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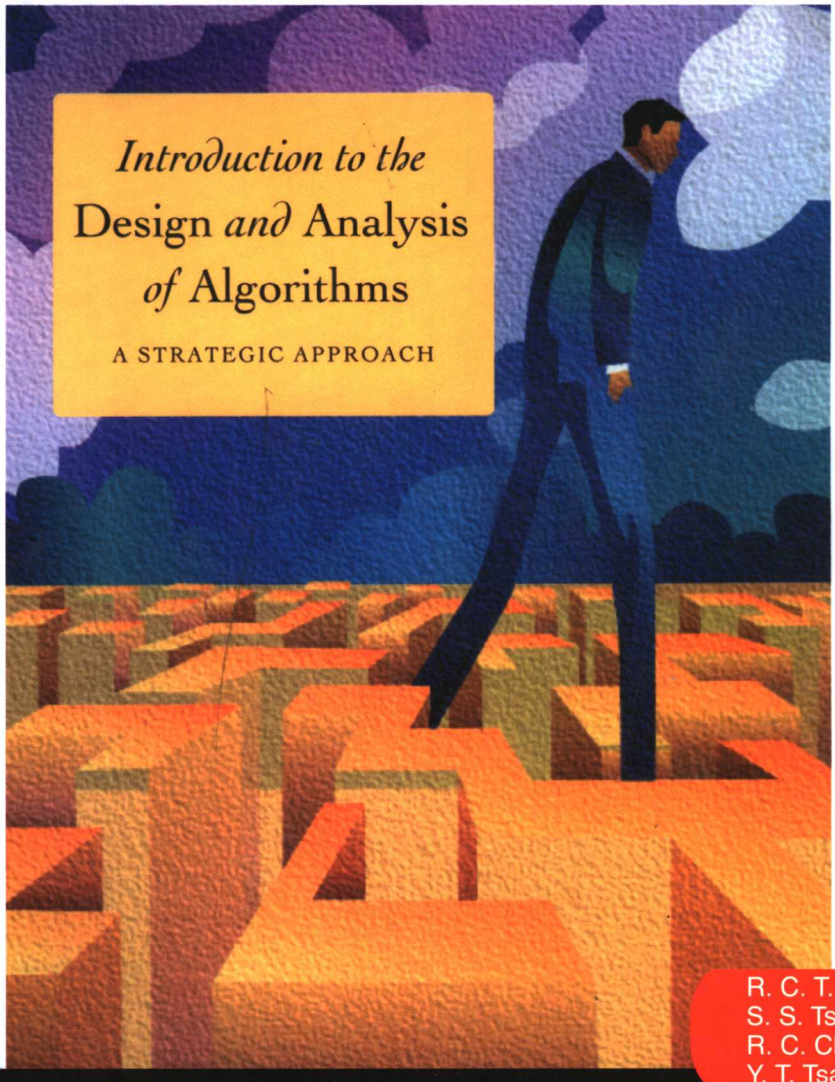

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机械工业出版社
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Introduction to the Design and Analysis of Algorithms
A Strategic Approach

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出版者的话

文艺复兴以降，源远流长的科学精神和逐步形成的学术规范，使西方国家在自然科学的各个领域取得了垄断性的优势；也正是这样的传统，使美国在信息技术发展的六十多年间名家辈出、独领风骚。在商业化的进程中，美国的产业界与教育界越来越紧密地结合，计算机学科中的许多泰山北斗同时身处科研和教学的最前线，由此而产生的经典科学著作，不仅擘划了研究的范畴，还揭橥了学术的源变，既遵循学术规范，又自有学者个性，其价值并不会因年月的流逝而减退。

近年，在全球信息化大潮的推动下，我国的计算机产业发展迅猛，对专业人才的需求日益迫切。这对计算机教育界和出版界都既是机遇，也是挑战；而专业教材的建设在教育战略上显得举足轻重。在我国信息技术发展时间较短、从业人员较少的现状下，美国等发达国家在其计算机科学发展的几十年间积淀的经典教材仍有许多值得借鉴之处。因此，引进一批国外优秀计算机教材将对我国计算机教育事业的发展起积极的推动作用，也是与世界接轨、建设真正的世界一流大学的必由之路。

