Experiment 6

Name: Sanju Arora **UID: 22BET10059**
Branch: BE-IT **Section/Group: 22BET_702-A**
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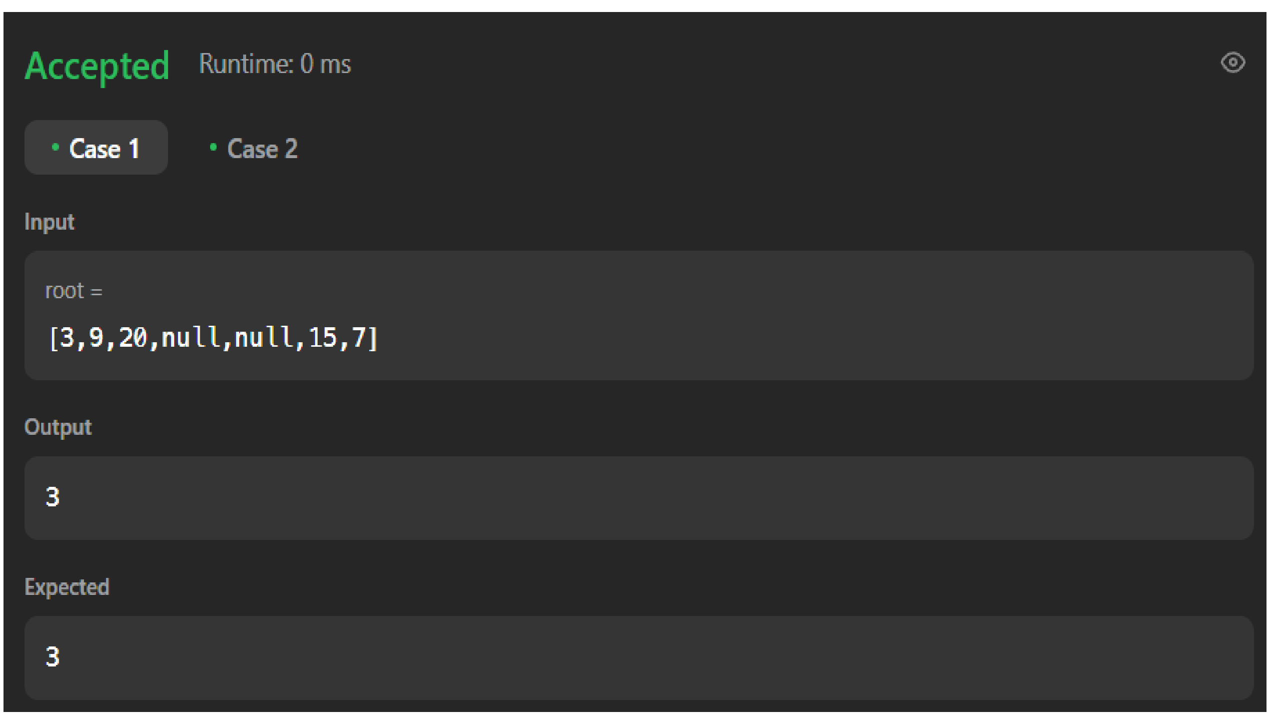
Subject Name: Advanced Programming Lab-2 **Subject Code: 22ITP-351**

Problem 1. Maximum Depth of Binary Tree- Given the root of a binary tree, return its maximum depth. A binary tree's maximum depth is the number of nodes along the longest path from the root node down to the farthest leaf node.

