WOBURN CHALLENGE

2018-19 Online Round 1

Friday, November 16th, 2018

Senior Division Problems

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wcipeg.com

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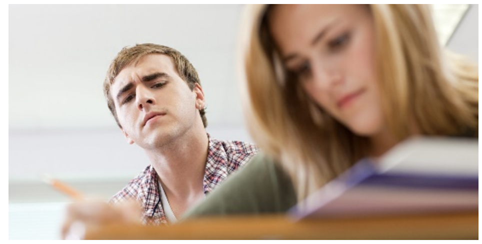
Problem S1: Inspiration

13 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: http://wcipeg.com/problem/wc181s1*



It's time for a history test! Unfortunately, while some students have come well-prepared, others appear to have forgotten about the test entirely. They may need some "inspiration" to get through it with passing grades.

The desks in H.S. High School's history classroom are laid out in a nice, traditional grid. The grid has R ($1 \le R \le 50{,}000$) rows, numbered $1..R$ from front to back, and C ($1 \le C \le 10$) columns, numbered $1..C$ from left to right. The state of each desk in a given row r and column c is described by an integer $D_{r,c}$ ($0 \le D_{r,c} \le 2$), which is one of the following:

- 0: That desk is unoccupied
- 1: That desk is occupied by a "type-1" student — one who has studied for the test
- 2: That desk is occupied by a "type-2" student — one who has *not* studied for the test

Each type-2 student is in trouble… unless they can catch a glimpse of inspiration, in the form of a type-1 student's test paper. Without looking too suspicious, a student can see manage to see the papers on some desks directly in front of them, in the same column. However, they can only clearly see at most the closest K ($1 \le K \le R - 1$) desks in front of them. In other words, the test paper of a type-1 student sitting in row r_1 and column c_1 can be seen by a type-2 student sitting in row r_2 and column c_2 if and only if $c_1 = c_2$ and $r_2 - K \le r_1 \le r_2 - 1$. Note that a type-2 student doesn't gain any additional benefit from seeing multiple type-1 students' papers, and that it's possible for a single type-1 student's paper to inspire multiple type-2 students.

How many of the type-2 students can be inspired by looking at at least one type-1 student's test paper?

Subtasks

In test cases worth 4/13 of the points, $K \le 10$.
In test cases worth another 5/13 of the points, $K = R - 1$.

Input Format

The first line of input consists of three space-separated integers, R, C, and K.
R lines follow, the i-th of which consists of integers, $D_{i,\,1..C}$, for $i = 1..R$.

Output Format

Output a single integer, the number of type-2 students who can be inspired.

Sample Input	Sample Output	Sample Explanation

`5 3 2`
`1 0 1`
`1 2 2`
`0 1 2`
`2 1 2`
`0 2 2`
	`4`	The type-2 students in the 2nd and 3rd rows of the 3rd column can both be inspired by the type-1 student sitting at the front of that row. The type-2 student in the 4th row of the 1st column can be inspired by the type-1 student sitting 2 desks in front of them. Finally, the type-2 student at the back of the 2nd column can be inspired by either of the type-1 students sitting 1 or 2 desks in front of them.

Problem S2: Essay Generator

20 Points / Time Limit: 4.00s / Memory Limit: 64M *Submit online: http://wcipeg.com/problem/wc181s2*

Alice has a W-word essay due tomorrow ($1 \le W \le 10{,}000$), but she's too busy programming to bother with that! However, Alice happens to know that H.S. High School's English teacher is sick of reading and grading long essays, so she figures that if she just submits a "reasonable" essay which fulfills the requirements but is as short as possible, she may get some pity marks!

As such, Alice wants to write a program to generate a sequence of W words to pass off as her essay, where each word is any string consisting of 1 or more lowercase letters (`"a"`..`"z"`) (not necessarily a real English word). The essay will have no punctuation or formatting, as those seem unnecessary to Alice. In an attempt to disguise the essay's generated nature, Alice will insist that all W words are distinct. Finally, for her plan to come together, she'll make the sum of the W words' lengths as small as possible.

Help Alice generate *any* essay which meets the above requirements.

Subtasks

In test cases worth 5/20 of the points, $W \le 20$.
In test cases worth another 5/20 of the points, $W \le 100$.

Input Format

The first and only line of input consists of a single integer, W.

Output Format

Output a single line containing Alice's essay: a sequence of W distinct space-separated words, with the sum of their lengths minimized.

Sample Input

```
2
```

Sample Output

```
i a
```

Sample Explanation

The sum of the lengths of the two words "`i a`" is 1 + 1 = 2, which is the minimum possible total length of a two-word essay. Various other essays (such as "`x y`") would also be accepted. However, the essay "`i i`" would not be accepted due to its words not being distinct, and the essay "`i am`" would not be accepted due to the total length of its words (1 + 2 = 3) not being as small as possible.

Problem S3: Reach for the Top

27 Points / Time Limit: 4.00s / Memory Limit: 128M *Submit online: http://wcipeg.com/problem/wc181s3*

It's time for Bob to face his biggest fear at H.S. High School: the dreaded gym class rope climb. In this brutal test of strength and endurance, Bob is tasked with ascending part of the way up an infinitely long vertical rope. He begins by grabbing onto the bottom of the rope, at a height of 0, and must reach any height of H ($1 \le H \le 1{,}000{,}000$) or greater (measured in metres).

