Mathematics in DSA Curriculum

Comprehensive Problem Set

April 17, 2025

Contents

1 Week 1: Number Theory (GCD, LCM, Primes)

1.1 Easy (5)

1. GCD of Two Numbers (LeetCode 1071)
2. LCM of Two Numbers (GFG)
3. Check if a Number is Prime (LeetCode 204)
4. Ugly Number (Primes 2,3,5) (LeetCode 263)
5. Sieve of Eratosthenes (LeetCode 204)

1.2 Medium (10)

1. Prime Factorization
2. Count Primes in Range (LeetCode 204)
3. GCD of Array (LeetCode 1979)
4. LCM of Array
5. Ugly Number II (Dynamic Programming) (LeetCode 264)
6. Super Ugly Number (LeetCode 313)
7. Largest Coprime Divisor
8. Sum of GCD of Pairs
9. Euler's Totient Function
10. Modular Multiplicative Inverse

1.3 Hard (10)

1. Number of Divisors in Range
2. Prime Pairs (Goldbach Conjecture) (LeetCode 2761)
3. Closest Prime Numbers in Range (LeetCode 2523)
4. GCD of Subarrays
5. LCM of Subarrays
6. Prime Substrings (LeetCode 2762)
7. Bezout's Identity (Extended GCD)
8. Chinese Remainder Theorem
9. Prime Counting Function (Legendre's Formula) (LeetCode 204)
10. Sum of Primes in Range (Segmented Sieve)

2 Week 2: Modular Arithmetic and Exponentiation

2.1 Easy (5)

1. Modular Addition
2. Power of Two (LeetCode 231)
3. Power of Three (LeetCode 326)
4. Modular Subtraction
5. Fast Exponentiation (Iterative)

2.2 Medium (10)

1. Modular Multiplication
2. Modular Division
3. Binary Exponentiation (Recursive)
4. Matrix Exponentiation
5. Super Pow (Modular Exponentiation) (LeetCode 372)
6. Geometric Series Sum (Mod Inverse)
7. Fermat's Little Theorem
8. Wilson's Theorem
9. Euler's Theorem
10. Discrete Logarithm (Baby-Step Giant-Step)

2.3 Hard (10)

1. Modular Square Root (Tonelli-Shanks)
2. Chinese Remainder Theorem (Non-Coprime Moduli)
3. Lucas Theorem (Combinatorics Mod Prime)
4. Pollard's Rho Algorithm (Factorization)
5. RSA Algorithm (Encryption/Decryption)
6. Diffie-Hellman Key Exchange
7. Modular Log (Baby-Step Giant-Step)

8. Primitive Root Modulo N
9. Carmichael Function
10. Quadratic Residues

3 Week 3: Combinatorics (Factorials, Combinations, Catalan Numbers)

3.1 Easy (5)

1. Factorial of a Number
2. Combinations (nCr) (LeetCode 77)
3. Pascal's Triangle (LeetCode 118)
4. Pascal's Triangle II (LeetCode 119)
5. Catalan Numbers

3.2 Medium (10)

1. Permutations (nPr) (LeetCode 46)
2. Unique Paths (Grid) (LeetCode 62)
3. Unique Paths II (Obstacles) (LeetCode 63)
4. Count Derangements
5. Count Binary Strings Without Consecutive 1s
6. Count Valid Parentheses (Catalan) (LeetCode 22)
7. Count Ways to Reach Nth Stair (LeetCode 70)
8. Count Ways to Tile a Board
9. Count Palindromic Subsequences (LeetCode 730)
10. Count Inversions (Merge Sort) (LeetCode 315)

3.3 Hard (10)

1. Count Permutation Sequences (LeetCode 60)
2. Count Valid Permutations (Dice) (LeetCode 1155)
3. Count Ways to Distribute Candies (LeetCode 135)
4. Count Ways to Partition a Set (Bell Numbers)
5. Count Ways to Color a Graph (LeetCode 256)
6. Count Ways to Place Houses (LeetCode 2320)
7. Count Ways to Build Rooms (LeetCode 1916)

8. Count Ways to Arrange Balls (LeetCode 2403)
9. Count Ways to Make Fair Array (LeetCode 1664)
10. Count Ways to Split a String (LeetCode 1573)

4 Week 4: Fibonacci and Recurrence Relations

4.1 Easy (5)

1. Fibonacci Number (LeetCode 509)
2. Climbing Stairs (LeetCode 70)
3. Tribonacci Number (LeetCode 1137)
4. House Robber (LeetCode 198)
5. Min Cost Climbing Stairs (LeetCode 746)

