WOBURN CHALLENGE

2018-19 Online Round 2

Friday, December 14th, 2018

Intermediate Division Problems

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wcipeg.com

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Problem I1: Seeing Double

14 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: http://wcipeg.com/problem/wc182j3*

While on an undercover mission in Montreal, agents Ethan Hunt and Benji Dunn of the IMF (Impossible Mission Force) will need to attend an exclusive party to listen in on a terrorist scheme. Of course, they'll both need to disguise themselves as members of the party's guest list to gain entry.

Ethan has a set of N ($1 \le N \le 100$) masks, the i-th of which allows him to impersonate a person whose name is a string A_i. Benji agent similarly has M ($1 \le M \le 100$) masks, the i-th of which allows him to impersonate a person whose name is a string B_i. Each of the $N + M$ names is a non-empty string consisting of at most 20 lowercase letters "`a`".."`z`". Neither agent has any duplicate masks in their own set — in other words, the names $A_{1..N}$ are distinct from one another, and the names $B_{1..M}$ are also distinct from one another.

Ethan and Benji will each select one of their masks and wear it to the party. However, they'll run into trouble if they happen to both impersonate the same person! Help them determine how many different people exist who might be impersonated by both agents simultaneously.

Input Format

The first line of input consists of a single integer, N.
N lines follow, the i-th of which consists of a single string, A_i, for $i = 1..N$.
The next line consists of a single integer, M.
M lines follow, the i-th of which consists of a single string, B_i, for $i = 1..M$.

Output Format

Output a single integer, the number of different people who might be impersonated by both agents simultaneously.

Sample Input

```
3
kurt
john
solomon
4
franz
solomon
kurt
james
```

Sample Output

```
2
```

Sample Explanation

It's possible for both Ethan and Benji to impersonate "`kurt`". It's also possible for both of them to impersonate "`solomon`". There are no other people who might be impersonated by both agents.

Problem I2: Ammunition

20 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: http://wcipeg.com/problem/wc182j4*

Ethan Hunt is really in the thick of things now — having infiltrated escaped convict Solomon Lane's hideout in the Rocky Mountains, he's now found himself surrounded by N ($1 \le N \le 1000$) of Solomon's guards, with but a single tranquilizer gun to defend himself!

The tranquilizer gun can hold up to M ($1 \le M \le 1000$) bullets at a time, and Ethan initially has it loaded with S ($0 \le S \le M$) bullets.

Hitting a guard with a single bullet is enough to tranquilize them, and of course, Ethan never misses. The problem is, he might simply not have enough bullets to tranquilize all of the guards. Fortunately, a potential solution has occurred to Ethan — some of the guards appear to be carrying bullets compatible with his gun, which he might be able to grab and use for himself!

The i-th guard is carrying B_i ($0 \le B_i \le 1000$) bullets, which they'll drop upon being tranquilized. This means that, if Ethan chooses to use up a bullet to tranquilize the i-th guard, he can then load up to B_i new bullets into his tranquilizer gun immediately afterwards. However, he may only use a number of new bullets which will not cause his gun's new bullet count to exceed M. He also may not leave excess bullets lying around and load them into his gun later on, as they'll get lost amidst the chaotic firefight.

Ethan may tranquilize 0 or more of the N guards in any order he'd like, as long as he always has at least one bullet available in his gun to tranquilize the next guard. What's the maximum number of guards who he can tranquilize?

Subtasks

In test cases worth 8/20 of the points, $N \le 10$ and $M = 1000$.
In test cases worth another 7/20 of the point, $M = 1000$.

Input Format

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

Output Format

Output a single integer, the maximum number of guards who Ethan can tranquilize.

Sample Input 1

```
3 1000 1
0 1 2
```

Sample Output 1

```
3
```

Sample Input 2

```
6 2 2
1 0 0 3 0 0
```

Sample Output 2

```
5
```

Sample Explanation

In the first case, Ethan could first choose to tranquilize the 2nd guard, using up his only bullet but then picking up another bullet. He could then use that bullet to tranquilize the 3rd guard, picking up two new bullets as a result. Finally, he could use one of those bullets to tranquilize the 1st guard.

