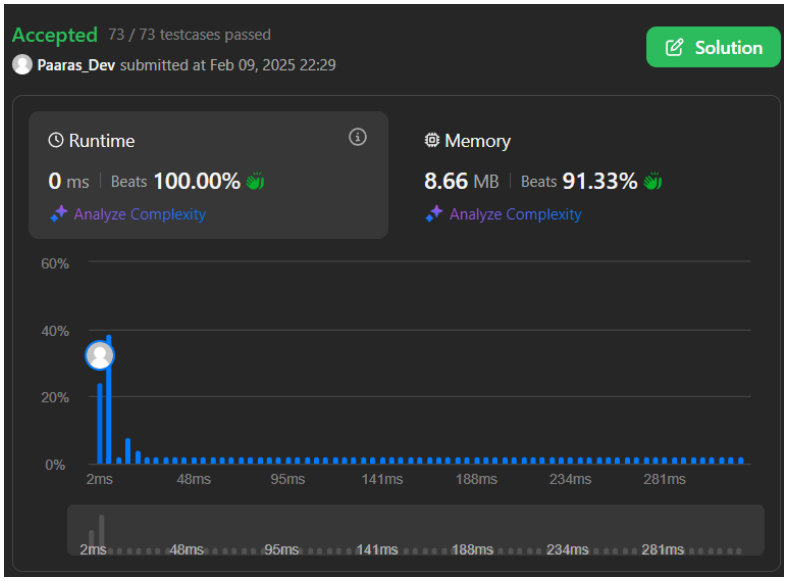
ASSIGNMENT -1 (ADVANCED PROGRAMMING)

1. **Problem 1:** Binary Tree In Order Traversal
2. **Implementation/Code:**

```
class Solution {

    public List<Integer> inorder(TreeNode root, List<Integer> list){
        if(root == null)return list;
        inorder(root.left,list);
        list.add(root.val);
        inorder(root.right,list);
        return list;
    }
    public List<Integer> inorderTraversal(TreeNode root) {
        List<Integer> list = new ArrayList<Integer>();
        return inorder(root,list);    }
}
```

3. **Output:**

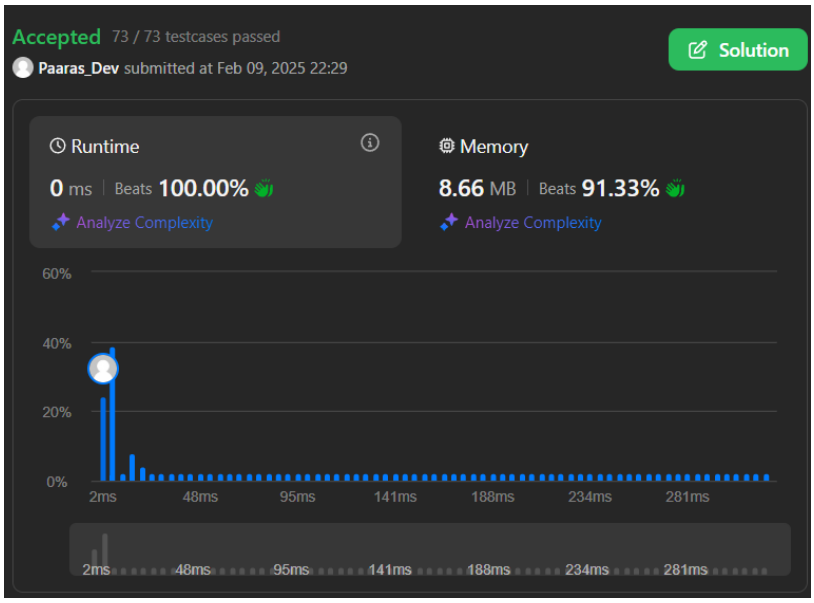


1. **Problem 2:** Symmetric Tree

2. **Implementation/Code:**

```
class Solution {
    public boolean isSymmetric(TreeNode root) {
        if (root == null) {
            return true;        }
        return isMirror(root.left, root.right);    }
    private boolean isMirror(TreeNode node1, TreeNode node2) {
        if (node1 == null && node2 == null) {
            return true;        }
        if (node1 == null || node2 == null) {
            return false;        }
        if (node1.val != node2.val) {
            return false;        }
        return isMirror(node1.left, node2.right) && isMirror(node1.right,
node2.left);    }}
```