Code:

```
class Solution {
public:
        int maxDepth(TreeNode* root) {
            if(!root) return 0;
            int maxLeft = maxDepth(root->left);
            int maxRight = maxDepth(root->right);
            return max(maxLeft, maxRight)+1;
    }
};
```

Output:

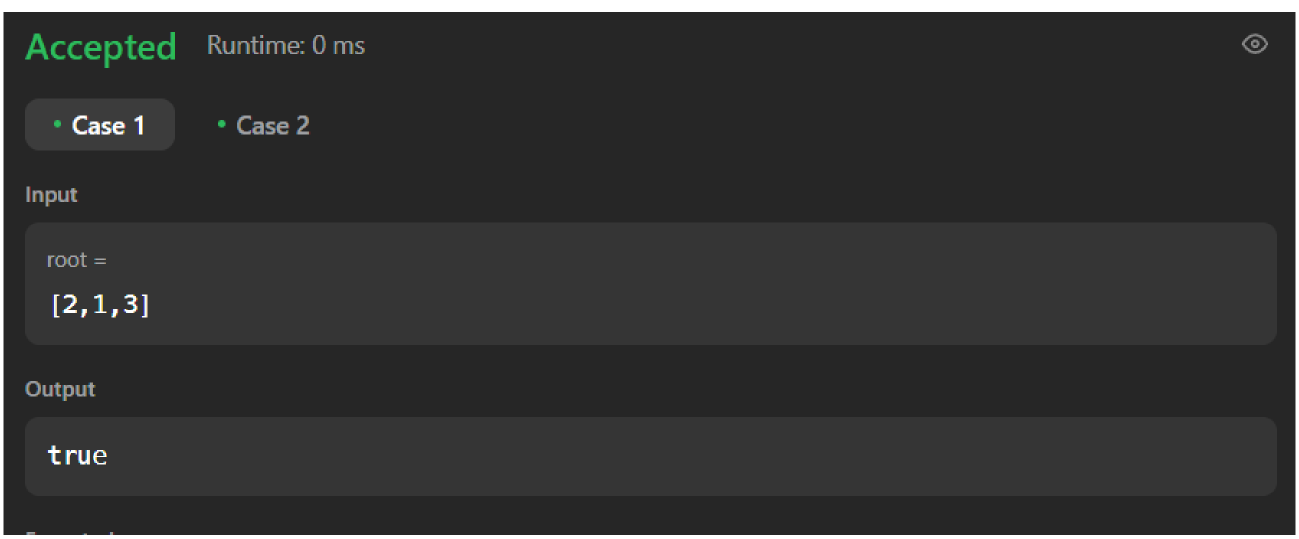


Problem 2. Validate Binary Search Tree- Given the root of a binary tree, determine if it is a valid binary search tree (BST).

Code:

```
class Solution {
public:
    void findInorder(TreeNode* root, vector<int> &inorder) {
        if (!root) return ;

        findInorder(root->left, inorder);
        inorder.push_back(root->val);
        findInorder(root->right, inorder);
    }

    bool isValidBST(TreeNode* root) {
        vector<int> inorder;
        findInorder(root, inorder);

        for (int i = 1; i < inorder.size(); i++) {
            if (inorder[i - 1] >= inorder[i]) return false;
        }

        return true;
    }
};
```

Output:

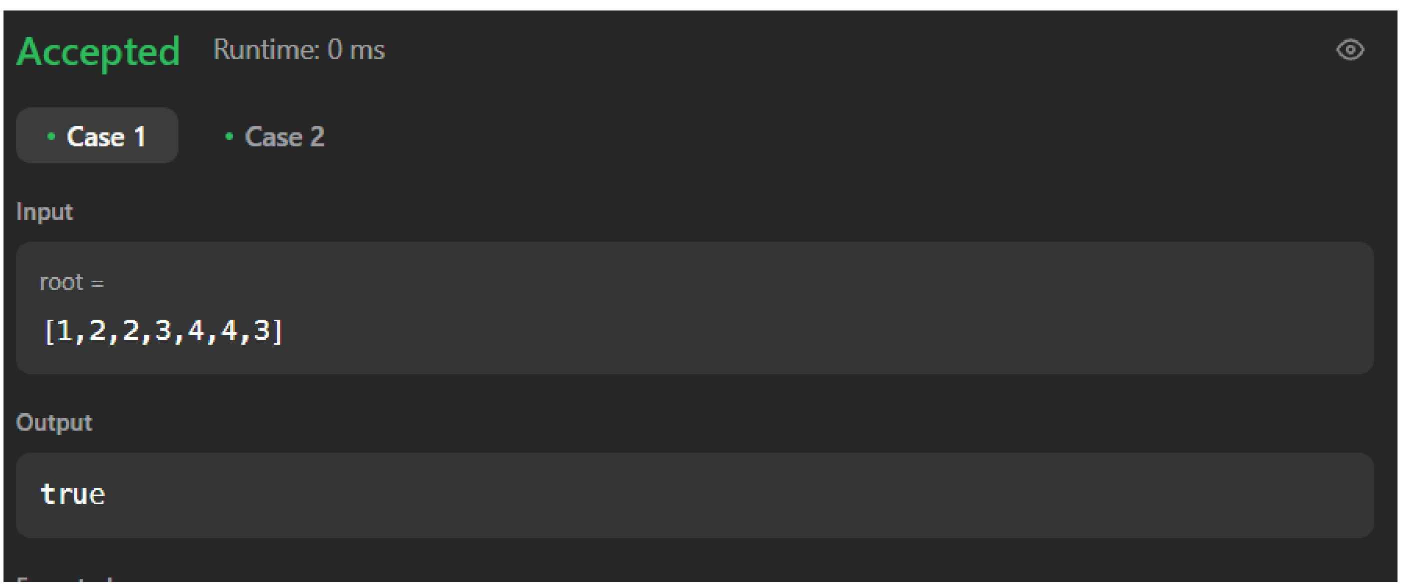


Problem 3. Symmetric Tree. - Given the root of a binary tree, check whether it is a mirror of itself (i.e., symmetric around its center).

Code:

```
class Solution {
public:
    bool isMirror(TreeNode* left, TreeNode* right) {
    if (!left && !right) return true;
    if (!left || !right) return false;
    return (left->val == right->val) && isMirror(left->left, right->right) && isMirror(left->right, right->left);
}

bool isSymmetric(TreeNode* root) {
    if (!root) return true;
    return isMirror(root->left, root->right);
}

};
```

Output:

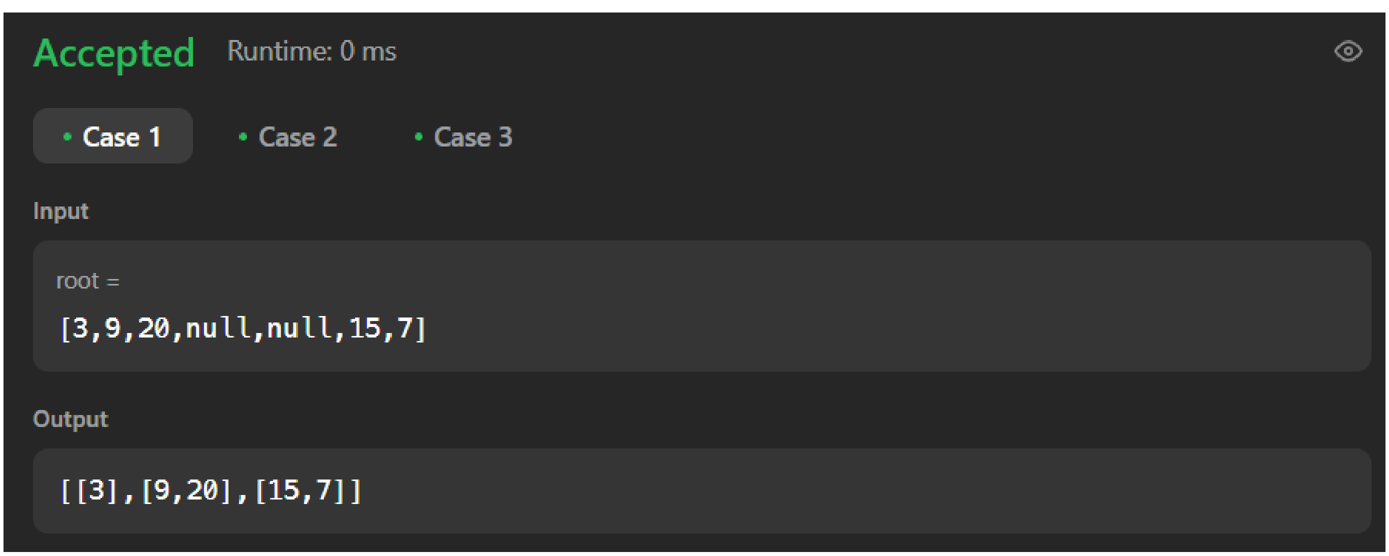


Problem 4. Binary Tree Level Order Traversal - Given the root of a binary tree, return the level order traversal of its nodes' values. (i.e., from left to right, level by level).

Code:

```
class Solution {
 public:
  vector<vector<int>> levelOrder(TreeNode* root) {
    if (root == nullptr)
      return {};
    vector<vector<int>> ans;
    queue<TreeNode*> q{{root}};
    while (!q.empty()) {
    vector<int> currLevel;
      for (int sz = q.size(); sz > 0; --sz) {
        TreeNode* node = q.front();
        q.pop();
        currLevel.push_back(node->val);
        if (node->left)
          q.push(node->left);
        if (node->right)
        q.push(node->right);
      }
      ans.push_back(currLevel);
    }
    return ans;
  }
};
```

Output:

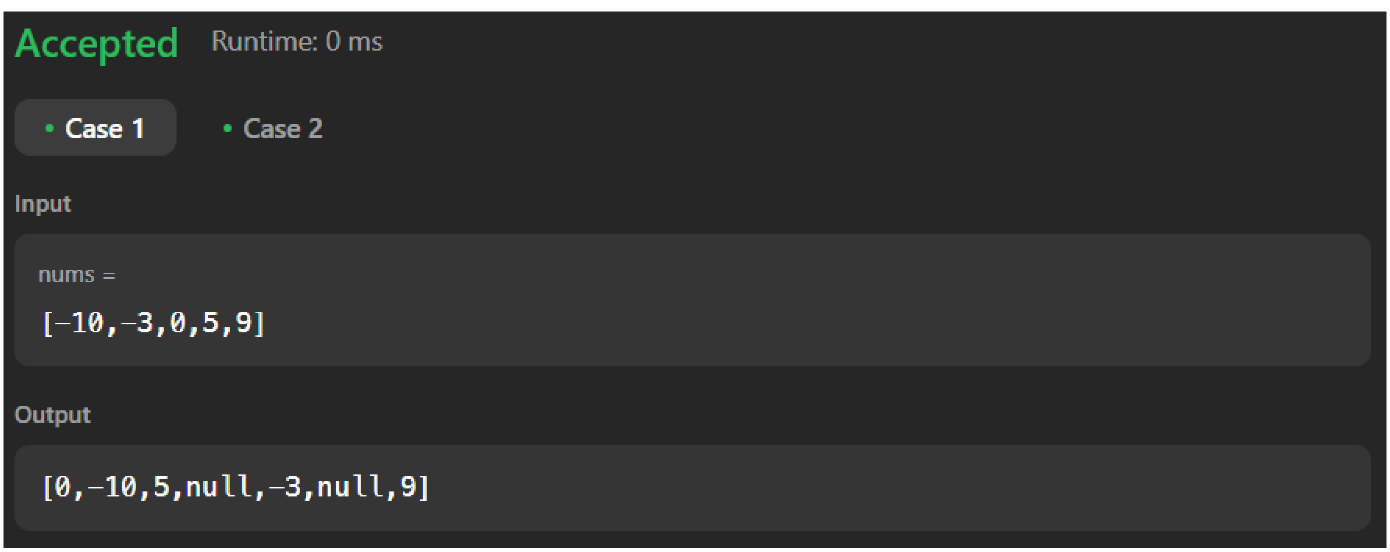


Problem 5. Convert Sorted Array to Binary Search Tree- Given an integer array nums where the elements are sorted in ascending order, convert it to a height-balanced binary search tree

