Table of Contents

0.	Organization of Chapters	13
	0.1 What Is This Book About?	13
	0.2 Should I Buy This Book?	13
	0.3 Organization of Chapters	14
	0.4 Some Prerequisites	17
1.	Introduction	18
	1.1 Variables	18
	1.2 Data Types	18
	1.3 Data Structures	19
	1.4 Abstract Data Types (ADTs)	19
	1.5 What is an Algorithm?	19
	1.6 Why the Analysis of Algorithms?	20
	1.7 Goal of the Analysis of Algorithms	20
	1.8 What is Running Time Analysis?	20
	1.9 How to Compare Algorithms	20
	1.10 What is Rate of Growth?	20
	1.11 Commonly Used Rates of Growth	21
	1.12 Types of Analysis	22
	1.13 Asymptotic Notation	22
	1.14 Big-O Notation	22
	1.15 Omega-Ω Notation	24
	1.16 Theta-Θ Notation	24
	1.17 Why is it called Asymptotic Analysis?	25
	1.18 Guidelines for Asymptotic Analysis	
	1.19 Properties of Notations	27
	1.20 Commonly used Logarithms and Summations	27
	1.21 Master Theorem for Divide and Conquer	
	1.22 Divide and Conquer Master Theorem: Problems & Solutions	28
	1.23 Master Theorem for Subtract and Conquer Recurrences	29
	1.24 Variant of Subtraction and Conquer Master Theorem	
	1.25 Method of Guessing and Confirming	
	1.26 Amortized Analysis	30
	1.27 Algorithms Analysis: Problems & Solutions	31
2.	Recursion and Backtracking	
	2.1 Introduction	
	2.2 What is Recursion?	42
	2.3 Why Recursion?	42
	2.4 Format of a Recursive Function	42
	2.5 Recursion and Memory (Visualization)	43

	2.6 Recursion versus Iteration	43
	2.7 Notes on Recursion	44
	2.8 Example Algorithms of Recursion	44
	2.9 Recursion: Problems & Solutions	
	2.10 What is Backtracking?	45
	2.11 Example Algorithms of Backtracking	45
	2.12 Backtracking: Problems & Solutions	
3.	Linked Lists	48
	3.1 What is a Linked List?	
	3.2 Linked Lists ADT	
	3.3 Why Linked Lists?	
	3.4 Arrays Overview	
	3.5 Comparison of Linked Lists with Arrays and Dynamic Arrays	
	3.6 Singly Linked Lists	
	3.7 Doubly Linked Lists	
	3.8 Circular Linked Lists	
	3.9 A Memory-efficient Doubly Linked List	
	3.10 Unrolled Linked Lists	
	3.11 Skip Lists	
	3.12 Linked Lists: Problems & Solutions	
4.		
,.	4.1 What is a Stack?	
	4.2 How Stacks are Used	
	4.3 Stack ADT	
	4.4 Applications	
	4.5 Implementation	
	4.6 Comparison of Implementations	
	4.7 Stacks: Problems & Solutions	
r		
5.	- A	
	5.1 What is a Queue?	
	5.2 How are Queues Used	
	5.3 Queue ADT	
	5.4 Exceptions	
	5.5 Applications	
	5.6 Implementation	
	5.7 Queues: Problems & Solutions	
6.	Trees	
	6.1 What is a Tree?	
	6.2 Glossary	
	6.3 Binary Trees	
	6.4 Types of Binary Trees	
	6.5 Properties of Binary Trees	137

	6.6 Binary Tree Traversals	139
	6.7 Generic Trees (N-ary Trees)	159
	6.8 Threaded Binary Tree Traversals (Stack or Queue-less Traversals)	166
	6.9 Expression Trees	171
	6.10 XOR Trees	174
	6.11 Binary Search Trees (BSTs)	174
	6.12 Balanced Binary Search Trees	189
	6.13 AVL (Adelson-Velskii and Landis) Trees	189
	6.14 Other Variations on Trees	207
7.	Priority Queues and Heaps	211
	7.1 What is a Priority Queue?	211
	7.2 Priority Queue ADT	211
	7.3 Priority Queue Applications	212
	7.4 Priority Queue Implementations	212
	7.5 Heaps and Binary Heaps	213
	7.6 Binary Heaps	214
	7.7 Heapsort	218
	7.8 Priority Queues [Heaps]: Problems & Solutions	219
8.	Disjoint Sets ADT	233
	8.1 Introduction	233
	8.2 Equivalence Relations and Equivalence Classes	233
	8.3 Disjoint Sets ADT	234
	8.4 Applications	234
	8.5 Tradeoffs in Implementing Disjoint Sets ADT	234
	8.8 Fast UNION Implementation (Slow FIND)	235
	8.9 Fast UNION Implementations (Quick FIND)	237
	8.10 Summary	240
	8.11 Disjoint Sets: Problems & Solutions	240
9.	Graph Algorithms	242
	9.1 Introduction	242
	9.2 Glossary	242
	9.3 Applications of Graphs	245
	9.4 Graph Representation	245
	9.5 Graph Traversals	250
	9.6 Topological Sort	256
	9.7 Shortest Path Algorithms	258
	9.8 Minimal Spanning Tree	263
	9.9 Graph Algorithms: Problems & Solutions	267
10.	. Sorting	287
	10.1 What is Sorting?	287
	10.2 Why is Sorting Necessary?	287
	10.3 Classification of Sorting Algorithms	287

