

Table of Contents

1	Introduction to Data Structures and Algorithms	1
1.1	Data Structures and Their Role	2
1.2	Algorithms and Their Purpose	3
1.3	Importance in Software Development	4
1.4	Role in Computational Thinking	5
1.5	Using Java for Learning	6
2	Analysis of Algorithms	7
2.1	Time Complexity Analysis	8
2.2	Space Complexity Analysis	9
2.3	Big O, Big Ω , and Big Θ Notation	10
2.4	Best, Worst, and Average Cases	11
2.5	Algorithm Design Paradigms	12
2.5.1	Greedy Algorithms	13
2.5.2	Divide and Conquer	14
2.5.3	Dynamic Programming	15
3	Data Types and Data Structures	16
3.1	Abstract Data Types (ADT)	17
3.1.1	Definition and Purpose	18
3.1.2	ADT vs. Data Structure	19
3.1.3	Interface and Implementation in Java	20
4	Linear Data Structures	21
4.1	Arrays and Their Applications	22
4.2	Stack	23
4.3	Queue	24
4.4	Linked Lists	25
4.4.1	Singly Linked List	26
4.4.2	Doubly Linked List	27
4.4.3	Circular Linked List	28
5	Non-Linear Data Structures	29
5.1	Trees	30
5.1.1	Binary Trees	31
5.1.2	Tree Traversals	32

Table of Contents

5.1.3	Binary Search Trees (BST)	33
5.2	Heaps and Priority Queues	34
5.3	Hash Tables	35
5.3.1	Hash Functions	36
5.3.2	Open Addressing	37
5.3.3	Separate Chaining	38
5.3.4	Hashing Efficiency	39
6	Recursion	40
6.1	Introduction to Recursion	41
6.2	Fibonacci Series	42
6.3	Tower of Hanoi	43
6.4	Tail Recursion	44
6.5	Recursion in Tree Traversals and Sorting	45
7	Sorting Algorithms	46
7.1	Bubble Sort	47
7.2	Selection Sort	48
7.3	Insertion Sort	49
7.4	Merge Sort	50
7.5	Quick Sort	51
7.6	Shell Sort	52
7.7	Radix Sort	53
7.8	Heap Sort	54
7.9	Complexity Comparison Tables	54
8	Searching Algorithms	55
8.1	Linear Search	56
8.1	Binary Search	57
9	Graph Algorithms	58
9.1	Introduction to Graphs	59
9.2	Graph Representations	60
9.3	Depth-First Search (DFS)	61
9.4	Breadth-First Search (BFS)	62
9.5	Weighted Graphs and Shortest Path Algorithms	63