WOBURN CHALLENGE

2016-17 Online Round 2

Sunday, December 11th, 2016

Senior Division Problems

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Problem S1: Most Illogical

15 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: wcipeg.com/problem/wc162s1*

Mr. Speck, the Vulcan chief engineer aboard the Starship Enterprise, has grown tired of his crewmates' illogical tendencies. He's found that, not only is the veracity of their statements often questionable, they sometimes even make claims which are objectively false! He'd like to ascertain the truth of some statements made by his colleagues in order to set them straight.

Mr. Speck has modeled a certain statement made by one of his crewmates as a Boolean expression, consisting of a sequence of N ($3 \le N \le 99$, N is odd) strings. Starting from the first string, every other string is a Boolean literal representing the veracity of a particular claim, which is either "`true`", "`false`", or "`unknown`". Starting from the second string, every other string is a Boolean operator, either "`or`" or "`and`".

Order of operations applies to this expression, with "`and`" having higher precedence than "`or`". For example, the expression "`false or true and false`" evaluates to "`false or (true and false)`" = "`false or false`" = "`false`".

Mr. Speck is interested in the accuracy of the entire statement - that is, the value of the whole Boolean expression. If every Boolean literal within it was known to be either "`true`" or "`false`", then the expression could be evaluated to similarly be either "`true`" or "`false`". However, each "`unknown`" literal may independently be either "`true`" or "`false`", which may cause the expression's value to be uncertain. If the expression can either evaluate to "`true`" or "`false`" depending on the actual values of its "`unknown`" literals, then the expression's value is considered to also be "`unknown`". Please help Mr. Speck determine the value of the Boolean expression, so that he may reprimand his crewmate accordingly!

In test cases worth 3/15 of the points, all of the operators will be "`or`".
In test cases worth another 3/15 of the points, all of the operators will be "`and`".
In test cases worth another 3/15 of the points, none of the Boolean literals will be "`unknown`".

Input Format

The first line of input consists of a single integer N.
The second line consists of N space-separated strings representing the Boolean expression.

Output Format

Output a single line consisting of a single string representing the result of the Boolean expression.

Sample Input 1

```
3
true or false
```

Sample Output 1

```
true
```

Sample Input 2

```
3
unknown and false
```

Sample Output 2

```
false
```

Sample Input 3

```
5
false or true and unknown
```

Sample Output 3

```
unknown
```

Problem S2: Away Mission

20 Points / Time Limit: 3.00s / Memory Limit: 64M *Submit online: wcipeg.com/problem/wc162s2*

During its travels, the Starship Enterprise has come across a rather curious planet which appears to be contain vast deposits of kironide, a rare and valuable mineral. Captain Kerk has ordered N ($1 \le N \le 200{,}000$) of his crewmembers to go on an away mission to the planet's surface in order to confirm the sensors' readings. If all goes well, they'll be able to locate the kironide and collect some samples… before anything on the planet collects *them* as samples.

Each of the N crewmembers will need to be outfitted with a shirt, of course. It's standard Starfleet procedure for shirts to be manufactured on demand, with the use of a shirt replicator. The replicator is fed three Colour Component Chips (CCCs) – a red, green, and blue one – which determine the colour of the resulting shirt. Each CCC, in addition to corresponding to a particular colour component (either red, green, or blue), is encoded with an integral value between 0 and 255, inclusive. Kerk has N red CCCs with values $R_{1..N}$ at his disposal. He similarly has N green CCCs with values $G_{1..N}$, and N blue CCCs with values $B_{1..N}$.

Kerk may feed the CCCs into the shirt replicator in any combinations he'd like to in order to create N shirts, as long as the replicator is always given CCCs corresponding to all three different colour components at a time, and each of the $3N$ CCCs is only used once.

A shirt is considered "red" if its red CCC's value is strictly larger than its other two CCCs' values. In other words, if a shirt was produced using red, green, and blue CCCs with values r, g, and b, then it's red if both $r > g$ and $r > b$.

Unfortunate accidents have a way of happening to crewmembers wearing red shirts, so producing as few red shirts as possible would be beneficial. However, a strange anomaly has recently struck the Enterprise, which may be having unusual psychological effects on its crew, based on the value of Q ($1 \le Q \le 2$). If $Q = 1$, then Kerk has remained resilient and is determined to arrange his CCCs such that as few as possible of the N shirts are red. Otherwise, if $Q = 2$, then Kerk's psychological state has been compromised, and he'll instead maximize the number of red shirts produced!

In either case, please help estimate the number of "accidents" which might occur on the away mission by determining how many of the crewmembers will end up wearing red shirts.

In test cases worth 4/20 of the points, $N \le 2000$ and $B_i = 0$ for $i = 1..N$ (and in exactly 50% of these, $Q = 1$).
In test cases worth another 8/20 of the points, $N \le 2000$ (and in exactly 50% of these, $Q = 1$).
In exactly 50% of the remaining test cases, $Q = 1$.

Input Format

The first line of input consists of two space-separated integers N and Q.
The next line consists of N space-separated integers $R_{1..N}$.
The next line consists of N space-separated integers $G_{1..N}$.
The next line consists of N space-separated integers $B_{1..N}$.

Output Format

Output a single integer – either the minimum possible number of red shirts that must be made if $Q = 1$, or the maximum possible number that can be made if $Q = 2$.

Sample Input 1

```
3 1
200 0 123
0 42 122
5 200 99
```

Sample Output 1

```
1
```

Explanation 1

One optimal set of shirts is as follows (with each one notated as (r, g, b)):

```
(200, 0, 200)
(0, 42, 99)
(123, 122, 5)
```

Of these, only the last one is red. Unfortunately, it's impossible for none of the shirts to be red.

