Problem C - Exploração de Cavernas

Check our instructions page for detailed information on the qualification and the format of this problem.

The National Organization of Intrepidity is planning an excursion of its phenomenal and very curious explorer group to a newly discovered cave system. There may still be treasures to discover inside.

The underground radar information obtained so far reveals that the system is a big corridor with entrances to caves in some sectors. It's possible to use advanced technology to dig and enter in any point of this corredor, but it's a costly operation.

The corridor has $\boldsymbol{N}$ sectors, with entrances to caves in $\boldsymbol{M}$ of them, the i^{th} of which having entrance in sector $\boldsymbol{M_i}$ (each sector can only have one cave entrance). The caves are not connected between themselves.

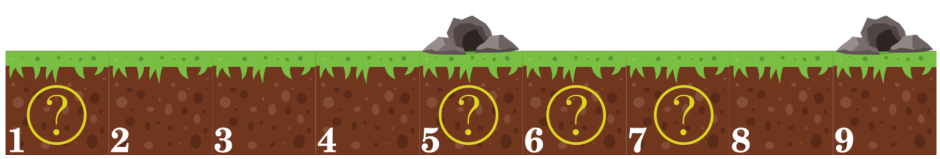
Part I

Some curious explorers are asking what is the distance in sectors to the nearest cave of a possible entrance sector.

There are $\boldsymbol{Q}$ questions, the i^{th} corresponds to an integer $\boldsymbol{Q_i}$, representing a sector. Your task is to determine the distance from each question to the closest sector that contains a cave.

Example

Suppose that $\boldsymbol{N} = 9$, $\boldsymbol{Q} = 4$ and $\boldsymbol{M} = 2$ and that we have the following corridor with the following entrances to caves:



The explorers ask for the cave distances from sectors 1, 6, 5 or 7:

- From sector 1, the closest entrance is in sector 5, which is at a distance of 4 sectors.
- From sector 6, the closest entrance is also in sector 5, which is at a distance of 1 sector.
- From sector 5 we are already at a cave entrance, therefore we are at a distance of 0 sectors.
- From sector 7, we can go both to sector 5 and to sector 9, which are both at a distance of 2 sectors.

Constraints

The following limits are guaranteed for all test cases of this Part that will be given to the program:

$1 \leq \boldsymbol{N} \leq 10^5$	Number of sectors on the corridor
$1 \leq \boldsymbol{M} \leq \boldsymbol{N}$	Number of sectors with entrances to caves
$1 \leq \boldsymbol{M_i} \leq \boldsymbol{N}$	Sectors with entrances to caves
$1 \leq \boldsymbol{Q} \leq 10^5$	Number of asked entrances
$1 \leq \boldsymbol{Q_i} \leq \boldsymbol{N}$	Entrance sector asked

The test cases of this Part of the problem are organized into two groups:

Subtask	Points	Additional Constraints
1	10	$\boldsymbol{N}, \boldsymbol{Q} \leq 100$
2	20	No additional constraints

Part II

New information reveals that it's highly unlikely that the treasures are at the entrance of the caves, they are likely to be at the end.

