Homework #3

RELEASEDATE: 2025/11/24

DUEDATE:2025/12/15, 23:59 on iLearning 3.0

1. *You need to submit your code to the designated place on iLearning 3.0.*
2. *As for coding, C and C++ are allowed.*
3. *Discussions on course materials and homework solutions are encouraged. But you should write the final solutions alone and understand them fully. Books, notes, and Internet resources can be consulted, but not copied from.*
4. *For each question, there will be a testcase (e.g. the testcase for question 1 is testcase1.txt) Please note that the testcase you received may not necessarily to be the same as the testcase used for grading. Please consider edge cases.*
5. *Let your program read the corresponding testcase and print the result to a corresponding text file (e.g. the output for question 2 should be output2.txt).*
6. *For each question, we have provided a corresponding answer (e.g assume you're solving problem 3, the corresponding answer is ans3.txt), and your output should be same as answer.*
7. *For each question, your program file should be named DS{problem number}_{student ID}.c. (e.g. assume your student ID is 7114056138 and you're solving question 3, your program file should be DS3_7114056138.c)*
8. *Each question is scored independently, but partial credit is not awarded; full credit is given only for complete correctness.*
9. *The time limits for questions 1 to 4 are 8, 8, 20, and 8 seconds, respectively (including reading and writing file).*

Teaching Assistant:

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- Lab: WCCCLab (S901)

1 Construct binary tree from inorder and postorder traversal (10 pt.)

Given two integer arrays inorder and postorder where inorder is the inorder traversal of a binary tree and postorder is the postorder traversal of the same tree, print the preorder traversal of the binary tree.

Input

The first line of input gives the number of test cases, T ($1 \le T \le 300$). Then T test cases follow each described in the following way:

1. The first line contains a single integer n ($1 \le n \le 5 \times 10^5$) indicates the length of array inorder (inorder and postorder have the same length).
2. The second line contains n integers $in_1, in_2, ..., in_n$ ($1 \le in_i \le 6 \times 10^5$) separated by spaces, which indicate the inorder traversal of the binary tree.
3. The third line contains n integers $post_1, post_2, ..., post_n$ ($1 \le post_i \le 6 \times 10^5$) separated by spaces, which indicate the postorder traversal of the binary tree.

note: inorder and postorder consist of unique values.

Output

For each input produce one line of output. This line contains the preorder of the binary tree (separated by spaces).

Sample Input

2

5

9 3 15 20 7

9 15 7 20 3

7

1 2 3 4 5 6 7

1 3 2 5 7 6 4

Sample Output

3 9 20 15 7

4 2 1 3 6 5 7

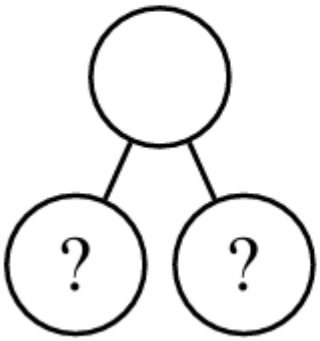
2 Set base stations (30 pt.)

In city T, there is a binary-tree–structured network. A telecommunications company plans to install new base stations in the city. When a base station is placed on a node of the tree, its signal can only cover the adjacent nodes—that is, the node's parent and its children.

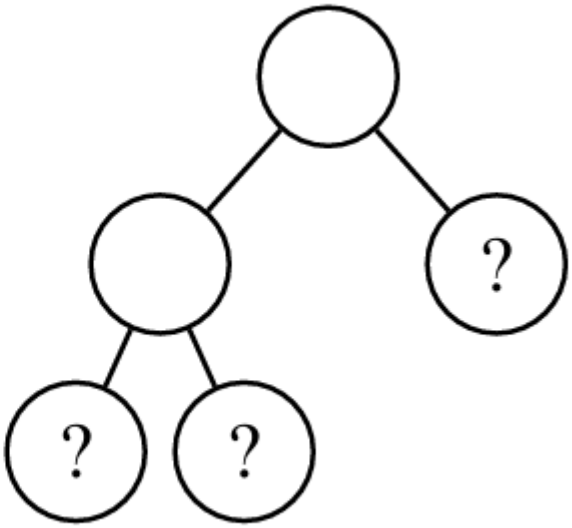
Now, please compute the minimum number of base stations the company needs to install in order to ensure that every node in the city receives signal coverage.