In the second case, Ethan could choose to tranquilize guards 1, 2, 4, 3, and 6, in that order. This would leave him with no bullets remaining to tranquilize the 5th guard, but tranquilizing 5 out of the 6 guards is the best he can do.

Problem I3: Laser Grid

26 Points / Time Limit: 3.00s / Memory Limit: 32M *Submit online: http://wcipeg.com/problem/wc182s1*

The IMF (Impossible Mission Force) has dispatched their best agent, Ethan Hunt, to recover a recently stolen microchip. This microchip contains critical Canadian governmental secrets, such as the Prime Minister's favourite colour, and must be recovered before its captors have time to download its data!

Ethan has tracked the microchip down to an underground base in Saskatchewan. Upon infiltrating it, he's found himself in the middle of a gigantic, square room. When viewed from above, the room can be represented as a square on a 2D plane, with its bottom-left corner at coordinates (0, 0) and its top-right corner at coordinates (1,000,000, 1,000,000). Ethan has lowered himself down into the room, and is standing at coordinates (X_E, Y_E) $(1 \le X_E, Y_E \le 999{,}999)$.

There are N $(0 \le N \le 100{,}000)$ vertical lasers extending across the entire room, the i-th of which is a line segment from coordinates $(V_i, 0)$ to $(V_i, 1{,}000{,}000)$ $(1 \le V_i \le 999{,}999)$. There are also M $(0 \le M \le 100{,}000)$ horizontal lasers extending across the entire room, the i-th of which is a line segment from coordinates $(0, H_i)$ to $(1{,}000{,}000, H_i)$ $(1 \le H_i \le 999{,}999)$. All vertical lasers have distinct V values, all horizontal lasers have distinct H values, and no laser goes directly through Ethan's location (in other words, no V value is equal to X_E, and no H value is equal to Y_E).

Ethan was hoping to simply find the stolen microchip, but he's been greeted by a more troubling sight: there are C $(1 \le C \le 100{,}000)$ microchips strewn about the room! The i-th microchip is at coordinates (X_i, Y_i) $(1 \le X_i, Y_i \le 999{,}999)$. No two microchips are at the same location, no microchip is at Ethan's location, and no laser goes directly through any microchip's location.

One of these C microchips must be the real one, with the rest being decoys, but they all look identical! Unfortunately, Ethan will only have time to go grab at most one of them before getting out of there. To make matters even worse, Ethan may not pass through any lasers on his way to pick up the microchip of his choice, as they'd trigger an alarm. He'll need to weigh his options and choose his plan of action carefully!

For each microchip, determine whether or not Ethan would be able to reach its location from (X_E, Y_E) by following any continuous path on the 2D plane (not necessarily a straight line segment), without leaving the confines of the room and without passing through any of the $N + M$ lasers.

Subtasks

In test cases worth 10/26 of the points, each integer in the input is no greater than 10.
In test cases worth another 10/26 of the points, $N \le 2000$, $M \le 2000$, and $C \le 2000$.

Input Format

The first line of input consists of two space-separated integers, X_E and Y_E.
The next line consists of three space-separated integers, N, M, and C.
N lines follow, the i-th of which consists of a single integer, V_i, for $i = 1..N$.
M lines follow, the i-th of which consists of a single integer, H_i, for $i = 1..M$.
C lines follow, the i-th of which consists of two space-separated integers, X_i and Y_i, for $i = 1..C$.

Output Format

Output C lines with a single character per line, either "`Y`" if Ethan would be able to reach the i-th microchip, or "`N`" otherwise, for $i = 1..C$.

