Master List of Competitive Programming Techniques
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Contents

1 Prefix and Suffix Techniques

These techniques precompute cumulative data to optimize range queries and updates, reducing time complexity for operations on arrays or matrices.

1.1 Prefix Sum

Description: Computes cumulative sums to enable O(1) subarray sum queries.

1. LeetCode 303: Range Sum Query - Immutable
2. LeetCode 560: Subarray Sum Equals K
3. LeetCode 523: Continuous Subarray Sum
4. LeetCode 930: Binary Subarrays With Sum
5. CSES: Range Sum Queries I
6. Codeforces 1206D: Zigzags
7. LeetCode 325: Maximum Size Subarray Sum Equals k
8. Codeforces 166E: Tetrahedron
9. CSES: Sum of Two Values
10. LeetCode 974: Subarray Sums Divisible by K

1.2 Suffix Sum

Description: Similar to prefix sum but computed from the end, useful for reverse traversals.

1. LeetCode 238: Product of Array Except Self
2. LeetCode 724: Find Pivot Index
3. LeetCode 152: Maximum Product Subarray
4. Codeforces 1296C: Yet Another Walking Robot
5. CSES: Subarray Sums II
6. LeetCode 1014: Best Sightseeing Pair
7. Codeforces 1207F: Remainder
8. LeetCode 2090: K Radius Subarray Averages
9. CSES: Array Division

10. LeetCode 1423: Maximum Points You Can Obtain from Cards

1.3 2D Prefix Sum

Description: Extends prefix sum to 2D matrices for O(1) range sum queries.

1. LeetCode 304: Range Sum Query 2D - Immutable
2. LeetCode 1314: Matrix Block Sum
3. LeetCode 1074: Number of Submatrices That Sum to Target
4. Codeforces 1196D2: RGB Substring (hard version)
5. CSES: Range Queries and Sums
6. LeetCode 2132: Stamping the Grid
7. Codeforces 1337D: Xenia and Colorful Gems
8. LeetCode 1292: Maximum Side Length of a Square with Sum Less than or Equal to Threshold
9. CSES: Forest Queries
10. LeetCode 221: Maximal Square

1.4 Difference Array

Description: Facilitates O(1) range updates by storing differences between consecutive elements.

1. LeetCode 370: Range Addition
2. LeetCode 1109: Corporate Flight Bookings
3. LeetCode 1893: Check if All the Integers in a Range Are Covered
4. CSES: Range Update Queries
5. Codeforces 295B: Greg and Graph
6. LeetCode 1094: Car Pooling
7. LeetCode 2772: Apply Operations to Make All Array Elements Equal to Zero
8. CSES: Polynomial Queries
9. Codeforces 1216F: Wi-Fi
10. LeetCode 2528: Maximize the Minimum Powered City

1.5 Prefix Max/Min

Description: Tracks maximum or minimum values over prefixes for monotonic range queries.

1. LeetCode 907: Sum of Subarray Minimums
2. LeetCode 2104: Sum of Subarray Ranges
3. LeetCode 84: Largest Rectangle in Histogram
4. Codeforces 547B: Mike and Feet
5. CSES: Nearest Smaller Values
6. LeetCode 918: Maximum Sum Circular Subarray
7. Codeforces 1313C2: Skyscrapers (hard version)
8. LeetCode 2281: Sum of Total Strength of Wizards
9. CSES: Sliding Window Cost
10. LeetCode 1856: Maximum Subarray Min-Product

2 Contribution Technique

Description: Computes results by summing individual element contributions, avoiding naive iteration. Useful in subarray sums, inversions, and combinatorics.

1. LeetCode 2104: Sum of Subarray Ranges
2. LeetCode 315: Count of Smaller Numbers After Self
3. LeetCode 327: Count of Range Sum
4. Codeforces 547B: Mike and Feet
5. CSES: Inversion Count
6. LeetCode 493: Reverse Pairs
7. Codeforces 1207F: Remainder
8. LeetCode 1524: Number of Subarrays With Odd Sum
9. Codeforces 61E: Enemy is Weak
10. LeetCode 907: Sum of Subarray Minimums

3 Mathematical Techniques

Description: Utilizes number theory and combinatorics to solve problems efficiently.

3.1 Modular Arithmetic

Description: Prevents integer overflow by performing operations under a modulus.

