13.024
Spring 2003
Homepleasure 2
(Because, really, we're all delighted to learn yet another programming language...)
Due Tuesday, February 25

Exercise 1 Vectorizing your code. Without using any loops (or typing the elements in), use the following vector:

$$x = [1\ 2\ 3\ 4\ 5\ 6\ 7\ 8\ 9\ 10]$$

to construct the following matrix (note the pattern in the values of each row and column).

$$\begin{bmatrix} 1+10i & 2+9i & 3+8i & 4+7i & 5+6i & 6+5i & 7+4i & 8+3i & 9+2i & 10+i \\ 2+9i & 3+8i & 4+7i & 5+6i & 6+5i & 7+4i & 8+3i & 9+2i & 10+i & 1+10i \\ 3+8i & 4+7i & 5+6i & 6+5i & 7+4i & 8+3i & 9+2i & 10+i & 1+10i & 2+9i \\ 4+7i & 5+6i & 6+5i & 7+4i & 8+3i & 9+2i & 10+i & 1+10i & 2+9i & 3+8i \\ 5+6i & 6+5i & 7+4i & 8+3i & 9+2i & 10+i & 1+10i & 2+9i & 3+8i & 4+7i \\ 6+5i & 7+4i & 8+3i & 9+2i & 10+i & 1+10i & 2+9i & 3+8i & 4+7i & 5+6i \\ 7+4i & 8+3i & 9+2i & 10+i & 1+10i & 2+9i & 3+8i & 4+7i & 5+6i & 6+5i \\ 8+3i & 9+2i & 10+i & 1+10i & 2+9i & 3+8i & 4+7i & 5+6i & 6+5i & 7+4i \\ 9+2i & 10+i & 1+10i & 2+9i & 3+8i & 4+7i & 5+6i & 6+5i & 7+4i & 8+3i \\ 10+i & 1+10i & 2+9i & 3+8i & 4+7i & 5+6i & 6+5i & 7+4i & 8+3i & 9+2i \end{bmatrix}$$

Exercise 2 Matrix element manipulation Write an m-file. Within this file, create 3 matrices

$$A = \begin{bmatrix} 1+i & 2-i & 3-i \\ 4 & 5 & 6-i \\ 7-i & 8-i & 9+i \end{bmatrix} \qquad B = \begin{bmatrix} 1+i & 2-2i \\ 5 & 6-i \\ 11i & 9+i \end{bmatrix} \qquad C = \begin{bmatrix} 1 \\ 6-i \\ 6 \end{bmatrix}$$

Within this file, use Matlab's commands to find their transposes, A^T, B^T, C^T and to find the elements with the largest absolute values in each row of these transposes. Find the inverse of A. Using Matlab commands, locate all elements of A^{-1} with absolute value greater than 3 and less than 7. Output both these values and their indices as would appear in matrix notation. For example, if

$$A^{-1} = \begin{bmatrix} 1 & 2 \\ 4 & 6 \end{bmatrix}$$

then $A^{-1}_{12} = 4$ and $A^{-1}_{22} = 6$ would satisfy this condition. The indices for these elements would then be 12 and 22 or equivalently $m = 1, n = 2$ and $m = 2, n = 2$.

Exercise 3 Writing functions In an m-file, write a *function* named logm2 which will calculate the base ten logarithm of every value of an input vector and subtract two from it. The function should return this new vector with the variable name lv2.

Exercises 4-7 Pulling it all together Write a modular m-file program with the following parts: the main program calling 3 subprograms, a subprogram which reads data files and manipulates this data, a subprogram which plots data and a subprogram which outputs data. Comment each of these files appropriately.

4 The first data file will be a .mat file which you will need to create. Put these values into it:

$$x = 1 : .43 : 68; \qquad y = log2(x);$$

using the *save* command.

The second data file will be an ascii file which you will find in my public directory. To copy a file from my public directory to your athena directory, you can either type

cp /afs/athena.mit.edu/user/b/r/browns/Public/hmpl2 hmpl2

at an Athena prompt, or you can copy it using your favorite web browser at

http://web.mit.edu/browns/Public/

The first subprogram should read the two data files - as they are different types of files, different methods of reading them will need to be employed. The .mat file can be read using the *load* command. The ascii file will need to be read using a combination of *fopen*, *fscanf* or *fgetl*, and *fclose*.

Once the variables, x, y, z have been read in from their respective data files, the function logm2 which you made in exercise 3 should be applied to each of them. You will now have 3 new variables which comprise

$$xl2 = log_{10}(x) - 2 \qquad yl2 = log_{10}(y) - 2 \qquad zl2 = log_{10}(z) - 2$$

5 The second subprogram should contain plotting commands. You are asked to plot $xl2$ v. $yl2$, $yl2$ v. $zl2$ and $xl2$ v. $zl2$ in three log-log subplots in a single figure. Each plot should have appropriately labeled axes, a title, and a legend. Plot both the data pairs (points) and a line connecting them. The figure number should be specified and each subplot should be cleared before plotting each time the program is run.

6 The third subprogram should output the new variables into two different files. The first file should be a .mat file and the second an ascii file. The .mat file can be made using the *save* command. In the ascii file, each variable should be saved in exponential form and separated by 4 spaces using *fopen*, *fprintf* and *fclose.*

7 The main program should look something like

```
% main program

subprogram1
subprogram2
subprogram3
```

with whatever set of program names you like.

The main program and subprograms should be mailed to browns@mit.edu. They can be either in .m format from your Matlab editor, or text files. No emacs, MSword, or other word processor files please. Please send each program as a separate attachment and include your name or nickname within the name of the main program. A printout of all programs for the exercises and results should be handed in as well.