Problem 8: C1000001
10 Points

Problem ID: `piano`
Rank: `3`

Introduction

Billy the billion-tentacled octopus wants to perform some profound pieces at his upcoming piano recital! He'll be showcasing his custom built piano with a few "engineering" quirks.

Billy's piano has 1000000 octaves with 12000004 keys numbered from 1 to 12000004! In scientific pitch notation, key 1 plays A0, 2 plays A#0, 3 plays B0, 4 plays C1, …, 40 plays C4 (middle C), …, 49 plays A4 (A440), …, and 12000004 plays C1000001 (which has such a high frequency it deatomizes air particles!).

With a billion tentacles, Billy can press as many notes as he needs simultaneously. Although the piano is long, he can instantly move to different parts of the piano when he isn't pressing down any keys. However, at any given point in time, he has limited reach! Help Billy determine what piece to play by finding the reach needed to play each piece!

Problem Statement

Given a piece of music with $\mathbf{N}$ timesteps involving a sequence of actions $\mathbf{A_1}, \mathbf{A_2}, \ldots, \mathbf{A_N}$ and keys $\mathbf{K_1}, \mathbf{K_2}, \ldots, \mathbf{K_N}$, where at timestep i, action $\mathbf{A_i}$ is taken with key $\mathbf{K_i}$, find the reach needed to play the entire piece.

An action can involve either pressing or releasing a key.

The reach needed at a given timestep is equal to the maximum difference between any two currently pressed key numbers. The reach needed to play the entire piece is equal to the maximum reach needed at any single timestep.

All keys begin in the released state, and are pressed/released in the order of their respective timestep.

Input Format

The first line of the input contains a positive integer $\mathbf{T}$ denoting the number of test cases that follow. For each test case:

- The first line contains an integer $\mathbf{N}$ denoting the number of timesteps in the piece
- The next $\mathbf{N}$ lines contain 2 space-separated values each $\mathbf{A_i}$ $\mathbf{K_i}$, denoting actions and keys in the order they are played
  - The single character $\mathbf{A_i}$ denotes the action to perform on key $\mathbf{K_i}$, and is one of the following:
    - `P`, denoting $\mathbf{K_i}$ is pressed at timestep i
    - `R`, denoting $\mathbf{K_i}$ is released at timestep i
  - The integer $\mathbf{K_i}$ denotes the key to take action $\mathbf{A_i}$ with
- The final line is blank to separate individual test cases

Output Format

For each test case, output a single line containing a positive integer denoting the reach needed to play the entire piece.

Problem Constraints

$1 \le \mathbf{T} \le 100$

$2 \le \mathbf{N} \le 10^5$

$\mathbf{N}$ is even.

The sum of $\mathbf{N}$ across all test cases in an input does not exceed 10^5.

$1 \le \mathbf{K_i} \le 12 \times 10^6 + 4 = 12000004$

$\mathbf{A_i} \in \{$`P`, `R`$\}$

The piece as a whole is additionally subject to the following constraints:

- All keys begin in the released state
- Every pressed key will be released by the end of the piece
- The same key may be pressed and released multiple times
- If a key is pressed, it will not be pressed again until it is released and vice versa

Sample Test Cases

Sample Input

```
2
4
P 40
R 40
P 40
R 40

10
P 47
P 32
P 20
R 47
P 44
R 44
P 51
R 51
R 32
R 20
```

Sample Output

```
0
31
```

Sample Explanations

For test case 1, only one note is ever played at any given time. The maximum and minimum key number currently pressed is the same, so their difference is zero.

For test case 2, we We have the following keys pressed and reach needed at each timestep:

Timestep	Keys	Reach
1	47	0 (47 - 47)
2	47, 32	15 (47 - 32)
3	47, 32, 20	27 (47 - 20)
4	32, 20	12 (32 - 20)
5	32, 20, 44	24 (44 - 20)

Timestep	Keys	Reach
6	32, 20	12 (32 - 20)
7	32, 20, 51	31 (51 - 20)
8	32, 20	12 (32 - 20)
9	20	0 (20 - 20)
10	(None)	0 (No keys)

The maximum reach at any timestep is 31, which occurs at timestep 7 when keys 51, 32, and 20 are pressed. The reach needed at this timestep is the largest difference between any two pressed keys, 51 - 20 = 31.