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Section – 620-B

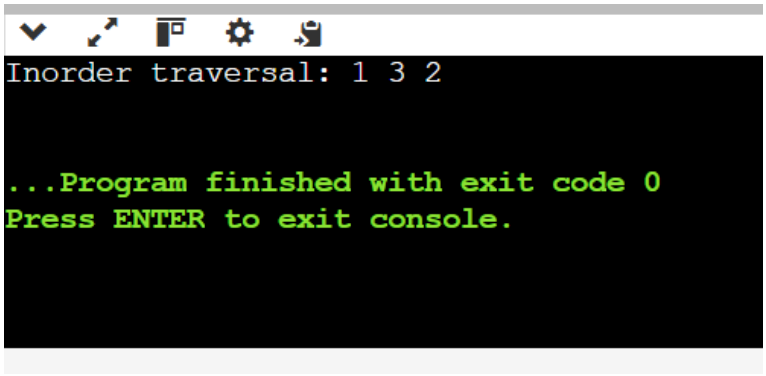
Q1. Given the root of a binary tree, return the inorder traversal of its nodes' values.

Ans

```
#include <iostream>
#include <vector>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
void inorderTraversal(TreeNode* root, vector<int>& result) {
    if (root == nullptr) {
        return;
    }
    inorderTraversal(root->left, result);
    result.push_back(root->val);
    inorderTraversal(root->right, result);
}
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(1);
    root->right = new TreeNode(2);
```

```
    root->right->left = new TreeNode(3);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    vector<int> result;
    inorderTraversal(root, result);
    cout << "Inorder traversal: ";
    for (int val : result) {
        cout << val << " ";
    }
    cout << endl;
    return 0;
}
```

Output



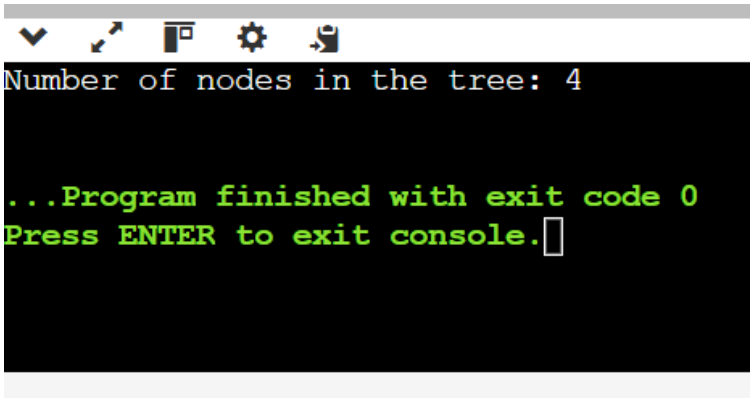
Q2. Given the root of a complete binary tree, return the number of the nodes in the tree.

Ans

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

```
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
int countNodes(TreeNode* root) {
    if (root == nullptr) {
        return 0;
    }
    return 1 + countNodes(root->left) + countNodes(root->right);
}
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(1);
    root->left = new TreeNode(2);
    root->right = new TreeNode(3);
    root->left->left = new TreeNode(4);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    int nodeCount = countNodes(root);
    cout << "Number of nodes in the tree: " << nodeCount << endl; // Output: 6
    return 0;
}
```

Output



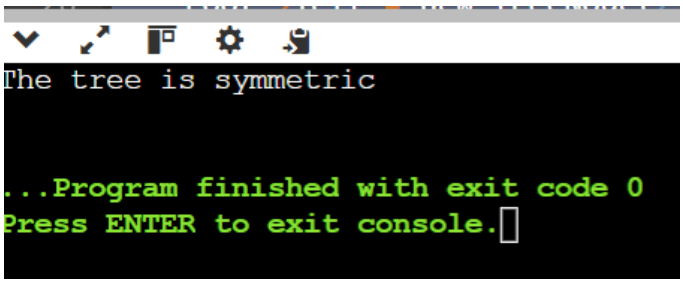
Q3. Symmetric tree

Ans

```
#include <iostream>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
int isMirror(TreeNode* left, TreeNode* right) {
    if (left == nullptr && right == nullptr) {
        return true;
    }
    if (left == nullptr || right == nullptr) {
        return false;
    }
    return (left->val == right->val) && isMirror(left->left, right->right) &&
isMirror(left->right, right->left);
}
```

```
int isSymmetric(TreeNode* root) {
    if (root == nullptr) {
        return true;
    }
    return isMirror(root->left, root->right);
}
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(1);
    root->left = new TreeNode(2);
    root->right = new TreeNode(2);
    root->left->left = new TreeNode(3);
    root->left->right = new TreeNode(4);
    root->right->left = new TreeNode(4);
    root->right->right = new TreeNode(3);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    bool symmetric = isSymmetric(root);
    cout << "The tree is " << (symmetric ? "symmetric" : "not symmetric") <<
endl;
    return 0;
}
```

