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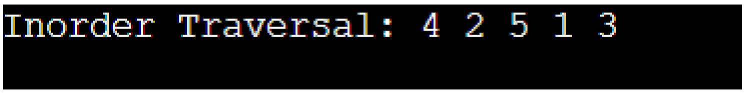
Q1. Binary Order Traversal

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

void inorderTraversal(TreeNode* root) {
if (root == NULL) return;
inorderTraversal(root->left);     cout <<
root->val << " ";
inorderTraversal(root->right);
}

int main() {
    TreeNode* root = new TreeNode(1);
root->left = new TreeNode(2);     root->right
= new TreeNode(3);     root->left->left =
new TreeNode(4);     root->left->right = new
TreeNode(5);

    cout << "Inorder Traversal: ";
inorderTraversal(root); // Output: 4 2 5 1 3     cout
<< endl;

    return 0;
}
```

Output:

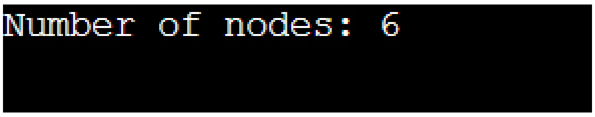


```
Inorder Traversal: 4 2 5 1 3
```

Q2. Count Complete Tree Node

```
#include <iostream>
#include <cmath> using
namespace std; struct
TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

int getHeight(TreeNode* node) {
int height = 0;     while (node) {
height++;         node = node-
>left;
    }
    return height;
}

int countNodes(TreeNode* root) {
    if (!root) return 0;     int leftHeight = getHeight(root-
>left);     int rightHeight = getHeight(root->right);     if
(leftHeight == rightHeight) {         return (1 <<
leftHeight) + countNodes(root->right);
    } else {
        return (1 << rightHeight) + countNodes(root->left);     }
}

int main() {
    TreeNode* root = new TreeNode(1);
root->left = new TreeNode(2);     root->right
= new TreeNode(3);     root->left->left =
new TreeNode(4);     root->left->right = new
TreeNode(5);     root->right->left = new
TreeNode(6);

    cout << "Number of nodes: " << countNodes(root) << endl; // Output:
6

    return 0;
}
```

Output:



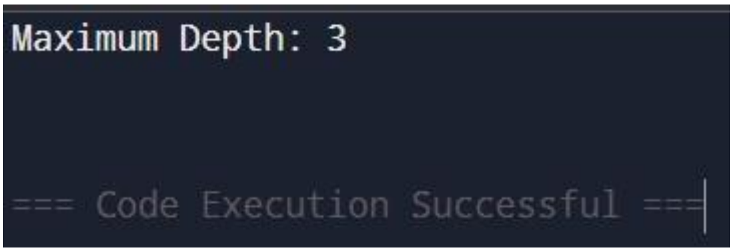
```
Number of nodes: 6
```

Q3. Binary Tree – Find Maximum Depth

```
#include <iostream>
#include <algorithm> using
namespace std; struct
TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};
```

```
int maxDepth(TreeNode* root) {
    if (!root) return 0;     int leftDepth =
maxDepth(root->left);     int rightDepth =
maxDepth(root->right);     return 1 +
max(leftDepth, rightDepth);
}

int main() {
    TreeNode* root = new TreeNode(3);
root->left = new TreeNode(9);     root->right
= new TreeNode(20);     root->right->left =
new TreeNode(15);     root->right->right =
new TreeNode(7);

    cout << "Maximum Depth: " << maxDepth(root) << endl; // Output: 3

    return 0;
}
```

Output:



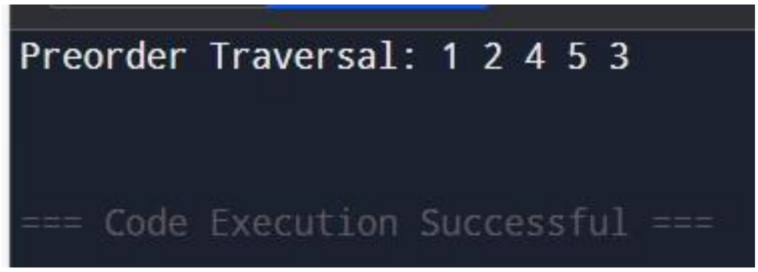
```
Maximum Depth: 3


