MBSTU CSE Victory Day Contest 2020

Editorial

A. Help Your Little Bunny

Setter: Rasedul Russell
Alternative Writer: Sadee Ibn Sultan
Tag: combinatorics

Explanation:

Bunny's position (0,0)

Mother's position is (N, 0)

Observation:

1. Here, there is no problem with x because it is always increasing.
2. We only need exactly N/2 (+1)'s and N/2 (-1)'s for y.
3. We can consider a sequence consisting of +1 and -1 Where the

   Partial sum is always >= 0.
4. If N is odd Then bunny can't go to her mother for this print

   "my little bunny is lost".

Now we can consider the problem of counting all the unique Paths of step length N. We can approach this problem by thinking of the steps as (+1)'s and (−1)'s that create a sequence. Every up step in y axis in the path is a (+1) in the sequence, and every down step is a (−1).

As the path can never cross the x = y line when graphed, there can never be more (−1)'s than (+1)'s or vice versa. Thus the number of unique Paths becomes the number of sequences with non-negative partial sums that can be formed from N/2 (+1)'s and N/2 (−1)'s.

It is clear that using this sequence methodology and combinatorics, the number of unique Paths of length N is ${}^{N}C_{N/2} \times 1 / (N/2 + 1)$. This sequence of numbers is known as Catalan Numbers.

Author's Solution: https://paste.ubuntu.com/p/fKRFvWj8gW/
Alternative Solution: https://paste.ubuntu.com/p/xxYQrvg4Gw/

B. Help Your Friend L!

Setter: Saikat Sharma
Alternative Writer: Sadee Ibn Sultan
Tag: String, ad hoc

Explanation:
We have a string S.
Let, n = |S| (size of string S)
i) n > 2 and S[0] == capital-letter and (S[1] == space or S[1] == lowercase)
ii) if S[i] == capital-letter then S[i-1] == space // i = 1 … n-1
iii) if S[i] == space then S[i-1] != space // i = 1 … n-1
iv) (S[n-1] == '.' or S[n-1] == '?' or S[n-1] == '!') and S[n-2] != space

If all those conditions are true then the string S is a valid sentence otherwise it's a invalid sentence.

Author's Solution: https://paste.ubuntu.com/p/ghMqrB2NzM/
Alternative Solution: https://paste.ubuntu.com/p/5nwTZWq9d7/

C. Rise up

Setter : Nafis Shahriar Tasin
Alternative Writer : Sadee Ibn Sultan
Tag : Greedy, Implementation

Explanation: As the total number of stones in N piles is 2^N -1 and we have to make the number of stones power of two and also increasing from left to right. There is only one way to do so. The numbers will be 1 2 4 8 …. 2^{N-1} from left to right.

So an easy solution will be to just simply iterate from left to right and get the sum of the values, as in a position i the sum of number of stones from first position to ith position will have to be 2^i - 1, so if the current sum is more than the required sum we can move the extra stones to the next pile and number of moves will increase by one.

Again we will have to do the same thing by iterating from right to left.

But yes this problem can also be solved by only one loop.

Author's Solution: https://paste.ubuntu.com/p/VTzdYZK8HZ/
Alternative Solution: https://paste.ubuntu.com/p/2SdTr3pyzn/

D. Wedding Day

Setter: Nafis Shahriar Tasin
Alternative Writer: Sadee Ibn Sultan
Tag: Greedy, Implementation.

Explanation: As any two adjacent lights can not be in the same state, if we consider 1 as on state and 0 as off state then we have to make the lighting in the form 0101... or 1010...
if we want to get 0101... form we have to change all zeros in even positions to one and all the ones in odd positions to zeroes,
and if we want to get 1010... form we have to change all zeros in odd positions to one and all the ones in even positions to zeroes.

The minimum number of changes of these two ways will be the answer.

So we can pre calculate the numbers of zeros in the odd and even positions and the number of ones in the odd and even positions.

Then in each query we can recalculate these numbers according to the change and answer each query accordingly.

Author's Solution: https://paste.ubuntu.com/p/Ms9V8dFZFr/
Alternative Solution: https://paste.ubuntu.com/p/D5bMzWz8HC/

E. Miguel and His Dream House

Setter: Sadee Ibn Sultan
Alternative Writer: Nafis Shahriar Tasin
Tag: Hashing , Data Structure

Explanation:
Let's compute the prefix xor of the array values: we compute pi = a1 ⊕a2 ⊕ · · · ⊕ai for each 1 ≤ i ≤ n with p0 = 0. Then the xor of values in range [l, r] can be computed simply as pr ⊕pl−1 (recall that xor is associative and x⊕x = 0 for any x). Now if every element appears an even number of times on range [l, r], what can we say about their xor? It's zero! Because the values cancel in pairs. So we only need to check if pr ⊕ pl−1 is zero and we're done!
Well, not quite! While the xor of the elements being zero is a necessary condition, it's not a sufficient one. For example, the xor of the values {1, 2, 3} is 0, although each one appears an odd number of times. The problem is, there are certain sets of values that just happen to have an even number of bits on each position. This should be rare, but such a sequence can definitely be there.
But notice that we only care about the frequency of each value, not the value itself. So if we replace the same values by some other value, it doesn't affect our problem. Let's hash each different number in the array to a very large unique random value. This way, although the problem remains the same, the probability of such 'bad' sequences occurring becomes really really low (we need an even number of bits on 64 bit positions, an almost impossible requirement when the values are chosen at random). So our previous solution will work well.
Data structure is needed to implement the update , delete and query the XOR in the given range. It is safe to double hash value from 1 to $2 * 10^6$.

