

1 Introduction

This lab is to do some timing for the recursive traversals verses the iterative traversal algorithms for a binary search tree structure. For these you will be

1. Plotting your results using LibreOffice Calc.
2. Transferring the charts to a LibreOffice Writer document.
3. Answering any questions about the analysis which are to be written in the LibreOffice Writer document.
4. Export the LibreOffice Writer document to a PDF file (there is a button in the toolbar to do that).
5. This document will be zipped up with your code files into one zip file to be uploaded to MyClasses.

2 Instructions

When you are finished submit all your work through the MyClasses page for this class. Create a directory called Lab04, put each programming exercise into its own subdirectory of this directory, zip the entire Lab04 directory up into the file Lab04.zip, and then submit this zip file to Lab #4.

Make sure that you:

- Follow the coding and documentation standards for the course as published in the MyClasses page for the class.
- Make sure that each project includes a makefile that will compile the program on the Linux HPCL lab machines.
- Check the contents of the zip file before uploading it. Make sure all the files are included.
- Make sure that the file was submitted correctly to MyClasses.

3 Exercise

Start with the BinaryTreeTemplatedTraversals example in the example code. Although this is a templated structure we will just deal with integer binary search trees.

1. We will be comparing the run-times of the three traversals between the recursive algorithms and the iterative algorithms. We do not want to print the trees out since they will be large. So create copies of the 7 functions that do the traversals, there are three recursive ones and there are 4 iterative ones (two different algorithms for post order traversal). The copies should just add one to the value of each node in place of printing it out.
2. Write a main program that will
 - (a) Create a BinaryTree structure storing long data types.
 - (b) Ask the user for the number of nodes that they want to add to the tree.
 - (c) Populate the tree with that many nodes, each with a randomly generated value.
 - (d) Time each of the 7 algorithms on the add one versions of the code. So each run of the program should give you 7 times, one for each of the algorithms individually.

3. Experiment with the tree sizes to get a range of sizes that produces usable data, I would expect that the number of nodes would need to be fairly large. Take 5–10 sizes of the number of nodes evenly distributed over your usable data range. Make charts of the data for each of the 7 algorithms. With this data do the following and answer the following questions.
- (a) Plot the pre-order traversals together on one graph (xy-scatter). In class we did an off-the-cuff estimate that these were $O(n)$. Does the data and the graph support that conclusion? If so, explain why and if not what does the empirical data suggest, that is, what is the smallest $g(n)$ for its $O(g(n))$?
 - (b) Plot the post-order traversals together on one graph (xy-scatter), all three of them. We thought that these were also $O(n)$. Does the data and the graph support that conclusion? If so, explain why and if not what does the empirical data suggest, that is, what is the smallest $g(n)$ for its $O(g(n))$?
 - (c) Plot the in-order traversals together on one graph (xy-scatter). We thought that these were also $O(n)$. Does the data and the graph support that conclusion? If so, explain why and if not what does the empirical data suggest, that is, what is the smallest $g(n)$ for its $O(g(n))$?
 - (d) Plot the three recursive traversals together on one graph (xy-scatter). What are any trends you notice?
 - (e) Plot the four iterative traversals together on one graph (xy-scatter). What are any trends you notice?
 - (f) Taking all of the data and graphs together, what are your conclusions from this analysis?

Put all of the data, graphs, and your commentary into a single LibreOffice Writer document, PDF the document, zip it up with all of your program code and submit the zip file to the MyClasses assignment.