1. LeetCode 149: Max Points on a Line
2. LeetCode 974: Subarray Sums Divisible by K
3. CSES: Exponentiation
4. Codeforces 300C: Beautiful Numbers
5. LeetCode 1922: Count Good Numbers
6. CSES: Counting Divisors
7. Codeforces 546D: Soldier and Number Game
8. LeetCode 1230: Toss Strange Coins
9. Codeforces 622F: The Sum of k-th Powers
10. LeetCode 1835: Find XOR Sum of All Pairs Bitwise AND

3.2 Inclusion-Exclusion Principle

Description: Counts elements in overlapping sets by adding and subtracting intersections.

1. LeetCode 1201: Ugly Number III
2. LeetCode 878: Nth Magical Number
3. Codeforces 449D: Jzzhu and Numbers
4. CSES: Inclusion Exclusion
5. LeetCode 2581: Count Number of Possible Root Nodes
6. Codeforces 1017C: The Phone Number
7. LeetCode 2597: The Number of Beautiful Subsets
8. Codeforces 627D: Preorder

9. CSES: Counting Coprime Pairs
10. LeetCode 2478: Number of Beautiful Partitions

3.3 Sieve of Eratosthenes

Description: Efficiently generates prime numbers up to a given limit.

1. LeetCode 204: Count Primes
2. LeetCode 2762: Continuous Subarrays
3. CSES: Counting Divisors
4. Codeforces 26A: Almost Prime
5. LeetCode 2962: Count Subarrays Where Max Element Appears at Least K Times
6. Codeforces 230B: T-primes
7. CSES: Prime Multiples
8. LeetCode 2523: Closest Prime Numbers in Range
9. Codeforces 776B: Sherlock and his girlfriend
10. LeetCode 1998: GCD Sort of an Array

3.4 Euler's Totient Function

Description: Counts numbers coprime to n, used in number theory problems.

1. Codeforces 906D: Power Tower
2. CSES: Euler Totient Function
3. Codeforces 1114C: Trailing Loves (or L'oeufs?)
4. LeetCode 1922: Count Good Numbers
5. Codeforces 446C: DZY Loves Fibonacci Numbers
6. CSES: Counting Coprime Pairs
7. Codeforces 276C: Little Girl and Maximum Sum
8. LeetCode 2478: Number of Beautiful Partitions
9. Codeforces 1295D: Same GCDs

10. CSES: Divisor Analysis

3.5 Extended Euclidean Algorithm

Description: Computes GCD and modular inverses.

1. LeetCode 365: Water and Jug Problem
2. CSES: Linear Diophantine Equations
3. Codeforces 982C: Cut 'em all!
4. LeetCode 1067: Digit Count in Range
5. Codeforces 622F: The Sum of k-th Powers
6. CSES: Counting Coprime Pairs
7. LeetCode 1250: Check If It Is a Good Array
8. Codeforces 1017C: The Phone Number
9. CSES: Divisor Analysis
10. LeetCode 878: Nth Magical Number

3.6 Binary Exponentiation

Description: Computes large powers in O(log n) time.

1. LeetCode 50: Pow(x, n)
2. CSES: Exponentiation
3. Codeforces 913C: Party Lemonade
4. LeetCode 372: Super Pow
5. CSES: Exponentiation II
6. Codeforces 622F: The Sum of k-th Powers
7. LeetCode 1922: Count Good Numbers
8. Codeforces 1010D: Mars rover
9. CSES: Fibonacci Numbers
10. LeetCode 2337: Move Pieces to Obtain a String

3.7 Chinese Remainder Theorem (CRT)

Description: Solves systems of modular congruences.

1. LeetCode 878: Nth Magical Number
2. Codeforces 447C: DZY Loves Sequences
3. CSES: Divisor Analysis
4. Codeforces 1017C: The Phone Number
5. LeetCode 1201: Ugly Number III
6. Codeforces 1295D: Same GCDs
7. CSES: Counting Coprime Pairs
8. LeetCode 1922: Count Good Numbers
9. Codeforces 622F: The Sum of k-th Powers
10. LeetCode 2478: Number of Beautiful Partitions

3.8 Combinatorics

Description: Solves counting problems using combinations, permutations, and related concepts.

1. LeetCode 377: Combination Sum IV
2. LeetCode 518: Coin Change II
3. CSES: Grid Paths
4. Codeforces 300C: Beautiful Numbers
5. LeetCode 1239: Maximum Length of a Concatenated String with Unique Characters
6. CSES: Counting Tilings
7. LeetCode 935: Knight Dialer
8. Codeforces 626F: Group Projects
9. LeetCode 1863: Sum of All Subset XOR Totals
10. CSES: Binomial Coefficients

4 DP Optimization Techniques

Description: Enhances dynamic programming with techniques to reduce time or space complexity.

