

# Tutorial 1

## Getting Started with MATLAB

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The purpose of this tutorial is to present basics of MATLAB. We do not assume any prior knowledge of this package. This tutorial is intended for users running a professional version of MATLAB 5.3, Release 11 under Windows 95. Topics discussed in this tutorial include the **Command Window**, numbers and arithmetic operations, saving and reloading a work, using help, MATLAB demos, interrupting a running program, long command lines, and MATLAB resources on the Internet.

### 1.1 The Command Window

You can start MATLAB by double clicking on the MATLAB icon that should be on the desktop of your computer. This brings up the window called the **Command Window**. This window allows a user to enter simple commands. To clear the **Command Window** type **clc** and next press the **Enter** or **Return** key. To perform a simple computations type a command and next press the **Enter** or **Return** key. For instance,

```
s = 1 + 2
s =
    3

fun = sin(pi/4)
fun =
    0.7071
```

In the second example the trigonometric function sine and the constant  $\pi$  are used. In MATLAB they are named **sin** and **pi**, respectively.

Note that the results of these computations are saved in *variables* whose names are chosen by the user. If they will be needed during your current MATLAB session, then you can obtain their values typing their names and pressing the **Enter** or **Return** key. For instance,

```
s
s =
    3
```

Variable name begins with a letter, followed by letters, numbers or underscores. MATLAB recognizes only the first 31 characters of a variable name.

To change a format of numbers displayed in the **Command Window** you can use one of the several formats that are available in MATLAB. The default format is called **short** (four digits after the decimal point.) In order to display more digits click on **File**, select **Preferences...**, and next select a format you wish to use. They are listed below the **Numeric Format**. Next click on **Apply** and **OK** and close the current window. You can also select a new format from within the **Command Window**. For instance, the following command

```
format long
```

changes a current format to the format **long**. To display more digits of the variable **fun** type

```
fun
fun =
    0.70710678118655
```

To change a current format to the default one type

```
format short
```

```
fun
fun =
    0.7071
```

To close MATLAB type **exit** in the **Command Window** and next press **Enter** or **Return** key. A second way to close your current MATLAB session is to select **File** in the MATLAB's toolbar and next click on **Exit MATLAB** option. All unsaved information residing in the MATLAB **Workspace** will be lost.

## 1.2 Numbers and arithmetic operations in MATLAB

There are three kinds of numbers used in MATLAB:

- integers
- real numbers
- complex numbers

Integers are entered without the decimal point

```
xi = 10
```

```
xi =  
    10
```

However, the following number

```
xr = 10.01
```

```
xr =  
    10.0100
```

is saved as the real number. It is not our intention to discuss here machine representation of numbers. This topic is usually included in the numerical analysis courses.

Variables **realmin** and **realmax** denote the smallest and the largest positive real numbers in MATLAB. For instance,

```
realmin
```

```
ans =  
    2.2251e-308
```

Complex numbers in MATLAB are represented in rectangular form. The imaginary unit  $\sqrt{-1}$  is denoted either by **i** or **j**

```
i
```

```
ans =  
    0 + 1.0000i
```

In addition to classes of numbers mentioned above, MATLAB has three variables representing the nonnumbers:

- **-Inf**
- **Inf**
- **NaN**

The **-Inf** and **Inf** are the IEEE representations for the negative and positive infinity, respectively. Infinity is generated by overflow or by the operation of dividing by zero. The **NaN** stands for the *not-a-number* and is obtained as a result of the mathematically undefined operations such as  $0.0/0.0$  or  $\infty - \infty$ .

