Sorting Basics

Introduction: The Art of Organizing Data

Sorting is one of the most fundamental operations in computer science, enabling efficient data retrieval, searching, and organization. Various sorting algorithms exist, each with its own strengths, weaknesses, and use cases. Understanding their working principles and complexities is crucial for optimizing performance in real-world applications.

What is Sorting?

Sorting refers to the process of arranging elements in a specific order, typically ascending or descending. Sorting is widely used in searching algorithms, database management, and data analysis.

Types of Sorting Algorithms

Sorting algorithms can be broadly classified into:

- **Comparison-Based Sorting:** Elements are compared with each other (e.g., Bubble Sort, Quick Sort).
- **Non-Comparison-Based Sorting:** Sorting relies on special properties of data (e.g., Counting Sort, Radix Sort).

Elementary Sorting Algorithms

These algorithms are simple but inefficient for large datasets.

1. Bubble Sort

Concept:

- Repeatedly swaps adjacent elements if they are in the wrong order.
- Passes through the array multiple times until sorted.

Time Complexity:

- Worst/Average Case: O(n^2)
- Best Case (Already Sorted): O(n)

Key Insights:

- Simple but inefficient for large datasets.
- Optimized versions exist to stop early if no swaps occur.

2. Selection Sort

Concept:

- Finds the smallest element and swaps it with the first element.
- Repeats for the remaining elements until sorted.

Time Complexity:

- Worst/Average/Best Case: O(n^2)

Key Insights:

- Requires fewer swaps compared to Bubble Sort.
- Still inefficient for large datasets.

3. Insertion Sort

Concept:

- Builds a sorted sequence one element at a time by placing each element in its correct position.

Time Complexity:

- Worst/Average Case: O(n^2)
- Best Case (Nearly Sorted): O(n)

Advanced Sorting Algorithms (Divide and Conquer Approach)

These algorithms break the problem into smaller subproblems for efficient sorting.

4. Merge Sort

Concept:

- Divides the array into halves, recursively sorts them, and merges the sorted halves.

Time Complexity:

- Worst/Average/Best Case: O(n log n)

Key Insights:

- Stable sorting algorithm.
- Requires extra space (O(n)), making it less space-efficient.

5. Quick Sort

Concept:

- Selects a pivot, partitions the array into elements smaller and greater than the pivot, then recursively sorts the partitions.

Time Complexity:

- Worst Case: O(n^2) (When pivot selection is poor)
- Average/Best Case: O(n log n)

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Questions: (Easy - yellow , Medium - orange , Hard - black)

1) Two Sum - https://leetcode.com/problems/two-sum/
2) Merge Sorted Array * - https://leetcode.com/problems/merge-sorted-array/
3) Majority Element * - https://leetcode.com/problems/majority-element/
4) Sort Colors (Dutch National Flag) * - https://leetcode.com/problems/sort-colors/
5) Merge Intervals * - https://leetcode.com/problems/merge-intervals/
6) Insertion Sort List - https://leetcode.com/problems/insertion-sort-list/
7) Merge k Sorted Lists * - https://leetcode.com/problems/merge-k-sorted-lists/
8) Wiggle Sort II - https://leetcode.com/problems/wiggle-sort-ii/
9) Count of Smaller Numbers After Self - https://leetcode.com/problems/count-of-smaller-numbers-after-self/