



DEPARTMENT OF

COMPUTER SCIENCE & ENGINEERING

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Experiment 6

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Semester: 6th

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Subject Name: Advanced Programming Lab-2 **Subject Code:** 22ITP-351

1. Aim 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.

2. Validate Binary Search Tree :

Given the root of a binary tree, determine if it is a valid binary search tree (BST).

A valid BST is defined as follows:

- left subtree of a node contains only nodes with keys less than the node's key.
- The right subtree of a node contains only nodes with keys greater than the node's key.
- Both the left and right subtrees must also be binary search trees.

3. Symmetric Tree:

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

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).

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.

6. Binary Tree Inorder Traversal:

Given the root of a binary tree, return the inorder traversal of its nodes' values.

7. Binary Tree 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).

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.

9. Kth Smallest Element in a BST :

Given the root of a binary search tree, and an integer k, return the k^{th} smallest value (1-indexed) of all the values of the nodes in the tree.

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:

```
struct Node {  
    int val;  
    Node *left;  
    Node *right;  
    Node *next;  
}
```

Populate each next pointer to point to its next right node. If there is no next right node, the next pointer should be set to NULL.

Initially, all next pointers are set to NULL.

11.Objective :

1. Learn how to recursively or iteratively compute the height (or depth) of a binary tree.
2. Understand the properties of a Binary Search Tree (BST).
3. Understand mirror properties of a binary tree.
4. Learn Breadth-First Search (BFS) using queues.
5. Learn how to construct a height-balanced BST from a sorted array.
6. Understand inorder traversal (left-root-right).
7. Extend BFS level-order traversal to include zigzag ordering.
8. Understand tree reconstruction from traversal orders.
9. Use inorder traversal (sorted order) to efficiently find the kth smallest element.
10. Understand tree linking using level pointers.

12. Implementation of Code/Output 1 :

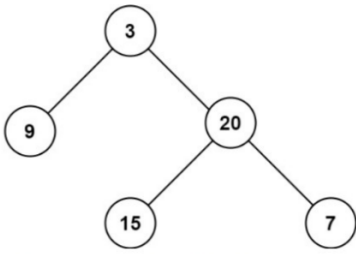
104. Maximum Depth of Binary Tree

Easy Topics Companies

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.

Example 1:



```
Input: root = [3,9,20,null,null,15,7]
Output: 3
```

Solved

```

10  */
11  */
12  class Solution {
13  public:
14      int maxDepth(TreeNode* root)
15      {
16          if(root==NULL)
17              return 0;
18          return max(1+maxDepth(root->left), 1+maxDepth(root->right));
19      }
20  }
    
```

Ln 21, Col 3 Saved

Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

root =
[3,9,20,null,null,15,7]

Output

3

Expected

13.Code 2 :

98. Validate Binary Search Tree

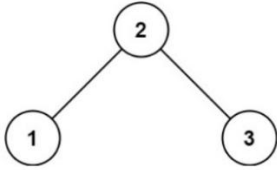
Medium Topics Companies

Given the `root` of a binary tree, determine if it is a *valid binary search tree (BST)*.

A **valid BST** is defined as follows:

- The left *subtree* of a node contains only nodes with keys **less than** the node's key.
- The right subtree of a node contains only nodes with keys **greater than** the node's key.
- Both the left and right subtrees must also be binary search trees.

Example 1:



```
Input: root = [2,1,3]
Output: true
```

Solved

```

17
18 private:
19     bool valid(TreeNode* node, long minimum, long maximum) {
20         if (!node) return true;
21         if (!(node->val > minimum && node->val < maximum)) return false;
22         return valid(node->left, minimum, node->val) && valid(node->right, node->val, maximum);
23     }
24
25
26
    
```

Ln 26, Col 3 Saved

Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

root =
[2,1,3]

Output

true

Expected

14.Code 3 :

Problem List

Description

Editorial

Solutions

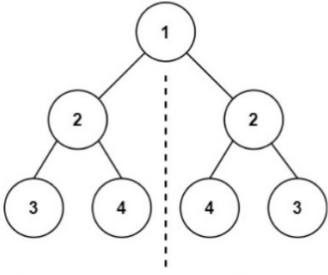
Submissions

101. Symmetric Tree

Easy Topics Companies

Given the `root` of a binary tree, check whether it is a mirror of itself (i.e., symmetric around its center).

