

AE04 Assignment I (MATLAB)

1. You don't have to hand in the assignment. This is just for practice.
2. Questions similar to basic questions will appear in written rounds where you don't have access to a computer.
3. You may use ChatGPT, however I have some advice:
 - (a) You WILL score below C grade if you are habituated to blindly copy pasting questions into Chat GPT without thinking.
 - (b) I suggest you try the questions for a while. It is ok to try various things and fail. After many attempts, you can use ChatGPT to help you.
 - (c) Come up with a strategy and then use ChatGPT to help you finish the strategy. That's a good way to learn.
4. Don't worry, the exams will be easier than the assignment. The exams will also be easier if you honestly do the assignment.

Single line codes

Write a single line code in matlab command window to do the following. Single line code means there should be a single = sign in your text. (but there can be multiple == signs)

1. Let M be a matrix of numbers. The ans variable should be matrix that has replaced all the numbers bigger than 42 to 0 and all the numbers less than 42 to be left untouched.
2. Let M be a matrix of numbers. The ans variable should be a matrix whose entries are: 1 when an entry is bigger than 100 and 0 if an entry is less than or equal to 100.
3. Let M be a matrix of numbers. The ans variable should be a 0 if there are even number of entries bigger than 42 in each entry of every row. Otherwise, the answer should be 1.
4. Let M be a matrix of real numbers. The ans variable should be 1 if all elements in M are unique otherwise the ans variable should be 0.
5. Let M be a matrix. The ans variable should be the index of the row that has the maximum product of its elements. Assume no row is entirely zeros.
6. A saddle point is an element in a matrix M that is the smallest in its row and the largest in its column. The ans variable must be a list of (row,column) indices of all the saddle points in M .

Script

1. Write a script in Matlab to import an excel sheet of data of students with a column of heights and a column of weights. Now write a script that
 - (a) computes the sample mean and standard deviations of the heights and weights.
 - i. computes the OLS slope and intercept using your standard deviations and means.
 - ii. plot the regression line and the input data of points on a clearly labelled figure with legends. Show the value of R^2 on the plot.

The catch is: You cannot use any built in function for mean, standard deviations, slope and intercept, R^2 computations. You have to build the script for scratch. Of course, liberally use MATLAB functions for plotting.

2. Convert the above into a function that takes two input vectors of equal length X, Y and returns an array $[m, c, R^2]$ which is the slope, intercept and R^2 . In other words, this is the Linear Regression function created entirely by you!
3. You are given a vector data containing 10,000 readings of a thermostat of a hall from MSE in summer. Write a script that removes all readings that are more than 3 sample standard deviations from the mean. The final answer should be a shorter array.
4. You are given a array data of size 1,000,000 containing noisy measurements. Find the locations of peaks, where a peak is defined as a value larger than its immediate neighbors.

Simulation

1. Simulate daily closing stock prices for a company over 5 years (252 days per year). Assume:
 - (a) Initial price = Rs.10000.
 - (b) Daily return follows a normal distribution with mean 0.05% and standard deviation 1%.

Write a script to calculate:

- (a) The highest and lowest prices,
 - (b) The year with the highest average price,
- from your simulated data.
2. You are given a 5000×24 matrix likes, where each row represents a user and each column represents the number of “likes” they gave in a specific hour of the day. Find
 - (a) The total number of likes per hour.
 - (b) The most active user (row with the highest total likes).
 3. Simulate the flow of vehicles through a highway section with 100 cars. Each car has a randomly assigned speed between 20 and 120 km/h. Calculate:
 - (a) The average speed.
 - (b) The percentage of cars exceeding the speed limit (100 km/h).
 4. Simulate a walk of a drunk dog moving on the plane in steps of 1 unit starting from $(0, 0)$. Each second, the dog can only move 1 unit to the left OR 1 unit to the right OR 1 unit top OR 1 unit down. with equal probability. Do the following:
 - (a) Create a movie of the movement of the dog using MATLAB.
 - (b) Plot the distribution of the dog’s position at 100th second. Is the shape similar at 1000th second?