3. **Output:**

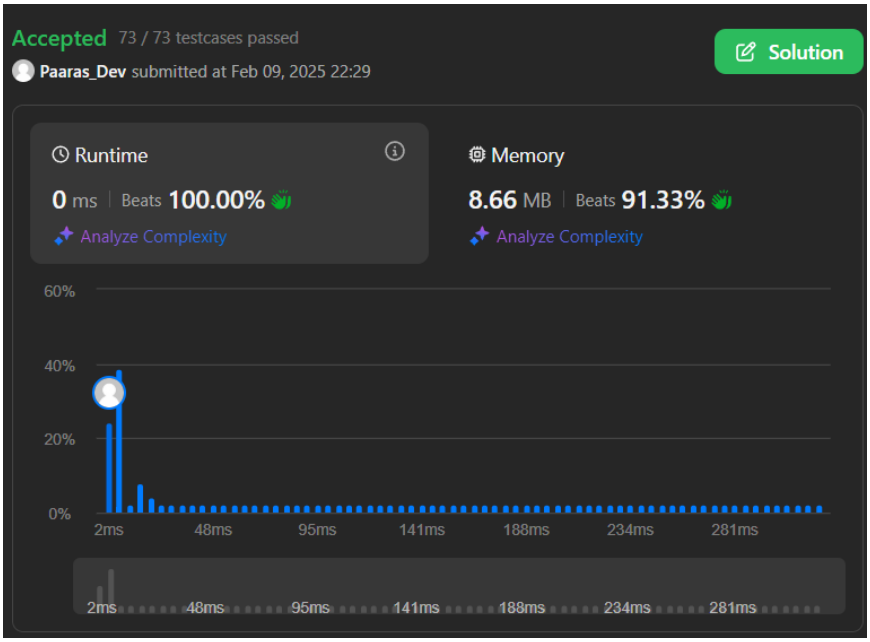


1. **Problem 3:** Maximum Depth of Binary Tree

2. **Implementation/code:**

```
public class Solution {
    public int maxDepth(TreeNode root) {
        return height(root);    }
    private int height(TreeNode node) {
        if (node == null) return 0;
        int leftHeight = height(node.left);
        int rightHeight = height(node.right);
        return 1 + Math.max(leftHeight, rightHeight);
    }
}
```

