

---

Peter Sestoft

---

# **Java Precisely**

Third Edition

The MIT Press  
Cambridge, Massachusetts  
London, England

# Contents

|   |            |
|---|------------|
| <b>Preface</b>  | <b>xi</b>  |
| <b>Notational Conventions</b>   | <b>xii</b> |
| <b>1 Running Java: Compilation, Loading, and Execution</b>  | <b>2</b>   |
| <b>2 Names and Reserved Names</b>   | <b>2</b>   |
| <b>3 Java Naming Conventions</b>  | <b>2</b>   |
| <b>4 Comments and Program Layout</b>  | <b>2</b>   |
| <b>5 Types</b>  | <b>4</b>   |
| 5.1 Primitive Types . . . . .   | 4          |
| 5.2 Reference Types . . . . .   | 4          |
| 5.3 Array Types . . . . .   | 4          |
| 5.4 Boxing: Wrapping Primitive Types as Reference Types . . . . .   | 4          |
| 5.5 Subtypes and Compatibility . . . . .  | 6          |
| 5.6 Signatures and Subsumption . . . . .  | 6          |
| 5.7 Type Conversion . . . . .   | 6          |
| <b>6 Variables, Parameters, Fields, and Scope</b>   | <b>8</b>   |
| 6.1 Values Bound to Variables, Parameters, or Fields . . . . .  | 8          |
| 6.2 Variable Declarations . . . . .   | 8          |
| 6.3 Scope of Variables, Parameters, and Fields . . . . .  | 8          |
| <b>7 Strings</b>  | <b>10</b>  |
| 7.1 String Formatting . . . . .   | 12         |
| <b>8 Arrays</b>   | <b>16</b>  |
| 8.1 Array Creation and Access . . . . .   | 16         |
| 8.2 Array Initializers . . . . .  | 16         |
| 8.3 Multidimensional Arrays . . . . .   | 18         |
| 8.4 The Utility Class Arrays . . . . .  | 18         |
| <b>9 Classes</b>  | <b>22</b>  |
| 9.1 Class Declarations and Class Bodies . . . . .   | 22         |
| 9.2 Top-Level Classes, Nested Classes, Member Classes, and Local Classes . . . . .                            | 22         |
| 9.3 Class Modifiers . . . . .   | 22         |
| 9.4 The Class Modifiers <code>public</code> , <code>final</code> , <code>abstract</code> . . . . .            | 24         |
| 9.5 Subclasses, Superclasses, Class Hierarchy, Inheritance, and Overriding . . . . .                          | 24         |
| 9.6 Field Declarations in Classes . . . . .   | 26         |
| 9.7 The Member Access Modifiers <code>private</code> , <code>protected</code> , <code>public</code> . . . . . | 26         |
| 9.8 Method Declarations . . . . .   | 28         |
| 9.9 Parameter Arrays and Variable-Arity Methods . . . . .   | 30         |

