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C++ 大学教程 (第四版)

英文版

C++ How to Program, Fourth Edition

采用了 Deitel 的 Live-Code 方式, 对 C++ 的基本概念、使用 UML 的面向对象设计 (OOD) 以及使用 CGI 的 Web 编程进行了完整、权威的介绍!

这本世界上使用最为广泛的 C++ 编程教材的第四版, 为读者展现了 C++ 的各种卓越的性能; 提供了面向对象设计与实现的实例学习, 其中使用了对象管理组 (OMG) 发布的统一建模语言 (UML); 同时介绍了使用 CGI 的 *n* 层 Web 应用开发。

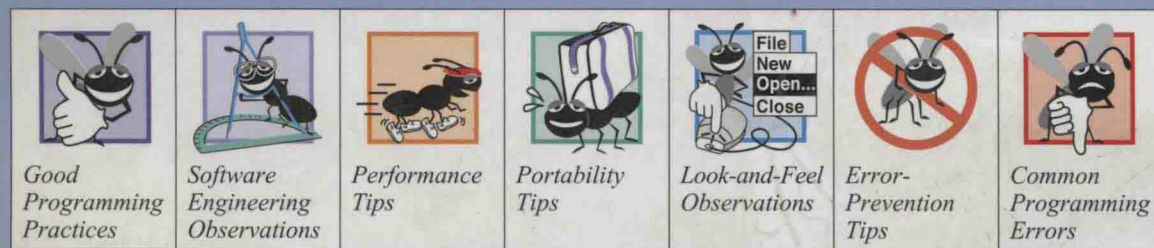
Harvey M. Deitel 博士和 Paul J. Deitel 博士是 Deitel & Associates 公司的创始人。该公司在培训与教材出版方面获得了国际上的广泛认可, 尤其致力于 C++、C、Visual C++®、.NET、Java、C#、Visual Basic®、.NET、XML、Python、Perl、Internet、Web、.NET 和面向对象技术。Deitel 一家编写了许多畅销的编程语言教材, 其中包括 *Java How to Program* 和 *Internet & World Wide Web How to Program* 等。

在本书中, Deitel 一家为我们介绍了面向对象编程的基本概念以及 C++ 的编程基础, 相关的内容包括:

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- 异常处理/运算符重载
- string 和 vector 对象
- 类/对象/封装
- 模板/数据结构/文件/流
- 基于指针的数组和字符串
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- 使用 UML 的面向对象设计
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本书可以帮助学生建立真实世界中的 C++ 应用程序, 并且提供了丰富的教学特性:

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- 数百个提示、推荐做法与警告, 使用下列图标表示



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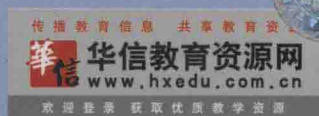
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(第四版) (英文版)

C++ How to Program

Fourth Edition

H. M Deitel

[美]

Deitel & Associates, Inc.

著

P. J. Deitel

Deitel & Associates, Inc.

電子工業出版社

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内 容 简 介

本书的作者 Deitel 一家是美国编程教材方面的名家,他们的作品繁多,并且多为美国各著名大学的指定教材。本书是一本 C++ 编程方面的优秀教程,全面介绍了过程式编程与面向对象编程的原理与方法,细致地分析了各种性能问题、可移植性问题以及可能出错的情况。作者通过大量的示例程序,重点突出了利用 UML 进行面向对象的设计,引入了使用 CGI 的 Web 应用开发,并且帮助学生创建真实世界的 C++ 应用程序。本书无论从广度和深度上来说都非常全面,并且从基础概念讲起,同样适合没有编程经验的读者学习。通过可以实际使用的完整例子,可以使读者潜移默化地掌握概念。

本书可作为高等院校相关专业的编程语言教材和 C++ 编程教材,也是软件设计人员进行 C++ 程序开发的宝贵参考资料。

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C++

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FOURTH EDITION

H. M. Deitel

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TO

Don Kostuch:

For your steadfast commitment to excellence in teaching and writing about C++ and object technology.

Thank you for being our mentor, our colleague and our friend.

Thank you for a decade of being our most critical, yet most constructive reviewer.

It is a privilege for us to be your students.

Harvey and Paul Deitel

Preface

Welcome to ANSI/ISO Standard C++! At Deitel & Associates, we write college-level programming-language textbooks and professional books and work hard to keep our published books up-to-date with a steady flow of new editions. Writing *C++ How to Program, Fourth Edition*, (4/e for short), was a joy. This book and its support materials have everything instructors and students need for an informative, interesting, challenging and entertaining C++ educational experience. As the book goes to publication, it is compliant with the latest version of the ANSI/ISO C++ Standard (one of the most important worldwide standards for the computing community) and with object-oriented design using the latest version of the UML (Unified Modeling Language) from the Object Management Group (OMG). We tuned the writing, the pedagogy, our coding style, the book's ancillary package and even added a substantial treatment of developing Internet- and Web-based applications. We have added a comprehensive Tour of the Book section to Chapter 1. This will help instructors, students and professionals get a sense of the rich coverage the book provides of C++ object-oriented programming, object-oriented design with the UML and generic programming. If you are evaluating the book, please read the Tour of the Book now in pages 44–56.

