

Assignment 6: Matlab Array Calculations

Date Due: October 18, 2013

Instructor: Trani

Problem 1

Task 1

Create a Matlab script to:

a) Load the Rainfall Rate data file in Matlab. The data contains two columns as shown below.

```
% Rainfall rate data for the month of July in Santo Domingo, Dominican Republic
%
% First column is the observation number
% The second column is the actual rainfall rate in inches
1.0000  4.3712
2.0000  5.0026
3.0000  6.9719
4.0000  4.8237
```

The data clearly illustrates that rainfall rate is a random variable.

b) Create two distinct variables containing the numerical values of the two columns of the data file loaded in part (a). The first vector should contain all elements of column 1 and should be labeled "observation". The second vector contains the values of rainfall rate and should be labeled "rainfallRate".

Task 2

Enhance the script of Task 1. Using the "hist" command in Matlab, plot a histogram with 20 bins of the rainfall rate data. Label your axes and headings accordingly. Comment on the shape of the rainfall rate data distribution of the data. Is there a central tendency? Comment.

Task 3

Enhance the script of Task 2 to calculate the mean and standard deviation of rainfall rate using the Matlab commands "mean" and "std", respectively. Output the values of the mean and standard deviation to the command window using the Matlab "disp" command. Comment on the results obtained.

Task 4

Enhance the script of Task 3. Create a new variable that saves the rainfall rate data sorted from low to high values. use the Matlab command "sort(x)" where x is the vector that contains the data to be sorted. Make a "stem" plot with sorted rainfall rate in the (y-axis) and the observation in the (x-axis). Add labels as needed.

Task 5

Enhance the script of Task 4. Create a Cumulative Density Function (CDF) plot (read Wikipedia article: http://en.wikipedia.org/wiki/Cumulative_distribution_function). The Matlab command to generate the CDF plot is:

cdfplot(x)

where x is the random variable. Label the axes correctly: x-axis is the rainfall rate (inches) and y-axis is the cumulative distribution function (F(x)).

Observe the CDF plot and answer the following:

a) What is the probability that rainfall rates in the future are less than 3 inches (per month)?

b) If an engineer wants to design a storm water system to handle 95% of the rainfall rates without a ponding (storage) system. Determine the rainfall rate for this design.

Task 6

Use the index variables analysis presented in class to find the number of rainfall rate observations above 6 inches. After finding the number of observations above 6 inches, display the number in the command window (use the “disp” command).

Problem 2

A formula to estimate the noise generated by rail vehicles is,

$$Leq = SEL_{ref} + 10 \log(N_{cars}) + 20 \log(S/50) + 10 \log(V) - 31.4$$

where:

Leq = equivalent noise level (decibels - dBA)

SEL ref = reference sound exposure level (decibels - dBA)

Ncars = number of cars in the train

S = train speed (mph)

V = hourly average train volume (trains per hour)

Task 1:

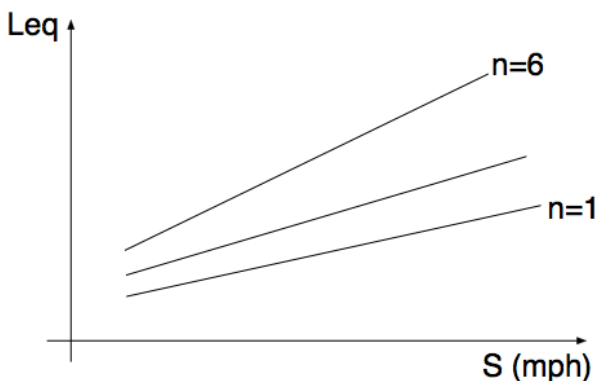
Write a Matlab script to calculate the value of Leq given values of S (speed), SELref (sound exposure level), Ncars (train cars), and hourly train volume (V). Assume the value of SELref to be 76 dBA for this train. Display the result in the command window and write the following statement: “ The Value of Equivalent Noise Level is: yyyy (db)”.

Task 2:

Test the Matlab script created in Task 1 to calculate the value of Leq. In your calculations assume the train has 6 cars, the hourly train volume is 30 trains/hr and the train travels at 45 mph.

Task 3:

Modify the Matlab script to create solutions for Leq (in y-axis) as a function of train speed (to be plotted in the x-axis). The idea is to generate solutions for Leq for speeds ranging from 0-70 mph for 1, 2, 3, 4, 5 and 6 cars as shown in the sketch below. Use Matlab vector operations and not a FOR loop.



Problem 3

The equation to predict the drag (D) of a high-speed train moving at speed (v) is given by the formula:

$$D = \frac{1}{2} \rho v^2 A C_d$$

where: ρ is the density of air (1.225 kg/cu.meter at sea level conditions), A is the reference area of the high-speed train (in sq. meters) and C_d is a non-dimensional drag coefficient unique to each train. Typically, the value of C_d is derived empirically from wind tunnel tests. In the formula above the units of v are meters per second and the units of D are in Newtons (since drag is a force).

The power required (P) by the train engine to overcome the total resistance is:

$$P = Dv = \frac{1}{2} \rho v^3 A C_d$$

A modern high-speed train has the following characteristics:

$$A = 8.4 \text{ square meters}$$

$$C_d = 0.26 \text{ (dimensionless)}$$

Task 1:

Create a Matlab script calculates the train drag and power given speed, reference area, density and drag coefficient. This script should estimate the drag force and the power required on the high-speed train for a range of velocities ranging from 1 to 85 m/s at steps of 0.001 m/s. Use Matlab vector operations and not a FOR loop.

In this script make a plot of speed vs. Drag and a second plot of speed vs. Power. Arrange these two plots in a single Figure frame using the subplot command.

Task 2:

Modify the script created in Task 1 and query the user for the values of Area (A), Density (ρ) and drag coefficient (C_d). Test your script with values of $A=7.0$, $C_d=0.26$ and $\rho=1.20$ kg/cu.meter.



Problem 4

Repeat the Example Problem # 3 shown in the course notes (**Notes 11 - Matlab Matrices**) using problem partitioning. In other words, create a Matlab script that calculates the moment and deflection equations in two sections: a) a section of the beam to the left of the applied load and b) to the right of the applied load. The calculations should avoid using the FOR LOOP demonstrated in Example # 3.

Task 1:

Plot the deflection and moment at every section of the beam (every 1 inch).

Task 2:

Find the CPU time to do the calculations in this new script.