	10.4 Other Classifications	288
	10.5 Bubble Sort	288
	10.6 Selection Sort	289
	10.7 Insertion Sort	290
	10.8 Shell Sort	
	10.9 Merge Sort	
	10.10 Heap Sort	
	10.11 Quick Sort	
	10.12 Tree Sort	
	10.13 Comparison of Sorting Algorithms	
	10.14 Linear Sorting Algorithms	
	10.15 Counting Sort	
	10.16 Bucket Sort (or Bin Sort)	
	10.17 Radix Sort	
	10.18 Topological Sort	
	10.19 External Sorting	
	10.20 Sorting: Problems & Solutions	300
11.	. Searching	310
	11.1 What is Searching?	310
	11.2 Why do we need Searching?	310
	11.3 Types of Searching	310
	11.4 Unordered Linear Search	310
	11.5 Sorted/Ordered Linear Search	310
	11.6 Binary Search	311
	11.7 Interpolation Search	312
	11.8 Comparing Basic Searching Algorithms	312
	11.9 Symbol Tables and Hashing	313
	11.10 String Searching Algorithms	313
	11.11 Searching: Problems & Solutions	313
12.	Selection Algorithms [Medians]	335
	12.1 What are Selection Algorithms?	335
	12.2 Selection by Sorting	335
	12.3 Partition-based Selection Algorithm	335
	12.4 Linear Selection Algorithm - Median of Medians Algorithm	335
	12.5 Finding the K Smallest Elements in Sorted Order	335
	12.6 Selection Algorithms: Problems & Solutions	336
13.	Symbol Tables	345
	13.1 Introduction	345
	13.2 What are Symbol Tables?	345
	13.3 Symbol Table Implementations	345
	13.4 Comparison Table of Symbols for Implementations	346
14.	. Hashing	347

14.1 What is Hashing?	347
14.2 Why Hashing?	347
14.3 HashTable ADT	347
14.4 Understanding Hashing	347
14.5 Components of Hashing	348
14.6 Hash Table	348
14.7 Hash Function	349
14.8 Load Factor	350
14.9 Collisions	350
14.10 Collision Resolution Techniques	350
14.11 Separate Chaining	350
14.12 Open Addressing	350
14.13 Comparison of Collision Resolution Techniques	352
14.14 How Hashing Gets O(1) Complexity	352
14.15 Hashing Techniques	353
14.16 Problems for which Hash Tables are not suitable	353
14.17 Bloom Filters	353
14.18 Hashing: Problems & Solutions	354
15. String Algorithms	362
15.1 Introduction	362
15.2 String Matching Algorithms	362
15.3 Brute Force Method	362
15.4 Robin-Karp String Matching Algorithm	363
15.5 String Matching with Finite Automata	364
15.6 KMP Algorithm	365
15.7 Boyce-Moore Algorithm	368
15.8 Data Structures for Storing Strings	369
15.9 Hash Tables for Strings	369
15.10 Binary Search Trees for Strings	369
15.11 Tries	369
15.12 Ternary Search Trees	371
15.13 Comparing BSTs, Tries and TSTs	377
15.14 Suffix Trees	377
15.15 String Algorithms: Problems & Solutions	380
16. Algorithms Design Techniques	387
16.1 Introduction	387
16.2 Classification	387
16.3 Classification by Implementation Method	387
16.4 Classification by Design Method	388
16.5 Other Classifications	389
17. Greedy Algorithms	390
17.1 Introduction	390

	17.2 Greedy Strategy	
	17.3 Elements of Greedy Algorithms	
	17.4 Does Greedy Always Work?	
	17.5 Advantages and Disadvantages of Greedy Method	
	17.6 Greedy Applications	
	17.7 Understanding Greedy Technique	-391
	17.8 Greedy Algorithms: Problems & Solutions	-393
18.	Divide and Conquer Algorithms	-399
	18.1 Introduction	-399
	18.2 What is Divide and Conquer Strategy?	-399
	18.3 Does Divide and Conquer Always Work?	-399
	18.4 Divide and Conquer Visualization	-399
	18.5 Understanding Divide and Conquer	-400
	18.6 Advantages of Divide and Conquer	-400
	18.7 Disadvantages of Divide and Conquer	-401
	18.8 Master Theorem	-401
	18.9 Divide and Conquer Applications	-401
	18.10 Divide and Conquer: Problems & Solutions	-401
19.	Dynamic Programming	-416
	19.1 Introduction	-416
	19.2 What is Dynamic Programming Strategy?	-416
	19.3 Properties of Dynamic Programming Strategy	-416
	19.4 Can Dynamic Programming Solve All Problems?	-416
	19.5 Dynamic Programming Approaches	-416
	19.6 Examples of Dynamic Programming Algorithms	-417
	19.7 Understanding Dynamic Programming	-417
	19.8 Longest Common Subsequence	-419
	19.9 Dynamic Programming: Problems & Solutions	-421
20.	Complexity Classes	-453
	20.1 Introduction	-453
	20.2 Polynomial/Exponential Time	-453
	20.3 What is a Decision Problem?	-453
	20.4 Decision Procedure	-454
	20.5 What is a Complexity Class?	-454
	20.6 Types of Complexity Classes	-454
	20.7 Reductions	-456
	20.8 Complexity Classes: Problems & Solutions	-458
21.	Miscellaneous Concepts	-460
	21.1 Introduction	
	21.2 Hacks on Bitwise Programming	-460
	21.3 Other Programming Questions with Solutions	-464
Ref	erences	