Whether you are an instructor, a student, an experienced professional or a novice programmer, this book has much to offer. C++ is a world-class programming language for developing industrial-strength, high-performance computer applications. We carefully audited the manuscript against the ANSI/ISO C++ standard document,¹ which defines C++, and we were privileged to have as a reviewer Steve Clamage of Sun Microsystems who heads the ANSI J16 Committee responsible for evolving the C++ standard. As a result, the programs you create by studying this text should port easily to any ANSI/ISO-compliant compiler.

1. An electronic PDF copy of the C++ standard document, number ISO-IEC 14882-1998, is available for \$18 at webstore.ansi.org/ansidocstore/default.asp; a paper copy is available from this site for \$175.

Preface

In this Preface, we overview *C++ How to Program, 4/e*'s comprehensive suite of educational materials that help instructors maximize their students' C++ learning experience. We explain conventions we use, such as syntax coloring the code examples, "code washing" and highlighting important code segments to help focus students' attention on the key concepts introduced in each chapter. We overview the new features of *C++ How to Program, 4/e*, including our early treatment of arrays and strings as objects, an enhanced treatment of object-oriented programming, Web-application development with CGI, the enhanced elevator-simulation object-oriented design (OOD) case study with the UML, and the extensive use of UML diagrams that have been upgraded to UML version 1.4 standards.

Prentice Hall has bundled *Microsoft's Visual C++[®] 6 Introductory Edition* software with the text and offers a separate value-pack containing *C++ How to Program, 4/e*, with Metrowerks *CodeWarrior* for the Macintosh and Windows. We list several compilers that are available on the Web free for download. To further support novice programmers, we offer six of our new *DIVE-INTO Series* publications that are available free for download at www.deitel.com. These materials explain how to compile, execute and debug C++ programs using various popular C++ development environments.

We overview the complete package of ancillary materials available to instructors and students using *C++ How to Program, 4/e*. These include an *Instructor's Resource CD* with solutions to the book's chapter exercises and a *Test-Item File* with hundreds of multiple-choice questions and answers. Additional instructor resources are available at the book's Companion Web Site (www.prenhall.com/deitel), which includes a *Syllabus Manager* and customizable PowerPoint[®] Lecture Notes. Numerous support materials are available for students at the Companion Web Site, as well. For instructors who want to hold closed-lab sessions (or highly structured homework assignments), we provide the optional, for-sale manual, *C++ in the Lab*. This publication includes carefully constructed Prelab Activities, Lab Exercises and Postlab Activities.

This Preface also discusses *The C++ Multimedia Cyber Classroom, 4/e*, an interactive, multimedia CD-based version of the book. This learning aid provides audio "walk-throughs" of programs, animations of programs executing and hundreds of exercises and solutions. We describe how to order both the Cyber Classroom and *The Complete C++ Training Course, 4/e*, boxed product, which contains the Cyber Classroom and the textbook.

We discuss several DEITEL e-learning initiatives, including an explanation of Deitel content available for the *Blackboard*, *CourseCompass* and *WebCT* Course Management Systems, each of which supports *C++ How to Program, 4/e*. *Premium CourseCompass*, which offers enhanced Deitel content based on *The C++ Multimedia Cyber Classroom, 4/e*, will be available in January 2003.

C++ How to Program, 4/e, was reviewed by 52 distinguished academics and industry professionals; we list their names and affiliations so you can get a sense of how carefully this book was scrutinized. The Preface concludes with information about the authors and about Deitel & Associates, Inc. As you read this book, if you have any questions, please send an e-mail to deitel@deitel.com; we will respond promptly. Please visit our Web site, www.deitel.com, regularly and be sure to sign up for the *DEITEL BUZZ ONLINE* e-mail newsletter at www.deitel.com/newsletter/subscribe. We use the Web site and the newsletter to keep our readers current on all DEITEL publications and services.

Features of C++ How to Program, Fourth Edition

This book contains many features including:

Full-Color Presentation

This book is in full color to show programs and their outputs as they typically would appear on a computer screen. We syntax color all the C++ code, as do many C++ integrated-development environments and code editors. This greatly improves code readability—an especially important goal, given that this book contains over 20,000 lines of code. Our syntax-coloring conventions are as follows:

```

comments appear in green
keywords appear in dark blue
errors appear in red
constants and literal values appear in light blue
all other code appears in black

```

Code Highlighting and User-Input Highlighting

We have added extensive code highlighting. In our code walkthroughs (at Deitel, we call these “writearounds”), we have eliminated most of the “redundant” code snippets that appeared inline in the text in the *Third Edition*. We kept them in the earliest portion of the book as a pedagogic device to help novices. We want the reader to see all new code features in context, so from Chapter 3 forward, our code walkthroughs simply refer to the line numbers of the new code segments inside complete source programs. To make it easier for readers to spot the featured segments, we have highlighted them in bright yellow. This feature also helps students review the material rapidly when preparing for exams or labs. We have also highlighted in our screen dialogs all user inputs to distinguish them from program outputs.

“Code Washing”

Code washing is our term for applying comments, using meaningful identifiers, applying indentation and using vertical spacing to separate meaningful program units. This process results in programs that are much more readable and self-documenting. We have done extensive “code washing” of all the source code programs in the text, the lab manual, the ancillaries and the *Cyber Classroom*.

Early Introduction of Standard Library **string** and **vector** Objects

Object-oriented programming languages generally offer the ability to create string and array objects by instantiating them from library classes or from programmer-defined classes. It is also important for students learning C++ to become familiar with C-style, pointer-based arrays and strings, because of the massive amount of C and early C++ legacy code they will encounter in industry. In *C++ How to Program, 4/e*, we show all three means of creating strings and arrays. In Chapters 4 and 5 we show the traditional, C-like pointer-based arrays and strings, respectively. In Chapter 8, Operator Overloading, we create our own user-defined classes **Array** and **String**. At the end of Chapter 8, we introduce library classes **vector** and **string**, which we explain in detail in Chapter 15 and Chapter 21, respectively. Through Chapter 8, we favor pointer-based arrays and strings; after Chapter 8, we favor the library classes. The Chapter 15 material on **string** could be taught at any point after Chapter 8. The Chapter 21 material on **vector** (and other aspects of the STL) could also reasonably be taught after Chapter 8, although we recommend covering Chapter 11, Templates, first.

Tuned Treatment of Object-Oriented Programming in Chapters 9 and 10

This is one of the most significant improvements in this new edition. We performed a high-precision upgrade to Chapters 9 and 10. The improvements make the material clearer and more accessible to students and professionals, especially those studying object-orientation for the first time.

Redesigned Pedagogy of Chapter 9, Object-Oriented Programming: Inheritance.

The new Chapter 9 carefully walks the reader through a five-example sequence that demonstrates **private** data, **protected** data and software reuse via inheritance. We begin by demonstrating a class with **private** data members and **public** member functions to manipulate that data. Next, we implement a second class with several additional capabilities. To do this, we duplicate much of the first example's code. In our third example, we begin our discussion of inheritance and software reuse—we use the class from the first example as a base class and inherit its data and functionality into a new derived class. This example introduces the inheritance mechanism and demonstrates that a derived class cannot access its base class's **private** data directly. This motivates our fourth example, in which we introduce **protected** data in the base class and demonstrate that the derived class can indeed access its base class's **protected** data. The last example in the sequence demonstrates proper software engineering by defining the base class's data as **private** and using the base class's **public** member functions (that were inherited by the derived class) to manipulate the base class's **private** data from the derived class. We follow the five-part introduction with a three-level class hierarchy that employs the software engineering techniques introduced earlier in the chapter. The chapter closes with a discussion of the three inheritance types supported by C++ and a general discussion of software engineering with inheritance.

Redesigned Pedagogy of Chapter 10, Object-Oriented Programming: Polymorphism. The new Chapter 10 builds on the inheritance concepts presented in Chapter 9 and focuses on the relationships between classes in a class hierarchy. Chapter 10 uses a four-example sequence to present the powerful processing capabilities that these relationships enable. We begin with an example that illustrates the “is-a” relationship between a derived-class object and its base-class type. This relationship enables the derived-class object to be treated as an object of its base class. We show that we are able to aim a base-class pointer at a derived-class object and invoke the base-class's functions on that object. In our second example, we demonstrate that the reverse is not true—a base-class object is not considered to be an object of its derived-class type—and we show that compiler errors occur if a program attempts to manipulate a base-class object in this manner. Our third example demonstrates that the only functions which can be invoked through a base-class pointer are those functions defined by the base class. The example shows that attempts to invoke derived-class-only functions result in error messages. The last example in the sequence introduces polymorphism with virtual functions, which enable a program to process objects of classes related by a class hierarchy as objects of their base-class type. When a virtual function is invoked via a base-class pointer (or reference), the derived-class-specific version of that function is invoked. The chapter continues with a case study on polymorphism in which we process an array of objects that all have a common abstract base class that contains the set of functions common to every class in the hierarchy. We follow this example with an in-depth discussion of how polymorphism works “under the hood.” We conclude with a case study that demonstrates how a program that processes objects polymorphically can still