Author's Solution: https://pastebin.ubuntu.com/p/5cG2hZPkqt/
Alternative Solution: https://pastebin.ubuntu.com/p/rxjmZm7crg/

F. I'm Impostor

Setter: Sayed Sohan
Alternative Writer: Nafis Shahriar Tasin
Tag: Combinatorics, Pattern.

Explanation: There are total m imposters among n.We can choose m impostors among n in nCm ways.
Now for the winning condition,
i = 1 number of impostor and crewmate alive, we can choose that =$mCi * (n - m)Ci$ ways.
i+1 number of impostors and crewmates alive, we can choose that =
$mC(i + 1) * (n - m)\, C(i + 1)$ ways.
.
.
.
m number of impostors and crewmates alive, we can choose that =$mCm * (n - m)Cm$ ways.

So the total answer is $= nCm * \sum_{i=1}^{m} \{mCi * (n - m)Ci\}$. As the answer is big don't forget to use modular arithmetic with mod 1e9+7 or you'll get RE/TLE..

Bonus Task: It is also possible to solve without using the (1..m) loop. You can see it if you look thoroughly.

Author's Solution: https://paste.ubuntu.com/p/rpvRJdYgzC/
Alternative Solution: https://paste.ubuntu.com/p/YmmH994fGM/

G. Game of Tree

Setter: Nafis Shahriar Tasin
Alternative Writer: Sadee Ibn Sultan
Tag: Graph, Greedy.

Explanation: As one can not color a node that is already colored by the others if we consider the chosen node K as the root, if you chose a node in a subtree of a child of K you can never color any node in the subtree in any other child of K as it will be already colored by your friend.
Moreover if you choose any immediate child of K your friend can never color the childs of your node as these will be colored by you before your friend reaches these nodes.
So the optimal move for you is to choose the child of K with most nodes in its subtree and you will color this whole subtree and all other nodes will be colored by your friend.

Now if you can color more nodes by choosing the optimal node than your friend you win otherwise you can never win.

Author's Solution: https://paste.ubuntu.com/p/7Pn3YJ3r8s/
Alternative Solution: https://paste.ubuntu.com/p/5s96DWQBJ7/

H. Hyouka

Setter: Tamim Dari Chowdhury
Alternative Writer: Sadee Ibn Sultan
Tag: Binary Search

Explanation:

Brute force solution won't work for this problem.
To solve this problem - do a binary search, and for each mid value (let's say x) check whether we can take K sets of balls each having x balls from
the N boxes. Change the range of mid values according to the check results to get the maximum possible answer.

Author's Solution: https://pastebin.ubuntu.com/p/NW4NBnt5wB/
Alternative Solution: https://pastebin.ubuntu.com/p/J7pfpDtcVf/

I. Business for Badminton

Setter: Piyush
Alternative Writer: Sadee Ibn Sultan, Saikat Sharma
Tag: DP

Explanation: Since Monty doesn't involve in buying-selling on the next day of his selling, so we could not calculate the maximum profit through pure greedy selection. There are three states of Monty here in this problem.

1. Buy
2. Sell
3. Hold/Play badminton

If he buys any day he has two options- either Sell or Hold/Play badminton. The state transitions are given in the following

1. Buy -> Sell or Hold
2. Sell -> Hold
3. Hold -> Sell or Buy

By doing the all possible state transfers through all the given N days you can calculate the maximum profit Monty can make at last.

Author's Solution: https://pastebin.ubuntu.com/p/c2vf7yCww3/
Alternative Solution: https://paste.ubuntu.com/p/3NWxkGYFmm/

J. Victory

Setter: Sadee Ibn Sultan
Alternative Writer: Saikat Sharma
Tag: Giveaway

Explanation: print the sum which is 676.

Author's Solution: https://paste.ubuntu.com/p/B3wmGPS225/

K. Stay Home! Warm Your Love for Geometry!!

Setter: Belal Hossain
Alternative Writer: Sadee Ibn Sultan, Nafis Shahriar
Tag: Basic Geometry

Explanation: This problem has more than five solutions. One of the solutions is finding out the values of **x,y** and **z** using Pythagoras formula for the right triangles **ABC**, **ABD** and **BDC**. Applying Pythagoras formula we get, $x = \frac{AB^2}{\sqrt{AB^2 + BC^2}}$

$y = \sqrt{AB^2 + BC^2} - x$ and $z = \sqrt{BC^2 - y^2}$

Finally you need to print the value of $x^2 + y * z - z^2$. Don't worry if your answer does not match with the jury's answer after the floating point. Your answer will be considered accepted if its absolute or relative error does not exceed 10^{-6}.

Author's Solution: https://pastebin.ubuntu.com/p/jTymwcxBp4/
Alternative Solution: https://pastebin.ubuntu.com/p/wmhMDK4JH9/ (Sadee)
https://pastebin.ubuntu.com/p/vw8xyCXvzf/ (Nafis)

L. Zootopia

Setter: Sadee Ibn Sultan
Alternative Writer: Saikat Sharma
Tag: Digit-DP

Explanation: It is a basic digit dp problem. To make count of which distinct digit we are using , we can track it with a mask. So the digit dp state is (pos,boro,choto,mask,sum). We make all possible checks and return the desired result in range from L to R.

Author's Solution: https://paste.ubuntu.com/p/ZtBh3nYrB3/
Alternative Solution: https://paste.ubuntu.com/p/8yQwY4WZb8/