Assignment -03

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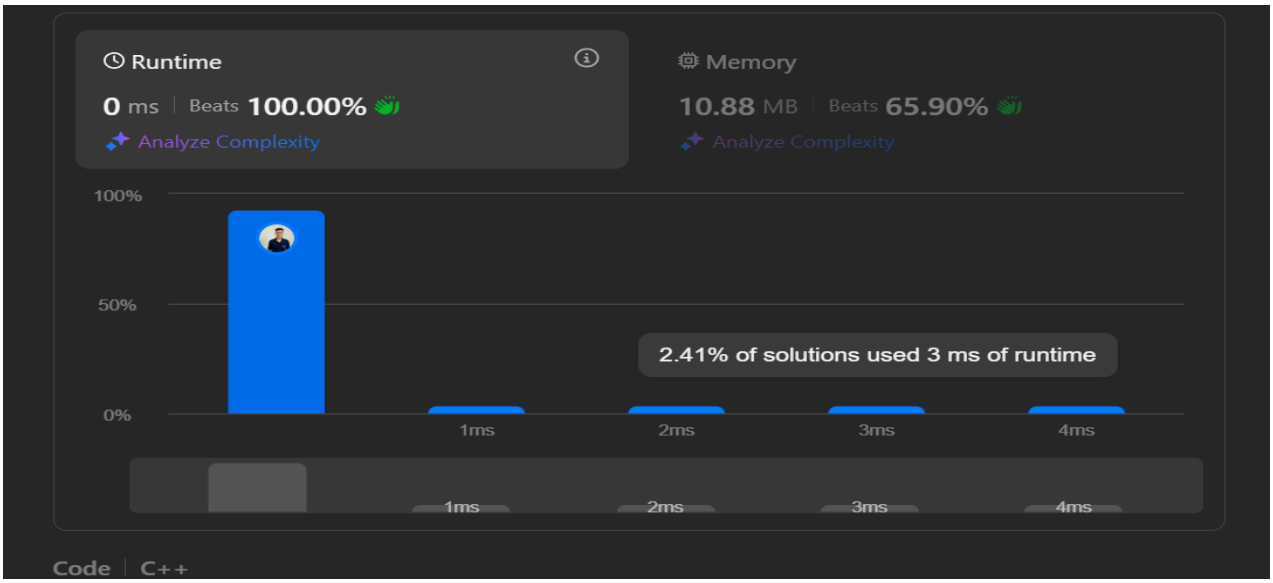
Semester: 6th **Subject Code:** 22CSP-351

Subject Name: Advanced Programming lab - 2

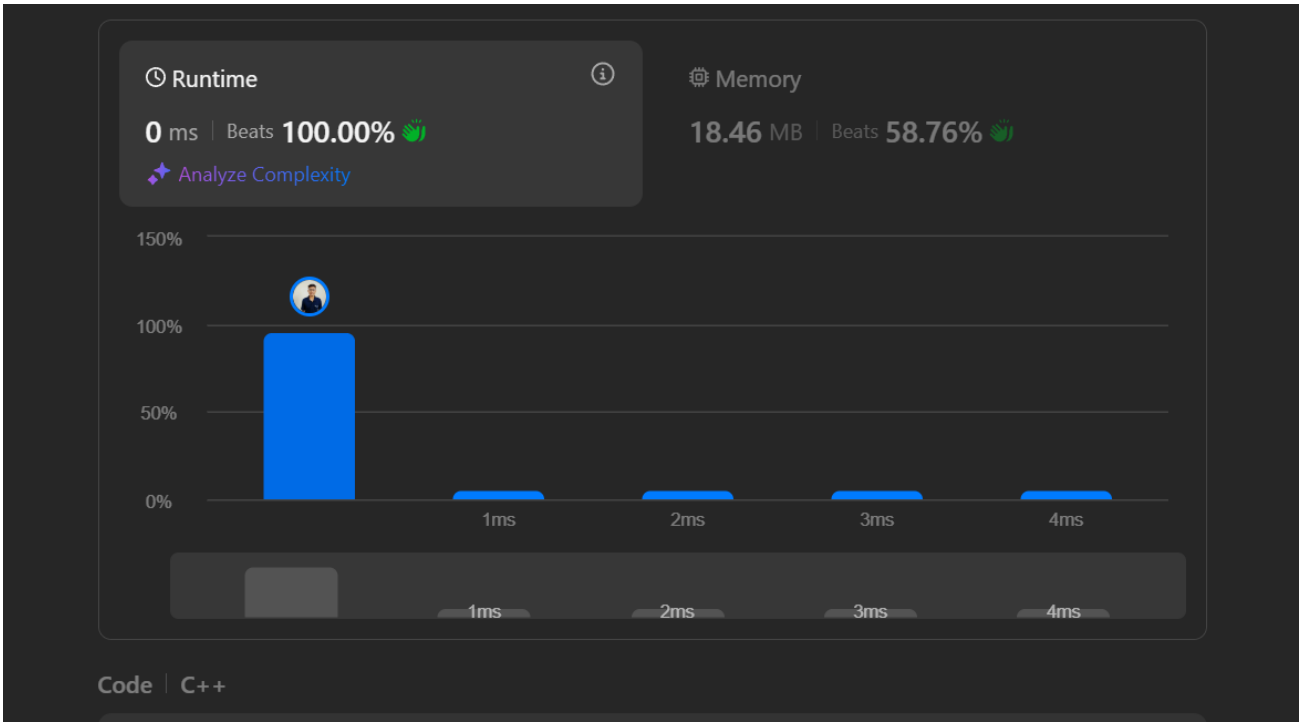
1 BINARY TREE INORDER TRAVERSAL

```
class Solution {
public:
    void inOrder(TreeNode* root , vector<int> &arr){
        if(root==nullptr) return;

        inOrder(root->left,arr);
        arr.push_back(root->val);
        inOrder(root->right,arr);
      }
      vector<int> inorderTraversal(TreeNode* root) {
        vector<int> ans;
        inOrder(root, ans);
        return ans;
    }
};
```