Input

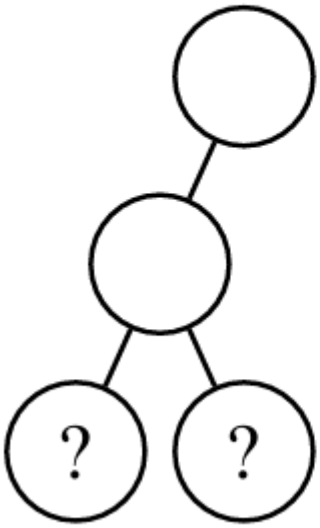
The first line of input gives the number of test cases, T ($1 \leq T \leq 300$). Then T test cases follow each described in the following way. Each line represents a test case, composed of 0 and null, separated by commas. The number of nodes in the tree is in the range [1, 5×10^5]. Nodes are filled from the upper level to the lower level, from left to right. The following is an example of input [0,0,N,0,0], N represents NULL:



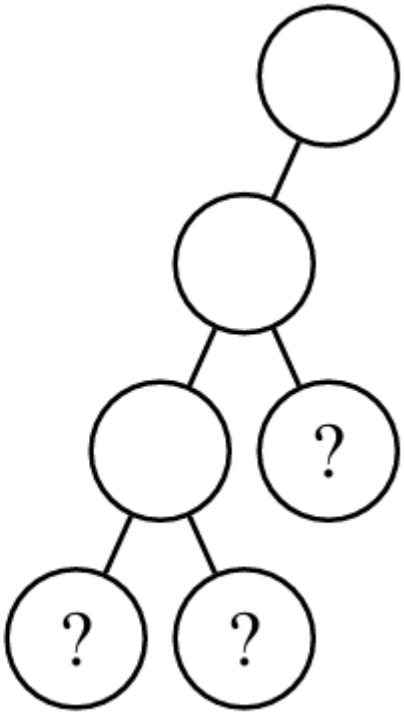
[0,0,N,0,0]



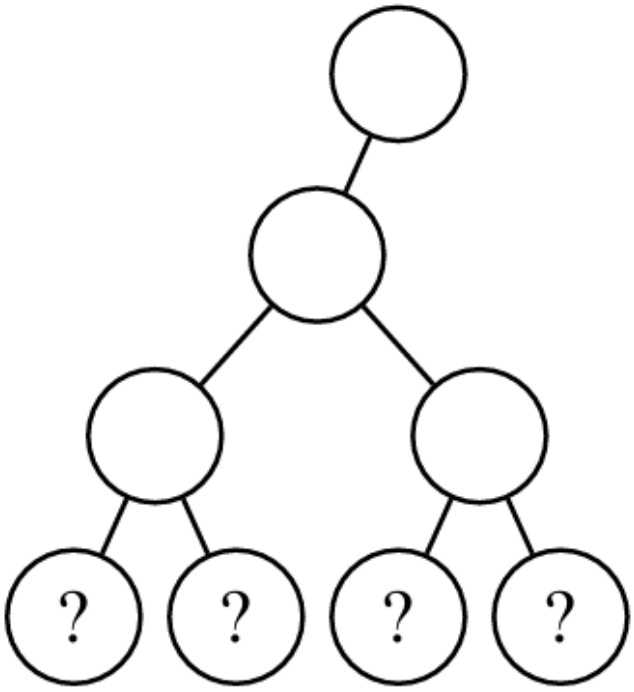
[0,0,N,0,0]



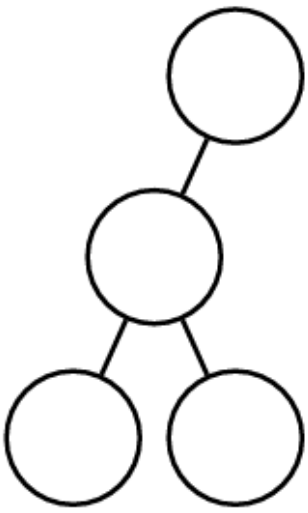
[0,0,N,0,0]



[0,0,N,0,0]



[0,0,N,0,0]



Final binary tree

Output

For each input, produce one line of output. This line contains an integer that indicates the minimum number of base stations the company needs to install.

Sample Input

2

0,0,N,0,0

0,0,N,0,N,0,N,N,0

Sample Output

1

2

3 The Champagne Tower (30 pt.)

At a banquet, a champagne tower is set up, represented as a binary tree. Guests will perform actions according to the host's instructions:

1. Operation 1 (format: 1 a): Pour champagne starting from node a. This will cause a and all of its descendants to become filled with champagne.
2. Operation 2 (format: 2 b): Sip champagne starting from node b. This will cause b and all of its ancestors to have their champagne drained.
3. Operation 3 (format: 3 c): Output whether node c is currently filled with champagne. Output 1 if it is filled, otherwise output 0.

