobothreans) 163

9

The Mesozoans:
Possible Flatworm Relatives 173

- The Mesozoans 173
 - Class Orthonectida 174
 - Class Rhombozoa 175

10

The Rotifers
and Acanthocephalans 177

- Introduction 177
- Phylum Rotifera 178
- Introduction and General Characteristics 178
 - Class Seisonidea 182
 - Class Bdelloidea 183
 - Class Monogononta 183
- Other Features of Rotifer Biology 188
 - Digestive System 188
 - Nervous and Sensory Systems 189
 - Excretion and Water Balance 189
- Phylum Acanthocephala 189

11

The Nemertines 195

- Introduction and General Characteristics 195
- Other Features of Nemertine Biology 202
 - Classification 202
 - Protection from Predators 202
 - Reproduction and Development 202

12

The Molluscs 207

- Introduction and General Characteristics 207
- Class Polyplacophora 210
- Class Aplacophora 214
- Class Monoplacophora 214
- Class Gastropoda 216
 - The Prosobranchs 221
 - The Opisthobranchia 227
 - The Pulmonata 229
- Class Bivalvia (= Pelecypoda) 230
 - Subclass Protobranchia 233
 - Lamellibranchs 235
 - Subclass Anomalodesmata 243
- Class Scaphopoda 246
- Class Cephalopoda 247
- Other Features of Molluscan Biology 257
 - Reproduction and Development 257
 - Circulation, Blood Pigments,
and Gas Exchange 260
 - Nervous System 261
 - Digestive System 261
 - Excretory System 261

13

The Annelids
and Sipunculans 285

- Introduction 285
- Phylum Annelida 285
 - General Annelid Characteristics 285
- Class Polychaeta 287
 - Polychaete Reproduction 293
- Family Siboglinidae
(formerly the Pogonophora) 295
 - General Characteristics 295
 - Siboglinid Reproduction
and Development 300
- Class Clitellata 302
 - Subclass Oligochaeta 302
 - Oligochaete Reproduction 304
 - Subclass Hirudinea 306
 - Leech Reproduction 308

Class Echinura 308

Other Features of Annelid Biology 311

Digestive System 311

Nervous System and Sense Organs 311

Circulatory System 314

Phylum Sipuncula 314

14

The Arthropods 329

- Introduction and General Characteristics 329
 - The Exoskeleton 330
 - The Hemocoel 330
 - Molting 331
 - Nerves and Muscles 332
 - The Circulatory System 333
 - Arthropod Visual Systems 333
 - Classification and Evolutionary
Relationships 337
- Subphylum Trilobitomorpha 338
 - Class Trilobita 338
- Subphylum Chelicerata 339
 - Class Merostomata 339
 - Class Arachnida 340
 - Class Pycnogonida (= Pantopoda) 344
- Subphylum Mandibulata 345
 - Class Myriapoda 345
 - Orders Chilopoda and Diplopoda 346
 - Class Insecta (= Hexapoda) 347
 - Class Crustacea 358
 - Subclass Malacostraca 359
 - Subclass Branchiopoda 363
 - Subclass Ostracoda 365
 - Subclass Copepoda 365
 - Subclass Pentastomida 371
 - Subclass Cirripedia 373
- Other Features
 - of Arthropod Biology 373
 - Reproduction and Development 373
 - Digestion 380
 - Excretion 382
 - Blood Pigments 383

15

Two Phyla of Likely Arthropod Relatives: Tardigrades and Onychophorans 407

Introduction and General Characteristics 407

Phylum Tardigrada 408

Phylum Onychophora 410

16

The Nematodes 417

Introduction and General Characteristics 417

Body Coverings and Body Cavities 418

Musculature, Internal Pressure, and Locomotion 420

Organ Systems and Behavior 421

Reproduction and Development 423

Parasitic Nematodes 424

Beneficial Nematodes 429

17

Four Phyla of Likely Nematode Relatives: Nematomorpha, Priapulida, Kinorhyncha, and Loricifera 437

Introduction 437

Phylum Nematomorpha 438

Phylum Priapulida 438

Phylum Kinorhyncha (= Echinoderida) 440

Phylum Loricifera 440

18

Five Phyla (Plus One Species) of Uncertain Affiliation: Myxozoa, Gnathostomulida, Gastrotricha, *Xenoturbella bocki*, Chaetognatha, and Cyclophora 445

