Data Structure

Assignment 3

Due: 23:59:59, April 8, 2022,

Submission guideline is same as in previous assignments, again, submitting code to online judge system and submitting a pdf file with your solution and illustration is both required.

Online submission website: https://vjudge.net/contest/486490

Question 1 (Wonderful tree) Let us think of a rooted tree. A rooted tree is a tree in which one vertex has been designated the root. In a rooted tree, the vertex u will be regarded as a parent of a vertex v if and only if there is a path (u->v). Every vertex has a unique parent except the root which has no parent. A child of a vertex v is a vertex of which v is the parent. A leaf is a vertex with no children.

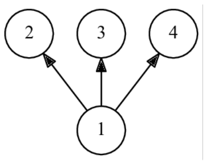
Among all the trees, you are invited to determine whether a given rooted tree is a wonderful tree or not. It should be recognized as a wonderful tree if its every non-leaf vertex has more than 2 (i.e., >=3) leaf children.

Examples:

Input with n lines. The first line is an integer n, referring to the number of vertices in the tree. The ith *(2≤i≤n)* line in the remaining n-1 lines contain an integer parenti *(1 ≤ i ≤ n-1),* which is the index of the parent of the *(i+1)th* vertex *(1≤ $parent_i$ ≤ i).* We assume that the 1st vertex is the root, and the root has at least 2 children *(3 ≤ n ≤ 1 000).*

Output "Yes" if the given tree is a wonderful tree, otherwise print "No".

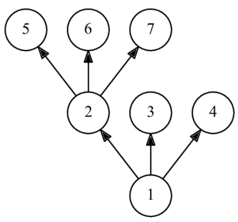
Input:
4
1
1
1



Ouput:
Yes

Explanation: The second line (2nd vertex) has the parent of 1st vertex.The non-leaf vertex (1st) has three leaf children. The figure shown in the right helps you visualize the given root tree.

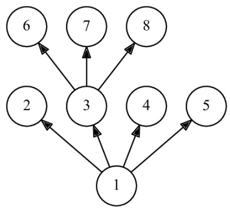
Input:
7
1
1
1
2
2
2



Output:
No

Explanation: The non-leaf vertex (1st) has two leaf children, which is contradictory to the wonderful tree definition.

Input:
8
1
1
1
1
3
3
3



Output:
Yes
Explanation: The non-leaf vertex (1st and 3rd) has three leaf children.

Question 2 (Find word) There is a collection of n cards on the table, indexed from the left to the right, i.e., the leftmost card is the *1st* card and the rightmost card is the *nst* card. Each card has a word printed on: the *ith* card has the word w_i.

There are q students come to query about the word, each student only has one query. To process the *jth* query denoted as q_j, you need to:
(1) Find the leftmost card with the queried word q_j, i.e., the card with minimum index.
(2) Print the index of the card you found.
(3) Move the card to the front of the cards.

Examples:

Input with 3 lines. The first line contains two integers *n, q*, *(2 ≤ n ≤ 3*10^5, 1≤q≤3*10^5*, referring to the number of cards and the number of queries, respectively.
The second line contains *n* integers $w_1, w_2, \ldots, w_n$ $(1 \le w_i \le 50)$, referring to the word of cards (different number denotes different words).
The third line shows the query list in *q* integers, $q_1, q_2, \ldots, q_q$ $(1 \le q_j \le 50)$, referring to the query word. We assume that all queried words are included in the existing cards.
Output the answers for each query.

Input:
7 5
2 1 1 4 3 3 1
3 2 1 1 4
Output:
5 2 3 1 5
Explanation:
In the first query, the card is in [2,1,1,4,3,3,1] as initially, the first card with word query q_1=3 is indexed by 5.
In the second query, the card is in [3,2,1,1,4,3,1], the first card with word query q_2=2 is indexed by 2.
In the third query, the card is in [2,3,1,1,4,3,1], the first card with word query q_3=1 is indexed by 3.
In the fourth query, the card is in [1,2,3,1,4,3,1], the first card with word query q_4=1 is indexed by 1.
In the fifth query, the card is in [1,2,3,1,4,3,1], the first card with word query q_5=4 is indexed by 5.
Thus, the output is the list of print indices: 5 2 3 1 5

Question 3 (Group discussion) A lecture hall with n people indexed from 1 to n. Each people either has no mentor or exactly one mentor, who is another person with a different index. A person X is considered as the *supervisor* of another person Y if at least one of the following is true:
(1) Person X is the mentor of person Y.
(2) Person Y has a mentor person Z such that person X is the supervisor of person Z.

People in hall will not form a cycle, i.e., there will not exist a person who is the supervisor of his own mentor. You need to divide n people in the lecture hall into several groups for discussion as required: (1) each person belongs to exactly one group; (2) Within any group, there must not be two people X and Y such that X is the supervisor of Y. Please tell us the minimum number of groups must be formed.

Examples:

Input with $n+1$ lines. The first line contains an integer n $(1 \le n \le 2000)$, referring to the number of people. Each of the next n lines contains an integer m $(1 \le m_i \le n$ or $m_i = -1)$. *Every* m_i represents the mentor for the i^{th} person. If m_i *equals to -1, it means that the* i^{th} person does not have a mentor. We assume that no person will be the mentor of himself $(m_i \neq i)$.
Output the minimal number of the groups that must be formed.

Input:
5
-1
1
2
1
-1
Output:
3
Explanation: There are five persons in total. The (1), (2,4), (3,5) persons can form three groups as required.

Chinese University of Hong Kong places very high importance on honesty in academic work submitted by students, and adopts a policy of zero tolerance on academic dishonesty. Any related offence will lead to disciplinary action including termination of studies at the University. Collaboration or discussion of the assignment is allowed, but you need to write down the code and illustration in your own words.