EMPossible

Reading

Textbook: *Numerical Methods for Engineers*, 7th Ed.
Steven C. Chapra & Raymond P. Canale
McGraw Hill

Website: https://empossible.net/academics/emp4301_5301/

Assignment: Read Chapters 17 & 18,
Watch Topic 5 from course website

Problem #1: Linear Regression

Given the following set of measured data:

```
   x      y(x)
=====   =====
-4.97   -2.92
-4.27   -2.44
-3.71   -2.40
-3.51   -1.74
-1.83   -0.97
-0.31   -0.31
-0.96    0.42
-0.22    0.51
 1.34    1.06
 1.33    1.27
 2.56    1.67
 4.10    3.06
 4.11    4.70
```

Implement linear regression in MATLAB to fit these points to a straight line of the following form. Show all of your work, including the intermediate matrices and column vectors. Do NOT use any built-in curve fitting functions in MATLAB.

$$y(x) = mx + b \qquad -5 \le x \le 5$$

Report your calculated values of m and b. On the same plot, show your fitted line as well as the measured data within the specified interval. Be sure the plot is clear, professional, and "publication ready." Attach a completed graphics checklist to this homework.

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Problem #2: Nonlinear Regression

The United States Space Force (USSF) has become aware of a threat from Klingons that remain cloaked in interstellar space. A very short piece of a noisy signal was intercepted from Voyager 1, our farthest space probe launched in 1977. Intelligence knows the Klingons will attack earth on the due date of this assignment, but the time of day of the attack is unknown. However, intelligence believes that the frequency of this signal (in kilohertz) encodes the time of the attack in hours. The USSF has a plan to defend earth, but it is critical to determine the time of the attack down the exact hour and minute. Any error in this estimate will cause the plan to fail and earth will be destroyed. Even worse, you will get a low score on this problem.

Download the MATLAB datafile `klingondat.mat` from the course website which stores two arrays, `tm` and `fm`. The array `tm` contains the discrete times of the samples (units of seconds) and `fm` contains the intercepted signal at each time (units of volts). Perform nonlinear regression to fit the intercepted signal to the function $f(t) = A\sin(2\pi ft + \phi)$. In single figure, plot your fit function, the samples, and report your fit values of A, f, and ϕ to at least four digits of precision. After this, interpret the frequency f, in units of kilohertz, as the time of the attack in hours. Report the exact <u>day</u> and <u>time</u> of the attack in the format of 20 Feb 2023 at 9:37am. Be sure your plot is of professional quality and meaningful units.

Problem #3: Interpolation

The following points were derived from a very accurate model.

x	y
-0.5	0
0	1.0
0.5	1.0
1.0	-3.0

Fit these points to a third-order polynomial and report the coefficients.

Use interpolation to calculate $y(-0.25)$ and $y(0.75)$.

Use extrapolation to calculate $y(-1.0)$ and $y(2.0)$.

Solve this problem by hand. Do NOT use MATLAB except to calculate one matrix inverse. Show all work.