Example 1:



Input: `root = [1,2,2,3,4,4,3]`
Output: `true`

Example 2:

15.9K 197 153 Online

Code

C++ Auto

```

16     }
17
18 private:
19     bool isMirror(TreeNode* n1, TreeNode* n2) {
20         if (n1 == nullptr && n2 == nullptr) {
21             return true;
22         }
23
24         if (n1 == nullptr || n2 == nullptr) {
25             return false;
26         }

```

Ln 26, Col 2 Saved Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

root = [1,2,2,3,4,4,3]

Output

true

Expected

15.Code 4 :

Problem List

Description

Editorial

Solutions

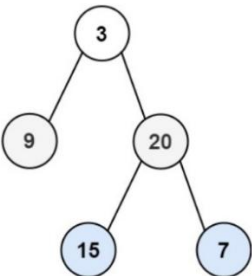
Submissions

102. Binary Tree Level Order Traversal

Medium Topics Companies Hint

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).

Example 1:



Input: `root = [3,9,20,null,null,15,7]`
Output: `[[3],[9,20],[15,7]]`

16K 123 250 Online

Code

C++ Auto

```

3     vector<vector<int>> levelOrder(TreeNode* root) {
4         vector<vector<int>> ans;
5         if (!root) return ans;
6
7         queue<TreeNode*> q;
8         q.push(root);
9
10        while (!q.empty()) {
11            int level_size = q.size();
12            vector<int> level;
13

```

Ln 28, Col 3 Saved Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2 Case 3

Input

root = [3,9,20,null,null,15,7]

Output

[[3],[9,20],[15,7]]

Expected

16.Code 5 :

Problem List

Description

Editorial

Solutions

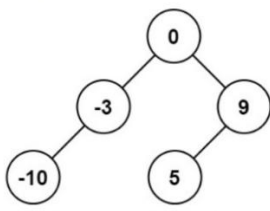
Submissions

108. Convert Sorted Array to Binary Search Tree


Easy Topics Companies

Given an integer array `nums` where the elements are sorted in **ascending order**, convert it to a **height-balanced** binary search tree.

Example 1:



Input: `nums = [-10,-3,0,5,9]`
Output: `[0,-3,9,-10,null,5]`
Explanation: `[0,-10,5,null,-3,null,9]` is also accepted:



11.3K 125 93 Online

Code

```

10 private:
11     TreeNode* helper(vector<int>& nums, int left, int right) {
12         if (left > right) return nullptr;
13         int mid = left + (right - left) / 2;
14         TreeNode* root = new TreeNode(nums[mid]);
15         root->left = helper(nums, left, mid - 1);
16         root->right = helper(nums, mid + 1, right);
17         return root;
18     }
19 };

```

Ln 19, Col 3 Saved Run Submit

Testcase

Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

```

nums =
[-10,-3,0,5,9]

```

Output

```

[0,-10,5,null,-3,null,9]

```

Expected

17.Code 6 :

Problem List

Description

Editorial

Solutions

Submissions

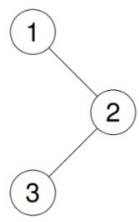
94. Binary Tree Inorder Traversal

Easy Topics Companies

Given the `root` of a binary tree, return the *inorder traversal* of its nodes' values.

Example 1:

Input: `root = [1,null,2,3]`
Output: `[1,3,2]`
Explanation:



13.9K 190 264 Online

Code

```

1 class Solution {
2 public:
3     vector<int> inorderTraversal(TreeNode* root) {
4         vector<int> res;
5         inorder(root, res);
6         return res;
7     }
8
9 private:
10    void inorder(TreeNode* node, vector<int>& res) {
11        if (!node) {

```

Ln 18, Col 3 Saved Run Submit

Testcase

Test Result

Accepted Runtime: 0 ms

Case 1 Case 2 Case 3 Case 4

Input

```

root =
[1,null,2,3]

```

Output

```

[1,3,2]

```

Expected

18.Code 7 :

Problem List

Description

Editorial

Solutions

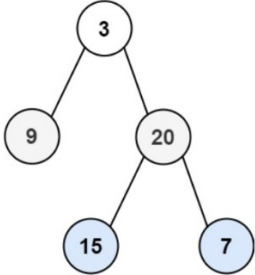
Submissions

103. Binary Tree Zigzag Level Order Traversal

Medium Topics Companies

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).

