Introduction to Matlab: Basic Commands and Functions *

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Matrices

The name "Matlab" is short for "Matrix Laboratory", indicating that it refers to a *numerical* application, which allows you to create matrices and offers you a great deal of computational procedures. In Matlab, each variable is a matrix that contains m rows and n columns. Accordingly, by $m > 1 \cap n = 1$ the variable is actually defined as a column vector, and for $m = n = 1$ the variable is a scalar. Given that almost any numerical problem you will encounter as a part of your studies can be expressed in matrix form, Matlab will in almost any case allow you to solve it. This exercise has the purpose to get you familiar with creating, changing and manipulating matrices.

1 M-files

M-files: Matlab allows you to place all your commands in a text file which is then saved with the extension `.m`. This has the advantage that you write all your desired commands and execute them only once at the end. If you made a mistake, you just have to edit the text file and run it again.

Open a new .m-file (File ⇒ New ⇒ M-File). Save the file in your working directory (call it basics.m).

2 Basic Commands

Use the matlab guide provided on the seminar webpage to solve the following tasks.

(a) Create a 2×3 matrix A:

$$A = \begin{pmatrix} 1 & 3 & 2 \\ 5 & 0 & 2 \end{pmatrix}$$

(b) Create a 4×2 matrix V consisting of zeros, a 3×1 vector W consisting of ones, and a 3×3 identity matrix I. Save your workspace under an adequate name, clear the workspace and command history, then reload the workspace. Create a vector $Z = [1, 2, \dots, 100]'$.

(c) Create a column vector R_0 with 10 normally distributed random variables, and a row vector R_{10} with 10 normally distributed variables

*Slightly rearranged by Philipp Wegmueller with an expected mean of 10. Further create a column vector U with 10 uniformly distributed random variables.

(d) Change the element $(1, 2)$ of matrix A to 8.

(e) Create a vector B that contains only the second row of A.

(f) Create a 2×3 matrix C

$$C = \begin{pmatrix} 4 & 1 & 2 \\ 1 & 3 & 3 \end{pmatrix}$$

Extract those elements of C that are equal or less than 2 in a vector D.

3 Basic Manipulations

The command `clear` just kills off everything, so you start from scratch, and MATLAB has nothing in memory In order to comment out a line, you can use the percentage sign (%). If you use a double percent, you make a section (%%). If you want to execute a selected line, press `F9`. If you want to run the code for a section, press `CTRL + ENTER`.

(a) Clear your workspace and create:

$$E = \begin{pmatrix} 4 & 1 \\ 1 & 3 \end{pmatrix}$$

and

$$F = \begin{pmatrix} 1 & 1 \\ 2 & 3 \end{pmatrix}$$

Try out addition and subtraction of these matrices. Addition and subtraction of matrices is straightforward. You just have to make sure that the dimension of the two matrices you want to add or subtract match.

(b) Type in the commands `G=E*F` and `H=E.*F`. What is the difference?

(c) Compute $K = E^{-1}F$. Try out the different ways to do this.

4 Basic Plotting and Statistics

(a) Clear your workspace. Generate a vector of uniformly distributed random variables between 0 and 100 and assign them to a vector `x`. Draw 100 numbers. The command for a uniform random variable between 0 and 1 is `rand`, so you just have to multiply it by 100.

(b) Plot `x` in a graph.

(c) Create a vector `x1` consisting only of the first 50 observations and another vector `x2` consisting only of the last 50 observations. Create a subplot where you plot `x1` and `x2`. Consult the Matlab guide for details on how you would add axis-labels, legends, titles, and change line styles and colors.

(d) Compute the mean and standard deviation of `x`, `x1` and `x2`. Repeat task (b) and include the mean in your plot.

5 Some easy loops

Read chapter 3 of the Matlab-Guide and try it out directly in Matlab. For example, carry out the following simple tasks:

- Create a vector g with values ranging from 0 to 10 with increments of 0.1 and use a for-loop to increase each value by 0.05.
- Create a scalar $A = 2$. Create a while-loop that increases A by one as long as $A < 10$.
- If-loop: Draw a random number from e.g. a uniform distribution between 0 and 2. If this random number is smaller than 0.9, return the statement 'This number is smaller than 0.9', else return 'This number is greater than (or equal to) 0.9'.

6 Geometric series

(a) Write an m-file that calculates the sum of a geometric series $s(n) = 1 + q + q^2 + q^3 + \cdots + q^{(n-1)}$ for $q = 0.5$ and $n = 10$.

(b) Calculate the values of the geometric series above for $n = 1 \ldots 10$ and store the results in a vector s.

(c) Store the values of the geometric series for $n = 1 \ldots 10$ and $q = 0.2$ in the first row of a matrix S. Store the values for $q = 0.5$ and $q = 0.8$ in rows 2 and 3.

7 Difference equations

Let $y_t = f \cdot y_{t-1} + w_t$. Assume that $f = 0.7$, $y_1 = 1.5$ and $w_t = 0$ for all periods t.

(a) Generate the time path of y for $t = 1, 2, \ldots, 20$ using a "for" loop. Plot the time path of y. What happens if $f = 1$?

(b) Consider a temporary change in w: $w_2 = 1$. How is the time path of y affected? Compute and plot the impulse response function.

(c) Consider a permanent change in w: $w_t = 1$ for $t = 2, 3, \ldots$ How is the time path of y affected? Compute and plot the immediate and future effects.

(d) *Optional:* Let's assume that w_t is a stochastic variable, a normally distributed random variable: $w_t \sim N(0, \epsilon^2 = 0.01)$. Generate a sequence w_t for $t = 2, .., 20$. Compute and plot the time path of y. Compare this to the time path under (a). How does the impulse response function change?

8 An (almost) infinite geometric series

Write a m-file that calculates the sum of a geometric series $s(n) = 1 + q + q^2 + q^3 + q^{(n-1)}$ for q = 0.5 and $n \to \infty$ using a "for" loop. Stop the loop when the value of s(n) equals approximately s(n-1). The previous exercise may give you an idea of how to do that.

9 The long-term effect of permanent change in a difference equation

The long term effect to a permanent change of w in the difference equation $y_t = f y_{t-1} + w_t$ converges towards a certain value. Write a m-file that calculates this value for $f = 0.7$. Use a “for‘” loop and terminate the loop when the value of the effect in t equals approximately the effect in $t - 1$.

9.1 The “while” loop

(a) Another (almost) infinite geometric series. Do exercise 8 using a “while” loop.

(b) Another long-term effect. Do exercise 9 using a “while” loop.

(c) Write a script file that executes the following betting game: A player starts with a capital of 20 units. In each round, he can bet any fraction of his current capital, which he loses with probability 0.5. If he wins, he gets paid back twice the amount of his bet. The game is over once the player has quintupled his initial capital, or if he has lost everything.

10 The function m-file

(a) Write a function that computes the hypotenuse of a right-angled triangle.

(b) Write a function file that gives you congratulations if you have drawn a positive normal random number but admonishes you if you have drawn a negative number.