3. **Output:**

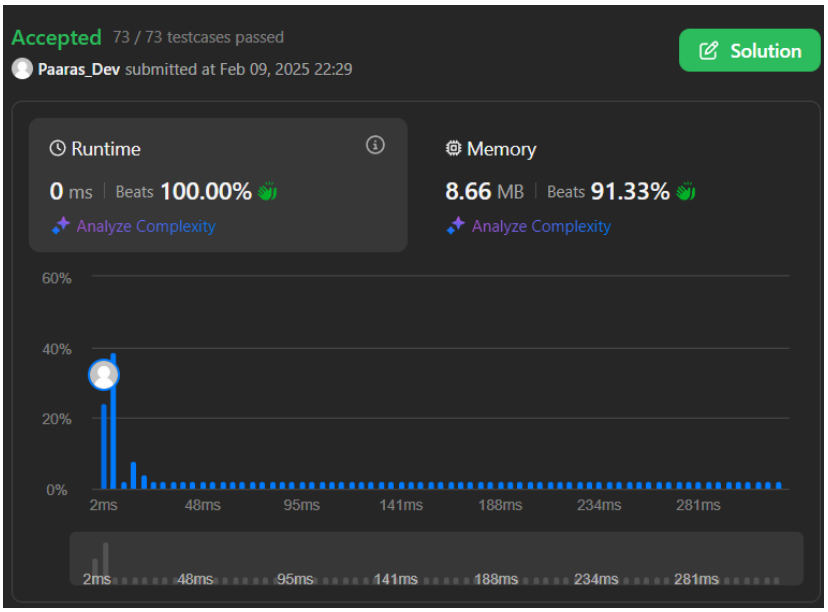


1. **Problem 4:** Validate Binary search Tree

2. **Implementation/code:**

```
class Solution {
    private long minVal = Long.MIN_VALUE;
    public boolean isValidBST(TreeNode root) {
        if (root == null) return true;
        if (!isValidBST(root.left)) return false;
        if (minVal >= root.val) return false;
        minVal = root.val;
        if (!isValidBST(root.right)) return false;
        return true;    } }
```

3. **Output:**



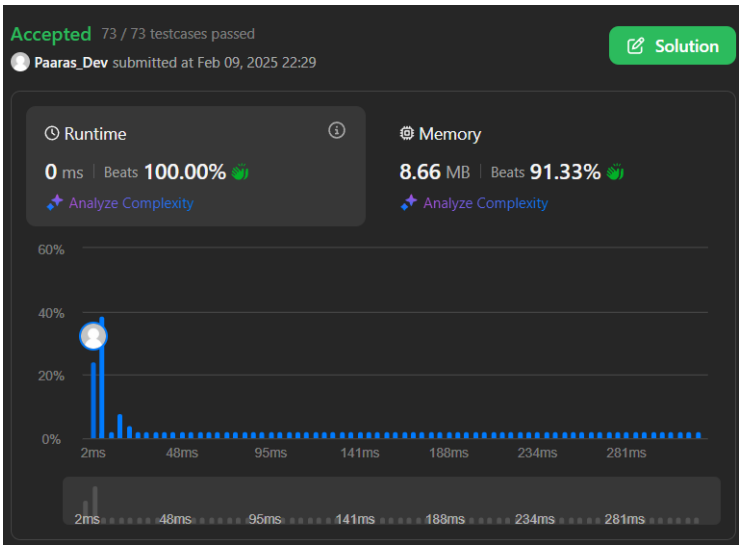
1. **Problem 5:** Kth Smallest Element in a BST

2. **Implementation/Code:**

```
class Solution {
    public int kthSmallest(TreeNode root, int k) {
      int count = countNodes(root.left);
      if (k <= count) {
          return kthSmallest(root.left, k);
      } else if (k > count + 1) {
          return kthSmallest(root.right, k-1-count);
      }
      return root.val; }
   public int countNodes(TreeNode n) {
      if (n == null) return 0;

      return 1 + countNodes(n.left) + countNodes(n.right);
   }}
```