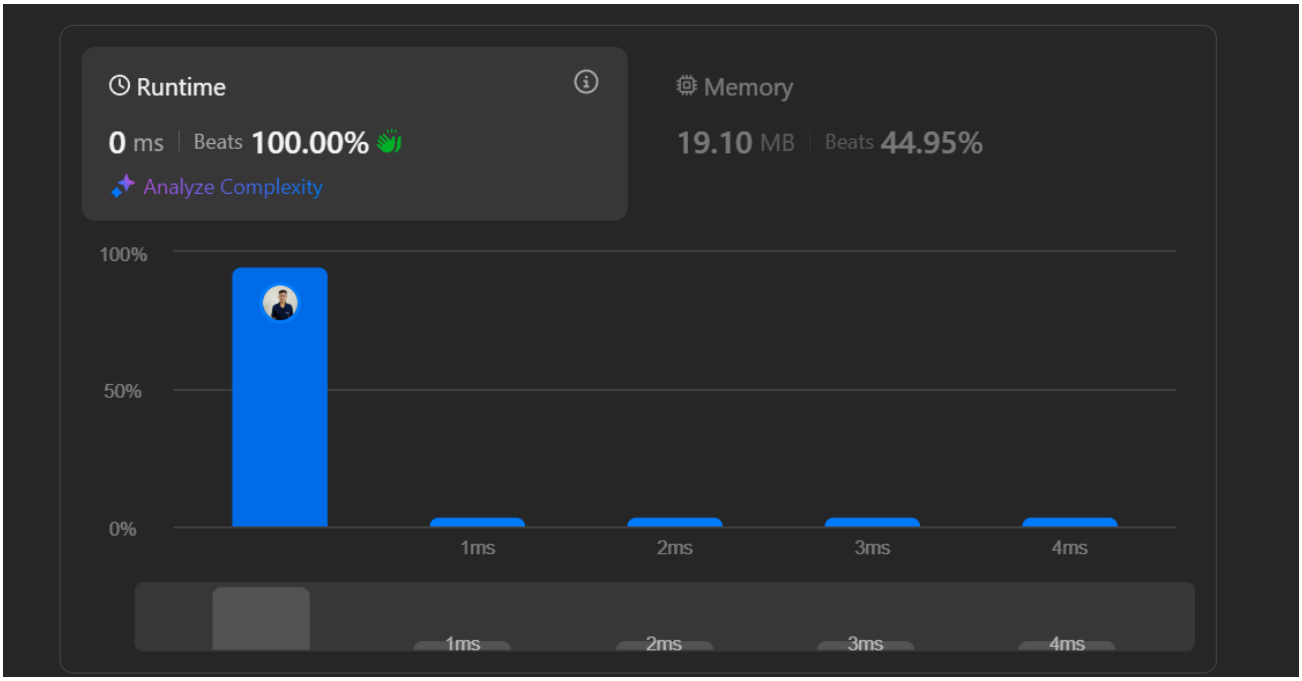
2. SYMMETRIC TREE

```
class Solution {
public:
    bool isSymmetric(TreeNode* root) {
        if (!root) {
            return true;
        }
        return isSymmetricUtil(root->left, root->right);
    }

    bool isSymmetricUtil(TreeNode* root1, TreeNode* root2) {
        if (root1 == NULL || root2 == NULL) {
            return root1 == root2;
        }
        return (root1->val == root2->val) &&
               isSymmetricUtil(root1->left, root2->right) &&
               isSymmetricUtil(root1->right, root2->left);
    }
};
```