4.1 Memoization/Tabulation

Description: Stores intermediate results to avoid recomputation.

1. LeetCode 300: Longest Increasing Subsequence
2. LeetCode 1143: Longest Common Subsequence
3. LeetCode 416: Partition Equal Subset Sum
4. CSES: Dice Combinations
5. LeetCode 322: Coin Change
6. Codeforces 189A: Cut Ribbon
7. LeetCode 139: Word Break
8. CSES: Minimizing Coins
9. LeetCode 198: House Robber
10. Codeforces 455A: Boredom

4.2 Bitmask DP

Description: Uses bitmasks to represent subsets in DP problems.

1. LeetCode 1987: Number of Unique Good Subsequences
2. LeetCode 1349: Maximum Students Taking Exam
3. Codeforces 453B: Little Pony and Harmony Chest
4. CSES: Hamiltonian Flights
5. LeetCode 943: Find the Shortest Superstring
6. Codeforces 580D: Kefa and Dishes
7. LeetCode 1863: Sum of All Subset XOR Totals
8. CSES: Counting Tilings
9. Codeforces 401D: Roman and Numbers

10. LeetCode 691: Stickers to Spell Word

4.3 Divide and Conquer DP

Description: Optimizes DP when recurrence exhibits monotonicity.

1. LeetCode 410: Split Array Largest Sum
2. LeetCode 1335: Minimum Difficulty of a Job Schedule
3. Codeforces 868F: Yet Another Minimization Problem
4. LeetCode 312: Burst Balloons
5. Codeforces 321E: Ciel and Gondolas
6. LeetCode 1770: Maximum Score from Performing Multiplication Operations
7. Codeforces 1012C: Hills and Valleys
8. LeetCode 1039: Minimum Score Triangulation of Polygon
9. Codeforces 455C: Civilization
10. LeetCode 887: Super Egg Drop

4.4 Knuth Optimization

Description: Optimizes interval-based DP with monotonic cost functions.

1. LeetCode 410: Split Array Largest Sum
2. Codeforces 321E: Ciel and Gondolas
3. LeetCode 1335: Minimum Difficulty of a Job Schedule
4. Codeforces 868F: Yet Another Minimization Problem
5. LeetCode 312: Burst Balloons
6. Codeforces 1012C: Hills and Valleys
7. LeetCode 1039: Minimum Score Triangulation of Polygon
8. Codeforces 455C: Civilization
9. LeetCode 887: Super Egg Drop
10. Codeforces 834D: The Bakery

4.5 Convex Hull Trick

Description: Optimizes DP with monotonic slopes using geometric properties.

1. LeetCode 1770: Maximum Score from Performing Multiplication Operations
2. Codeforces 319C: Kalila and Dimna in the Logging Industry
3. LeetCode 410: Split Array Largest Sum
4. Codeforces 1083E: The Fair Nut and Rectangles
5. LeetCode 312: Burst Balloons
6. Codeforces 868F: Yet Another Minimization Problem
7. LeetCode 1335: Minimum Difficulty of a Job Schedule
8. Codeforces 1012C: Hills and Valleys
9. LeetCode 1039: Minimum Score Triangulation of Polygon
10. Codeforces 455C: Civilization

4.6 DP on Trees

Description: Solves problems on tree structures using dynamic programming.

1. LeetCode 337: House Robber III
2. CSES: Tree Matching
3. Codeforces 1324F: Maximum White Subtree
4. LeetCode 124: Binary Tree Maximum Path Sum
5. CSES: Tree Distances I
6. LeetCode 968: Binary Tree Cameras
7. Codeforces 1187E: Tree Painting
8. CSES: Company Queries II
9. LeetCode 1463: Cherry Pickup II
10. Codeforces 708C: Centroids

4.7 Digit DP

Description: Counts numbers satisfying specific digit constraints.

1. LeetCode 1012: Numbers With Repeated Digits
2. LeetCode 902: Numbers At Most N Given Digit Set
3. CSES: Digit Queries
4. LeetCode 1067: Digit Count in Range
5. Codeforces 1036C: Classy Numbers
6. LeetCode 2376: Count Special Integers
7. Codeforces 628D: Magic Numbers
8. LeetCode 2719: Count of Integers
9. CSES: Counting Numbers
10. Codeforces 401D: Roman and Numbers

4.8 SOS DP (Sum over Subsets)

Description: Efficiently computes sums over all subsets using bitmasks.

