

# Dynamic Summation

Given a tree of  $N$  nodes, where each node is uniquely numbered in between  $[1, N]$ . Each node also has a value which is initially 0. You need to perform following two operations in the tree.

1. Update Operation
2. Report Operation

## Update Operation

U r t a b

Adds  $a^b + (a+1)^b + (b+1)^a$  to all nodes in the subtree rooted at  $t$ , considering that tree is rooted at  $r$  (see explanation for more details).

## Report Operation

R r t m

Output the sum of all nodes in the subtree rooted at  $t$ , considering that tree is rooted at  $r$ . Output the sum modulo  $m$  (see explanation for more details).

## Input Format

First line contains  $N$ , number of nodes in the tree.  
Next  $N-1$  lines contain two space separated integers  $x$  and  $y$  which denote that there is an edge between node  $x$  and node  $y$ .  
Next line contains  $Q$ , number of queries to follow.  
Next  $Q$  lines follow, each line will be either a report operation or an update operation.

## Output Format

For each report query output the answer in a separate line.

## Constraints

- $1 \leq N \leq 100000$
- $1 \leq Q \leq 100000$
- $1 \leq m \leq 101$
- $1 \leq r, t, x, y \leq N$
- $x \neq y$
- $1 \leq a, b \leq 10^{18}$

## Notes

1. There will be at most one edge between a pair of nodes.
2. There will be no loop.
3. Tree will be completely connected.

## Sample Input

4

```
1 2
2 3
3 4
4
U 3 2 2 2
U 2 3 2 2
R 1 2 8
R 4 3 9
```

Sample Output

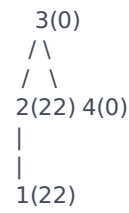
```
2
3
```

Explanation

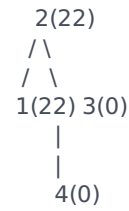
Initially Values in each node : [0,0,0,0]  
The first query is **U 3 2 2 2**. Here, tree is rooted at 3. It looks like



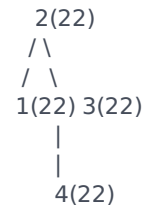
For the sub tree rooted at 2 ( nodes 2 and 1 ), we add  $a^b + (a+1)^b + (b+1)^a = 2^2 + 3^2 + 3^2 = 22$ . After first update operation, nodes 1, 2, 3, and 4 will have values 22, 22, 0 and 0 respectively.



The second query is **U 2 3 2 2**. Here, tree is rooted at 2. It looks like



For the sub tree rooted at 3 (nodes 3 and 4), we add  $a^b + (a+1)^b + (b+1)^a = 2^2 + 3^2 + 3^2 = 22$ . After second update operation, nodes 1, 2, 3, and 4 each have values 22,22,22,22 respectively.



The first report query is **R 1 2 8** asks for the sum modulo 8 of the subtree rooted at 2, when the tree is rooted at 1. The tree looks like

```
1(22)
 \
  \
   2*(22)
    |
    |
   3*(22)
    |
    |
   4*(22)
```

The sum of the values of nodes 2, 3 and 4 are

```
(22 + 22 + 22) % 8 = 2
```

The second report query is **R 4 3 9** asks for the sum modulo 9 of the subtree rooted at 3 when the tree is rooted at 4. The tree looks like

```
4(22)
 \
  \
   3*(22)
    |
    |
   2*(22)
    |
    |
   1*(22)
```

The sum of the values of nodes 3, 2 and 1 are

```
(22 + 22 + 22) % 9 = 3
```

**Time Limits:**

C, C++: 4s | Java and other JVM based languages: 10s | Python, Python3 = 45s | Other interpreted Language: 30s | C#, Haskell: 10s | Rest: 3 times of [default](#).