Code:

```
#include <vector>
using namespace std;

class Solution {
public:
    TreeNode* sortedArrayToBST(vector<int>& nums) {
        return helper(nums, 0, nums.size() - 1);
    }

private:
    TreeNode* helper(vector<int>& nums, int left, int right) {
        if (left > right) return nullptr;
        int mid = left + (right - left) / 2;
        TreeNode* root = new TreeNode(nums[mid]);
        root->left = helper(nums, left, mid - 1);
        root->right = helper(nums, mid + 1, right);
        return root;
    }
};
```

Output:

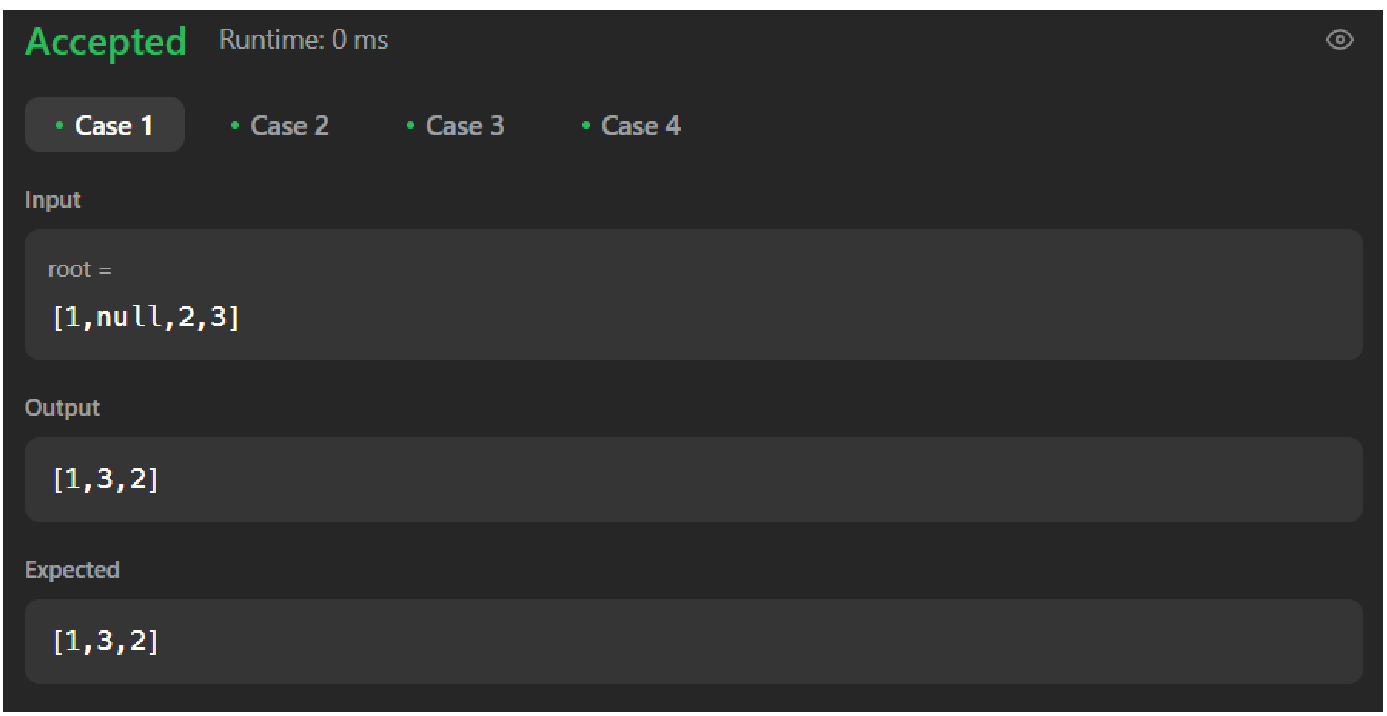


Problem 6. Binary Tree Inorder Traversal-Given the root of a binary tree, return the inorder traversal of its nodes' values.