1. LeetCode 1863: Sum of All Subset XOR Totals
2. Codeforces 449D: Jzzhu and Numbers
3. LeetCode 1987: Number of Unique Good Subsequences
4. Codeforces 165E: Compatible Numbers
5. LeetCode 421: Maximum XOR of Two Numbers in an Array
6. Codeforces 1208F: Bits And Pieces
7. CSES: Bit Strings
8. LeetCode 1442: Count Triplets That Can Form Two Arrays of Equal XOR
9. Codeforces 580D: Kefa and Dishes
10. LeetCode 943: Find the Shortest Superstring

5 Greedy Techniques

Description: Solves problems by making locally optimal choices, applicable when the problem has greedy-choice property and optimal substructure.

1. LeetCode 435: Non-overlapping Intervals
2. LeetCode 452: Minimum Number of Arrows to Burst Balloons
3. LeetCode 646: Maximum Length of Pair Chain
4. Codeforces 478D: Red-Green Towers
5. CSES: Tasks and Deadlines
6. LeetCode 1029: Two City Scheduling
7. Codeforces 545C: Woodcutters
8. LeetCode 621: Task Scheduler
9. CSES: Movie Festival
10. Codeforces 489C: Given Length and Sum of Digits

6 Two Pointers and Sliding Window

Description: Optimizes subarray/substring problems by maintaining a window that expands or shrinks.

6.1 Two Pointers

Description: Uses two pointers to traverse arrays, often for finding pairs or subarrays.

1. LeetCode 167: Two Sum II - Input Array Is Sorted
2. LeetCode 15: 3Sum
3. LeetCode 16: 3Sum Closest
4. CSES: Sum of Two Values
5. LeetCode 11: Container With Most Water
6. Codeforces 381A: Sereja and Dima
7. LeetCode 713: Subarray Product Less Than K
8. LeetCode 125: Valid Palindrome

9. Codeforces 580C: Kefa and Park
10. LeetCode 283: Move Zeroes

6.2 Sliding Window

Description: Maintains a dynamic window to solve subarray problems efficiently.

1. LeetCode 3: Longest Substring Without Repeating Characters
2. LeetCode 209: Minimum Size Subarray Sum
3. LeetCode 76: Minimum Window Substring
4. Codeforces 617E: XOR and Favorite Number
5. LeetCode 904: Fruit Into Baskets
6. LeetCode 992: Subarrays with K Different Integers
7. LeetCode 1004: Max Consecutive Ones III
8. CSES: Sliding Window Cost
9. LeetCode 239: Sliding Window Maximum
10. Codeforces 1285C: Fadi and LCM

7 Binary Search Techniques

Description: Optimizes search by halving the search space, used for arrays and answer optimization.

7.1 Binary Search on Array

Description: Finds elements in a sorted array in O(log n).

1. LeetCode 704: Binary Search
2. LeetCode 33: Search in Rotated Sorted Array
3. LeetCode 81: Search in Rotated Sorted Array II
4. LeetCode 153: Find Minimum in Rotated Sorted Array
5. CSES: Missing Number
6. LeetCode 162: Find Peak Element
7. Codeforces 474B: Worms

8. LeetCode 278: First Bad Version
9. CSES: Apartment
10. LeetCode 374: Guess Number Higher or Lower

7.2 Binary Search on Answer

Description: Finds optimal values by searching over possible answers.

1. LeetCode 410: Split Array Largest Sum
2. LeetCode 875: Koko Eating Bananas
3. LeetCode 1011: Capacity To Ship Packages Within D Days
4. Codeforces 1354D: Multiset
5. CSES: Factory Machines
6. LeetCode 1231: Divide Chocolate
7. Codeforces 525E: Anya and Cubes
8. LeetCode 1482: Minimum Number of Days to Make m Bouquets
9. CSES: Traffic Lights
10. Codeforces 706C: Hard problem

8 Monotonic Data Structures

Description: Maintains elements in sorted order for efficient queries.

8.1 Monotonic Stack

Description: Maintains a stack of elements in monotonic order for problems like next greater element.

1. LeetCode 84: Largest Rectangle in Histogram
2. LeetCode 739: Daily Temperatures
3. LeetCode 901: Online Stock Span
4. Codeforces 547B: Mike and Feet
5. LeetCode 907: Sum of Subarray Minimums
6. LeetCode 503: Next Greater Element II

7. Codeforces 1313C2: Skyscrapers (hard version)
8. LeetCode 316: Remove Duplicate Letters
9. CSES: Nearest Smaller Values
10. LeetCode 2281: Sum of Total Strength of Wizards

8.2 Monotonic Queue

Description: Maintains a deque for sliding window maximum/minimum in O(n).

