

SECOND EDITION

Object-Oriented Software Development Using Java™

PRINCIPLES,
PATTERNS, AND
FRAMEWORKS

Xiaoping Jia

CONTENTS

Preface xv

CHAPTER 1 Object-Oriented Software Development	1
1.1 The Challenges of Software Development	2
1.2 An Engineering Perspective	4
1.2.1 Software Development Activities	4
1.2.2 Software Development Processes	5
1.2.3 Desirable Qualities of Software Systems	6
1.2.4 Is Software Development an Engineering Process?	8
1.3 Object Orientation	9
1.3.1 Modeling the Real World	9
1.3.2 Evolution of Programming Models	10
1.3.3 A Brief History	10
1.4 Iterative Development Processes	11
1.4.1 Object-Oriented Development Activities	12
1.4.2 Rational Unified Process	13
1.4.3 Extreme Programming	15
Chapter Summary	16
Further Readings	17
Exercises	18
CHAPTER 2 Object-Oriented Modeling Using UML	19
2.1 Principles and Concepts	19
2.1.1 Objects and Classes	20
2.1.2 Principles	26
2.2 Modeling Relationships and Structures	29
2.2.1 Inheritance	29
2.2.2 Association	32
2.2.3 Aggregation and Composition	34
2.2.4 Dependency	35
2.3 Modeling Dynamic Behavior	36

2.3.1	Sequence Diagram	36
2.3.2	State Diagram	37
2.4	Modeling Requirements with Use Cases	41
2.4.1	Terms and Concepts	41
2.4.2	Use Case Diagrams	42
2.5	Case Study: An E-Bookstore	44
2.5.1	Conceptualization	44
2.5.2	Use Cases	44
2.5.3	Object Models	46
	Chapter Summary	51
	Further Readings	52
	Exercises	52

CHAPTER 3 Introduction to Java **55**

3.1	An Overview of the Java 2 Platform	56
3.2	The Java Run-Time Architecture	59
3.2.1	Program Execution Models	60
3.2.2	Java Virtual Machine	61
3.3	Getting Started with Java	65
3.3.1	A Simple Java Application	65
3.3.2	A Java Applet	67
	Common Problems and Solutions	72
	Chapter Summary	73
	Further Readings	73
	Exercises	74

CHAPTER 4 Elements of Java **75**

4.1	Lexical Elements	76
4.1.1	Character Set	76
4.1.2	Identifiers	77
4.1.3	Primitive Types and Literals	77
4.1.4	Operators and Expressions	80
4.2	Variables and Types	87
4.2.1	Variable Declarations	88
4.2.2	Type Compatibility and Conversion	88
4.2.3	Reference Types	89
4.2.4	Arrays	91
4.3	Statements	93
4.3.1	Expression Statements	94
4.3.2	Statement Blocks	94
4.3.3	Local Variable Declarations	95
4.3.4	The <code>return</code> Statement	95
4.3.5	Selection Statements	96

4.3.6	Loop Statements	96
4.3.7	The <code>break</code> and <code>continue</code> Statements	99
4.4	Class Declarations	101
4.4.1	Syntax of Class Declarations	101
4.4.2	Creating and Initializing Objects	104
4.4.3	Accessing Fields and Methods	106
4.4.4	Method Invocation and Parameter Passing	107
4.4.5	Class (Static) Fields and Methods	110
4.4.6	Object Reference <code>this</code>	114
4.4.7	Interfaces and Abstract Classes	117
4.4.8	Strings	118
4.4.9	Wrapper Classes	128
4.5	Packages	134
4.5.1	Using Packages	135
4.5.2	Partitioning the Name Space	136
4.5.3	Packages and the Directory Structure	136
4.5.4	Organization of the Java Class Library	138
4.6	Exceptions	139
4.6.1	Sources of Exceptions	140
4.6.2	Hierarchy of Exceptions	140
4.6.3	Throwing Exceptions	143
4.6.4	Catching and Handling Exceptions	144
4.7	A Simple Animation Applet	148
	Chapter Summary	155
	Exercises	156
	Project	157

