ENGR 102 - Lab Assignment #9

Fall 2020

General course learning outcomes:

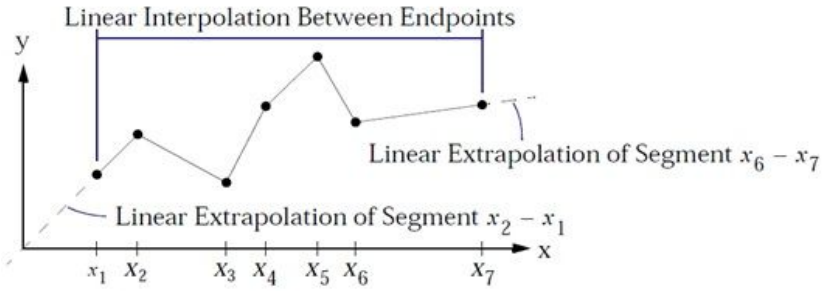
- demonstrate programming techniques in the construction of computer programs, including:
  - collecting, creating, storing and manipulating data in larger structures such as lists,
  - using control structures such as conditionals and loops,
  - outputting processed results to a file, and
  - decomposing a complicated task into more manageable pieces.
- apply programming techniques to solve problems in engineering.
- complete a team programming assignment that ties together concepts learned in the class.

Activity 1: Top-Down Design of a Program - to do in lab (team)

☑ *Utilize the top-down design method in creating a Python program.*
☑ *Output processed results to a file*

Following the process described in the lecture, create a top-down design for a program. Then, construct code for the program.

Create a program that lets a user enter an arbitrary number of data points as x, y values. Assume the user will type only numbers or 'q' as an x-value to quit. Do *not* assume the user will input data in ascending order. Then calculate a linear interpolation/extrapolation from those points to provide the user with a value at any point a user requests. The user should be able to enter *any* x value and have a y value returned, such that the y value is the best estimate (using a linear estimation) from the *nearest* x value(s). Allow the user to repeatedly interpolate or extrapolate, as appropriate, for new y-values until a 'q' is input.



http://aerospacengineering.net/wp-content/uploads/2014/04/figure_FR_8.jpg

Interpolation
For a value x in the interval (x_0, x_1), the value y along the straight line given by coordinates (x_0, y_0) and (x_1, y_1), is found from the equation:

$$y = y_0 + (x - x_0)\frac{y_1 - y_0}{x_1 - x_0} = \frac{y_0(x_1 - x) + y_1(x - x_0)}{x_1 - x_0},$$

Extrapolation
If the two data points nearest the point x to be extrapolated are (x_{k-1}, y_{k-1}) and (x_k, y_k), linear extrapolation gives the function:

$$y(x_*) = y_{k-1} + \frac{x_* - x_{k-1}}{x_k - x_{k-1}}(y_k - y_{k-1}).$$

(continued, next page)

1. Before the user inputs x, y data, ask what the dependent variable values represent (e.g., Number of rabid elephants, kilograms of cheese consumed by llamas, quantity of squid ink in reservoir). Assume the x-values will be time.

2. Once the user has finished typing in x, y data points, write the following to an external file titled "nailedIt.txt":
    a. First line includes your team number and team names
    b. Second line includes the date you created the file
    c. Third line is blank
    d. Fourth line includes what the x-values represents (time), and what the y-values represent
    e. Fifth line contains a series of dashes (----------)
    f. Subsequent lines contain an x, y value pair. One x, y pair per line with a comma separating the values.
    g. After the last x, y value pair has printed, print another series of dashes

3. Your program should then begin asking the user to provide x-values for interpolation or extrapolation. After every new x value that the program interpolates or extrapolates, append an additional line to the file. Include first the new x, y value pair, and then print whether this was an interpolation or extrapolation.

Example file after running program:

```
----------------------------------------------------------------
Team 12 David Tennant, Jodie Whittaker, Matt Smith, Peter Capaldi
October 12, 2021

x-values = time, y-values = kilograms of cheese consumed by llamas
----------------------------------------------------------------
5, 1022
2, 87
3, 99
8, 1180
97, 5
65, 42
----------------------------------------------------------------
72, 33.9     interpolation
40, 541.1    extrapolation
30, 740.8    extrapolation
10, 1140.1   interpolation
```