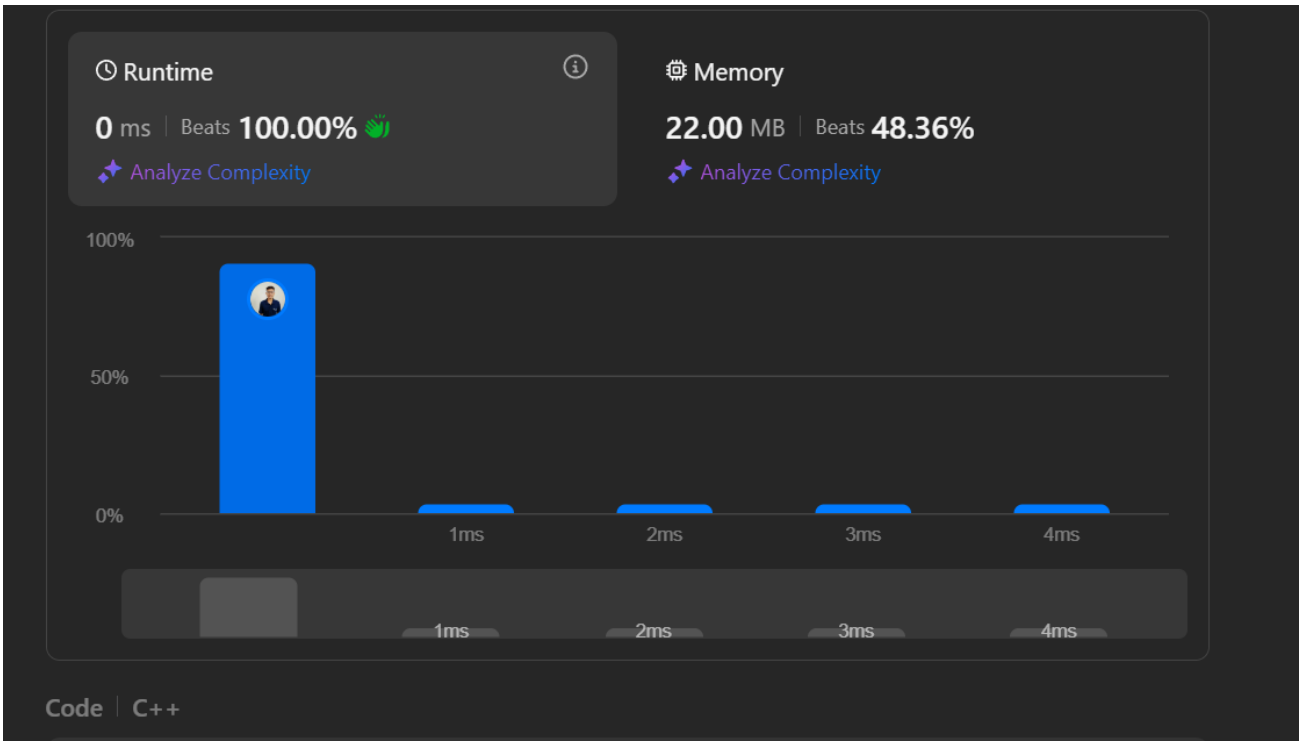
3 MAXIMUM DEPTH OF BINARY TREE

```
class Solution {
public:
   int maxDepth(TreeNode* root) {

      if(root==nullptr){
        return 0;
      }

      int lh=maxDepth(root->left);
      int rh=maxDepth(root->right);

      return  1+ max(lh,rh);

   }
};
```



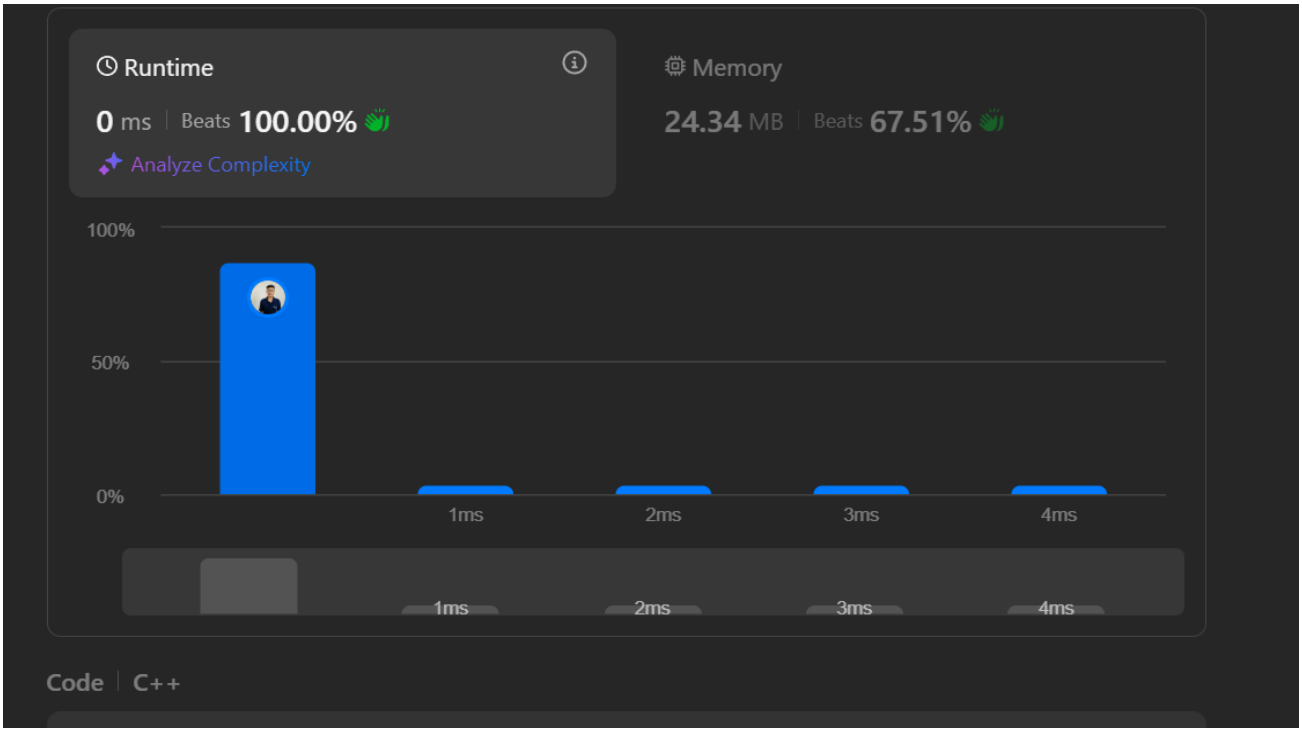
4. VALIDATE BINARY SEARCH TREE

```
class Solution {
public:
    bool isValid(TreeNode* root, long minVal, long maxVal) {
        if (!root)
            return true;
        if (root->val <= minVal || root->val >= maxVal)
            return false;
        return isValid(root->left, minVal, root->val) &&
               isValid(root->right, root->val, maxVal);
    }

    bool isValidBST(TreeNode* root) {
        return isValid(root, LONG_MIN, LONG_MAX);
    }
};
```



