

Contents

| | |
|---|-----------|
| Preface | 13 |
| 1 Getting Started | 17 |
| 1.1 Introduction | 17 |
| 1.2 Typographical Conventions | 17 |
| 1.3 What's New in MATLAB | 18 |
| 1.4 What's in <i>Mastering MATLAB</i> | 18 |
| 2 Basic Features | 20 |
| 2.1 Simple Math | 20 |
| 2.2 The MATLAB Workspace | 22 |
| 2.3 About Variables | 23 |
| 2.4 Comments, Punctuation, and Aborting Execution | 26 |
| 2.5 Complex Numbers | 28 |
| 2.6 Floating-Point Arithmetic | 30 |
| 2.7 Mathematical Functions | 32 |
| 3 The MATLAB Desktop | 38 |
| 3.1 MATLAB Windows | 38 |
| 3.2 Managing the MATLAB Workspace | 39 |
| 3.3 Memory Management | 43 |
| 3.4 Number Display Formats | 43 |
| 3.5 System Information | 44 |
| 3.6 The MATLAB Search Path | 46 |
| 4 Script M-files | 47 |
| 4.1 Script M-file Use | 47 |
| 4.2 Block Comments and Code Cells | 51 |
| 4.3 Setting Execution Time | 53 |
| 4.4 Startup and Finish | 54 |
| 5 Arrays and Array Operations | 56 |
| 5.1 Simple Arrays | 56 |
| 5.2 Array Addressing or Indexing | 57 |
| 5.3 Array Construction | 59 |
| 5.4 Array Orientation | 62 |
| 5.5 Scalar–Array Mathematics | 66 |
| 5.6 Array–Array Mathematics | 66 |
| 5.7 Standard Arrays | 73 |

| | | |
|-----------|--|------------|
| 5.8 | Array Manipulation | 77 |
| 5.9 | Array Sorting | 92 |
| 5.10 | Subarray Searching | 95 |
| 5.11 | Array-Manipulation Functions | 102 |
| 5.12 | Array Size | 108 |
| 5.13 | Arrays and Memory Utilization | 111 |
| 6 | Multidimensional Arrays | 117 |
| 6.1 | Array Construction | 117 |
| 6.2 | Array Mathematics and Manipulation | 121 |
| 6.3 | Array Size | 132 |
| 7 | Numeric Data Types | 135 |
| 7.1 | Integer Data Types | 135 |
| 7.2 | Floating-Point Data Types | 141 |
| 7.3 | Summary | 143 |
| 8 | Cell Arrays and Structures | 145 |
| 8.1 | Cell Array Creation | 146 |
| 8.2 | Cell Array Manipulation | 149 |
| 8.3 | Retrieving Cell Array Content | 151 |
| 8.4 | Comma-Separated Lists | 155 |
| 8.5 | Cell Functions | 159 |
| 8.6 | Cell Arrays of Strings | 162 |
| 8.7 | Structure Creation | 164 |
| 8.8 | Structure Manipulation | 169 |
| 8.9 | Retrieving Structure Content | 171 |
| 8.10 | Comma-Separated Lists (Again) | 173 |
| 8.11 | Structure Functions | 176 |
| 8.12 | Summary | 180 |
| 9 | Character Strings | 181 |
| 9.1 | String Construction | 181 |
| 9.2 | Numbers to Strings to Numbers | 187 |
| 9.3 | String Evaluation | 194 |
| 9.4 | String Functions | 195 |
| 9.5 | Cell Arrays of Strings | 199 |
| 9.6 | Searching Using Regular Expressions | 203 |
| 10 | Relational and Logical Operations | 211 |
| 10.1 | Relational Operators | 211 |
| 10.2 | Logical Operators | 215 |
| 10.3 | Operator Precedence | 216 |
| 10.4 | Relational and Logical Functions | 217 |
| 10.5 | NaNs and Empty Arrays | 220 |

| | |
|---|------------|
| 11 Control Flow | 224 |
| 11.1 For Loops | 224 |
| 11.2 While Loops | 230 |
| 11.3 If-Else-End Constructions | 231 |
| 11.4 Switch-Case Constructions | 234 |
| 11.5 Try-Catch Blocks | 236 |
| 12 Functions | 239 |
| 12.1 M-file Function Construction Rules | 240 |
| 12.2 Input and Output Arguments | 245 |
| 12.3 Function Workspaces | 248 |
| 12.4 Functions and the MATLAB Search Path | 252 |
| 12.5 Creating Your Own Toolbox | 255 |
| 12.6 Command–Function Duality | 256 |
| 12.7 Function Handles and Anonymous Functions | 257 |
| 12.8 Nested Functions | 263 |
| 12.9 Debugging M-files | 267 |
| 12.10 Syntax Checking and File Dependencies | 269 |
| 12.11 Profiling M-files | 270 |
| 13 File and Directory Management | 272 |
| 13.1 Native Data Files | 272 |
| 13.2 Data Import and Export | 275 |
| 13.3 Low-Level File I/O | 279 |
| 13.4 Directory Management | 281 |
| 13.5 File Archives and Compression | 285 |
| 13.6 Internet File Operations | 286 |
| 14 Set, Bit, and Base Functions | 289 |
| 14.1 Set Functions | 289 |
| 14.2 Bit Functions | 294 |
| 14.3 Base Conversions | 295 |
| 15 Time Computations | 297 |
| 15.1 Current Date and Time | 297 |
| 15.2 Date Format Conversions | 298 |
| 15.3 Date Functions | 304 |
| 15.4 Timing Functions | 306 |
| 15.5 Plot Labels | 307 |
| 16 Matrix Algebra | 310 |
| 16.1 Sets of Linear Equations | 310 |
| 16.2 Matrix Functions | 315 |