1. LeetCode 239: Sliding Window Maximum
2. CSES: Sliding Window Maximum
3. LeetCode 862: Shortest Subarray with Sum at Least K
4. Codeforces 372C: Watching Fireworks is Fun
5. LeetCode 1438: Longest Continuous Subarray With Absolute Diff Less Than or Equal to Limit
6. Codeforces 1359D: Yet Another Yet Another Task
7. LeetCode 1499: Max Value of Equation
8. CSES: Sliding Window Cost
9. LeetCode 907: Sum of Subarray Minimums
10. Codeforces 547B: Mike and Feet

9 Sweep Line and Event Sorting

Description: Processes events in sorted order, commonly used in interval and geometry problems.

1. LeetCode 218: The Skyline Problem
2. LeetCode 253: Meeting Rooms II
3. LeetCode 759: Employee Free Time
4. Codeforces 1359D: Yet Another Yet Another Task
5. CSES: Event Sorting
6. LeetCode 1235: Maximum Profit in Job Scheduling

7. Codeforces 1284C: New Year and Naming
8. LeetCode 986: Interval List Intersections
9. CSES: Line Segment Intersection
10. Codeforces 582B: Intersection of Polygons

10 Trees and Graph Techniques

Description: Algorithms for traversing and querying tree and graph structures.

10.1 DFS/BFS

Description: Fundamental traversal algorithms for graphs and trees.

1. LeetCode 200: Number of Islands
2. LeetCode 547: Number of Provinces
3. LeetCode 695: Max Area of Island
4. CSES: Message Route
5. LeetCode 130: Surrounded Regions
6. Codeforces 580C: Kefa and Park
7. LeetCode 417: Pacific Atlantic Water Flow
8. CSES: Labyrinth
9. LeetCode 994: Rotting Oranges
10. Codeforces 757B: Bash's Big Day

10.2 Disjoint Set Union (DSU)

Description: Manages connected components and union operations.

1. LeetCode 684: Redundant Connection
2. LeetCode 721: Accounts Merge
3. LeetCode 1319: Number of Operations to Make Network Connected
4. CSES: Road Reparation
5. LeetCode 947: Most Stones Removed with Same Row or Column

6. Codeforces 1213G: Path Queries
7. LeetCode 1584: Min Cost to Connect All Points
8. CSES: Building Roads
9. LeetCode 803: Bricks Falling When Hit
10. Codeforces 25C: Roads in Berland

10.3 Lowest Common Ancestor (LCA)

Description: Finds the lowest common ancestor in a tree for path queries.

1. LeetCode 236: Lowest Common Ancestor of a Binary Tree
2. LeetCode 235: Lowest Common Ancestor of a Binary Search Tree
3. CSES: Company Queries II
4. LeetCode 1650: Lowest Common Ancestor of a Binary Tree III
5. Codeforces 519E: A and B and Lecture Rooms
6. CSES: Distance Queries
7. LeetCode 1483: Kth Ancestor of a Tree Node
8. Codeforces 1328E: Tree Queries
9. CSES: Subtree Queries
10. LeetCode 1740: Find Distance in a Binary Tree

10.4 Heavy-Light Decomposition

Description: Decomposes trees into heavy and light paths for efficient queries.

1. Codeforces 1324F: Maximum White Subtree
2. CSES: Path Queries
3. Codeforces 609E: Minimum spanning tree for each edge
4. CSES: Subtree Queries
5. Codeforces 1187E: Tree Painting
6. CSES: Distance Queries
7. LeetCode 1463: Cherry Pickup II

8. Codeforces 716C: Plus and Square Root
9. CSES: Company Queries II
10. Codeforces 593D: Happy Tree Party

10.5 Centroid Decomposition

Description: Divides trees into balanced subtrees for efficient processing.

1. Codeforces 342E: Xenia and Tree
2. Codeforces 161D: Distance in Tree
3. Codeforces 708C: Centroids
4. CSES: Distance Queries
5. Codeforces 757F: Team Rocket Rises Again
6. LeetCode 1463: Cherry Pickup II
7. Codeforces 321C: Ciel the Commander
8. CSES: Subtree Queries
9. Codeforces 1406C: Link Cut Centroids
10. Codeforces 293E: Close Vertices

10.6 Topological Sort

Description: Orders vertices in a directed acyclic graph (DAG).

1. LeetCode 207: Course Schedule
2. LeetCode 210: Course Schedule II
3. LeetCode 444: Sequence Reconstruction
4. CSES: Course Schedule
5. LeetCode 269: Alien Dictionary
6. Codeforces 510C: Fox And Names
7. LeetCode 310: Minimum Height Trees
8. CSES: Task Assignment
9. Codeforces 1385E: Directing Edges

10. LeetCode 802: Find Eventual Safe States

10.7 Tarjan's Algorithm

Description: Finds strongly connected components in directed graphs.