5. K th SMALLEST ELEMENT IN A BINARY TREE

```
class Solution {
  void inorder(TreeNode* root, int& counter, int k, int& kSmallest) {
      if (!root || counter >= k) return;

      inorder(root->left, counter, k, kSmallest);

      if (++counter == k) {
         kSmallest = root->val;
         return;
      }

      inorder(root->right, counter, k, kSmallest);
   }
public:
   int kthSmallest(TreeNode* root, int k) {
      int kSmallest = INT_MIN, counter = 0;
      inorder(root, counter, k, kSmallest);
      return kSmallest;
   }
};
```

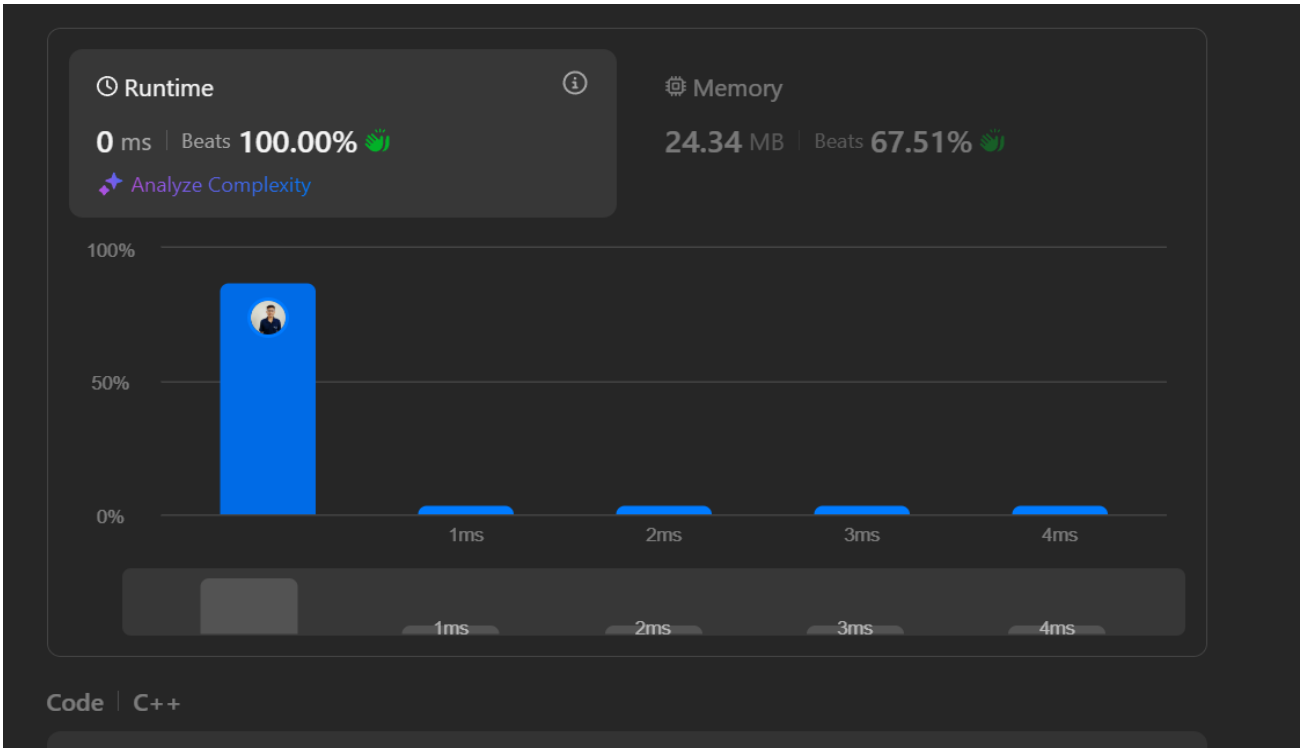


6. BINARY TREE LEVEL ORDER TRAVERSAL

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

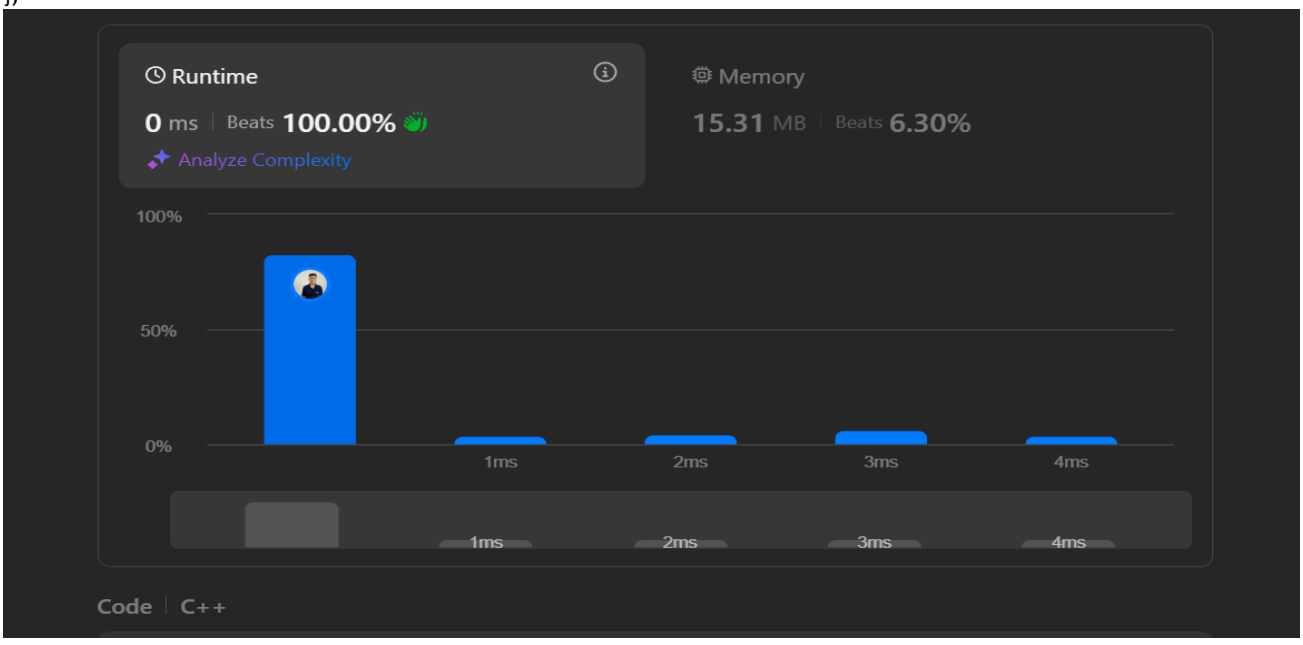
7. BINARY TREE LEVEL ORDER TRAVERSAL II

```
class Solution {
public:
    vector<vector<int>> levelOrderBottom(TreeNode* root) {
        if (!root) return {};
        vector<vector<int>> result;
        queue<TreeNode*> q;
        q.push(root);

        while (!q.empty()) {
            int size = q.size();
            vector<int> level;
            for (int i = 0; i < size; ++i) {
                TreeNode* node = q.front();
                q.pop();
                level.push_back(node->val);
                if (node->left) q.push(node->left);
                if (node->right) q.push(node->right);
            }
            result.push_back(level);
        }
        reverse(result.begin(), result.end());
        return result;
    }
};
```



