Binary Search Tree Implementations:

1. CODE:

```
class Node{
   int k;
   Node l,r;
   public Node(int it){
      k=it;
      l=r=null;
   }
}
class bst_implementation_node{
   static Node insert(Node root, int k){
      if(root==null)
         return new Node(k);
      if(root.k==k)
         return root;
      if(k<root.k)
         root.l=insert(root.l,k);
      else
         root.r=insert(root.r,k);
      return root;
   }
   static void inorder(Node root){
      if(root!=null){
         inorder(root.l);
         System.out.print(root.k+" ");
         inorder(root.r);
      }
   }
   public static void main(String[] args){
      Node root=null;
      root=insert(root, 50);
      root=insert(root, 30);
      root=insert(root, 20);
      root=insert(root, 40);
      root=insert(root, 70);
      root=insert(root, 60);
      root=insert(root, 80);
      inorder(root);
   }
}
```

OUTPUT:

```
[Running] cd "c:\Data\Knowledge\DSA\Programs\Bst\" && javac bst_implementation_node.java && java
bst_implementation_node
20 30 40 50 60 70 80
```

Time complexity: O(n)

2. CODE:

```
import java.util.TreeSet;
class bst_implementation_treeset{
   public static void main(String[] args){
      TreeSet<Integer> bst=new TreeSet<>();
      bst.add(50);
      bst.add(30);
      bst.add(20);
      bst.add(70);
      bst.add(40);
      bst.add(80);
      bst.add(60);
      System.out.println(bst);
   }
}
```

OUTPUT:

```
[Running] cd "c:\Data\Knowledge\DSA\Programs\Bst\" && javac bst_implementation_treeset.java && java
bst_implementation_treeset
[20, 30, 40, 50, 60, 70, 80]
```

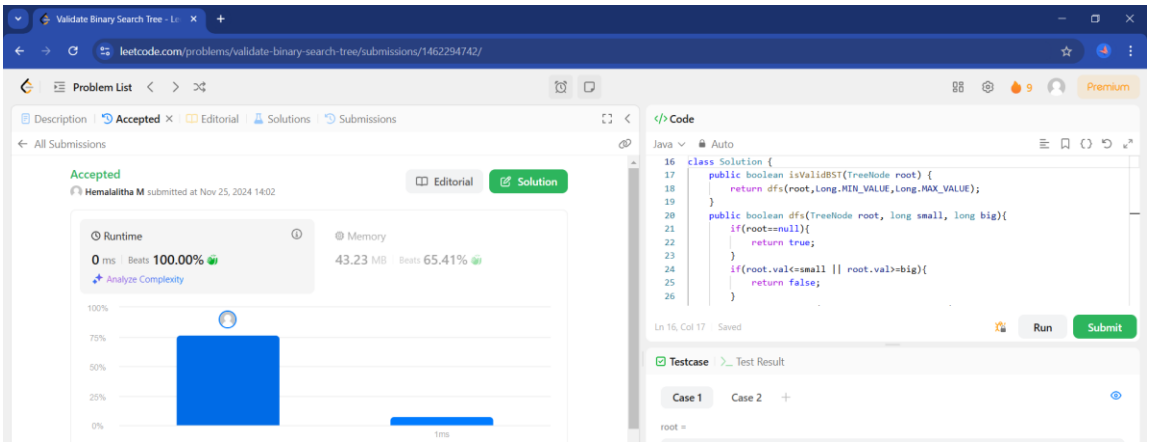
Time complexity: O(log n)

3. Validate binary search tree:

CODE:

```
class Solution {
   public boolean isValidBST(TreeNode root) {
      return dfs(root,Long.MIN_VALUE,Long.MAX_VALUE);
   }
   public boolean dfs(TreeNode root, long small, long big){
      if(root==null){
         return true;
      }
      if(root.val<=small || root.val>=big){
         return false;
      }
      boolean left=dfs(root.left,small,root.val);
      boolean right=dfs(root.right,root.val,big);
      if(left && right){
         return true;
      }
      return false;
   }
}
```

OUTPUT:



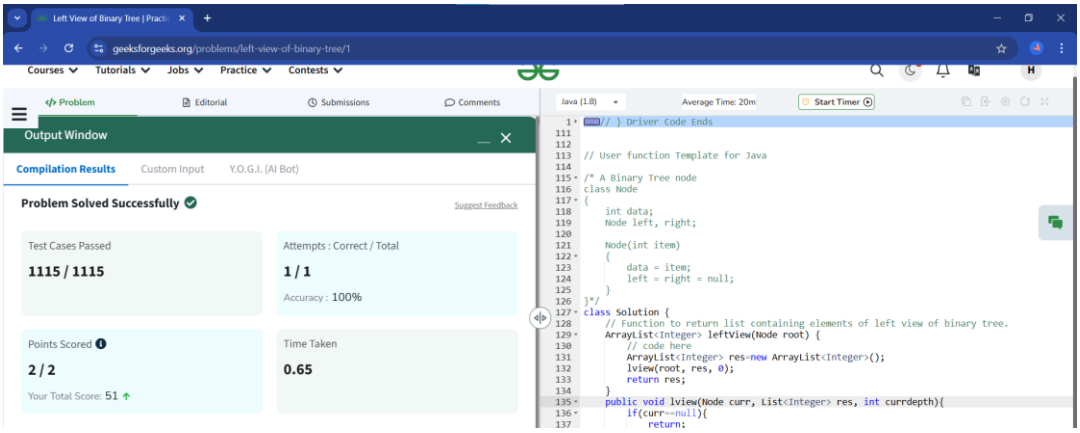
Time complexity: O(n)

4. Left view of BST:

CODE:

```
class Solution {
   ArrayList<Integer> leftView(Node root) {
      ArrayList<Integer> res=new ArrayList<Integer>();
      lview(root, res, 0);
      return res;
   }
   public void lview(Node curr, List<Integer> res, int currdepth){
      if(curr==null){
         return;
      }
      if(currdepth==res.size()){
         res.add(curr.data);
      }
      lview(curr.left, res, currdepth+1);
      lview(curr.right, res, currdepth+1);
   }
}
```

OUTPUT:



Time complexity: O(n)

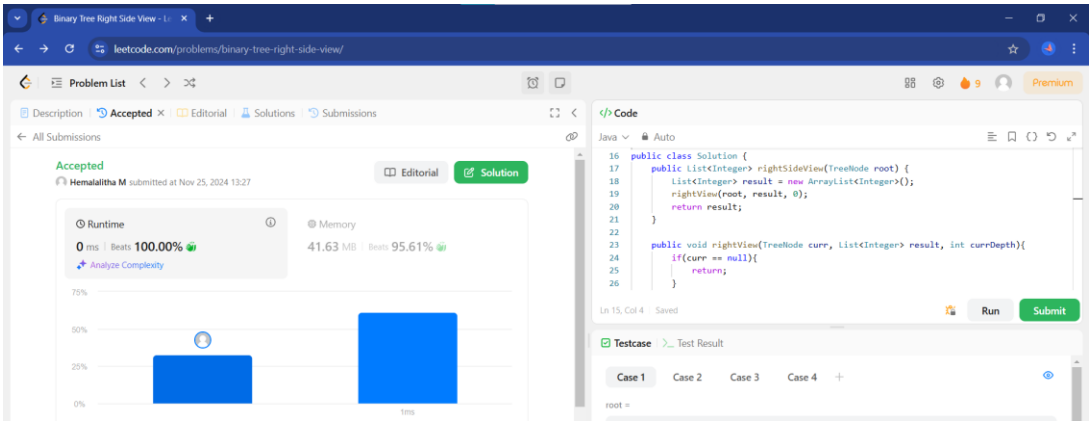
5. Right view of BST:

CODE:

```java
public class Solution {
    public List<Integer> rightSideView(TreeNode root) {
        List<Integer> result = new ArrayList<Integer>();
        rightView(root, result, 0);
        return result;
    }
    public void rightView(TreeNode curr, List<Integer> result, int currDepth){
        if(curr == null){
            return;
        }
        if(currDepth == result.size()){
            result.add(curr.val);
        }
        rightView(curr.right, result, currDepth + 1);
        rightView(curr.left, result, currDepth + 1);

    }
}
```

