2020 Canadian Computing Olympiad
Day 2, Problem 1
Travelling Salesperson

Time Limit: 7 seconds

Problem Description

In the city of RedBlue, every pair of buildings is connected by a road, either red or blue. To switch from travelling along red roads to blue roads or vice versa costs one ticket. The length of a route is the number of buildings that are visited. For example, the following route has a length of five and costs one ticket.

1 — 2 — 3 — 4 — 3

If we wanted to travel on a blue road again after visiting vertex 3 for the second time, we would need another ticket, for a total of two tickets:

1 — 2 — 3 — 4 — 3 — 2

You are a travelling salesperson visiting the city of RedBlue, and you wish to visit each building at least once, while minimizing repeated visits of the same buildings. You have not yet decided which building you are starting your route from, so you would like to plan out all possible routes. Furthermore, you only have access to one ticket. For each building, you would like to find a route of minimum length that begins at that building, visits all the buildings at least once, and uses at most one ticket.

Input Specification

The first line will contain a single integer N $(2 \leq N \leq 2\,000)$, the number of buildings in RedBlue.

Lines 2 to N each contain a string, with line i containing the string C_i, representing the colours of the roads connected to building i. The string $C_i = C_{i,1}C_{i,2}...C_{i,i-1}$ has a length of $i-1$ and consists only of the characters `R` and `B`. If $C_{i,j}$ is `R`, then the road between buildings i and j is red. Otherwise, it is blue.

Output Specification

Output $2N$ lines. Lines $2i-1$ for $1 \leq i \leq N$ should contain a single integer M_i, representing the length of the travel plan starting at building i. Lines $2i$ for $1 \leq i \leq N$ should each contain M_i space separated integers, describing the order in which you visit the buildings, starting at building i.

Scoring

For every one of your travel plans, a score is computed. Let K_i be the length of the optimal route starting at each building, and let M_i be the length of your route. If M_i is greater than $2K_i$, then your score will be 0, and you will receive a verdict of Wrong Answer. If M_i is equal to K_i, then your score will be 25. Otherwise you will a receive a score of $\lfloor 8 + 8 \times \frac{2K_i - M_i}{K_i - 1} \rfloor$. Your score for the test case is the minimum score for each travel plan.

If any of your plans are invalid, your score will be 0, and you will receive a verdict of Wrong Answer.

Your submission's score is the minimum score over all test cases.

Sample Input

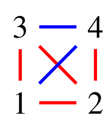
```
4
R
RR
BRB
```

Possible Output for Sample Input

```
5
1 4 2 1 3
6
2 3 1 2 3 4
5
3 1 2 3 4
4
4 3 1 2
```

Explanation of Possible Output for Sample Input

RedBlue looks like this:



The route starting from building 3 has an optimal length of 4 by visiting the buildings in the order $3, 2, 1, 4$. The solution's route has a length of 5, meaning the score is equal to $\lfloor 8 + 8 \times \frac{2 \times 4 - 5}{4 - 1} \rfloor = 16$.

2020 Canadian Computing Olympiad
Day 2, Problem 2
Interval Collection

Time Limit: 3.5 seconds

Problem Description

Altina is starting an interval collection. An interval is defined as two positive integers $[l, r]$ such that $l < r$. We say that the length of this interval is $r - l$. Additionally, we say that an interval $[l, r]$ contains another interval $[x, y]$ if $l \leq x$ and $y \leq r$. In particular, each interval contains itself.

For a non-empty set S of intervals, we define the set of common intervals as all the intervals $[x, y]$ that are contained within every interval $[l, r]$ in S. If the set of common intervals is non-empty, then we say the **greatest common interval** of S is equal to the common interval with the largest length.

For the same set S, we define the set of enclosing intervals as all the intervals $[x, y]$ that contain every interval $[l, r]$ in S. Note that this set is always non-empty, so we say the **least enclosing interval** of S is equal to the enclosing interval with the smallest length.

Initially, Altina owns no intervals in her collection. There are Q events that change the set of intervals she owns.

The first type of event is when Altina adds an interval $[l, r]$ to her collection. Note that this interval could have the same $[l, r]$ as another interval in her collection. They should be treated as separate intervals.

The second type of event is when Altina removes an existing interval $[l, r]$ from her collection. Note that if Altina has more than one interval with the same $[l, r]$, she removes exactly one of them.

After each event, Altina chooses a non-empty subset S of intervals she owns in her collection that satisfy the following conditions:

- Among all sets S Altina could choose, she chooses one that has **no** greatest common interval, if possible. If this is impossible, then she chooses one which has the length of its greatest common interval as small as possible.
- Among all sets S that satisfy the previous condition, she chooses one which has the length of its least enclosing interval as small as possible.

Your task is to determine the length of the least enclosing interval of the set S Altina chose after each event.

Input Specification
The first line of input contains Q ($1 \leq Q \leq 500\,000$), the number of add and remove operations in total. The next Q lines are in one of the following forms:

- `A` l r: add the interval $[l, r]$ to Altina's collection.
- `R` l r: remove one of the instances of the interval $[l, r]$ from Altina's collection . It is guaranteed the interval to be removed exists and that the collection will be non-empty after the interval is removed.

For all subtasks, $1 \leq l < r \leq 1\,000\,000$.

For 3 of the 25 marks available, $Q \leq 500$.

For an additional 8 of the 25 marks available, $Q \leq 12\,000$.

For an additional 7 of the 25 marks available, $Q \leq 50\,000$.

For an additional 4 of the 25 marks available, the following condition holds after each event: for every two separate intervals $[l_1, r_1]$ and $[l_2, r_2]$ in Altina's collection, either $r_1 < l_2$ or $r_2 < l_1$.

Output Specification
The output consists of Q lines, each line containing the length of the least enclosing interval for Altina's choice of S as described in the problem description.

Sample Input
```
5
A 1 5
A 2 7
A 4 6
A 6 8
R 4 6
```

Output for Sample Input
```
4
6
5
4
7
```

Explanation of Output for Sample Input
After the interval $[1, 5]$ is added, there is only one interval, so $S = \{[1, 5]\}$ is the only valid choice and the least enclosing interval is $[1, 5]$.

After the interval $[2, 7]$ is added, $S = \{[1, 5], [2, 7]\}$ has the greatest common interval $[2, 5]$ and least enclosing interval $[1, 7]$.

After the interval $[4, 6]$ is added, $S = \{[1, 5], [4, 6]\}$ has the greatest common interval $[4, 5]$ and least enclosing interval $[1, 6]$.

After the interval $[6, 8]$ is added, $S = \{[4, 6], [6, 8]\}$ has no greatest common interval and its least enclosing interval $[4, 8]$. Note that $S = \{[1, 5], [6, 8]\}$ also has no greatest common interval but its least enclosing interval $[1, 8]$ has a greater length than $[4, 8]$.

After the interval $[4, 6]$ is removed, $S = \{[1, 5], [6, 8]\}$ has no greatest common interval and least enclosing interval $[1, 8]$.

2020 Canadian Computing Olympiad
Day 2, Problem 3
Shopping Plans

Time Limit: 2 seconds

Problem Description

You are shopping from a store that sells a total of N items. The i-th item has a *type* a_i which is an integer between 1 and M. A feasible shopping plan is a subset of these items such that for all types j, the number of items of type j is in the interval $[x_j, y_j]$.

The i-th item in the store has a cost of c_i, and the cost of a shopping plan is the sum of the costs of items in the plan. You are interested in the possible costs of feasible shopping plans. Find the costs of the K cheapest feasible shopping plans. Note that if there are two different shopping plans with the same cost, they should be counted separately in the output.

Input Specification

The first line consists of three space-separated integers N, M, and K ($1 \leq N, M, K \leq 200\,000$). N lines follow, the i-th of which contains two space-separated integers a_i and c_i ($1 \leq a_i \leq M$, $1 \leq c_i \leq 10^9$). M lines follow, the j-th of which contains two space-separated integers x_j and y_j ($0 \leq x_j \leq y_j \leq N$).

For 5 of the 25 marks available, $x_j = y_j = 1$ and $N, M, K \leq 4000$.

For an additional 5 of the 25 marks available, $x_j = y_j = 1$ and $N, M, c_i \leq 4000$.

For an additional 5 of the 25 marks available, $x_j = y_j = 1$.

For an additional 5 of the 25 marks available, $x_j = 0$.

Output Specification

Output K lines. On the i-th line, output the cost of the i-th cheapest feasible shopping plan, if one exists, or `-1` if there are fewer than i feasible shopping plans.

Sample Input 1

```
5 2 7
1 5
1 3
2 3
1 6
2 1
1 1
1 1
```

Output for Sample Input 1

```
4
6
6
7
8
9
-1
```

Explanation of Output for Sample Input 1

A feasible shopping plan must combine exactly one item with a cost in $\{5, 3, 6\}$ with exactly one item with a cost in $\{3, 1\}$.