机械工业出版社华章图文信息有限公司较早意识到“出版要为教育服务”。自1998年开始，华章公司就将工作重点放在了遴选、移译国外优秀教材上。经过几年的不懈努力，我们与Prentice Hall，Addison-Wesley，McGraw-Hill，Morgan Kaufmann等世界著名出版公司建立了良好的合作关系，从它们现有的数百种教材中甄选出Tanenbaum，Stroustrup，Kernighan，Jim Gray等大师名家的一批经典作品，以“计算机科学丛书”为总称出版，供读者学习、研究及庋藏。大理石纹理的封面，也正体现了这套丛书的品位和格调。

“计算机科学丛书”的出版工作得到了国内外学者的鼎力襄助，国内的专家不仅提供了中肯的选题指导，还不辞劳苦地担任了翻译和审校的工作；而原书的作者也相当关注其作品在中国的传播，有的还专程为其书的中译本作序。迄今，“计算机科学丛书”已经出版了近百个品种，这些书籍在读者中树立了良好的口碑，并被许多高校采用为正式教材和参考书籍，为进一步推广与发展打下了坚实的基础。

随着学科建设的初步完善和教材改革的逐渐深化，教育界对国外计算机教材的需求和应用都步入一个新的阶段。为此，华章公司将加大引进教材的力度，在“华章教育”的总规划之下出版三个系列的计算机教材：除“计算机科学丛书”之外，对影印版的教材，则单独开辟出“经典原版书库”；同时，引进全美通行的教学辅导书“Schaum's Outlines”系列组成“全美经典学习指导系列”。为了保证这三套丛书的权威性，同时也为了更好地为学校和老师们服务，华章公司聘请了中国科学院、

北京大学、清华大学、国防科技大学、复旦大学、上海交通大学、南京大学、浙江大学、中国科技大学、哈尔滨工业大学、西安交通大学、中国人民大学、北京航空航天大学、北京邮电大学、中山大学、解放军理工大学、郑州大学、湖北工学院、中国国家信息安全测评认证中心等国内重点大学和科研机构在计算机的各个领域的著名学者组成“专家指导委员会”，为我们提供选题意见和出版监督。

这三套丛书是响应教育部提出的使用外版教材的号召，为国内高校的计算机及相关专业的教学度身订造的。其中许多教材均已为M. I. T.，Stanford，U.C. Berkeley，C. M. U. 等世界名牌大学所采用。不仅涵盖了程序设计、数据结构、操作系统、计算机体系结构、数据库、编译原理、软件工程、图形学、通信与网络、离散数学等国内大学计算机专业普遍开设的核心课程，而且各具特色——有的出自语言设计者之手、有的历经三十年而不衰、有的已被全世界的几百所高校采用。在这些圆熟通博的名师大作的指引之下，读者必将在计算机科学的宫殿中由登堂而入室。

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Preface

There are probably many reasons for studying algorithms. The primary one is to enable readers to use computers efficiently. A novice programmer, without good knowledge of algorithms, may prove to be a disaster to his boss and the organization where he works. Consider someone who is going to find a minimal spanning tree. If he does so by examining all possible spanning trees, no computer which exists now, or will exist in the future, is good enough for him. Yet, if he knows Prim's algorithm, an IBM personal computer is sufficient. In another example where someone wants to solve speech recognition, it would be very difficult for him to get started. Yet, if he knows the longest common subsequence problem can be solved by the dynamic programming approach, he will find the problems to be surprisingly easy. Algorithm study is not only important to computer scientists. Communication engineers also use dynamic programming or A^* algorithms in coding. The largest group of non-computer scientists who benefit very much from studying algorithms are those who work on molecular biology. When one wants to compare two DNA sequences, two protein, or RNA, 3-dimensional structures, one needs to know sophisticated algorithms.

