Homework 3 Coding Assignment Autograder Update

January 26, 2024

This is the third homework assignment for AMATH 301 Winter 2024. This homework assignment is about our introduction to python.

For the written exercises, you should upload a scanned PDF to Gradescope and then follow the prompts given by Gradescope to assign certain pages of your PDF document to the correct problems.

For the coding exercises, you will be prompted to upload your python files directly to Gradescope.

The course syllabus found on Canvas has information on how homework is graded and how homework should be presented and submitted. Please let me or the TAs know if you have any questions or concerns.

This assignment is due on Monday, January 29 at 11:59pm.

Coding Assignment Autograder Update:

Here is the Gradescope autograder update for hw3 coding. If you have already completed the original hw3 coding assignment, you will have to make a few minor modifications to your code to submit it so the autograder can grade it.

1. We will now be uploading just one python script for all three questions. If you already have three scripts for each problem, please combine them into one python script. This is different than what we did for homework 2 but the way the autograder is set up we need just one python file.
2. Make sure your variables have the correct names, this is how the autograder will grade your code.
3. Please not the names of the variable names are different for problem 3 than what they originally were. However, the variables for problem 1 and 2 are the same as the origional assignment.

Problems

1. Let

$$\mathbf{A} = \begin{bmatrix} 2 & 0 & -1 \\ 4 & -5 & 2 \end{bmatrix}, \quad \mathbf{B} = \begin{bmatrix} 7 & -5 & 1 \\ 1 & -4 & -3 \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} 1 & 2 \\ -2 & 1 \end{bmatrix},$$

and

$$\mathbf{D} = \begin{bmatrix} 3 & 5 \\ -1 & 4 \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} -5 \\ 3 \end{bmatrix}.$$

You may have noticed that these are the same matrices from question 1 of the written assignment for homework 2. Write a python script that does the followng:

a.) Assigns each of the matrices to a variable with the same variable name as the matrices listed above. For example: you should save x = np.array([[-5],[3]]).

b.) Computes $\mathbf{B} - \frac{1}{2}\mathbf{A}$ and assigns it to the variable ans1.

c.) $\mathbf{CD}$ and assign it to the variable ans2.

d.) $\mathbf{A} + 3\mathbf{B}$ and assign it to the variable ans3.

e.) $\mathbf{DB}$ and assign it to the variable ans4.

f.) $\mathbf{Cx}$ and assign it to the variable ans5.

g.) $\mathbf{A}^T + \mathbf{B}^T$ and assign it to the variable ans6.

h.) $(\mathbf{CD})^T$ and assign it to the variable ans7.

2. Using a nested for loop, create the following 12×15 matrix.

$$\mathbf{A} = \begin{bmatrix} 1 & \frac{1}{2} & \frac{1}{3} & \cdots & \frac{1}{12} & \cdots & \frac{1}{15} \\ 2 & \frac{2}{2} & \frac{2}{3} & \cdots & \frac{2}{12} & \cdots & \frac{2}{15} \\ 3 & \frac{3}{2} & \frac{3}{3} & \cdots & \frac{3}{12} & \cdots & \frac{3}{15} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \cdots & \vdots \\ 12 & \frac{12}{2} & \frac{12}{3} & \cdots & \frac{12}{12} & \cdots & \frac{12}{15} \end{bmatrix}.$$

Note that $a_{ij} = i/j$.

a.) Assign the matrix above to the variable A1.

b.) Assign a copy of A1 to the variable A2. Modify the 4th row of A2 to be a row of zeros.

c.) Use array slicing to assign the submatrix made up of rows 3, 4, and 5 and the last 4 columns of A1 to the variable A3.

d.) Assign the row 2 of A1 to the variable A4. Make sure that A4 is a 2D array of shape (1,15).

3. (This problem of the coding assignment will be graded manually)
The third order Taylor polynomial centered at $x = 0$ approximating $f(x) = e^x$ is

$$p_3(x) = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!}.$$

Write a python script that creates the plot with the following features:

(a) Create a python script that assigns x to the 1D array containing 100 evenly spaced points between -2 and 2. One option is to use:

x1 = np.linspace(-2,2,100). (formerly x = np.linspace(-2,2,100))

(b) Create the 1D array y1 = 1 + x1 + x1**2/2 + x1**3/6 and the 1D array f1 = np.exp(x1). Use these 1D arrays and matplotlib.pyplt to create a plot of $p_3(x) = 1 + x + \frac{x^2}{2} + \frac{x^3}{6}$ and $f(x) = e^x$. Make sure that your plot has a legend that labels $p_3(x)$ and $f(x)$ correctly, has the label "x" on the x axis, "y" on the y-axis, and has the title "Taylor Approximation 1" (formerly "Taylor Approximation").

(c) Repeat parts a and b using x2 = np.linspace(-5,5,100), y2 = 1 + x2 + x2**2/2 + x2**3/6 and f2 = np.exp(x2). Additionally use the title "Taylor Series 2" in the plot.

(d) Using the print() function, describe the difference in the two plots from parts b and c in 1 or 2 sentences.