01286222 Lab 10a Name ธนภัทร์ เกิดเปี่ยม id 65050368

Objective(s):

a. To be able to implement binary-search-tree insert(int d) method

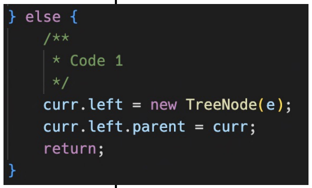
b. To be able to implement binary tree traversal method

c. To be able to implement binary tree search method

Task 1:

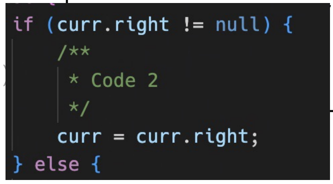
Given TreeNode.java and BST.java, complete insert(int d) and preOrder()

```
public class BST {
  TreeNode root;
  public BST() { root = null; }
  //  public TreeNode getRoot() {
  //    return root;
  //  }
  public void insert(int d) {
    if (root == null) {
        root = new TreeNode(d);
    } else {
        TreeNode cur = root;
        while (cur != null) {
          if (d < cur.data) {
             if (cur.left != null)
                cur = cur.left;
             else {
                /* your code 1*/
             }
          } else { //! (d < p.data
            if (cur.right != null)
              /* your code 2*/;
            else {
              cur.right = new TreeNode(d);
              cur.right.parent = cur;
                    return;
            }
          }
        } //while
    }
  } //insert by iteration
  public void printPreOrder() {
    printPreOrderRecurse(root);
  }
  private void printPreOrderRecurse(TreeNode node) {

  }
```



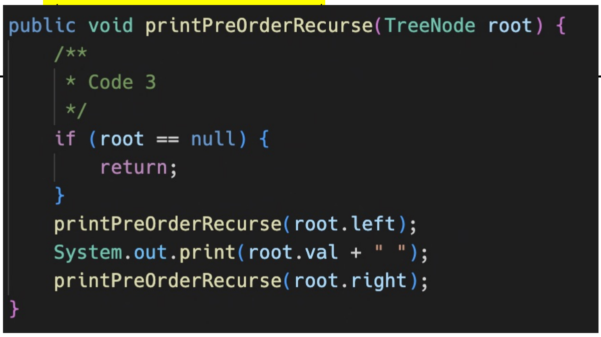
```
} else {
    /**
     * Code 1
     */
    curr.left = new TreeNode(e);
    curr.left.parent = curr;
    return;
}
```

```
package code;

public class TreeNode {
    int data;
    TreeNode left, right, parent;

  public TreeNode(int d) {
        data = d;
  }
  @Override
  public String toString() {
  // There are 4 cases no child,
  // left-child-only,
  // right-child-only,
  //and both children
    /* your code 6*/
    return "null<-" + data + "->null";
                      no child
```



```
if (curr.right != null) {
    /**
     * Code 2
     */
    curr = curr.right;
} else {
```

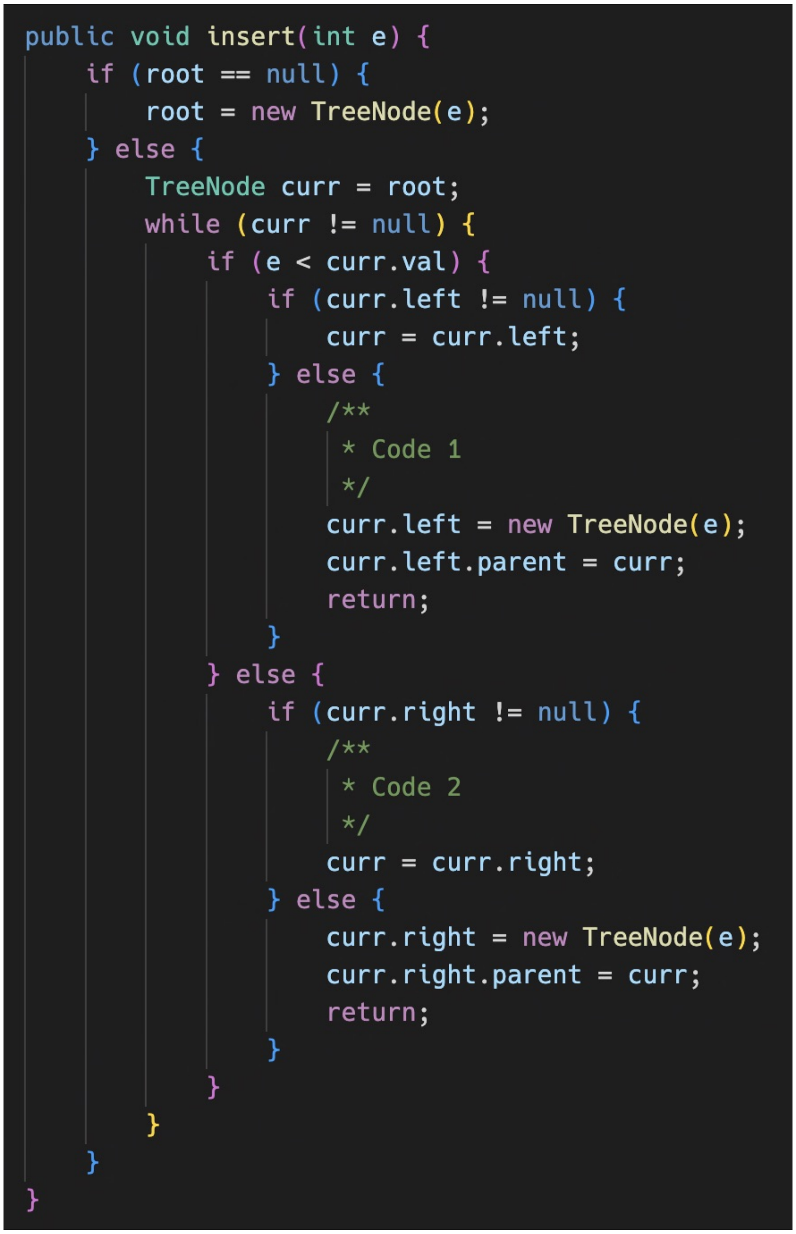
Note that BST's root cannot be accessed from main, in that case its access modifier should be private and provide getRoot() (commented).



```
public void printPreOrderRecurse(TreeNode root) {
    /**
     * Code 3
     */
    if (root == null) {
        return;
    }
    printPreOrderRecurse(root.left);
    System.out.print(root.val + " ");
    printPreOrderRecurse(root.right);
}
```

```
public static void demo1() {
  println("-insert and preOrder traversal-");
  int[] dat = { 15, 20, 10, 18, 16,
                12, 8, 25, 19, 30 };

  BST bst = new BST();
  for (int j = 0; j < dat.length; j++)
        bst.insert(dat[j]);

  bst.printPreOrder();
  //8 10 12 15 16 18 19 20 25 30
  System.out.println();
  //demo2(bst);
}
```

Instruction: capture your code for insert(int d) and `printPreOrderRecurse(TreeNode node)`



```
public void insert(int e) {
    if (root == null) {
        root = new TreeNode(e);
    } else {
        TreeNode curr = root;
        while (curr != null) {
            if (e < curr.val) {
                if (curr.left != null) {
                    curr = curr.left;
                } else {
                    /**
                     * Code 1
                     */
                    curr.left = new TreeNode(e);
                    curr.left.parent = curr;
                    return;
                }
            } else {
                if (curr.right != null) {
                    /**
                     * Code 2
                     */
                    curr = curr.right;
                } else {
                    curr.right = new TreeNode(e);
                    curr.right.parent = curr;
                    return;
                }
            }
        }
    }
}
```

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Task 2:

complete `printInOrderRecurse(TreeNode node)` and `printPostOrderRecurse(TreeNode node)`

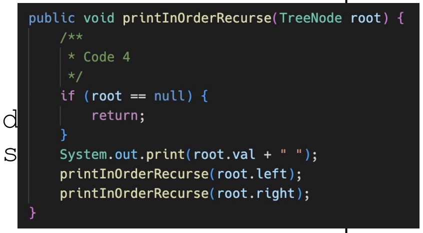
confirm your output.

Instruction: use the 3 traversal,

draw bst

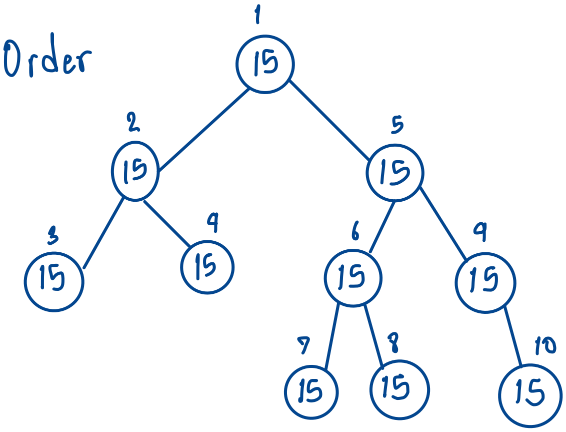
```
//uncomment demo2() invocation inside demo1()
  static void demo2(BST bst) {
    System.out.println("-more traversal---");
    bst.printInOrder();
    System.out.println();
    // 15 10 8 12 20 18 16 19 25 30

    bst.printPostOrder();
    System.out.println();
    // 8 12 10 16 19 18 30 25 20 15

    // demo3(bst);
  }
```

```
    public void printInOrder() {
        printInOrderRecurse(root);
    }
    private void printInOrderRecurse(TreeNode
node) {
        /* your code 4*/
    }
    public void printPostOrd
        printPostOrderRecurs
    }
    private void
printPostOrderRecurse(TreeNode node) {
        /* your code 5*/
    }
```

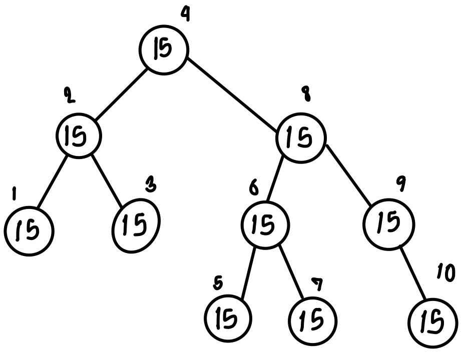


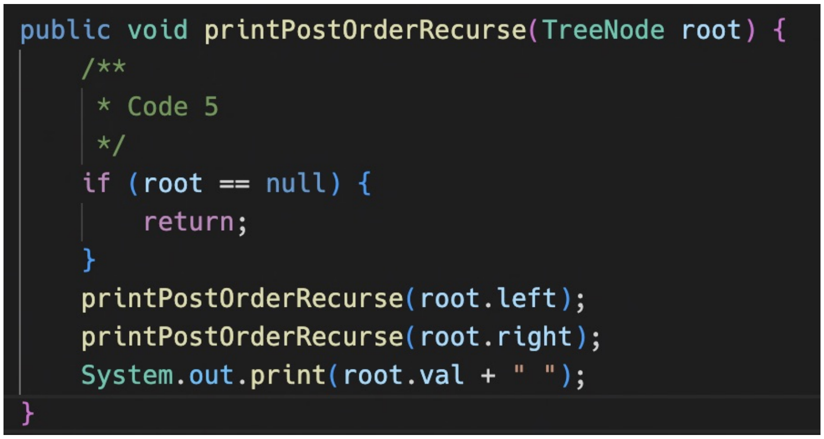
```
public void printInOrderRecurse(TreeNode root) {
    /**
     * Code 4
     */
    if (root == null) {
        return;
    }
    System.out.print(root.val + " ");
    printInOrderRecurse(root.left);
    printInOrderRecurse(root.right);
}
```

PreOrder



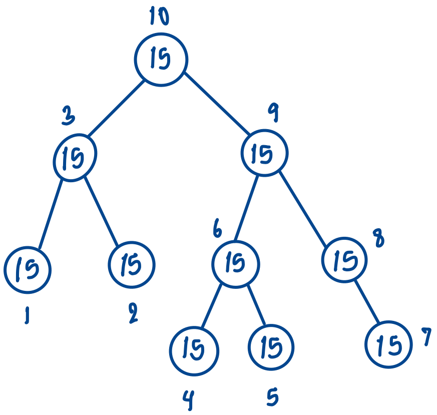
InOrder





```
public void printPostOrderRecurse(TreeNode root) {
    /**
     * Code 5
     */
    if (root == null) {
        return;
    }
    printPostOrderRecurse(root.left);
    printPostOrderRecurse(root.right);
    System.out.print(root.val + " ");
}
```

PreOrder



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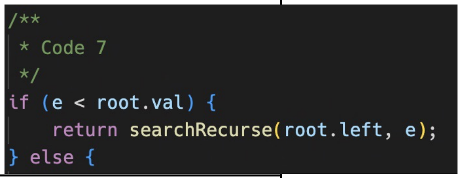
Task 3:

In fact, processing TreeNode in main is cumbersome (as we preferred encapsulation). However, we'll leave search(int d) to return TreeNode as is. We'll check the search result in the method.

```
println("-search recursive---");
println(bst.search(20)); // 18<-20->25
println(bst.search(25)); // null<-25->30
println(bst.search(12)); // null<-12->null
println(bst.search(1));  // null
println(bst.searchRecurse(10
                    , bst.getRoot()));
//if searchRecurse and getRoot is available

println("-search iterative---");
println(bst.searchIter(20));
println(bst.searchIter(25));
println(bst.searchIter(12));
println(bst.searchIter(1));
```

```
public TreeNode search(int d) {
  TreeNode result = searchRecurse(d, root);
  return result;
}
public TreeNode searchRecurse(int d, TreeNode n) {
  if (n == null) return null;
  if (d == n.data) return n;
  /* your code 7*/
  return searchRecurse(d, n.right);
}
```

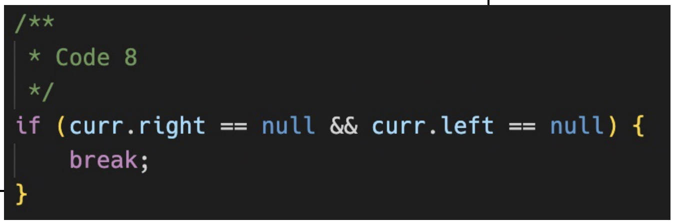


```
/**
 * Code 7
 */
if (e < root.val) {
    return searchRecurse(root.left, e);
} else {
```

```
public TreeNode searchIter(int key) {
  if (root.data == key)
      return root;
  TreeNode current = root;
  while (current != null) {
      if (key < current.data) {
          if (current.left != null)
              current = current.left;
      } else {
          if (current.right != null)
              current = current.right;
      }

      if (current.data == key)
          return current;

      /* your code 8 */
  } //while
  return null;
}
```



```
/**
 * Code 8
 */
if (curr.right == null && curr.left == null) {
    break;
}
```

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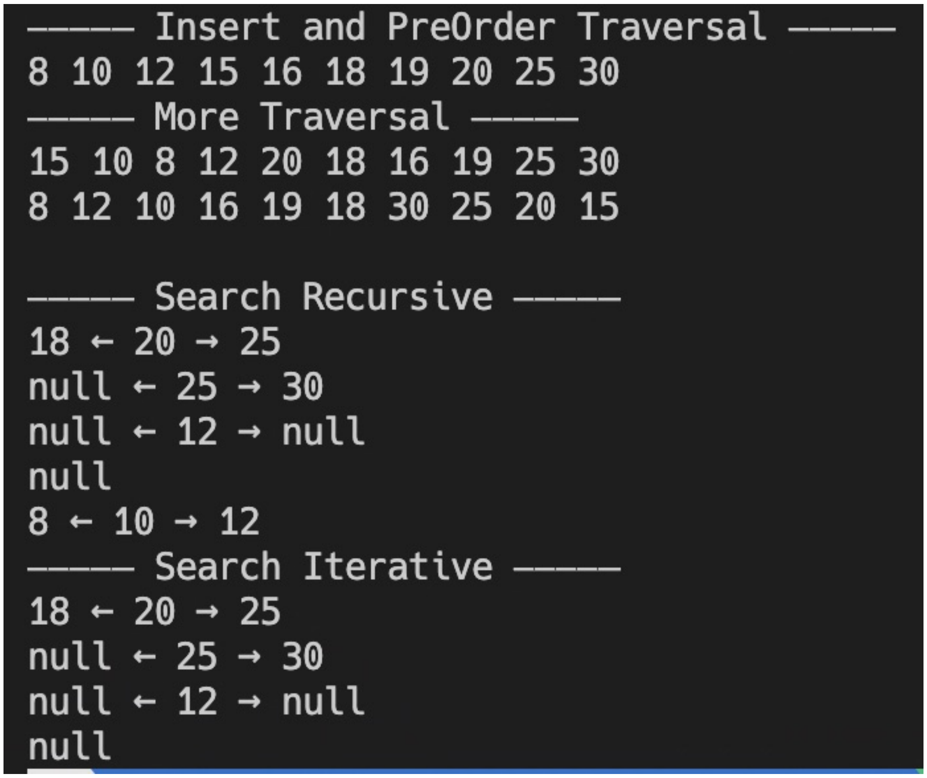
Instructions:

Complete /* your code 6 */ in TreeNode.java so that we can check the search result.

Complete /* your code 7 */ and /* your code 8 */

(The result commented is to confirm your work correctness.)

Capture your demo3()'s output.



```
----- Insert and PreOrder Traversal -----
8 10 12 15 16 18 19 20 25 30
----- More Traversal -----
15 10 8 12 20 18 16 19 25 30
8 12 10 16 19 18 30 25 20 15

----- Search Recursive -----
18 ← 20 → 25
null ← 25 → 30
null ← 12 → null
null
8 ← 10 → 12
----- Search Iterative -----
18 ← 20 → 25
null ← 25 → 30
null ← 12 → null
null
```

Submission: MyStackA_XXYYYY.java and MyRPN_XXYYYY.java

Due date: TBA