## 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 | 11 |
| N^1.5 | 5 |
| N^2 | 2 |
| N log N | 7 |
| N log(log(N)) | 10 |
| N log^2 N | 6 |
| 2/N | 12 |
| 2^N | 1 |
| 2^(N/2) | 4 |
| 37 | 9 |
| 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 runtime complexities?

a. O(N)
   Time per task = 35secs/ 20 inputs = 1.75sec
   Total = 100 * 1.75 sec = 175 seconds

b. O(N + log N)
   175 seconds
c. O(N^3)
   Time = 35 * (100/20)^3 = 4375 seconds
d. O(2^N)[1]
   Time = 35 * (2)^80 = 42,312,403,686,512,021,114,716,160 seconds

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

   63 to have a complete binary tree of depth 5

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 Node::findHeight(Node* current, int height)
{
    If (( current->left == NULL)&&(current->right == nullptr))
        Return height;
    Height ++;
    If (current->left != nullptr)
        findHeight(current->getLeft(), height);
```

[1] You might need an online calculator with arbitrarily large numbers for this one. Scientific notation and 8 significant figures is just fine.

```
        else
                findHeight(current->getRight(), height);
```

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.

```
 Int fibTime(int z)
 {
        Int a = 1, b = 1;
        For (int I = 3; I <= z; i++) {
                Int c = a + b;
                A = b;
                B=c
        }
        Return b;
```

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

   Git Is a program intended to be helpful in a team setting to be able to help each other and make sure you have the most up to date working cde in a team if you are in a workspace

7. (10 pts) What is the Linux tool gdb? What is the difference between cmake and make?

   Gdb is a debugging tool to test your code. Make is a buildsystem, it drives the complier and other build tools for code. Cmake is a generator is a generator it produces makefiles

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);
    }
```

Argc and argv get set by command-line operations. Argc is the number of strings the program was ran with. Argv is an array of char* , holding words

## 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.