

Problem Set 1: Recursion and Complexity Analysis

CS3330 Data Structures and Algorithms
Term 5 2018: May 29 – July 29
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Overview: For problem 1(a) this assignment you will need a C++ compiler. In order to receive credit, your program must compile and run; and you must provide the actual source code file so that I can compile and run your program (e.g. the file you modified ending in **.cpp**). Examples on how to import existing source code files into your compiler are provided in the file called **Importing Source Code.pdf**. The remaining problems for the assignment must be written up within a single Microsoft Word document. You must include your name and course number within all files that you submit, including the source code file as a comment at the top of the file that you modified.

1. **[6 points] Recursion.** Read the assigned chapter and notes for Week 1 located in the Modules area. Then provide solutions for the following:

(a) **[3 points]** Download the **f.cpp** file, then using the definition below, implement the details of a recursive function called $f(n)$. This function can be directly translated into C/C++ from the following mathematical definition:

$$f(n) = \begin{cases} 0 & \text{if } n \leq 0 \\ n + f(n - 1) & n \leq 1 \text{ or } n \geq 5 \\ n + f(n - 4) & \text{otherwise} \end{cases}$$

The function must be implemented based on the mathematical definition provided above.

Hint: For this program, you only need to modify the provided file by adding the necessary code to implement the TODO areas as noted in the comments. Everything else will remain the same.

Output: The output for this program once it is implemented will be as follows:

```
f(-32) is 0
f(0) is 0
f(16) is 130
f(45) is 1029
f(541) is 146605
```

```
** Press any key to continue **
```

(b) **[1 point]** What type of recursion does the $f()$ function in part (a) use? Briefly explain your answer.

(c) **[2 points]** Perform an Internet search and provide a brief description (at least a paragraph with four to five sentences) of an example of a practical use for recursion in a computer application. For example, the practical use you mention should be something other than a

simple function implementations such as factorial, the power of a number, Fibonacci, etc. The description should be in your own words. Include the reference to your source or sources in APA format at the end of your description.

2. **[4 points] Complexity Analysis.** Begin by reading the assigned chapter and notes for Week 2 located in the Modules area. Then answer the following questions:

- (a) **[2 points]** What is the asymptotic complexity (or big-O) of the section of code used for adding two $n \times n$ matrices **b** and **c**, with the result going into matrix **a**?

```
for (int i=0; i < n; i++)
{
    for (int j=0; j < n; j++)
    {
        a[i][j] = b[i][j] + c[i][j];
    }
}
```

Hint: No programming is necessary for this problem. Just tell me the complexity of the code, and provide a brief explanation on how you arrived at the solution.

- (b) **[2 points]** Briefly explain the difference between big- Ω (Omega) and Θ -notation in your own words. Also provide the mathematical definitions of each.

Other Notes: Submit your solutions as a single Zip file using the Problem Set 1 link. If you are using the Visual C++ or Dev-C++ compiler, only submit the source code files for your program (the files ending in **.cpp**). For space reasons, please do not submit the entire Visual C++ or Dev-C++ project folders. **Please ask if you have any questions or need clarification on what to do for this assignment.**