

Part 1

LEARNING MATLAB

1 Introduction

The name `MATLAB` is an acronym that stands for `MATrix LABoratory`. `MATLAB` is an interactive environment for performing technical computations. The software package `MATLAB` has been commercially available since 1984 and is now considered a standard tool at most universities and many industries worldwide. The core of `MATLAB` consists of compiled C-coded routines for matrix computation, numerical analysis and graphics. However, the major functionality in `MATLAB` is coded as so called *m-files*, which are plain text files having file extension `.m`. These files consist of source code written in the `MATLAB` programming language. All *m-files* can be viewed and edited in any standard text editor. A user may therefore copy and edit any of the *m-files* distributed with the `MATLAB` software package, or the user may write new *m-files* from scratch, adding extra functionality to the interactive computation environment of `MATLAB`.

The compiled functions built into the `MATLAB` kernel together with the standard *m-files* provide the user of `MATLAB` with access to many powerful routines for numerical matrix algebra. Specific application oriented *m-files* are collected in packages referred to as a *toolbox*, often having an application specific notation familiar to researchers and engineers active in the field. There are both commercial and free *toolboxes* that add powerful functionality to `MATLAB` from a specific application field. There are *toolboxes* for signal processing, simulation, symbolic computation, control theory, optimization, system identification and several other fields of applied science and engineering.

Platforms and software versions

`MATLAB` is available for several different *platforms*. These include PC with Windows or Linux, Macintosh and Sun workstations. Once inside `MATLAB`, virtually all syntax is platform independent and *m-files* written for `MATLAB` on one platform is generally executable

under all other platforms. The only exception to this rule is *m*-files that perform hardware interface operations or specific operation system calls, and *m*-files that have been compiled, also called *mex*-files. This book has been developed on different Windows and Sun Solaris platforms, using MATLAB versions ranging from 5.2 to 6.5.

The manufacturer of MATLAB, the Mathworks Inc., uses a dual numbering of MATLAB with versions and releases. A release is basically a running number of the distribution CD's containing MATLAB and all of its toolboxes with different version numbers. MATLAB version 5.2 is part of Release 10, MATLAB version 5.3 is part of Release 11 and MATLAB version 6.0 is part of Release 12, respectively. At the time this book goes into print the current version of MATLAB is version 6.5 which is part of Release 13. The release versions will in the sequel be abbreviated R13 and so on. Note, however, that most of the material is timeless, and only major differences will be pointed out.

Preliminaries

Content: Starting MATLAB and searching for on-line help.

Functions:

`help`, `helpdesk`, `demo`, `type`, `tour`, `ver`

On PC with Windows and on Mac systems, MATLAB is started from the graphical user interface of the operating system and it should be obvious where to find MATLAB. For example, using Windows, a MATLAB folder should be available under the start menu after successful installation of the system. On most Unix systems, MATLAB is launched from a terminal window by executing the command `matlab`.

A guided tour 2 (Starting MATLAB)

When launching MATLAB an initial introduction message, like the one shown to the right, provides the user with some suggestions on where to find help and information. Try typing the commands `demo` and `tour` to get a brief introduction to the MATLAB system.

The version of MATLAB, SIMULINK and all installed toolboxes is available from the output of the command `ver`.

Terminate MATLAB with the command `quit` or `exit`.

To get started, type one of these: `helpwin`, `helpdesk`, or `demo`.

For product information, type `tour` or visit www.mathworks.com.

```
>> ver matlab
MATLAB Version 6.1.0 on PCWIN
MATLAB License Number: DEMO
MATLAB Toolbox Version 6.1
>> quit
```

There is an advanced system of *documentation* and *help information* available in MATLAB. The command `helpdesk` loads the main MATLAB Help Desk page into a browser. This hyper linked help system contains comprehensive manuals and tutorials together with detailed searchable information about all commands in the installed MATLAB system. You are encouraged to get acquainted with the MATLAB Help Desk since it will prove very useful when troubleshooting in MATLAB. The Help Desk is convenient since you can search for the name of functions with some desirable functionality. The command `help function` prints the help text for a specific function directly in the command window. This is often a good way to

