ENGR 102 - Lab Assignment #12B

Fall 2020

You are to write the following program as described below. For all programs, include comments in your code that describe the purpose of individual blocks. Remember the appropriate header information.

Program 1: From Talon to Beak and Back Again *(or Bottom Up–Top Down Design with a Bird)*

☑ *Declare and use functions to solve computing-related problems*
☑ *Decompose a complicated task into more manageable pieces*

Last week your team created functions to complete the Angry Birds program. This week you will perform a bottom-up, top-down design inspection of the program.

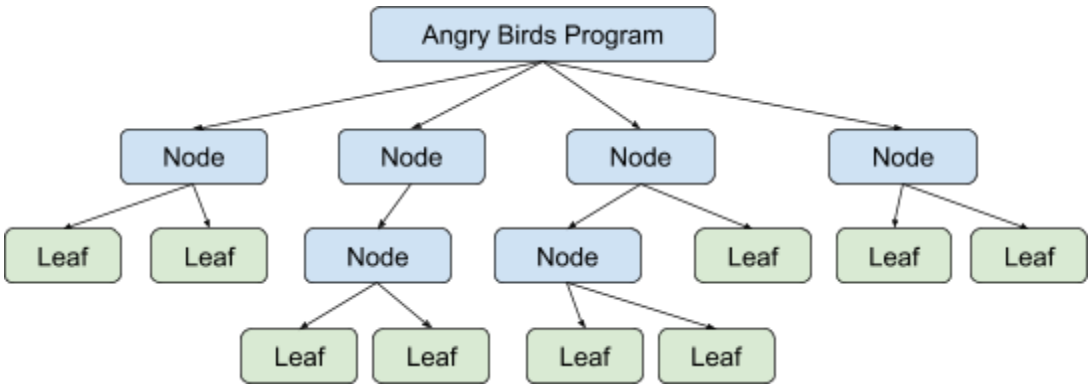
As a reminder, this homework is an individual exercise. Although you worked together with your teams to create the original program and functions, this activity should be completed separately.

You will create a PDF documenting your team's program design. You should use a top-down / bottom-up hybrid approach to demonstrate the design of your program.

A. Create a well-defined list of functions you implemented, each with its own clear purpose. Include in your list:
   - The purpose of the function.
   - What the function does.
   - Parameters the function requires (including data type, etc.).
   - Return values the functions creates (including data type, etc.).
   - Any other functions required for this function to work, and how they integrate with each other.

B. Show how the individual functions work together to create your program. Demonstrate this by creating a hierarchical (top-down) design chart including all of the nodes and leaves of the program design. Functions should occupy specific leaves and/or nodes of the design as appropriate.

   The design chart must be of the type I demonstrated in class, with boxes and arrows visualizing the design of the program as a hierarchy. Nodes and leaves must all be clearly defined.



   Your submission may be hand-drawn and scanned, drawn and rendered through a tablet or computer application, or created through a program (PowerPoint, Word, LucidChart, etc. Verify that your submission is legible.

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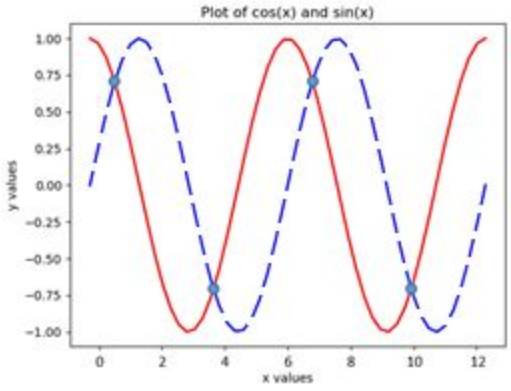
Program 2: NumPy, Sine and Cosine, Oh My!

☑ *Create and use arrays in NumPy*

Write a program to plot $y_1 = \sin(x)$ and $y_2 = \cos(x)$ versus x on the same plot for the domain $0 \le x \le 4\pi$. Also, plot the points where the two curves intersect with an asterisk or some other marker, that is, where $\sin(x) = \cos(x)$. Recall that $\sin(x) = \cos(x)$ for $x = \pi/4 \pm \pi k$.

Use the numpy and matplotlib packages to create the points and plot the following figure.



Program 3: Matrix Multiply and Plot

☑ *Create and use arrays in NumPy*

Write a program that repeatedly multiplies a matrix by a point, and plots the data to the screen. Use numpy even if you find it easier to perform this computation a different way.

a. For the assignment, we have a 2D point, (x,y), that can be represented as a vector: $v = \begin{bmatrix} x \\ y \end{bmatrix}$.

b. We can also define a 2x2 matrix, $M = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$.

c. Computing the product of M with v gives us a new point v': $Mv = v'$.

d. We can then use v' as the new point, multiply by matrix M again, and get another point, i.e. $Mv'=v''$.

e. This can go on indefinitely, creating a long sequence of points.

Create a program that uses numpy to create a matrix and a point. Then, repeatedly multiply the matrix by the point to get a new point. You should repeat this between 150 and 250 times. Use matplotlib to plot the data.

Begin with (1, 0) and $\begin{bmatrix} 1.00583 & -0.087156 \\ 0.087156 & 1.00583 \end{bmatrix}$.