CSC-361 Homework: Binary Trees

For this problem set, please work with a group of 2 or 3. Only one submission from the group is required.

Consider a binary tree that stores a single (unsigned) binary number where each digit is stored as a leaf. For example, we may represent the binary number $1101_2 = 13_{10}$ and $10111_2 = 23_{10}$ with the respective trees below.
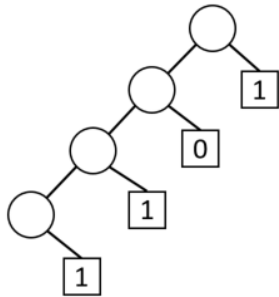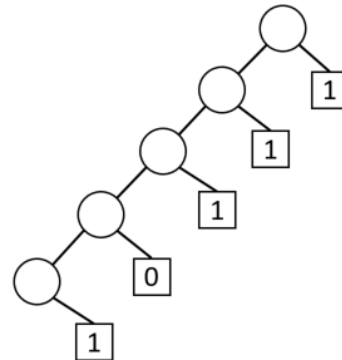

Figure 1: $1101_2 = 13_{10}$

Figure 2: $10111_2 = 23_{10}$

For the following questions, you may assume that binary numbers are represented with the `BinaryTree` class and the inheriting `BinaryDigitTree` class shown below. This implementation includes a protected `TreeNode` class as well as access to the root as an instance variable (`_root`).

```
public class BinaryTree<DataT>
{
    protected TreeNode<DataT> _root;

    protected final class TreeNode<DataT>
    {
        public TreeNode<DataT> _left;
        public TreeNode<DataT> _right;
        public DataT _data;

        public TreeNode(TreeNode<DataT> left,
                        DataT data,
                        TreeNode<DataT> right)
        {
            _left = left;
            _data = data;
            _right = right;
        }

        public TreeNode(DataT data)
        {
            this(null, data, null);
```

```
            }
    }

    public class BinaryDigitTree extends BinaryTree<Integer>
    {
        /* Methods to be completed below in questions 1-4 */
    }
```

The representation (described above) of a binary number using a binary digit tree is strictly left skewed: internal nodes always occur as left children and right children are always leaves.

The following questions require source code implementations. Although not explicitly possible to execute your solutions, please provide typed solutions.

1. An easy way to divide a binary number by 2 is to remove the rightmost bit thus shifting all bits to the right by one digit. That is, when $10110_2 = 22_{10}$ is divided by 2, we acquire $1011_2 = 11_{10}$. This division operation thus automatically takes the floor of the result (e.g. $10111_2 = 23_{10}$ is divided by 2, we acquire $1011_2 = 11_{10}$). Write a method to perform division by 2 with a binary digit tree.

2. Write a method to perform division by a given power of 2. In particular, the input to the method is a non-negative integer.

3. Write a recursive method to evaluate (in base 10) the value of a binary number represented as a binary digit tree.

4. Write an iterative method to evaluate (in base 10) the value of a binary number represented as a binary digit tree.