Example 1:



Input: `root = [3,9,20,null,null,15,7]`
Output: `[[3], [20,9], [15,7]]`

11.3K 136 80 Online

Code

```

35         }
36         level++;
37         if(level%2==0){//if level is even then reverse the array before pushing
38             reverse(sub.begin(),sub.end());
39         }
40         arr.push_back(sub);
41     }
42     return arr;
43 }
44 };

```

Ln 44, Col 3 Saved

Run Submit

Testcase

Test Result

Accepted Runtime: 0 ms

Case 1 Case 2 Case 3

Input

```

root =
[3,9,20,null,null,15,7]

```

Output

```

[[3], [20,9], [15,7]]

```

Expected

19.Code 8 :

Problem List

Description

Editorial

Solutions

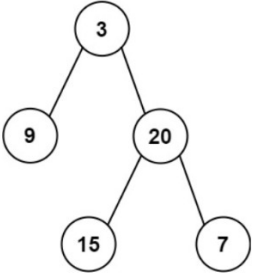
Submissions

106. Construct Binary Tree from Inorder and Postorder Traversal

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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*.

Example 1:



Input: `inorder = [9,3,15,20,7], postorder = [9,15,7,20,3]`
Output: `[3,9,20,null,null,15,7]`

8.3K 78 65 Online

Code

```

22
23     int rootNode = postorder[postIndex--];
24     TreeNode* node = new TreeNode(rootNode);
25     int index=inorderMapIndices[rootNode];
26
27     node->right = constructTree(inorder, postorder, postIndex, index+ 1, end);
28     node->left = constructTree(inorder, postorder, postIndex, start, index - 1);
29     return node;
30 }
31 };

```

Ln 31, Col 3 Saved

Run Submit

Testcase

Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

```

inorder =
[9,3,15,20,7]

```

postorder =

```

[9,15,7,20,3]

```

Output

20.Code 9:

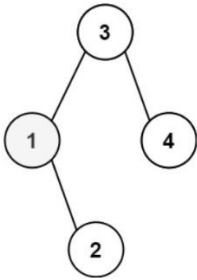
Description | Editorial | Solutions | Submissions

230. Kth Smallest Element in a BST

Medium Topics Companies Hint

Given the `root` of a binary search tree, and an integer `k`, return the k^{th} smallest value (1-indexed) of all the values of the nodes in the tree.

Example 1:



```

Input: root = [3,1,4,null,2], k = 1
Output: 1

```

11.9K 122 131 Online

Code

C++ Auto

```

1 class Solution {
2 public:
3     int kthSmallest(TreeNode* root, int k) {
4         vector<int> temp;
5         inorder(root, temp);
6         return temp[k-1];
7     }
8
9     void inorder(TreeNode* root, vector<int> &temp){
10         if(!root) return;
11         inorder(root->left, temp);

```

Ln 15, Col 3 Saved Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

root =
[3,1,4,null,2]

k =
1

Output

21.Code 10 :

Problem List < > >

Description | Editorial | Solutions | Submissions

116. Populating Next Right Pointers in Each Node

Medium Topics Companies

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:

```

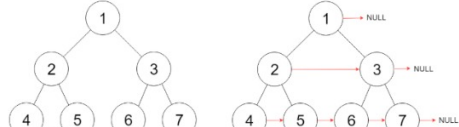
struct Node {
    int val;
    Node *left;
    Node *right;
    Node *next;
}

```

Populate each next pointer to point to its next right node. If there is no next right node, the next pointer should be set to `NULL`.

Initially, all next pointers are set to `NULL`.

Example 1:



10K 72 50 Online

Code

C++ Auto

```

19 class Solution {
20 public:
21     Node* connect(Node* root) {
22         if(root==nullptr) return {};
23
24         queue<Node*> q;
25         q.push(root);
26
27         while(!q.empty()){
28             int n = q.size();
29

```

Ln 45, Col 3 Saved Run Submit

Testcase Test Result

Accepted Runtime: 0 ms

Case 1 Case 2

Input

root =
[1,2,3,4,5,6,7]

Output

[1,#,2,3,#,4,5,6,7,#]

Expected



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22.Learning Outcome :

1. Concepts: Depth-first search (DFS), Recursion
2. A valid BST requires every node's left child to be smaller and right child to be larger.
3. A tree is symmetric if its left subtree is a mirror of the right subtree.
4. Concepts: Recursion, Divide & Conquer, Balanced BST
5. Concepts: Inorder traversal, Recursion, Iterative (Stack)
6. Concepts: Tree Reconstruction, Recursion, Hash Map Optimization