1. LeetCode 1192: Critical Connections in a Network
2. Codeforces 427C: Checkposts
3. LeetCode 1568: Minimum Number of Days to Disconnect Island
4. Codeforces 652E: Pursuit For Artifacts
5. CSES: Planets and Kingdoms
6. Codeforces 505C: Mr. Kitayuta, the Treasure Hunter
7. LeetCode 207: Course Schedule
8. Codeforces 286C: Lucky Number Representation
9. CSES: Giant Pizza
10. Codeforces 962F: Simple Cycles Edges

10.8 Shortest Path Algorithms

Description: Finds shortest paths in graphs (Dijkstra, Bellman-Ford, Floyd-Warshall).

1. LeetCode 743: Network Delay Time
2. LeetCode 787: Cheapest Flights Within K Stops
3. CSES: Flight Routes
4. LeetCode 1334: Find the City With the Smallest Number of Neighbors at a Threshold Distance
5. Codeforces 295B: Greg and Graph
6. LeetCode 1514: Path with Maximum Probability
7. CSES: Shortest Routes I
8. LeetCode 1631: Path With Minimum Effort
9. Codeforces 20C: Dijkstra?
10. LeetCode 1976: Number of Ways to Arrive at Destination

10.9 0-1 BFS

Description: Finds shortest paths in graphs with 0/1 edge weights using a deque.

1. LeetCode 505: The Maze II
2. LeetCode 1293: Shortest Path in a Grid with Obstacles Elimination
3. Codeforces 173B: Painting Pebbles
4. CSES: Labyrinth
5. LeetCode 1129: Shortest Path with Alternating Colors
6. Codeforces 821D: Okabe and City
7. LeetCode 1368: Minimum Cost to Make At Least One Valid Path
8. CSES: Monsters
9. Codeforces 59E: Shortest Path
10. LeetCode 1928: Minimum Cost to Reach Destination in Time

11 String Algorithms

Description: Specialized algorithms for efficient string processing and pattern matching.

11.1 KMP / Z-Algorithm

Description: Efficiently finds pattern occurrences in a string.

1. LeetCode 28: Implement strStr()
2. LeetCode 214: Shortest Palindrome
3. CSES: String Matching
4. LeetCode 1392: Longest Happy Prefix
5. Codeforces 471D: MUH and Cube Walls
6. LeetCode 796: Rotate String
7. Codeforces 432D: Prefixes and Suffixes
8. LeetCode 459: Repeated Substring Pattern
9. CSES: Finding Borders

10. Codeforces 360B: Levko and Array

11.2 Rabin-Karp

Description: Uses rolling hash for efficient string matching.

1. LeetCode 1044: Longest Duplicate Substring
2. LeetCode 28: Implement strStr()
3. Codeforces 471D: MUH and Cube Walls
4. LeetCode 214: Shortest Palindrome
5. CSES: String Matching
6. LeetCode 686: Repeated String Match
7. Codeforces 432D: Prefixes and Suffixes
8. LeetCode 1392: Longest Happy Prefix
9. CSES: Finding Borders
10. LeetCode 187: Repeated DNA Sequences

11.3 Trie

Description: Stores strings in a prefix tree for efficient prefix queries.

1. LeetCode 208: Implement Trie (Prefix Tree)
2. LeetCode 211: Design Add and Search Words Data Structure
3. LeetCode 212: Word Search II
4. CSES: Word Combinations
5. LeetCode 676: Implement Magic Dictionary
6. Codeforces 514C: Watto and Mechanism
7. LeetCode 421: Maximum XOR of Two Numbers in an Array
8. LeetCode 648: Replace Words
9. Codeforces 706B: Interesting drink
10. LeetCode 1804: Implement Trie II (Prefix Tree)

11.4 Suffix Array / Automaton

Description: Advanced structures for string processing and pattern matching.

1. LeetCode 1044: Longest Duplicate Substring
2. Codeforces 432D: Prefixes and Suffixes
3. LeetCode 1163: Last Substring in Lexicographical Order
4. Codeforces 235C: Cyclical Quest
5. CSES: String Matching
6. Codeforces 128B: String
7. LeetCode 1062: Longest Repeating Substring
8. Codeforces 452F: Permutation
9. CSES: Finding Borders
10. Codeforces 271D: Good Substrings

11.5 Manacher's Algorithm

Description: Finds the longest palindromic substring in O(n).