Introduction 445

Phylum Myxozoa (= Myxospora) 445

Phylum Gnathostomulida 446

Phylum Gastrotricha 447

Phylum Uncertain 449

Xenoturbella bocki 449

Phylum Chaetognatha 449

General Characteristics and Feeding 449

Chaetognath Reproduction 452

Chaetognath Lifestyles and Behavior 452

Chaetognath Relationships 453

Phylum Cyclophora 455

19

The Lophophorates (Phoronids, Brachiopods, Bryozoans) and Entoprocts 461

Introduction and General Characteristics 461

Phylum Phoronida 463

Phylum Brachiopoda 464

Phylum Bryozoa

(= Ectoprocta; = Polyzoa) 468

Class Phylactolaemata 471

Class Gymnolaemata 473

Class Stenolaemata 476

Other Features of Lophophorate Biology 476

Reproduction 476

Digestion 477

Nervous System 477

Phylum Entoprocta (= Kamptozoa) 478

20

The Echinoderms 485

Introduction and General Characteristics 485

Class Crinoidea 488

Class Stellerioidea 491

Subclass Ophiuroidea 491

Subclass Asteroidea 493

The Concentricycloids 496

Class Echinoidea 497

Class Holothuroidea 502

Other Features of Echinoderm Biology 507

Reproduction and Development 507

Nervous System 507

21

The Hemichordates 515

Introduction and General Characteristics 515

Class Enteropneusta 516

Class Pterobranchia 518

22

The Nonvertebrate Chordates 523

Introduction and General Characteristics 523

Subphylum Urochordata (= Tunicata) 524

Class Ascidiacea 524

Class Larvacea (= Appendicularia) 527

Class Thaliacea 528

Other Features of Urochordate Biology 531

Reproduction 531

Excretory and Nervous Systems 532

Subphylum Cephalochordata (= Acrania) 532

23

Invertebrate Reproduction and Development— An Overview 539

Introduction 539

Asexual Reproduction 540

Sexual Reproduction 542

Patterns of Sexuality 542

Gamete Diversity 543

Getting the Gametes Together 545

Larval Forms 551

Dispersal as a Component of the Life-History Pattern 561

Glossary of Frequently Used Terms 571

Index 575

Contents

List of Contributors	xi
Preface	xiii

1 Bioenergetics

Dominique P. Bureau, Sadasivam J. Kaushik,
and C. Young Cho

1.1	Introduction	2
1.2	History of Nutritional Energetics	3
1.3	Energy Exchange in Biological Systems	5
1.4	Energy Utilization and Requirements	7
1.5	Digestible Energy of Feedstuffs	14
1.6	Effect of Biological and Environmental Factors	16
1.7	Urinary and Branchial Energy and Metabolizable Energy	18
1.8	Factors Affecting Metabolic Waste Output	21
1.9	Heat Production	24
1.10	Minimal Metabolism	29
1.11	Heat Increment of Feeding	35
1.12	Digestion and Absorption Processes (HdE)	37
1.13	Recovered Energy and Growth	43
1.14	Reproduction	47
1.15	Integrating and Using Information from Bioenergetics	48
1.16	Limitations and Perspectives of Bioenergetics	53
	References	54

2 The Vitamins

John E. Halver

2.1	Historical Introduction	62
2.2	The Water-Soluble Vitamins	66
2.3	The Fat-Soluble Vitamins	113
2.4	Other Factors	128
2.5	Anemias and Hemapoiesis	130
	References	132

3 Amino Acids and Proteins

Robert P. Wilson

	144
3.1 Introduction	145
3.2 Protein Requirements	151
3.3 Qualitative Amino Acid Requirements	152
3.4 Quantitative Amino Acid Requirements	170
3.5 Other Methods of Estimating Amino Acid Needs	175
References	

4 The Lipids

John R. Sargent, Douglas R. Tocher,
and J. Gordon Bell

	182
4.1 Introduction	184
4.2 Structures and Biosynthesis	194
4.3 Functions	201
4.4 Fatty Acids and Dietary Energy	
4.5 Optimal Levels and Ratios of Dietary <i>n</i> -3 and <i>n</i> -6 Polyunsaturated Fatty Acids	206
4.6 Dietary Phosphoglycerides: Inositol and Choline	227
4.7 Fatty Acid Peroxidation	232
4.8 Sources of Lipids for Farmed Fish Feeds	239
4.9 Prospects	244
References	246

