

## BST Solutions

Solution 1:

Time Complexity :  $O(n)$

Space Complexity:  $O(n)$

```
import java.util.*;
```

```
class Solution{
```

```
    static class Node{
        int val;
        Node left, right;
    };
```

```
    static Node newNode(int item){
        Node temp = new Node();
        temp.val = item;
        temp.left = temp.right = null;
        return temp;
    }
```

```
    static int sum = 0;
```

```
    static int rangeSumBST(Node root, int low,
                                                                    int high){
```

```
        if (root == null)
            return 0;
```

```
        Queue<Node> q = new LinkedList<Node>();
        q.add(root);
```

```
        while (q.isEmpty() == false){
```

```
            Node curr = q.peek();
            q.remove();
            if (curr.val >= low &&
                curr.val <= high){
                sum += curr.val;
            }
        }
```

```

        if (curr.left != null &&
            curr.val > low) q.add(curr.left);
        if (curr.right != null &&
            curr.val < high)
            q.add(curr.right);
    }
    return sum;
}

static Node insert(Node node, int data){

    if (node == null)
        return newNode(data);
    if (data <= node.val)
        node.left = insert(node.left,
                           data);
    else
        node.right = insert(node.right,
                             data);
    return node;
}

public static void main(String[] args){

    Node root = null;
    root = insert(root, 10);
    insert(root, 5);
    insert(root, 15);
    insert(root, 3);
    insert(root, 7);
    insert(root, 18);

    int L = 7, R = 15;
    System.out.print(rangeSumBST(root, L, R));

}
}

```

**Solution 2:**

Time Complexity :  $O(h)$

Space Complexity:  $O(1)$

```
class Solution{
```

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```
static int min_diff, min_diff_key; static class Node{
    int key;
    Node left, right;
};

static Node newnode(int key){
    Node node = new Node();
    node.key = key;
    node.left = node.right = null;
    return (node);
}

static void
maxDiffUtil(Node ptr, int
k){ if (ptr == null)
    return ;

    if (ptr.key == k){
        min_diff_key = k;
        return;
    }

    if (min_diff > Math.abs(ptr.key - k)){
        min_diff = Math.abs(ptr.key - k);
        min_diff_key = ptr.key;
    }

    if (k < ptr.key)
        maxDiffUtil(ptr.left, k);
    else
        maxDiffUtil(ptr.right, k);
}

static int maxDiff(Node root, int k){
    min_diff = 999999999;
    min_diff_key = -1;
    maxDiffUtil(root, k);
    return min_diff_key;
}
```

```
public static void main(String args[]){
    Node root = newnode(9); root.left = newnode(4);
    root.right = newnode(17);
    root.left.left = newnode(3);
    root.left.right = newnode(6);
    root.left.right.left = newnode(5);
    root.left.right.right = newnode(7);
    root.right.right = newnode(22);
    root.right.right.left = newnode(20);
    int k = 18;
    System.out.println( maxDiff(root, k));

}
}
```

Solution 3 :

Time Complexity :  $O(n)$

Space Complexity:  $O(h)$

```
import java.io.*;
```

```
class Node {
    int data;
    Node left, right;
    Node(int x)
    {
        data = x;
        left = right = null;
    }
}
```

```
class Solution {

    static int count = 0;
    public static Node insert(Node
        root, int x) { if (root ==
            null)
                return new Node(x);
```

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```
        if (x < root.data)
            root.left = insert(root.left, x);
        else if (x > root.data) root.right = insert(root.right, x);
        return root;
    }

    public static Node kthSmallest(Node root, int k){

        if (root == null)
            return null;

        Node left = kthSmallest(root.left, k);
        if (left != null)
            return left;
        count++;
        if (count == k)
            return root;
        return kthSmallest(root.right, k);
    }

    public static void printKthSmallest(Node root, int k){
        Node res = kthSmallest(root, k);
        if (res == null)
            System.out.println("There are less than k nodes in the BST");
        else
            System.out.println("K-th Smallest Element is " + res.data);
    }

    public static void main(String[] args){
        Node root = null;
        int keys[] = { 20, 8, 22, 4, 12, 10, 14 };
        for (int x : keys)
            root = insert(root, x);
        int k = 3;
        printKthSmallest(root, k);
    }
}
```

