CONTENTS

Chapter 5 — Sorting 1

*5.1. Combinatorial Properties of Permutations 11
*5.1.1. Inversions 11
*5.1.2. Permutations of a Multiset 22
*5.1.3. Runs 35
*5.1.4. Tableaux and Involutions 47
5.2. Internal Sorting 73
5.2.1. Sorting by Insertion 80
5.2.2. Sorting by Exchanging 105
5.2.3. Sorting by Selection 138
5.2.4. Sorting by Merging 158
5.2.5. Sorting by Distribution 168
5.3. Optimum Sorting 180
5.3.1. Minimum-Comparison Sorting 180
*5.3.2. Minimum-Comparison Merging 197
*5.3.3. Minimum-Comparison Selection 207
*5.3.4. Networks for Sorting 219
5.4. External Sorting 248
5.4.1. Multiway Merging and Replacement Selection 252
*5.4.2. The Polyphase Merge 267
*5.4.3. The Cascade Merge 288
*5.4.4. Reading Tape Backwards 299
*5.4.5. The Oscillating Sort 311
*5.4.6. Practical Considerations for Tape Merging 317
*5.4.7. External Radix Sorting 343
*5.4.8. Two-Tape Sorting 348
*5.4.9. Disks and Drums 356
5.5. Summary, History, and Bibliography 380

Chapter 6 — Searching 392

6.1. Sequential Searching 396
6.2. Searching by Comparison of Keys 409
6.2.1. Searching an Ordered Table 409
6.2.2. Binary Tree Searching 426
6.2.3. Balanced Trees 458
6.2.4. Multiway Trees 481

6.3. Digital Searching 492
6.4. Hashing 513
6.5. Retrieval on Secondary Keys 559

Answers to Exercises 584

Appendix A — Tables of Numerical Quantities 748

1. Fundamental Constants (decimal) 748
2. Fundamental Constants (octal) 749
3. Harmonic Numbers, Bernoulli Numbers, Fibonacci Numbers . . . 750

Appendix B — Index to Notations 752

Appendix C — Index to Algorithms and Theorems 757

Index and Glossary 759