Input

The first line of input gives the number of test cases, T ($1 \leq T \leq 300$). Then T test cases follow each described in the following way:

1. The first line contains a single integer n ($1 \leq n \leq 5 \times 10^5$) indicates the length of array inorder (inorder and preorder have the same length).

2. The second line contains n integers $in_1, in_2, ..., in_n$ ($1 \leq in_i \leq n$) separated by spaces, which indicate the the inorder traversal of the binary tree.

3. The third line contains n integers $pre_1, pre_2, ..., pre_n$ ($1 \leq pre_i \leq n$) separated by spaces, which indicate the the preorder traversal of the binary tree.

4. The fourth line contains includes a number q ($1 \leq q \leq 5 \times 10^5$), which represents the quantity of operations to be executed.

5. In each of the subsequent q lines, you will find two numbers, c_i ($1 \leq c_i \leq 3$) and v_i ($1 \leq v_i \leq n$), separated by spaces. Here, c_i represents the type of operation, and v_i signifies the node on which the operation is carried out.

Type of operation:

1. Fill node a with champagne. Then a and all its descendants are filled with champagne.

2. Sip node b. Then node b and all its ancestors are drained.

3. Determine whether node c is filled with champagne at the moment.

note: inorder and preorder consist of unique values.

Output

For every type 3 operation, output 1 on a new line if the node n is currently filled with champagne, and 0 if the node is not filled with champagne at that moment. Ensure that the outputs for the type 3 operations are presented in the same sequence as they appear in the input.

Sample Input

1

5

3 2 4 1 5

1 2 3 4 5

1 2

1 1

2 3

3 1

3 2

3 3

3 4

1 2

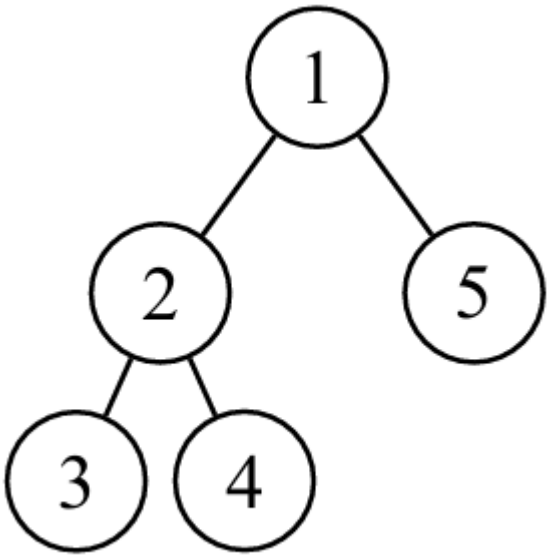
2 4

3 1

3 3

3 4

3 5



Input

Sample Output

0

0

0

1

0

1

0

1

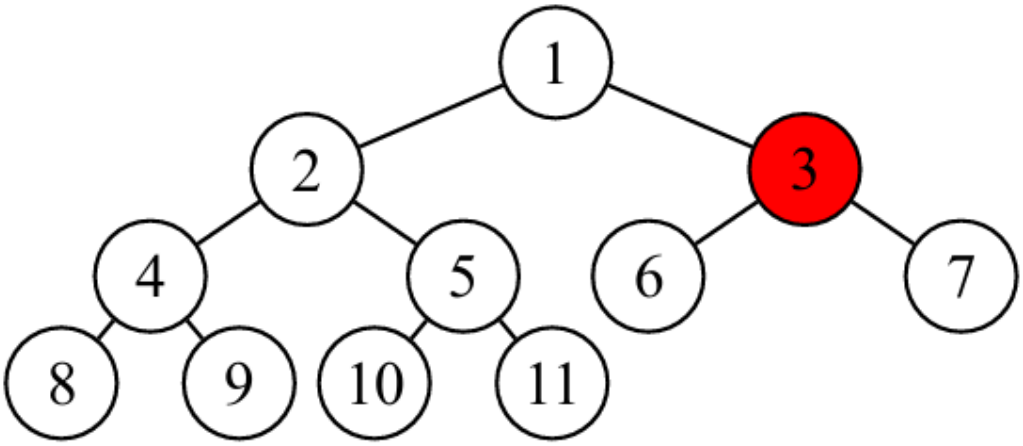
4 Node Battle: Can You Triumph? (30pt.)