Output



Q4. Inorder traversal inverting

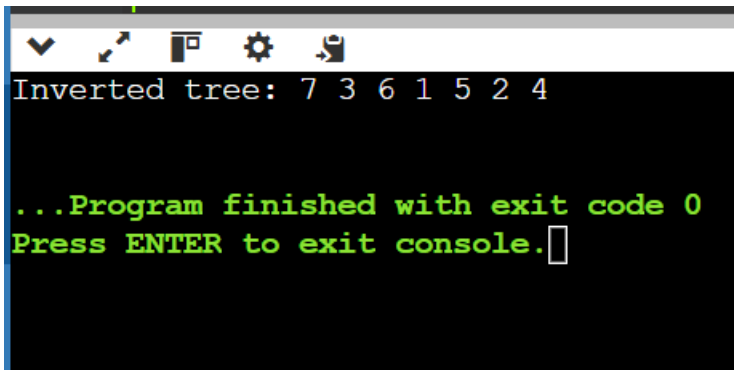
Ans

```
#include <iostream>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
TreeNode* invertTree(TreeNode* root) {
    if (root == nullptr) {
        return root;
    }
    TreeNode* temp = root->left;
    root->left = root->right;
    root->right = temp;
    invertTree(root->left);
    invertTree(root->right);
    return root;
}
```

```
TreeNode* createExampleTree() {
    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);
    root->right->right = new TreeNode(7);
    return root;
}
void printInOrder(TreeNode* root) {
    if (root == nullptr) {
        return;
    }
    printInOrder(root->left);
    cout << root->val << " ";
    printInOrder(root->right);
}

int main() {
    TreeNode* root = createExampleTree();
    root = invertTree(root);
    cout << "Inverted tree: ";
    printInOrder(root);
    cout << endl;
    return 0;
```

}

Output

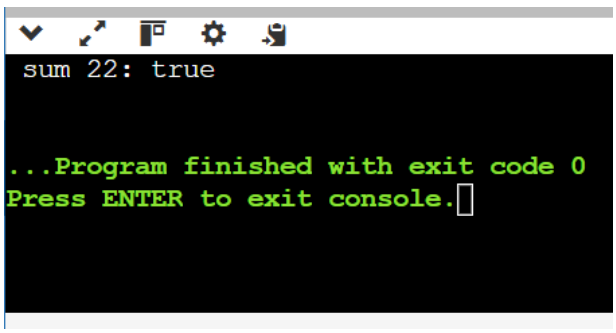


Q5. Path sum

Ans

```
#include <iostream>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
bool hasPathSum(TreeNode* root, int sum) {
    if (root == nullptr) {
        return false;
    }
    if (root->left == nullptr && root->right == nullptr) {
        return (sum == root->val);
    }
```

```
    return hasPathSum(root->left, sum - root->val) || hasPathSum(root->right,
sum - root->val);
}
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(5);
    root->left = new TreeNode(4);
    root->right = new TreeNode(8);
    root->left->left = new TreeNode(11);
    root->left->left->left = new TreeNode(7);
    root->left->left->right = new TreeNode(2);
    root->right->left = new TreeNode(13);
    root->right->right = new TreeNode(4);
    root->right->right->right = new TreeNode(1);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    int sum = 22;
    bool result = hasPathSum(root, sum);
    cout << " sum " << sum << ": " << (result ? "true" : "false") << endl;
    return 0;
} Output
```



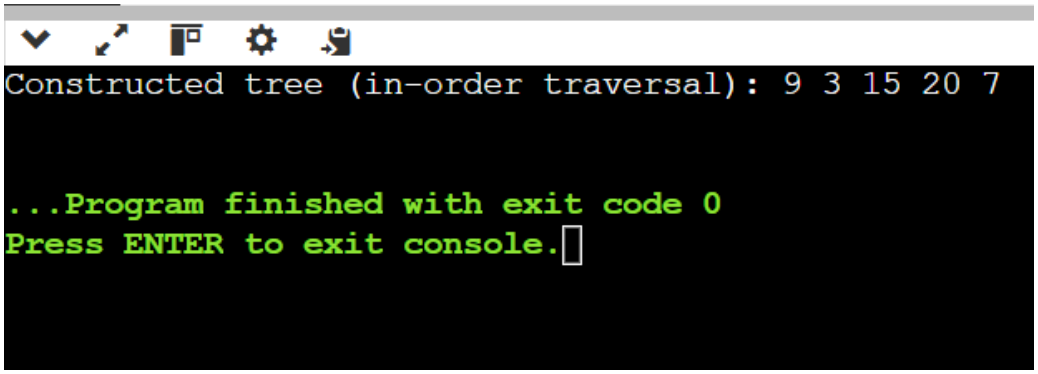
Q6. Constructed tree (in-order traversal)

