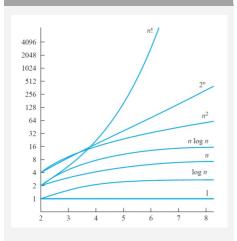


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Runtime Complexity



Formally: there exist constants c and n0 such that for all sufficiently large n: $f(n) \le c \cdot g(n)$ $c,n0 \ n : n \ge n0$, $f(n) \le c \cdot g(n)$

Master theorem

$$\begin{split} &T(n)=a\cdot T(n/b)+f(n),\ a\ge 1\ and\ b>1\\ &\text{let }c=\log_b\ a\\ &\text{Case 1: (only leaves) if }f(n)=O(n^{C-e}),\ then\\ &T(n)=Theta(n^C)\ for\ some\ e>0\\ &\text{Case 2: (all\ nodes) if }f(n)=theta(n^C\log^k\ n)\ ,\\ &k\ge 0\ ,\ T(n)=theta(n^C\log^{k+1}n)\\ &\text{Case 3: (only\ internal\ nodes) if }f(n)=\\ &\text{omega}(n^{C+e}),\ then\ T(n)=theta(f(n))\ for\ some\ e>0\\ \end{split}$$

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Kruskals Algorithm

Sort all edges by their weights

- Choose the minimum weight edge and join correspondent vertices (subject to cycles).
- Go to the next edge.
- Continue to grow the forest until all vertices are connected
 Runtime Complexity:

Sorting edges – O(E log E)

 $\label{eq:cycle} \text{Cycle detection} - \text{O(V)} \text{ for each edge}$

Total: O(V * E + E * log E)

Depth-First-Search (DFS)

It starts at a selected node and explores as far as possible along each branch before backtracking. DFS uses a stack for backtracking

Breadth-First-Search (BFS)

It starts at a selected node and explores all nodes at the present depth prior to moving on to the nodes at the next depth level. BFS uses a FIFO queue for bookkeeping

Amortized Analysis

Aggregate method: The amortized cost of an operation is given by T(n) / n Accounting Method: We assign different charges to each operation; some operations may charge more or less than they actually cost

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Topological Sort

- 1. Select a vertex that has zero in-degree.
- 2. Add the vertex to the output.
- 3. Delete this vertex and all its outgoing edges.
- 4. Repeat

Coin Change

opt[k,x] = min(opt[k-1,x], opt[k,x-dk] + 1)Base : opt[1,x] = x, opt[k,0] = 0

01 knapsack

opt[k,x] = max(vk + opt[k-1, x - wk], opt[k-1,x]

base: opt[0,x] = 0, opt[k,0] = 0opt[k,x] = opt[k-1,x] if wk > x

Djikstra's Algorithm

When algorithm proceeds, all vertices are divided into two groups

- vertices whose shortest path from the source is known
- vertices whose shortest path from the source is NOT discovered yet.
 Move vertices one at a time from the undiscovered set of vertices to the known set of the shortest distances, based on the

Runtime: O(V.log V + E.log V)

shortest distance from the source.

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Неар

	Binary	Binomial	Fibonacci
findMin	Θ(1)	Θ(1)	Θ(1)
deleteMin)Θ(log n)	Θ(log n)	O(log n) (ac)
insert	Θ(log n)	Θ(1) (ac)	<u> </u>
decreaseKey	Θ(log n)	Θ(log n)	Θ(1) (ac)
merge	Θ(n)	Θ(log n)	Θ(1) (ac)

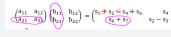
Karatsuba

$$a \times b = (x1 \cdot 10^{n/2} + x0) \cdot (y1 \cdot 10^{n/2} + y0)$$

Strassen Algorithm



Strassen's Algorithm



Prim's Algorithm

- 1) Start with an arbitrary vertex as a subtree C.
- 2) Expand C by adding a vertex having the minimum weight edge of the graph having exactly one end point in C.
- 3) Update distances from C to adjacent vertices.
- 4) Continue to grow the tree until C gets all vertices.

Runtime:

binary heap : O(V.log V + E. log V)
Fibonacci heap: O(V. log V + 1) (ac)

Greedy Algorithm

It is used to solve optimization problems
It makes a local optimal choice at each step
Earlier decisions are never undone
Does not always yield the optimal solution

Longest Common Subsequence

base case: lcs[i,0] = lcs[0,j] = 0

$$\begin{split} & LCS[i,j] = (1 + LCS[i-1,j-1]) \text{ if } s[i] = s[j] \\ & LCS[i,j] = (max(lcs[i-1,j] \text{ , } max[i,j-1]) \text{ if } s[i] \text{ != } s[j] \end{split}$$

C

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