List of basic arithmetic operations in MATLAB include six operations

Operation	Symbol
addition	+
subtraction	-
multiplication	*
division	/ or \
exponentiation	^

MATLAB has two division operators / - the right division and \ - the left division. They do not produce the same results

```
rd = 47/3
```

```
rd =
    15.6667
```

```
ld = 47\3
```

```
ld =
    0.0638
```

### 1.3 Saving and reloading your work

All variables used in the current MATLAB session are saved in the **Workspace**. You can view the content of the Workspace by clicking on **File** in the toolbar and next selecting **Show Workspace** from the pull-down menu. You can also check contents of the Workspace typing **whos** in the **Command Window**. For instance,

```
whos
```

```

Name          Size          Bytes  Class

ans           1x1             16  double array (complex)
fun           1x1              8  double array
ld            1x1              8  double array
rd            1x1              8  double array
s             1x1              8  double array
xi            1x1              8  double array
xr            1x1              8  double array
```

```
Grand total is 7 elements using 64 bytes
```

shows all variables used in current session. You can also use command **who** to generate a list of variables used in current session

```
who
```

Your variables are:

```
ans      ld      s      xr
fun      rd      xi
```

To save your current workspace select **Save Workspace as...** from the **File** menu. Chose a name for your file, e.g. **filename.mat** and next click on **Save**. Remember that the file you just created must be located in MATLAB's search path. Another way of saving your workspace is to type **save filename** in the **Command Window**. The following command **save filename s** saves only the variable **s**.

Another way to save your workspace is to type the command **diary filename** in the **Command Window**. All commands and variables created from now will be saved in your file. The following command: **diary off** will close the file and save it as the text file. You can open this file in a text editor, by double clicking on the name of your file, and modify its contents if you wish to do so.

To load contents of the file named **filename** into MATLAB's workspace type **load filename** in the **Command Window**.

More advanced computations often require execution of several lines of computer code. Rather than typing those commands in the **Command Window** you should create a file. Each time you will need to repeat computations just invoke your file. Another advantage of using files is the ease to modify its contents. To learn more about files, see [1], pp. 67-75 and also Section 2.2 of Tutorial 2.

## 1.4 Help

One of the nice features of MATLAB is its help system. To learn more about a function you are to use, say **rref**, type in the **Command Window**

```
help svd
```

```
SVD    Singular value decomposition.
[U,S,V] = SVD(X) produces a diagonal matrix S, of the same
dimension as X and with nonnegative diagonal elements in
decreasing order, and unitary matrices U and V so that
X = U*S*V'.
S = SVD(X) returns a vector containing the singular values.
[U,S,V] = SVD(X,0) produces the "economy size"
decomposition. If X is m-by-n with m > n, then only the
first n columns of U are computed and S is n-by-n.
```

```
See also SVDS, GSVD.
```

```
Overloaded methods
help sym/svd.m
```

If you do not remember the exact name of a function you want to learn more about use command **lookfor** followed by the incomplete name of a function in the **Command Window**. In the following example we use a "word" **sv**

**lookfor sv**

```

ISVMS True for the VMS version of MATLAB.
HSV2RGB Convert hue-saturation-value colors to red-green-blue.
RGB2HSV Convert red-green-blue colors to hue-saturation-value.
GSVD Generalized Singular Value Decomposition.
SVD Singular value decomposition.
SVDS Find a few singular values and vectors.
HSV Hue-saturation-value color map.
JET Variant of HSV.
CSVREAD Read a comma separated value file.
CSVWRITE Write a comma separated value file.
ISVARNAME Check for a valid variable name.
RANDSVD Random matrix with pre-assigned singular values.
Trusvibs.m: % Example: trusvibs
SVD Symbolic singular value decomposition.
RANDSVD Random matrix with pre-assigned singular values.

```

The **helpwin** command, invoked without arguments, opens a new window on the screen. To find an information you need double click on the name of the subdirectory and next double click on a function to see the help text for that function. You can go directly to the help text of your function invoking **helpwin** command followed by an argument. For instance, executing the following command

**helpwin zeros**

```

ZEROS Zeros array.
ZEROS(N) is an N-by-N matrix of zeros.
ZEROS(M,N) or ZEROS([M,N]) is an M-by-N matrix of zeros.
ZEROS(M,N,P,...) or ZEROS([M N P ...]) is an M-by-N-by-P-by-...
array of zeros.
ZEROS(SIZE(A)) is the same size as A and all zeros.

See also ONES.

