Homework 6

Ch En 263 – Numerical Tools

Due date: 7 May 2020

Instructions

- For the problems in Excel, submit a workbook named "LastName_FirstName_HW6.xlsx" where each worksheet tab is named "Problem_1", "Problem_2", etc.
- For the problems in Python, submit a separate file for each problem named "LastName_FirstName_HW6_ProblemXX.py" where XX is the problem number.
- For your convenience, optional Excel and Python template files are available on the course website.
- If needed, a supplementary handwritten or typed document can be submitted via pdf on Learning Suite with the name "LastName_FirstName_HW6.pdf".
- **Please report how long it took you to complete the assignment (in hours) in the "Notes" section on Learning Suite.**

Practice Problems

1. Do the following in an Excel Workbook.
   (a) In a tab named "Problem_1a" Make a list of the integers 1 to 100 in a column. In a second column, compute the cumulative sum. The last value in the second column should give you the sum,
   $$s = \sum_{i=1}^{100} i.$$
   Copy the value of the sum to the top of the worksheet and highlight the box.
   (b) In a tab named "Problem_1b" create a multiplication table for numbers from 1 to 10 inclusive. You should have the numbers 1 to 10 in the top row, the numbers 1 to 10 in the left most column and the multiplication table in between.
2. Do the following in a Python file.
   (a) Write a `while` loop that prints the integers from 1 to 100.
   (b) Write a `while` loop to cumulatively sum the numbers between 1 and 100 (inclusive). In other words evaluate,
   $$s = \sum_{i=1}^{100} i.$$
   Output the value of the sum to the console.
   (c) Write a set of two nested `for` loops where the outer loop ranges from $i \in [1, 10]$ and the inner loop ranges over $j \in [1, 10]$. Print the value of i and j at each iteration of the loop.

(d) Use a set of two nested `for` loops to create a multiplication table for numbers from 1 to 10 inclusive. The output should look like a table with rows and columns (they don't have to be perfectly aligned):

1 2 3 ...
2 4 6 ...

Tip: ***`print`*** *can be called with an optional argument:* ***`print(x, end='')`*** *that will print* ***`x`*** *without making a new line.*

3. Write a function called `factorial` that uses a loop to evaluate the expression $n!$ where n is an integer. Call `factorial(5)` to evaluate 5!, `factorial(10)` to evaluate 10! and `factorial(20)` to evaluate 20! and print the results to the console.

4. As we go up in the atmosphere, the pressure and temperature decrease. We can derive a relationship between pressure and height using a force balance and the ideal gas law. A force balance gives,

$$\frac{dP}{dz} = -\rho g$$

where P is pressure, z is height, ρ is the density of the air and g is gravitational acceleration. The ideal gas law gives an expression for the density,

$$\rho = \frac{MP}{RT}$$

where M is the mean molecular weight of air, T is temperature (K), and R is the gas constant.

Combining these equations, separating variables and integrating gives

$$P = P_0 \exp\left(-\frac{Mgz}{RT}\right) \tag{1}$$

where $P_0 = 1$ atm is the pressure at sea level. (This equation assumes a constant temperature, i.e. isothermal conditions.)

Write a function that will take a variable z (in meters) and return the pressure, P from Eq. 1 in atmospheres. Use a loop to output the value of P for z ranging from 0 to 30,000 feet (the height of Mt. Everest) in increments of 1000 ft. Your output on each line should look something like:

z = 0 ft, P = 1.0 atm

Assume that $M = 29$ kg/kmol, $g = 9.81$ m/s^2 and $T = 300$ K.