Assignment 6: Basic Matlab Operations

Date Due: March 27, 2020 Instructor: Trani

Problem 1

a) Convert the system of linear equations below to the standard form: Ax = B. Define A and B.

b) Solve the following system of equations using Matlab. Solve using two methods explained in class: a) taking the inverse of A and multiplying by B) using the backslash operator.

$$x_1 + 5x_2 + 7x_3 + 9x_4 = 34$$
$$2x_1 + 3x_2 + 6x_3 + 21x_4 = 2$$
$$13x_1 + 2x_2 + 8x_3 + 10x_4 = 5$$
$$2x_1 + 5x_2 + 3x_3 + 7x_4 = 6$$

Problem 2

Use Matlab to solve this problem. Create a new Matlab script and define two matrices, A and B as shown below. Use (;) to separate the rows in the matrix and use square parenthesis to define the numerical values inside the matrix.

A=[1 5 7 9; 2 3 6 8; 13 2 6 10; 2 5 3 7];

B=[10 2 5 6];

Perform the following matrix operations. In one line comment on the results obtained after each operation.

a) $C = B \times A$

b) $D = A(2,2:3)$

c) $E = 1.75 * B' + 5$

d) $F = A(:,3)$

e) $G = A(3,:) + B / 2$

f) $H = A(3,:)$ compare with part (d). Comment.

g) $I = diag(A) + 2 * B'$

h) $J = ones(4,4) + 2 * A$

i) $x = inv(A) * B'$

Problem 3

Use Matlab to solve this problem.

a) Create a new Matlab script and define two vectors representing the displacement experienced by a building under a small earthquake:

x=0:.1:25;

y=x.^1.94.*exp(-x).*(1-cos(x/3.6));

In your script make a simple plot using the "plot" function in Matlab. Label the x-axis as 'Time (seconds)' and the y axis as 'Displacement (mm)'. Add a grid to the plot using the 'grid' attribute of the plot.

b) Modify the script created in part (a) and using the interactive 'Tools-Edit Plot' adjust the color of the line to be dark blue and the line width to be 2.0. Use "diamond" markers (^) in the modified plot.

c) Modify the script created in part (a) creating another variable z.

$z = gradient(y)$ % the Matlab function gradient takes the first derivative of the values in (y)

Using the "subplot" command create a new figure with two plots. Plot the values of x vs. y in the upper part of the window and x vs. z in the lower part of the same window. Change the line colors to distinguish the two views.

d) Verify that the "gradient" function is working. Verify a few numbers by hand if necessary.

Problem 4

Use Matlab to solve this problem. Use the the Autobahn data file provided in the Syllabus page (week 1 - practice files).

a) Create a Matlab file and paste all the Autobahn data into. Save the file with any name of your choice.

b) Crete a Matlab script and read the data using the Import the Autobahn data using the "load" command.

c) Create variables for each column of data provided. Label the variables Speed and Density.

d) Plot the traffic density vs. speed using a standard x-y plot. Density is the independent variable and speed the dependent variable in your plot.

e) Perform a simple linear regression analysis using the Basic Fitting tools available in the plot window (under tools). State the linear equation that represents the best fit to the data.

f) Looking at the plot and your regression equation, estimate the traffic sped when 15 vehicles per kilometer are detected on the road by a real-time surveillance camera.

Problem 5

Use the population file provided in this assignment to duo the following analysis. The population file contains the number of people (**in thousands**) at each county in the United States. A sample snapshot of the file is shown below.

	County	State	1970	1975	1980	1985	1990	1995	2000	2005	2010
2	AUTAUGA	AL	24.659	29.619	32.216	32.248	34.353	39.112	43.9	48.088	52.194
3	BALDWIN	AL	59.526	67.812	78.949	89.402	98.955	120.896	141.404	161.836	187.061
4	BARBOUR	AL	22.642	24.864	24.739	25.001	25.505	27.854	29.043	29.151	30.02
5	BIBB	AL	13.823	14.751	15.745	16.157	16.697	18.507	19.934	21.612	22.661
6	BLOUNT	AL	27.04	32.138	36.536	37.416	39.473	44.06	51.209	55.944	60.545
7	BULLOCK	AL	11.734	11.112	10.599	10.778	11.032	11.431	11.615	11.354	11.469
8	BUTLER	AL	21.964	21.195	21.772	22.425	21.886	21.824	21.331	20.555	20.272
9	CALHOUN	AL	103.185	108.245	120.025	118.648	116.118	116.79	111.34	112.812	115.001
10	CHAMBERS	AL	36.333	37.506	39.228	38.613	36.884	37.179	36.58	35.527	35.096
11	CHEROKEE	AL	15.781	18.11	18.888	18.891	19.643	21.871	24.054	24.924	26.156

a) Import the data into Matlab using the Matlab import wizard (Import Data). While importing the data, define each column as a variable and make sure the data type assigned to the variable is correct (i.e., numbers vs text). You can import the data as column vectors if desired to facilitate the analysis.

b) Generate the code in Matlab to import the data. This code can be added to your Matlab script to answer the following questions. Copy or save the code generated by Matlab into a script.

c) Enhance the script created in part(b) to find the populations of all counties in the state of Virginia in the last Census (2010). Clearly show in your script how do you find the counties in Virginia first. Then how do you find the population in those counties. Refer to the lecture notes on using pointer variables.

d) Further enhance the script created in part(d) to find the populations of Guadalupe County in Texas for all the years the data is available. Show how do you identify the county and then extract the population for each year. Make a plot of population vs. time.

e) Enhance the script in part (d) to find the total population of the US (all counties) in years 1970 and 2010. Matlab has a command “sum(A)” that can add the elements of a matrix A.

f) Find the counties whose population is greater than 400,000 people. Create a new variable with the names of the counties that meet the population criteria.