

Complexities

Name	Worst case	Average case	Best case
Fractional Knapsack	$O(n \cdot \log(n))$		
0-1 Knapsack	$O(n \cdot W)$		
MergeSort	$O(n \cdot \log(n))$		
Selection-Sort	$O(n^2)$		
Insertion-sort	$O(n^2)$		
Heap-sort	$O(n \cdot \log(n))$		
Quick-sort	$O(n^2)$		$O(n \cdot \log(n))$
ComparisonBased Sort			$\Omega(n \cdot \log(n))$
BucketSort	$O(n + N)$		
RadixSort	$O(d \cdot (n + N))$		
QuickSelect	$O(n^2)$	$O(n)$	$O(n)$

Divide-and-Conquer

Divide-and-conquer is a general algorithm design paradigm:
 -> Divide: divide the input data S in two or more disjoint subsets S1, S2, ...
 -> Conquer: solve the subproblems recursively
 -> Combine: combine the solutions for S1, S2, ..., into a solution for S

Greedy Method

◆ **The greedy method** is a general algorithm design paradigm, built on the following elements:

- **configurations**: different choices, collections, or values to find
- **objective function**: a score assigned to configurations, which we want to either maximize or minimize

◆ It works best when applied to problems with the **greedy-choice** property:

- a globally-optimal solution can always be found by a series of local improvements from a starting configuration.

Dynamic Programming

◆ Applies to a problem that at first seems to require a lot of time (possibly exponential), provided we have:

- **Simple subproblems**: the subproblems can be defined in terms of a few variables, such as j, k, l, m, and so on.
- **Subproblem optimality**: the global optimum value can be defined in terms of optimal subproblems
- **Subproblem overlap**: the subproblems are not independent, but instead they overlap (hence, should be constructed bottom-up).

Master Theorem

$$T(n) = \begin{cases} c & \text{if } n < d \\ aT(n/b) + f(n) & \text{if } n \geq d \end{cases}$$

Master Theorem

1. if $f(n)$ is $O(n^{\log_b a - \epsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a + \epsilon})$, then $T(n)$ is $\Theta(f(n))$, provided $af(n/b) \leq \delta f(n)$ for some $\delta < 1$.



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