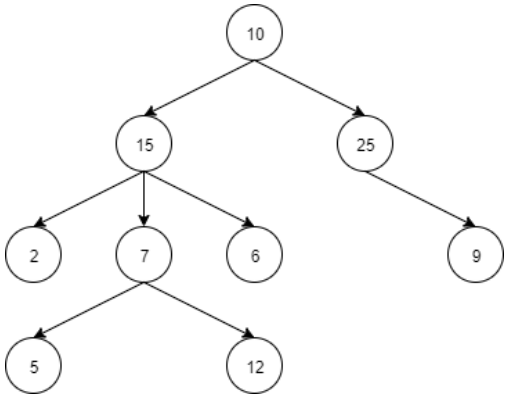
COMP 203 DATA STRUCTURES AND ALGORITHMS
HOMEWORK 3 (Total=100 points)
SOLUTION MANUAL

Read the questions and rules carefully. They are clear and well defined.
Rules:
1. No Cheating: You are not allowed to collaborate with your friends and use any kind of websites or AI. If your homework gives a sign of any of them, **directly it will be graded as zero**.
2. Goal: Please do your homework alone. Our main aim is to **learn** whatever we cover so far.
3. Submission: Submit your homework in **2 java files. No other file types will be accepted. You will submit only 2 java files. DON'T USE ZIP/RAR etc. In these cases, your points will be deducted by 30%.**
4. Coding policy: Explain your code in comments. **This is a must!**
5. Latency policy: A 10% deduction will be applied for each day of late submission.

SOLUTION



Include comments of your code for each method and class.
Submit QTree.java to Canvas.

1. total 55 pt

```
import java.util.LinkedList; //5pt usage of linkedlist
import java.util.Queue;

class Node<E> { //2pt
   E data;
   Queue<Node<E>> childrenList;
   Node<E> parent;

   public Node(E data) {//3pt
```

```
        this.data = data;
        this.childrenList = new LinkedList<>();
        this.parent = null;
    }
}

public class QTree<E> {//5pt
    private Node<E> root;

    public QTree() {
        this.root = null;
    }

    public void deleteNode(Node<E> root, E deletedValue) { //10pt
        if (root == null) {
            return;
        }

        if (root.data.equals(deletedValue)) {
            if (root.parent != null) {
                root.parent.childrenList.remove(root);
            } else {
                // Deleting the root node
                this.root = null;
            }
            return;
        }

        for (Node<E> child : root.childrenList) {
            deleteNode(child, deletedValue);
        }
    }

    public Node<E> find(Node<E> root, E value) { //10pt
        if (root == null) {
            return null;
        }

        if (root.data.equals(value)) {
            return root;
        }
```

```
    for (Node<E> child : root.childrenList) {
        Node<E> foundNode = find(child, value);
        if (foundNode != null) {
            return foundNode;
        }
    }

    return null;
}

public static void main(String[] args) {
    // Creating the given tree  //10pt
    QTree<Integer> tree = new QTree<>();
    Node<Integer> node10 = new Node<>(10);
    Node<Integer> node15 = new Node<>(15);
    Node<Integer> node25 = new Node<>(25);
    Node<Integer> node2 = new Node<>(2);
    Node<Integer> node7 = new Node<>(7);
    Node<Integer> node6 = new Node<>(6);
    Node<Integer> node5 = new Node<>(5);
    Node<Integer> node12= new Node<>(12);
   Node<Integer> node9 = new Node<>(9);

    tree.root = node10;
    node10.childrenList.add(node15);
    node10.childrenList.add( node25);

    node15.childrenList.add(node2);
   node15.childrenList.add(node7);
   node15.childrenList.add(node6);


    node7.childrenList.add(node5);
    node7.childrenList.add(node12);

    node25.childrenList.add(node9);

    // Testing methods
    System.out.println("Before deletion:");
    tree.printTree(tree.root);
```

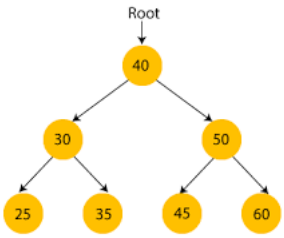
```
        tree.deleteNode(tree.root, 4); //5pt

        System.out.println("\nAfter deletion of node with value 4:");
        tree.printTree(tree.root);

        Node<Integer> foundNode = tree.find(tree.root, 5); //5pt
        System.out.println("\nNode with value 5 found: " + (foundNode != null));
    }

    private void printTree(Node<E> root) {
        if (root != null) {
            System.out.print(root.data + " -> ");
            for (Node<E> child : root.childrenList) {
                System.out.print(child.data + " ");
            }
            System.out.println();
            for (Node<E> child : root.childrenList) {
                printTree(child);
            }
        }
    }
}
```

2.



Include comments of your code for each method and class.
Submit BinarySearchTree.java to Canvas.

Total 45 pt

```
class Node<E> { //2pt
    E data;
    Node<E> left;
```

```
    Node<E> right;

    public Node(E data) {//3pt
        this.data = data;
        this.left = null;
        this.right = null;
    }
}

public class BinarySearchTree<E extends Comparable<E>> { //5pt
    private Node<E> root;

    public BinarySearchTree() {
        this.root = null;
    }

    public void insert(Node<E> root, E value) { //10pt
        if (this.root == null) {
            this.root = new Node<>(value);
        } else {
            if (value.compareTo(root.data) < 0) {
                if (root.left == null) {
                    root.left = new Node<>(value);
                } else {
                    insert(root.left, value);
                }
            } else if (value.compareTo(root.data) > 0) {
                if (root.right == null) {
                    root.right = new Node<>(value);
                } else {
                    insert(root.right, value);
                }
            }
            // Duplicate values are not considered in this implementation
        }
```

```
}

public Node<E> delete(Node<E> root, E value) { //10pt
   if (root == null) {
      return root;
   }

   if (value.compareTo(root.data) < 0) {
      root.left = delete(root.left, value);
   } else if (value.compareTo(root.data) > 0) {
      root.right = delete(root.right, value);
   } else {
      // Node with only one child or no child
      if (root.left == null) {
         return root.right;
      } else if (root.right == null) {
         return root.left;
      }

      // Node with two children
      root.data = minValue(root.right);
      root.right = delete(root.right, root.data);
   }

   return root;
}

private E minValue(Node<E> root) {
   E minValue = root.data;
   while (root.left != null) {
      minValue = root.left.data;
      root = root.left;
   }
   return minValue;
}
```

```
    public static void main(String[] args) {
        BinarySearchTree<Integer> bst = new BinarySearchTree<>();

        // Creating the given binary search tree //5pt
        bst.insert(bst.root, 40);
        bst.insert(bst.root, 30);
        bst.insert(bst.root, 50);
        bst.insert(bst.root, 25);
        bst.insert(bst.root, 35);
        bst.insert(bst.root, 45);
        bst.insert(bst.root, 60); //5pt


        // Testing methods
        System.out.println("Before deletion:");
        bst.PreOrderTraversal(bst.root);

        bst.delete(bst.root, 60); //5pt

        System.out.println("\nAfter deletion of node with value 60:");
        bst.PreOrderTraversal(bst.root);
    }

    private void PreOrderTraversal(Node<E> root) { // to print the tree
        if (root != null) {
            System.out.print(root.data + " ");
            PreOrderTraversal(root.left);
            PreOrderTraversal(root.right);
        }
    }
}
```