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Data Structures & Algorithms

# Approach

At a high level, we are taking a Binary Tree implementation and turning it into a Double (Left/Right) Threaded Binary Tree Implementation.

What does this mean? It means that we have a Binary Tree, or a K-ary tree where K = 2, and we want to be able to use pointers from each node to access the inorder predecessor and successor (in addition to the standard pointers to access the left and/or right children and/or parent node).

Each of our “threaded” pointers (those that point to an inorder predecessor or successor) must be marked as such using a boolean (which indicates the “isAThread” quality of each pointer, so “true” means that the pointer is a thread to an inorder predecessor or successor and “false” means it is a regular pointer to another node).

1. The first thing I am going to do is put all the existing code into a Visual Studio C++ console application project.
2. Next, I will create main.cpp and add it as a source file in Visual Studio
3. In main.cpp, I will inherit the appropriate file-“BST.h”-and write my main() function that will handle creation and manipulation of the BST object through the BST implementation.
   1. To get a hang of how data moves through the objects, I’ll create a BST object, add a few couts in various methods to see which are called and when, and compile/run the program.
4. Determining changes
   1. We’ll need to make changes to the following files
      1. BinNode.h
      2. BSTNode.h
      3. BST.h
      4. Main.cpp
   2. Let’s break this down
5. Changes to BSTNode.h
   1. Since implements the Binary Nodes from BinNodes.h, we will need to make sure there is support for threaded pointers and associated Booleans.
   2. This will NOT be done by adding more pointers. We will merely reuse the pointers for the left and right children that are already there, but label them as either “threaded” or “regular” pointers using a private Boolean (“true” if “threaded”, “false” if “regular”).
   3. By adding more pointers, we defeat the purpose of the exercise. The goal is to optimize the binary tree structure in which there are left and right child pointers, allowing for more efficient access to other parts of the tree (the inorder predecessors and successors) where possible when no left or right child node exists.
   4. So, create context Booleans indicating the type of pointer of the lc and rc pointers.
   5. Create getter and setter methods for these Booleans.
   6. Integrate these new variables into the constructor w/ parameters method.
   7. Amend isLeaf() to incorporate a check for the context variable when deciding if the node has no children (because now, all of them will have at least one child).
      1. If it has no children, it’s a leaf
      2. If all of its children are threaded, it’s a leaf
         1. Have to count number of children and get the “true” thread context variables for them
         2. If they’re equal, it’s a leaf
   8. Now, we have to ensure that the methods in BST.h that call methods in our BSTNode class do so with the appropriate parameters (the booleans needed for thread/regular context).
6. Changes to BST.h
   1. Insert()
   2. InsertHelp()
      1. Need to incorporate the use of hasInorderPredecessor and hasInorderSuccessor here
         1. To properly set the “isLcThreaded” and “isRcThreaded” variables in BSTNode.h based on the insertion position of the new node
         2. Also need to take into account that when new nodes are added and those (previously null, now threaded and active) pointers are redirected to a non-threaded target node (an actual child node), those variables will need to be set to “false” for accuracy, otherwise a bunch of them will say they are threaded when they aren’t.
         3. Incorporating “lcIsThreaded” and “rcIsThreaded” booleans in insertHelp() based on the “hasInorderPredecessor” and “hasInorderSuccessor” Boolean functions in BST.h when insertHelp() is run for all cases except the root will ensure this isn’t an issue.
   3. Add private functions
      1. Bool hasInorderPredecessor()
      2. Bool hasInorderSuccessor()
7. Changes to Main.cpp

# Integrity Statements

* 1. I have not shared the source code in my program with anyone other than my instructor’s approved human sources.
  2. I have not used source code obtained from another student, or any other unauthorized source, either modified or unmodified.
  3. If any source code or documentation used in my program was obtained from another source, such as a text book or course notes, that has been clearly noted with a proper citation in the comments of my program.
  4. I have not knowingly designed this program in such a way as to defeat or interfere with the normal operation of any machine it is graded on or to produce apparently correct results when in fact it does not.