Sample Input

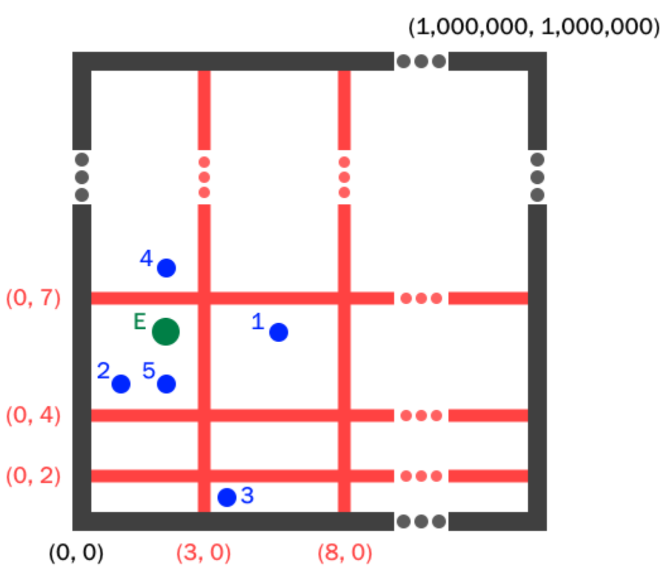
```
2 6
2 3 5
3
8
4
2
7
6 6
1 5
4 1
2 8
2 5
```

Sample Output

```
N
Y
N
N
Y
```

Sample Explanation

The room is illustrated below, with lasers indicated in red, Ethan's location in green, and the microchips in blue. Note that most of the x-coordinates and y-coordinates on the plane (from around 10 to around 999,997) have been collapsed together.



Ethan would only be able to reach the 2nd or 5th microchip.

Problem I4: Plutonium

40 Points / Time Limit: 2.00s / Memory Limit: 64M *Submit online: http://wcipeg.com/problem/wc182s2*

Ethan Hunt has traced a string of illegal plutonium trafficking down to a remote warehouse situated on a frigid island in Nunavut!

The warehouse has been operating for a period of N ($1 \le N \le 200,000$) days, and it had P_i ($1 \le P_i \le 10^6$) boxes of plutonium in stock at the end of the i-th day.

At the end of the first day, there was a single box ($P_1 = 1$). On each subsequent day i ($2 \le i \le N$), it's possible that a buyer came to withdraw *all* of the plutonium in the warehouse in the morning. Whether or not that occurred, one new box of plutonium then arrived at the warehouse in the afternoon. In other words, if a withdrawal occurred on day i, then $P_i = 1$, and otherwise, $P_i = P_{i-1} + 1$.

Ethan has entrusted the task of monitoring the warehouse to his friend and fellow IMF member Luther Stickell. Accurately monitoring the warehouse proved problematic, but Luther did his best to come up with a list of observations $O_{1..N}$ ($0 \le O_i \le 10^6$). If $O_i = 0$, then Luther has no idea how much plutonium the warehouse had in stock at the end of the i-th day. Otherwise, if $O_i > 0$, then Luther believes that the warehouse had exactly O_i boxes of plutonium in stock at the end of the i-th day (in other words, that $P_i = O_i$).

Ethan would now like to use Luther's observations to determine how many sellers withdrew plutonium from the warehouse. Due to gaps in Luther's observations, there may be multiple sequences of events which are consistent with them, so Ethan is interested in both the minimum and maximum possible number of withdrawals which could have taken place over the course of days 2..N. It's also possible that Luther's observations are inconsistent with any possible sequence of events.

Subtasks

In test cases worth 12/40 of the points, $N \le 20$.
In test cases worth another 16/40 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 a single integer, O_i, for $i = 1..N$.

Output Format

Output either two integers, the minimum and maximum possible number of withdrawals, or the single integer −1 if it's impossible for Luther's observations to be accurate

Sample Input 1

```
6
1 0 0 0 3 0
```

Sample Output 1

```
1 3
```

Sample Input 2

```
3
1 0 4
```

Sample Output 2

```
-1
```

Sample Explanation

In the first case, it's possible that plutonium was only withdrawn a single time, on the morning of the 3rd day. It's also possible for as many as 3 withdrawals to have taken place, on the mornings of the 2nd, 3rd, and 6th days.

In the second case, the warehouse could contain at most 3 boxes of plutonium at the end of the 3rd day (if no withdrawals had taken place), which is inconsistent with Luther's observed count of 4.