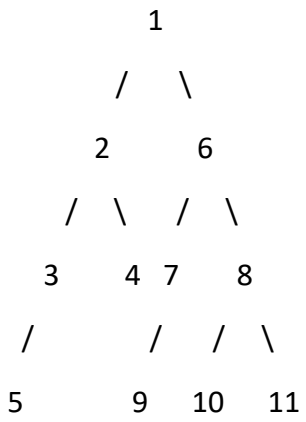
Flatten a Binary Tree To a Linked List LeetCode

Given the root of a binary tree, flatten the tree into a "linked list":

- The "linked list" should use the same Node class where the right child pointer points to the next node in the list and the left child pointer is always null.
- The "linked list" should be in the same order as a preorder traversal of the binary tree.

Example:



Output: 1 → 2 → 3 → 5 → 4 → 6 → 7 → 9 → 8 → 10 → 11

Approach 1: Flatten a binary tree using a recursive approach

- A public function **flattenRecursive** is used to initiate the flattening process.
- It utilizes the helper function **flattenHelper** that recursively flattens the binary tree into a linked list.
- In the **flattenHelper** function, a post-order traversal is used:
  - Recursively flatten the right subtree first, then the left subtree.
  - Connect the current node to the previously flattened portion.
- The result is a flattened binary tree with right child pointers set correctly.
- **Time Complexity: O(N) as it visits each node exactly once.**
- **Space Complexity: O(H), where H is the height of the binary tree. In the worst case, where the tree is skewed, H could be N, making the space complexity O(N). In a balanced tree, it is O(log N).**

Approach 2: Flatten a binary tree using an iterative approach (stack-based)

- A public function **flattenIterative** is used to initiate the iterative flattening process.
- It uses a stack-based iterative approach.
- A stack is employed to traverse the binary tree in a pre-order manner, pushing nodes as they are visited.
- Right child pointers are correctly set as nodes are popped from the stack.
- The result is a flattened binary tree with right child pointers set correctly.
- **Time Complexity: O(N) as it visits each node exactly once.**
- **Space Complexity: O(H), where H is the height of the binary tree. In the worst case, where the tree is skewed, H could be N, making the space complexity O(N). In a balanced tree, it is O(log N).**

Approach 3: Flatten Binary Tree to Linked List using the Iterative Morris Traversal

- A public function **flattenMorrisTraversal** is used to initiate the Morris traversal flattening process.
- It utilizes Morris traversal, which doesn't use additional data structures.
- The key idea is to connect the right child of the in-order predecessor to the current node's right child and move to the left child.
- The left child of each node is set to null during the process.
- The result is a flattened binary tree with right child pointers set correctly.
- **Time Complexity: O(N) as it visits each node exactly once.**
- **Space Complexity: O(1) as it doesn't use additional data structures.**

Conclusion:

- All three approaches successfully flatten the binary tree into a linked list, maintaining the correct order of elements.
- The recursive approach is straightforward but uses additional space for the function call stack.
- The iterative approach eliminates the need for the function call stack and has a space complexity of O(H).
- The Morris traversal approach is the most memory-efficient with a space complexity of O(1).