Ans

```
#include <iostream>
#include <vector>
#include <unordered_map>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
TreeNode* buildTreeHelper(vector<int>& inorder, vector<int>& postorder, int inStart, int inEnd, int& postIndex, unordered_map<int, int>& inMap) {
    if (inStart > inEnd) {
        return nullptr;
    }
    int rootVal = postorder[postIndex--];
    TreeNode* root = new TreeNode(rootVal);
    int inIndex = inMap[rootVal];
    root->right = buildTreeHelper(inorder, postorder, inIndex + 1, inEnd, postIndex, inMap);
    root->left = buildTreeHelper(inorder, postorder, inStart, inIndex - 1, postIndex, inMap);

    return root;
}
```

```
TreeNode* buildTree(vector<int>& inorder, vector<int>& postorder) {
    unordered_map<int, int> inMap;
    for (int i = 0; i < inorder.size(); ++i) {
        inMap[inorder[i]] = i;
    }
    int postIndex = postorder.size() - 1;
    return buildTreeHelper(inorder, postorder, 0, inorder.size() - 1, postIndex,
inMap);
}
void printInOrder(TreeNode* root) {
    if (root == nullptr) {
        return;
    }
    printInOrder(root->left);
    cout << root->val << " ";
    printInOrder(root->right);
}
int main() {
    vector<int> inorder = {9, 3, 15, 20, 7};
    vector<int> postorder = {9, 15, 7, 20, 3};
    TreeNode* root = buildTree(inorder, postorder);
    cout << "Constructed tree (in-order traversal): ";
    printInOrder(root);
    cout << endl;
    return 0;
}
```

Output



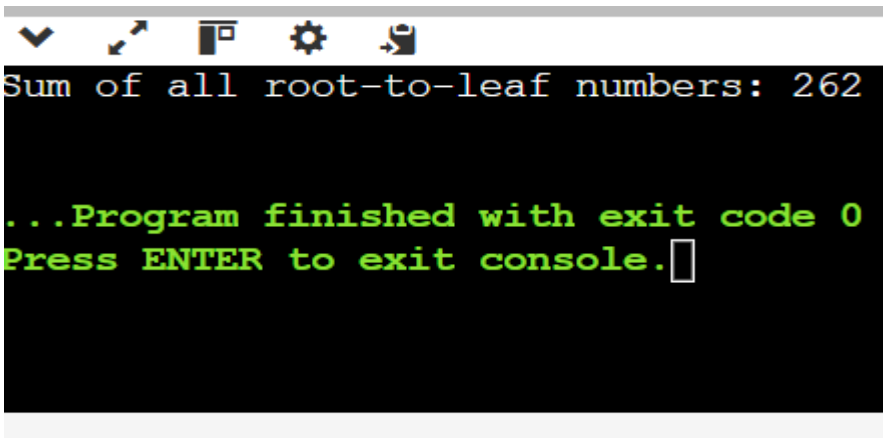
Q7. Sum of all root leaf no.

Ans

```
#include <iostream>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
int sumNumbersHelper(TreeNode* root, int currentSum) {
    if (root == nullptr) {
        return 0;
    }
    currentSum = currentSum * 10 + root->val;
    if (root->left == nullptr && root->right == nullptr) {
        return currentSum;
    }
    return sumNumbersHelper(root->left, currentSum) +
sumNumbersHelper(root->right, currentSum);
```

```
}

int sumNumbers(TreeNode* root) {
    return sumNumbersHelper(root, 0);
}
TreeNode* createExampleTree() {
    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);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    int result = sumNumbers(root);
    cout << "Sum of all root-to-leaf numbers: " << result << endl;
    return 0;
}
```

