CSC 401, Weekly Coding Assignment #2, Fall 2024 Name_____

Instructions: For these weekly coding assignments, you will be asked to extend the examples from class to create custom code to answer the questions below. You will create an R code file that uses built-in datasets as the data sources. You will write the code, and an example showing that the code works. Be sure to include any packages in the code that are required for the functions to run (you may want to clear the environment in RStudio before your final check to make sure nothing is missing). The instructor will run the file to ensure that it works with no errors. Clearly label your code so it's clear which question/task is being responded to.

Submission:
A word document with any explanations (if needed), and a clearly labeled R code file.

Tasks/Questions:

1. Follow the models in the lecture notes to create a 3-variable regression model and a 7-variable regression model from the mtcars dataset to model mpg. Your choice of variables is up to you. Implement the algorithm to find the regression model. Compare the results of each algorithm. Describe the similarities and differences you see.

2. Update the 5-variable model for mpg from the lecture notes and update one of the algorithms to apply a decaying learning rate. Describe the differences between the results of the coefficients with and without the decaying rate.

3. Experiment with creating matrices of various sizes. What happens if the dimensions you choose require more elements than you've specified?

4. Try matrix multiplication with non-square matrices. What does each type of multiplication work? When does it not work? Do enough examples to establish a clear pattern.

5. Create 3 matrices. One should have more rows than columns, one should have more columns than rows, and one square, each dimension should be 5 or larger. Verify that the square matrix is non-singular (i.e. check that its determinant is not zero).
   a. Test each matrix with our three decomposition methods: LU, QR and SVD. Do any of them fail to work? Why? (check assumptions of the decomposition)
   b. Find $A^T A$ for each of your matrices. Then find the eigenvalues of all three $A^T A$ matrices and your original square matrix. How do these values compare to the results of the SVD from part a?