

国外优秀信息科学与技术系列教学用书

计算机科学基础

——从数据操纵到计算理论

(影印版)

FOUNDATIONS OF
COMPUTER SCIENCE

From Data Manipulation to Theory of Computation

■ Behrouz A. Forouzan
with Sophia Chung Fegan



高等教育出版社
Higher Education Press

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出版说明

20 世纪末,以计算机和通信技术为代表的信息科学和技术对世界经济、科技、军事、教育和文化等产生了深刻影响。信息科学技术的迅速普及和应用,带动了世界范围信息产业的蓬勃发展,为许多国家带来了丰厚的回报。

进入 21 世纪,尤其随着我国加入 WTO,信息产业的国际竞争将更加激烈。我国信息产业虽然在 20 世纪末取得了迅猛发展,但与发达国家相比,甚至与印度、爱尔兰等国家相比,还有很大差距。国家信息化的发展速度和信息产业的国际竞争能力,最终都将取决于信息科学技术人才的质量和数量。引进国外信息科学和技术优秀教材,在有条件的学校推动开展英语授课或双语教学,是教育部为加快培养大批高质量的信息技术人才采取的一项重要举措。

为此,教育部要求由高等教育出版社首先开展信息科学和技术教材的引进试点工作。同时提出了两点要求,一是要高水平,二是要低价格。在高等教育出版社和信息科学技术引进教材专家组的努力下,经过比较短的时间,第一批由教育部高等教育司推荐的 20 多种引进教材已经陆续出版。这套教材出版后受到了广泛的好评,其中有不少是世界信息科学技术领域著名专家、教授的经典之作和反映信息科学技术最新进展的优秀作品,代表了目前世界信息科学技术教育的一流水平,而且价格也是最优惠的,与国内同类自编教材相当。这套教材基本覆盖了计算机科学与技术专业的课程体系,体现了权威性、系统性、先进性和经济性等特点。

目前,教育部正在全国 35 所高校推动示范性软件学院的建设,这也是加快培养信息科学技术人才的重要举措之一。为配合软件学院的教学工作,结合各软件学院的教学计划和课程设置,高等教育出版社近期聘请有关专家和软件学院的教师遴选推荐了一批相应的原版教学用书,正陆续组织出版,以方便各软件学院开展双语教学。

我们希望这些教学用书的引进出版,对于提高我国高等学校信息科学技术的教学水平,缩小与国际先进水平的差距,加快培养一大批具有国际竞争力的高质量信息技术人才,起到积极的推动作用。同时我们也欢迎广大教师和专家们对我们的教材引进工作提出宝贵的意见和建议。联系方式: hep.cs@263.net。

高等教育出版社
二〇〇二年九月

To my wife Faezeh

— Behrouz Forouzan

Preface

Welcome to computer science! You are about to start the exploration of a wonderful and exciting world that offers many challenging and exciting careers. Computers play a large part in our everyday lives and will continue to do so in the future.

Computer science is a young discipline that is evolving and progressing. Computer networks have connected people from far-flung points of the globe. Virtual reality is creating three-dimensional images that amaze the eyes. Space exploration owes part of its success to computers. Computer-created special effects have changed the movie industry. And computers have played important roles in genetics.

ORGANIZATION OF THE BOOK

This book is designed for a CS0 course. It covers in breadth all areas in computer science. We divided the text into five parts: Computers and Data, Computer Hardware, Computer Software, Data Organization, and Advanced Topics (Figure P.1).

