Lab 03

For full points you will need to answer all the questions.

Section 1: Linear Algebra

This exercise will be done in Python. Refer to the following link for how to do many of these problems. However, for multiplying matrices, it's better to use `matmul`. See the numpy documentation.

$$m1 = \begin{bmatrix} 1 & 3 & 5 \\ 4 & 12 & 8 \end{bmatrix}, \qquad m2 = \begin{bmatrix} 1 & 5 & 9 \\ 3 & 4 & 15 \end{bmatrix}$$

1. Add m1 to m2
2. Subtraction: m1 – m2
3. Matrix multiplication (you may have to transpose):
    a. Multiply m1 x m2
    b. Multiply m2 x m1
    c. Are the resultant matrices the same? Explain.
4. Inversion
    a. Using `numpy` append, append the following vector to the bottom of m1, $v1 = [2 \quad 6 \quad 7]$. The resulting matrix should be: $m3 = \begin{bmatrix} 1 & 3 & 5 \\ 4 & 12 & 8 \\ 2 & 6 & 7 \end{bmatrix}$
    b. Invert m3. You will get an error message. What does it say?
    c. Find the determinant of m3
    d. Using `numpy` append, append the following vector to the bottom of m1, $v2 = [2 \quad 0 \quad 7]$. The resulting matrix should be: $m4 = \begin{bmatrix} 1 & 3 & 5 \\ 4 & 12 & 8 \\ 2 & 0 & 7 \end{bmatrix}$.
    e. Repeat b & c above. Why can you invert one but not the other?
5. Eigen vectors and values
    a. Find the Eigen vectors and values of m4

Section 2: Probability

1. Generate the following. A reference for how to produce random normal observations can be found here. Use `seed(155)` to make sure the results are always the same.
    a. x1: 40 observations from a random normal distribution with a mean of 15 and standard deviation of 2
    b. x2: 40 observations from a random normal distribution with a mean of 17 and standard deviation of 1.5
    c. Produce histograms of these distributions on the same plot
2. Subtract the first set of observations from the second set to get x3. This is equivalent to vector subtraction. Produce a histogram of the differences. What is the distribution of x3?

Section 3: Statistics

For this section, use the `statistics` module, `numpy`, and/or `scipy.stats`.

1. Compute the mean & median for x1 & x3. Compute the mode for x3.
    a. The mode values may not be what you would expect. Look at the x3 values and explain what has happened. Hint: Look at the first value in x3.
    b. When you round the x3 values to the closest integer using the `round()` function, what is the new mode?
2. Compute the sample variance, sample standard deviation, and standard error for x1 & x3. For the standard error, see this reference.
3. For x1 & x3
    a. Compute the range
    b. Find Q1 and Q2
    c. Compute the IQR
4. Which quantity is more variable (has a greater spread in the distribution), x1 or x3?