

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;  
            }
```

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```
        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;  
}
```



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```
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);
}
}
```

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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.isEmpty() || st2.isEmpty())
                break;
            top1 = st1.pop();
            top2 = st2.pop();
            if (top1.data + top2.data == x)
                count++;
        }
        return count;
    }
}
```



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```
        }  
        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);
```



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```
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;
    }
}
```

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```
    }  
    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));  
}  
}
```



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