CHAPTER 5 Classes and Inheritance 159

5.1	Overloading Methods and Constructors	159
5.2	Extending Classes	163
5.2.1	Constructors of Extended Classes	164
5.2.2	Subtypes and Polymorphism	165
5.2.3	Overriding Methods	171
5.3	Extending and Implementing Interfaces	176
5.3.1	Subtypes Revisited	177
5.3.2	Single Versus Multiple Inheritance	179
5.3.3	Name Collisions among Interfaces	183
5.3.4	Marker Interfaces	184
5.4	Hiding Fields and Class Methods	184
5.5	Applications—Animation Applets	186
5.5.1	Parameters of Applets	186
5.5.2	An Idiom for Animation Applets	188
5.5.3	Double-Buffered Animation	193
5.5.4	Reading Files in Applets	200

Common Problems and Solutions	202
Chapter Summary	202
Exercises	204
Projects	204

CHAPTER 6 From Building Blocks to Projects

207

6.1	Design and Implementation of Classes	207
6.1.1	Public and Helper Classes	207
6.1.2	Class Members	209
6.1.3	Design Guidelines	209
6.1.4	Documenting the Source Code	214
6.2	Contracts and Invariants	216
6.2.1	Contracts of Methods	216
6.2.2	Invariants of Classes	222
6.2.3	Assertions	224
6.2.4	Design by Contract	226
6.3	The Canonical Form of Classes	227
6.3.1	No-Argument Constructor	228
6.3.2	Object Equality	228
6.3.3	Hash Code of Objects	230
6.3.4	Cloning Objects	231
6.3.5	String Representation of Objects	234
6.3.6	Serialization	234
6.4	Unit Testing	235
6.4.1	Simple Unit Testing	235
6.4.2	JUnit—A Unit-Testing Tool	239
6.4.3	Testing Coverage Criteria	241
6.5	Project Build	243
6.5.1	Ant—A Build Tool	243
Chapter Summary	246	
Further Readings	247	
Exercises	247	

CHAPTER 7 Design by Abstraction

249

7.1	Design Patterns	249
7.1.1	Design Pattern: Singleton	251
7.2	Designing Generic Components	252
7.2.1	Refactoring	252
7.2.2	Design Pattern: Template Method	266
7.2.3	Generalizing	271
7.2.4	Design Pattern: Strategy	275
7.3	Abstract Coupling	276
7.3.1	Enumerating Elements	278

7.3.2 Design Pattern: Iterator	283
7.4 Design Case Study—Animation of Sorting Algorithms	284
7.4.1 The Initial Implementation	285
7.4.2 Separating Algorithms	290
7.4.3 Design Pattern: Factory	296
7.4.4 Separating Display Strategies	296
Chapter Summary	302
Further Readings	304
Exercises	304
Project	304
CHAPTER 8 Object-Oriented Application Frameworks	305
8.1 Application Frameworks	305
8.1.1 Characteristics	306
8.1.2 Design Requirements	307
8.1.3 Specific Frameworks Considered	308
8.2 The Collections Framework	308
8.2.1 Abstract Collections	309
8.2.2 Interfaces of Collections	310
8.2.3 Implementations of Collections	315
8.2.4 Iterators of Collections	319
8.2.5 Ordering and Sorting	324
8.3 The Graphical User Interface Framework—AWT and Swing	333
8.3.1 The GUI Components	333
8.3.2 Design Pattern: Composite	336
8.3.3 Layout Managers	338
8.3.4 Handling Events	348
8.3.5 Frames and Dialogs	359
8.4 The Input/Output Framework	366
8.4.1 Byte Streams	367
8.4.2 Design Pattern: Decorator	380
8.4.3 Character Streams	382
8.4.4 Random Access Files	389
Chapter Summary	392
Further Reading	394
Exercises	394
Projects	395
CHAPTER 9 Design Case Study: A Drawing Pad	397
9.1 Planning	397
9.2 Iteration 1: A Simple Scribble Pad	398
9.2.1 The Scribbling Canvas and Its Listener	399
9.2.2 The Application	402

