## Sorting Algorithms

| Algorithm | Avg. Time | Best Case | Worst Case | Stable? | When to Use | Analogy / Idea |
|---|---|---|---|---|---|---|
| Bubble Sort | $O(n^2)$ | O(n) | $O(n^2)$ | ✅ Yes | Learning basics, small lists | Biggest bubble floats to the top. |
| Selection Sort | $O(n^2)$ | $O(n^2)$ | $O(n^2)$ | ❌ No | Rarely used in practice | Picking the smallest player each time. |
| Insertion Sort | $O(n^2)$ | O(n) | $O(n^2)$ | ✅ Yes | Small datasets, nearly sorted data | Sorting cards in your hand. |
| Merge Sort | O(n log n) | O(n log n) | O(n log n) | ✅ Yes | Large datasets, linked lists | Split & merge piles of papers. |
| Quick Sort | O(n log n) | O(n log n) | $O(n^2)$ | ❌ No | General-purpose, fast in practice | Choosing a pivot & arranging around it. |
| Heap Sort | O(n log n) | O(n log n) | O(n log n) | ❌ No | Priority queues, heaps | Pulling tallest book repeatedly. |
| Counting Sort | O(n+k) | O(n+k) | O(n+k) | ✅ Yes | Small range integers | Counting ages in a class. |
| Radix Sort | O(n·k) | O(n·k) | O(n·k) | ✅ Yes | Fixed-length integers/ strings | Sorting names letter by letter. |
| Bucket Sort | O(n+k) | O(n) | $O(n^2)$ | ✅ Yes | Uniform distribution, decimals | Putting coins into jars by size. |
| Tim Sort (Python/Java default) | O(n log n) | O(n) | O(n log n) | ✅ Yes | Real-world general sorting | Hybrid of merge + insertion sort. |