|           |  |           |
|-----------|--|-----------|
| 9.10      | Constructor Declarations . . . . .   | 30        |
| 9.11      | Nested Classes, Member Classes, Local Classes, and Inner Classes . . . . . | 32        |
| 9.12      | Anonymous Classes . . . . .  | 32        |
| 9.13      | Initializer Blocks, Field Initializers, and Initializers . . . . .         | 32        |
| <b>10</b> | <b>Classes and Objects in the Computer</b>                                 | <b>34</b> |
| 10.1      | What Is a Class? . . . . .   | 34        |
| 10.2      | What Is an Object? . . . . .   | 34        |
| 10.3      | Inner Objects . . . . .  | 34        |
| <b>11</b> | <b>Expressions</b>   | <b>36</b> |
| 11.1      | Table of Expression Forms . . . . .  | 36        |
| 11.2      | Arithmetic Operators . . . . .   | 38        |
| 11.3      | Logical Operators . . . . .  | 38        |
| 11.4      | Bitwise Operators and Shift Operators . . . . .                            | 38        |
| 11.5      | Assignment Expressions . . . . .   | 40        |
| 11.6      | Conditional Expressions . . . . .  | 40        |
| 11.7      | Object Creation Expressions . . . . .                                      | 40        |
| 11.8      | Instance Test Expressions . . . . .  | 40        |
| 11.9      | Field Access Expressions . . . . .   | 42        |
| 11.10     | The Current Object Reference <code>this</code> . . . . .                   | 42        |
| 11.11     | Type Cast Expression . . . . .   | 42        |
| 11.12     | Method Call Expressions . . . . .  | 44        |
| 11.13     | Lambda Expressions (Java 8.0) . . . . .                                    | 48        |
| 11.14     | Method Reference Expressions (Java 8.0) . . . . .                          | 48        |
| <b>12</b> | <b>Statements</b>  | <b>52</b> |
| 12.1      | Expression Statements . . . . .  | 52        |
| 12.2      | Block Statements . . . . .   | 52        |
| 12.3      | The Empty Statement . . . . .  | 52        |
| 12.4      | Choice Statements . . . . .  | 54        |
| 12.5      | Loop Statements . . . . .  | 56        |
| 12.6      | Returns, Labeled Statements, Exits, and Exceptions . . . . .               | 60        |
| 12.7      | The Try-with-Resources Statement . . . . .                                 | 64        |
| 12.8      | The <code>assert</code> Statement . . . . .                                | 64        |
| <b>13</b> | <b>Interfaces</b>  | <b>66</b> |
| 13.1      | Interface Declarations . . . . .   | 66        |
| 13.2      | Classes Implementing Interfaces . . . . .                                  | 66        |
| 13.3      | Default and Static Methods on Interfaces (Java 8.0) . . . . .              | 68        |
| 13.4      | Annotation Type Declarations . . . . .                                     | 68        |
| <b>14</b> | <b>Enum Types</b>  | <b>70</b> |
| <b>15</b> | <b>Exceptions, Checked and Unchecked</b>                                   | <b>72</b> |
| <b>16</b> | <b>Compilation, Source Files, Class Names, and Class Files</b>             | <b>74</b> |

|  |            |
|--|------------|
| <b>17 Packages and Jar Files</b>   | <b>74</b>  |
| <b>18 Mathematical Functions</b>   | <b>76</b>  |
| <b>19 String Builders and String Buffers</b>   | <b>78</b>  |
| <b>20 Threads, Concurrent Execution, and Synchronization</b>   | <b>80</b>  |
| 20.1 Threads and Concurrent Execution  | 80         |
| 20.2 Locks and the <code>synchronized</code> Statement   | 82         |
| 20.3 Operations on Threads   | 84         |
| 20.4 Operations on Locked Objects  | 84         |
| 20.5 The Java Memory Model and Visibility Across Threads   | 86         |
| <b>21 Generic Types and Methods</b>  | <b>88</b>  |
| 21.1 Generics: Safety, Generality, and Efficiency  | 88         |
| 21.2 Generic Types, Type Parameters, and Type Instances  | 88         |
| 21.3 How Can Type Instances Be Used?   | 88         |
| 21.4 Generic Classes   | 90         |
| 21.5 Constraints on Type Parameters  | 92         |
| 21.6 How Can Type Parameters Be Used?  | 92         |
| 21.7 Generic Interfaces  | 94         |
| 21.8 Generic Methods   | 96         |
| 21.9 Wildcard Type Arguments   | 98         |
| 21.10 The Raw Type   | 100        |
| 21.11 The Implementation of Generic Types and Methods  | 100        |
| <b>22 Generic Collections and Maps</b>   | <b>102</b> |
| 22.1 Interface <code>Collection&lt;T&gt;</code>  | 104        |
| 22.2 Interface <code>List&lt;T&gt;</code> and Its Implementations <code>LinkedList&lt;T&gt;</code> and <code>ArrayList&lt;T&gt;</code> | 105        |
| 22.3 Interface <code>Set&lt;T&gt;</code> and Its Implementations <code>HashSet&lt;T&gt;</code> and <code>LinkedHashSet&lt;T&gt;</code> | 106        |
| 22.4 Interface <code>SortedSet&lt;T&gt;</code> and Implementation <code>TreeSet&lt;T&gt;</code>  | 106        |
| 22.5 Interface <code>Map&lt;K,V&gt;</code> and Implementation <code>HashMap&lt;K,V&gt;</code>  | 108        |
| 22.6 Interface <code>SortedMap&lt;K,V&gt;</code> and Implementation <code>TreeMap&lt;K,V&gt;</code>                                    | 110        |
| 22.7 Going through a Collection: Interfaces <code>Iterator&lt;T&gt;</code> and <code>Iterable&lt;T&gt;</code>                          | 112        |
| 22.8 Interface <code>ListIterator&lt;T&gt;</code>  | 114        |
| 22.9 Equality, Hash Codes, and Comparison  | 114        |
| 22.10 The <code>Comparator&lt;T&gt;</code> Interface   | 116        |
| 22.11 The Utility Class <code>Collections</code>   | 118        |
| 22.12 Choosing the Right Collection Class or Map Class   | 120        |
| <b>23 Functional Interfaces (Java 8.0)</b>   | <b>122</b> |
| 23.1 Functional Programming  | 122        |
| 23.2 Generic Functional Interfaces   | 124        |
| 23.3 Primitive-Type Specialized Functional Interfaces  | 124        |
| 23.4 Covariance and Contravariance in Functional Interfaces  | 126        |
| 23.5 Interface <code>Function&lt;T,R&gt;</code>  | 126        |
| 23.6 Interface <code>UnaryOperator&lt;T&gt;</code>   | 126        |