=== Code Execution Successful ===
```

Q4. Binary Order Pre Traversal

```
#include <iostream>
```

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

vector<int> preorderTraversal(TreeNode* root) {
vector<int> result;     if (root == NULL) return
result;     stack<TreeNode*> stk;
stk.push(root);
    while (!stk.empty()) {         TreeNode*
node = stk.top();         stk.pop();
result.push_back(node->val);         if (node-
>right) stk.push(node->right);         if
(node->left) stk.push(node->left);
    }
    return result;
}

int main() {
    TreeNode* root = new TreeNode(1);
root->left = new TreeNode(2);     root->right
= new TreeNode(3);     root->left->left =
new TreeNode(4);     root->left->right = new
TreeNode(5);

    vector<int> result = preorderTraversal(root);

    cout << "Preorder Traversal: ";
for (int val : result) {         cout
<< val << " ";
    }
    cout << endl;

    return 0;
}
```

Output:



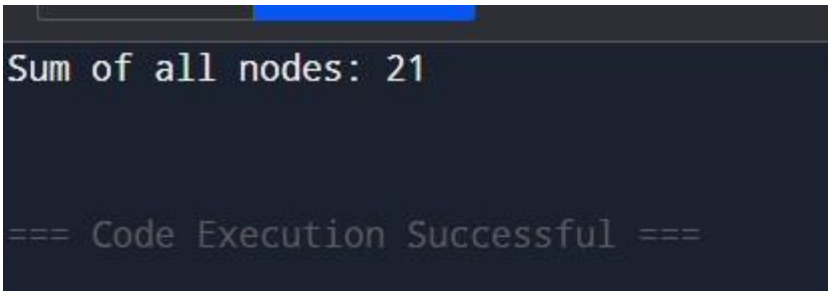
```
Preorder Traversal: 1 2 4 5 3


=== Code Execution Successful ===
```

Q5. Binary Tree – Sum of all Nodes

```
#include <iostream>
#include <queue> using
namespace std;
```

```
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

int sumOfNodes(TreeNode* root) {
if (root == NULL) return 0;     int
sum = 0;     queue<TreeNode*> q;
    q.push(root);
    while (!q.empty()) {
        TreeNode* current = q.front();
        q.pop();         sum += current->val;
if (current->left) q.push(current->left);         if
(current->right) q.push(current->right);
    }
    return sum;
}

int main() {
    TreeNode* root = new TreeNode(1);
root->left = new TreeNode(2);     root->right
= new TreeNode(3);     root->left->left =
new TreeNode(4);     root->left->right = new
TreeNode(5);     root->right->right = new
TreeNode(6);

    cout << "Sum of all nodes: " << sumOfNodes(root) << endl; // Output:
21

    return 0;
}
```

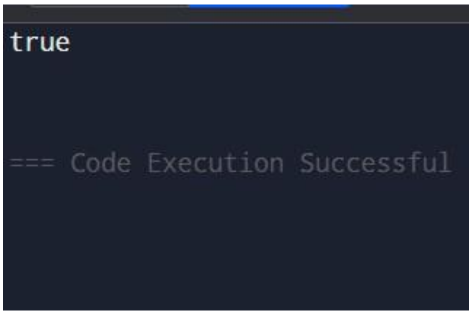
Output:



```
Sum of all nodes: 21


=== Code Execution Successful ===
```

Q6. Same Tree

```
#include <iostream>
#include <queue> using
namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

bool isSameTree(TreeNode* p, TreeNode* q) {
queue<TreeNode*> qp, qq;     qp.push(p);
qq.push(q);     while (!qp.empty() &&
!qq.empty()) {
        TreeNode* nodeP = qp.front(); qp.pop();
        TreeNode* nodeQ = qq.front(); qq.pop();
        if (!nodeP && !nodeQ) continue;         if (!nodeP || !nodeQ ||
nodeP->val != nodeQ->val) return false;         qp.push(nodeP-
>left);         qp.push(nodeP->right);         qq.push(nodeQ->left);
qq.push(nodeQ->right);
    }
    return qp.empty() && qq.empty();
}

int main() {
    TreeNode* p = new TreeNode(1);     p->left = new
TreeNode(2);     p->right = new TreeNode(3);
TreeNode* q = new TreeNode(1);     q->left = new
TreeNode(2);     q->right = new TreeNode(3);     cout
<< (isSameTree(p, q) ? "true" : "false") << endl;
return 0;
}
```



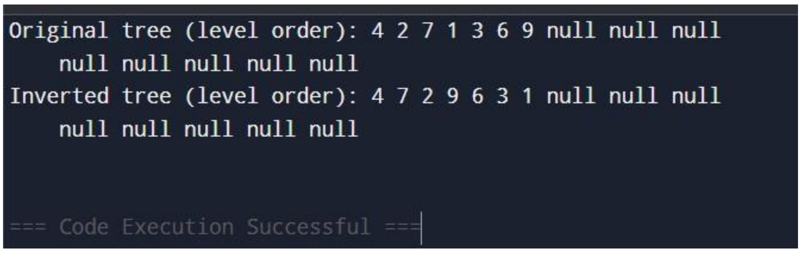
```
true


=== Code Execution Successful
```

