

Fourth AP Edition

Java Methods

Object-Oriented Programming
and
Data Structures

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Preface

This book offers a thorough introduction to the concepts and practices of object-oriented programming in Java. It also introduces some of the common data structures and related algorithms: one- and two-dimensional arrays, `ArrayList`, `Sets` and `Maps`, and their implementations in the Java Collections Framework.

Chapters 1-14 follow the syllabus of the AP Computer Science in Java course (AP CS “A”). They will prepare you well for the AP exam. Chapters 15-18 on file input and output, graphics, graphical user interfaces, and events handling in Java will give you a better sense of real-world Java programming; this material also makes case studies, labs, and exercises more fun. Chapter 19 revisits recursion at a deeper level. Chapter 20 introduces the concepts of look-up tables, sets, and maps, and their implementation in the Java Collections Framework. The last chapter, Computing in Context, discusses creative, responsible, and ethical computer use.

This edition builds on our earlier books, *Java Methods A & AB: OOP and Data Structures* (Skylight Publishing, 2006), and *Java Methods*, second and third AP Editions (2011 and 2015). The AB-level AP CS exam was discontinued by the College Board in 2009. Teachers who continue teaching advanced data structures and students who want to learn this material on their own can find complete data structures chapters in the *Java Methods* Third AP edition e-book. In this edition we have added a lab and exercises to the `ArrayList` chapter.

The book follows four main threads: Java syntax and style, OOP concepts and techniques, algorithms, and Java libraries. As in the software engineering profession itself, these threads are interwoven into an inseparable braid.

We strive to present the technical details while grounding them in clear explanations of the underlying concepts. OOP has an extensive conceptual layer and complex terminology. Fortunately, many OOP concepts are more straightforward than the terminology makes them appear. Most of the key elements are actually quite intuitive: *objects* (entities that combine data elements and functions), *classes* (definitions of types of objects), *methods* (functions that carry out certain tasks), *instantiation* (creating an object of a particular class), *inheritance* (one class extending the features of another class), *encapsulation* (hiding the implementation details of a class), *polymorphism* (automatically calling the correct methods for

specific objects disguised as objects of more generic types), and *event-driven* applications (where the operating system, the user, or events in the program trigger certain actions).

We also emphasize good programming style, an element not mandated by formal Java language specifications but essential for writing readable and professional code.

Our labs and case studies aim to demonstrate the most appropriate uses of the programming techniques and data structures we cover. OOP is believed to facilitate teamwork, software maintenance, and software reuse. While it is not possible for an introductory textbook to present a large-scale real-world project as a case study, the case studies and labs in this book offer a taste of how these OOP benefits can play out in larger projects.

It is not our goal to teach exclusively the material required for the AP CS A exam. While we mostly stay within the Java AP subset defined by the College Board for AP CS exams in Java, we also want to give you a solid conceptual foundation and introduce sound software design and coding practices. If you are preparing for the AP exam, you'll need to be familiar with the College Board's Course and Exam Description and use our review book, *Be Prepared for the AP Computer Science Exam in Java* (Skylight Publishing).

We assume that at least two or three class periods each week will be held in a computer lab with students working independently or in small groups. A set of *Student Files* downloadable from this book's web site contains all the case studies, labs, and exercises in the book; a downloadable set of *Teacher Files*, available to teachers only, provides complete solutions to all the labs and exercises.

Still, with all the examples and case studies, we leave a lot of work to you, the student. This is not a *Java-in-n-days* book or an *n-hours-to-complete* book. It is a book for learning essential concepts and technical skills at a comfortable pace, for acquiring a repertoire of techniques and examples to work from, and for consulting as needed when you start writing your own Java code professionally or for fun.

Working through this book will not make you a Java expert right away, but it will bring you to the level of an entry-level Java programmer with a better than average understanding of the fundamental concepts. Object-oriented programming was originally meant to make software development more accessible to beginners, and *Java Methods* is written in that spirit.

Without further delay, let us begin learning object-oriented programming in Java!



Since our first book came out in 1998, many of our colleagues, too many to name, have become good friends. We are grateful to them for their loyal support, encouragement, and the many things they have taught us over the years.

We thank the students in Maria's AP Computer Science classes for their patience while studying from earlier editions of this book; they have caught several typos and mistakes and made many useful suggestions.

Our special thanks to Margaret Litvin for her thorough and thoughtful editing.



The cover image of a star with lens flare and bokeh effect was generated using 3D software.