H. Santa's Gift

time limit per test: 4 seconds
memory limit per test: 512 megabytes
input: standard input
output: standard output

Santa has an infinite number of candies for each of m flavours. You are given a rooted tree with n vertices. The root of the tree is the vertex 1. Each vertex contains exactly one candy. The i-th vertex has a candy of flavour f_i.

Sometimes Santa fears that candies of flavour k have melted. He chooses any vertex x randomly and sends the subtree of x to the Bakers for a replacement. In a replacement, all the candies with flavour k are replaced with a new candy of the same flavour. The candies which are not of flavour k are left unchanged. After the replacement, the tree is restored.

The *actual* cost of replacing one candy of flavour k is c_k (given for each k). The Baker keeps the price fixed in order to make calculation simple. Every time when a subtree comes for a replacement, the Baker charges C, no matter which subtree it is and which flavour it is.

Suppose that for a given flavour k the probability that Santa chooses a vertex for replacement is same for all the vertices. You need to find out the expected value of *error* in calculating the cost of replacement of flavour k. The error in calculating the cost is defined as follows.

Error\ E(k) =\ (Actual Cost\ –\ Price\ charged\ by\ the\ Bakers) ^ 2.

Note that the actual cost is the cost of replacement of one candy of the flavour k multiplied by the number of candies in the subtree.

Also, sometimes Santa may wish to replace a candy at vertex x with a candy of some flavour from his pocket.

You need to handle two types of operations:

- Change the flavour of the candy at vertex x to w.
- Calculate the expected value of error in calculating the cost of replacement for a given flavour k.

Input

The first line of the input contains four integers n (2 \leqslant n \leqslant 5 \cdot 10^4), m, q, C (1 \leqslant m, q \leqslant 5 \cdot 10^4, 0 \leqslant C \leqslant 10^6) — the number of nodes, total number of different flavours of candies, the number of queries and the price charged by the Bakers for replacement, respectively.

The second line contains n integers f_1, f_2, \dots, f_n (1 \leqslant f_i \leqslant m), where f_i is the initial flavour of the candy in the i-th node.

The third line contains n - 1 integers p_2, p_3, \dots, p_n (1 \leqslant p_i \leqslant n), where p_i is the parent of the i-th node.

The next line contains m integers c_1, c_2, \dots c_m (1 \leqslant c_i \leqslant 10^2), where c_i is the cost of replacing one candy of flavour i.

The next q lines describe the queries. Each line starts with an integer t (1 \leqslant t \leqslant 2) — the type of the query.

If t = 1, then the line describes a query of the first type. Two integers x and w follow (1 \leqslant x \leqslant n, 1 \leqslant w \leqslant m), it means that Santa replaces the candy at vertex x with flavour w.

Otherwise, if t = 2, the line describes a query of the second type and an integer k (1 \leqslant k \leqslant m) follows, it means that you should print the expected value of the error in calculating the cost of replacement for a given flavour k.

The vertices are indexed from 1 to n. Vertex 1 is the root.

Output

Output the answer to each query of the second type in a separate line.

Your answer is considered correct if its absolute or relative error does not exceed 10^{-6}.

Formally, let your answer be a, and the jury's answer be b. The checker program considers your answer correct if and only if $\frac{|a-b|}{max(1,b)}\leqslant 10^{-6}$.

Example

input

```
3 5 5 7
3 1 4
1 1
73 1 48 85 89
2 1
2 3
1 2 3
2 1
2 3
```

output

```
2920.333333333333
593.000000000000
49.000000000000
3217.000000000000
```

Note

For 1-st query, the error in calculating the cost of replacement for flavour 1 if vertex 1, 2 or 3 is chosen are 66^2, 66^2 and $(-7)^2$ respectively. Since the probability of choosing any vertex is same, therefore the expected value of error is $\frac{66^2+66^2+(-7)^2}{3}$.

Similarly, for 2-nd query the expected value of error is $\frac{41^2+(-7)^2+(-7)^2}{3}$.

After 3-rd query, the flavour at vertex 2 changes from 1 to 3.

For 4-th query, the expected value of error is $\frac{(-7)^2+(-7)^2+(-7)^2}{3}$.

Similarly, for 5-th query, the expected value of error is $\frac{89^2+41^2+(-7)^2}{3}$.