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BinarySearchNode.java

```
public class BinarySearchNode {
    Integer data;
    BinarySearchNode left;
    BinarySearchNode right;

    BinarySearchNode(Integer data) {
        this.data = data;
        this.left = null;
        this.right = null;
    }
    public String toString() {
        return "[ " + data + ", " + left + ", " + right + " ]";
    }
}
```

BinarySearchTree.java

```
public class BinarySearchTree {
    private BinarySearchNode root;

    //constructor
    BinarySearchTree() {
        root = null;
    }

    //methods for inserting a data
    public void insert(Integer data) {
        BinarySearchNode p = root; //start from the root
        BinarySearchNode parent = null; //parent of p, initially=null
        boolean isLeftChild = false; //true id p is the left child of parent
        while (p != null) {
            int result = data.compareTo(p.data);
            if (result == 0) { //data == p.data
                //data already in the tree, return
                System.out.println(data + " already exists");
                return;
            } else if (result < 0) { //data < p.data
                parent = p;
                isLeftChild = true;
                p = p.left;
```

```java
            } else { //data > p.data
                parent = p;
                isLeftChild = false;
                p = p.right;
            }
        }
        //Crate a new node under parent
        //Determine whether it is left or right child based on isLeftChild
        BinarySearchNode newNode = new BinarySearchNode(data);
        if (parent == null) {
            root = newNode;
        } else if (isLeftChild) {
            parent.left = newNode;
        } else {
            parent.right = newNode;
        }
    }

    //methods for searching a data
    public void search(Integer data) {
        BinarySearchNode p = root; //start from the root
        while (p != null) {
            int result = data.compareTo(p.data); //compare data and p.data
            if (result == 0) { //data == p.data
                System.out.println(data + " is found");
                return;
            } else if (result < 0) { //data < p.data
                //proccess the left child
                p = p.left;
            } else { //data > p.data
                //proccess the right child
                p = p.right;
            }
        }
        //data is not found
        System.out.println(data + " is not found");
    }

    //methods for deleting a data
    public void delete(Integer data) {
        BinarySearchNode p = root; //start from the root
        BinarySearchNode parent = null; //parent of p, initially=null
        boolean isLeftChild = false; //true if p is the left child of parent
        while (p != null) {
            int result = data.compareTo(p.data); //data == p.data
            if (result == 0) { //found the data
                if (p.left==null && p.right==null) { //p is an external node
                    if (parent == null) root = null;
                    else if (isLeftChild) parent.left = null;
                    else parent.right = null;
                } else if (p.left == null) { //p only has right subtree
                    //replace with the right child
                    if (parent == null) root = p.right;
                    else if (isLeftChild) parent.left = p.right;
                    else parent.right = p.right;
                } else if (p.right == null) { //p only has left subtree
                    //replace with the left child
                    if (parent == null) root = p.left;
                    else if (isLeftChild) parent.left = p.left;
                    else parent.right = p.left;
                } else { //p has both right and left subtrees
                    //find the smallest node from the right subtree
                    BinarySearchNode x = findMin(p);
                    //replace p with x with x
                    if (parent == null) root = x;
                    else if (isLeftChild) parent.left = x;
                    else parent.right = x;
                    x.right = p.right;
                    x.left = p.left;
                    p.right = null;
                    p.left = null;
                }
                //data has been succesfully deleted
                System.out.println(data + " has been deleted");
                return;
            } else if (result < 0) { //data < p.data
                parent = p;
                isLeftChild = true;
                p = p.left;
            } else { //data > p.data
                parent = p;
                isLeftChild = false;
                p = p.right;
            }
        }
         //data is not found
         System.out.println(data + " is not found");
    }

    //methods for finding the smallest node of a right subtree
    private BinarySearchNode findMin(BinarySearchNode parent) {
        BinarySearchNode p = parent.right;
        //traverse to the leftmost node of this subtree to find the smallest node
        while (p.left != null) {
            p = p.left;
        }
        return p;
    }

    public String toString() { return inorder(root); }

    private String inorder(BinarySearchNode p) {
        if (p == null) return "";
        return inorder(p.left) + " " + p.data + " " + inorder(p.right);
    }
}
```

TestBinarySearchTree.java

```java
public class TestBinarySearchTree {
    public static void main(String[] args){
        //create a BST
        BinarySearchTree bst = new BinarySearchTree();
        bst.insert(5);
        bst.insert(3);
        bst.insert(8);
        bst.insert(2);
        bst.insert(4);
        bst.insert(6);
        bst.insert(7);
        System.out.println(bst);

        //search data from the BST
        bst.search(2);
        bst.search(9);

        //delete data from the BST
        bst.delete(8);
        System.out.println(bst);
        bst.delete(6);
        System.out.println(bst);
        bst.delete(7);
        System.out.println(bst);
        bst.delete(2);
        System.out.println(bst);
    }
}
```

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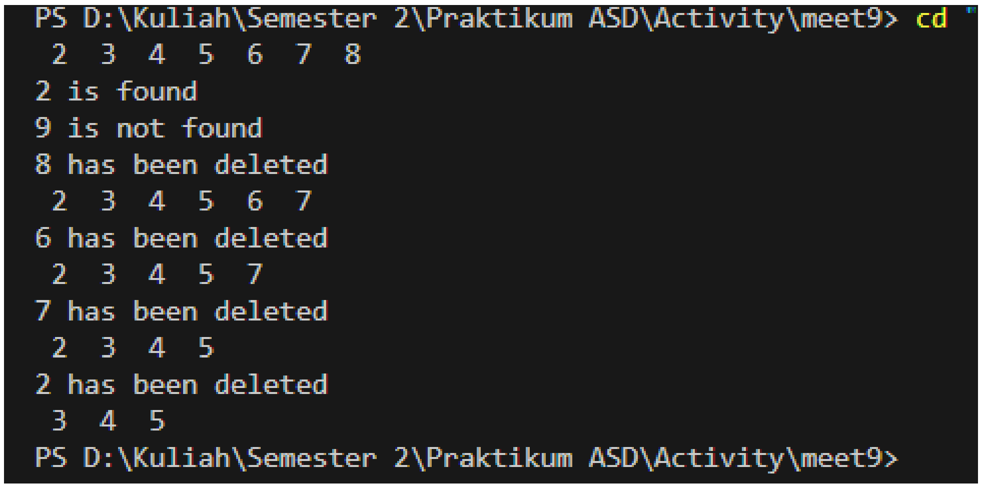

```
PS D:\Kuliah\Semester 2\Praktikum ASD\Activity\meet9> cd "
 2  3  4  5  6  7  8
2 is found
9 is not found
8 has been deleted
 2  3  4  5  6  7
6 has been deleted
 2  3  4  5  7
7 has been deleted
 2  3  4  5
2 has been deleted
 3  4  5
PS D:\Kuliah\Semester 2\Praktikum ASD\Activity\meet9>
```