3. **Output:**

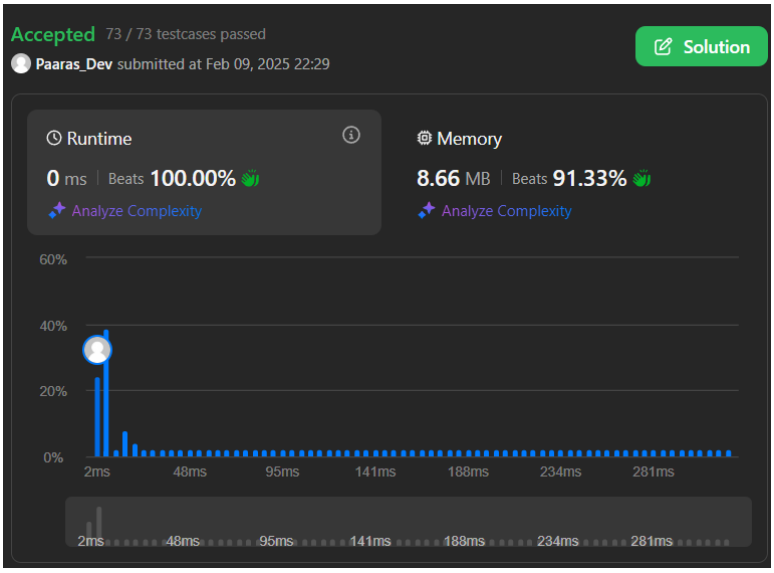


1. **Problem 6:** Binary Tree Level Order Traversal

2. **Implementation/Code:**

```
class Solution {
    public List<List<Integer>> levelOrder(TreeNode root) {
        List<List<Integer>> result = new ArrayList<>();
        if (root == null) return result;
        Queue<TreeNode> queue = new LinkedList<>();
        queue.offer(root);
        while (!queue.isEmpty()) {
            int size = queue.size();
            List<Integer> level = new ArrayList<>();
            for (int i = 0; i < size; i++) {
                TreeNode node = queue.poll();
                level.add(node.val);
                if (node.left != null) queue.offer(node.left);
                if (node.right != null) queue.offer(node.right);     }
            result.add(level); }
        return result;    }}
```

3. **Output:**

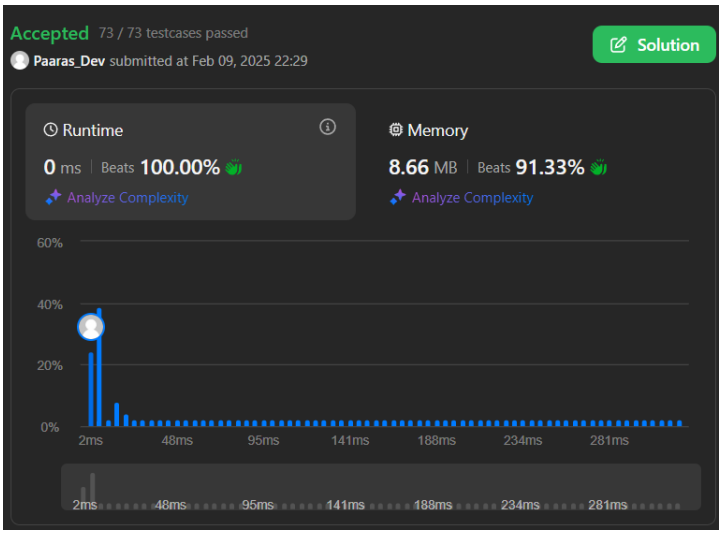


1. **Problem 7:** Binary Tree Level Order Traversal II

2. **Implementation/code:**

```
class Solution {
    public List<List<Integer>> levelOrderBottom(TreeNode root) {
        List<List<Integer>> result = new LinkedList<>();
        if (root == null) return result;
        Queue<TreeNode> queue = new LinkedList<>();
        queue.add(root);
        while (!queue.isEmpty()) {
            List<Integer> level = new ArrayList<>();
            int size = queue.size();
            for (int i = 0; i < size; i++) {
                TreeNode node = queue.poll();
                level.add(node.val);
                if (node.left != null) queue.add(node.left);
                if (node.right != null) queue.add(node.right);          }
            result.add(0, level);        }
        return result;    }}
```

