Problem A. Subordinates

Time Limit 1000 ms
Mem Limit 524288 kB

Given the structure of a company, your task is to calculate for each employee the number of their subordinates.

Input

The first input line has an integer n: the number of employees. The employees are numbered $1, 2, \ldots, n$, and employee 1 is the general director of the company.

After this, there are $n-1$ integers: for each employee $2, 3, \ldots, n$ their direct boss in the company.

Output

Print n integers: for each employee $1, 2, \ldots, n$ the number of their subordinates.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$

Example

Input	Output
5 1 1 2 3	4 1 1 0 0

Problem B. Tree Matching

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes.

A *matching* is a set of edges where each node is an endpoint of at most one edge. What is the maximum number of edges in a matching?

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print one integer: the maximum number of pairs.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 1 2 1 3 3 4 3 5	2

Explanation: One possible matching is $(1, 2)$ and $(3, 4)$.

Problem C. Tree Diameter

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes.

The *diameter* of a tree is the maximum distance between two nodes. Your task is to determine the diameter of the tree.

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print one integer: the diameter of the tree.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 1 2 1 3 3 4 3 5	3

Explanation: The diameter corresponds to the path $2 \to 1 \to 3 \to 5$.

Problem D. Tree Distances I

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes.

Your task is to determine for each node the maximum distance to another node.

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print n integers: for each node $1, 2, \ldots, n$, the maximum distance to another node.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 1 2 1 3 3 4 3 5	2 3 2 3 3

Problem E. Tree Distances II

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes.

Your task is to determine for each node the sum of the distances from the node to all other nodes.

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print n integers: for each node $1, 2, \ldots, n$, the sum of the distances.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 1 2 1 3 3 4 3 5	6 9 5 8 8

Problem F. Company Queries I

Time Limit 1000 ms
Mem Limit 524288 kB

A company has n employees, who form a tree hierarchy where each employee has a boss, except for the general director.

Your task is to process q queries of the form: who is employee x's boss k levels higher up in the hierarchy?

Input

The first input line has two integers n and q: the number of employees and queries. The employees are numbered $1, 2, \ldots, n$, and employee 1 is the general director.

The next line has $n-1$ integers $e_2, e_3, \ldots, e_n$: for each employee $2, 3, \ldots, n$ their boss.

Finally, there are q lines describing the queries. Each line has two integers x and k: who is employee x's boss k levels higher up?

Output

Print the answer for each query. If such a boss does not exist, print -1.

Constraints

- $1 \le n, q \le 2 \cdot 10^5$
- $1 \le e_i \le i - 1$
- $1 \le x \le n$
- $1 \le k \le n$

Example

Input	Output
5 3 1 1 3 3 4 1 4 2 4 3	3 1 -1

Problem G. Company Queries II

Time Limit 1000 ms
Mem Limit 524288 kB

A company has n employees, who form a tree hierarchy where each employee has a boss, except for the general director.

Your task is to process q queries of the form: who is the lowest common boss of employees a and b in the hierarchy?

Input

The first input line has two integers n and q: the number of employees and queries. The employees are numbered $1, 2, \ldots, n$, and employee 1 is the general director.

The next line has $n-1$ integers $e_2, e_3, \ldots, e_n$: for each employee $2, 3, \ldots, n$ their boss.

Finally, there are q lines describing the queries. Each line has two integers a and b: who is the lowest common boss of employees a and b?

Output

Print the answer for each query.

Constraints

- $1 \le n, q \le 2 \cdot 10^5$
- $1 \le e_i \le i-1$
- $1 \le a, b \le n$

Example

Input	Output
5 3 1 1 3 3 4 5 2 5 1 4	3 1 1

Problem H. Distance Queries

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes.

Your task is to process q queries of the form: what is the distance between nodes a and b?

Input

The first input line contains two integers n and q: the number of nodes and queries. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Finally, there are q lines describing the queries. Each line contains two integer a and b: what is the distance between nodes a and b?

Output

Print q integers: the answer to each query.

Constraints

- $1 \leq n, q \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 3 1 2 1 3 3 4 3 5 1 3 2 5 1 4	1 3 2

Problem I. Counting Paths

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes, and m paths in the tree.

Your task is to calculate for each node the number of paths containing that node.

Input

The first input line contains integers n and m: the number of nodes and paths. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Finally, there are m lines describing the paths. Each line contains two integers a and b: there is a path between nodes a and b.

Output

Print n integers: for each node $1, 2, \ldots, n$, the number of paths containing that node.

Constraints

- $1 \leq n, m \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 3 1 2 1 3 3 4 3 5 1 3 2 5 1 4	3 1 3 1 1

Problem J. Subtree Queries

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a rooted tree consisting of n nodes. The nodes are numbered $1, 2, \ldots, n$, and node 1 is the root. Each node has a value.

Your task is to process following types of queries:

1. change the value of node s to x
2. calculate the sum of values in the subtree of node s

Input

The first input line contains two integers n and q: the number of nodes and queries. The nodes are numbered $1, 2, \ldots, n$.