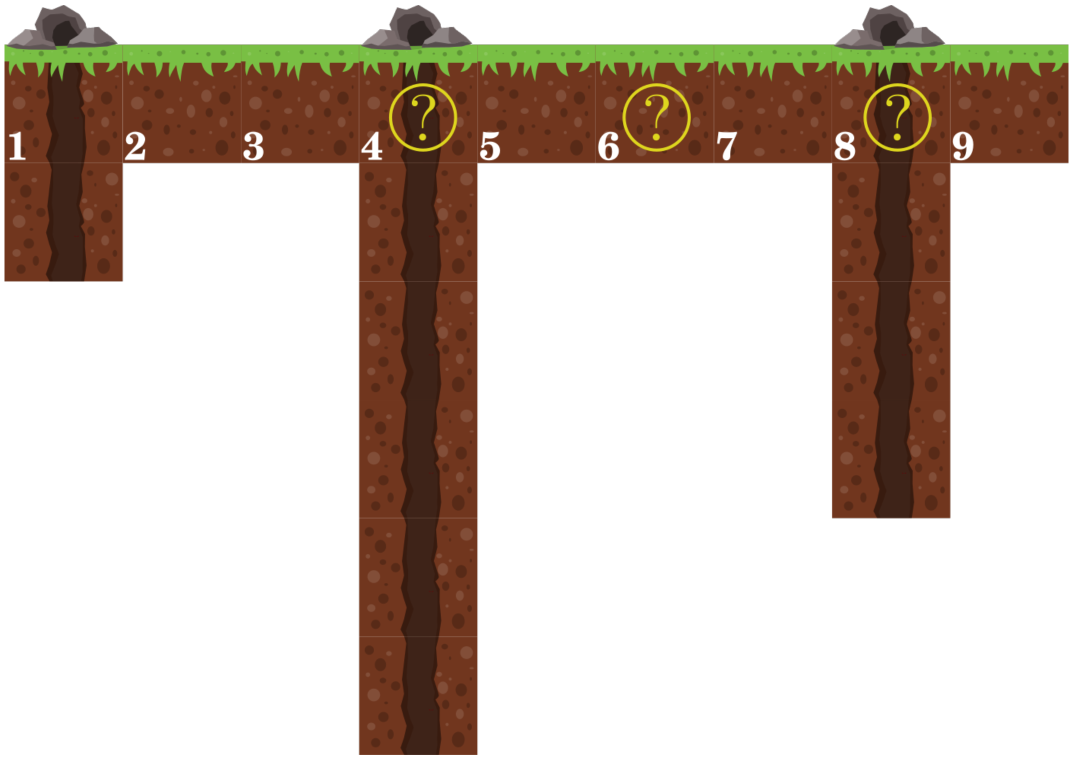
NOI analysed the data again and found the depth of each cave in sectors. The i^{th} cave has depth $\boldsymbol{P_i}$.

The explorers are asking what is the closest distance to any position where it's possible to find a treasure, meaning the end of any cave.

You are given $\boldsymbol{Q}$ questions, the i^{th} of which corresponds to sector $\boldsymbol{Q_i}$. Answer all questions.

Example

Suppose that $\boldsymbol{N} = 9$, $\boldsymbol{Q} = 3$ and $\boldsymbol{M} = 3$ and that we have the following cave system:



The sectors in positions 4, 6 and 8 were asked.

- The closest end of a cave from sector 4 is of the cave in sector 1, which is at a distance of 4 sectors.
- The closest end of a cave from sector 6 is of the cave in sector 8, which is at a distance of 5 sectors.
- The closest end of a cave from sector 8 is of the cave in the same sector, which is at a distance of 3 sectors.

Constraints

The following limits are guaranteed for all test cases of this Part that will be given to the program:

$1 \leq \boldsymbol{N} \leq 10^5$	Number of sectors on the corridor
$1 \leq \boldsymbol{M} \leq \boldsymbol{N}$	Number of sectors with entrances to caves
$1 \leq \boldsymbol{M_i} \leq \boldsymbol{N}$	Sectors with entrances to caves
$0 \leq \boldsymbol{P_i} \leq 10^9$	Depth of the caves
$1 \leq \boldsymbol{Q} \leq 10^5$	Number of entrance sectors asked
$1 \leq \boldsymbol{Q_j} \leq \boldsymbol{N}$	Entrance sector asked

The test cases of this Part of the problem are organized into two groups:

Subtask	Points	Additional Constraints
3	10	$\boldsymbol{N}, \boldsymbol{Q} \leq 100$
4	30	No additional constraints

Part III

Apparently the information provided by the underground radar wasn't as reliable as we thought. The entity responsible for the radar is frenetically sending corrections.

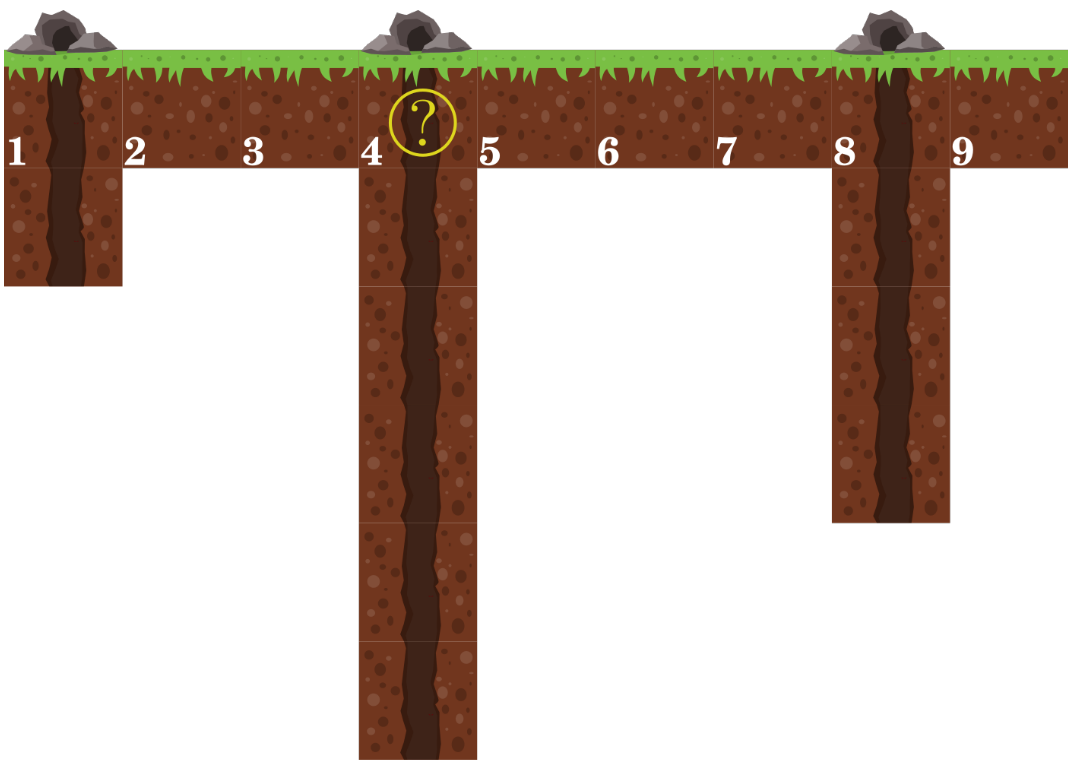
Adding to the confusion, the explorers continue being curious. Answer their questions adjusting to the information received until then.

There are $\boldsymbol{Q}$ events, which can be of three different types, written in the order they were received:

- Explorer question. As in Part II, the explorers ask the minimal distance to the end of a cave if they enter through sector $\boldsymbol{Q_j}$ (it's guaranteed that there exists some cave in some sector).
- Add a new entrance to a cave in sector $\boldsymbol{Q_j}$ with depth $\boldsymbol{P_j}$ (it's guaranteed that sector $\boldsymbol{Q_j}$ doesn't have a cave).
- Remove entrance to the cave in sector $\boldsymbol{Q_j}$ (it's guaranteed that $\boldsymbol{Q_j}$ has a cave).

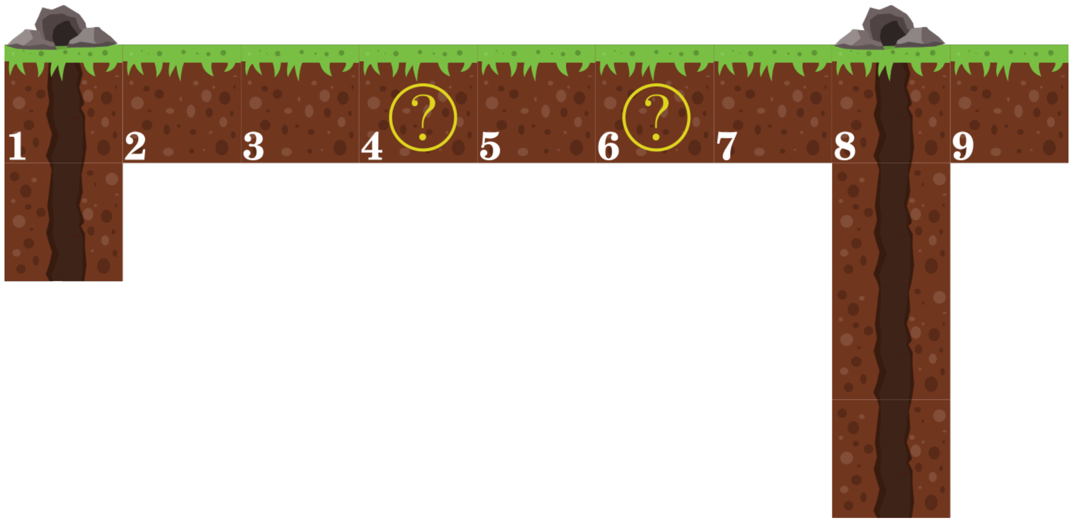
Example

Suppose that $\boldsymbol{N} = 9$, $\boldsymbol{Q} = 7$ and $\boldsymbol{M} = 3$ and that we initially have the following cave system:



The sector 4 was asked, and the closest end of a cave is at a distance of 4 sectors.

Information was received saying that the cave in sector 4 shouldn't be there. Removing it, we get the following cave system:

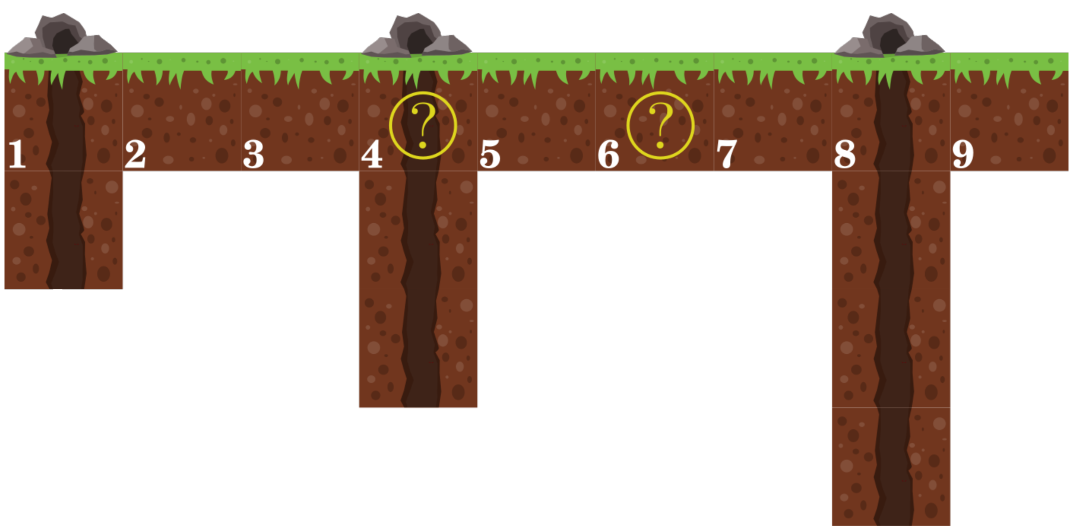


Sectors 4 and 6 were asked.

From sector 4, the closest end is still at a distance of 4 sectors.

From sector 6, the closest end is at a distance of 5 sectors.

New information was received saying a new cave should be added to sector 4, with a deptth of 2, getting the following cave system:



Sectors 4 and 6 were asked again.

From sector 4, the closest end is now at a distance of 2 sectors.

From sector 6, the closest end is now at a distance of 4 sectors.

Constraints

The following limits are guaranteed for all test cases of this Part that will be given to the program:

$1 \leq \boldsymbol{N} \leq 10^5$	Number of sectors in the corridor
$1 \leq \boldsymbol{M} \leq \boldsymbol{N}$	Initial number of caves
$1 \leq \boldsymbol{M_i} \leq \boldsymbol{N}$	Sectors that initially have a cave
$0 \leq \boldsymbol{P_i}, \boldsymbol{P_j} \leq 10^9$	Depth of the caves
$1 \leq \boldsymbol{Q} \leq 10^5$	Number of events
$1 \leq \boldsymbol{Q_j} \leq \boldsymbol{N}$	Sectors asked of updated

The test cases of this Part of the problem are organized into one group:

Subtask	Points	Additional Constraints
5	30	No additional constraints

Summary of Subtasks

The test cases of the problem are organized into 5 groups with different constraints:

Subtask	Points	Part	Additional Constraints
1	10	Part I	$\boldsymbol{N}, \boldsymbol{Q} \leq 100$
2	20	Part I	No additional constraints
3	10	Part II	$\boldsymbol{N}, \boldsymbol{Q} \leq 100$
4	30	Part II	No additional constraints
5	30	Part III	No additional constraints

Input Format

The first line has an integer $\boldsymbol{P}$ that represents the Part the testcase represents. If it's 1, then it refers to Part I, if it's 2 then it refers to Part II and if it's 4 it referes to Part III.

The next line has three integers, $\boldsymbol{N}$, $\boldsymbol{Q}$ and $\boldsymbol{M}$, separated by a space.

Part I

$\boldsymbol{M}$ lines follow, the i^{th} containing $\boldsymbol{M_i}$.

$\boldsymbol{Q}$ lines follow, the j^{th} containing $\boldsymbol{Q_j}$.

Part II

$\boldsymbol{M}$ lines follow, the i^{th} containing two values separated by a space, $\boldsymbol{M_i}$ and $\boldsymbol{P_i}$.

$\boldsymbol{Q}$ lines follow, the j^{th} containing $\boldsymbol{Q_j}$.

Part III

$\boldsymbol{M}$ lines follow, the i^{th} containing two values separated by a space, $\boldsymbol{M_i}$ and $\boldsymbol{P_i}$.

$\boldsymbol{Q}$ lines follow, with 3 possible formats. The j^{th} line can be:

- `?` $\boldsymbol{Q_j}$
- `A` $\boldsymbol{Q_j}$ $\boldsymbol{P_j}$

- `R` Q_j

This means, a `?` followed by Q_j, separated by a space, representing the explorers questions; a `A` followed by two values, Q_j and P_j, all separated by a space, representing the addition update; or a `R` followed by Q_j, also separated by a space, representing the removal update.

Output Format

Part I and Part II

The output should have Q lines, each one with the distance value asked.

Part III

The output should have a line for each `?` received, printing the asked minimal distance.

Example 1 Input

```
1
9 4 2
5
9
1
6
5
7
```

Example 1 Output

```
4
1
0
2
```

Example 1 Description

This example corresponds to the example mentioned in Part I of the problem statement.

Example 2 Input

```
2
9 3 3
1 1
4 5
8 3
4
6
8
```

Example 2 Output

```
4
5
3
```

Example 2 Description

This example corresponds to the example mentioned in Part II of the problem statement.

Example 3 Input

```
3
9 7 3
1 1
4 5
8 3
? 4
R 4
? 4
? 6
A 4 2
? 4
? 6
```

Example 3 Output

```
4
4
5
2
4
```

Example 3 Description

This example corresponds to the example mentioned in Part III of the problem statement.