1. LeetCode 5: Longest Palindromic Substring
2. LeetCode 647: Palindromic Substrings
3. LeetCode 336: Palindrome Pairs
4. Codeforces 1326D2: Prefix-Suffix Palindrome (Hard version)
5. CSES: Palindrome Queries
6. LeetCode 214: Shortest Palindrome
7. Codeforces 7C: Line
8. LeetCode 1616: Split Two Strings to Make Palindrome
9. CSES: Finding Borders
10. Codeforces 159D: Palindrome pairs

12 Bit Manipulation Techniques

Description: Uses bitwise operations for efficient computation and subset enumeration.

1. LeetCode 136: Single Number
2. LeetCode 338: Counting Bits
3. LeetCode 191: Number of 1 Bits
4. Codeforces 617E: XOR and Favorite Number
5. CSES: Bit Strings
6. LeetCode 421: Maximum XOR of Two Numbers in an Array
7. LeetCode 318: Maximum Product of Word Lengths
8. Codeforces 165E: Compatible Numbers
9. LeetCode 260: Single Number III
10. CSES: Hamming Distance

13 Advanced Data Structures

Description: Complex data structures for efficient queries and updates.

13.1 Fenwick Tree (BIT)

Description: Supports point updates and prefix sum queries.

1. LeetCode 307: Range Sum Query - Mutable
2. LeetCode 315: Count of Smaller Numbers After Self
3. CSES: Range Queries and Sums
4. LeetCode 493: Reverse Pairs
5. Codeforces 339D: Xenia and Bit Operations
6. CSES: Dynamic Range Sum Queries
7. LeetCode 327: Count of Range Sum
8. Codeforces 1354D: Multiset
9. LeetCode 673: Number of Longest Increasing Subsequence

10. CSES: Range Minimum Queries II

13.2 Segment Tree

Description: Supports range queries and updates on arrays.

1. LeetCode 307: Range Sum Query - Mutable
2. LeetCode 732: My Calendar III
3. CSES: Range Queries and Sums
4. LeetCode 218: The Skyline Problem
5. Codeforces 380C: Sereja and Brackets
6. CSES: Range Update Queries
7. LeetCode 315: Count of Smaller Numbers After Self
8. Codeforces 339D: Xenia and Bit Operations
9. LeetCode 327: Count of Range Sum
10. CSES: Dynamic Range Sum Queries

13.3 Lazy Propagation

Description: Optimizes range updates in segment trees.

1. LeetCode 307: Range Sum Query - Mutable
2. CSES: Range Update Queries
3. LeetCode 732: My Calendar III
4. Codeforces 558E: A Simple Task
5. CSES: Polynomial Queries
6. LeetCode 218: The Skyline Problem
7. Codeforces 1216F: Wi-Fi
8. CSES: Range Queries and Sums
9. LeetCode 2772: Apply Operations to Make All Array Elements Equal to Zero
10. Codeforces 438D: The Child and Sequence

13.4 Persistent Segment Tree

Description: Maintains historical versions of segment trees.

1. Codeforces 484E: Sign on Fence
2. Codeforces 813E: Army Creation
3. LeetCode 315: Count of Smaller Numbers After Self
4. Codeforces 960F: Pathwalks
5. CSES: Dynamic Range Sum Queries
6. Codeforces 1478F: Nezzar and Nice Beatmap
7. LeetCode 327: Count of Range Sum
8. Codeforces 380C: Sereja and Brackets
9. CSES: Range Queries and Sums
10. Codeforces 1093G: Multidimensional Queries

13.5 Sparse Table

Description: Supports range minimum/maximum queries on immutable arrays.

1. LeetCode 907: Sum of Subarray Minimums
2. CSES: Static Range Minimum Queries
3. LeetCode 84: Largest Rectangle in Histogram
4. Codeforces 1313C2: Skyscrapers (hard version)
5. CSES: Range Minimum Queries I
6. LeetCode 2104: Sum of Subarray Ranges
7. Codeforces 547B: Mike and Feet
8. CSES: Nearest Smaller Values
9. LeetCode 2281: Sum of Total Strength of Wizards
10. Codeforces 689D: Friends and Subsequences

13.6 Treap/Splay Tree/AVL

Description: Self-balancing trees for dynamic operations.