9.3	Iteration 2: Menus, Options, and Files	403
9.3.1	Strokes	403
9.3.2	The Scribble Canvas	405
9.3.3	The Canvas Listener	408
9.3.4	The Application	409
9.3.5	Choosing Colors	416
9.4	Iteration 3: Refactoring	421
9.4.1	The Shapes	421
9.4.2	The Tools	424
9.4.3	Extending Components	428
9.5	Iteration 4: Adding Shapes and Tools	432
9.5.1	The Shapes	433
9.5.2	The Toolkit	436
9.5.3	Design Pattern: State	438
9.5.4	A Concrete Tool—TwoEndsTool	439
9.5.5	Extending Components	442
9.5.6	Design Pattern: Factory Method	447
9.6	Iteration 5: More Drawing Tools	448
9.6.1	Filled Shapes	448
9.6.2	Drawing Filled Shapes	449
9.6.3	The Application	452
9.7	Iteration 6: The Text Tool	453
9.7.1	The Text Shape	454
9.7.2	The Keyboard Input Tool	455
9.7.3	The Font Option Menu	459
	Chapter Summary	462
	Further Readings	462
	Project	463

CHAPTER 10 More Design Patterns**465**

10.1	Type-Safe Enumeration Types	465
10.1.1	A Simple Maze Game	465
10.1.2	Enumeration Types	466
10.1.3	Unordered Type-Safe Enumeration Idiom	468
10.1.4	Ordered Type-Safe Enumeration Idiom	469
10.2	Creational Design Patterns	470
10.2.1	A Simple Design of the Maze Game	470
10.2.2	Design Pattern: Abstract Factory	484
10.2.3	Design Pattern: Factory Method	491
10.2.4	Design Pattern: Prototype	495
10.2.5	Design Pattern: Builder	502
10.3	Behavioral Patterns	507
10.3.1	Design Pattern: Command	507

10.3.2 Supporting Undo	509
10.4 Structural Patterns	513
10.4.1 Design Pattern: Adapter	513
10.4.2 Design Pattern: Composite	531
Chapter Summary	544
Further Readings	545

CHAPTER 11 Concurrent Programming **547**

11.1 Threads	547
11.1.1 Creation of Threads	548
11.1.2 Controlling Threads	553
11.2 Thread Safety and Liveness	556
11.2.1 Synchronization	557
11.2.2 Cooperation Among Threads	564
11.2.3 Liveness Failures	569
11.3 Design Case Study—Tic-Tac-Toe Game	571
11.3.1 The Game Board	572
11.3.2 The Game	577
11.3.3 The Players	579
11.3.4 Idiom: Taking Turns	582
Chapter Summary	583
Further Reading	584
Exercises	584
Projects	585

CHAPTER 12 Distributed Computing **587**

12.1 Socket-Based Communication	588
12.1.1 Server and Client Sockets	588
12.1.2 Servers and Clients Using Sockets	590
12.1.3 Design Case Study—Stock Quotes I	600
12.2 Remote Method Invocation	614
12.2.1 The Architecture	614
12.2.2 Using RMI	616
12.2.3 Design Case Study—Stock Quotes II	620
12.3 Java Database Connectivity	628
12.4 Common Object Request Broker Architecture	640
Chapter Summary	641
Further Readings	642
Exercises	642
Projects	643

APPENDIX A Summary of the APPLET Tag	645
APPENDIX B Summary of Documentation Tags	647
APPENDIX C Summary of Java Naming Conventions	649
Glossary	653
References	663
Index	667