UCRPC Fall 2017: Week #8

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Lower Div Problemset

Contents

A. Night Duty

Rachel is the queen of a kingdom of 26 people. Each person has a name, but for purposes of government each individual appears as a letter from 'a' to 'z' on official documents.

She looks at person 'a' one day and sees them really tired. 'a' was on guard duty last night, and each citizen is fine with doing guard duty as long as they get a nice night's sleep afterwards.

She is worried that she is overworking her citizens by chance. Ignoring the fact that she can resolve all her problems fairly by proceeding in the order a, b, c, d, e... z, she decides to see if she has wronged any of her citizens.

She looks through the records of her citizens at work, but it can be tedious. She will grant you a plot of land and citizenship under the character 'A' if you are able to produce a program that can take in records as a string, and tell if she is being fair by outputting your name, A. If she is not being fair, output the character of the first person who is wronged.

Input is started with input t which denotes the number of test cases. It is then followed by t lines, each line representing a record.

Input	Output
3 abcdefg abababa aabcdee	A A a

Explanation:
In abcdefg, everyone gets at least one night's rest.

In abababa, a and b are not quite happy but at least get a fair night's rest.

In aabcdee, a and e are both being overworked, but output 'a' because they were first.

B. Power Overload

Tristan is a real estate investor that often ends up owning homes with terrible power grids. So terrible, that turning on a few lights might cause an overload. Fixing all of them might be expensive, so he wants to avoid fixing it if it's not worth it.

Tristan decides to make some simple tests with various lights and other electronics. He will make a guess of a home owner's power usage, and see if at any point he goes over the house's limit l.

For each house, he knows the max power the house can take before overloading, and for an array of electronics he knows each of their power consumption.

He writes a list of things to flip either off or on, and everything is initially off. Tell Tristan in this program if the house overloads.

Each input is begun with input t, which represents the number of test cases. Each test case starts with one line of input l, n, and m. n values follow, where n_i represents the ith electronic's power usage. m values follow, where m_i represents the ith flip.

Input	Output
2 10 6 4 1 2 5 8 20 3 3 3 4 2 10 6 4 1 2 5 8 20 3 3 4 4 2	OK OVERLOAD

1st case explanation:
Limit = 10
Electronics = 1, 2, 5, 8, 20, 3
Instructions = 3, 3, 4, 2

Step 1: Electronic 3 turned on, power is now at 5.

Step 2: Electronic 3 is already on, so turn it off. Power is now at 0.

Step 3: Electronic 4 turned on, power is now at 8.

Step 4: Electronic 2 turned on, power is now at 10.

No overload!

C. Bitcoin Manipulation

Patrick is an investor in the bitcoin market. He also happens to be a time wizard, and has a theoretically limitless amount of funds to start with. He travels n hours into the future, and obtains a list of all bitcoin prices from the time he departed to the time he arrived. Unfortunately, he can only do this once.

The bitcoin police is aware of his nonsense and limits him having only one whole bitcoin at any given time.

He wants to maximize his profit. What is the most money he can make?

The input is headed by the value t for the number of test cases. For each test case there is the value n. n values follow, where n_i represents the price of bitcoin at the ith hour.

Note that an O(n^2) solution will not give Patrick enough time to work with to begin trading.

Input	Output
4 5 1 2 3 4 5 6 8 1 2 4 5 3 4 3 4 5 5 4 3 2 1 8 10 2 3 4 5 3 4 9	5 6 0 9

Explanation:
V: 1 2 3 4 5 6
Out: 5
Patrick buys at hour 1, sells at hour 6.

V: 1 2 4 5 3 4 3 4
Out: 6
Patrick buys at hour 1, sells at hour 4, buys on hour 5, sells on hour 6, buys on hour 7, sells on hour 8.

V: 5 4 3 2 1
Out: 0
Patrick is smart enough to not buy at any point because there is no profit.

V: 10 2 3 4 5 3 4 9
Out: 9
Patrick buys at hour 2, sells at hour 5, buys at hour 6, sells on the final day.

D. Bitcoin Manipulation 2

Patrick is making TOO MUCH MONEY!!! The bitcoin enforcers now limit Patrick to one purchase and one sale. What is the max amount of money Patrick makes now?

The input is headed by the value t for the number of test cases. For each test case there is the value n. n values follow, where n_i represents the price of bitcoin at the ith hour.

Note that an O(n^2) solution will not give Patrick enough time to work with to begin trading.

Input	Output
4 5 1 2 3 4 5 6 8 1 2 4 5 3 4 3 4 5 5 4 3 2 1 8 10 2 3 4 5 3 4 9	5 4 0 7

Explanation:
V: 1 2 3 4 5 6
Out: 5
Patrick buys at hour 1, sells at hour 6.

V: 1 2 4 5 3 4 3 4
Out: 4
Patrick buys at hour 1, sells on hour 4

V: 5 4 3 2 1
Out: 0
Patrick is smart enough to not buy at any point because there is no profit.

V: 10 2 3 4 5 3 4 9
Out: 7
Patrick buys at hour 2, sells on the final day.

E. KOI-7923.0

CS 14 recommended

Jeff Coughlin, a NASA scientist, recently stated that one of the most earth-like planets out there right now is KOI-7923.0. The temperature of this planet is warm enough such that liquid water can stay liquid.

We travel several hundred years into the future, and NASA is now colonizing this planet. As part of the space program, they send a terraformer designed to create an atmosphere with oxygen, wildlife, and an ocean with water.

It's now time to land the first colonists. There's just one problem. NASA made a bit too much ocean, and now the planet is entirely islands. They take some n x n images from space showing the planet in this kind of format:

```
0000000000
0000000000
0000111000
0000010000
0000000000
0000010000
0000001000
0000000000
0010000000
0011110000
```

0 represents ocean water, while 1 represents land. NASA wants to figure out how many islands there are so they can create separate cities, and make different landing craft for each one. They define islands as a landmass surrounded by water in all cardinal directions.

That's where you come in. Tell NASA how many islands are in each picture.

Input begins with t, the number of test cases. Each test case begins with n. n x n values follow, representing the islands.

Input	Output
1 10 0000000000 0000000000 0000111000 0000010000 0000000000 0000010000 0000001000 0000001100 0010000000 0011110000	4

Explanation:
This is the same photograph from the example. We have 4 islands, which are

111
 1

1

1
11

1
1111

Two of the islands has a diagonal neighbor but they each are surrounded by water on all 4 cardinal sides, so they are unique islands.
So, we output 4.

F. Kaprekar Constant

CS 14 recommended

The Indian mathematician Kaprekar is famous in the world of mathematics for many things - one of which is his constant, 6174. Consider the following rules:

Take any number, where at least two digits are different values. Repeat the following operations however many times you want.

1. Order the digits in descending order to obtain X.
2. Order the digits in ascending order to obtain Y.
3. Your new number is X - Y.

For the sequence of 3 digit numbers, the result after some runs is 495. For 4 digit numbers, it is the constant - 6174.

You are a student doing research under a professor who is the great-great-great -great-great-great-great-great-great-great-great-great-great-great-great-great- great-great-great-great-great-great-great-great-great-great-great-great grandson of Kaprekar and is interested in these constants. He wants to find the constant for a 5 digit number.

It turns out, the 5 digit case is very special. He therefore wants you to write a program to print the number resulting from 999,999 trials of this method.

Input begins with t, the number of test cases. Each test case then represents a number, n that you want to find the 999,999th number in.

Note that he might ask for a large amount of queries as part of his research, and expect them quickly.

Input	Output
3 87433 53955 63954	53395 59994 75933