OUTPUT:



Time complexity: O(n)

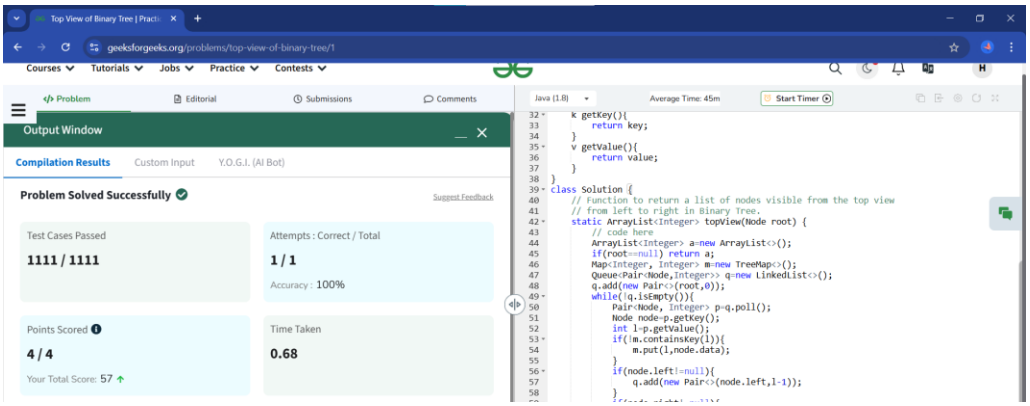
6. Top view of BST:

CODE:

```
class Pair<k,v>{
   k key;
   v value;
   Pair(k key, v value){
      this.key=key;
      this.value=value;
   }
   k getKey(){
      return key;
   }
   v getValue(){
      return value;
   }
}
class Solution {
```

```
    static ArrayList<Integer> topView(Node root) {
        ArrayList<Integer> a=new ArrayList<>();
        if(root==null) return a;
        Map<Integer, Integer> m=new TreeMap<>();
        Queue<Pair<Node,Integer>> q=new LinkedList<>();
        q.add(new Pair<>(root,0));
        while(!q.isEmpty()){
            Pair<Node, Integer> p=q.poll();
            Node node=p.getKey();
            int l=p.getValue();
            if(!m.containsKey(l)){
                m.put(l,node.data);
            }
            if(node.left!=null){
                q.add(new Pair<>(node.left,l-1));
            }
            if(node.right!=null){
                q.add(new Pair<>(node.right, l+1));
            }
        }
        for(int v:m.values()){
            a.add(v);
        }
        return a;
    }
}
```

OUTPUT:



Time complexity: O(n log n)

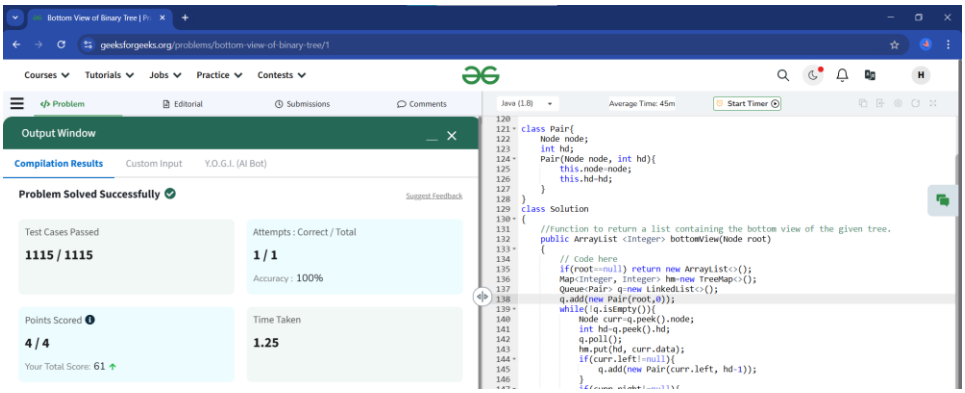
7. Bottom view of BST:

CODE:

```
class Pair{
    Node node;
    int hd;
    Pair(Node node, int hd){
        this.node=node;
        this.hd=hd;
    }
```

```
}
class Solution
{
   public ArrayList <Integer> bottomView(Node root)
   {
      // Code here
      if(root==null) return new ArrayList<>();
      Map<Integer, Integer> hm=new TreeMap<>();
      Queue<Pair> q=new LinkedList<>();
      q.add(new Pair(root,0));
      while(!q.isEmpty()){
         Node curr=q.peek().node;
         int hd=q.peek().hd;
         q.poll();
         hm.put(hd, curr.data);
         if(curr.left!=null){
            q.add(new Pair(curr.left, hd-1));
         }
         if(curr.right!=null){
            q.add(new Pair(curr.right, hd+1));
         }
      }
      ArrayList<Integer> res=new ArrayList<>();
      for(int val:hm.values()){
         res.add(val);
      }
      return res;
   }
}
```

OUTPUT:



Time complexity: O(n log n)

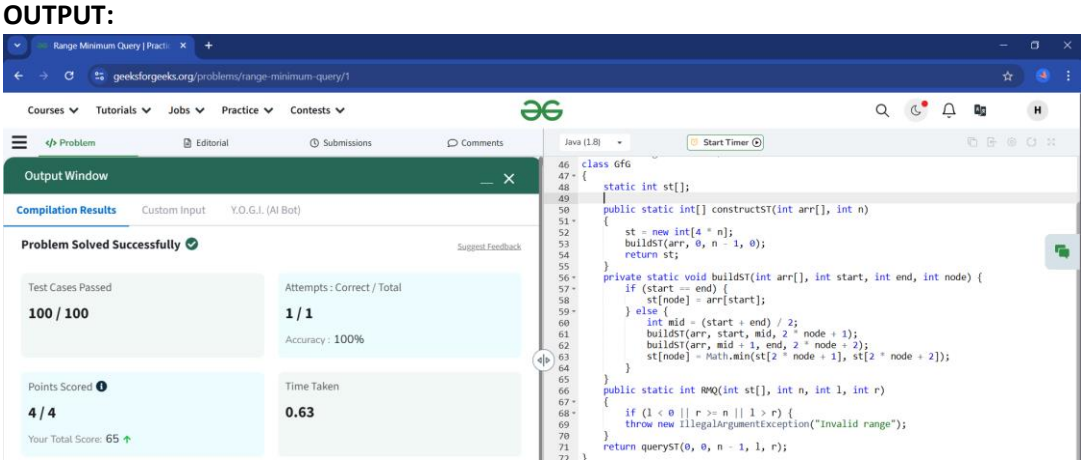
8. Segment tree:

CODE:

```
class GfG
{
   static int st[];
```

```
    public static int[] constructST(int arr[], int n)
    {
        st = new int[4 * n];
        buildST(arr, 0, n - 1, 0);
        return st;
    }
    private static void buildST(int arr[], int start, int end, int node) {
        if (start == end) {
            st[node] = arr[start];
        } else {
            int mid = (start + end) / 2;
            buildST(arr, start, mid, 2 * node + 1);
            buildST(arr, mid + 1, end, 2 * node + 2);
            st[node] = Math.min(st[2 * node + 1], st[2 * node + 2]);
        }
    }
    public static int RMQ(int st[], int n, int l, int r)
    {
        if (l < 0 || r >= n || l > r) {
        throw new IllegalArgumentException("Invalid range");
    }
    return queryST(0, 0, n - 1, l, r);
}
private static int queryST(int node, int start, int end, int l, int r) {
    if (start > r || end < l) {
        return Integer.MAX_VALUE;
    }
    if (start >= l && end <= r) {
        return st[node];
    }
    int mid = (start + end) / 2;
    int leftMin = queryST(2 * node + 1, start, mid, l, r);
    int rightMin = queryST(2 * node + 2, mid + 1, end, l, r);
    return Math.min(leftMin, rightMin);
    }
}
```

OUTPUT:



Time complexity: O(n)