

Assignment 9: Matlab Functions and Polynomials

Date Due: April 10, 2024

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Problem 1

Figure 1 shows fuel economy car data compiled by the Oak Ridge National Laboratory. The data is included in a companion Excel file.

Year	FuelEconomy_mpg	Weight_lbs	HP	AccelTime_s
1980	19.2	3227.9	103.8	15.6
1981	20.5	3201.8	102.1	15.6
1982	21.1	3201.8	103.0	16.6
1983	21.0	3257.3	106.9	14.9
1984	21.0	3261.6	108.6	14.7
1985	21.3	3271.1	114.1	14.1
1986	21.8	3238.0	114.4	13.4
1987	22.0	3220.5	117.6	13.4
1988	21.9	3283.5	123.5	13.3

Figure 1. Light Vehicle Data for Problem 1.

- Create Matlab script to read the data. Save every column as a vector.
- Add code to the script in (a) to find the best 4th order polynomial to fit horsepower (independent variable) and acceleration from 0-60 mpg (dependent variable). Display the 4th order polynomial in the Command Window and make a screen capture. The polynomial is of the form:

$$Accel = A(HP^4) + B(HP^3) + C(HP^2) + D(HP) + E$$

Where:

A, B, C, D, E are the regression coefficients found using the Least-Square Method.

HP is the vehicle horsepower (horsepower)

$Accel$ is the vehicle acceleration time from 0-60 mph (seconds)

- Make a plot of HP versus acceleration and also plot the polynomial found.
- Plot the residuals of the regression using the Matlab basic fitting functionality
- State the value of R-square and tell if the polynomial is a good fit.

Problem 2

Figure 2 presents consumption data and emissions is for a small SUV vehicle. The fuel consumption and emissions are presented in columns 3 and 4.

Speed (km/hr)	Speed (m/s)	Fuel Consumption (l/s)	CO2 Emissions (mg/s)
0	0.00	0.00025	2.04
10	2.78	0.00034	2.44
15	4.17	0.00040	3.04
20	5.56	0.00045	4.15
30	8.33	0.00055	6.33
40	11.11	0.00065	8.91
50	13.89	0.00075	12.01
60	16.67	0.00090	16.10
70	19.44	0.00105	22.24
80	22.22	0.00120	32.85
90	25.00	0.00140	53.81
100	27.78	0.00180	101.39

Figure 2. Small SUV Fuel Consumption Data.

- A) Create Matlab script to read the data. Save every column as a vector.
- B) Add code to the script in (A) to find the best second order polynomial to predict fuel consumption (dependent variable) as a function of speed (independent variable). Display the polynomial in the Command Window and make a screen capture. The polynomial is of the form:

$$FC = A(V^2) + B(V) + C$$

Where:

A, B, C are the regression coefficients found using the Least-Square Method.

V is the vehicle speed (m/s)

FC is the vehicle instantaneous fuel consumption (liters/second)

- C) Make a plot (in code) of the fuel consumption data and also show your polynomial fit in the same plot.
- D) Add code to part (C) to find the best 5th order polynomial to predict vehicle emissions (mg/s) as a function of speed (m/s). The polynomial takes the form:

$$Em = A(V^5) + B(V^4) + C(V^3) + D(V^2) + E(V) + F$$

Where:

A, B, C, D, E, F are the regression coefficients found by Matlab using the Least-Square Method.

V is the vehicle speed (m/s)

Em is the vehicle instantaneous emission rate (mg/s)

- E) Make a plot (in code) of the emissions data and also show your polynomial fit in the same plot.

- F) Comment on the quality of both polynomial fits.

Problem 3

The United States Federal Code publishes a city driving cycle to compare fuel economy standards for all vehicles sold in the US.

Time (s)	Speed (mph)	Speed (m/s)
0	0.0	0.00
1	0.0	0.00
2	0.0	0.00
3	0.0	0.00
4	0.0	0.00
5	0.0	0.00
6	0.0	0.00
7	0.0	0.00

Figure 3. United States Driving City Cycle.

- A) Create a Matlab script to read the data.
- B) Add to the script in part (A) to integrate numerically the vehicle speed to obtain the distance traveled in meters. Report the result of the total distance traveled and the travel time in the Command Window. You are allowed to use the trapezoidal function or the Quad function in Matlab to do the numerical integration Your choice.
- C) Add code to part (B) to make a plot of time (in x-axis) and the speed profile (m/s). Write the total distance traveled in the title of the plot. The title should be coded in your script.
- D) Create a single function with the regression equations found in Problem 2 (parts B and D) to predict the fuel consumption and emissions as a function of speed. Your function produces two outputs (F_c and E_m) and requires one input (V). You are allowed to hard code the coefficients of the regression equations in the function.
- E) Add code to part (C) to predict the instantaneous fuel consumption and emissions generated by the light SUV vehicle at every point in the US city driving cycle.
- F) Make a subplot with F_c versus time and another subplot for E_m versus time.
- G) Predict the total emissions produced by the SUV by numerically integrating the values of E_m over time.