|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Level Zero |  |  |  |  |  |
| STL | String |  |  |  |  |
|  | Vector |  |  |  |  |
|  | Pair |  |  |  |  |
|  | Stack |  |  |  |  |
|  | queue |  |  |  |  |
|  | Priority\_queue |  |  |  |  |
|  | dequeue |  |  |  |  |
|  | sort |  |  |  |  |
|  | reverse |  |  |  |  |
|  | Next\_permutation |  |  |  |  |
|  | set |  |  |  |  |
|  | map |  |  |  |  |
|  | iterator |  |  |  |  |
|  |  |  |  |  |  |
| Number theory | Prime Generation, Sieve and How to Optimize |  |  |  |  |
|  | Bit wise Sieve |  |  |  |  |
|  | Modular Arithmetic ( + - \*) |  |  |  |  |
|  | Modular Inverse (/) |  |  |  |  |
|  | Big Mod ( a^b % p) |  |  |  |  |
|  | Prime Factorization |  |  |  |  |
|  | Number of Divisor |  |  |  |  |
|  | Sum of Divisor |  |  |  |  |
|  |  |  |  |  |  |
| Graph | Graph Representations (Adjacency Matrix) |  |  |  |  |
|  | Graph Representations (Adjacency List using vector) |  |  |  |  |
|  | Breadth First Search BFS |  |  |  |  |
|  | Depth First Search DFS |  |  |  |  |
|  | Bi coloring |  |  |  |  |
|  | Topological Sorting |  |  |  |  |
|  | Articulation Point |  |  |  |  |
|  | Bridge |  |  |  |  |
|  | Strongly Connected Components SCC |  |  |  |  |
|  | Dijkstra and variations |  |  |  |  |
|  | Bellman Ford and variations |  |  |  |  |
|  | Floyd Warshall and variations |  |  |  |  |
|  | Kth Shortest Path |  |  |  |  |
|  | Minimum Spanning Tree ( Prims) |  |  |  |  |
|  | Minimum Spanning Tree ( Kruskal) |  |  |  |  |
|  | 2-SAT |  |  |  |  |
|  |  |  |  |  |  |
| DP | Longest Common Sub sequence LCS |  |  |  |  |
|  | Coin change |  |  |  |  |
|  | Edit Distance |  |  |  |  |
|  | Tree DP |  |  |  |  |
|  | LIS/LDS in nlogn |  |  |  |  |
|  |  |  |  |  |  |
| Total Solve Problems | 200+ in UVa, Codeforces, LightOJ, Topcoder, SPOJ and USACO |  |  |  |  |
| After Complete | Participate on Codeforces, Topcoder regular contest (Div 2) |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Level One |  |  |  |  |  |
| Number Theory/Math | Extended Euclid |  |  |  |  |
|  | Euler Phi and inverse phi |  |  |  |  |
|  | Factorizing n! |  |  |  |  |
|  | Basic combinatorics, Probability and Game theory |  |  |  |  |
|  |  |  |  |  |  |
| Graph | Maximum Flow ( Ford Fulkerson ) |  |  |  |  |
|  | Maximum Flow ( Dinic ) |  |  |  |  |
|  | Maximum Bipartite Matching and Variations |  |  |  |  |
|  | Maximum Independent Set |  |  |  |  |
|  | Minimum Cost Maximum Flow |  |  |  |  |
|  | Vertex Cover |  |  |  |  |
|  | Weighted Bipartite Matching |  |  |  |  |
|  | Graph Coloring |  |  |  |  |
|  | Stable Marriage Problem |  |  |  |  |
|  |  |  |  |  |  |
| Greedy | Task Scheduling |  |  |  |  |
|  | Maximum Sum 1D in O(n) |  |  |  |  |
|  | Maximum Sum 2D in O(n^3) |  |  |  |  |
|  | Maximum Rectangle O(n^2) |  |  |  |  |
|  |  |  |  |  |  |
| Dynamic Programming | Matrix Chain Multiplication |  |  |  |  |
|  | Bitmask DP (Traveling salesman problem) |  |  |  |  |
|  | Modular DP(DP with MOD value as a state) |  |  |  |  |
|  | Tree Dp |  |  |  |  |
|  |  |  |  |  |  |
| Data Structure | Trie |  |  |  |  |
|  | Union Find |  |  |  |  |
|  | BST and variations |  |  |  |  |
|  | Heap |  |  |  |  |
|  | Binary Indexed Tree and Applications |  |  |  |  |
|  | Segment tree |  |  |  |  |
|  | Least Common Ancestor |  |  |  |  |
|  | Range Minimum Query |  |  |  |  |
|  | Splay Tree |  |  |  |  |
|  | Treap |  |  |  |  |
|  | Centroid Decomposition |  |  |  |  |
|  | Dominator Tree |  |  |  |  |
|  |  |  |  |  |  |
| Total Solve Problems | 500+ in UVa, Codeforces, LightOJ, Topcoder, SPOJ and USACO |  |  |  |  |
| After Complete | Participate in Codeforces, Topcoder regular contest (Div 1) it should be Div 1 ;) |  |  |  |  |
|  |  |  |  |  |  |
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| Level two |  |  |  |  |  |
| Game Theory | Nim |  |  |  |  |
|  | Grundy Number and Dp Formulation |  |  |  |  |
|  | Alpha Beta Pruning Minimax\* |  |  |  |  |
|  | Blue Red Hackenbush |  |  |  |  |
|  | Minimum Weighted Bipartite Matching/Kuhn-Munacres/Hungarian/Chinese Postman |  |  |  |  |
|  | Green Hackenbush |  |  |  |  |