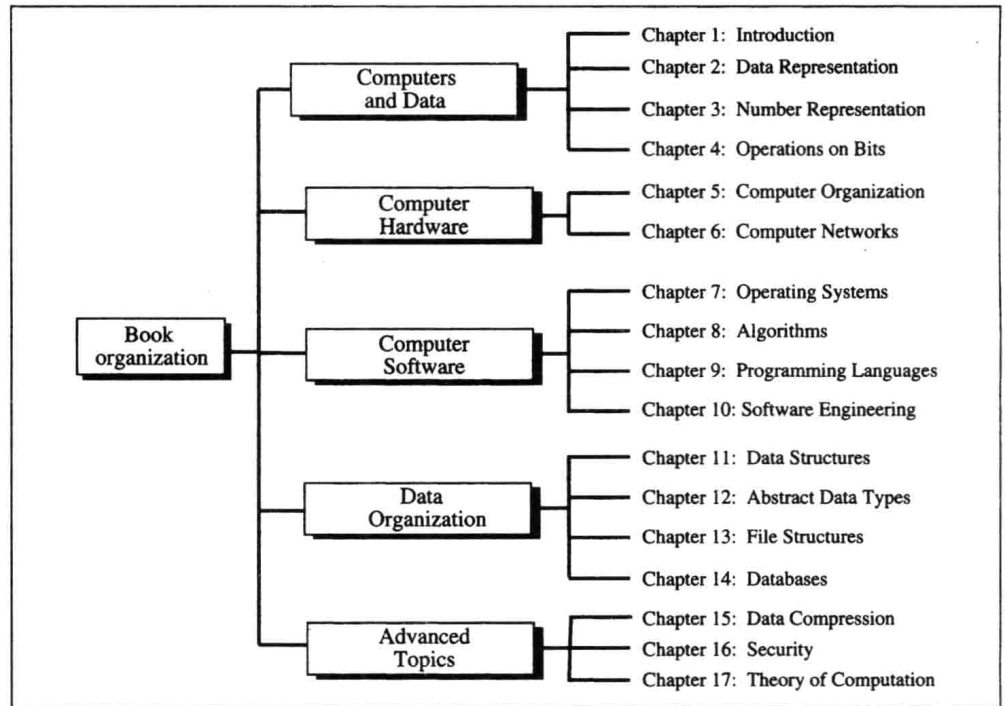


Figure P.1 Book's outline

Part I: Computers and Data

In Part I, we look at a computer and the data that it processes. This part contains four chapters.

Chapter 1: Introduction In this chapter, we look at the computer as a data processing entity. We introduce the von Neumann concept and discuss the general components of a computer. We postpone the detailed discussion of computer components until Chapter 5.

Chapter 2: Data Representation In this chapter, we discuss the representation of text, images, audio, and video as bit patterns. Numeric representation is postponed until Chapter 3.

Chapter 3: Number Representation In this chapter, we present the representation of numbers. We show how integers and floating-point numbers are stored in a computer.

Chapter 4: Operations on Bits In this chapter, we discuss the manipulation of bit patterns, both arithmetic and logical.

Part II: Computer Hardware

In Part II, we look at computer hardware. This part is divided into two chapters.

Chapter 5: Computer Organization In this chapter, we discuss the computer as a stand-alone machine. We describe the parts of computer hardware and how they work.

Chapter 6: Computer Networks In this chapter, we discuss how computers are connected to create computer networks and internetworks.

Part III: Computer Software

In Part III, we look at various aspects of computer software.

Chapter 7: Operating Systems In this chapter, we discuss the operating system as the most important part of system software. We present the duties of an operating system and how they evolved. We also discuss the parts of a modern operating system.

Chapter 8: Algorithms In this chapter, we discuss algorithms. Algorithms play such an important role in computer science that some people believe computer science means the study of algorithms. We define the concept of algorithms and use some tools to represent algorithms. A full discussion of these tools is presented in Appendixes C, D, and E.

Chapter 9: Programming Languages In this chapter, we first present computer languages in general. Then we discuss the elements of C, a popular language.

Chapter 10: Software Engineering In this chapter, we discuss software engineering, a very important discipline for the computer major.

Part IV: Data Organization

In Part IV, we look again at data, but from the user's point of view.

Chapter 11: Data Structures In this chapter, we discuss data structures. Data, at the higher level, are organized into structures. We present common data structures in use today such as arrays, records, and linked lists.

Chapter 12: Abstract Data Types In this chapter, we discuss abstract data types (ADTs). In data processing, you need to define data as a package including the operations defined for the package. We describe lists, stacks, queues, trees, and graphs so that students think about data in the abstract.

Chapter 13: File Structures In this chapter, we discuss file structures. We show how files are logically organized. We discuss sequential access and random access files. A student needs to know these concepts before taking a first course in programming.

Chapter 14: Databases In this chapter, we discuss databases. Files in an organization are very rarely stored separately and in isolation. Often, they are organized into one entity called a database. We present the relational database and touch on a language (SQL) that can retrieve information from this type of database.