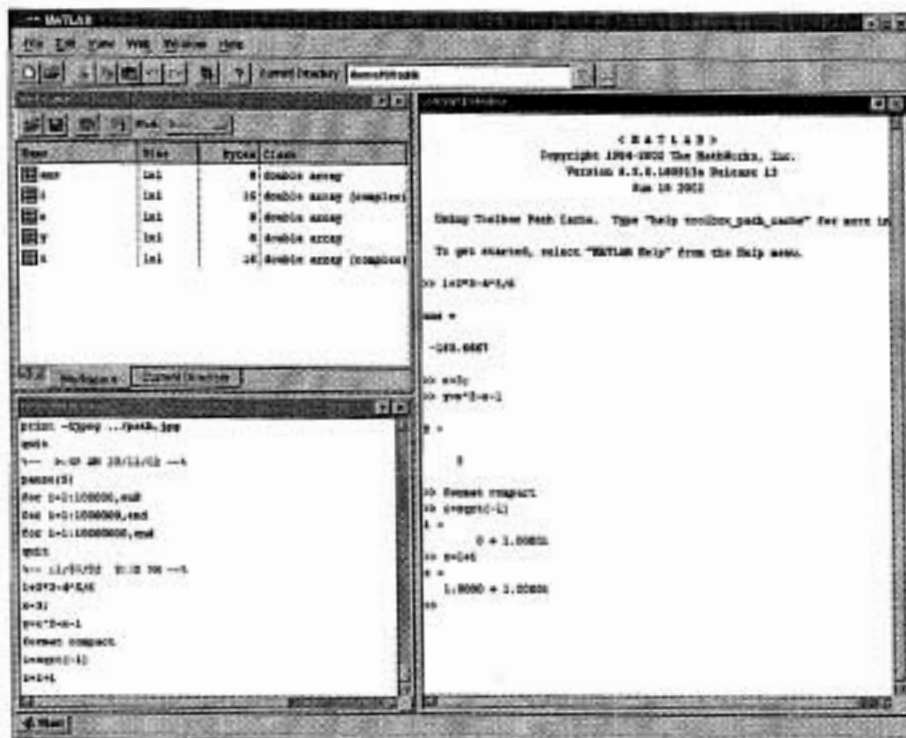


Figure 1.1 The graphical interface to the MATLAB workspace is provided in Release 10 and higher. It provides a number of easy to use tools for interactively changing the settings of your MATLAB system, editing the workspace variables, moving around in the directory structure and accessing previously typed MATLAB syntax.

get quick information about the syntax and functionality of a MATLAB function that you know by name.

An important feature with MATLAB is that the source code for most of the functions is available to browse, copy and alter. Some of the functions in MATLAB are compiled from source C-code and built into the MATLAB kernel, but most of the functions are m-files that have public source code and can be listed using the command `type function`.

A guided tour 3 (Preliminaries)

The function `sum` is part of the MATLAB kernel, while the matrix trace function `trace` is an m-file, which is open source but in turn uses the built-in function `sum`.

Note that the m-file contains three parts. The first row is the function header defining the syntax, the first paragraph of comments starting with `%` provides a brief help text, and the last row is the actual command sequence that executes the m-file. The first paragraph of help information is displayed when typing `help` followed by the function name. Details regarding the matlab `search path` system and issues of writing your own m-files are discussed in great detail in Section 8.

You can open any m-file in the built-in editor by typing `edit`, or in a standard text editor. The search path to the m-file is printed using the command `which`. Note that we will use three dots whenever a line break is needed to fit the page format. This convention is also used in MATLAB, see page 23.

The arrow keys on the computer keyboard can be used to edit the command line. These key arrows will prove very useful when correcting minor misspellings in long input lines. By pressing the up-arrow you can search through the commands you have written previously. By typing the first character, or characters, of a specific command before pressing the up-arrow, only those commands matching this initial input will be scanned through. In R12, a completely new desktop look was presented, where one area of the MATLAB window contains a list of all previous commands. Here you can select and edit any previous call.

The command line is cleared by pressing the escape key (twice on Unix stations). The left and right arrows move the cursor to facilitate deletion and insertion of characters. The control key together with the left and right arrows move the cursor one word forward and backward, respectively, on the current command line. If you are familiar with the text editor *Emacs*, you will find that most of the usual control commands for editing can be used in lieu of the arrow keys. However, some keyboard functions are system dependent, so be aware of that `control-y` on Unix stations may *kill* MATLAB, rather than pasting the buffer!

```
>> type sum
sum is a built-in function.
>> type trace

function t = trace(a)
%TRACE Sum of diagonal elements.
% TRACE(A) is the sum of the
% diagonal elements of A,
% which is also the sum of the
% eigenvalues of A.

% The MathWorks, Inc.
% Copyright 1984-2001
% The MathWorks, Inc.
% $Revision: 5.7 $
% $Date: 2001/04/15 12:01:34 $

t = sum(diag(a));
>> which trace
C:\MATLABR12\toolbox\matlab\...
matfun\trace.m
```

The table below summarizes the various keys for editing the command line.

↑	Ctrl-p	Recall previous input line
↓	Ctrl-n	Recall next input line
foo ↑ and ↓	Ctrl-p/n	Recall input lines starting with foo
→	Ctrl-f	Step forward one character
←	Ctrl-b	Step backward one character
Ctrl→	Ctrl-r	Move to the start of the following word to the right
Ctrl←	Ctrl-l	Move to the start of the previous word to the left
home	Ctrl-a	Move to the beginning of the line
end	Ctrl-e	Move to the end of the line
esc	Ctrl-u	Clear the current line
del	Ctrl-d	Delete the character at the cursor
	Ctrl-k	Delete the rest of the line

Try the commands listed above to learn how to edit the command line.