CptS 223 – Advanced Data Structures in C++

Written Homework Assignment 1: Math Review, Big-O, Recursion and General Linux/Git Topics

Assigned: Monday, February 1, 2021
Due: Sunday, February 14, 2021

I. Problem Set:

1. (15, -1 pts/rank) Order the following set of functions by their growth rate (from fastest to slowest – rank 1 – 12, where 1 is the fastest and 12 is the slowest). Hint: you can plot their curves in a X-Y axis using http://fooplot.com/:

Unordered Complexities	Ordered Complexities
N	8
√N	10
N^1.5	6
N^2	4
N log N	7
N log(log(N))	9
N log^2 N	5
2/N	12
2^N	1
2^(N/2)	2
37	11
N^2 log(N)	3

2. (15 pts) A program takes 35 seconds for input size 20 (i.e., n=20). Ignoring the effect of constants, approximately how much time can the same program be expected to take if the input size is increased to 100 given the following run time complexities?
   a. O(N) 175

b. O(N + log N) 179

c. O(N^3) 1750000

d. O(2^N)[1] 2.2183885E+30

3. (10 pts) How many nodes in a complete trinary tree of depth 5? Hint: use geometric series.

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4. (15 pts) Write a simple recursive function to calculate (and return) the height of a general binary tree T. The height of a tree T is defined as the number of levels below the root. In other words, it is equal to the length of the longest path from the root (i.e., number of edges along the path from the root to the deepest leaf). Note that the term "nodes" is used to include both internal nodes and leaf nodes. You can assume the following tree node structure:

```
class Node
{
        Node *left; // points to the left subtree
        Node *right; // points to the right subtree
}
```

Your answer can be in C++ syntax or in the form of a generic pseudocode.

```
Int depth(Node tree)
{
    If tree empty return 0
    Else
        left = depth(tree->left)
        Right = depth(tree->right)
        Return max(left, right) + 1
}
```

5. (15 pts) Rewrite the pseudocode presented in class for the Fibonacci numbers *without* recursion (hint: use loop) and discuss the pros and cons of recursion compared to iteration.

```
Void fibonacci(int length)
{
        Int num1 = 0, num2 = 1, next = 0;
        for(int i = 1; i <= length; i++)
        {
                if (i == 1) cout << num1 << endl;
                Else if(i == 2) cout << num2 << endl;
                Else
                        Next = num1 + num2;
                        Num1 = num2;
                        Num2 = next;
                        Cout << next << endl;
        }
}
```

6. (10 pts) What is Git and what is the purpose of using Git in general?

Git is a version control system that is used to track the history of your code and the edits that are made. It should be used for

7. (10 pts) What is the Linux tool gdb? What is the difference between cmake and make?
GDB is the GNU debugger, for debugging code when you do not have an IDE with one built in. Cmake is a c specific build program that will usually create a makefile for you to build your programs, whereas make just follows an existing makefile.

8. (10 pts) How do argc and `argv` variables get set if the program is called from the terminal and what values do they get set with?

```
int main(int argc, char* argv[])
{
        return(0);
```

}

If called from the terminal, argc is the number of arguments passed, and argv contains all the actual argument characters passed.

II. Submitting Written Homework Assignments:

1. On your local file system, create a new directory called HW1. Move your HW1.pdf file in to the directory. In your local Git repo, create a new branch called HW1. Add your HW1 directory to the branch, commit, and push to the remote origin which is your private GitHub repo.
2. Do not push new commits to the branch after you submit your link to Canvas otherwise it might be considered as late submission.
3. Submission: You must submit a URL link to the branch of your private GitHub repository. Please add the GitHub accounts of the instructor and two TAs (see Syllabus) as the collaborators of your repository. Otherwise, we won't be able to see your repository.

III. Grading Guidelines:

This assignment is worth 100 points. We will grade according to the following criteria: See above problems for individual point totals.