Systems and Control - AE 315, 231

Week 1: Assignment No. 1

King Fahd University for Petroleum and Minerals - Aerospace Dept.

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Assignment Instructions

1. Attempt all the presented questions for partial grades.
2. Deliverables:
   (a) The **MATLAB script** (.m) file.
   (b) A **report** showing your work **results** (.pdf). (On MATLAB, go to PUBLISH tab, select publish, choose the file type as pdf, click save)
   (c) Name your files according to this format: `AE_315__Your_Name__HW_#.(pdf/m)`

1 Math operations

1. (4 points) Evaluate the following expressions
   (a) $f(\theta) = \sin^2(\theta) + \cos^2(\theta)$, where:
      i. $\theta = \pi$ rad.
      ii. $\theta = 30^\circ$
   (b) $x = \dfrac{\log(10) + e^{-8.1}}{\sqrt{2^2 \times 4 + 1}}$
   (c) $f(x) = \dfrac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$, where $\sigma = 0.2,\ \mu = 0,\ x = 0$

   Hints: Take care of the distinction between radians and degrees, pay attention to the order of operations, and try to use `lookfor, help, doc` commands whenever you have a confusion in any function.

2 Vectors and matrices

1. (3 points) Using the colon operator create the following vectors:
   (a) $\boldsymbol{v}_1 = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 5 & 6 & 7 \end{bmatrix}$
   (b) $\boldsymbol{v}_2 = \begin{bmatrix} 10 & 8 & 6 & 4 & 2 & 0 & -2 & -4 \end{bmatrix}$
   (c) $\boldsymbol{v}_3 = \begin{bmatrix} 1.1 & 1.3 & 1.5 & 1.7 & 1.9 \end{bmatrix}$
2. (1 point) Consider a system of linear equations of the form of $A\boldsymbol{x} = \boldsymbol{b}$ have the following:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}, \quad \boldsymbol{b} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \quad \text{and} \quad \boldsymbol{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

This system can be solved using the simple formula

$$\boldsymbol{x} = A^{-1}\boldsymbol{b}$$

write a MATLAB code to solve for the $\boldsymbol{x}$ vector.

3 Visualization

1. (2 points) Reconsider the formula given in Question 1, point (c) agian:

$$\boldsymbol{f}(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\boldsymbol{x}-\mu}{\sigma}\right)^2} \tag{1}$$

The formula describes what so called the Normal (Gaussian) distribution. We want to investigate the effect of changing both μ (the mean) and σ (the standard deviation) on the shape of this function. So,

(a) Create a vector $\boldsymbol{x}$ using `linspace` command starting with -5 and ending at 5 with a total number of points = 100.

(b) Evaluate the following function in equation 1 with the following parameters:

i. $\boldsymbol{f}_1$ with $\mu = 0$ and $\sigma = 0.15$

ii. $\boldsymbol{f}_2$ with $\mu = 0$ and $\sigma = 1$

iii. $\boldsymbol{f}_3$ with $\mu = -2$ and $\sigma = 0.4$

Hint: You should expect f_1, f_2, and f_3 to be vectors of size (1, 100), check using `whos command`

(c) Plot $\boldsymbol{f}_1, \boldsymbol{f}_2, \boldsymbol{f}_3$ in the y-axis against the $\boldsymbol{x}$ vector on the x-axis

(d) Write down a code to show the `xlabel` (x), `ylabel` ($f(x)$), `legend`, and the `title (plot for the normal distribution)`

Hint: You should end up having a plot that looks like figure 1.

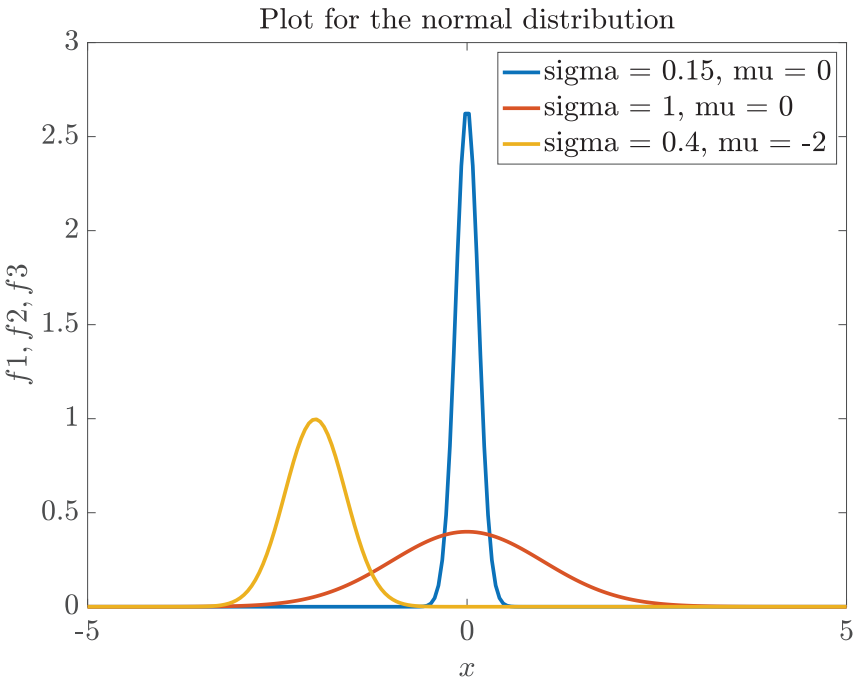

Figure 1: Question 3 plot reference