**BME 6310**

**Fall 2021**

**Homework #2**

**Due 11am, Wednesday, Sep. 15**

**Remember to show all your work. Submit all relevant code and one pdf with answers to all problems, pictures of your code and of your code working.**

1. Write a function that implements Gaussian elimination to solve a system of equations by performing a forward sweep and a back substitution. Input will be **A** and **b**, where **A** is an *n* x *n* matrix and **b** is a solution vector such that **Ax=b**. The output will be the solution vector **x**. Make sure you check for the possibility of a zero in the pivot element and subsequently make the appropriate change to your system so that the problem can still be solved. Assume that **A** has full rank and you only have one solution to **Ax=b**. Be sure to demonstrate that your function works for an example (theoretical) problem.
2. Find a biomedical engineering problem of interest that involves solving a system of equations. Demonstrate that your function from problem 1 can be used to solve this system.
3. What is the relationship between the rank of a matrix and the solution of the corresponding system of equations?
4. Given the following SVD of a matrix A:

A =  

What is the rank of A?

Use this decomposition of A, with no calculations, to write a basis for Nul A and Nul AT. Write out an interpretation for each of these subspaces. What can they tell you about a given system?

Calculate A and illustrate how the bases for Nul A and Nul AT provide valid solutions to the respective problems.

1. Find an SVD of the following matrix using built-in functions of python/Matlab. Illustrate how the basis vectors for the four fundamental spaces describe the associated properties of the matrix.



1. Watch <https://www.youtube.com/watch?v=FgakZw6K1QQ>.
2. Find a data set in your own field of interest. Perform PCA with a built-in function in python/matlab. Plot your data on a 2-D plot with the first two principal components. What fraction of variation is captured in your first two components? Which variable has the highest weight in your first component? Offer an interpretation of why it makes sense for that variable to have the highest weight on your first component.