The next line has n integers $v_1, v_2, \ldots, v_n$: the value of each node.

Then there are $n-1$ lines describing the edges. Each line contans two integers a and b: there is an edge between nodes a and b.

Finally, there are q lines describing the queries. Each query is either of the form "$1\ s\ x$" or "$2\ s$".

Output

Print the answer to each query of type 2.

Constraints

- $1 \le n, q \le 2 \cdot 10^5$
- $1 \le a, b, s \le n$
- $1 \le v_i, x \le 10^9$

Example

Input	Output
5 3 4 2 5 2 1 1 2 1 3 3 4 3 5 2 3 1 5 3 2 3	8 10

Problem K. Path Queries

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a rooted tree consisting of n nodes. The nodes are numbered $1, 2, \ldots, n$, and node 1 is the root. Each node has a value.

Your task is to process following types of queries:

1. change the value of node s to x
2. calculate the sum of values on the path from the root to node s

Input

The first input line contains two integers n and q: the number of nodes and queries. The nodes are numbered $1, 2, \ldots, n$.

The next line has n integers $v_1, v_2, \ldots, v_n$: the value of each node.

Then there are $n-1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Finally, there are q lines describing the queries. Each query is either of the form "$1\ s\ x$" or "$2\ s$".

Output

Print the answer to each query of type 2.

Constraints

- $1 \le n, q \le 2 \cdot 10^5$
- $1 \le a, b, s \le n$
- $1 \le v_i, x \le 10^9$

Example

Input	Output
5 3 4 2 5 2 1 1 2 1 3 3 4 3 5 2 4 1 3 2 2 4	11 8

Problem L. Path Queries II

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a tree consisting of n nodes. The nodes are numbered $1, 2, \ldots, n$. Each node has a value.

Your task is to process following types of queries:

1. change the value of node s to x
2. find the maximum value on the path between nodes a and b.

Input

The first input line contains two integers n and q: the number of nodes and queries. The nodes are numbered $1, 2, \ldots, n$.

The next line has n integers $v_1, v_2, \ldots, v_n$: the value of each node.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Finally, there are q lines describing the queries. Each query is either of the form "$1\ s\ x$" or "$2\ a\ b$".

Output

Print the answer to each query of type 2.

Constraints

- $1 \leq n, q \leq 2 \cdot 10^5$
- $1 \leq a, b, s \leq n$
- $1 \leq v_i, x \leq 10^9$

Example

Input	Output
5 3 2 4 1 3 3 1 2 1 3 2 4 2 5 2 3 5 1 2 2 2 3 5	4 3

Problem M. Distinct Colors

Time Limit 1000 ms
Mem Limit 524288 kB

You are given a rooted tree consisting of n nodes. The nodes are numbered $1, 2, \ldots, n$, and node 1 is the root. Each node has a color.

Your task is to determine for each node the number of distinct colors in the subtree of the node.

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

The next line consists of n integers $c_1, c_2, \ldots, c_n$: the color of each node.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print n integers: for each node $1, 2, \ldots, n$, the number of distinct colors.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$
- $1 \leq c_i \leq 10^9$

Example

Input	Output
5 2 3 2 2 1 1 2 1 3 3 4 3 5	3 1 2 1 1

Problem N. Finding a Centroid

Time Limit 1000 ms
Mem Limit 524288 kB

Given a tree of n nodes, your task is to find a *centroid*, i.e., a node such that when it is appointed the root of the tree, each subtree has at most $\lfloor n/2 \rfloor$ nodes.

Input

The first input line contains an integer n: the number of nodes. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n-1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print one integer: a centroid node. If there are several possibilities, you can choose any of them.

Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 1 2 2 3 3 4 3 5	3

Problem O. Fixed-Length Paths I

Time Limit 1000 ms
Mem Limit 524288 kB

Given a tree of n nodes, your task is to count the number of distinct paths that consist of exactly k edges.

Input

The first input line contains two integers n and k: the number of nodes and the path length. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print one integer: the number of paths.

Constraints

- $1 \leq k \leq n \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Example

Input	Output
5 2 1 2 2 3 3 4 3 5	4

Problem P. Fixed-Length Paths II

Time Limit 1000 ms
Mem Limit 524288 kB

Given a tree of n nodes, your task is to count the number of distinct paths that have at least k_1 and at most k_2 edges.

Input

The first input line contains three integers n, k_1 and k_2: the number of nodes and the path lengths. The nodes are numbered $1, 2, \ldots, n$.

Then there are $n - 1$ lines describing the edges. Each line contains two integers a and b: there is an edge between nodes a and b.

Output

Print one integer: the number of paths.

Constraints

- $1 \le k_1 \le k_2 \le n \le 2 \cdot 10^5$
- $1 \le a, b \le n$

Example

Input	Output
5 2 3 1 2 2 3 3 4 3 5	6