Code:

```
class Solution {
public:
    vector<int> inorderTraversal(TreeNode* root) {
        vector<int> result;
        helper(root, result);
        return result;
    }

    void helper(TreeNode* root, vector<int>& result) {
        if (root != nullptr) {
            helper(root->left, result);
            result.push_back(root->val);
            helper(root->right, result);
        }
    }
}
```

Output:

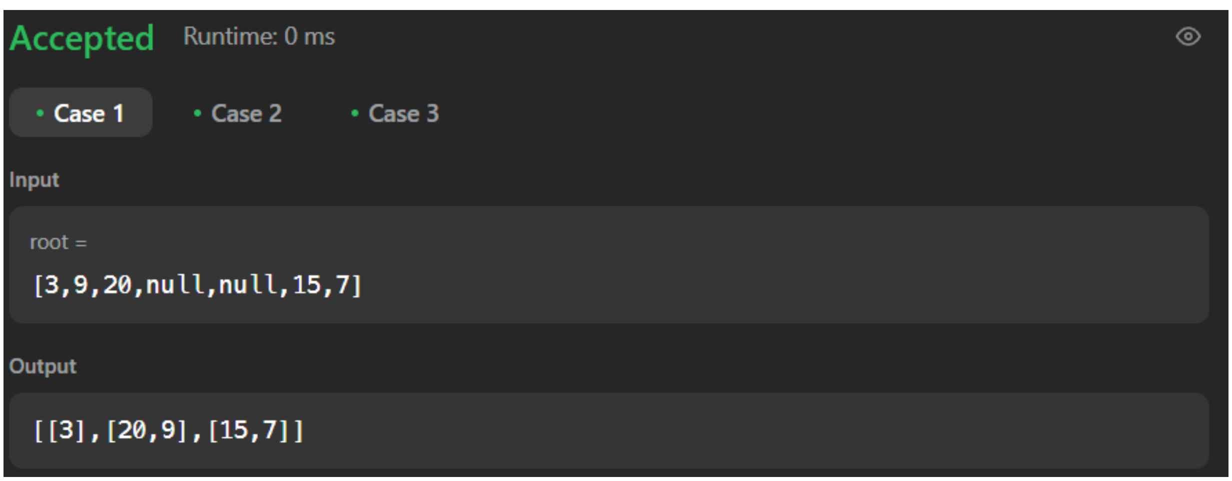


Problem 7. Binary Zigzag Level Order Traversal- Given the root of a binary tree, return the zigzag level order traversal of its nodes' values. (i.e., from left to right, then right to left for the next level and alternate between)..

Code:

```
class Solution {
public:
    void solve(vector<vector<int>>& ans, TreeNode* temp, int level) {
        if (temp == NULL) return;
        if (ans.size() <= level) ans.push_back({});
        if (level % 2 == 0) ans[level].push_back(temp->val);
        else ans[level].insert(ans[level].begin(), temp->val);
        solve(ans, temp->left, level + 1);
        solve(ans, temp->right, level + 1);
    }

    vector<vector<int>> zigzagLevelOrder(TreeNode* root) {
        vector<vector<int>> ans;
        solve(ans, root, 0);
        return ans;
    }
}
```

Output:

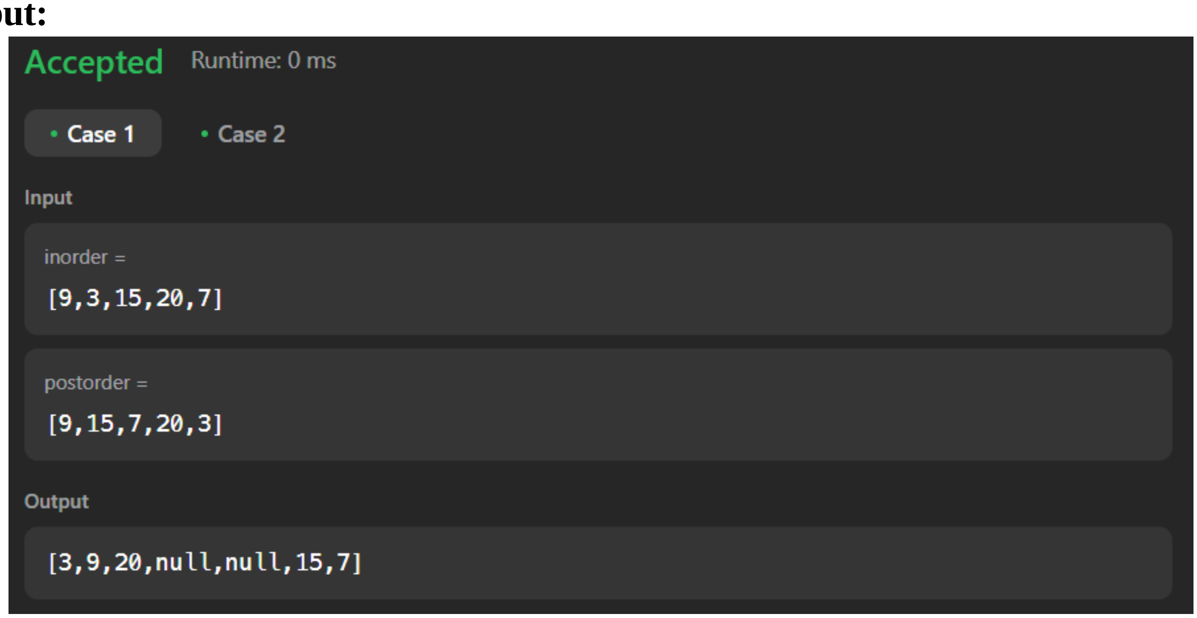


Problem 8. Construct Binary Tree from Inorder and Postorder Traversal- Given two integer arrays inorder and postorder where inorder is the inorder traversal of a binary tree and postorder is the postorder traversal of the same tree, construct and return the binary tree.

Code:

```
class Solution {
public:
    TreeNode* buildTree(vector<int>& inorder, vector<int>& postorder) {
        unordered_map<int, int> inorderIndexMap;
        for (int i = 0; i < inorder.size(); ++i) {
            inorderIndexMap[inorder[i]] = i;
        }
        int postIndex = postorder.size() - 1;
        return constructTree(inorder, postorder, inorderIndexMap, postIndex, 0, inorder.size() - 1);
    }
    TreeNode* constructTree(vector<int>& inorder, vector<int>& postorder, unordered_map<int, int>& inorderIndexMap, int& postIndex, int inStart, int inEnd) {
        if (inStart > inEnd) return nullptr;
        int rootVal = postorder[postIndex--];
        TreeNode* root = new TreeNode(rootVal);
        int rootIndex = inorderIndexMap[rootVal];
        root->right = constructTree(inorder, postorder, inorderIndexMap, postIndex, rootIndex + 1, inEnd);
        root->left = constructTree(inorder, postorder, inorderIndexMap, postIndex, inStart, rootIndex - 1);

        return root;
    }
};
```

Output:

