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0521803802 - A Guide to MATLAB: For Beginners and Experienced Users

Brian R. Hunt, Ronald L. Lipsman and Jonathan M. Rosenberg

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A Guide to MATLAB

This book is a short, focused introduction to MATLAB, a comprehensive software system for mathematics and technical computing. It will be useful to both beginning and experienced users. It contains concise explanations of essential MATLAB commands, as well as easily understood instructions for using MATLAB's programming features, graphical capabilities, and desktop interface. It also includes an introduction to SIMULINK, a companion to MATLAB for system simulation.

Written for MATLAB 6, this book can also be used with earlier (and later) versions of MATLAB. This book contains worked-out examples of applications of MATLAB to interesting problems in mathematics, engineering, economics, and physics. In addition, it contains explicit instructions for using MATLAB's Microsoft Word interface to produce polished, integrated, interactive documents for reports, presentations, or online publishing.

This book explains everything you need to know to begin using MATLAB to do all these things and more. Intermediate and advanced users will find useful information here, especially if they are making the switch to MATLAB 6 from an earlier version.

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★ indicates an advanced chapter or section that can be skipped on a first reading.

Preface

MATLAB is an integrated technical computing environment that combines numeric computation, advanced graphics and visualization, and a high-level programming language.

– www.mathworks.com/products/matlab

That statement encapsulates the view of *The Math Works, Inc.*, the developer of MATLAB®. MATLAB 6 is an ambitious program. It contains hundreds of commands to do mathematics. You can use it to graph functions, solve equations, perform statistical tests, and do much more. It is a high-level programming language that can communicate with its cousins, e.g., FORTRAN and C. You can produce sound and animate graphics. You can do simulations and modeling (especially if you have access not just to basic MATLAB but also to its accessory SIMULINK®). You can prepare materials for export to the World Wide Web. In addition, you can use MATLAB, in conjunction with the word processing and desktop publishing features of Microsoft Word®, to combine mathematical computations with text and graphics to produce a polished, integrated, and interactive document.

A program this sophisticated contains many features and options. There are literally hundreds of useful commands at your disposal. The MATLAB help documentation contains thousands of entries. The standard references, whether the MathWorks User's Guide for the product, or any of our competitors, contain myriad tables describing an endless stream of commands, options, and features that the user might be expected to learn or access.

MATLAB is more than a fancy calculator; it is an extremely useful and versatile tool. Even if you only know a little about MATLAB, you can use it to accomplish wonderful things. The hard part, however, is figuring out which of the hundreds of commands, scores of help pages, and thousands of items of documentation you need to look at to start using it quickly and effectively.

That's where we come in.

Why We Wrote This Book

The goal of this book is to get you started using MATLAB successfully and quickly. We point out the parts of MATLAB you need to know without overwhelming you with details. We help you avoid the rough spots. We give you examples of real uses of MATLAB that you can refer to when you're doing your own work. And we provide a handy reference to the most useful features of MATLAB. When you're finished reading this book, you will be able to use MATLAB effectively. You'll also be ready to explore more of MATLAB on your own.

You might not be a MATLAB expert when you finish this book, but you will be prepared to become one — if that's what you want. We figure you're probably more interested in being an expert at your own specialty, whether that's finance, physics, psychology, or engineering. You want to use MATLAB the way we do, as a tool. This book is designed to help you become a proficient MATLAB user as quickly as possible, so you can get on with the business at hand.

Who Should Read This Book

This book will be useful to complete novices, occasional users who want to sharpen their skills, intermediate or experienced users who want to learn about the new features of MATLAB 6 or who want to learn how to use SIMULINK, and even experts who want to find out whether we know anything they don't.

You can read through this guide to learn MATLAB on your own. If your employer (or your professor) has plopped you in front of a computer with MATLAB and told you to learn how to use it, then you'll find the book particularly useful. If you are teaching or taking a course in which you want to use MATLAB as a tool to explore another subject — whether in mathematics, science, engineering, business, or statistics — this book will make a perfect supplement.

As mentioned, we wrote this guide for use with MATLAB 6. If you plan to continue using MATLAB 5, however, you can still profit from this book. Virtually all of the material on MATLAB commands in this book applies to both versions. Only a small amount of material on the MATLAB interface, found mainly in Chapters 1, 3, and 8, is exclusive to MATLAB 6.

How This Book Is Organized

In writing, we drew on our experience to provide important information as quickly as possible. The book contains a short, focused introduction to MATLAB. It contains practice problems (with complete solutions) so you can test your knowledge. There are several illuminating sample projects that show you how MATLAB can be used in real-world applications, and there is an entire chapter on troubleshooting.

The core of this book consists of about 75 pages: Chapters 1–4 and the beginning of Chapter 5. Read that much and you'll have a good grasp of the fundamentals of MATLAB. Read the rest — the remainder of the Graphics chapter as well as the chapters on M-Books, Programming, SIMULINK and GUIs, Applications, MATLAB and the Internet, Troubleshooting, and the Glossary — and you'll know enough to do a great deal with MATLAB.

Here is a detailed summary of the contents of the book.

