Assignment 1

21_AIE_203

Data Structure and Algorithms – SEM-III

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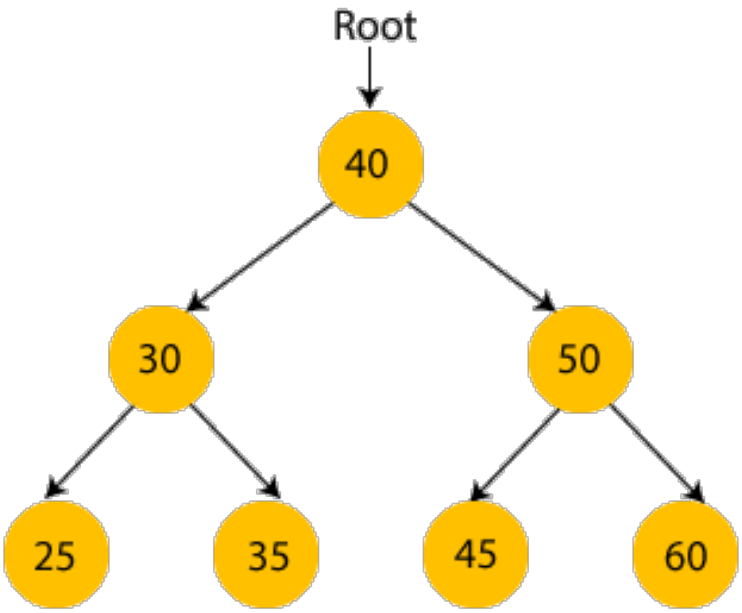
Q1. Write a note on BST (Binary Search Tree) give an example for inorder traversal and write code in java/python for inorder traversal.

Ans. BST (Binary Search Tree) is a data structure and a type of binary tree where the value in node on the left of the parent node is always less and in similar fashion the value in node on the right of the parent node is always greater.



Inorder traversal follows: Left, Root, Right

Inorder traversal of the above tree:

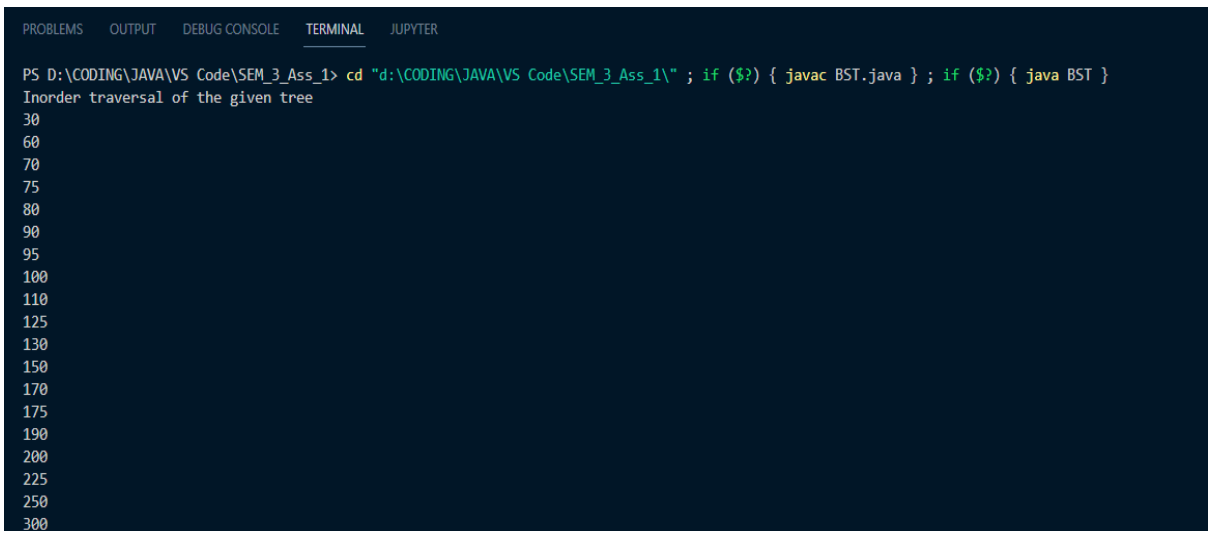
25,30,35,40,45,50,60

Code:

```java
// binary search tree
import java.util.*;
public class BST {

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

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

    static Node root;
    static Node node = root;

    static void insert(int data) {
        root = insertRec(root, data);
    }
    static Node insertRec(Node root, int data) {
        if (root == null) {
            root = new Node(data);
            return root;
        }
        if (data < root.data) {
            root.left = insertRec(root.left, data);
        } else if (data > root.data) {
            root.right = insertRec(root.right, data);
        }
        return root;
    }
    static void inorder() {
        inorderRec(root);
    }
    static void inorderRec(Node root) {
        if (root != null) {
            inorderRec(root.left);
            System.out.println(root.data);
            inorderRec(root.right);
```

```
        }
    }
    public static void main(String[] args) {
        BST tree = new BST();
        tree.insert(150);
        tree.insert(100);
        tree.insert(200);
        tree.insert(75);
        tree.insert(125);
        tree.insert(175);
        tree.insert(250);
        tree.insert(60);
        tree.insert(90);
        tree.insert(110);
        tree.insert(130);
        tree.insert(170);
        tree.insert(190);
        tree.insert(225);
        tree.insert(300);
        tree.insert(30);
        tree.insert(70);
        tree.insert(80);
        tree.insert(95);
        System.out.println("Inorder traversal of the given tree");
        tree.inorder();
    }
}
```

Output:



Q2. Write a code to check whether the given binary tree is a BST?

a) root = 10, root.left = 4, root.right = 11, root.left.left = 1, root.left.right = 2

b) root = 5, root.left = 3, root.right, root.left.left = 2, root.left.right = 4

Ans. CODE:

```
class BTreeLL{

// A binary tree node has data, pointer to
// left child and a pointer to right child

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

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

static Node root;
static Node node = root;

// Inorder traversal of a binary tree
    static void inorderTraversal(Node node)
    {
        if (node != null)
        {
            inorderTraversal(node.left);
            System.out.print(node.data + " ");
            inorderTraversal(node.right);
        }
```

```
    }


//check whether the tree is binary search or not

static boolean isBST(Node root) {
    if (root == null) {
        return true;
    }
    if (root.left != null && root.left.data > root.data) {
        return false;
    }
    if (root.right != null && root.right.data < root.data) {
        return false;
    }
    if (!isBST(root.left) || !isBST(root.right)) {
        return false;
    }
    return true;
}


// Driver code
public static void main(String args[])
{
    root = new Node(10);
    root.left = new Node(4);
    root.left.left = new Node(1);
    root.left.right = new Node(2);
    root.right = new Node(11);

    System.out.println("Is the tree a BST? " + isBST(root));

}
}
```

Output:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  JUPYTER

PS D:\CODING\JAVA\VS Code\SEM_3_Ass_1> java .\isBST.java
Is the tree a BST? false
```

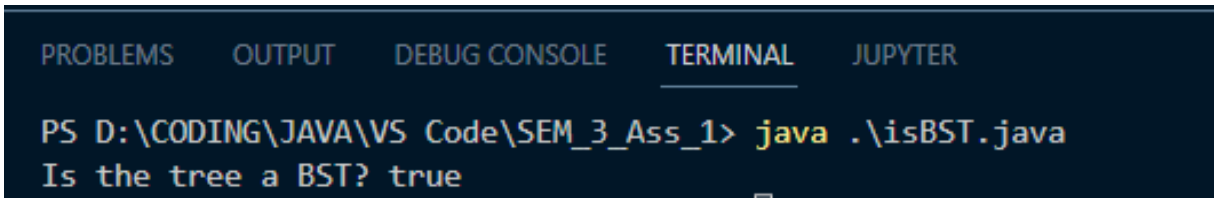
Q2. B)

CODE:

```
class BTreeLL{

// A binary tree node has data, pointer to
// left child and a pointer to right child

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

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

static Node root;
static Node node = root;

// Inorder traversal of a binary tree
    static void inorderTraversal(Node node)
    {
        if (node != null)
        {
            inorderTraversal(node.left);
            System.out.print(node.data + " ");
            inorderTraversal(node.right);
        }

    }


//check whether the tree is binary search or not

static boolean isBST(Node root) {
    if (root == null) {
```

```
        return true;
    }
    if (root.left != null && root.left.data > root.data) {
        return false;
    }
    if (root.right != null && root.right.data < root.data) {
        return false;
    }
    if (!isBST(root.left) || !isBST(root.right)) {
        return false;
    }
    return true;
}


// Driver code
public static void main(String args[])
{
    root = new Node(5);
    root.left = new Node(3);
    root.left.left = new Node(2);
    root.left.right = new Node(4);
    root.right = new Node(7);

    System.out.println("Is the tree a BST? " + isBST(root));

}
}
```

Output:



Q3. Create a BST with level 5

a) display the values of the nodes on the left side of the tree.

b) display the values of the nodes on the right side of the tree.

CODE:

```java
// Java program to delete element
// in binary tree

import java.util.LinkedList;
import java.util.Queue;

class Left{

// A binary tree node has data, pointer to
// left child and a pointer to right child

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

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

static Node root;
static Node node = root;

// Inorder traversal of a binary tree
    static void inorderTraversal(Node node)
    {
        if (node != null)
        {
            inorderTraversal(node.left);
            System.out.print(node.data + " ");
            inorderTraversal(node.right);
```

```
        }

    }


static boolean isBST(Node root) {
    if (root == null) {
        return true;
    }
    if (root.left != null && root.left.data > root.data) {
        return false;
    }
    if (root.right != null && root.right.data < root.data) {
        return false;
    }
    if (!isBST(root.left) || !isBST(root.right)) {
        return false;
    }
    return true;
}
static int upper_level = 0;


static void leftSide(Node node, int level)
{
    // Base Case
    if (node == null)
        return;

    // If this is the first node of its level
    if (upper_level < level) {
        System.out.print(node.data + " ");
        upper_level = level;
    }

    // Recur for left and right subtrees
    leftSide(node.left, level + 1);
    leftSide(node.right, level + 1);

}

// A wrapper over leftViewUtil()
```

```
static void leftView()
{
    upper_level = 0;
    leftSide(root, 1);
}
public static void main(String args[])
{
    root = new Node(100);
    root.left = new Node(50);
    root.left.left = new Node(30);
    root.left.right = new Node(70);
    root.right = new Node(150);
    root.right.left = new Node(140);
    root.right.right = new Node(180);
    root.right.right.left = new Node(160);
    root.left.left.left = new Node(20);
    root.left.left.right = new Node(40);
    root.right.right.left.right = new Node(170);
    root.right.right.left.left = new Node(155);
    root.right.right.right = new Node(200);
    root.right.right.left.right.left = new Node(165);
    root.right.right.left.right.right = new Node(175);
    root.left.left.right.left = new Node(35);
    root.left.left.right.right = new Node(45);
    root.left.left.right.left.right = new Node(37);
    root.left.left.right.left.left = new Node(33);

    System.out.println("Is the tree a BST? " + isBST(root));
    System.out.println("Left nodes");
    leftView();
}
}
```

Output:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  JUPYTER

PS D:\CODING\JAVA\VS Code\SEM_3_Ass_1> java .\Left_Right.java
Is the tree a BST? true
Left nodes
100 50 30 20 35 33
```

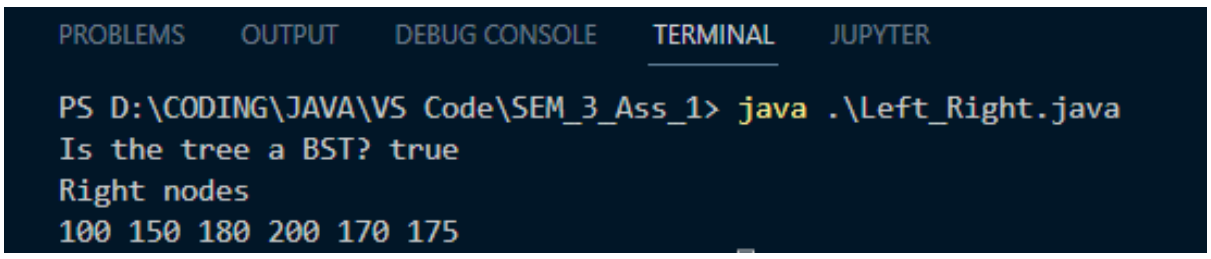
b) CODE:

```
// Java program to delete element
// in binary tree

import java.util.LinkedList;
import java.util.Queue;

class Left{

// A binary tree node has data, pointer to
// left child and a pointer to right child

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

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

static Node root;
static Node node = root;

// Inorder traversal of a binary tree
    static void inorderTraversal(Node node)
    {
        if (node != null)
        {
            inorderTraversal(node.left);
            System.out.print(node.data + " ");
            inorderTraversal(node.right);
        }

    }
```

```
static boolean isBST(Node root) {
    if (root == null) {
        return true;
    }
    if (root.left != null && root.left.data > root.data) {
        return false;
    }
    if (root.right != null && root.right.data < root.data) {
        return false;
    }
    if (!isBST(root.left) || !isBST(root.right)) {
        return false;
    }
    return true;
}
static int upper_level = 0;


static void rightSide(Node node, int level)
{
    // Base Case
    if (node == null)
        return;

    // If this is the first node of its level
    if (upper_level < level) {
        System.out.print(node.data + " ");
        upper_level = level;
    }

    // Recur for left and right subtrees
    rightSide(node.right, level + 1 );
    rightSide(node.left, level + 1);
}

static void rightView()
{
    upper_level = 0;
    rightSide(root, 1);
}
```

```java
public static void main(String args[])
{
    root = new Node(100);
    root.left = new Node(50);
    root.left.left = new Node(30);
    root.left.right = new Node(70);
    root.right = new Node(150);
    root.right.left = new Node(140);
    root.right.right = new Node(180);
    root.right.right.left = new Node(160);
    root.left.left.left = new Node(20);
    root.left.left.right = new Node(40);
    root.right.right.left.right = new Node(170);
    root.right.right.left.left = new Node(155);
    root.right.right.right = new Node(200);
    root.right.right.left.right.left = new Node(165);
    root.right.right.left.right.right = new Node(175);
    root.left.left.right.left = new Node(35);
    root.left.left.right.right = new Node(45);
    root.left.left.right.left.right = new Node(37);
    root.left.left.right.left.left = new Node(33);


    System.out.println("Is the tree a BST? " + isBST(root));
    System.out.println("Right nodes");
    rightView();

}
}
```

Output:



Q4. For the previous binary search tree display all paths from root to leaf nodes.

Code:

```
class path {

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

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

    static void inorderTraversal(Node node)
    {
        if (node != null)
        {
            inorderTraversal(node.left);
            System.out.print(node.data + " ");
            inorderTraversal(node.right);
        }

    }

static boolean isBST(Node root) {
    if (root == null) {
        return true;
    }
    if (root.left != null && root.left.data > root.data) {
        return false;
    }
    if (root.right != null && root.right.data < root.data) {
        return false;
```

```
    }
    if (!isBST(root.left) || !isBST(root.right)) {
        return false;
    }
    return true;
}

static void printPath(Node node) {
    int path[] = new int[1000];
    printPathsRecurs(node, path, 0);
}

static void printPathsRecurs(Node node, int path[], int pathLen) {
    if (node == null)
        return;

    /* append this node to the path array */
    path[pathLen] = node.data;
    pathLen++;

    /* it's a leaf, so print the path that led to here */
    if (node.left == null && node.right == null)
        printArr(path, pathLen);
    else {
        /* otherwise try both subtrees */
        printPathsRecurs(node.left, path, pathLen);
        printPathsRecurs(node.right, path, pathLen);
    }
}

/* Utility that prints out an array on a line. */
static void printArr(int integ[], int len) {
    int i;
    for (i = 0; i < len; i++) {
        System.out.print(integ[i] + " ");
    }
    System.out.println("");
    System.out.println();
}

public static void main(String[] args) {
    root = new Node(100);
```

```
    root.left = new Node(50);
    root.left.left = new Node(30);
    root.left.right = new Node(70);
    root.right = new Node(150);
    root.right.left = new Node(140);
    root.right.right = new Node(180);
    root.right.right.left = new Node(160);
    root.left.left.left = new Node(20);
    root.left.left.right = new Node(40);
    root.right.right.left.right = new Node(170);
    root.right.right.left.left = new Node(155);
    root.right.right.right = new Node(200);
    root.right.right.left.right.left = new Node(165);
    root.right.right.left.right.right = new Node(175);
    root.left.left.right.left = new Node(35);
    root.left.left.right.right = new Node(45);
    root.left.left.right.left.right = new Node(37);
    root.left.left.right.left.left = new Node(33);

    System.out.println("All the paths from root to leaf are: ");
    printPath(root);
}
}
```

Output:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  JUPYTER

PS D:\CODING\JAVA\VS Code\SEM_3_Ass_1> java path.java
100 50 30 40 35 37

100 50 30 40 45

100 50 70

100 150 140

100 150 180 160 155

100 150 180 160 170 165

100 150 180 160 170 175

100 150 180 200
```

THANK YOU