Recitation Problems – Week 3

440:127 – Spring 2015 – S. J. Orfanidis

Please do the following drill problems on matrix properties during your recitation session, including any additional problems given to you by your TA. Upload your completed work within 48hrs of your recitation session. Please follow your TA's instructions on how and where to upload your files.

1. Consider the 5×4 matrix:

$$A = \begin{bmatrix} 2 & 6 & 5 & 2 \\ 8 & 3 & 1 & 5 \\ 3 & 5 & 3 & 6 \\ 5 & 9 & 7 & 1 \\ 8 & 7 & 2 & 4 \end{bmatrix}$$

Using appropriate MATLAB operations do the following, each with a *single MATLAB command*, and without retyping the matrix elements of A:

a. Construct the matrix B whose columns are the cumulative sums of the columns of A.

b. Reconstruct A from B.

c. Repeat parts (a) and (b) when B is defined as the cumulative sum of the rows of A.

d. Set $B = A$, then, with a single command implement the operation:

$$A = \begin{bmatrix} 2 & 6 & 5 & 2 \\ 8 & 3 & 1 & 5 \\ 3 & 5 & 3 & 6 \\ 5 & 9 & 7 & 1 \\ 8 & 7 & 2 & 4 \end{bmatrix} \quad \Rightarrow \quad B = \begin{bmatrix} 2 & 6 & 5 & 2 \\ 8 & 0 & 0 & 5 \\ 3 & 0 & 0 & 6 \\ 5 & 0 & 0 & 1 \\ 8 & 7 & 2 & 4 \end{bmatrix}$$

e. Flip the matrix A upside-down. Then, flip A left-right. Combine the previous two operations into one that flips A both upside-down and left-right. Do not use the built-in functions **flipud**, **fliplr** in this part.

f. Swap the second and third columns of A. Swap the first and fifth rows of A.

g. Reshape A into the following matrices B and C:

$$A = \begin{bmatrix} 2 & 6 & 5 & 2 \\ 8 & 3 & 1 & 5 \\ 3 & 5 & 3 & 6 \\ 5 & 9 & 7 & 1 \\ 8 & 7 & 2 & 4 \end{bmatrix} \quad \Rightarrow \quad B = \begin{bmatrix} 2 & 8 & 9 & 3 & 5 \\ 8 & 6 & 7 & 7 & 6 \\ 3 & 3 & 5 & 2 & 1 \\ 5 & 5 & 1 & 2 & 4 \end{bmatrix}, \qquad C = \begin{bmatrix} 2 & 8 & 3 & 5 & 8 \\ 6 & 3 & 5 & 9 & 7 \\ 5 & 1 & 3 & 7 & 2 \\ 2 & 5 & 6 & 1 & 4 \end{bmatrix}$$

Then, recover A from B and from C.

h. Transform A into the following matrix B:

$$A = \begin{bmatrix} 2 & 6 & 5 & 2 \\ 8 & 3 & 1 & 5 \\ 3 & 5 & 3 & 6 \\ 5 & 9 & 7 & 1 \\ 8 & 7 & 2 & 4 \end{bmatrix} \quad \Rightarrow \quad B = \begin{bmatrix} 2 & 0 & 6 & 0 & 5 & 0 & 2 \\ 8 & 0 & 3 & 0 & 1 & 0 & 5 \\ 3 & 0 & 5 & 0 & 3 & 0 & 6 \\ 5 & 0 & 9 & 0 & 7 & 0 & 1 \\ 8 & 0 & 7 & 0 & 2 & 0 & 4 \end{bmatrix}$$

Then, recover A from B.

2. You wish to take a loan to get a car, but from different dealers you are offered several possible choices of loan rates and loan durations that you need to evaluate, e.g., a longer loan is cheaper per month, but you end up paying more overall, and the car depreciates more. The payment per month, P, is computed by the following formula:

$$P = \frac{Ar(1+r)^M}{(1+r)^M - 1}$$

where A is the loan amount, M is the total number of months, r is the monthly rate, i.e., $r = \text{APR}/1200$, where APR is the annual percentage rate. Assume $A = 20000$, and consider the following choices of rates and loan durations corresponding to $[3, 4, 5, 6]$ year loans:

$$\text{APR} = [4, 5, 6] \quad \text{(annual percentage rate)}$$

$$M = [36, 48, 60, 72] \quad \text{(months)}$$

a. Using **meshgrid**, calculate all possible monthly payment amounts P with a single Matlab command, arranged in a 4×3 matrix, with the three columns corresponding to the three APR rates, and the four rows corresponding to the four durations.

b. Using at most three **fprintf** commands, print P in the manner shown below, where the rates are listed horizontally, and the months vertically:

```
       |   4%       5%       6%
------|-------------------------
36 mo | 590.48   599.42   608.44
48 mo | 451.58   460.59   469.70
60 mo | 368.33   377.42   386.66
72 mo | 312.90   322.10   331.46
```

Hint: To print a percent sign inside an fprintf format specification, use a double percent sign, %%, for example, `'%3.2f%%'`.

c. Using at most three **fprintf** commands, print the results also in a transposed fashion as shown below:

```
   |  36 mo    48 mo    60 mo    72 mo
---|----------------------------------
4% | 590.48   451.58   368.33   312.90
5% | 599.42   460.59   377.42   322.10
6% | 608.44   469.70   386.66   331.46
```

d. The total amount that you pay back for the loan is MP. Using the meshgrid matrices from part (a) and at most three **fprintf** commands, print a table of total payments as shown below:

```
       |    4%          5%          6%
------|-------------------------------
36 mo | 21257.27   21579.05   21903.79
48 mo | 21675.89   22108.12   22545.63
60 mo | 22099.83   22645.48   23199.36
72 mo | 22529.06   23191.10   23864.96
```