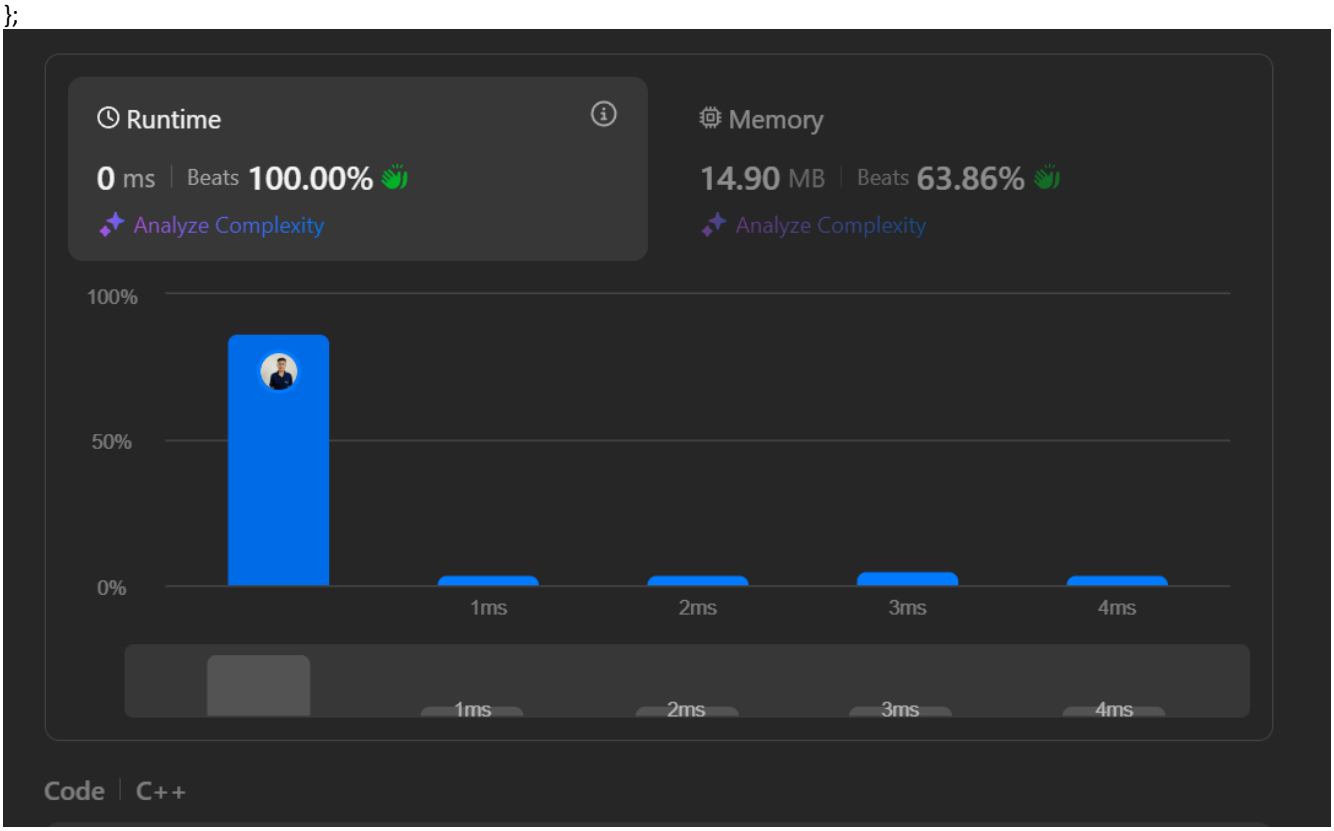
8. BINARY TREE ZIGZAG LEVEL ORDER TRAVERSAL

```
class Solution {
public:
    vector<vector<int>> zigzagLevelOrder(TreeNode* root){
        vector<vector<int>> result;
        if(root == NULL){
            return result;
        }
        queue<TreeNode*> nodesQueue;
        nodesQueue.push(root);
        bool leftToRight = true;
        while(!nodesQueue.empty()){
            int size = nodesQueue.size();
            vector<int> row(size);
            for(int i = 0; i < size; i++){
                TreeNode* node = nodesQueue.front();
                nodesQueue.pop();
                int index = leftToRight ? i : (size - 1 - i);
                row[index] = node->val;
                if(node->left){
                    nodesQueue.push(node->left);
                }
                if(node->right){
                    nodesQueue.push(node->right);
                }
            }
            leftToRight = !leftToRight;
            result.push_back(row);
        }
        return result;
    }
};
```



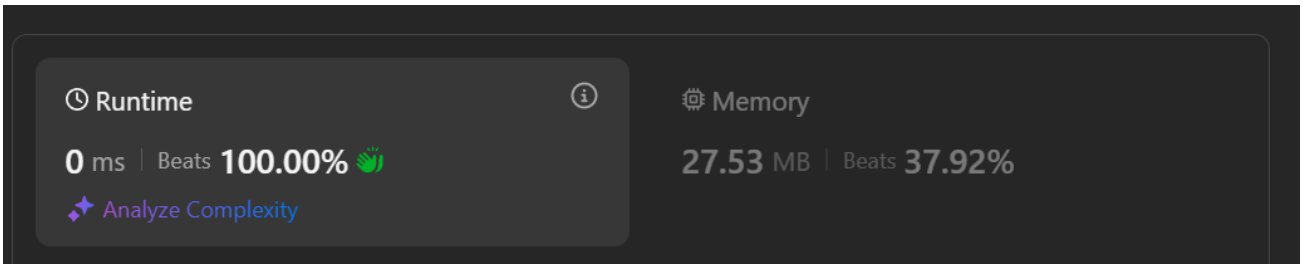
9. BINARY TREE RIGHT SIDE VIEW

```
class Solution {
public:
    vector<int> rightSideView(TreeNode* root) {
        vector<int> res;

        recursionRight(root, 0, res);

        return res;
    }
    void recursionRight(TreeNode* root, int level, vector<int>& res) {
        if (root == NULL) {
            return;
        }

        if (res.size() == level) {
            res.push_back(root->val);
        }
        recursionRight(root->right, level + 1, res);
        recursionRight(root->left, level + 1, res);
    }
};
```