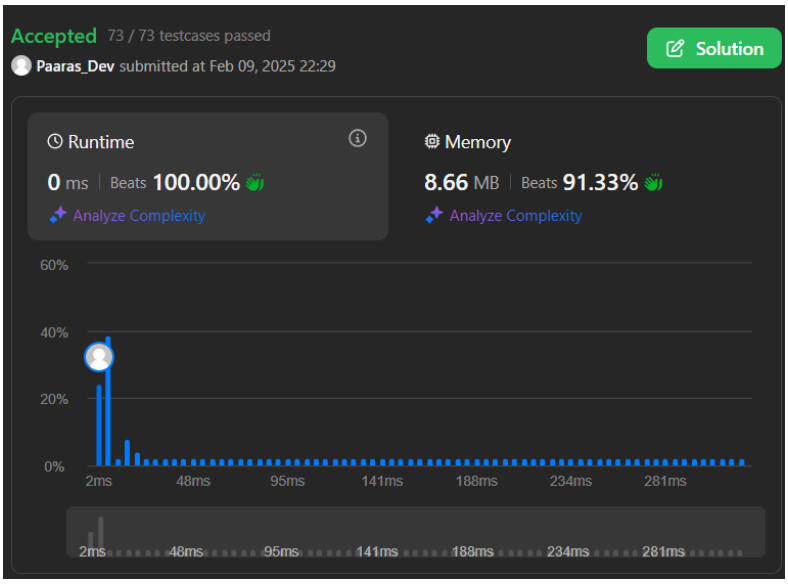
3. **Output:**



1. **Problem 8:** Binary Tree Zig Zag Level Order Traversal
2. **Implementation/code:**

```
class Solution {
    public List<List<Integer>> zigzagLevelOrder(TreeNode root) {
        List<List<Integer>> res = new ArrayList<>();
        if (root == null) return res;
        Queue<TreeNode> queue = new LinkedList<>();
        queue.add(root);
        boolean leftToRight = true;
        while (!queue.isEmpty()) {
            int size = queue.size();
            LinkedList<Integer> level = new LinkedList<>();
            for (int i = 0; i < size; i++) {
                TreeNode node = queue.poll();
                if (leftToRight) level.addLast(node.val);
                else level.addFirst(node.val);
                if (node.left != null) queue.add(node.left);
                if (node.right != null) queue.add(node.right);  }
            res.add(level);
            leftToRight = !leftToRight;  }
        return res;  }}
```

3. **Output:**

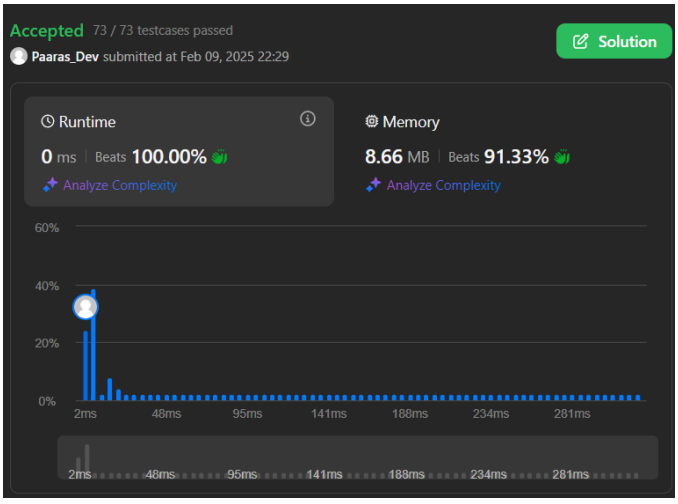


1. **Problem 9:** Binary Tree Right Side View

2. **Implementation/code:**

```
class Solution {
    public List<Integer> rightSideView(TreeNode root) {
        List<Integer> res = new ArrayList<>();
        if (root == null) return res;
        Queue<TreeNode> queue = new LinkedList<>();
        queue.add(root);
        while (!queue.isEmpty()) { int size = queue.size();
            for (int i = 0; i < size; i++) {
                TreeNode node = queue.poll();
                if (i == size - 1) res.add(node.val);
                if (node.left != null) queue.add(node.left);
                if (node.right != null) queue.add(node.right);  } }
        return res; }}
```