1. Codeforces 356A: Knight Tournament
2. Codeforces 702F: T-Shirts
3. LeetCode 315: Count of Smaller Numbers After Self
4. Codeforces 609E: Minimum spanning tree for each edge
5. LeetCode 493: Reverse Pairs
6. Codeforces 701D: As Fast As Possible
7. CSES: Range Queries and Sums
8. Codeforces 960F: Pathwalks
9. LeetCode 327: Count of Range Sum
10. Codeforces 438D: The Child and Sequence

14 Game Theory and Impartial Games

Description: Analyzes strategies in competitive scenarios using game theory principles.

1. LeetCode 877: Stone Game
2. LeetCode 1140: Stone Game II
3. LeetCode 1563: Stone Game V
4. Codeforces 1194D: 1-2-K Game
5. CSES: Game Routes
6. LeetCode 486: Predict the Winner
7. Codeforces 276C: Little Girl and Game
8. LeetCode 1406: Stone Game III
9. Codeforces 455A: Boredom
10. CSES: Nim Game II

15 Bonus Techniques

Description: Advanced techniques for specialized problems.

15.1 Meet in the Middle

Description: Divides the problem into two parts to reduce complexity.

1. LeetCode 698: Partition to K Equal Sum Subsets
2. Codeforces 577B: Modulo Sum
3. LeetCode 454: 4Sum II
4. Codeforces 1208F: Bits And Pieces
5. LeetCode 473: Matchsticks to Square
6. Codeforces 1006C: Three Parts of the Array
7. LeetCode 2035: Partition Array Into Two Arrays to Minimize Sum Difference
8. Codeforces 888G: Xor-MST
9. CSES: Sum of Four Values
10. LeetCode 1755: Closest Subsequence Sum

15.2 Hashing

Description: Uses hash functions to compress large ranges or detect duplicates.

1. LeetCode 454: 4Sum II
2. LeetCode 974: Subarray Sums Divisible by K
3. LeetCode 1044: Longest Duplicate Substring
4. Codeforces 271D: Good Substrings
5. LeetCode 187: Repeated DNA Sequences
6. CSES: String Matching
7. LeetCode 1062: Longest Repeating Substring
8. Codeforces 1285C: Fadi and LCM
9. LeetCode 652: Find Duplicate Subtrees
10. Codeforces 514C: Watto and Mechanism

15.3 Matrix Exponentiation

Description: Solves linear recurrences in O(log n) using matrix operations.

1. LeetCode 509: Fibonacci Number
2. CSES: Fibonacci Numbers
3. LeetCode 1137: N-th Tribonacci Number
4. Codeforces 622F: The Sum of k-th Powers
5. CSES: Exponentiation II
6. LeetCode 1922: Count Good Numbers
7. Codeforces 185A: Plant
8. CSES: Matrix Exponentiation
9. Codeforces 621E: Wet Shark and Blocks
10. LeetCode 790: Domino and Tromino Tiling

16 Additional Competitive Programming Topics

Description: Covers additional essential CP techniques not included in the initial list.

16.1 Flow Algorithms

Description: Solves problems involving maximum flow or minimum cut in graphs.

1. LeetCode 1749: Maximum Absolute Sum of Any Subarray
2. Codeforces 498C: Array and Operations
3. CSES: Max Flow
4. LeetCode 1881: Maximum Value after Insertion
5. Codeforces 653D: Delivery Bears
6. CSES: Min Cut
7. Codeforces 546E: Soldier and Traveling
8. LeetCode 2698: Find the Punishment Number of an Integer
9. Codeforces 704A: Thor

10. CSES: School Dance

16.2 Minimum Spanning Tree (MST)

Description: Finds the minimum weight tree connecting all vertices.

1. LeetCode 1584: Min Cost to Connect All Points
2. LeetCode 1135: Connecting Cities With Minimum Cost
3. CSES: Road Network
4. Codeforces 609E: Minimum spanning tree for each edge
5. LeetCode 1168: Optimize Water Distribution in a Village
6. Codeforces 1244D: Paint the Tree
7. CSES: Building Roads
8. Codeforces 1108F: MST Unification
9. LeetCode 1489: Find Critical and Pseudo-Critical Edges in Minimum Spanning Tree
10. Codeforces 25C: Roads in Berland

16.3 Mo's Algorithm

Description: Efficiently processes offline range queries on arrays.

1. Codeforces 617E: XOR and Favorite Number
2. Codeforces 86D: Powerful array
3. LeetCode 315: Count of Smaller Numbers After Self
4. Codeforces 940F: Machine Learning
5. CSES: Range Queries and Sums
6. Codeforces 375D: Count the Pairs
7. LeetCode 327: Count of Range Sum
8. Codeforces 547B: Mike and Feet
9. CSES: Distinct Values Queries
10. Codeforces 221D: Little Elephant and Array