Besides, studying algorithms is great fun. Having studied algorithms for so long, the authors are still quite excited whenever they see a new and well-designed algorithm or some new and brilliant idea about the design and analysis of algorithms. They feel that they have a moral responsibility to let others share their fun and excitement. Many seemingly difficult problems can actually be solved by polynomial algorithms while some seemingly trivial problems are proved to be NP-complete. The minimal spanning tree problem appears to be quite difficult to many novice readers, yet it has polynomial algorithms. If we twist the problem a little bit so that it becomes the traveling salesperson problem, it suddenly becomes an NP-hard problem. Another case is the 3-satisfiability problem. It is an NP-complete problem. By lowering the dimensionality, the 2-satisfiability problem becomes a P problem. It is always fascinating to find out these facts.

In this book, we adopt a rather different approach to introduce algorithms. We actually are not introducing algorithms; instead, we are introducing the strategies which can be used to design algorithms. The reason is simple: It is obviously more important to know the basic principles, namely the strategies, used in designing algorithms, than algorithms themselves. Although not every algorithm is based on one of the strategies which we introduce in this book, most of them are.

Prune-and-search, amortized analysis, on-line algorithms, and polynomial-time approximation schemes are all relatively new ideas. Yet they are quite important ideas. Numerous newly developed algorithms are based on amortized analysis, as you will see at the end of the chapter on this topic.

We start by introducing strategies used to design polynomial algorithms. When we have to cope with problems which appear to be difficult ones and do not have polynomial algorithms at present, we will introduce the concept of NP-completeness. It is easy to apply the concept of NP-completeness, yet it is often difficult to grasp the physical meaning of it. The critical idea is actually why every NP problem instance is related to a set of Boolean formulas and the answer of this problem instance is "yes" if and only if the formulas are satisfiable. Once the reader understands this, he can easily appreciate the importance of NP-completeness. We are confident that the examples presented to explain this idea will help most students to easily understand NP-completeness.

This book is intended to be used as a textbook for senior undergraduate students and junior graduate students. It is our experience that we cannot cover all the materials if this is used in one semester (roughly 50 hours). Therefore, we recommend that all chapters be touched evenly, but not completely if only one semester is available. Do not ignore any chapter! The chapter on NP-completeness is very important and should be made clear to the students. The most difficult chapter is Chapter 10 (Amortized Analysis) where the mathematics is very much involved. The instructor should pay close attention to the basic ideas of amortized analysis, instead of being bogged down in the proofs. In other words, the students should be able to understand why a certain data structure, coupled with a good algorithm, can perform very well in the amortized sense. Another rather difficult chapter may be Chapter 12 (On-Line Algorithms).

Most algorithms are by no means easy to understand. We have made a tremendous effort to present the algorithms clearly. Every algorithm that is introduced is accompanied by examples. Every example is presented with figures. We have provided more than 400 figures in our book which will be very helpful to novice readers.

We have also cited many books and papers on algorithm design and analysis. Latest results are specifically mentioned so that the readers can easily find directions for further research. The Bibliography lists 825 books and papers, which correspond to 1,095 authors.

We present experimental results when it is appropriate. Still, the instructor should encourage students to test the algorithms by implementing them. At the

end of each chapter, is a list of papers for further reading. It is important to encourage the students to read some of them in order to advance their understanding of algorithms. Perhaps they will appreciate how hard the authors worked to decipher many of the difficult-to-read papers! We have also included some programs, written in Java, for the students to practice.

It is simply impossible to name all the persons who have helped the authors tremendously in preparing this book; there are just too many of them. However, they all belong to one class. They are either the authors' students or colleagues (many students later became colleagues). In the weekly Friday evening seminars, we always had lively discussions. These discussions pointed out new directions of algorithm research and helped us decide which material should be included in the book. Our graduate students have been monitoring roughly 20 academic journals to ensure that every important paper on algorithms is stored in a database with keywords attached to it. This database is very valuable for writing this book. Finally, they read the manuscript of this book, offered criticisms and performed experiments for us. We cannot imagine completing this book without the help from our colleagues and students. We are immensely grateful to all of them.

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