## Solution 4 :

Time Complexity :  $O(n_1 + n_2)$ Space Complexity:  $O(h_1 + h_2)$ 

```
import java.util.Stack;
public class Solution {

    static class Node {
        int data;
        Node left, right;

        public Node(int data) {
            this.data = data;
            left = null;
            right = null;
        }
    }

    static Node root1;
    static Node root2;
    static int countPairs(Node root1, Node root2,
                           int x)
    {
        if (root1 == null || root2 == null)
            return 0;
        Stack<Node> st1 = new Stack<>();
        Stack<Node> st2 = new Stack<>();
        Node top1, top2;

        int count = 0;
        while (true) {
            while (root1 != null) {
                st1.push(root1);
                root1 = root1.left;
            }
            while (root2 != null) {
                st2.push(root2);
                root2 = root2.right;
```

```
    }
    if (st1.empty() || st2.empty()) break;

    top1 = st1.peek();
    top2 = st2.peek();
    if ((top1.data + top2.data) == x) {
        count++;
        st1.pop();
        st2.pop();
        root1 = top1.right;
        root2 = top2.left;
    }

    else if ((top1.data + top2.data) < x) {
        st1.pop();
        root1 = top1.right;
    }

    else {
        st2.pop();
        root2 = top2.left;
    }
}
return count;
}
```

```
public static void main(String args[])
{
    root1 = new Node(5);
    root1.left = new Node(3);
    root1.right = new Node(7);
    root1.left.left = new Node(2);
    root1.left.right = new Node(4);
    root1.right.left = new Node(6);
    root1.right.right = new Node(8);

    root2 = new Node(10);
    root2.left = new Node(6);
    root2.right = new Node(15);
    root2.left.left = new Node(3);
```

```
        root2.left.right = new Node(8); root2.right.left = new Node(11);
        root2.right.right = new Node(18);

        int x = 16;
        System.out.println("Pairs = "
            + countPairs(root1, root2, x));
    }
}
```

### Solution 5 :

Time Complexity :  $O(n)$

Space Complexity:  $O(n)$

```
class Solution {

    static class Node{
        Node left;
        Node right;
        int data;

        Node(int data){
            this.data = data;
            this.left = null;
            this.right = null;
        }
    };

    static class Info{
        int max;
        int min;
        boolean isBST;
        int sum;
        int currmax;

        Info(int m,int mi, boolean is,
            int su, int cur) {
```

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```

        max = m;
        min = mi;
        isBST = is;
        sum = su;
        currmax = cur;
    }
    Info(){
};

static class INT{
    int a;
}

static Info MaxSumBSTUtil( Node root, INT maxsum){
    if (root == null)
        return new Info( Integer.MIN_VALUE,
                           Integer.MAX_VALUE, true, 0, 0 );
    if (root.left == null && root.right == null){
        maxsum.a = Math.max(maxsum.a, root.data);
        return new Info( root.data, root.data,
                           true, root.data, maxsum.a );
    }

    Info L = MaxSumBSTUtil(root.left, maxsum);
    Info R = MaxSumBSTUtil(root.right, maxsum);

    Info BST=new Info();
    if (L.isBST && R.isBST && L.max < root.data &&
        R.min > root.data) {

        BST.max = Math.max(root.data, Math.max(L.max, R.max));
        BST.min = Math.min(root.data, Math.min(L.min, R.min));

        maxsum.a = Math.max(maxsum.a, R.sum +
            root.data + L.sum); BST.sum = R.sum + root.data +
            L.sum;
        BST.currmax = maxsum.a;

        BST.isBST = true;
        return BST;
    }
}

```

```
    }  
    BST.isBST = false;  
    BST.currmax = maxsum.a;  
    BST.sum = R.sum + root.data + L.sum;  
    return BST;  
}  
  
static int MaxSumBST( Node root){  
    INT maxsum = new INT();  
    maxsum.a = Integer.MIN_VALUE;  
    return MaxSumBSTUtil(root,  
maxsum).currmax; }  
  
public static void main(String args[]){  
    Node root = new Node(5);  
    root.left = new Node(14);  
    root.right = new Node(3);  
    root.left.left = new Node(6);  
    root.right.right = new Node(7);  
    root.left.left.left = new Node(9);  
    root.left.left.right = new Node(1);  
  
    System.out.println( MaxSumBST(root));  
}  
}
```