Q7. Invert Binary Tree

```
#include <iostream>

#include <queue> using

namespace std;


struct TreeNode {

    int val;

    TreeNode* left;

    TreeNode* right;

    TreeNode(int x) : val(x), left(NULL), right(NULL) {}

};


TreeNode* invertTree(TreeNode* root) {

if (root == NULL) return NULL;

queue<TreeNode*> q;

    q.push(root);     while

(!q.empty()) {         TreeNode*

node = q.front();

        q.pop();
        TreeNode* temp = node->left;
node->left = node->right;         node-
>right = temp;         if (node->left)
q.push(node->left);         if (node-
>right) q.push(node->right);

    }
    return root;
}

void printLevelOrder(TreeNode* root) {
if (root == NULL) return;
queue<TreeNode*> q;
    q.push(root);     while
(!q.empty()) {         TreeNode*
node = q.front();
        q.pop();         if (node) {
cout << node->val << " ";
            q.push(node->left);
            q.push(node->right);
} else {             cout << "null
";
        }
    }
}
```

```
int main() {
   TreeNode* root = new TreeNode(4);     root-
>left = new TreeNode(2);     root->right = new
TreeNode(7);     root->left->left = new
TreeNode(1);     root->left->right = new
TreeNode(3);     root->right->left = new
TreeNode(6);     root->right->right = new
TreeNode(9);

   cout << "Original tree (level order): ";
printLevelOrder(root);     cout << endl;

   root = invertTree(root);     cout <<
"Inverted tree (level order): ";
printLevelOrder(root);     cout << endl;

   return 0;
}
```

Output:



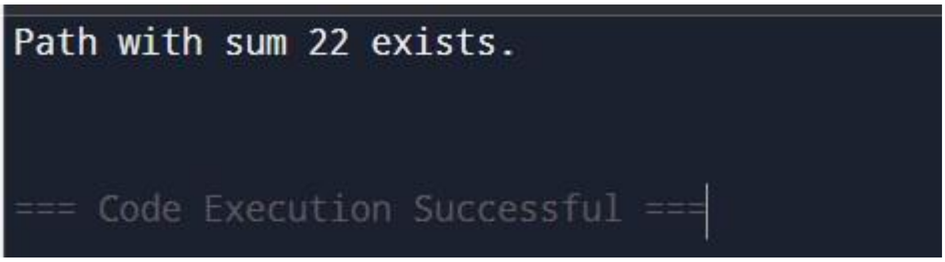
```
Original tree (level order): 4 2 7 1 3 6 9 null null null
    null null null null null
Inverted tree (level order): 4 7 2 9 6 3 1 null null null
    null null null null null


=== Code Execution Successful ===
```

Q8. Path Sum

```
#include <iostream>
```

```
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

bool hasPathSum(TreeNode* root, int sum) {     if
(root == NULL) return false;     if (root->left ==
NULL && root->right == NULL) {         return sum
== root->val;
    }
    int remainingSum = sum - root->val;
    return hasPathSum(root->left, remainingSum) ||
hasPathSum(root>right, remainingSum);
}

int main() {
    TreeNode* root = new TreeNode(5);
root->left = new TreeNode(4);     root->right
= new TreeNode(8);     root->left->left =
new TreeNode(11);     root->right->left =
new TreeNode(13);     root->right->right =
new TreeNode(4);     root->left->left->left =
new TreeNode(7);     root->left->left->right
= new TreeNode(2);     root->right->right-
>right = new TreeNode(1);

    int targetSum = 22;     if (hasPathSum(root, targetSum)) {
cout << "Path with sum " << targetSum << " exists." << endl;
    } else {
        cout << "No path with sum " << targetSum << " exists." << endl;
    }

    return 0;
}
```

Output:



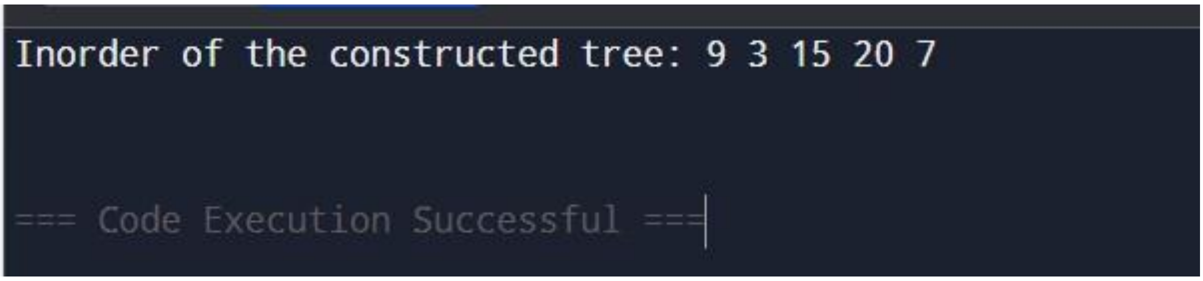
```
Path with sum 22 exists.


=== Code Execution Successful ===
```