Output



Q8. Zigzag level order traversal

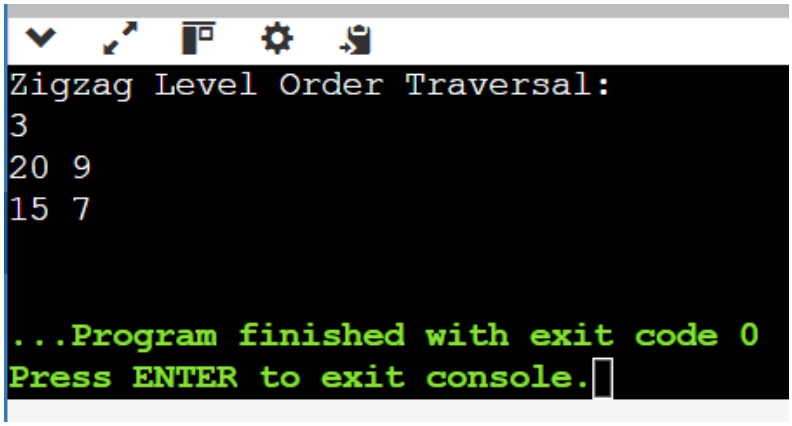
Ans

```
#include <iostream>
#include <vector>
#include <deque>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
vector<vector<int>> zigzagLevelOrder(TreeNode* root) {
    vector<vector<int>> result;
    if (root == nullptr) {
        return result;
    }
    deque<TreeNode*> dq;
    dq.push_back(root);
    bool leftToRight = true;
    while (!dq.empty()) {
        int levelSize = dq.size();
        vector<int> level(levelSize);
        for (int i = 0; i < levelSize; ++i) {
            TreeNode* node;
            if (leftToRight) {
```

```
            node = dq.front();
            dq.pop_front();
            level[i] = node->val;
            if (node->left) dq.push_back(node->left);
            if (node->right) dq.push_back(node->right);
        } else {
            node = dq.back();
            dq.pop_back();
            level[i] = node->val;
            if (node->right) dq.push_front(node->right);
            if (node->left) dq.push_front(node->left);
        }
    }
    result.push_back(level);
    leftToRight = !leftToRight;
  }
  return result;
}
TreeNode* createExampleTree() {
  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);
  return root;
}
```

```
int main() {
    TreeNode* root = createExampleTree();
    vector<vector<int>> result = zigzagLevelOrder(root);

    cout << "Zigzag Level Order Traversal: " << endl;
    for (const auto& level : result) {
        for (int val : level) {
            cout << val << " ";
        }
        cout << endl;
    }

    return 0;
}
```

Output



Q9. Given a binary search tree (BST), write a function to find the kth smallest element in the tree.

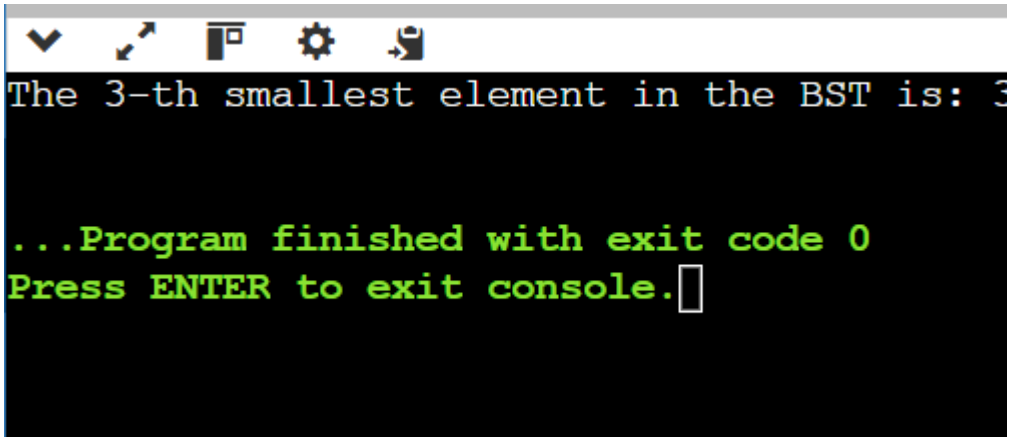
Ans

```
#include <iostream>
```

```
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
void inorder(TreeNode* root, int& k, int& result) {
    if (root == nullptr) {
        return;
    }

    inorder(root->left, k, result);

    if (--k == 0) {
        result = root->val;
        return;
    }

    inorder(root->right, k, result);
}
int kthSmallest(TreeNode* root, int k) {
    int result = -1;
    inorder(root, k, result);
    return result;
}
```

```
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(5);
    root->left = new TreeNode(3);
    root->right = new TreeNode(6);
    root->left->left = new TreeNode(2);
    root->left->right = new TreeNode(4);
    root->left->left->left = new TreeNode(1);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    int k = 3;
    int result = kthSmallest(root, k);
    cout << "The " << k << "-th smallest element in the BST is: " << result << endl;
    return 0;
}
```

Output



Q10. Sum of all nodes given the root of binary tree

Ans

```
#include <iostream>
using namespace std;
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
int sumOfNodes(TreeNode* root) {
    if (root == nullptr) {
        return 0;
    }
    return root->val + sumOfNodes(root->left) + sumOfNodes(root->right);
}
TreeNode* createExampleTree() {
    TreeNode* root = new TreeNode(1);
    root->left = new TreeNode(2);
    root->right = new TreeNode(3);
    root->left->right = new TreeNode(5);
    root->right->right = new TreeNode(6);
    return root;
}
int main() {
    TreeNode* root = createExampleTree();
    int sum = sumOfNodes(root);
    cout << "Sum of all nodes: " << sum << endl;
```

```
    return 0;
}
```

Output