15.11.2018

MAT 116E

HOMEWORK-1

This homework is designed to teach you to think in terms of matrices and vectors. You will find that complicated operations can often be done with one or two lines of code if you use appropriate functions and have the data stored in an appropriate structure. The other purpose of this homework is to make you comfortable with using **help** to learn about new funtions. The names of the functions you'll need to look u pare provided in **bold** where needed.

Homework must be submitted on the ninova system after the midterm exam.

What to turn in: Copy the text from your scripts and paste it into a document. If a question asks you to plot or display something to the screen, also include the plot and screen output your code generates. Submit either a *.doc or *.pdf file.

For problems 1-7, write a script called `shortProblems.m` and put all the commands in it. Separate and label different problems using comments.

1. **Scalar variables.** Make the following variables
   a. $a = 10$
   b. $b = 2.5\times 10^{23}$
   c. $c = 2+3i$, where i is the imaginary number
   d. $d = e^{j2\pi/3}$, where j is the imaginary number and e is Euler's number (use **exp**, **pi**)

2. **Vector variables.** Make the following variables
   a. $aVec = \begin{bmatrix} 3.14 & 15 & 9 & 26 \end{bmatrix}$
   b. $bVec = \begin{bmatrix} 2.71 \\ 8 \\ 28 \\ 182 \end{bmatrix}$
   c. $cVec = \begin{bmatrix} 5 & 4.8 & \cdots & -4.8 & -5 \end{bmatrix}$ (all the numbers from 5 to -5 in increments of -0.2)
   d. $dVec = \begin{bmatrix} 10^0 & 10^{0.01} & \cdots & 10^{0.99} & 10^1 \end{bmatrix}$ (logarithmically spaced numbers between 1 and 10, use **logspace**, make sure you get the length right!)
   e. $eVec = Hello$ ($eVec$ is a string, which is a vector of characters)

3. **Matrix variables.** Make the following variables
   a. $aMat = \begin{bmatrix} 2 & \cdots & 2 \\ \vdots & \ddots & \vdots \\ 2 & \cdots & 2 \end{bmatrix}$ a 9x9 matrix full of 2's (use **ones** or **zeros**)

b. $bMat = \begin{bmatrix} 1 & 0 & \cdots & & 0 \\ 0 & \ddots & 0 & \ddots & \\ \vdots & 0 & 5 & 0 & \vdots \\ & \ddots & 0 & \ddots & 0 \\ 0 & & \cdots & 0 & 1 \end{bmatrix}$ a 9x9 matrix of all zeros, but with the values $\begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 4 & 3 & 2 & 1 \end{bmatrix}$ on the main diagonal (use **zeros**, **diag**).

c. $cMat = \begin{bmatrix} 1 & 11 & \cdots & 91 \\ 2 & 12 & \ddots & 92 \\ \vdots & \vdots & \ddots & \vdots \\ 10 & 20 & \cdots & 100 \end{bmatrix}$ a 10x10 matrix where the vector 1:100 runs down the columns (use **reshape**).

d. $dMat = \begin{bmatrix} NaN & NaN & NaN & NaN \\ NaN & NaN & NaN & NaN \\ NaN & NaN & NaN & NaN \end{bmatrix}$ a 3x4 NaN matrix (use **nan**)

e. $eMat = \begin{bmatrix} 13 & -1 & 5 \\ -22 & 10 & -87 \end{bmatrix}$

f. Make $fMat$ be a 5x3 matrix of random integers with values on the range -3 to 3 (use **rand** and **floor** or **ceil**)

4. **Scalar equations.** Using the variables created in 1, calculate x, y, and z.

a. $x = \dfrac{1}{1+e^{(-(a-15)/6)}}$

b. $y = \left(\sqrt{a} + \sqrt[21]{b}\right)^{\pi}$, recall that $\sqrt[g]{h} = h^{1/g}$, and use **sqrt**

c. $z = \dfrac{\log\left(\Re\left[(c+d)(c-d)\right]\sin\left(a\pi/3\right)\right)}{c\overline{c}}$ where $\Re$ indicates the real part of the complex number in brackets, $\overline{c}$ is the complex conjugate of c, and $\log$ is the *natural* log (use **real**, **conj**, **log**).

5. **Vector equations.** Using the variables created in 2, solve the equations below, elementwise. For example, in part a, the first element of $xVec$ should just be the function evaluated at the value of the first element of $cVec$: $xVec_1 = \dfrac{1}{\sqrt{2\pi 2.5^2}} e^{-cVec_1^2/(2 \cdot 2.5^2)}$, and similarly for all the other elements so that $xVec$ and $cVec$ have the same size. Use the elementwise operators **.***, **./**, **.^**.

a. $xVec = \frac{1}{\sqrt{2\pi 2.5^2}} e^{-cVec^2/(2\cdot 2.5^2)}$

b. $yVec = \sqrt{(aVec^T)^2 + bVec^2}$, $aVec^T$ indicates the transpose of $aVec$

c. $zVec = \log_{10}(1/dVec)$, remember that $\log_{10}$ is the log base 10, so use **log10**

6. **Matrix equations.** Using the variables created in 2 and 3, solve the equations below. Use matrix operators.
    a. $xMat = (aVec \cdot bVec) \cdot aMat^2$
    b. $yMat = bVec \cdot aVec$, note that this is *not* the same as $aVec \cdot bVec$
    c. $zMat = |cMat|(aMat \cdot bMat)^T$, where $|cMat|$ is the determinant of $cMat$, and T again indicates the transpose (use **det**).

7. **Common functions and indexing.**
    a. Make $cSum$ the column-wise sum of $cMat$. The answer should be a row vector (use **sum**).
    b. Make $eMean$ the mean across the rows of $eMat$. The answer should be a column (use **mean**).
    c. Replace the top row of $eMat$ with $[1 \quad 1 \quad 1]$.
    d. Make $cSub$ the submatrix of $cMat$ that only contains rows 2 through 9 and columns 2 through 9.
    e. Make the vector $lin = [1 \quad 2 \quad \cdots \quad 20]$ (the integers from 1 to 20), and then make every other value in it negative to get $lin = [1 \quad -2 \quad 3 \quad -4 \quad \cdots \quad -20]$.
    f. Make r a 1x5 vector using **rand**. Find the elements that have values <0.5 and set those values to 0 (use **find**).