|  |  |  |  |  |  |
| String Algorithms | Suffix Tree, Automata |  |  |  |  |
|  | KMP Matcher |  |  |  |  |
|  | Suffix Array Construction\* |  |  |  |  |
|  | Longest Common Substring |  |  |  |  |
|  | Aho Chorasic Algorithm |  |  |  |  |
|  | Manacher's Algo |  |  |  |  |
|  | Hashing |  |  |  |  |
|  |  |  |  |  |  |
| Miscellaneous | Meet In the Middle Approach |  |  |  |  |
|  | Konigs Theorem |  |  |  |  |
|  | Matrix Tree Theorem\* |  |  |  |  |
|  | Joseph Problem (Using queue n^2) |  |  |  |  |
|  | Joseph Problem (Using recursion n) |  |  |  |  |
|  | Managing Biginteger |  |  |  |  |
|  | Permutations and Combinations |  |  |  |  |
|  | Tower of Hanoi, Variations |  |  |  |  |
|  | N Queens Proble |  |  |  |  |
|  | Hashing |  |  |  |  |
|  | Finding Nth Permutation |  |  |  |  |
|  | Huffman Coding |  |  |  |  |
|  | Traveling Salesman Problem (Backtracking with pruning) |  |  |  |  |
|  | Finding Determinant of a Matrix |  |  |  |  |
|  | Finding kth number from a sequence of unsorted numbers in log(n) |  |  |  |  |
|  | Transforming Hexagonal grid, Triangular grid to 3d coordinate system |  |  |  |  |
|  | Matrix Multiplication |  |  |  |  |
|  | Solving Linear Recurrence with Matrix Exponentiation |  |  |  |  |
|  | Heavy-Light Decomposition |  |  |  |  |
| Advance DP | All Light OJ Advance DP Problems |  |  |  |  |
| Geometry | Convex Hull |  |  |  |  |
|  | Point inside Convex Polygon ( log(n) ) |  |  |  |  |
|  | Picks Theorem, Number of Lattice Points inside a polygon |  |  |  |  |
|  | Binary Search |  |  |  |  |
|  | Ternary Search |  |  |  |  |
|  | Segment Segment Intersection |  |  |  |  |
|  | Area Of A Concave Polygon |  |  |  |  |
|  | Point Inside A Polygon (Convex and Concave) |  |  |  |  |
|  | Minimum Circle Covering all Points |  |  |  |  |
|  | Union of rectangle ( How to cluster, how to make it in nlogn, bently ) |  |  |  |  |
|  | Closest Pair |  |  |  |  |
| Total Solve Problems | 800+ in UVa, Codeforces, LightOJ, Topcoder, SPOJ and USACO |  |  |  |  |
|  |  |  |  |  |  |
| Level three |  |  |  |  |  |
| Number Theory/Math | Shanks Algorithm |  |  |  |  |
|  | Dilworth's theorem\* |  |  |  |  |
|  | BurnsideLemma (http://petr-mitrichev.blogspot.com/2008/11/burnsides-lemma.html) |  |  |  |  |
|  | Wilson's Theorem\* |  |  |  |  |
|  | Lucas Theorem\* |  |  |  |  |
|  | Gauss Elimination |  |  |  |  |
|  |  |  |  |  |  |
| Graph | Minimum Spanning Tree ( For Directed Graphs ) |  |  |  |  |
|  | Euler Path (Construction and optimization) |  |  |  |  |
|  | Gomory-Hu Tree |  |  |  |  |
|  | Edge Cover |  |  |  |  |
|  | Largest Clique |  |  |  |  |
|  | IDA\* Search Problem, 15 Puzzle |  |  |  |  |
|  | Group Theory |  |  |  |  |
|  | Hamiltonian Cycle |  |  |  |  |
|  | Min Weight Cycles in Graph |  |  |  |  |
|  | Stoer Wagner ( Finding the minimum cut of a graph ) |  |  |  |  |
|  | Planar Graph Detection |  |  |  |  |
|  | Havel-Hakimi Algorithm (Construct graph given degree of nodes) |  |  |  |  |
|  | Maximum Matching(Blossom Shrinking) |  |  |  |  |
|  | Max cost-max flow(min cost flow for negative cycle) |  |  |  |  |
|  |  |  |  |  |  |
| Geometry | Convex Hull 3D |  |  |  |  |
|  | Line Sweeping/Angle Sweep |  |  |  |  |
|  | Fitting a Rectangle inside Another |  |  |  |  |
|  | Polygon Intersection |  |  |  |  |
|  | Area of a 3d Polygon |  |  |  |  |
|  | Polygon Clipping\* |  |  |  |  |
|  | Rotating Calipers\* |  |  |  |  |
|  | Triangulation |  |  |  |  |
|  | Optimal BST |  |  |  |  |
|  | KD tree |  |  |  |  |
|  | Link-cut tree |  |  |  |  |
|  | Interval Tree |  |  |  |  |
|  | Quad tree |  |  |  |  |
|  | Complete USACO training system |  |  |  |  |
| Total Solve Problems | 1000+ in UVa, Codeforces, LightOJ, Topcoder, SPOJ and USACO |  |  |  |  |
| Extra | Segment Trees, with lazy propagation |  |  |  |  |
|  | Heavy Light Decomposition |  |  |  |  |
|  | FFT |  |  |  |  |
|  | Tree Decomposition |  |  |  |  |
|  | Persistent Segment Tree |  |  |  |  |
|  | Palindromic Tree |  |  |  |  |
|  | DP Optimizations |  |  |  |  |
|  | SOS DP |  |  |  |  |
|  | MO's, MO's with update |  |  |  |  |
|  | DSU on Tree |  |  |  |  |