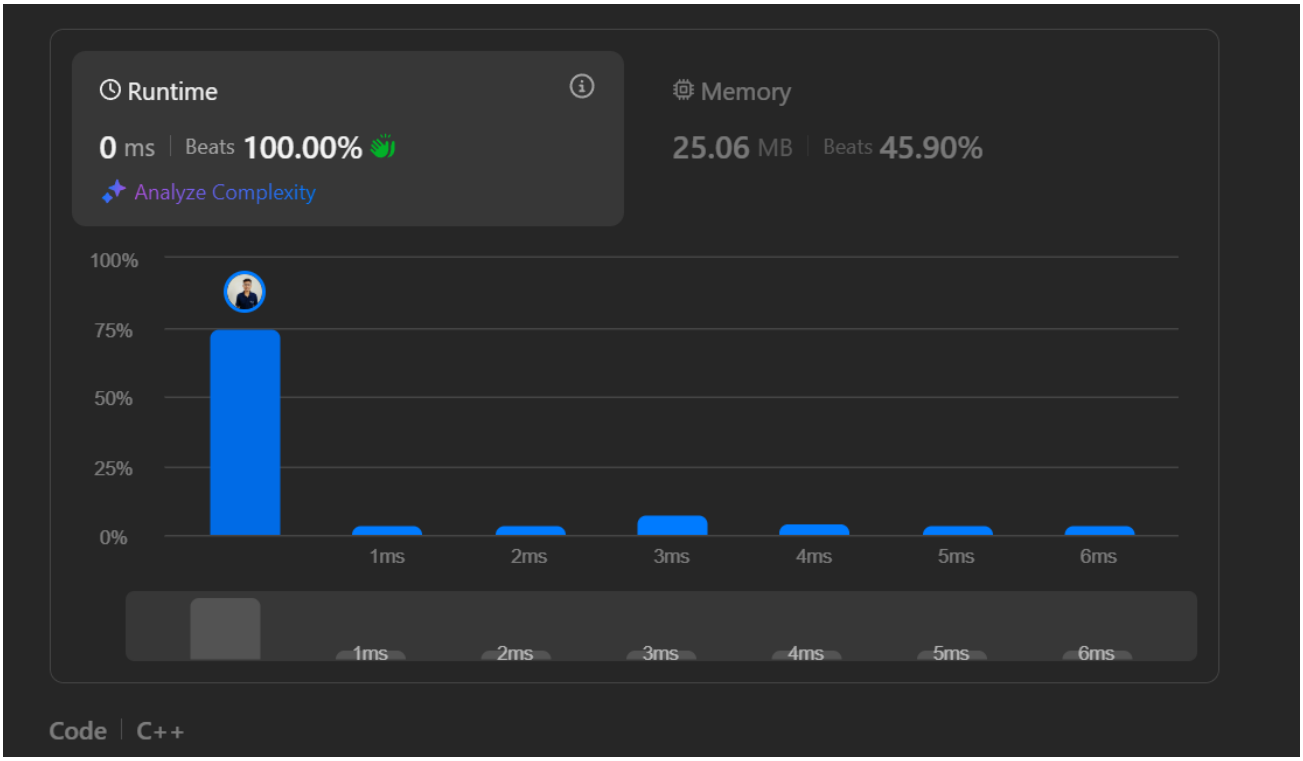
10. CONSTRUCT BINARY TREE FROM INORDER AND POSTORDER

```
class Solution {
public:
    TreeNode* buildTree(vector<int>& inorder, vector<int>& postorder) {
        if (inorder.size() != postorder.size()) {
            return NULL;
        }

        map<int, int> hm;
        for (int i = 0; i < inorder.size(); i++) {
            hm[inorder[i]] = i;
        }

        return buildTreePostIn(inorder, 0, inorder.size() - 1, postorder, 0,
                               postorder.size() - 1, hm);
    }

    TreeNode* buildTreePostIn(vector<int>& inorder, int is, int ie,
                              vector<int>& postorder, int ps, int pe,
                              map<int, int>& hm) {

        if (ps > pe || is > ie) {
            return NULL;
        }

        TreeNode* root = new TreeNode(postorder[pe]);

        int inRoot = hm[postorder[pe]];
        int numsLeft = inRoot - is;

        root->left = buildTreePostIn(inorder, is, inRoot - 1, postorder, ps,
                                     ps + numsLeft - 1, hm);

        root->right = buildTreePostIn(inorder, inRoot + 1, ie, postorder,
                                      ps + numsLeft, pe - 1, hm);

        return root;
    }
};
```