You and your friend embark on a game set within the framework of a binary tree, governed by a set of rules that stipulate your friend's first move, enabling them to place a stone on any node to assert ownership. Following this, you're your turn, granting you the liberty to choose any unclaimed node for the placement of your own stone. Assume your friend chooses node x and you choose node y ($x \neq y$).

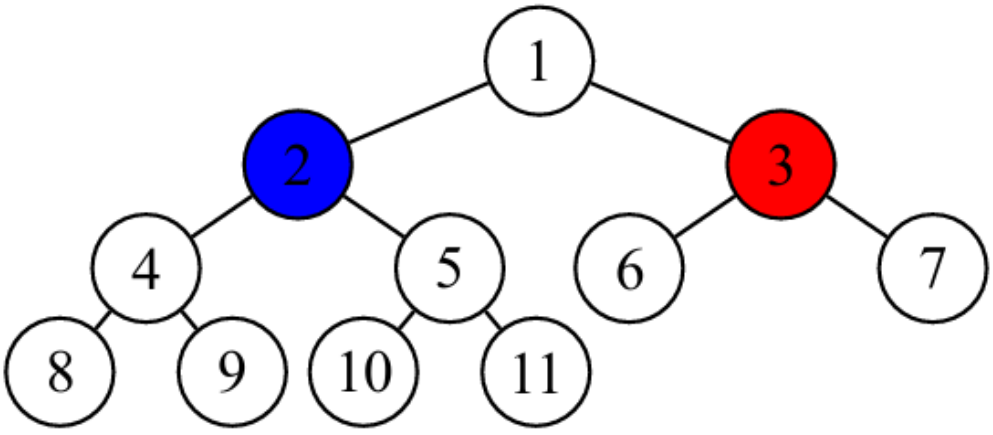
Subsequently, continue the game within the binary tree by alternating turns to position stones, following the rule that you are only allowed to place a stone on a node that is either a child or parent of one you've previously marked as yours, as long as the selected location remains unclaimed.

When a player is unable to continue placing stones within the binary tree, that player ends the game. If both players end the game, the player who has placed the most stones within the binary tree wins. You are the second player, and you need to determine whether you can choose y in such a way to guarantee a win this game set within the binary tree.

Example 1:

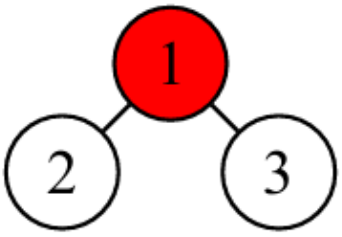


Input: Your friend chooses 3 (the red one)



You can first choose 2 (the blue one), guaranteeing your win in the game

Example 2:



Input: Your friend chooses 1 (the red one), and you can't guarantee a win in the game

Input

The first line of input gives the number of test cases, T ($1 \le T \le 300$). Then T test cases follow each described in the following way:

1. The first line contains a single integer x ($1 \le x \le 5\times10^5$), indicating the first node your friend selected.
2. The second line contains a single integer n ($1 \le n \le 5\times10^5$ and n is odd) indicates the length of array inorder (inorder and level order have the same length).
3. The third line contains n integers $in_1, in_2,..., in_n$ ($1 \le in_i \le 5\times10^5$) separated by spaces, which indicate the the inorder traversal of the binary tree.
4. The fourth line contains n integers $level_1, level_2,..., level_n$ ($1 \le level_i \le 5 \times 10^5$) separated by spaces, which indicate the level order traversal of the binary tree.

note: inorder and level order consist of unique values.

Output

For each input, produce one line of output. If you can guarantee that you can win, print 1; otherwise, print 0

Sample Input

2

3

11

8 4 9 2 10 5 11 1 6 3 7

1 2 3 4 5 6 7 8 9 10 11

1

3

2 1 3

1 2 3

Sample Output

1

0

Submission File:

Please submit the homework to iLearning 3.0 before the deadline. You need to upload your coding part as a single ZIP compressed file to iLearning 3.0 before the deadline. The zip file should be named DS_3_{student ID}.zip (e.g assume your student ID is 7114056138, your zip file should be DS_3_7114056138.zip). The zip file should contain no directories and only the following items:

- all the source code
- an optional README, anything you want the TAs to read before grading your code