|           |   |            |
|-----------|---|------------|
| 23.7      | Interfaces Predicate<T> and BiPredicate<T,U> . . . . .                    | 128        |
| 23.8      | Interfaces Consumer<T> and BiConsumer<T,U> . . . . .                      | 128        |
| 23.9      | Interface Supplier<T> . . . . .   | 128        |
| 23.10     | Interface BiFunction<T,U,R> . . . . .                                     | 130        |
| 23.11     | Interface BinaryOperator<T> . . . . .                                     | 130        |
| <b>24</b> | <b>Streams for Bulk Data (Java 8.0)</b>                                   | <b>132</b> |
| 24.1      | Creating Streams . . . . .  | 134        |
| 24.2      | Stream Builders . . . . .   | 134        |
| 24.3      | Methods on Streams . . . . .  | 136        |
| 24.4      | Numeric Streams: DoubleStream, IntStream, and LongStream . . . . .        | 140        |
| 24.5      | Summary Statistics for Numeric Streams . . . . .                          | 140        |
| 24.6      | Collectors on Streams . . . . .   | 142        |
| <b>25</b> | <b>Class Optional&lt;T&gt; (Java 8.0)</b>                                 | <b>146</b> |
| <b>26</b> | <b>Input and Output</b>   | <b>148</b> |
| 26.1      | Creating an IO Stream from Another One . . . . .                          | 149        |
| 26.2      | Kinds of Input and Output Methods . . . . .                               | 150        |
| 26.3      | Imports, Exceptions, Thread Safety . . . . .                              | 150        |
| 26.4      | Sequential Character Input: Readers . . . . .                             | 152        |
| 26.5      | Sequential Character Output: Writers . . . . .                            | 153        |
| 26.6      | Printing Primitive Data to a Character Stream: PrintWriter . . . . .      | 154        |
| 26.7      | The Appendable Interface and the CharSequence Interface . . . . .         | 154        |
| 26.8      | Reading Primitive Data from a Character Stream: StreamTokenizer . . . . . | 156        |
| 26.9      | Sequential Byte Input: InputStream . . . . .                              | 158        |
| 26.10     | Sequential Byte Output: OutputStream . . . . .                            | 159        |
| 26.11     | Binary Input-Output of Primitive Data: DataInput and DataOutput . . . . . | 160        |
| 26.12     | Serialization of Objects: ObjectInput and ObjectOutput . . . . .          | 162        |
| 26.13     | Buffered Input and Output . . . . .                                       | 164        |
| 26.14     | Random Access Files: RandomAccessFile . . . . .                           | 166        |
| 26.15     | Files, Directories, and File Descriptors . . . . .                        | 168        |
| 26.16     | Thread Communication: PipedInputStream and PipedOutputStream . . . . .    | 168        |
| 26.17     | Socket Communication . . . . .  | 170        |
| <b>27</b> | <b>Reflection</b>   | <b>172</b> |
| 27.1      | Reflective Use of Types: The Class<T> Class . . . . .                     | 172        |
| 27.2      | Reflection: The Field Class . . . . .                                     | 174        |
| 27.3      | Reflection: The Method Class and the Constructor<T> Class . . . . .       | 174        |
| 27.4      | Exceptions Thrown When Using Reflection . . . . .                         | 174        |
| <b>28</b> | <b>Metadata Annotations</b>   | <b>176</b> |
| <b>29</b> | <b>What Is New in Java 8.0</b>  | <b>178</b> |
|           | <b>References</b>   | <b>180</b> |

