Assignment #1

Linear Algebra & Probability Theory

How TA evaluates your assignments:

Report: half of your score will be graded proportional to the quality of your report. You should provide a distinct section for each problem, include the desired outputs and explain what you've done. Don't forget to discuss your results as well. It is not necessary to accommodate your source codes in your reports unless you want to refer to them. Compactness, expressiveness and neatness are of high importance.

Source Code: create an m-file for any problem and write all your codes there. If a problem consists of several sub-problems, separate them by comments in your code. Finally, name your m-files according to the number of the problems.

As you have to upload you submission electronically, it is of high interest to prepare your reports using Microsoft Office tools or Latex. However, scanned handwritten solutions are also acceptable as long as they are readable, neat and expressive.

What to hand in:

You must submit your report (.pdf) and source codes (m-files) for each assignment. Zip all your files into an archive file and use the following template to name it:

HW1_XXXXX.zip

where XXXXX must be replaced with your student ID. Your file size must not be bigger than 20MB. Send your files to *mohammadhme@gmail.com* with a subject of PR961_HW1_ XXXXX (replace XXXXX with your student number).

The Due Date for This Assignment is: Mehr 30th

Problems:

1. Generate 100 samples from normal distribution specified by $\mu = -1,\ \sigma^2 = 0.25, 0.5, 1$. Plot histogram of generated samples and compare the results.

2. Generate and plot samples from normal distribution specified by:
   a. $N = 100, M = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \Sigma = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$
   b. $N = 100, M = \begin{bmatrix} -1 \\ 1 \end{bmatrix}, \Sigma = \begin{bmatrix} 2 & 0 \\ 0 & 5 \end{bmatrix}$
   c. $N = 100, M = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \Sigma = \begin{bmatrix} 2 & 5 \\ 5 & 3 \end{bmatrix}$
3. Let X be a dicrete random variable with values $x = 0,1,2$ and probabilities $P(X = 0) = 0.25$, $P(X = 1) = 0.5$ *and* $P(X = 2) = 0.25$ respectively.
   a. Find $E(X)$
   b. Find $E(X^2)$
   c. Find $var(X)$
   d. Find the expected value and variance of $g(x) = 3X + 2$

4. If X1,X2,X3,X4 are (pairwise) uncorrelated random variables each having mean 0 and variance 1, compute the correlations of:
   a. X1 + X2 and X2 + X3.
   b. X1 + X2 and X3 + X4.
5. Suppose A is a matrix with distinct eigenvalues λ and μ. Show that $tr(A) = \lambda + \mu$ and $\det(A) = \lambda\mu$.

6.

a. Compute eigenvalues and eigenvectors of $A = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 2 & 2 \\ 0 & 9 & -5 \end{bmatrix}$ and compare your results with Matlab outputs.

b. 2×2 matrix A matrix has $\lambda_1 = 2$ and $\lambda_2 = 5$, with corresponding eigenvectors $v1 = [1\ 0]^T$ and $v2 = [1\ \ 1]^T$. Find A.

7. Following problems from the reference book [1].

Chapter 2 Problems:

Q1,Q2,Q4

Computer Projects:

Implement the following projects from the reference book [1]. Make sure that your codes are well-commented. Code-only submissions will gain at most 33/100 pts. So, do not forget to provide a compact, well-documented and informative submission.

Chapter 2 Computer exercises:

Q1, Q2, Q3, Q4, Q5, Q6

Reference:

[1] Duda, Richard O., Peter E. Hart, and David G. Stork. Pattern classification. John Wiley & Sons, 2012.