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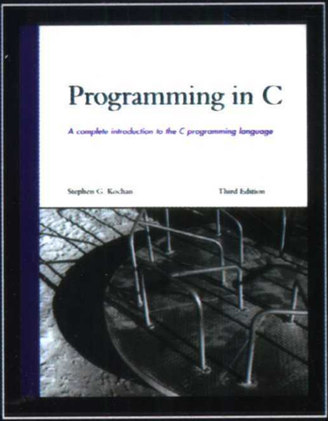
# Programming in C
## Third Edition

# C语言程序设计
## （英文版·第3版）

［美］Stephen G. Kochan 著



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[美] Stephen G. Kochan 著

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## 内 容 提 要

本书主要讲解如何用C语言编程。书中涵盖了C语言的所有特性，包括ANSI C99标准最新增加的特性。本书通过示例讲解C语言，使用完整的程序来阐释每个新概念，而且对所有C函数都提供了详细的说明。此外，每章结尾都配有习题，附录还提供了详细的C语言的小结和标准C语言库，便于快速参考。读者既可从本书中学到语言的基础，又可以学到好的编程实践。

无论是课堂讲解还是自学，本书都是理想的C语言教材。

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**C 语言程序设计（英文版·第 3 版）**

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*To my mother and father*

# 前　言

真是难以置信，我撰写本书第1版已经是20多年前的事了！那时，Kernighan和Ritchie的*The C Programming Language*是市面上唯一的一本C语言的书。现在时代已经变了！

回想20世纪80年代ANSI C标准出现时，本书被分成了两本书：最初的那本书仍然称为*Programming in C*，而涵盖ANSI C的那本书名改成了*Programming in ANSI C*。这样做是因为编译器供应商花费几年的时间才发布了ANSI C编译器并使编译器得到广泛应用。当时要在一本教材中既包含ANSI C又包含非ANSI C让我感觉非常棘手，所以有这样的决定。

自1989年发布第一个标准以来，ANSI C标准已经修订过几次。最新一版（C99）的ANSI C标准是编写本版书的主要原因。本版阐述了这一标准对C语言的修改。

除了涵盖C99特性之外，本书还包括两章新的内容：一章讨论C程序的调试，另一章简要概述了面向对象编程（OOP），增加这一章是因为有几种面向对象编程语言是基于C语言的，包括C++、Java和Objective-C。

我非常感谢这些年来一直使用本书的人，能收到读者的反馈让我感到非常满足，这也是我今天还坚持写作的动力！

非常欢迎新读者的加入，希望本书能够满足你的需要。

## 致谢

我要感谢在本书各个版本的准备过程中给予帮助的人们，他们是Douglas McCormick、Jim Scharf、Henry Tabickman、Dick Fritz、Steve Levy、Tony Ianinno和Ken Brown。我也要感谢纽约大学的Henry Mulish，他在如何写作方面教了我很多，并将我带入出版行业。

我要感谢本书的开发编辑Mark Renfrow和项目编辑Dan Knott。我还要感谢本书的文字编辑Karen Annett和技术编辑Bradley Jones。最后，我要感谢Sams出版社的所有参与本书出版的人员，尽管我并未直接与他们一起工作。

Stephen Kochan
2004年6月
steve@kochan-wood.com

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# 1 Introduction

THE C PROGRAMMING LANGUAGE WAS pioneered by Dennis Ritchie at AT&T Bell Laboratories in the early 1970s. It was not until the late 1970s, however, that this programming language began to gain widespread popularity and support. This was because until that time C compilers were not readily available for commercial use outside of Bell Laboratories. Initially, C's growth in popularity was also spurred on in part by the equal, if not faster, growth in popularity of the Unix operating system. This operating system, which was also developed at Bell Laboratories, had C as its "standard" programming language. In fact, well over 90% of the operating system itself was written in the C language!

The enormous success of the IBM PC and its look-alikes soon made MS-DOS the most popular environment for the C language. As C grew in popularity across different operating systems, more and more vendors hopped on the bandwagon and started marketing their own C compilers. For the most part, their version of the C language was based on an appendix found in the first C programming text—*The C Programming Language*—by Brian Kernighan and Dennis Ritchie. Unfortunately, this appendix did not provide a complete and unambiguous definition of C, meaning that vendors were left to interpret some aspects of the language on their own.

In the early 1980s, a need was seen to standardize the definition of the C language. The American National Standards Institute (ANSI) is the organization that handles such things, so in 1983 an ANSI C committee (called X3J11) was formed to standardize C. In 1989, the committee's work was ratified, and in 1990, the first official ANSI standard definition of C was published.

Because C is used around the world, the International Standard Organization (ISO) soon got involved. They adopted the standard, where it was called ISO/IEC 9899:1990. Since that time, additional changes have been made to the C language. The most recent standard was adopted in 1999. It is known as ANSI C99, or ISO/IEC 9899:1999. It is this version of the language upon which this book is based.

C is a "higher-level language," yet it provides capabilities that enable the user to "get in close" with the hardware and deal with the computer on a much lower level. This is because, although C is a general-purpose structured programming language, it was originally designed with systems programming applications in mind and, as such, provides the user with an enormous amount of power and flexibility.

This book proposes to teach you how to program in C. It assumes no previous exposure to the language and was designed to appeal to novice and experienced programmers alike. If you have previous programming experience, you will find that C has a unique way of doing things that probably differs from other languages you have used.

Every feature of the C language is treated in this text. As each new feature is presented, a small *complete* program example is usually provided to illustrate the feature. This reflects the overriding philosophy that has been used in writing this book: to teach by example. Just as a picture is worth a thousand words, so is a properly chosen program example. If you have access to a computer facility that supports the C programming language, you are strongly encouraged to download and run each program presented in this book and to compare the results obtained on your system to those shown in the text. By doing so, not only will you learn the language and its syntax, but you will also become familiar with the process of typing in, compiling, and running C programs.

You will find that program readability has been stressed throughout the book. This is because I strongly believe that programs should be written so that they can be easily read—either by the author or by somebody else. Through experience and common sense, you will find that such programs are almost always easier to write, debug, and modify. Furthermore, developing programs that are readable is a natural result of a true adherence to a structured programming discipline.

Because this book was written as a tutorial, the material covered in each chapter is based on previously presented material. Therefore, maximum benefit will be derived from this book by reading each chapter in succession, and you are highly discouraged from "skipping around." You should also work through the exercises that are presented at the end of each chapter before proceeding on to the next chapter.

Chapter 2, "Some Fundamentals," which covers some fundamental terminology about higher-level programming languages and the process of compiling programs, has been included to ensure that you understand the language used throughout the remainder of the text. From Chapter 3, "Compiling and Running Your First Program," on, you will be slowly introduced to the C language. By the time Chapter 16, "Input and Output Operations in C," rolls around, all the essential features of the language will have been covered. Chapter 16 goes into more depth about I/O operations in C. Chapter 17, "Miscellaneous and Advanced Features," includes those features of the language that are of a more advanced or esoteric nature.

Chapter 18, "Debugging Programs," shows how you can use the C preprocessor to help debug your programs. It also introduces you to interactive debugging. The popular debugger `gdb` was chosen to illustrate this debugging technique.

Over the last decade, the programming world has been abuzz with the notion of object-oriented programming, or OOP for short. C is not an OOP language; however, several other programming languages that are based on C are OOP languages. Chapter 19, "Object-Oriented Programming," gives a brief introduction to OOP and some of its terminology. It also gives a brief overview of three OOP languages that are based on C, namely C++, C#, and Objective-C.

Appendix A, "C Language Summary," provides a complete summary of the language and is provided for reference purposes.

Appendix B, "The Standard C Library," provides a summary of many of the standard library routines that you will find on all systems that support C.

Appendix C, "Compiling Programs with `gcc`," summarizes many of the commonly used options when compiling programs with GNU's C compiler `gcc`.

In Appendix D, "Common Programming Mistakes," you'll find a list of common programming mistakes.

Finally, Appendix E, "Resources," provides a list of resources you can turn to for more information about the C language and to further your studies.

Answers to the quizzes at the end of chapters can be found at `www.kochan-wood.com`.

This book makes no assumptions about a particular computer system or operating system on which the C language is implemented. The text makes brief mention of how to compile and execute programs using the popular GNU C compiler `gcc`.

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An earlier edition of this book was also dedicated to the memory of Maureen Connelly, a former production editor at Hayden Book Company, the publishers of the first edition of this book.

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