Binary Tree Zigzag Level Order Traversal Documentation

Problem Statement

Given the root of a binary tree, return the zigzag level order traversal of its nodes' values. The traversal should alternate between left to right and right to left for each subsequent level.

Example 1:

Input: root = [3, 9, 20, null, null, 15, 7]

Output: [[3], [20, 9], [15, 7]]

Example 2:

Input: root = [1]

Output: [[1]]

Example 3:

Input: root = []

Output: []

Constraints

- The number of nodes in the tree is in the range [0, 2000].
- Node values are in the range [-100, 100].

Solution

The solution uses a breadth-first search (BFS) approach to traverse the binary tree in a zigzag manner. The algorithm utilizes a deque to manage the nodes at each level, appending from the left or right based on the current traversal direction. The direction alternates at each level.

Explanation

1. **Initialization:** The result list is initialized to store the final zigzag level order traversal. The queue deque is initialized with the root node. The left_to_right flag is initialized to True to control the direction of traversal.

2. **BFS Traversal:** The outer while loop runs as long as there are nodes in the queue.
   - *Level Processing:* The level_size variable holds the number of nodes at the current level. The level_nodes deque is used to store the nodes' values for the current level.
   - *Node Processing: For each node in the current level:*
     - The node is dequeued.
     - If left_to_right is True, the node's value is appended to level_nodes; otherwise, it is appended to the left.
     - If the node has a left child, it is enqueued.
     - If the node has a right child, it is enqueued.
   - *Level Completion:* After processing all nodes at the current level, level_nodes is converted to a list and added to result. The left_to_right flag is toggled to alternate the traversal direction for the next level.

3. **Return Result:** After all levels are processed, the result list, containing the zigzag level order traversal, is returned.

This solution ensures that the binary tree is traversed level by level, with the traversal direction alternating at each level to achieve the zigzag pattern.