4.2 Medium (10)

1. House Robber II (LeetCode 213)
2. Decode Ways (LeetCode 91)
3. Unique Binary Search Trees (LeetCode 96)
4. K-th Symbol in Grammar (LeetCode 779)
5. Tiling a Rectangle with Squares (LeetCode 1240)
6. Domino and Tromino Tiling (LeetCode 790)
7. Knight Dialer (LeetCode 935)
8. Number of Dice Rolls With Target Sum (LeetCode 1155)
9. Count Vowels Permutation (LeetCode 1220)
10. Number of Ways to Stay in the Same Place (LeetCode 1269)

4.3 Hard (10)

1. Split Array Largest Sum (LeetCode 410)
2. Minimum Cost to Merge Stones (LeetCode 1000)
3. Minimum Falling Path Sum (LeetCode 931)
4. Maximum Height by Stacking Cuboids (LeetCode 1691)
5. Number of Music Playlists (LeetCode 920)
6. Count All Possible Routes (LeetCode 1575)
7. Number of Ways to Reorder Array (LeetCode 1569)
8. Count Ways to Build Rooms (LeetCode 1916)
9. Number of Ways to Separate Numbers (LeetCode 1977)
10. Count Number of Special Subsequences (LeetCode 1955)

5 Week 5: Bit Manipulation Techniques

5.1 Easy (5)

1. Single Number (LeetCode 136)
2. Number of 1 Bits (LeetCode 191)
3. Hamming Distance (LeetCode 461)
4. Power of Two (LeetCode 231)
5. Missing Number (LeetCode 268)

5.2 Medium (10)

1. Single Number II (LeetCode 137)
2. Single Number III (LeetCode 260)
3. Reverse Bits (LeetCode 190)
4. Subsets (Bitmask) (LeetCode 78)
5. Gray Code (LeetCode 89)
6. Divide Two Integers (Bit Shifts) (LeetCode 29)
7. Sum of Two Integers (Bitwise) (LeetCode 371)
8. Maximum Product of Word Lengths (LeetCode 318)
9. Find the Difference (LeetCode 389)
10. Binary Watch (LeetCode 401)

5.3 Hard (10)

1. Minimum Flips to Make a OR b Equal to c (LeetCode 1318)
2. Find XOR Sum of All Pairs (LeetCode 1835)
3. Count Pairs With XOR in Range (LeetCode 1803)
4. Minimum Number of Flips to Convert Binary Matrix (LeetCode 1284)
5. Maximum XOR of Two Numbers in an Array (LeetCode 421)
6. Repeated DNA Sequences (Bitmask) (LeetCode 187)
7. Minimum Number of Operations to Make Array Continuous (LeetCode 2009)
8. Find K-th Smallest Pair Distance (LeetCode 719)
9. Count Unique Characters of All Substrings (LeetCode 828)
10. Number of Wonderful Substrings (LeetCode 1915)

6 Week 6: Probability Basics and Expected Value Problems

6.1 Easy (5)

1. Flipping a Coin (Simulation) (LeetCode 519)
2. Rolling a Dice (Simulation) (LeetCode 1223)
3. Probability of Drawing a Red Ball
4. Probability of Two Dice Sum
5. Expected Value of a Dice Roll

6.2 Medium (10)

1. New 21 Game (DP + Probability) (LeetCode 837)
2. Knight Probability in Chessboard (LeetCode 688)
3. Random Pick with Weight (LeetCode 528)
4. Random Pick Index (Reservoir Sampling) (LeetCode 398)
5. Generate Random Point in a Circle (LeetCode 478)
6. Probability of Winning a Game
7. Expected Number of Trials
8. Monty Hall Problem
9. Birthday Paradox
10. Gambler's Ruin Problem

6.3 Hard (10)

1. Dice Roll Simulation (DP) (LeetCode 1223)
2. Number of Dice Rolls With Target Sum (DP) (LeetCode 1155)
3. Soup Servings (DP + Probability) (LeetCode 808)
4. Random Flip Matrix (Reservoir Sampling) (LeetCode 519)
5. Random Point in Non-overlapping Rectangles (LeetCode 497)
6. Expected Value of a Binomial Distribution
7. Expected Value of a Geometric Distribution

8. Markov Chains (Weather Prediction)
9. Bayes' Theorem (Medical Testing)
10. Chebyshev's Inequality

7 Additional Notes

About This Curriculum

- **Problem Sources:** Each problem is linked to its source (LeetCode or GeeksforGeeks).
- **Difficulty Progression:** Problems are organized from Easy to Medium to Hard within each topic.
- **Topic Coverage:** Each week focuses on a core mathematical concept essential for DSA with practical coding problems.
- **Completion Tracking:** All problems are marked as completed in this document.