Part V: Advanced Topics

In this part, we discuss three advanced topics that are gaining importance in computer science: data compression, security, and the theory of computation. These topics can be skipped if time is a factor or if the background of students is lacking.

Chapter 15: Data Compression In this chapter, we present two categories of data compression: lossless and lossy. We discuss run-length encoding, Huffman coding, and the Lempel Ziv algorithm as examples of lossless compression. We discuss JPEG and MPEG as examples of lossy compression.

Chapter 16: Security In this chapter, we discuss four aspects of security: privacy, authentication, integrity, and nonrepudiation. We show how to use encryption/decryption and the digital signature to create a secure system.

Chapter 17: Theory of Computation In this chapter, we briefly explore the theory of computation. We show how no language is superior to another in solving a problem. We show that there are some problems that cannot be solved by any computer program written in any language.

BIRD'S-EYE VIEW

The reader should keep in mind that this book does not discuss any topic in computer science in depth; to do so would require multiple volumes. The book tries to cover in breadth topics related to computer science. Our experience shows that knowing data representation and manipulation, for example, helps students better understand programming in low- and high-level languages. Knowing general information about computer science will help students be more successful when taking courses in networking and internetworking. The book is a bird's-eye view of computer science.

FEATURES OF THE BOOK

There are several features of this book that not only make it unique but make it easier for beginning students to understand.

Concepts

Throughout the book, we have tried to emphasize the concept rather than the mathematical model. We believe an understanding of the concept leads to an understanding of the model.

Visual Approach

A brief examination of the book will show that our approach is very visual. There are nearly 300 figures. While this tends to increase the length of a book, figures aid in understanding the text.

Examples

Whenever appropriate, we have used examples to demonstrate the concept and the mathematical model.

End-of-Chapter Material

The end material of each chapter contains three parts: key terms, summary, and practice set.

Key Terms The key terms provide a list of the important terms introduced in the chapter. Every key term is defined in the glossary.

Summary The summaries contain a concise overview of all the key points of the chapter. They are bulleted for readability.

Practice Sets Each practice set contains three parts: review questions, multiple-choice questions, and exercises.

- **Review questions** test the overall key points and concepts of the chapter.
- **Multiple-choice questions** are designed to test the understanding of the materials.
- **Exercises** are designed to see if students can apply the concepts and formulas.

Appendixes

Seven appendixes are included for quick reference to tables or materials that are discussed in various chapters. These appendixes are

- ASCII table
- Unicode
- Flowcharts
- Pseudocode
- Structure Charts
- Discrete Cosine Transform
- Acronyms

Glossary

A glossary of all key terms is included at the end of the book.

Solutions to Practice Sets

The solutions to the odd-numbered review questions, multiple-choice questions, and exercises are available online at www.brookscole.com/compsci.

INSTRUCTIONAL MATERIALS

The Powerpoint presentation of all figures and highlighted points in addition to the solution of all review questions, multiple-choice questions, and exercises is available online at www.brookscole.com/compsci.

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No text of this scope can be developed without the support of many people. This is especially true for this text.

We would like to acknowledge the support of the De Anza staff for their continuing encouragement and their comments. We particularly acknowledge the contribution of Scott DeMouthe for reading the manuscript and solving the problems.

To anyone who has not been through the process, the value of peer reviews cannot be appreciated enough. Writing a text rapidly becomes a myopic process. The important guidance of reviewers who can stand back and review the text as a whole cannot be measured. To twist an old cliché, “They are not valuable; they are priceless.” We would especially like to acknowledge the contributions of the reviewers: Essam El-Kwae, University of North Carolina at Charlotte; Norman J. Landis, Fairleigh Dickinson University; John A. Rohr, University of California at Los Angeles; Robert Signorile, Boston College; and Robert Statica, New Jersey Institute of Technology

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Last, and most obviously not least, is the support of our families and friends. Many years ago, an author described writing a text as “a locking yourself in a room” process. While the authors suffer through the writing process, families and friends suffer through their absence. We can only hope that as they view the final product, they feel that their sacrifices were worth it.

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From Data Manipulation to Theory of Computation

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