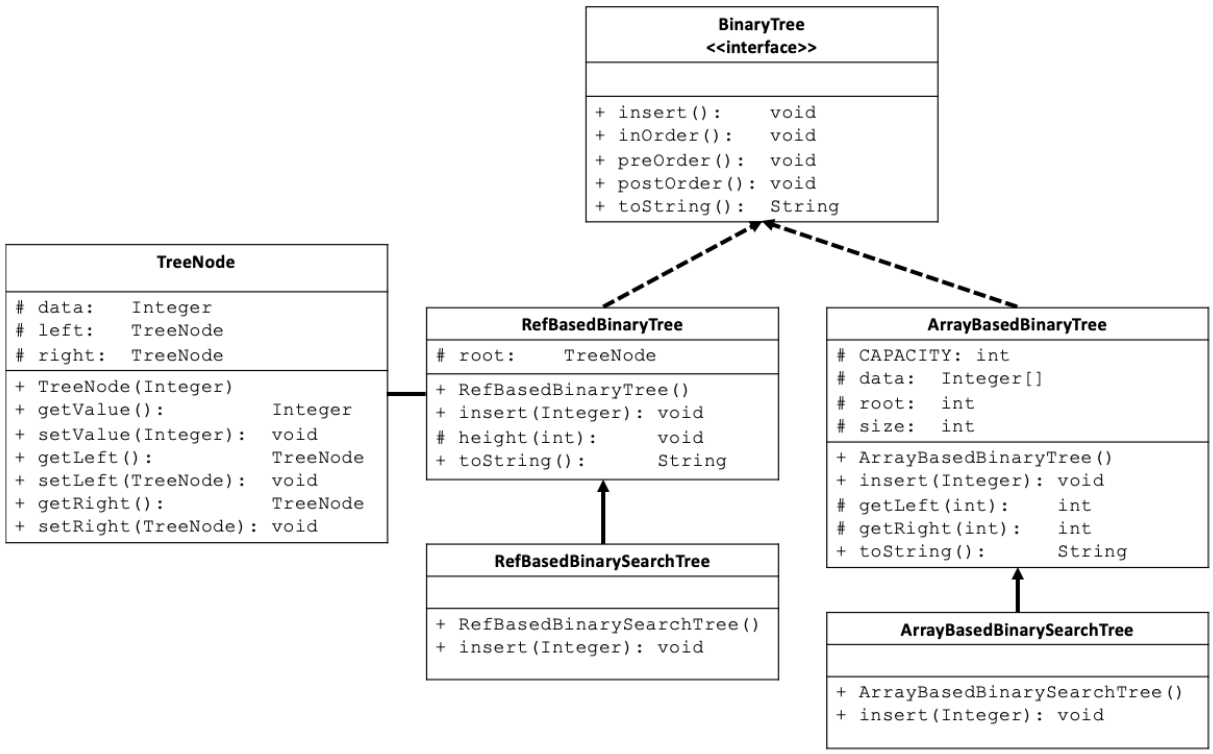
Lab 9

Objectives

- Extending Binary Trees to make Binary Search Trees
- Practice with extending a class and overriding methods

Part I – Extending BinaryTree

In this lab you will implement the `ArrayBasedBinarySearchTree.java` and `RefBasedBinarySearchTree.java` that will **`extend`** the `ArrayBasedBinaryTree.java` and `RefBasedBinaryTree.java` respectively (as shown in the UML diagram below).



RECALL: A Binary Search Tree maintains the invariant that for every node n in the tree, all node's in n's left subtree have a key less than n's, and all nodes in n's right subtree have a key larger than n's.
Download all the files provided to you in this lab to your Lab9 folder.

1. You will be implementing the necessary methods in `ArrayBasedBinarySearchTree.java` that extends `ArrayBasedBinaryTree.java`
2. Observe which methods `ArrayBasedBinarySearchTree` will inherit from the super class
3. Implement the required methods that you will **override** from the super class (insertion will be much different as the insert must maintain the invariant of the Binary Search Tree).
4. Look at the **`main`** method. Hand draw what the tree will look like after the calls to insert in the main and write out the expected in-order, pre-order and post-order traversals.
5. Compile and run and compare the output with your expected results from Step 5.
6. Repeat steps 3-5 for `RefBasedBinarySearchTree.java`

CHECKPOINTS 1 (ArrayBased) & 2 (RefBased) – Now might be a good time to check-in with the TA if you are aren't sure you have completed the tasks as expected. Please don't hesitate to ask questions if you are unclear about anything.

Part II – Adding functionality

In this part of the lab you will be adding functionality to `RefBasedBinaryTree.java` and `RefBasedBinarySearchTree.java`

For each method description below do the following:

1. Implement and test the method in `RefBasedBinaryTree.java`
2. In small groups discuss whether `RefBasedBinarySearchTree.java` should inherit the implementation from `RefBasedBinaryTree.java` or if it should override it. Discuss whether each algorithm will be different given the constraints of a Binary **Search** Tree. Can we reduce the number of nodes we will need to visit using a Binary Search Tree instead of just a Binary Tree?
3. Double check with a TA which methods you should override in `RefBasedBinarySearchTree.java`.
4. If you determined you should override a method in `RefBasedBinarySearchTree.java`, implement it
5. *OPTIONAL – but great for studying: implement two versions of each method: an **iterative** version and then a **recursive** version. If you do this, keep one commented out, so the tester can run without error.*

```
/*
 * Method name: sum
 * Purpose: computes the sum of all elements in this BinaryTree
 * Parameters: none
 * Returns: int – the sum
 */

/*
 * Method name: find
 * Purpose: determines whether val is in this BinaryTree
 * Parameters: int val
 * Returns: boolean – true if val is found, false otherwise
 */

/*
 * Method name: getMax
 * Purpose: gets and returns the largest value in this BinaryTree
 * Parameters: none
 * Throws: TreeEmptyException if called on an empty tree
 * Returns: int – the largest value
 */
```

CHECKPOINT 3 – LAB COMPLETE – Make sure to demonstrate your completed work to your TA during your scheduled lab.