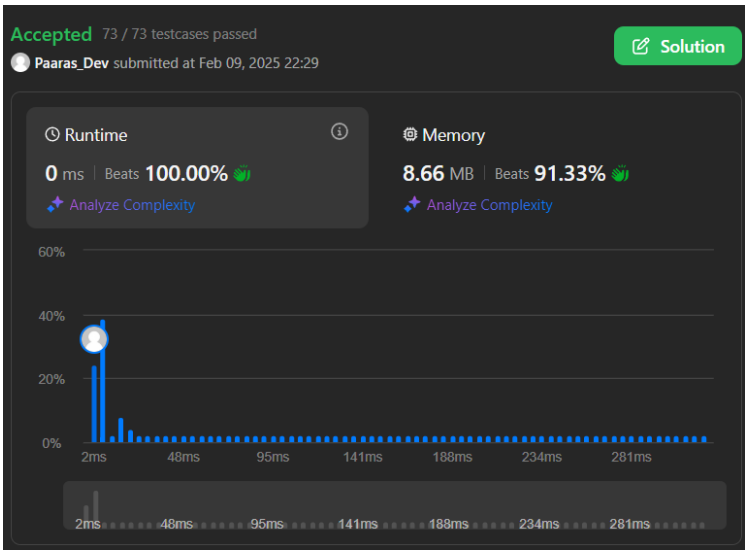
3. **Output:**



1. **Problem 10:** Construct Binary Tree From Inorder and Postorder Traversal
2. **Code:**

```
import java.util.*;
class Solution {
    int postIndex;
    Map<Integer, Integer> inMap;
    public TreeNode buildTree(int[] inorder, int[] postorder) {
        inMap = new HashMap<>();
        postIndex = postorder.length - 1;
        for (int i = 0; i < inorder.length; i++) {
            inMap.put(inorder[i], i); }
        return build(postorder, 0, inorder.length - 1); }
    private TreeNode build(int[] postorder, int inStart, int inEnd) {
        if (inStart > inEnd) return null;
        int rootVal = postorder[postIndex--];
        TreeNode root = new TreeNode(rootVal);
        int inIndex = inMap.get(rootVal);
        root.right = build(postorder, inIndex + 1, inEnd);
        root.left = build(postorder, inStart, inIndex - 1);
        return root; }}
```

3. **Output:**



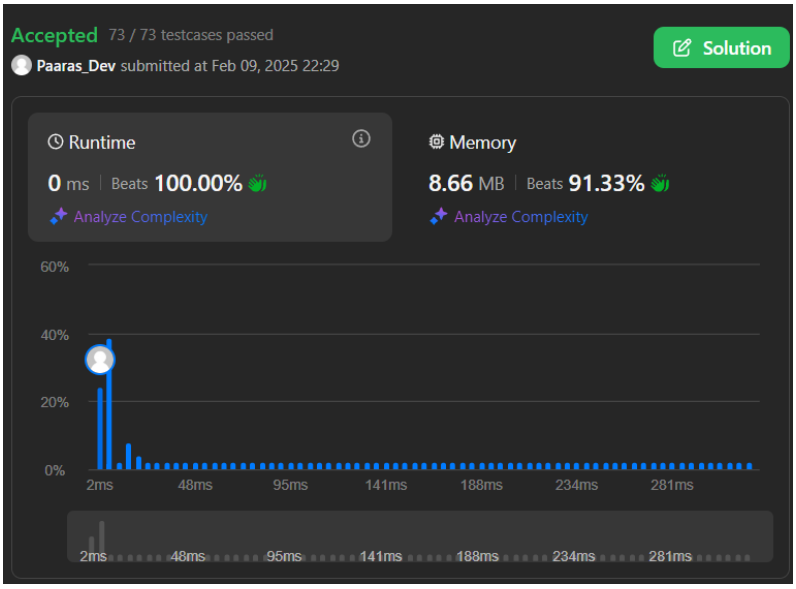
1. **Problem 11:** Find Bottom Left Tree Value
2. **Code:**

```
class Solution {
    public int findBottomLeftValue(TreeNode root) {
        Queue<TreeNode> queue = new LinkedList<>();
        queue.add(root);
        int bottomLeft = root.val;

        while (!queue.isEmpty()) {
            TreeNode node = queue.poll();
            bottomLeft = node.val;

            if (node.right != null) queue.add(node.right);
            if (node.left != null) queue.add(node.left);
        }
        return bottomLeft;
    }}
```

