Problem C - Concurso de Espadachins

"The best swordsman in the world doesn't need to fear the second best swordsman in the world, but some ignorant antagonist who has never had a sword in his hand before."

The Division of Combat Contests (DCC) is an association of martial arts enthusiasts, which is responsible for the organization of several tournaments in these famous disciplines, such as *kickboxing*, *taekwondo* and *competitive programming*. This time, in what is an absolute first, the DCC will organize a swordfighting tournament.

In that tournament, $\boldsymbol{N}$ swordsmen will compete (where $\boldsymbol{N}$ is a power of 2, i.e. $\boldsymbol{N} = 2^n$ for some non-negative integer n), in an elimination format. In the first round, the first duel will be between the 1st and 2nd swordsmen, the second duel between the 3rd and 4th, and so on until all contestants have taken part in a duel. In each one of the following rounds, the winners of the previous round will compete. The first duel will be between the winners of the 1st and 2nd duels of the previous round, the second between the winners of the 3rd and the 4th, and so on until all of the previous round's winners have once again been put to test.

When only a single contestant remains, we will have found who is the best swordsman in all of the DCC!

We should also mention how the winner of a given duel is determined. Each swordsman has a skill score, described by a non-negative integer lesser than or equal to 10^6. When two swordsmen of similar skill meet, the most experienced one takes the win. However, when the difference between their skills is too large, the least experienced one ends up winning. This is, if there is a duel between swordsman with skills a and b, and $|a - b| < 1000$, the winner is the one with skill equal to $\max(a, b)$; otherwise, the winner is the swordsman with skill equal to $\min(a, b)$. In case of a draw, the win is given to the swordsman with the lowest contestant number.

After knowing $\boldsymbol{N}$, the number of contestants, and each of their skill scores, the DCC has requested your support to guarantee that everything in the tournaments goes as planned.

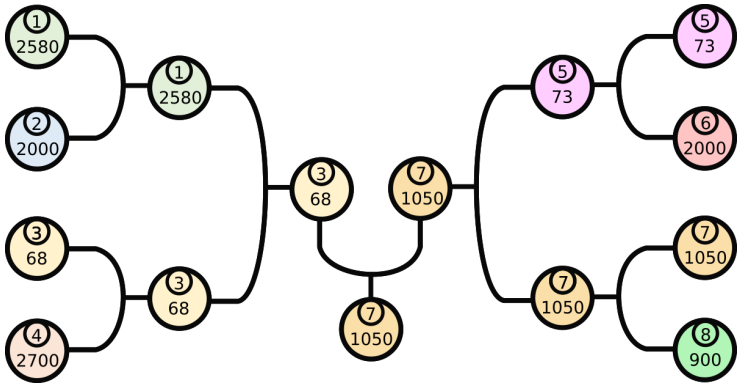
Part I

In order to prepare in advance for the celebration of the tournament winner, DCC is interested in knowing who will emerge as the victor. Determine who the tournament winner is.

Example

Consider a tournament with $N = 8$ swordsmen, where their skill scores are as follows: 2580, 2000, 68, 2700, 73, 2

We can then observe how the tournament unfolds:



Notice that in the quarterfinal match between contestants 1 and 2, the absolute value of the difference of skill scores is $|2580 - 2000| = 580 < 1000$, and therefore the one with higher skill wins.

On the other hand, in the quarterfinal match between contestants 5 and 6, since the absolute value of the difference of skill scores is $1927 \geq 1000$, the swordsman with the lower skill wins.

Constraints

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

$1 \leq N \leq 65536$ Number of contestants

Note: The value of N will always be a power of 2.

The test cases for this part of the problem are organized into a single group:

Subtask	Points	Additional Constraints
1	20	No additional constraints

Part II

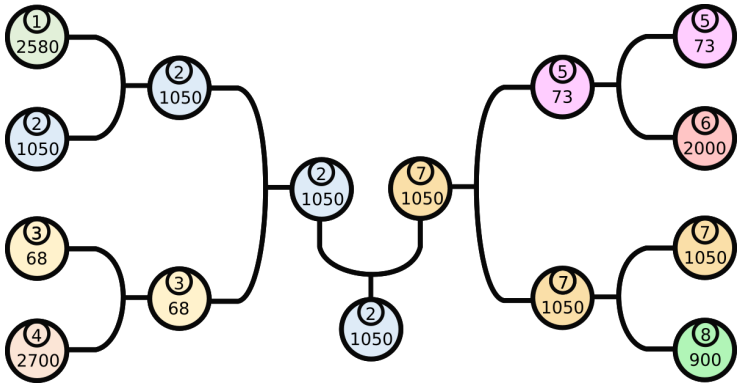
To be a good swordsman, one must train regularly. If a swordsman puts in enough effort, they can increase their skill score, whereas if they slack off, it may decrease. DCC is interested in knowing how each contestant should alter their training to become the winner of the tournament.

For each i between 1 and N, indicate a skill score that would ensure that swordsman i becomes the tournament winner. If no such value exists, indicate -1.

Example

Consider the tournament mentioned in the example given in Part I.

If swordsman 2 had a skill score of 1050 instead of 2000, the tournament would unfold as follows:



Thus, swordsman 2 would emerge as the winner. Let's see how we could alter the skill scores of the other swordsmen to win the tournament.

If, starting from the given initial conditions, we changed the skill of swordsman $2, 3, 4$, or 6 to 1050, they would win. Swordsman 8 would become victorious if his skill were 1051.

No skill score would allow swordsmen 1 or 5 to win the tournament.

Note: If there is a value that allows a swordsman to be the winner, it does not have to be unique. For example, note that besides 1050, swordsman 2 could change his skill score to 1055 or 1060 and emerge as the winner of the tournament. It is only necessary to indicate one possible value, if it exists.

Constraints

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

$1 \leq \boldsymbol{N} \leq 65536$ Number of contestants

Note: The value of $\boldsymbol{N}$ will always be a power of 2.

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

Subtask	Points	Additional Constraints
2	15	$\boldsymbol{N} \leq 256$
3	25	No additional constraints

Part III

DCC needs to be prepared for all possibilities and, more than ever, needs your help. Therefore, you will receive a sequence of Q requests of the following 3 types:

a) **Change** – Change the skill score of swordsman i to the value v.

b) **Winner** – Determine the winner of the current tournament.

c) **Crystal Ball** – Given a swordsman i, indicate a skill score that would guarantee swordsman i to be the winner of the tournament. If no such value exists, indicate -1.

Example

Consider the tournament mentioned in the example given in Part I.

Let $Q = 4$ and consider the following requests in order:

i) Winner.

ii) Crystal Ball – swordsman 2.

iii) Change the skill score of swordsman 8 to 50.

iv) Winner.

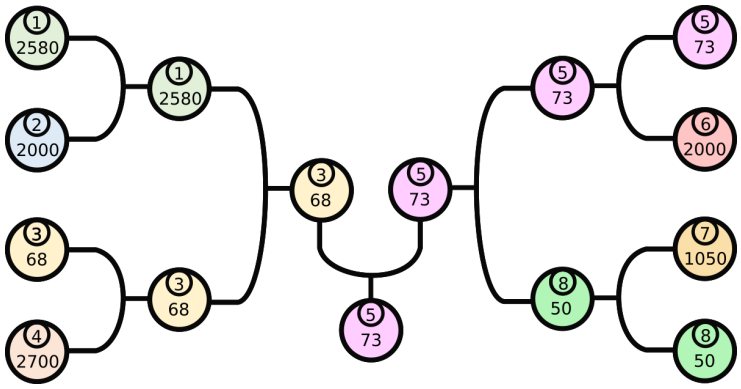
Let's respond, in order, to these requests.

As seen in the example from Part I, the winner of the given tournament is swordsman 7.

As seen in the example from Part II, if we changed the skill score of swordsman 2 to 1050, they would win the tournament.

In the third request, we should change the skill score of swordsman 8 to 50.

Under the current circumstances, the next tournament would result in swordsman 5 being the winner.



Constraints

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

$1 \leq \boldsymbol{N} \leq 65536$ Number of participants
$1 \leq \boldsymbol{Q} \leq 10^5$ Number of requests

Note: The value of $\boldsymbol{N}$ will always be a power of 2.

The test cases for this part of the problem are organized into a single group:

Subtask	Points	Additional Constraints
4	40	No additional constraints

Summary of Subtasks

The test cases of the problem are organized into 4 groups with different additional constraints:

Subtask	Points	Part	Additional Constraints
1	20	Part I	No additional constraints
2	15	Part II	$\boldsymbol{N} \leq 256$
3	25	Part II	No additional constraints
4	40	Part III	No additional constraints

Input Format

The first line contains an integer $\boldsymbol{P}$, which represents the part of the test case. If it is 1, then the test case refers to Part I; if it is 2, then it refers to Part II; and if it is 3, then it refers to Part III.

In Parts I and II, the following lines contain: an integer $\boldsymbol{N}$, the number of swordsmen in the tournament; another line with $\boldsymbol{N}$ positive integers separated by spaces, where the $\boldsymbol{i}$-th number in this line represents the skill score of swordsman $\boldsymbol{i}$.

In Part III, the following lines contain two integers separated by spaces: $\boldsymbol{N}$, the number of swordsmen in the tournament, and $\boldsymbol{Q}$, the number of requests in the question; then a line with $\boldsymbol{N}$ positive integers separated by spaces, where the $\boldsymbol{i}$-th number in this line represents the skill score of swordsman $\boldsymbol{i}$, which is then followed by $\boldsymbol{Q}$ lines, where the first character of each line identifies the type of request:

a) If the first character is the letter `M`, it is a **Change** request. It is followed by a space and two integers separated by spaces: $\boldsymbol{i}$, the number of the swordsman whose skill is to be changed, and $\boldsymbol{v}$, their new skill score.

b) If the first character is the letter `V`, it is a **Winner** request. The line consists of just the character that has already been read.

c) If the first character is the letter `B`, it is a **Crystal Ball** request. It is followed by a space and an integer, i: the number of the swordsman for whom we want to find a skill score that would allow them to win the tournament (if it exists).

Output Format

Part I

The output should contain an integer, the number of the winning swordsman.

Part II

The output should contain N integers separated by spaces, where the i-th integer is a skill score that would ensure swordsman i to be the winner of the tournament (if it exists). If no such value exists, indicate -1.

Part III

The output should contain one line for each request of type `V` or `B`. If it is a request of type `V`, the line should contain an integer, the number of the winning swordsman. If it is a request of type `B` for swordsman i, the line should contain a skill score that would guarantee swordsman i to be the winner of the tournament (if it exists). If no such value exists, indicate -1.

Example 1 Input

```
1
8
2580 2000 68 2700 73 2000 1050 900
```

Example 1 Output

```
7
```

Example 1 Description

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

Example 2 Input

```
2
8
2580 2000 68 2700 73 2000 1050 900
```

Example 2 Output

```
11 100 100 100 -1 102 102 102
```

Example 2 Description

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

Note: As explained, this is not the only correct output for this test case.

Example 3 Input

```
3
8 4
2580 2000 68 2700 73 2000 1050 900
V
B 2
M 8 50
V
```

Example 3 Output

```
7
11
5
```

Example 3 Description

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

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