

This homework assignment is about the following recurrence relation.

$$C_0 = 1,$$
$$C_n = n + \frac{1}{n} \sum_{k=1}^n (C_{k-1} + C_{n-k}) \quad \text{for } n > 0.$$

In this assignment you will implement functions in C that solve this recurrence relation using recursion, bottom-up dynamic programming, and top-down dynamic programming.

In the zip file `hw4.zip`, there are three C header files, `Recursion.h`, `BottomUp.h`, and `TopDown.h`. You will implement your solutions to the above recurrence relation in these three files. There is also a file `Main.c` that tests your implementations.

In the file `Recursion.h`, there is a declaration of a function `C_recursion(int n)`. You should complete this function so that it is a recursive solution of the above recurrence relation.

In the file `BottomUp.h`, there is a declaration of a function `C_bottom_up(int n)`. You should complete this function so that it is a bottom-up dynamic programming solution of the above recurrence relation.

In the file `TopDown.h`, there is a declaration of a function `C_top_down(int n)`. You should complete this function so that it is a top-down dynamic programming solution of the above recurrence relation.

After you have those three functions working, notice that in the files `Recursion.h` and `TopDown.h` there are functions `C_recursion_count()` and `C_top_down_count()`. In these two functions you should reimplement the code that solves the recurrence relation but in addition, these two functions should count the number of recursive function calls that are needed to compute the solution to the recurrence relation. This lets you get a sense of why the (purely) recursive version is so slow, and how many recursive function calls are prevented by the memoization in the top-down dynamic programming. Modify the program `Main.c` so that it calls the functions `C_recursion_count()` and `C_top_down_count()` and prints out the result of the recurrence relation and the number of recursive function calls that were needed to compute the result.

When you have all five functions working, answer the questions that are in the file `CS332Hw4Surname.tex`.