Nov 10
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Assignment 8

COMP 2230_02

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COMP 2230 – Data Structures and Algorithm Analysis

Assignment #8: Binary Search Trees and Heaps

Due Date: Section 01 Nov. 14th Section 02 Nov 15th, 2024

Chapter 20

Programming problem:

Develop an array implementation of a binary search tree using the computational strategy to locate the children of a node. (2* n +1) for left child and 2 * (n + 1) for right child. Note the binary search tree of integers will not be a true binary search tree as define in chapter 20 of the text book. The binaryArrayTree will support the following operations:

1. Default constructor
2. toString in level order
3. Insert(int item)
4. toString2 in preorder

Assignment Submission:

Submit a print-out of the program source code and a sample of the output, for each problem. Note you must follow the marking guidelines as identified in the LabMark document.

Problem #1 Code

BinaryTreeArray.java

```
package Ass8_2230;

import java.lang.reflect.Array;
import java.util.Arrays;

public class BinaryArrayTree<T extends Comparable<T>> {

    private T[] tree;
    private static final int DEFAULT_SIZE = 10;

    @SuppressWarnings("unchecked")
    BinaryArrayTree() {
        tree = (T[]) new Comparable[DEFAULT_SIZE];
```

```
    }

    public void insert(T element) {
        int position =  findElementPos(element, 0);
        if(position >= tree.length) {
            expandCapacity();
        }
        tree[position] = element;
    }

    private int findElementPos(T element, int node) {
        int result;
        if (node >= tree.length || tree[node] == null) {
            result = node;
        } else if (element.compareTo(tree[node]) < 0) {
            result = findElementPos(element, 2 * node + 1);
        } else {
            result = findElementPos(element, 2 * node + 2);
        }
        return result;
    }

    private void expandCapacity() {
       tree = Arrays.copyOf(tree, tree.length * 2);

    }

    public String toString() {
        return Arrays.toString(tree);
    }

    public String toStringPreOrder() {
        String result = preOrder(0, "");
        return result.substring(0, result.length() - 2);
    }

    private String preOrder(int node, String s) {
        String result = s;
        if(node < tree.length && tree[node] != null) {
```

```
            //visit root
            result += tree[node] + ", ";
            //traverse left side
            result = preOrder(2 * node + 1, result);
            //traverse right side
            result = preOrder(2 * node + 2, result);
        }
        return result;
    }
}
```

BinaryArrayTreeTest.java

```
package Ass8_2230;

public class BinaryArrayTreeTest {
    public static void main(String[] args) {

        BinaryArrayTree<Integer> bst = new BinaryArrayTree<Integer>();

        System.out.println(bst);
        bst.insert(15);
        System.out.println(bst);
        bst.insert(17);
        System.out.println(bst);
        bst.insert(18);
        System.out.println(bst);
        bst.insert(19);
        System.out.println(bst);
        bst.insert(10);
        System.out.println(bst);
        bst.insert(7);
        System.out.println(bst);
        bst.insert(9);
        System.out.println(bst);
        bst.insert(2);
        System.out.println(bst);
        bst.insert(16);
        System.out.println(bst);
```

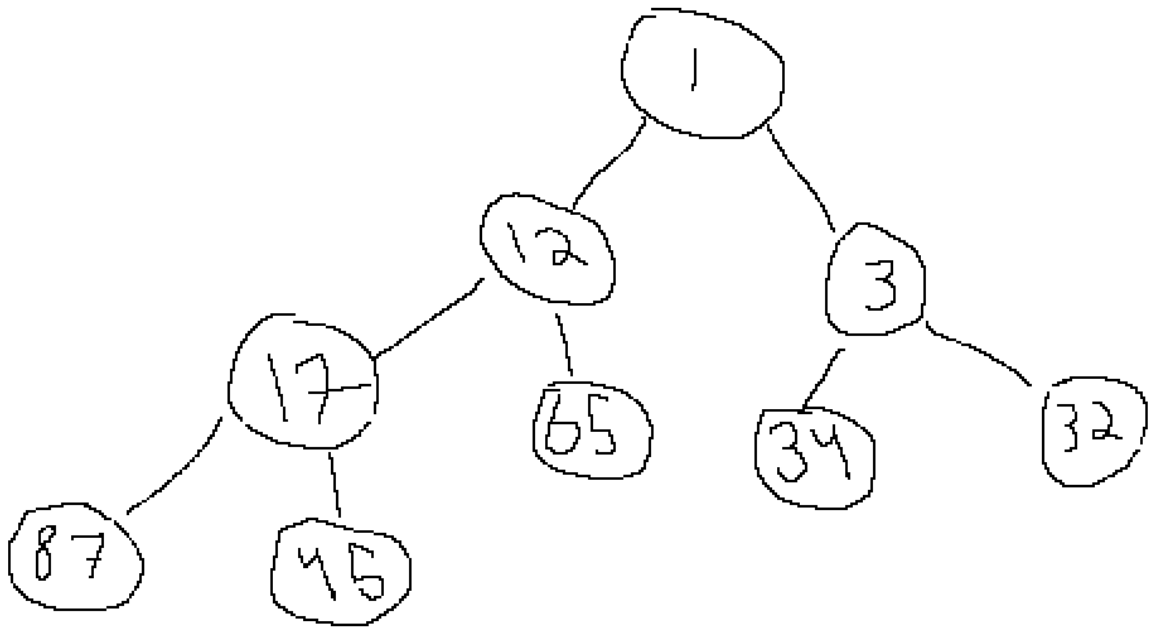
```
        System.out.println("Tree in Preorder: " + bst.toStringPreOrder());
    }
}
```

Problem #1 Test Output

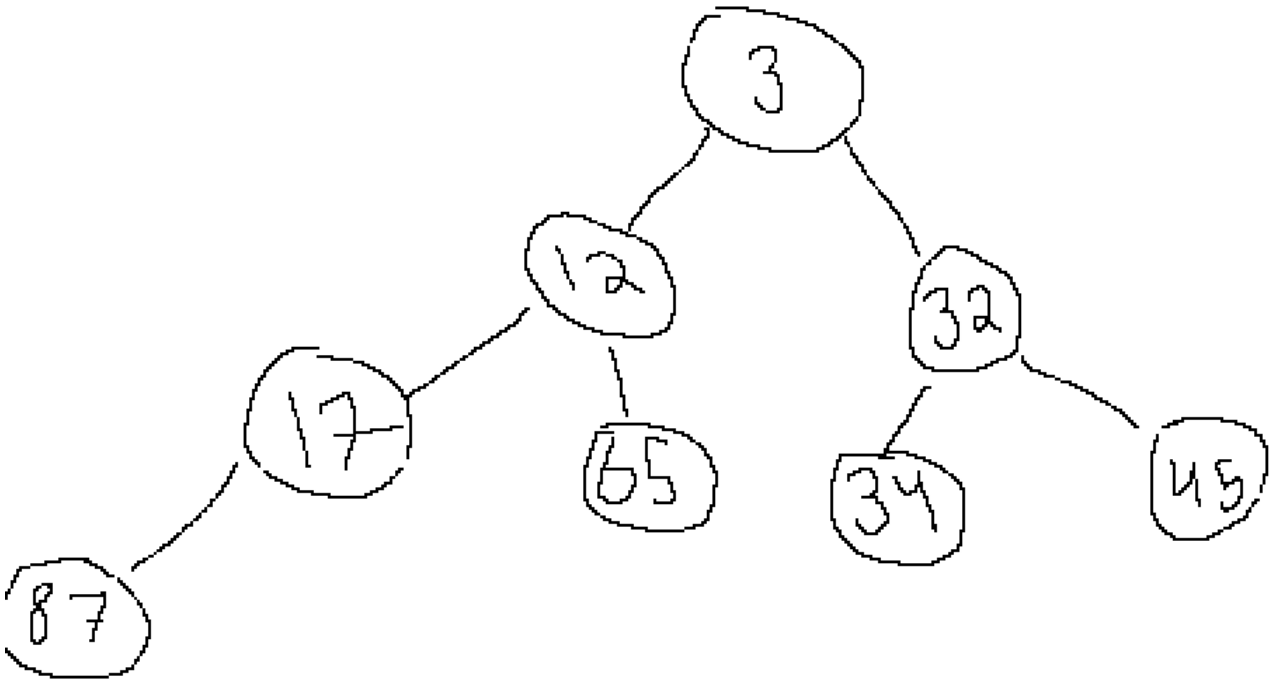
```
"C:\Program Files\Java\jdk-20\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition
[null, null, null, null, null, null, null, null, null, null]
[15, null, null, null, null, null, null, null, null, null]
[15, null, 17, null, null, null, null, null, null, null]
[15, null, 17, null, null, null, 18, null, null, null]
[15, null, 17, null, null, null, 18, null, null, null, null, null, null, null, 19, null, null, null, null, null]
[15, 10, 17, null, null, null, 18, null, null, null, null, null, null, null, 19, null, null, null, null, null]
[15, 10, 17, 7, null, null, 18, null, null, null, null, null, null, null, 19, null, null, null, null, null]
[15, 10, 17, 7, null, null, 18, null, 9, null, null, null, null, null, 19, null, null, null, null, null]
[15, 10, 17, 7, null, null, 18, 2, 9, null, null, null, null, null, 19, null, null, null, null, null]
[15, 10, 17, 7, null, 16, 18, 2, 9, null, null, null, null, null, 19, null, null, null, null, null]
Tree in Preorder: 15, 10, 7, 2, 9, 17, 16, 18, 19

Process finished with exit code 0
```

Chapter 21

1 Draw the min heap that results from adding the following integers (34 45 3 87 65 32 1 12 17)



2 Starting with the previous heap draw the heap that results from performing a removeMin operation.



3 Starting with an empty minheap, draw the heap after each of the following operations

addElement(40)

addElement(25)

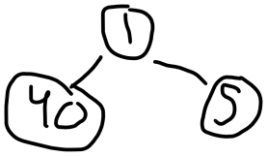
RemoveMin

AddElement(10)

RemoveMin()

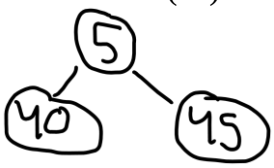
AddElement(5)

AddElement(1)

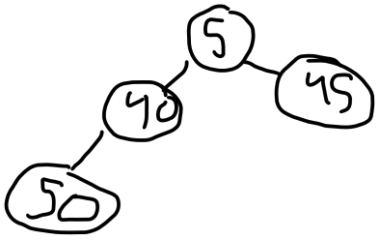


RemoveMin()

AddElement(45)



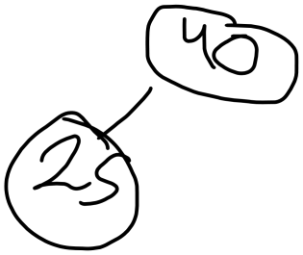
AddElement(50)



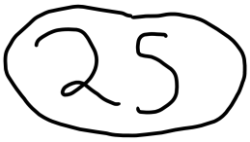
4 Repeat 3, this time with a maxheap

addElement(40)

addElement(25)



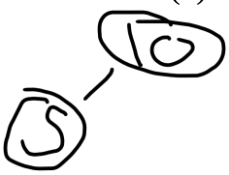
RemoveMax



AddElement(10)

RemoveMax()

AddElement(5)



AddElement(1)

RemoveMax()

AddElement(45)

AddElement(50)