Take-Off Programming Contest

[Fall 2024]

Problem Analysis

(Main Round)

Hosted by

Department of Computer Science & Engineering

Daffodil International University

Problem A. Neville's Magical Labeling
Problem Setter: Moniruzzaman Nahid
Tester: Kazi Amir Hamza
Category: Giveaway
Total Solved: 166
First to Solve: MD. Ahsanuzzaman

As values of A, B, C, … , Z are 1, 2, 3, … , 26 respectively, for “NEVILLE LONGBOTTOM”, we get,

N = 14, E = 5, V = 22, I = 9, L = 12, L = 12, E = 5, L = 12, O = 15, N = 14, G = 7, B = 2, O = 15, T = 20, T = 20, O = 15, M = 13

Sum: 212

So printing 212 will be enough.

Problem B. The Enchanted Staircase
Problem Setter: MD. Masum Billah
Tester: Kh Sadman Sakib
Category: Math, Number Theory
Total Solved: 0
First to Solve: N/A

Suppose there are N arithmetic sequences starting with S and ending with E, where the i^{th} sequence has a common difference d_i. It is easy to figure out that all $abs(d_i)$ will be a divisor of the number $abs(E - S)$. We can find all divisors of the number in $O(sqrt(abs(E - S))$ complexity and then contribution of i^{th} sequence to the answer can be found using arithmetic sequence sum formula.

Total Complexity: $O(T * sqrt(abs(E - S))$

Problem C. Harry, The Chill Guy
Problem Setter: Kazi Amir Hamza
Tester: Moniruzzaman Nahid
Category: Giveaway
Total Solved: 154
First to Solve: MD. Ahsanuzzaman

Comparing the sum of 3 different chill points with given X and Y is enough.

Problem D. Journey from Platform 9¾
Problem Setter: Sourov Biswas
Tester: Saimur Rahman Robin
Category: Math
Total Solved: 53
First to Solve: Ranjan Deb

First Half:
We already know this takes t seconds.

Second Half:
Since the train took t seconds at speed x, first half distance $= x * t$
This same distance must be covered at speed y
Time for second half $= x * t / y$

Now we have to check if the total time taken is bigger than 2676275 or not.

Problem E. The Vault of Forgotten Treasures
Problem Setter: Saimur Rahman Robin
Tester: Sourov Biswas
Category: Searching

Total Solved: 39
First to Solve: Shariar Abdullah Nafi

We need to check all possible pairs $(a[i], a[j])$ in the array, where $i < j$ to see if the product of the two values equals the target value K. We can easily implement it using nested loops.

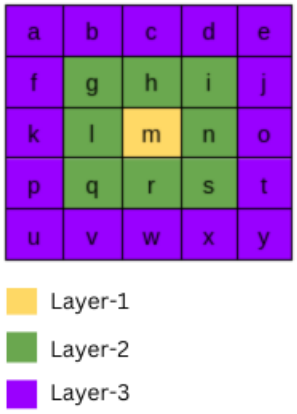
Problem F. The Polygon of Perplexity
Problem Setter: Md. Saimum Islam Hamza
Tester: Mohimenul Islam
Category: Geometry
Total Solved: 75
First to Solve: MD. Anisul Haque Chowdhury

The formula to calculate the interior angle of a regular polygon is:

$$\text{Interior Angle} = \frac{(n-2) \cdot 180^\circ}{n}$$

Now we have to subtract it from 180 to get our answer.

Problem G. Layers of the Wizarding World
Problem Setter: Piyash Basak
Tester: Kh Sadman Sakib
Category: Implementation
Total Solved: 4
First to Solve: Ranjan Deb



The problem requires finding the frequency of a letter in a specific layer. The expected complexity of answering each query is $O(4n)$, which can be achieved by simply iterating through a layer and counting the occurrence of the letter. It can also be solved in $O(1)$ by preprocessing the grid beforehand.

Problem H. Chocolate Frogs

Problem Setter: Kh Sadman Sakib
Tester: Piyash Basak
Category: Simulation
Total Solved: 0
First to Solve: N/A

The frog can start in any of the N boxes. As the expected complexity allows it, we can simulate the game N times placing the frogs in each of the N boxes at the beginning. The complexity will be $O(N * Q)$. The problem can also be solved in $O(N + Q)$ complexity, realising that we only need to find the number of times Harry guesses each box. We will need an array that keeps track of which box is at which location and swapping can be simulated by swapping elements in the array. Then, we can count how many times Harry guesses each box, and find the maximum.

Problem I. Muggle Math
Idea: Ferdous Ahmed Foysal
Problem Setter: Kh Sadman Sakib
Category: Observation
Total Solved: 1
First to Solve: Ranjan Deb

We definitely cannot repeat the process 1 billion times as it will result in TLE. Interestingly, we observe that if we do the process enough times on any 4-digit number, we get 6174 at some point, and it does not change anymore after that. Unless of course all digits of the number are the same, in that case we get 0 instantly.

This particular number, 6174, is actually called Kaprekar's Constant, discovered by Indian mathematician D. R. Kaprekar. For any 4-digit number it will take at most 7 steps to reach 6174. So, we can only do the operation $minimum(7,\ k)$ times to find our result.

Problem J. Prime Pair Hunt
Problem Setter: Abrar Hasnat
Tester: Kh Sadman Sakib
Category: Number Theory
Total Solved: 0
First to Solve: N/A

Every prime is an odd number except 2. If we extract a prime number (except 2) from another prime number, we will always get an even number. As the only even prime is 2, we basically have to find out the number of prime pairs with the difference between them equal to 2. Additionally, we should notice that difference between any prime numbers (except 3) and 2 is also always a prime.
To find out primes efficiently we can use Sieve of Eratosthenes.

Problem K. A Magical Quest
Problem Setter: Tasnim Ahmed
Tester: Kh Sadman Sakib
Category: Linear Search
Total Solved: 13
First to Solve: Md Saidur Rahman Sohad

We have to find the index of the maximum element. Let the index be i in a 0-based indexing, then our result is: $min(i, n - i)$

Problem L. Find the Needle in the Haystack!
Problem Setter: Abrar Hasnat
Tester: Kh Sadman Sakib
Category: Linear Search
Total Solved: 19
First to Solve: Md. Tanjimul Islam

For each query we need to count the frequency of each letter. The complexity for each query is $O(r - l)$. We can further optimize it observing that if $r - l + 1 > 26$, the range will definitely contain duplicates.

Extra Materials:
Problem Set: LINK
Contest page: LINK
Coded solutions to all the problems: LINK