```

generates an information about MATLAB's function **zeros**.

MATLAB also provides the browser-based help. In order to access these help files click on **Help** and next select **Help Desk (HTML)**. This will launch your Web browser. To access an information you need click on a highlighted link or type a name of a function in the text box. In order for the Help Desk to work properly on your computer the appropriate help files, in the HTML or PDF format, must be installed on your computer. You should be aware that these files require a significant amount of the disk space.

## 1.5 Demos

To learn more about MATLAB capabilities you can execute the **demo** command in the **Command Window** or click on **Help** and next select **Examples and Demos** from the pull-down menu. Some of the MATLAB demos use both the **Command** and the **Figure** windows.

To learn about matrices in MATLAB open the demo window using one of the methods described above. In the left pane select **Matrices** and in the right pane select **Basic matrix operations** then click on **Run Basic matrix ...** . Click on the **Start >>** button to begin the show.

If you are familiar with functions of a complex variable I recommend another demo. Select **Visualization** and next **3-D Plots of complex functions**. You can generate graphs of simple power functions by selecting an appropriate button in the current window.

## 1.6 Interrupting a running program

To interrupt a running program press simultaneously the **Ctrl-c** keys. Sometimes you have to repeat pressing these keys a couple of times to halt execution of your program. This is not a recommended way to exit a program, however, in certain circumstances it is a necessity. For instance, a poorly written computer code can put MATLAB in the infinite loop and this would be the only option you will have left.

## 1.7 Long command lines

To enter a statement that is too long to be typed in one line, use three periods, **...** , followed by **Enter** or **Return**. For instance,

```
x = sin(1) - sin(2) + sin(3) - sin(4) + sin(5) -...
    sin(6) + sin(7) - sin(8) + sin(9) - sin(10)

x =
    0.7744
```

You can suppress output to the screen by adding a semicolon after the statement

```
u = 2 + 3;
```

## 1.8 MATLAB resources on the Internet

If your computer has an access to the Internet you can learn more about MATLAB and also download user supplied files posted in the public domain. We provide below some pointers to information related to MATLAB.

- The MathWorks Web site: <http://www.mathworks.com/>

The MathWorks, the makers of MATLAB, maintains an important Web site. Here you can find information about new products, MATLAB related books, user supplied files and much more.

- The MATLAB newsgroup: <news://saluki-news.siu.edu/comp.soft-sys.matlab/>

If you have an access to the Internet News, you can read messages posted in this newsgroup. Also, you can post your own messages. The link shown above would work only for those who have access to the news server in Southern Illinois University at Carbondale.

- <http://dir.yahoo.com/science/mathematics/software/matlab/>

A useful source of information about MATLAB and good starting point to other Web sites.

- <http://www.cse.uiuc.edu/cse301/matlab.html>

Thus Web site, maintained by the University of Illinois at Champaign-Urbana, provides several links to MATLAB resources on the Internet.

- The Mastering Matlab Web site: <http://www.eece.maine.edu/mm>

Recommended link for those who are familiar with the book Mastering Matlab 5. A Comprehensive Tutorial and Reference, by D. Hanselman and B. Littlefield (see [2].)



## References

- [1] Getting Started with MATLAB, Version 5, The MathWorks, Inc., 1996.
- [2] D. Hanselman and B. Littlefield, Mastering MATLAB 5. A Comprehensive Tutorial and Reference, Prentice Hall, Upper Saddle River, NJ, 1998.
- [3] K. Sigmon, MATLAB Primer, Fifth edition, CRC Press, Boca Raton, 1998.
- [4] Using MATLAB, Version 5, The MathWorks, Inc., 1996.