HW 04 - turn in one week from today in Canvas

Turn in the 5 questions as a single .py file onto canvas. Use comments to clearly indicate which question you are working on. Your filename should end as _py2.py if you use Python2 and _py3.py if you use Python3.

1. Use a numpy random seed of 99. Generate an array with 100,000 random samples from the normally distribution of $\mu = 27.0, \sigma = 10.0$. Print the mean of these samples. Print the standard deviation of the samples. Print the maximum of these samples. Print the minimum of these samples.

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2. A finite element problem is described by

$$\boldsymbol{K}\boldsymbol{u} = \boldsymbol{f} \tag{1}$$

Given

$$\frac{E}{L}\begin{bmatrix} 0.00576 & -0.00576 & 0 & 0 \\ -0.00576 & 0.0095 & -0.002687 & 0 \\ 0 & -0.002687 & 0.0075 & -0.000733 \\ 0 & 0 & -0.000733 & 0.000733 \end{bmatrix}\begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix} = \begin{bmatrix} \frac{10000}{6} \\ \frac{10000}{3} \\ \frac{10000}{3} \\ \frac{10000}{6} \end{bmatrix} \tag{2}$$

where $E = 80 \times 10^{10}$ and $L = 0.25$. Determine $\boldsymbol{u}$. Print $\boldsymbol{u}$

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3. Remember the order of matrix multiplication matters. Compute

$$\begin{bmatrix} 9 & 5 & 0 \\ 9 & 5 & 0 \\ 5 & 4 & 9 \end{bmatrix} \begin{bmatrix} 5 & 10 & 5 \\ 4 & 4 & 3 \\ 6 & 10 & 4 \end{bmatrix} \begin{bmatrix} 10 \\ 6 \\ 9 \end{bmatrix} = \boldsymbol{v} \tag{3}$$

   print $\boldsymbol{v}$

4. Use a numpy random seed of 67. Generate an array of 100 random integers on the domain [3,14). Use np.argmax to find the index of the maximum value. Using this index, print the maximum value of the array. Use np.argmin to find the index of the minimum value of the array. Print the minimum value using the index location of the minimum value. Are these values equivlent to using np.min and np.max? Print a boolean True or False.

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5. Consider the following four x, y data points.

x	y
0.0	1.1
0.7	2.99
1.7	5.69
2.1	6.77

where an equation of a line is defined as

$$y = mx + b \tag{4}$$

The matrix equation for fitting a line is defined as

$$\begin{bmatrix} x_1 & 1.0 \\ x_2 & 1.0 \\ \vdots & \vdots \\ x_n & 1.0 \end{bmatrix} \begin{bmatrix} m \\ b \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} \tag{5}$$

where the first data points are x_1 and y_1. The second data points are x_2 and y_2, and so forth.

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5. In this case it is clear that $m = 2.7$ and $b = 1.1$, however I want you to perform a least squares fit to determine m, b. Run

   ```
   c, residuals, rank, sing = np.linalg.lstsq(A,y)
   ```

   where c[0] = m and c[1] = b. Print c. Print the residuals. And print rank.