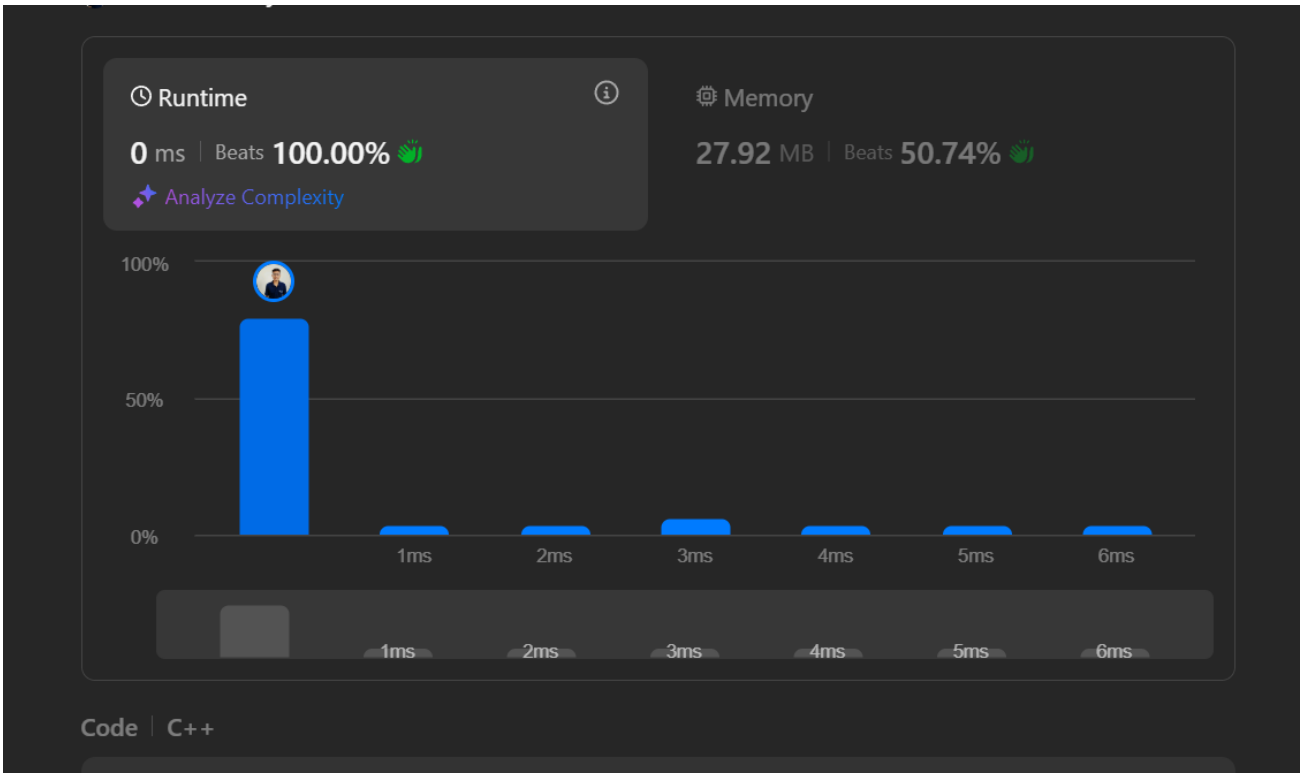
11. FIND BOTTOM LEFT TREE VALUE

```
class Solution {
public:
    int findBottomLeftValue(TreeNode* root) {
        int last=0;
        queue<TreeNode*> q;
        q.push(root);
        while(!q.empty())
        {
            int count=q.size();
            for(int i=0;i<count;i++)
            {
                TreeNode* curr=q.front();
                q.pop();
                if(i==0)
                    last=curr->val;
                if(curr->left)
                    q.push(curr->left);
                if(curr->right)
                    q.push(curr->right);
            }
        }
        return last;
    }
};
```



12. BINARY TREE MAXIMUM PATH SUM

```
class Solution {
public:
    int findMaxPathSum(TreeNode* root, int &maxi) {
        if (root == nullptr) {
            return 0;
        }
        int leftMaxPath = max(0, findMaxPathSum(root->left, maxi));
        int rightMaxPath = max(0, findMaxPathSum(root->right, maxi));
        maxi = max(maxi, leftMaxPath + rightMaxPath + root->val);
        return max(leftMaxPath, rightMaxPath) + root->val;
    }

    int maxPathSum(TreeNode* root) {
        int maxi = INT_MIN;
        findMaxPathSum(root, maxi);
        return maxi;
    }

};
```



13. VERTICAL ORDER TRAVERSAL OF BINARY TREE

```
class Solution {
public:
    vector<vector<int>> verticalTraversal(TreeNode* root){
        map<int, map<int, multiset<int>>> nodes;
        queue<pair<TreeNode*, pair<int, int>>> todo;
        todo.push({root, {0, 0}});

        while(!todo.empty()){
            auto p = todo.front();
            todo.pop();
            TreeNode* temp = p.first;
            int x = p.second.first;
            int y = p.second.second;
            nodes[x][y].insert(temp->val);

            if(temp->left){
                todo.push({temp->left, {x-1, y+1}});
            }

            if(temp->right){
                todo.push({temp->right, {x+1, y+1}});
            }
        }

        vector<vector<int>> ans;
        for(auto p: nodes){
            vector<int> col;
            for(auto q: p.second){
                col.insert(col.end(), q.second.begin(), q.second.end());
            }
            ans.push_back(col);
        }
        return ans;
    }
};
```