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## THEORY AND PROBLEMS OF

# DATA
# STRUCTURES

## SEYMOUR LIPSCHUTZ

## INCLUDING 457 SOLVED PROBLEMS

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# THEORY AND PROBLEMS

*of*

# DATA STRUCTURES

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Schaum's Outline of Theory and Problems of
DATA STRUCTURES
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This book is dedicated to my previous, current and future students with whom I want to share this poem:

> The basic truths in all teachings of mankind are alike
> and amount to one common thing:
> to find your way to the thing you feel when you love dearly,
> or when you create,
> or when you build your home,
> or when you give birth to your children,
> or when you look at the stars at night.
>
> Wilhelm Reich

# Preface

The study of data structures is an essential part of virtually every undergraduate and graduate program in computer science. This text, in presenting the more essential material, may be used as a textbook for a formal course in data structures or as a supplement to almost all current standard texts.

The chapters are mainly organized in increasing degree of complexity. Chapter 1 is an introduction and overview of the material, and Chapter 2 presents the mathematical background and notation for the presentation and analysis of our algorithms. Chapter 3, on pattern matching, is independent and tangential to the text and hence may be postponed or omitted on a first reading. Chapters 4 through 8 contain the core material in any course on data structures. Specifically, Chapter 4 treats arrays and records, Chapter 5 is on linked lists, Chapter 6 covers stacks and queues and includes recursion, Chapter 7 is on binary trees and Chapter 8 is on graphs and their applications. Although sorting and searching is discussed throughout the text within the context of specific data structures (e.g., binary search with linear arrays, quicksort with stacks and queues and heapsort with binary trees), Chapter 9, the last chapter, presents additional sorting and searching algorithms such as merge-sort and hashing.

Algorithms are presented in a form which is machine and language independent. Moreover, they are written using mainly IF-THEN-ELSE and REPEAT-WHILE modules for flow of control, and using an indentation pattern for easier reading and understanding. Accordingly, each of our algorithms may be readily translated into almost any standard programming language.

Adopting a deliberately elementary approach to the subject matter with many examples and diagrams, this book should appeal to a wide audience, and is particularly suited as an effective self-study guide. Each chapter contains clear statements of definitions and principles together with illustrative and other descriptive material. This is followed by graded sets of solved and supplementary problems. The solved problems illustrate and amplify the material, and the supplementary problems furnish a complete review of the material in the chapter.

I wish to thank many friends and colleagues for invaluable suggestions and critical review of the manuscript. I also wish to express my gratitude to the staff of the McGraw-Hill Schaum's Outline Series, especially Jeffrey McCartney, for their helpful cooperation. Finally, I join many other authors in explicitly giving credit to Donald E. Knuth who wrote the first comprehensive treatment of the subject of data structures, which has certainly influenced the writing of this and many other texts on the subject.

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