Q9. Construct Binary Tree from Preorder and Inorder Traversal

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

```
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

TreeNode* buildTreeHelper(vector<int>& preorder, int preStart, int
preEnd, vector<int>& inorder, int inStart, int inEnd, unordered_map<int,
int>& inorderMap) {     if (preStart > preEnd || inStart > inEnd) return
NULL;     int rootVal = preorder[preStart];
    TreeNode* root = new TreeNode(rootVal);
int inRootIndex = inorderMap[rootVal];     int
leftTreeSize = inRootIndex - inStart;
    root->left = buildTreeHelper(preorder, preStart + 1, preStart +
leftTreeSize, inorder, inStart, inRootIndex - 1, inorderMap);     root-
>right = buildTreeHelper(preorder, preStart + leftTreeSize + 1,
preEnd, inorder, inRootIndex + 1, inEnd, inorderMap);     return root;
}

TreeNode* buildTree(vector<int>& preorder, vector<int>& inorder) {
unordered_map<int, int> inorderMap;
    for (int i = 0; i < inorder.size(); i++) {
        inorderMap[inorder[i]] = i;
    }
    return buildTreeHelper(preorder, 0, preorder.size() - 1, inorder, 0,
inorder.size() - 1, inorderMap);
}

void printInorder(TreeNode* root) {
if (root == NULL) return;
printInorder(root->left);     cout <<
root->val << " ";
printInorder(root->right);
}

int main() {     vector<int> preorder = {3,
9, 20, 15, 7};     vector<int> inorder = {9,
3, 15, 20, 7};
    TreeNode* root = buildTree(preorder, inorder);

    cout << "Inorder of the constructed tree: ";
printInorder(root);     cout << endl;

    return 0;
}
```

Output:



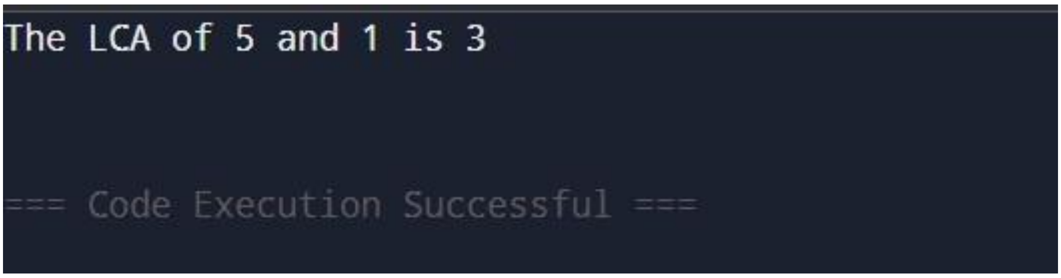
```
Inorder of the constructed tree: 9 3 15 20 7


=== Code Execution Successful ===
```

Q10. Lowest Common Ancestor Binary Tree

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};

class Solution { public:
    TreeNode* lowestCommonAncestor(TreeNode* root, TreeNode* p,
TreeNode* q) {         if (root == NULL || root == p || root == q) {
return root;
        }
        TreeNode* left = lowestCommonAncestor(root->left, p, q);
        TreeNode* right = lowestCommonAncestor(root->right, p, q);
        if (left != NULL && right != NULL) {
return root;
        }
        return (left != NULL) ? left : right;
    }
};
```

```
TreeNode* createTree() {    TreeNode* root =
new TreeNode(3);    root->left = new
TreeNode(5);    root->right = new
TreeNode(1);    root->left->left = new
TreeNode(6);    root->left->right = new
TreeNode(2);    root->right->left = new
TreeNode(0);    root->right->right = new
TreeNode(8);    root->left->right->left = new
TreeNode(7);    root->left->right->right = new
TreeNode(4);    return root;
}

int main() {
    Solution solution;
    TreeNode* root = createTree();
    TreeNode* p = root->left;
    TreeNode* q = root->right;
    TreeNode* lca = solution.lowestCommonAncestor(root, p, q);
    if (lca != NULL) {        cout << "The LCA of " << p->val << " and " <<
q->val << " is " << lca->val << endl;
    } else {
        cout << "No common ancestor found." << endl;
    }
    return 0;
}
```

Output:



```
The LCA of 5 and 1 is 3



=== Code Execution Successful ===
```