Chapter 1, *Getting Started*, describes how to start MATLAB on different platforms. It tells you how to enter commands, how to access online help, how to recognize the various MATLAB windows you will encounter, and how to exit the application.

Chapter 2, *MATLAB Basics*, shows you how to do elementary mathematics using MATLAB. This chapter contains the most essential MATLAB commands.

Chapter 3, *Interacting with MATLAB*, contains an introduction to the MATLAB Desktop interface. This chapter will introduce you to the basic window features of the application, to the small program files (M-files) that you will use to make most effective use of the software, and to a simple method (diary files) of documenting your MATLAB sessions. After completing this chapter, you'll have a better appreciation of the breadth described in the quote that opens this preface.

Practice Set A, *Algebra and Arithmetic*, contains some simple problems for practicing your newly acquired MATLAB skills. Solutions are presented at the end of the book.

Chapter 4, *Beyond the Basics*, contains an explanation of the finer points that are essential for using MATLAB effectively.

Chapter 5, *MATLAB Graphics*, contains a more detailed look at many of the MATLAB commands for producing graphics.

Practice Set B, *Calculus, Graphics, and Linear Algebra*, gives you another chance to practice what you've just learned. As before, solutions are provided at the end of the book.

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Chapter 6, *M-Books*, contains an introduction to the word processing and desktop publishing features available when you combine MATLAB with Microsoft Word.

Chapter 7, *MATLAB Programming*, introduces you to the programming features of MATLAB. This chapter is designed to be useful both to the novice programmer and to the experienced FORTRAN or C programmer.

Chapter 8, *SIMULINK and GUIs*, consists of two parts. The first part describes the MATLAB companion software SIMULINK, a graphically oriented package for modeling, simulating, and analyzing dynamical systems. Many of the calculations that can be done with MATLAB can be done equally well with SIMULINK. If you don't have access to SIMULINK, skip this part of Chapter 8. The second part contains an introduction to the construction and deployment of graphical user interfaces, that is, GUIs, using MATLAB.

Chapter 9, *Applications*, contains examples, from many different fields, of solutions of real-world problems using MATLAB and/or SIMULINK.

Practice Set C, *Developing Your MATLAB Skills*, contains practice problems whose solutions use the methods and techniques you learned in Chapters 6–9.

Chapter 10, *MATLAB and the Internet*, gives tips on how to post MATLAB output on the Web.

Chapter 11, *Troubleshooting*, is the place to turn when anything goes wrong. Many common problems can be resolved by reading (and rereading) the advice in this chapter.

Next, we have *Solutions to the Practice Sets*, which contains solutions to all the problems from the three practice sets. The *Glossary* contains short descriptions (with examples) of many MATLAB commands and objects. Though not a complete reference, it is a handy guide to the most important features of MATLAB. Finally, there is a complete *Index*.

Conventions Used in This Book

We use distinct fonts to distinguish various entities. When new terms are first introduced, they are typeset in an *italic* font. Output from MATLAB is typeset in a monospaced typewriter font; commands that you type for interpretation by MATLAB are indicated by a **boldface** version of that font. These commands and responses are often displayed on separate lines as they would be in a MATLAB session, as in the following example:

```
>> x = sqrt(2*pi + 1)
```

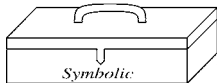
```
x =
```

```
2.697
```

Selectable menu items (from the menu bars in the MATLAB Desktop, figure windows, etc.) are typeset in a **boldface** font. Submenu items are separated from menu items by a colon, as in **File: Open...** Labels such as the names of windows and buttons are quoted, in a “regular” font. File and folder names, as well as Web addresses, are printed in a typewriter font. Finally, names of keys on your computer keyboard are set in a SMALL CAPS font.

We use four special symbols throughout the book. Here they are together with their meanings.

- ☞ Paragraphs like this one contain cross-references to other parts of the book or suggestions of where you can skip ahead to another chapter.
- ⇒ Paragraphs like this one contain important notes. Our favorite is “Save your work frequently.” Pay careful attention to these paragraphs.
- ✓ Paragraphs like this one contain useful tips or point out features of interest in the surrounding landscape. You might not need to think carefully about them on the first reading, but they may draw your attention to some of the finer points of MATLAB if you go back to them later.



Paragraphs like this discuss features of MATLAB’s Symbolic Math Toolbox, used for *symbolic* (as opposed to *numerical*) calculations. If you are not using the Symbolic Math Toolbox, you can skip these sections.

Incidentally, if you are a student and you have purchased the MATLAB Student Version, then the Symbolic Math Toolbox and SIMULINK are automatically included with your software, along with basic MATLAB. Caution: *The Student Edition of MATLAB*, a different product, does not come with SIMULINK.

About the Authors

We are mathematics professors at the University of Maryland, College Park. We have used MATLAB in our research, in our mathematics courses, for presentations and demonstrations, for production of graphics for books and for the Web, and even to help our kids do their homework. We hope that you’ll find MATLAB as useful as we do and that this book will help you learn to use it quickly and effectively. Finally, we would like to thank our editor, Alan Harvey, for his personal attention and helpful suggestions.