COMP 10280
Programming I (Conversion)
Practical Sheet 11
Déardaoin, 5 Deireadh Fómhair 2023

For each of the following questions, write an algorithm in pseudocode first before writing a Python program. Submit your algorithms in psuedocode as well as your Python programs.

1. Taking the program to calculate the factorial of a number presented in class, investigate how it would be possible to have just two cases, one where the number is less than 0 and one where it isn't. Rewrite the program to do this.

   Save this program as p11p1.py.

2. Write a program that prompts the user for a non-negative integer and uses a `while` loop to calculate that number of terms of the Fibonacci Series. Try to make the program as small and efficient as possible.

   Save this program as p11p2.py.

3. Write a program that prompts the user for a series of non-negative integers and, for each of the numbers entered, uses a `for` loop to calculate that number of terms of the Fibonacci Series. The program should stop when a negative number is entered.

   Save this program as p11p3.py.

4. The *Catalan Numbers* form a sequence of natural numbers. They are defined as follows:

$$C_n = \frac{1}{n+1}\binom{2n}{n} = \frac{(2n)!}{(n+1)!n!} = \prod_{k=2}^{n} \frac{n+k}{k} \text{ for } n \geq 0$$

   An alternative expression for C_n is:

$$C_n = \binom{2n}{n} - \binom{2n}{n+1} = \frac{1}{n+1}\binom{2n}{n} = \frac{1}{n}\binom{2n}{n+1} \text{ for } n \geq 0$$

   The Catalan numbers satisfy the recurrence relations

$$C_0 = 1 \text{ and } C_{n+1} = \sum_{i=0}^{n} C_i C_{n-i}, n \geq 0$$

   and

$$C_0 = 1 \text{ and } C_{n+1} = \frac{2(2n+1)}{n+2}C_n, n \geq 0$$

   The first few Catalan Numbers are:
   $C_0 = 1$, $C_1 = 1$, $C_2 = 2$, $C_3 = 5$, $C_4 = 14$, $C_5 = 42$, $C_6 = 132$, $C_7 = 429$, $C_8 = 1430$.
   (See, for example, https://en.wikipedia.org/wiki/Catalan_number.)

   Write a program that prompts the user for an integer and calculates that number of Catalan Numbers using one or more of the above techniques.

   Save this program as p11p4.py.

Please upload your work to the Brightspace site before Sunday evening.

You should keep a copy of your programs for your portfolio.