Sample Input 2

```
3 2
200 0 123
0 42 122
5 200 99
```

Sample Output 2

```
2
```

Explanation 2

One optimal set of shirts is as follows:

```
(200, 0, 99)
(0, 42, 200)
(123, 122, 5)
```

Problem S3: Turbolift Testing

27 Points / Time Limit: 4.00s / Memory Limit: 64M *Submit online: wcipeg.com/problem/wc162s3*

Lieutenant commander Scetty has been assigned quite the tedious task – testing a turbolift. Hardly a job worthy of the Enterprise's chief engineer! This particular turbolift has just 2 buttons – one to take the turbolift up 1 floor, and another to take it down 1 floor.

One "button press" is an action consisting of, well, pressing one of the buttons. It can be represented as a single character, either "`U`" if the up button is pressed, or "`D`" if the down button is pressed.

One "button sequence" is an ordered sequence of one or more button presses. The turbolift has the ability to perform N ($1 \le N \le 200{,}000$) different types of button sequences, numbered from 1 to N, with the i-th one represented by the string B_i. The j-th character in this string represents the j-th button press in the sequence. The strings $B_{1..N}$ are not necessarily distinct, and the sum of their lengths is at most 200,000.

The turbolift will start on floor 0 of the Enterprise. Due to recent technological advances, the ship has infinitely many floors above floor 0 (numbered upwards from 1), and infinitely many basement floors below it (numbered downwards from –1).

As part of the testing process, it will then be programmed to execute M ($1 \le M \le 200{,}000$) button sequences, one after another. The i-th button sequence in this sequence of sequences will be button sequence is S_i ($1 \le S_i \le N$). Note that some button sequences could be executed multiple times during the testing, while others could not be executed at all.

Throughout the process, Scetty will make notes about how low and high the turbolift ends up getting. In particular, he has Q ($1 \le Q \le 200{,}000$) questions to answer. The i-th one asks: "After the first P_i button presses, what are the minimum and maximum floor numbers that the turbolift will have reached up to that point?". P_i is a positive integer no greater than the total number of button presses which will be executed throughout the sequence of M button sequences. Note that both P_i and the answers may not fit within a 32-bit integer.

In test cases worth 12/27 of the points, $N \le 3000$, $M \le 3000$, and no single button sequence consists of more than 3000 button presses.

Input Format

The first line of input consists of three space-separated integers N, M, and Q.
N lines follow, the i-th of which consists of a single string B_i (for $i = 1..N$).
M lines follow, the i-th of which consists of a single integer S_i (for $i = 1..M$).
Q lines follow, the i-th of which consists of a single integer P_i (for $i = 1..Q$).

Output Format

Output Q lines, the i-th of which should consist of two space-separated integers – the lowest and highest floors that the turbolift will reach after no more than P_i button presses (for $i = 1..Q$).

Sample Input

```
2 3 3
DDUU
U
2
1
2
1
6
4
```

Sample Output

```
0 1
-1 2
-1 1
```

Explanation

The turbolift will receive 6 button presses in total, with the following results:

```
Button | Floor
--------------
   U   |   1
   D   |   0
   D   |  -1
   U   |   0
   U   |   1
   U   |   2
```

Problem S4: Diplomacy

38 Points / Time Limit: 3.00s / Memory Limit: 64M *Submit online: wcipeg.com/problem/wc162s4*

Having run low on dilithium, the Enterprise has stopped at an isolated space station to refuel. The station is inhabited by N ($1 \le N \le 200{,}000$) humanoids of various races. Unfortunately, it seems that their differences have been creating an increasingly heated conflict. In particular, there are constant debates over the station's artificial environmental settings! Some species prefer a warmer environment than others, or one with a stronger gravitational force. Though this might seem like a trivial matter, the frequent changing back and forth of the environmental settings appears to pose a serious threat to the state of tentative peace aboard the station, with threats of violent conflict in the air.

As a neutral third party, it'll be up to the crew of the Enterprise to step in and make a fair decision. The Enterprise's ambassador, Neelex, has been entrusted with selecting environmental settings in a neutral fashion, with the space station's residents agreeing to abide by his decision. However, if he makes a poor decision, there could still be serious trouble!

Two aspects of the space station's environmental settings may be set – its temperature (in degrees Celsius) and its gravity (in m/s^2). Each of these values may be set to any positive integer. The i-th humanoid aboard the station would like the temperature to be anywhere between A_i and B_i ($1 \le A_i \le B_i \le 10^9$), inclusive, and the gravity to be anywhere between C_i and D_i ($1 \le C_i \le D_i \le 10^9$), inclusive. They'll only be content if both the temperature and the gravity lie within their requested ranges (they don't care if only one of their requests is satisfied).

Neelex may not be able to choose a set of environmental settings to leave everyone happy, but he'd like to get as close to that as possible, in order to minimize the chance of a dispute. What's the maximum number of humanoids that can be satisfied by any possible choice of temperature and gravity settings?

In test cases worth 4/38 of the points, $B_i \le 200$, $D_i \le 200$, and $N \le 200$.
In test cases worth another 6/38 of the points, $N \le 200$.
In test cases worth another 10/38 of the points, $N \le 2000$.

Input Format

The first line of input consists of a single integer N.
N lines follow, the i-th of which consists of four space-separated integers A_i, B_i, C_i, and D_i (for i = 1..N).

Output Format

Output a single integer – the maximum number of humanoids that can be simultaneously satisfied.

Sample Input

```
4
64 100 35 55
100 200 10 40
111 190 39 69
12 120 38 38
```

Sample Output

```
3
```

Explanation

The first, second, and fourth humanoids will all be satisfied if the temperature is set to 100 and the gravity is set to 38. Any other configuration results in at most two humanoids being satisfied.