5 The Minerals

Santosh P. Lall

	260
5.1 Introduction	271
5.2 Essential Minerals for Finfish	300
5.3 Concluding Remarks	301
References	

6 Intermediary Metabolism

Konrad Dabrowski and Helga Guderley

	310
6.1 Introduction: Metabolic Circuitry and Control Mechanisms	313
6.2 Carbohydrate Metabolism	333
6.3 Protein and Amino Acid Metabolism	358
6.4 Conclusions	360
References	

7 Nutritional Physiology

Michael B. Rust

7.1	Introduction	
7.2	Gross Juvenile and Adult Anatomy	368
7.3	Sensory Organs	369
7.4	Food Capture Structures and Organs	378
7.5	Digestive Organs	389
7.6	Liver	393
7.7	Anatomy and Diet	413
7.8	Digestive Processes	415
7.9	Postabsorptive Transport and Processing	417
7.10	Control and Regulation of Digestion	427
7.11	Nutritional Physiology in Larval Fish	428
	References	432
		446

8 Nutritional Pathology

Ronald J. Roberts

8.1	Introduction	
8.2	Principles of Nutritional Pathology	454
8.3	The Deficiency and Imbalance Diseases	455
8.4	Micronutrients	459
8.5	Mineral Deficiencies and Imbalances	464
8.6	Dietary Mineral Toxicity	480
8.7	Mycotoxins	484
8.8	Toxic Algae	489
8.9	Cottonseeds	492
8.10	<i>Senecio</i> Alkaloids	492
8.11	<i>Leucaena</i> Toxins	492
8.12	Anthropogenic Chemicals	494
8.13	Binders	494
8.14	Photosensitizers	494
8.15	Sekoke Disease	495
8.16	Spleen- and Liver-Induced Cataracts	497
8.17	Single-Cell Protein Lesions	498
8.18	Antibiotic and Chemotherapeutic Toxicity	500
	References	500
		500

9 Diet Formulation and Manufacture

Ronald W. Hardy and Frederick T. Barrows

9.1	Introduction	
9.2	Aims and Strategy of Fish Feed Production	506
		514

9.3	Feed Ingredients	515
9.4	Diet Formulation	538
9.5	Diet Manufacture and Storage	558
9.6	Ingredient and Diet Evaluation	578
9.7	Glossary	594
	References	596

10 Adventitious Toxins

Jerry D. Hendricks

10.1	Introduction	602
10.2	Naturally Occurring Toxins in Formulated Fish Rations	603
10.3	Nonnatural Components and Additives in Formulated Rations	630
10.4	Summary	641
	References	641

11 Special Feeds

George M. Pigott and Barbee W. Tucker

11.1	Introduction	652
11.2	Formulation of Special Feeds	652
11.3	Feed Manufacturing	661
11.4	Summary	667
	References	668

12 Nutrition and Fish Health

Delbert M. Gatlin III

12.1	Introduction	672
12.2	Factors Affecting Fish Health	673
12.3	Dietary Components Influencing Fish Health	675
12.4	Feeding Practices Affecting Fish Health	694
12.5	Concluding Remarks and Research Needs	698
	References	699

13 Diet and Fish Husbandry

Richard T. Lovell

13.1	Introduction	704
13.2	Channel Catfish	708
13.3	Salmonids	720
13.4	Tilapias	732
13.5	Penaeid Shrimp	741
	References	753

14 Nutrient Flow and Retention

John E. Halver and Ronald W. Hardy

14.1	Introduction	756
14.2	Carbohydrate Metabolism	757
14.3	Glycolysis	757
14.4	Carbohydrate Synthesis	759
14.5	Pentose Phosphate Pathway	759
14.6	Glycogenolysis	759
14.7	Diet and Carbohydrate Metabolism	760
14.8	Lipid Metabolism	760
14.9	Odd-Chain-Length Fatty Acid Oxidation	762
14.10	Electron Transfer Cascade	763
14.11	Amino Acid Metabolism	763
14.12	Effect of Diet on Intermediary Metabolism	765
14.13	Measuring Protein Accretion and Degradation	766
14.14	Intake and Metabolism	767
14.15	Sexual Maturity and Metabolism	767
14.16	Prospects for Improvement of Protein Retention Efficiency	768
	References	769
Appendix		771
Index		807