To make matters even worse than usual, Alice has pranked Bob by spreading itching powder on some sections of the rope, which he'll need to avoid along the way! She's done so for N ($0 \le N \le H - 1$) sections, the i-th of which covers all heights from A_i to B_i, inclusive ($1 \le A_i \le B_i \le H - 1$). No two sections overlap with one another, even at their endpoints.

Bob's rope-climbing style is… unusual, to say the least, which may come in handy for avoiding Alice's itching powder. At any point, given that he's currently holding onto the rope at some height h_1, he may only perform one of the following two possible actions:

1. Jump upwards by a height of exactly J ($1 \le J \le H$), such that his new height is $h_2 = h_1 + J$, but only if the rope is not covered in itching powder at height h_2.
2. Drop downwards by any height, such that his new height is any integer h_2 ($0 \le h_2 < h_1$), but only if the rope is not covered in itching powder at height h_2.

Both types of actions involved in this technique are understandably quite tiring, so Bob would like to avoid performing more of them than necessary. Help him determine the minimum number of actions he must perform to reach a height of at least H metres, or determine that it's sadly impossible for him to ever reach such a height.

Subtasks

In test cases worth 8/27 of the points, $H \le 1000$ and $J \le 2$.
In test cases worth another 12/27 of the points, $H \le 1000$.

Input Format

The first line of input consists of three space-separated integers, H, J, and N.
N lines follow, the i-th of which consists of two space-separated integers, A_i and B_i, for $i = 1..N$.

Output Format

Output a single integer, either the minimum number of actions required for Bob to reach a height of at least H metres, or -1 if it's impossible for him to do so.

Sample Input 1

```
12 5 2
2 4
10 10
```

Sample Output 1

```
5
```

Sample Input 2

```
5 2 2
1 1
4 4
```

Sample Output 2

```
-1
```

Sample Explanation

In the first case, Bob can jump up to a height of 5, drop down to a height of 1, jump up to a height of 6, jump up to a height of 11, and finally jump up to a height of 16. This is the only strategy which involves 5 actions, which is the minimum possible number of actions.

In the second case, Bob must start by jumping up to a height of 2. From there, he may not jump upwards to a height of 4 (as the rope is covered in itching powder there), and similarly may not drop down to a height of 1, meaning that he can never grab the rope at any height aside from 0 or 2.

Problem S4: Bad Influence

40 Points / Time Limit: 8.00s / Memory Limit: 256M *Submit online: http://wcipeg.com/problem/wc181s4*

N ($1 \le N \le 300{,}000$) students are filing into H.S. High School's popular French class, one after another. The classroom has a whopping 10^6 desks, all arranged in a single row and numbered $1..10^6$ from left to right. The i-th student to arrive has a social standing of S_i ($1 \le S_i \le 10^6$), and will sit at desk D_i ($1 \le D_i \le 10^6$). All N students have distinct social standings and will sit at distinct desks.

Even though the students love learning French, they sometimes still get distracted by their phones and stop paying attention in class. Furthermore, this issue is exasperated by the effects of peer pressure! If the i-th student were to start using their phone, all students with smaller social standings who are sitting no further than R_i($1 \le R_i \le 10^6$) desks away from the i-th student will also start doing so (in other words, each student j such that $S_j < S_i$ and $D_i - R_i \le D_j \le D_i + R_i$). As a result of those students using their phones, even more students may in turn start using their phones, and so on.

When one or more students are present in the classroom, the "volatility" of that set of students is defined as the minimum number of students who would need to initially start using their phones by themselves, such that all of the students currently present would end up using their phones.

As the students file in, the French teacher wants to keep track of the volatility of her class, to give her an idea of what she'll be in for. So, after each student i sits down, the teacher is interested in the volatility of the students present so far (students $1..i$). Please help her compute this list of N volatilities.

Subtasks

In test cases worth 8/40 of the points, $N \le 10$.
In test cases worth another 6/40 of the points, $N \le 300$.
In test cases worth another 8/40 of the points, $N \le 3000$.

Input Format

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

Output Format

Output N lines, the i-th of which should consist of a single integer, the volatility after the first i students have arrived, for $i = 1..N$.

Sample Input

```
8
14 5 1
8 6 3
12 1 3
19 8 2
21 7 3
10 11 1
3 10 6
13 9 10
```

Sample Output

```
1
1
2
3
2
3
3
1
```

Sample Explanation

After the first student arrives, it would be necessary for just them to start using their phone, resulting in a volatility of 1.

After the second student arrives, it would still only be necessary for student 1 to start using their phone, as that would also cause student 2 to also use their phone. Therefore, the volatility of these two students is still 1.

After the third student arrives, it would be necessary for at least two of the three students to start using their phones (students 1 and 3). Therefore, the volatility of these three students is 2.

Once all students are present, they would all end up using their phones if only student 5 initially decided to use their phone. Therefore, the volatility of all 8 students is 1.