

Lab Activity 4: Advanced AVL Tree Operations in Python

In this lab activity, you will focus on implementing and exploring advanced operations and concepts related to AVL trees, a type of self-balancing binary search tree.

Prerequisites:

- Basic understanding of Binary Search Trees and their basic operations (insertion, deletion, search, and traversal).
- Familiarity with the concept of AVL trees and their balancing properties.

Tasks:

1. Implement the **isAVL()** Method:

- Develop a method to check if a given binary tree is a valid AVL tree by ensuring it maintains the AVL balance property.

2. Implement the **balanceFactor()** Method:

- Create a method to calculate the balance factor of each node in the AVL tree.

3. Implement the **rotateLeft()** and **rotateRight()** Methods:

- Implement rotation operations to rebalance the AVL tree when necessary.

4. Implement the **deleteNode()** Method:

- Develop a method to delete a specific node from the AVL tree while maintaining balance.

Guidelines:

- Create a class named **AVLNode** to represent each node in the AVL tree, including attributes for value, left child, right child, and height.
- Implement a class named **AVLTree** to represent the AVL tree and include all required methods within this class.

Instructions:

1. Implement the **AVLNode** Class:

- Define the **AVLNode** class with attributes for value, left child, right child, and height.

2. Implement the **AVLTree** Class:

- Develop the **AVLTree** class with methods for **isAVL()**, **balanceFactor()**, **rotateLeft()**, **rotateRight()**, and **deleteNode()**.

3. Testing:

- Test each method with various test cases to ensure correctness and functionality.

4. **Validation:**

- Create test cases for **isAVL()** with both valid and invalid AVL trees to verify results.

5. **Scenario Testing:**

- Generate test cases for **deleteNode()** with different scenarios (nodes at different levels, leaf nodes, etc.).

6. **Edge Cases Handling:**

- Ensure that your implementation handles edge cases effectively to maintain the balance of the AVL tree.