Practical Exercise 7 – Binary Search Trees

Overall Objective

To design and implement applications using binary search trees.

Background

You will need to know:

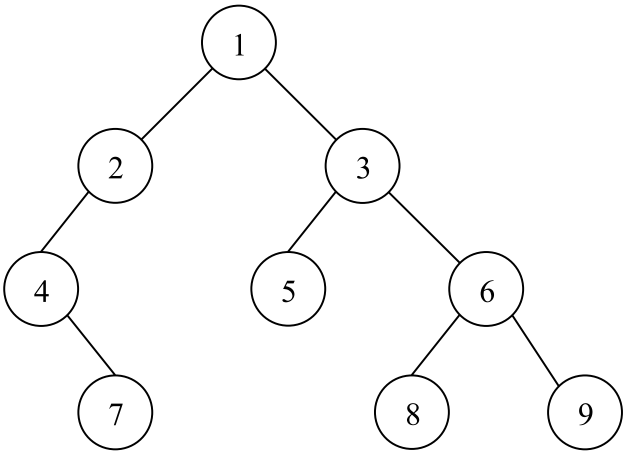
1. basic Java programming knowledge
2. classes and interfaces
3. generics
4. recursion
5. binary search tree concept

Description

Part 1: Discussion

1. For the Binary Tree given below, write the numbers in the order by using the following traversal methods:

   a. Pre-order
   b. In-order
   c. Post-order
   d. Breadth-first traversal

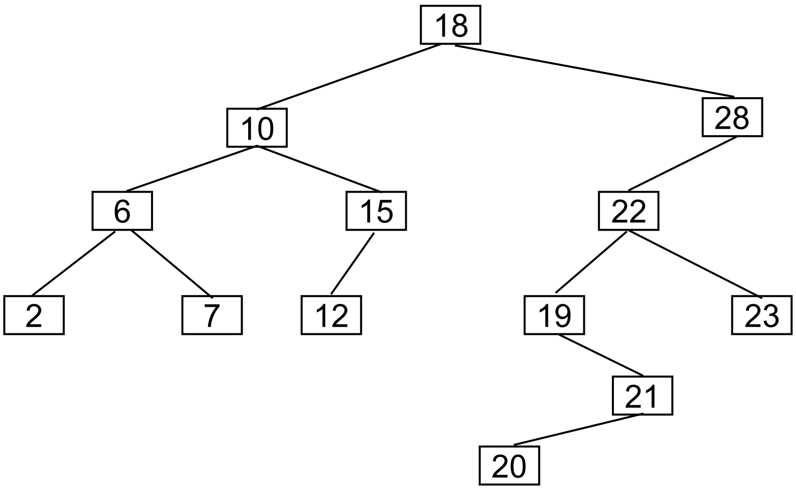


2. Suppose you have a binary tree whose data fields are single characters.

   a. When the data fields of nodes are printed in in-order, the output is ABCDEFGHIJ, and when they are printed in pre-order, the output is BAHCEDGFJI.
   Draw the binary tree showing the data in each node and the references between nodes. Show the step used to arrive at the result.

   b. When the data fields of nodes are printed in in-order, the output is ABCDEFGHIJ, and when they are printed in post-order, the output is BEDGFHCJIA.
   Draw the binary tree showing the data in each node and the references between the nodes. Show the steps used to arrive at the result.

3. Below is a Binary Search Tree (BST). What is the tree obtained after each of the following operations (each on the initial tree)?



a.	`insert(31);`	e.	`remove(15);`
b.	`insert(4);`	f.	`remove(28);`
c.	`insert(16);`	g.	`remove(6);`
d.	`remove(23);`	h.	`remove(18);`

Part 2: Programming Exercise

1. **Find the leaves**
   Add a method in `BinaryTree` class to return the number of the leaves as follows:

```
/** Returns the number of leaf nodes */
public int getNumberOfLeaves()
```

2. Write the test program that puts 20 random integers between -100 and 100 into a BST. The program should print out all the integers in the BST and test the `getNumberOfLeaves()` method above.

   [Note that in Java, there is a method `Math.random()`, which returns a double value between 0.0 and 1.0. And there is another method `Random.nextInt(int n)`, which returns a random value in the range of 0 (inclusive) and n (exclusive).]

3. In addition to the test program you have constructed for Question 2, write and test a method that sums all the integers in the BST.