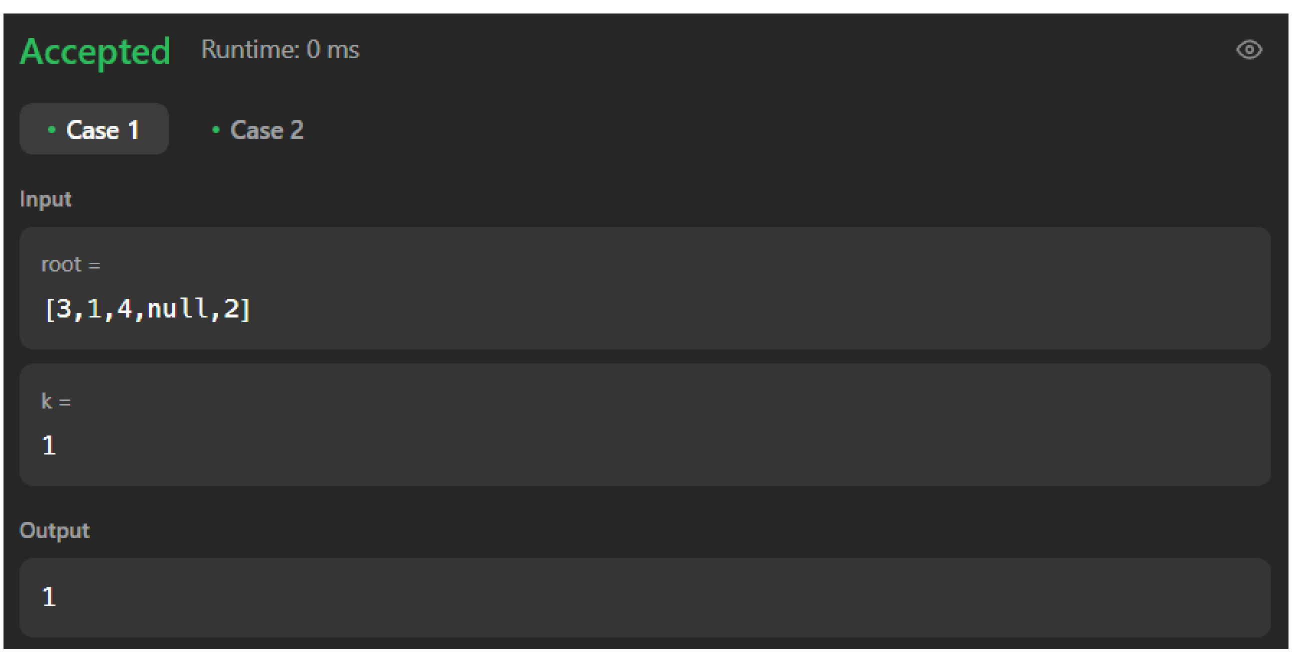


Problem 9. Kth Smallest element in a BST- Given the root of a binary search tree, and an integer k, return the kth smallest value (1-indexed) of all the values of the nodes in the tree.

Code:

```
class Solution {
public:
    void solve(TreeNode* root, int &cnt, int &ans, int k){
        if(root == NULL)    return;
        //left, root, right
        solve(root->left, cnt, ans, k);
        cnt++;
        if(cnt == k){
            ans = root->val;
            return;
        }
        solve(root->right, cnt, ans, k);
    }
    int kthSmallest(TreeNode* root, int k) {

        int cnt = 0;
        int ans;
        solve(root, cnt, ans, k);
        return ans;
    }
};
```

Output:



Problem 10. Populating Next Right Pointers in Each Node- You are given a perfect binary tree where all leaves are on the same level, and every parent has two children. The binary tree has the following definition:

Code:

```
class Solution {
public:
    Node* connect(Node* root) {
        if(root==nullptr) return {};
        queue<Node*> q;
        q.push(root);
        while(!q.empty()){
            int n = q.size();
            for(int i=0;i<n;i++){
                Node* t = q.front();
                q.pop();
                if(i!=n-1){
                    t->next=q.front();
                }
                if(t->left) q.push(t->left);
                if(t->right) q.push(t->right);
            }
        }
        return root;
    }
};
```

Output: