/*******************************
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Username: ua203
Problem Set: PS9
Due Date: July 29, 2020
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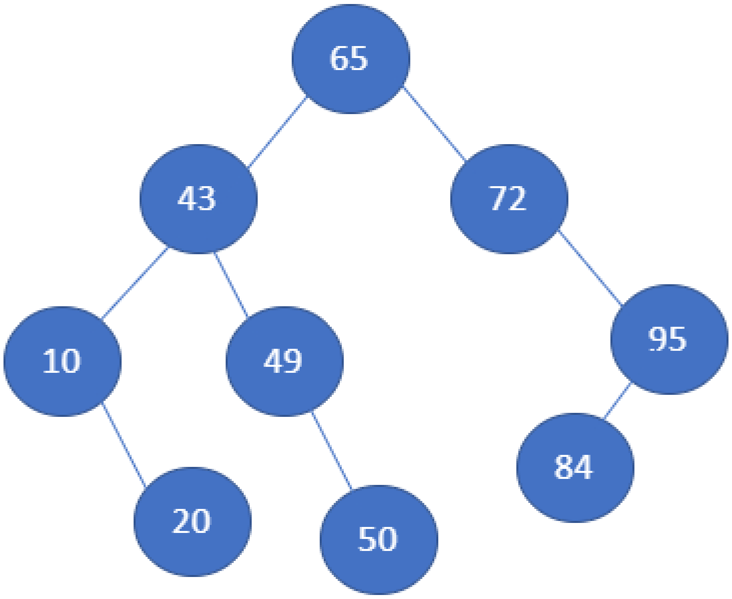
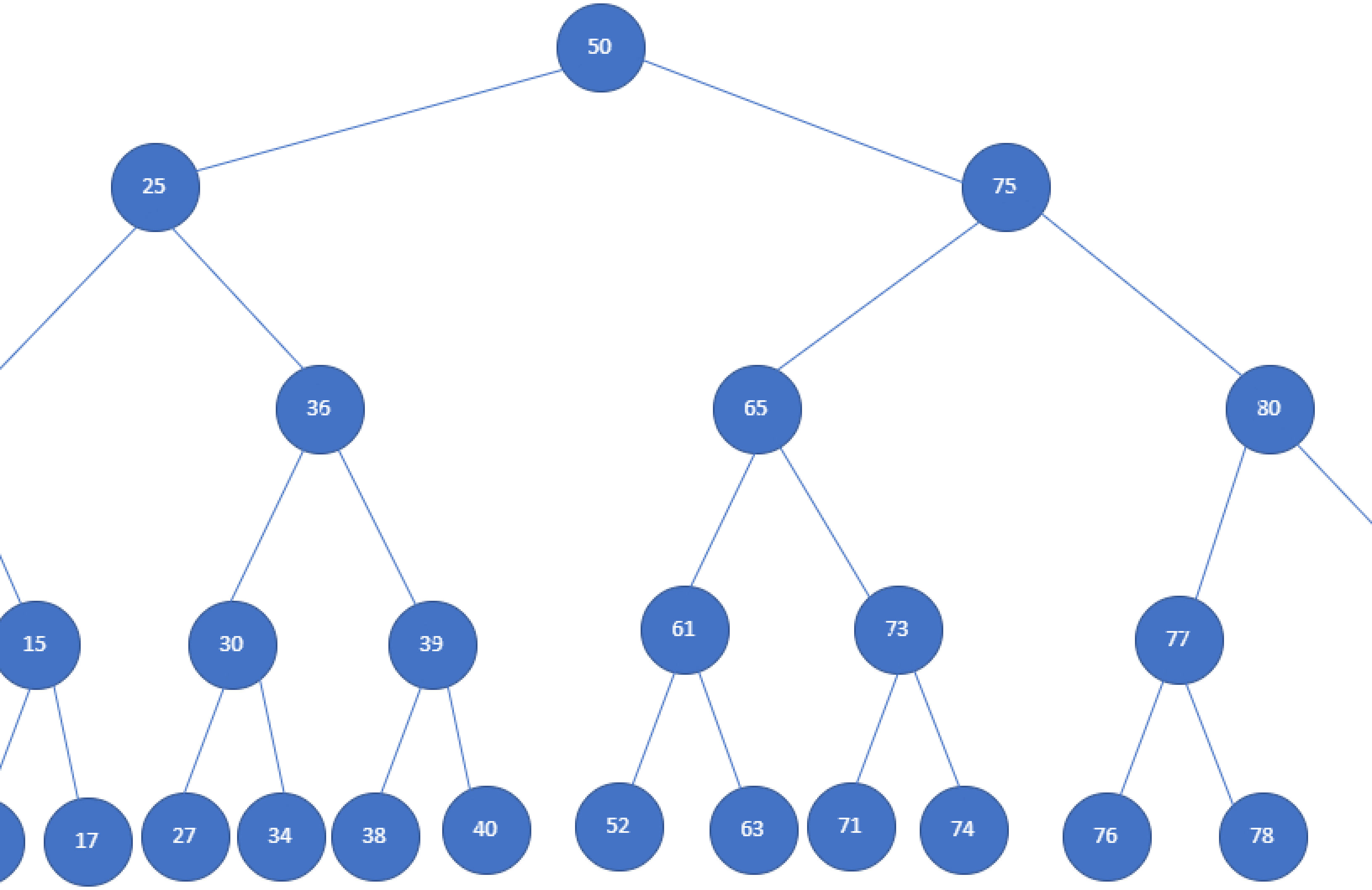
Data Structures

July 29, 2020

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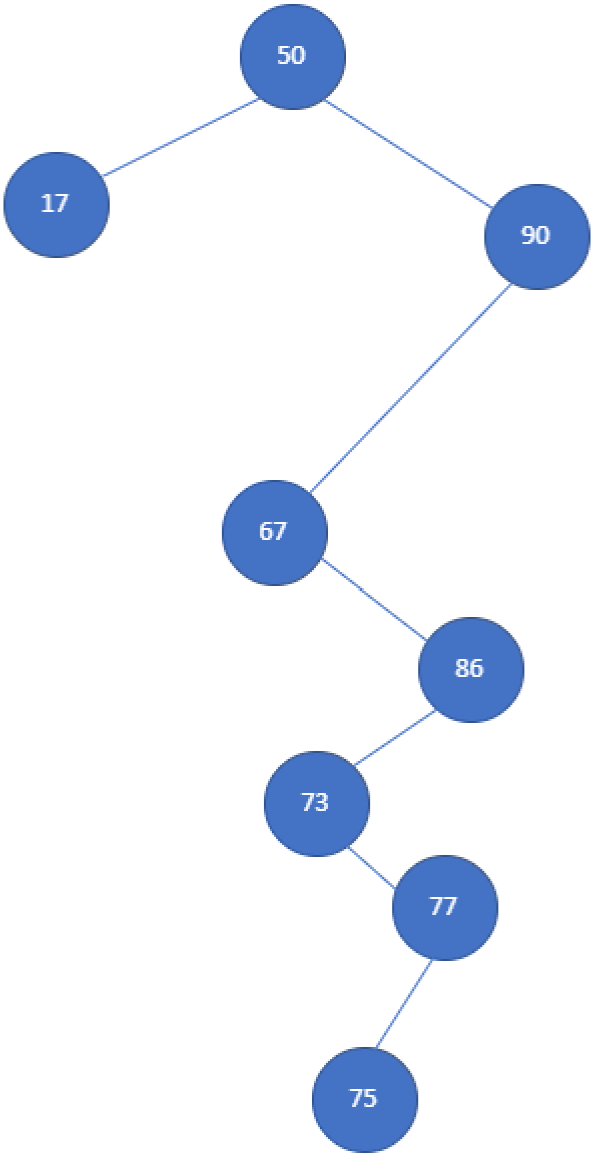
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# 1 UABinarySearchTree

```
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.IOException;

/**
 * Implementation of Binary Search Tree
 * @author noah
 *
 */

public class UABinarySearchTree {

        UANode root;
        UABinarySearchTree Tree;
        int size;

        /**
         * Loads nodes into Binary Search Tree, this method runs in O(n) time
         * @param file File being read from into Binary Tree
         * @throws IOException
         */
        public void load(String file) throws IOException {

                BufferedReader br = new BufferedReader(new FileReader(file));

                String line = "";

                while((line = br.readLine()) != null) {

                        String[] x = line.split(",");

                        treeInsert(Tree, new Node(x));

                }
                br.close();
        }
        /**
         * Finds the minimum key from given node, this method runs in O(n) time
         * @param x node given
         * @return The minimum key from given node x
         */
        public UANode treeMinimum(UANode x) {
                while(x.getLeft() != null) {
```

```
                x = x.getLeft();
        }
        return x;
}
/**
 * Finds the maximum key from given node, this method runs in O(n) time
 * @param x node given
 * @return The maximum key from given node x
 */
public UANode treeMaximum(UANode x) {
        while(x.getRight() != null) {
                x = x.getRight();
        }
        return x;
}
/**
 * Finds the direct successor of given node x, this method runs in O(lgn)?
 * @param x node given
 * @return Direct successor of x
 */
public UANode treeSuccessor(UANode x) {
        if(x.getRight() != null) {
                return treeMinimum(x.getRight());
        }

        UANode y = x.getParent();
        while(y != null && x == y.getRight()) {
                x = y;
                y = y.getParent();
        }
        return y;
}
/**
 * Finds the direct predecessor of given node x, this method runs in O(lgn)?
 * @param x node given
 * @return Direct predecessor of x
 */
public UANode treePredecessor(UANode x) {
        if(x.getLeft() != null) {
                return treeMaximum(x.getLeft());
        }

        UANode y = x.getParent();
        while(y != null && x == y.getLeft()) {
                x = y;
                y = y.getParent();
        }
        return y;
}
/**
 * Iteratively searches the tree for a node containing the key given in the paramete
 * @param x Node to start search from
 * @param key Key we are looking for
 * @return Node containing key that we were looking for
 */
public UANode treeSearch(UANode x, int key) {
        while(x != null && key != x.getKey()) {
                if(key < x.getKey()) {
                        x = x.getLeft();
                } else {
                        x = x.getRight();
                }
        }
        return x;
}
/**
 * Inserts a value into the Binary Search Tree, this method runs in O(lgn)
 * @param T
 * @param z
 */
public void treeInsert(UABinarySearchTree T, UANode z) {

        UANode y = null;
        UANode x = root;
        while(x != null) {

                y = x;

                if(z.getKey() < x.getKey()) {

                        x = x.getLeft();
                } else {

                        x = x.getRight();
                }
        }
        z.setParent(y);
        if(y == null) {

                root = z;
        } else if(z.getKey() < y.getKey()) {
                y.setLeft(z);
        } else {

                y.setRight(z);
        }
        size++;
}
/**
 * Transplants two nodes getting rid of pointers to param u, this method runs in O(1
 * @param T The tree we want to transplant in
 * @param u Node to be transplanted
 * @param v Node to be transplanted
 */
public void transplant(UABinarySearchTree T, UANode u, UANode v) {

        if(u.getParent() == null) {

                T.root = v;
        } else if(u == u.getParent().getLeft()) {

                u.getParent().setLeft(v);
        } else {

                u.getParent().setRight(v);
        }

        if(v != null) {

                v.setParent(u.getParent());
        }
}
/**
 * Deletes a node from the tree and correctly fixes location after a node is removed
 * @param T Tree we are deleting from
 * @param z Node to be deleted
 */
public void treeDelete(UABinarySearchTree T, UANode z) {
        if(z.getLeft() == null) {
                transplant(T,z,z.getRight());
        } else if(z.getRight() == null) {
                transplant(T,z,z.getLeft());
        } else {
                UANode y = treeMinimum(z.getRight());
                if(y.getParent() != z) {
                        transplant(T,y,y.getRight());
                        y.setRight(z.getRight());
                        y.getRight().setParent(y);
                }

                transplant(T,z,y);
                y.setLeft(z.getLeft());
                y.getLeft().setParent(y);
        }
        size--;
}
/**
 * Prints out the Binary Search Tree in reverse sorted order, this method runs in O(
 * @param x Node to start function from
 */
public void print(UANode x) {
        if(x != null) {
                print(x.getRight());
                System.out.println(x.getKey());
                print(x.getLeft());
        }
}
/**
 * Returns the amount of nodes currently in the Binary Search Tree, this method runs
 * @return size of Binary Search Tree
 */
public int size() {
        return this.size;
}

/**
 * Node class for Binary Search Tree that implements UANode interface
 * @author noah
 *
 */
public static class Node implements UANode{

        /**
         * Constructor to make load method more streamline when inserting from file
         * @param x
         */
        public Node(String[] x) {
                studentID = Integer.parseInt(x[0]);
                studentName = x[1];
                studentEmail = x[2];
        }

        private UANode left;
        private UANode right;
        private UANode parent;
        private int studentID;
        private String studentName;
        private String studentEmail;

        public int getKey() {
                return studentID;
        }

        public String getName() {
                return studentName;
        }

        public String getEmail() {
                return studentEmail;
        }

        public UANode getLeft() {
                return left;
        }

        public UANode getRight() {
                return right;
        }

        public UANode getParent() {
                return parent;
        }

        public void setKey(int key) {
                this.studentID = key;
        }

        public void setName(String name) {
                this.studentName = name;
        }

        public void setEmail(String email) {
                this.studentEmail = email;
        }

        public void setLeft(UANode left) {
                this.left = left;
        }
```

```
                public void setRight(UANode right) {
                        this.right = right;
                }

                public void setParent(UANode parent) {
                        this.parent = parent;
                }
                /**
                 * Overridden toString for Node fields
                 */
                public String toString() {
                        return "Student: | " + studentID + " | " + studentName + " | " + stu
                }


        }

        /**
         * Class to override print method of parent class
         * @author noah
         *
         */
        public static class UABinarySearchTree2 extends UABinarySearchTree{

                /**
                 * Prints the Binary Search Tree in sorted order, this method runs in O(n)
                 */
                public void print(UANode x) {
                        if(x != null) {
                                print(x.getLeft());
                                System.out.println(x.getKey());
                                print(x.getRight());
                        }
                }

        }


}
```