Mine and Tree

Time limit: 2.5s   **Memory limit:** 256M

In her spare time, Mine enjoys game shows and mathematics. In particular, she really likes geometry and graph theory. Today, she is a participant on the popular game show *GeomeTree*, where contestants show off their mathematical skills by performing operations on a point in the 2D coordinate plane, all while on a tree. Mine is in it to win it!

Each contestant is given an undirected graph with N $(1 \leq N \leq 10^5)$ vertices and $N - 1$ edges such that there is a unique path between every pair of vertices — a tree. On each vertex of the tree, an operation is written on it. The operation may either be "rotate your point by θ $(0 \leq \theta < 360)$ degrees counterclockwise around the origin", "translate your point by a vector (dx, dy) $(-10^5 \leq dx, dy \leq 10^5)$", or "move the point towards (but not past) another point (p, q) $(-10^5 \leq p, q \leq 10^5)$ such that the new distance between these points is $P\%$ $(0 \leq P < 100)$ of the old distance". Contestants perform M $(1 \leq M \leq 10^5)$ rounds of queries on this tree. Each round, there are two possible queries the contestant needs to perform.

The first kind of query is when the contestant is given two vertices of the tree (u, v) $(1 \leq u, v \leq N)$ and a point (x, y) $(-10^5 \leq x, y \leq 10^5)$. The contestant has to move the point from vertex u of the tree to vertex v of the tree, performing every operation written on the vertices to the point they were given along the way (including the operations on vertices u and v). Operations are cumulative, and you have to perform the operations sequentially.

The second kind of query is when the operation on a tree changes. The new operation will still be either a rotation, translation, or moving operation in accordance with the constraints above.

The first place prize in the game show is unlimited riches along with a platinum pass to a love hotel for two. We know which prize Mine is *really* interested in. However, all the other contestants are writing programs to play this ridiculously difficult game show for them. Since Mine is in a huge pinch right now, she has hired you to help her win! You have no choice but to write a program that helps her, otherwise you will be blasted into pieces by Pumpkin!

Input Specification

All the numbers in the input are integers.

The first line of input will have N and M, separated by a single space.

The next N lines will each have the operation of each vertex of the tree, in order from $1 \ldots N$.

An operation is one of the following:

- `R θ` is the rotate by θ degrees operation.
- `T dx dy` is the translate by (dx, dy) operation.
- `M p q P` is the move towards (p, q) such that the new distance is $P\%$ of the original distance operation.

The next $N - 1$ lines describe the graph. Each line is a pair of vertices which are connected by an edge in the graph. There will be no self-loops or duplicate edges, and it is guaranteed that the resulting graph is a tree.

The next M lines will describe the queries.

If the line begins with:

- Q it will be followed by `u v x y`, indicating the first kind of query.
- U it will be followed by `u` and the new operation on vertex u, in the same format as above, indicating the second kind of query.

Output Specification

For each Q query, output two space-separated real numbers, the final coordinates of the input point. Both of these numbers should be within an absolute or relative error of at most 10^{-6}.

Tips

Some of the test cases will have N and/or M very small. Some of the test cases will only have one or two types of operations. This information may be helpful if you're aiming for partial marks. For example, a well-implemented $\mathcal{O}(NM)$ solution in a fast language might get up to 55% of the marks for this problem.

Sample Input 1

```
1 1
M 4 4 75
Q 1 1 0 0
```

Sample Output 1

```
1.000000 1.000000
```

Sample Input 2

```
2 3
R 45
R 135
1 2
Q 1 1 100 100
Q 1 2 100 100
Q 2 2 100 100
```

Sample Output 2

```
0.000000 141.421356
-100.000000 -100.000000
-141.421356 0.000000
```

Sample Input 3

```
5 8
R 90
T 1 1
R 45
T 3 2
R 0
1 2
2 3
3 4
4 5
Q 1 1 0 0
Q 3 3 -4 9
U 5 R 180
Q 1 5 1 1
Q 5 1 1 1
U 2 T 3 -1
Q 2 3 3 5
Q 3 1 13 37
```

Sample Output 3

```
0.000000 0.000000
-9.192388 3.535534
-1.585786 -3.414214
-3.121320 1.707107
1.414214 7.071068
-34.355339 -13.970563
```

Sample Input 4

```
20 10
M 17799 86094 84
T 30788 -16797
M 52445 -47508 4
T 26532 51287
T -50591 96517
M 30308 -85463 63
T -12715 53304
R 98
R 175
M -87887 80937 50
T 97336 -1201
R 341
R 138
M 5953 -7108 94
M 54046 65569 12
M 73656 25913 73
M 77721 -53360 30
R 212
T 68308 -46135
R 168
20 18
5 18
1 18
11 5
8 11
12 18
19 1
16 1
10 16
13 19
17 12
3 13
7 16
14 17
2 5
9 1
15 3
4 5
6 20
Q 1 9 -94625 41969
Q 5 4 -36490 77405
Q 4 14 -22835 -22452
Q 3 12 69121 18026
Q 12 3 96668 -18244
U 12 R 167
```

```
Q 3 4 -36148 25858
U 14 M -50430 -4710 38
Q 1 19 -14698 -71595
Q 9 3 77136 -81565
```

Sample Output 4

```
72072.373558 -55521.798455
-60549.000000 225209.000000
72334.627176 -67005.847616
-43561.121525 -43816.554934
51641.774285 -44852.076359
-54419.181070 93065.877003
58809.520000 -92499.760000
48861.404178 -46505.826597
```