ENGR 102 - Lab Assignment #13B

Fall 2019

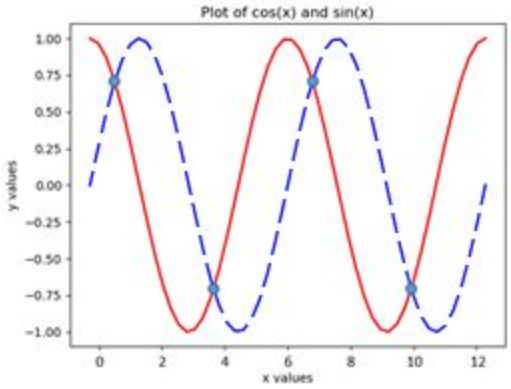
You are to write the following program as described below. For all programs, include comments in your code that describe the purpose of individual blocks. Remember the appropriate header information.

Program 1: NumPy, Pipes and Valves, 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 2: 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 $\begin{bmatrix} 1.00583 & -0.087156 \\ 0.087156 & 1.00583 \end{bmatrix}$.

(continued, next page)

Program 3: NumPy, Pipes and Valves, Oh My!

☑ *Create and use arrays in NumPy*

You've been tasked with finding the least expensive shop for purchasing your pipeline requirements. You have a table with your requirements for the year, and a cost table from your available shops.

Pipeline Requirements					
	3" Pipe	4" Pipe	3" Valve	4" Valve	Pump
Jan	200	975	3	2	1
Feb	225	850	8	2	1
Mar	250	850	3	3	1
Apr	100	850	3	3	2
May	0	500	0	5	0
Jun	0	500	0	5	1
Jul	150	595	5	8	1
Aug	175	675	20	8	3
Sep	250	1080	9	10	1
Oct	250	800	8	10	1
Nov	800	850	0	12	2
Dec	0	725	50	12	0

	Shop A	Shop B	Shop C
3" Pipe	$0.14	$0.09	$0.10
4" Pipe	$0.22	$0.21	$0.22
3" Valve	$5.50	$5.75	$5.65
4" Valve	$8.95	$8.94	$7.00
Pump	$185.00	$195.00	$205.00

Use Python and numpy arrays to find the following, even if other methods are easier for you. Matrix multiplication will be used in this program—information on this procedure is included on the next page.

a. Which shop is least expensive to use, if only choosing to purchase at a single shop for the entire year? What is the total cost? Use numpy array functions like min(), max(), average(), etc… to find the solutions.

b. If you are not limited to a single shop, which should you choose each month? Use numpy array functions like min(), max(), average(), etc… to find the solutions.

Hints:

- Create a numpy array for only the numeric values in each of the tables.
- Multiply the matrices using the matrix product operator, @
- What does the resulting array give you? How can you use Python to go through the information to find the answers to the questions? Review matrix multiplication below if needed.

Matrix Multiplication:

Two matrices multiplied by each other will yield another matrix. Not every matrix can be multiplied by any other matrix, as there are requirements on the relative size of the two matrix dimensions. If you haven't seen it before, or you've forgotten, here's a simple overview of how it works: https://www.mathsisfun.com/algebra/matrix-multiplying.html