What is a list of data structures that a competitive programmer must know?

Sameer Gulati · Updated August 12, 2019
International Master at Codeforces

This is a comprehensive list of Data Structures and Algorithms used in Competitive Programming with tutorials, implementations and problems. Use this list in conjunction with this strategy (Sameer Gulati's answer to What made you good at competitive programming?). I originally posted this list on the Codechef Discuss Forum. Moving forward I will be keeping this list updated here on Quora:

- Binary Search :
  Tutorial, Problems, Tutorial, Implementation, Problem
- Quicksort :
  Tutorial, Implementation, Tutorial
- Merge Sort :
  Tutorial, Implementation, Tutorial
- Suffix Array :
  Tutorial, Tutorial, Implementation, Tutorial, Implementation, Problem, Problem
- Knuth-Morris-Pratt Algorithm (KMP) :
  Tutorial, Tutorial, Implementation, Tutorial, Problem
- Rabin-Karp Algorithm :
  Tutorial, Implementation, Tutorial, Problem, Problem
- Tries :
  Tutorial, Problems, Tutorial : I, II, Tutorial, Problem, Problem, Problem
- Depth First Traversal of a Graph :
  Tutorial, Implementation, Tutorial, Problems, Problem, Problem, Problem
- Breadth First Traversal of a Graph :
  Tutorial, Implementation, Tutorial, Problems, Problem, Problem, Problem, Flood Fill
- Dijkstra's Algorithm :
  Tutorial, Problems, Problem, Tutorial(greedy), Tutorial (with heap), Implementation, Problem, Problem
- Binary Indexed Tree :
  Tutorial, Problems, Tutorial, Original Paper, Tutorial, Tutorial, Problem, Problem,
  Problem, Problem, Problem, Problem, Problem
- Segment Tree (with lazy propagation) :
  Tutorial, Implementation, Tutorial, Tutorial, Problems, Implementation, Tutorial, Implementation and Various Uses, Persistent Segment Tree: *62, II, problems same as BIT, Problem, Problem /HLD is used as well/
- Z algorithm :
  Tutorial, Problem, Tutorial, Tutorial, problems same as KMP.
- Floyd Warshall Algorithm :
  Tutorial, Implementation, Problem, Problem
- Sparse Table (LCP, RMQ) :
  Tutorial, Problems, Tutorial, Implementation(C++), Java implementation
- Heap / Priority Queue / Heapsort :
  Implementation, Explanation, Tutorial, Implementation, Problem, Chapter from CLRS
- Modular Multiplicative Inverse
- Binomial coefficients (nCr % M): Tutorial, Tutorial, Paper (Link Not Working), Problem
- Suffix Automaton :
  Detailed Paper, Tutorial, Implementation (I), Tutorial, Implementation (II), Problem, Problem, Problem, Problem, Tutorial, Implementation

- Counting Inversions :
  Divide and Conquer, Segment Tree, Fenwick Tree, Problem
- Euclid's Extended Algorithm
- Suffix Tree :
  Tutorial, Tutorial, Intro, Construction : *106, II, Implementation, Implementation, Problem, Problem, Problem, Problem
- Dynamic Programming :
  Chapter from CLRS(essential), Tutorial, Problems, Problem, Problem, Problem, Problem, Tutorial, Problem, Problem, Problem, Longest Increasing Subsequence, Bitmask DP, Bitmask DP, Optimization, Problem , Problem, Problem, Problem, Problem, Problem, Problem, DP on Trees : *134, II
- Basic Data Structures :
  Tutorial, Stack Implementation, Queue Implementation, Tutorial, Linked List Implementation
- Logarithmic Exponentiation
- Graphs :
  Definition, Representation, Definition, Representation, Problem, Problem
- Minimum Spanning Tree :
  Tutorial, Tutorial, Kruskal's Implementation, Prim's Implementation, Problem , Problem, Problem, Problem, Problem
- Efficient Prime Factorization
- Combinatorics :
  Tutorial, Problems, Problem, Tutorial
- Union Find/Disjoint Set :
  Tutorial, Tutorial, Problems, Problem, Problem, Problem
- Knapsack problem :
  Solution, Implementation
- Aho-Corasick String Matching Algorithm :
  Tutorial, Implementation, Problem, Problem, Problem, Problem
- Strongly Connected Components :
  Tutorial, Implementation, Tutorial, Problem, Problem, Problem
- Bellman Ford algorithm :
  Tutorial, Implementation, Tutorial, Implementation, Problem, Problem
- Heavy-light Decomposition :
  Tutorial, Problems, Tutorial, Implementation, Tutorial, Implementation, Implementation, Problem, Problem, Problem
- Convex Hull :
  Tutorial, Jarvis Algorithm Implementation, Tutorial with Graham scan, Tutorial, Implementation, Problem, Problem, Problem, Problem, Problem
- Line Intersection :
  Tutorial, Implementation, Tutorial, Problems
- Sieve of Erastothenes
- Interval Tree :
  Tutorial, Implementation, Problem, Problem, Problem, Problem, Problem , Problem, Tutorial
- Counting Sort
- Probabilities
- Matrix Exponentiation :
  Tutorial, Tutorial
- Network flow :
  (Max Flow)Tutorial : I, II, Max Flow(Ford-Fulkerson) Tutorial, Implementation , (Min Cut) Tutorial, Implementation, (Min Cost Flow)Tutorial : I, II, III, Dinic's Algorithm with Implementation, Max flow by Edmonds Karp with Implementation, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem

- Deque
- Binary Search Tree :
  Tutorial, Implementation, Searching and Insertion, Deletion
- Quick Select :
  Implementation, Implementation
- Treap/Cartesian Tree :
  Tutorial(detailed), Tutorial, Implementation, Uses and Problems, Problem, Problem
- Game Theory :
  Detailed Paper, Tutorial, Problems, Grundy Numbers, Tutorial with example problems - I, II, III, IV, Tutorial, Problems, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Problem, Nim
- STL (C++) :
  I, II, Crash Course
- Maximum Bipartite Matching
- Manacher's Algorithm :
  Implementation, Tutorial, Tutorial, Implementation, Tutorial, Implementation, Problem, Problem, Problem
- Miller-Rabin Primality Test : Code
- Stable Marriage Problem
- Hungarian Algorithm, Tutorial
- Sweep line Algorithm : I, II
- LCP :
  Tutorial, Implementation, Tutorial, Implementation
- Gaussian Elimination
- Pollard Rho Integer Factorization, problem
- Topological Sorting
- Detecting Cycles in a Graph : Directed - *293, II Undirected : *295
- Geometry : Basics, Tutorial
- Backtracking :
  N queens problem, Tug of War, Sudoku
- Eulerian and Hamiltonian Paths :

3K 134 28

- Graph Coloring :
  Tutorial, Implementation
- Meet in the Middle :
  Tutorial, Implementation
- Arbitrary Precision Integer(BigInt), II
- Radix Sort, Bucket Sort
- Johnson's Algorithm :
  Tutorial, Tutorial, Implementation
- Maximal Matching in a General Graph :
  Blossom/Edmond's Algorithm, Implementation, Tutte Matrix, Problem
- Recursion : I, II, Towers of Hanoi with explanation
- Inclusion and Exclusion Principle : I, II
- Co-ordinate Compression
- Sqrt-Decomposition :
  Tutorial, Tutorial, Problem, Problem
- Link-Cut Tree :
  Tutorial, Wiki, Tutorial, Implementation, Problem, Problem, Problem, Problem

- Burnside Lemma :
  Tutorial, Tutorial, Problem
- Edit/Levenshtein Distance :
  Tutorial, Introduction, Tutorial, Problem, Problem
- Branch and Bound
- Math for Competitive Programming
- Mo's Algorithm : Tutorial and Problems

PS: I've linked this Quora answer to the original Codechef post.

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Edit 1: Fixed the broken Topcoder links.

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Abhijit Tripathy · August 2, 2019

Sameer, thank you so much for writing this answer.

It is going to help many people.

21 Reply

Tusshar Laddha · August 10, 2019

Sameer Sir, how much month time it took for you to complete all of this, and moreover what is your trick to retain them in your brain.

4 Reply

Sameer Gulati · August 10, 2019

You don't need to do all of this. Just follow this strategy : Sameer Gulati's answer to What made you good at competitive programming? Use the list as a reference to learn something new you encounter or maybe revision

3 Reply

Akshit Aggarwal · August 3, 2019

That is a great list. It is randomly written or should someone who's doing CP for a couple of months can start studying the topics top to bottom?

1 Reply

Sameer Gulati · August 3, 2019

Randomly. I am gonna write a how to start CP answer soon. Just follow that and use this list when you need to learn a topic.

4 Reply

Greeshma Thank you so much.

Himanshu Bharti · August 2, 2019

Thanks for sharing this. Much useful to me.

3 Reply

Lavish Saluja · August 17, 2019

Can you also write in what order one should start getting a grasp on all these topics?

An awesome answer though. Thanks :)

1 Reply

I wouldn't recommend that approach. Follow this: Sameer Gulati's answer to What made you good at competitive programming? and use this list for help when you encounter a new concept.

2 Reply

Lavish Saluja I don't specifically want to get good at competitive programming. I want to be...

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About the Author

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