# DSA Time and Space Complexities (A to Z)

## Sorting Algorithms

| Algorithm | Best | Average | Worst | Space |
|---|---|---|---|---|
| Bubble Sort | O(n) | O(n²) | O(n²) | O(1) |
| Insertion Sort | O(n) | O(n²) | O(n²) | O(1) |
| Selection Sort | O(n²) | O(n²) | O(n²) | O(1) |
| Merge Sort | O(n log n) | O(n log n) | O(n log n) | O(n) |
| Quick Sort | O(n log n) | O(n log n) | O(n²) | O(log n) |
| Heap Sort | O(n log n) | O(n log n) | O(n log n) | O(1) |
| Counting Sort | O(n+k) | O(n+k) | O(n+k) | O(k) |
| Radix Sort | O(nk) | O(nk) | O(nk) | O(n+k) |
| Bucket Sort | O(n+k) | O(n+k) | O(n²) | O(n) |

## Searching Algorithms

| Algorithm | Best | Average | Worst | Space |
|---|---|---|---|---|
| Linear Search | O(1) | O(n) | O(n) | O(1) |
| Binary Search | O(1) | O(log n) | O(log n) | O(1) |
| Ternary Search | O(1) | O(log3 n) | O(log3 n) | O(1) |

## Tree Structures

| Structure | Best | Average | Worst | Space |
|---|---|---|---|---|
| BST | O(log n) | O(log n) | O(n) | O(n) |
| AVL Tree | O(log n) | O(log n) | O(log n) | O(n) |
| Red-Black Tree | O(log n) | O(log n) | O(log n) | O(n) |
| Segment Tree | O(log n) | O(log n) | O(log n) | O(n) |
| Fenwick Tree | O(log n) | O(log n) | O(log n) | O(n) |
| Trie | O(m) | O(m) | O(m) | O(nm) |

## Hashing

| Operation | Best | Average | Worst | Space |
|---|---|---|---|---|
| Insert/Search/Delete | O(1) | O(1) | O(n) | O(n) |

## Graphs

| Algorithm | Time | Space |
|---|---|---|
| BFS / DFS | O(V + E) | O(V) |
| Dijkstra's (Heap) | O((V + E) log V) | O(V + E) |

| | | |
|---|---|---|
| Bellman-Ford | O(VE) | O(V) |
| Floyd-Warshall | O(V³) | O(V²) |
| Prim's (Heap) | O(E + log V) | O(V + E) |
| Kruskal's | O(E log V) | O(V + E) |

## Divide & Conquer

| **Algorithm** | **Time** | **Space** |
|---|---|---|
| Merge Sort | O(n log n) | O(n) |
| Quick Sort | O(n²) / O(n log n) | O(log n) |
| Binary Search | O(log n) | O(1) |

## Dynamic Programming

| **Problem** | **Time** | **Space** |
|---|---|---|
| Fibonacci (memoized) | O(n) | O(n) |
| 0/1 Knapsack | O(nW) | O(nW) |
| LCS | O(nm) | O(nm) |
| Matrix Chain Mult. | O(n³) | O(n²) |

## Greedy Algorithms

| **Problem** | **Time** | **Space** |
|---|---|---|
| Activity Selection | O(n log n) | O(1) |
| Huffman Coding | O(n log n) | O(n) |
| Kruskal's / Prim's | O(E log V) | O(V + E) |

## Basic Data Structures

| **Structure** | **Access** | **Search** | **Insert** | **Delete** | **Space** |
|---|---|---|---|---|---|
| Array | O(1) | O(n) | O(n) | O(n) | O(n) |
| Stack / Queue | O(n) | O(n) | O(1) | O(1) | O(n) |
| Linked List | O(n) | O(n) | O(1) | O(1) | O(n) |
| Doubly Linked List | O(n) | O(n) | O(1) | O(1) | O(n) |
| Hash Table | - | O(1) | O(1) | O(1) | O(n) |

## Backtracking / Recursion

| **Problem** | **Time** | **Space** |
|---|---|---|
| N-Queens | O(N!) | O(N²) |
| Sudoku Solver | O(9^(n²)) | O(n²) |
| Subset Generation | O(2^n) | O(n) |

| Permutation Generation | $O(n!)$ | $O(n)$ |
| --- | --- | --- |