Matlab in Math 461, the first steps

Finding a computer with Matlab

It is possible to buy a student version of Matlab to use on your own computer, check out the bookstore. You can also run matlab by telnetting to a university computer- see the course web site for more details. Many of you will use a public computer lab, such as the owl lab down the hall in room 0203 of the Math building. Others may be found in the list in `http://www.oit.umd.edu/wheretogo/seeTable.cfm`. Log in. Start Matlab, for example on a Unix machine, type in `matlab` at the prompt. (You might have to type `tap matlab` first.) On PCs there will be some icon to click. Matlab will now give you a prompt:

>>

Using Matlab

You can enter a matrix into Matlab as follows:

>> `A = [ 1 2 3; 4, 5, 6; 7 8 9]`

In other words, enclose the matrix in square brackets and indicate the end of a row with a semicolon. Commas between the row entries are optional. In this assignment you will generate random matrices. Before generating any random matrices, type in the following to start the random numbers at a random value:

>> `rand('state',sum(100*clock));`

Now if you wanted to set A to be a random 5×7 matrix, you could type:

>> `A=rand(5,7)`

and A will be a random matrix with all entries between 0 and 1.

To generate a random 3×4 matrix with integer entries from 2 to 13, you would type:

>> `A = randint(3,4,[2,13])`

Matlab allows you to do various matrix operations easily. For example `rref(A)` is the reduced row echelon form of A. Also `x = A\b` solves $Ax = b$.[1] As we learn more linear algebra we will learn other operations we can do on vectors and matrices. Matlab can do them all.

When you generate a large matrix, you may not wish to have matlab print it out (and for assignments I really don't like to see large matrices printed out unneccessarily.) You can suppress Matlab printout of a result by ending the command with a semicolon. For example, `A = rand(7,9);` will generate a random 7×9 matrix but not print it out.

My web site has links to a few Matlab tutorials with more information if you need it. See the links given in `www.math.umd.edu/users/hck/461.html`

Saving and printing output

One way to save your output is to cut and paste from the Matlab window to your favorite word processor, but be careful to include all relevant output if you do this. Another is to use Matlab to save your session for you. If you are not on a unix machine you will probably need to give the command

>> `cd H:\`

to make sure Matlab saves to your home directory. or type

>> `cd A:\`

to save to your floppy disc. Now you can type in the command:

>> `diary prob1`

and Matlab will save all following output to a file called prob1. When you wish to stop saving, you may type

>> `diary off`

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[1] This is a white lie. If $Ax = b$ has no solution and A is not a square matrix matlab will still give an answer, the least squares solution which we will study later in the course. Also if there are many solutions, it will only give one of them (the one with smallest length) without warning you that there are more. Looking at the echelon form of A will tell you if there are more solutions.

You may then print the file prob1 as is and write your commentary by hand, or edit in your commentary with a word processor. Note, to print off a public machine you will need to set up an account to pay the printing charges.

Matlab and complex numbers

While Lay only considers linear algebra where the scalars are real numbers, in fact everything[2] we do in this course can be done for other types of scalars. A particularly useful case is where scalars are complex numbers[3]. See appendix B in Lay for the rudiments of complex numbers. Matlab deals easily with complex vectors and scalars. You can use `i` or `j` for $\sqrt{-1}$. For example $2+3i$ can be entered into matlab as `2+3i`, (and you don't even need to use `*` for multiplication). For another example, you can generate a random 3×4 complex matrix by `A = rand(3,4)+i*rand(3,4)`.

Matlab problems due Feb. 12

I encourage you to work in groups of two or three people, but you may work alone if you wish. Each group will hand in just one copy of the assignment. It is understood that all people in the group will contribute significantly to the assignment. Your completed project should include a printout of relevant computer output as well as additional analysis of the problem. If you edit the computer output– be sure to so indicate in an unambiguous fashion. It is not sufficient to just hand in matlab output without additional analysis to answer the question. I want you to demonstrate that you can not only type the right things into matlab, but interperet the output as well.

Problem 1: Generate a random 5×7 matrix by setting `A = rand(5,7)`. Put it in reduced echelon form by using the command `rref(A)`. Are the columns of A linearly independent? What is the span of the columns of A?

Problem 2: Generate a random vector u in $\mathbb{R}^7$ by setting `u = rand(7,1)`. Calculate the product $b = Au$, using your matrix A in problem 1. (Recall matrix multiplication is denoted by $*$ so you would set `b = A*u`). Now use Matlab to solve $Ax = b$ by setting `x = A\b`. You know that $x = u$ is a solution of $Ax = b$. Did Matlab give you the solution $x = u$? What is going on here? Find all solutions to $Ax = b$.

Problem 3: Solve the system of equations:

$$(1+i)x_1 + (2-i)x_2 + 3ix_3 = 7-5i$$

$$2x_1 + (1-i)x_3 = 4i$$

$$x_1 + 4ix_2 + (1+3i)x_3 = -5+7i$$

Problem 4: Solve the system of equations:

$$(1+i)x_1 - 3ix_2 + x_3 = 5-4i$$

$$(3-i)x_1 - (6+i)x_2 + 3x_3 = 1+2i$$

[2] Well, almost everything. When we talk about inner products things can get a little dicey for general scalars.

[3] Another useful case is where there are only two scalars, 0 and 1 where we set $1+1=0$ (in other words, addition is exclusive or). This is useful in the digital realm, for example in error correcting codes.