3. **Output:**

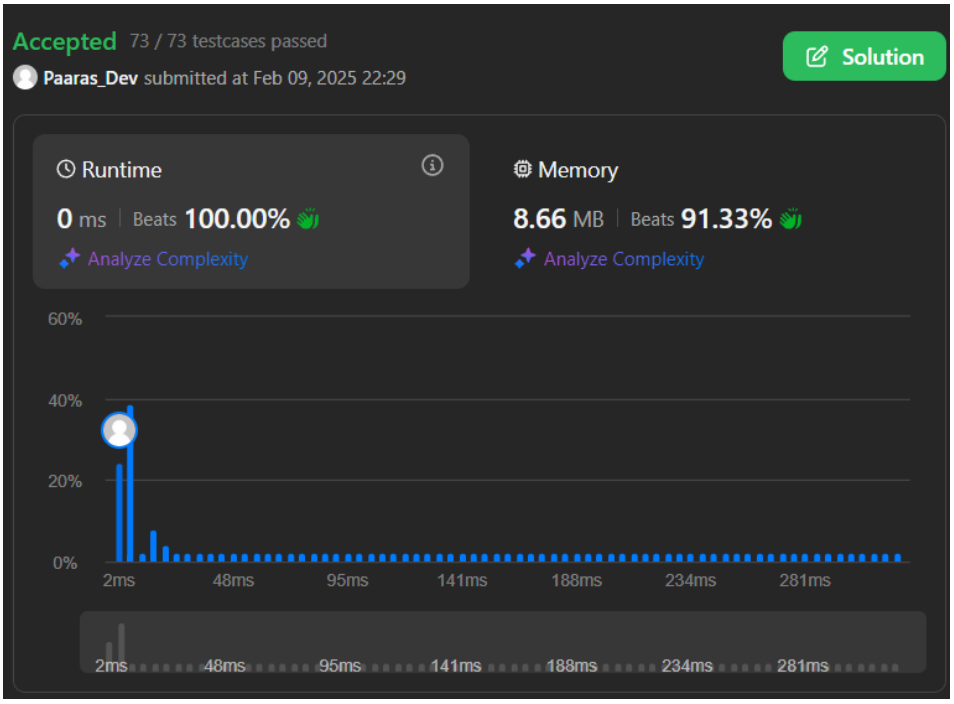


1. **Problem 12:** Binary Tree Maximum Path Sum

2. **Code:**

```
class Solution {
    int maxSum = Integer.MIN_VALUE;
    public int maxPathSum(TreeNode root) {
        dfs(root);
        return maxSum;    }
    private int dfs(TreeNode node) {
        if (node == null) return 0;
        int left = Math.max(0, dfs(node.left));
        int right = Math.max(0, dfs(node.right));
        maxSum = Math.max(maxSum, left + right + node.val);
        return node.val + Math.max(left, right); }}
```

3. **Output:**



1. **Problem 13:** Vertical Order Traversal of Binary Tree

2. **Code:**

```
class Solution {

    Map<Integer, TreeMap<Integer, PriorityQueue<Integer>>> map;

    public List<List<Integer>> verticalTraversal(TreeNode root) {
        if (root == null)
            return null;
        map = new TreeMap<>();
        dfs(root, 0, 0);
        List<List<Integer>> res = new LinkedList<>();
        for (int key : map.keySet()){
            List<Integer> list = new LinkedList<>();
            TreeMap<Integer, PriorityQueue<Integer>> tm = map.get(key);
            for (int k : tm.keySet()){
                PriorityQueue<Integer> pq = tm.get(k);
                while (!pq.isEmpty()){
                    list.add(pq.poll());
                }
            }
            res.add(list);
        }
        return res;
    }

    private void dfs(TreeNode root, int index, int level){
        if (root == null)
            return;
```

```
            map.putIfAbsent(index, new TreeMap<>());
            map.get(index).putIfAbsent(level, new PriorityQueue<>());
            map.get(index).get(level).add(root.val);
            dfs(root.left, index - 1, level + 1);
            dfs(root.right, index + 1, level + 1);
        }
    }
```

3. Output: