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INTRODUCTION TO COMPUTER SCIENCE: PROGRAMMING METHODOLOGY

TUTORIAL 14

TREE

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Definition of Binary Tree Class

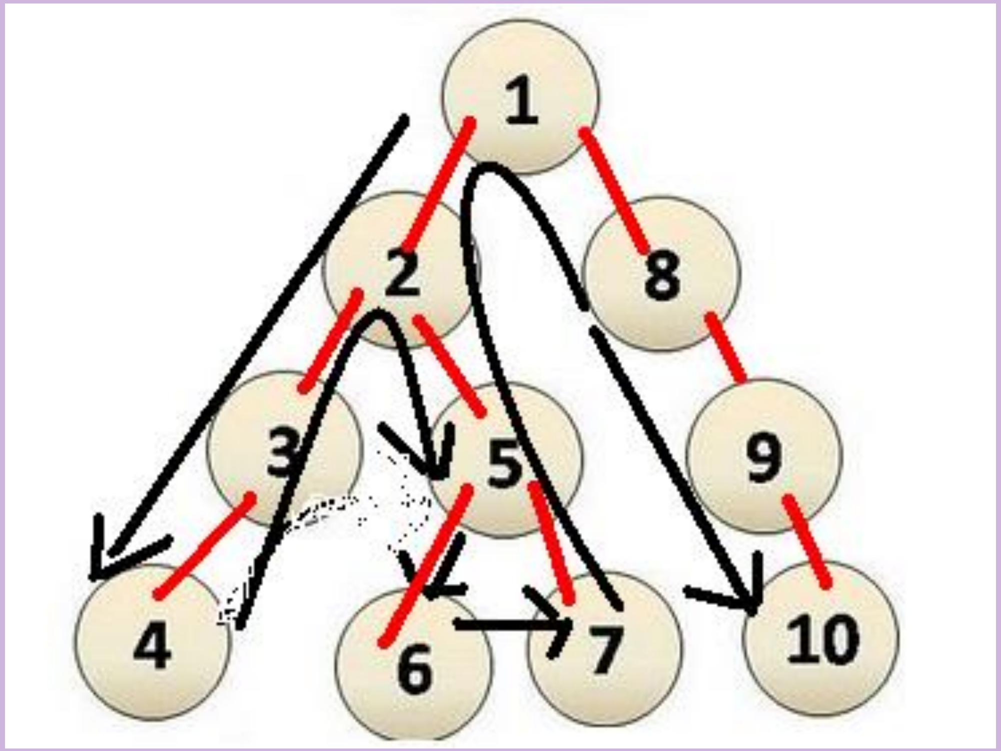
- Refer to the *LBTree.py* file.
- The nodes in the binary tree you define is of Node class defined by yourselves. Node class has four data fields, one(element) store the value of the node and three references(or pointers) store parent, left child and right child node respectively(or equivalently their addresses).
- The binary tree has two data fields, its root and its size(the total number of nodes).

Depth First Search

- **Depth-first search (DFS)** is a fundamental algorithm for traversing or searching tree data structures.

- One starts at the **root** and explores **as deep as possible** along each branch **before backtracking.**

- Refer to the *DFS.py* file.

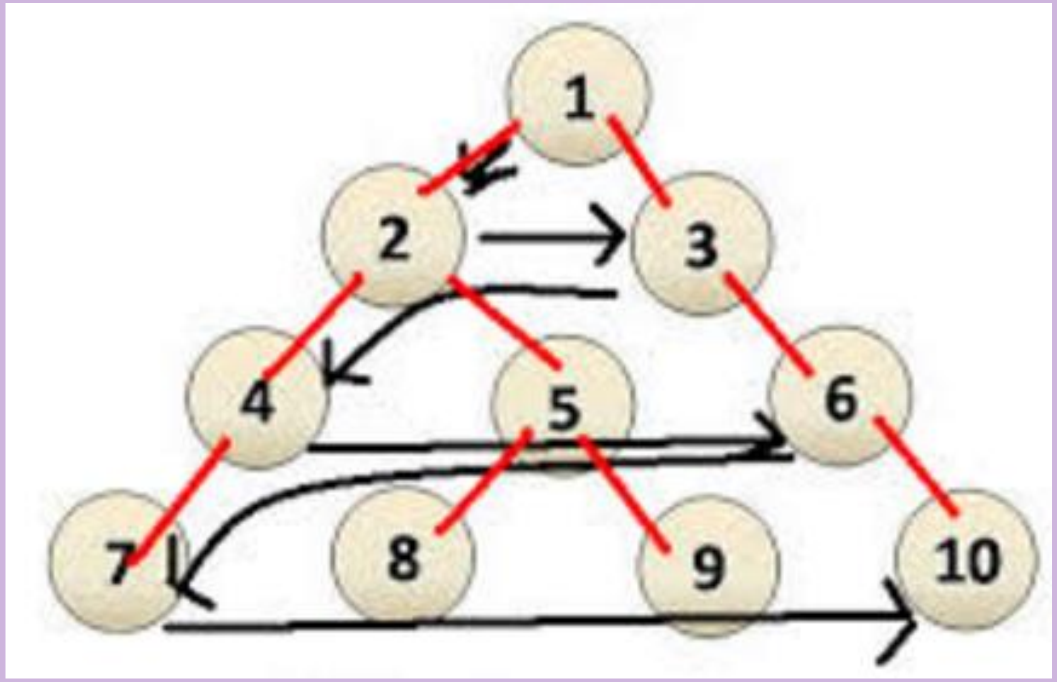


Breadth First Search

- **Breadth-first search (BFS)** is another very important algorithm for traversing or searching tree data structures.

- Starts at the **root** and we visit all the positions at depth **d** before we visit the positions at depth **d +1.**

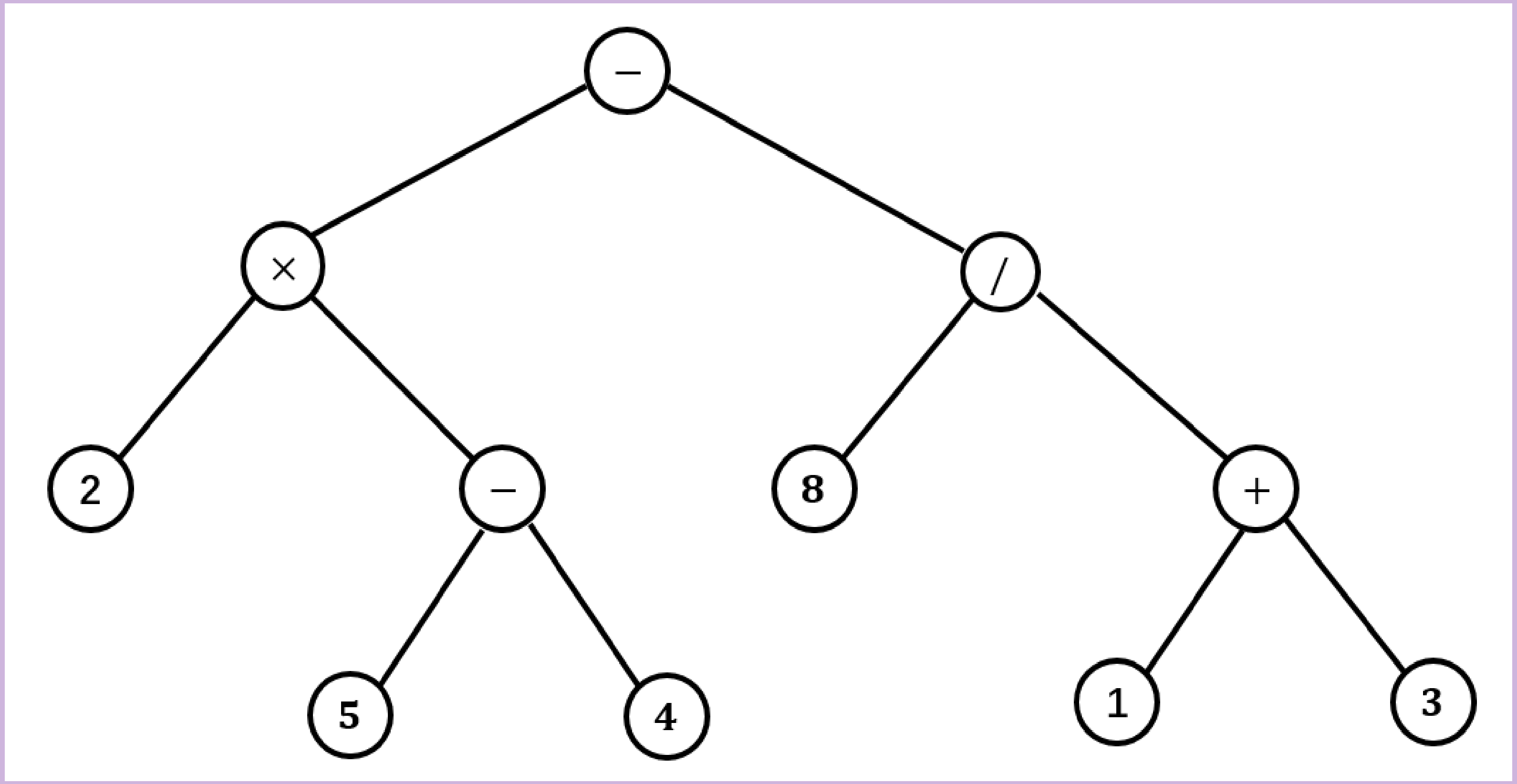
- Refer to the *BFS.py* file.



Q1: Represent an Expression

- **An arithmetic expression can be represented using a binary tree, with each node being a number or an operator. Try to draw a tree to represent an expression $\mathbf{2 \times (5 - 4) - (8/(1 + 3))}$.**

Q1: Answer



Q2: Create a Tree Object

- Using the definition of binary tree class, create an object of that class, with value of each node equal to that in the binary tree you draw in Q1.

Q3: Depth First Search

- i) Apply the Depth First Search algorithm to the tree you create in Q2, and check the order of elements in the tree printed out.

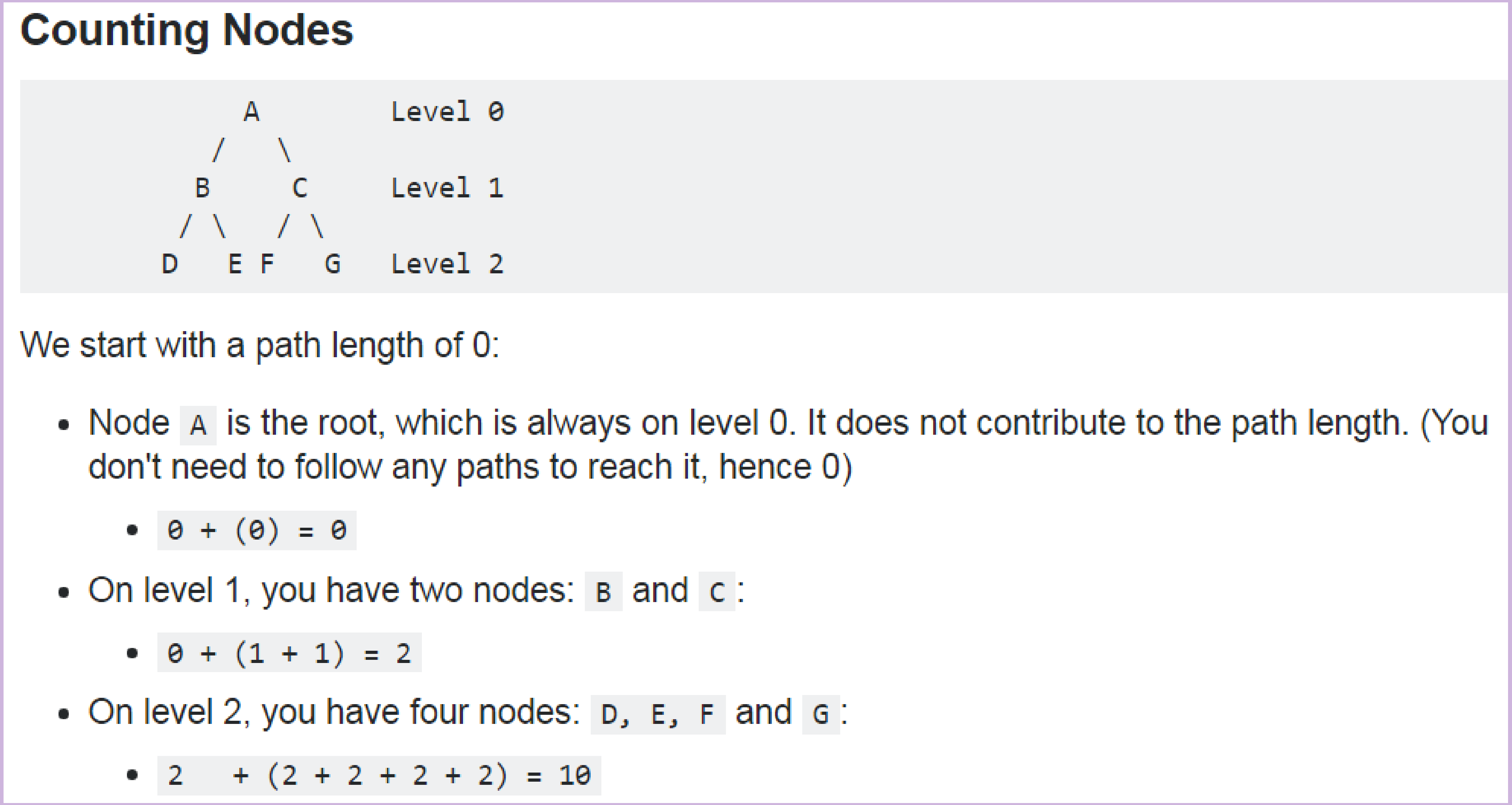
- ii) Modify the Depth First Search program a little bit, define a function that is able to evaluate an expression represented by a binary tree.

- iii) You can try i) ii) using Breadth First Search algorithm.

Q4: Path Length of a Tree-I

- The path length of a tree T is the sum of the depths of all positions in T. Describe a linear time method for computing the path length of a tree T.

Q4: Path Length of a Tree-II



Counting Nodes

```
          A         Level 0
        /   \
       B     C      Level 1
      / \   / \
     D   E F   G    Level 2
```

We start with a path length of 0:

- Node `A` is the root, which is always on level 0. It does not contribute to the path length. (You don't need to follow any paths to reach it, hence 0)
  - `0 + (0) = 0`
- On level 1, you have two nodes: `B` and `C`:
  - `0 + (1 + 1) = 2`
- On level 2, you have four nodes: `D, E, F` and `G`:
  - `2   + (2 + 2 + 2 + 2) = 10`