| | | |
|-----------|---|------------|
| 16.3 | Special Matrices | 317 |
| 16.4 | Sparse Matrices | 318 |
| 16.5 | Sparse Matrix Functions | 320 |
| 17 | Data Analysis | 323 |
| 17.1 | Basic Statistical Analysis | 323 |
| 17.2 | Basic Data Analysis | 337 |
| 17.3 | Data Analysis and Statistical Functions | 343 |
| 17.4 | Time Series Analysis | 344 |
| 18 | Data Interpolation | 348 |
| 18.1 | One-Dimensional Interpolation | 348 |
| 18.2 | Two-Dimensional Interpolation | 353 |
| 18.3 | Triangulation and Scattered Data | 357 |
| 18.4 | Summary | 365 |
| 19 | Polynomials | 367 |
| 19.1 | Roots | 367 |
| 19.2 | Multiplication | 368 |
| 19.3 | Addition | 368 |
| 19.4 | Division | 370 |
| 19.5 | Derivatives and Integrals | 371 |
| 19.6 | Evaluation | 372 |
| 19.7 | Rational Polynomials | 372 |
| 19.8 | Curve Fitting | 374 |
| 19.9 | Polynomial Functions | 377 |
| 20 | Cubic Splines | 379 |
| 20.1 | Basic Features | 379 |
| 20.2 | Piecewise Polynomials | 380 |
| 20.3 | Cubic Hermite Polynomials | 383 |
| 20.4 | Integration | 385 |
| 20.5 | Differentiation | 388 |
| 20.6 | Spline Interpolation on a Plane | 389 |
| 21 | Fourier Analysis | 393 |
| 21.1 | Discrete Fourier Transform | 393 |
| 21.2 | Fourier Series | 397 |
| 22 | Optimization | 402 |
| 22.1 | Zero Finding | 402 |
| 22.2 | Minimization in One Dimension | 407 |
| 22.3 | Minimization in Higher Dimensions | 409 |
| 22.4 | Practical Issues | 412 |

| | |
|---|------------|
| 23 Integration and Differentiation | 414 |
| 23.1 Integration | 414 |
| 23.2 Differentiation | 420 |
| 24 Differential Equations | 427 |
| 24.1 IVP Format | 427 |
| 24.2 ODE Suite Solvers | 428 |
| 24.3 Basic Use | 429 |
| 24.4 Setting Options | 433 |
| 24.5 BVPs, PDEs, and DDEs | 441 |
| 25 Two-Dimensional Graphics | 442 |
| 25.1 The plot Function | 442 |
| 25.2 Linestyles, Markers, and Colors | 444 |
| 25.3 Plot Grids, Axes Box, and Labels | 446 |
| 25.4 Customizing Plot Axes | 448 |
| 25.5 Multiple Plots | 451 |
| 25.6 Multiple Figures | 451 |
| 25.7 Subplots | 453 |
| 25.8 Interactive Plotting Tools | 454 |
| 25.9 Screen Updates | 456 |
| 25.10 Specialized 2-D Plots | 457 |
| 25.11 Easy Plotting | 465 |
| 25.12 Text Formatting | 467 |
| 25.13 Summary | 469 |
| 26 Three-Dimensional Graphics | 472 |
| 26.1 Line Plots | 472 |
| 26.2 Scalar Functions of Two Variables | 474 |
| 26.3 Mesh Plots | 478 |
| 26.4 Surface Plots | 481 |
| 26.5 Mesh and Surface Plots of Irregular Data | 487 |
| 26.6 Changing Viewpoints | 489 |
| 26.7 Camera Control | 491 |
| 26.8 Contour Plots | 492 |
| 26.9 Specialized 3-D Plots | 494 |
| 26.10 Volume Visualization | 498 |
| 26.11 Easy Plotting | 505 |
| 26.12 Summary | 507 |
| 27 Using Color and Light | 511 |
| 27.1 Understanding Colormaps | 511 |
| 27.2 Using Colormaps | 513 |
| 27.3 Displaying Colormaps | 514 |

| | | |
|-----------|---|------------|
| 27.4 | Creating and Altering Colormaps | 516 |
| 27.5 | Using Color to Describe a Fourth Dimension | 518 |
| 27.6 | Transparency | 521 |
| 27.7 | Lighting Models | 523 |
| 27.8 | Summary | 527 |
| 28 | <i>Images, Movies, and Sound</i> | 529 |
| 28.1 | Images | 529 |
| 28.2 | Image Formats | 531 |
| 28.3 | Image Files | 532 |
| 28.4 | Movies | 534 |
| 28.5 | Movie Files | 536 |
| 28.6 | Sound | 540 |
| 28.7 | Summary | 541 |
| 29 | <i>Printing and Exporting Graphics</i> | 543 |
| 29.1 | Printing and Exporting Using Menus | 544 |
| 29.2 | Command Line Printing and Exporting | 545 |
| 29.3 | Printers and Export File Formats | 546 |
| 29.4 | PostScript Support | 548 |
| 29.5 | Choosing a Renderer | 549 |
| 29.6 | Handle Graphics Properties | 550 |
| 29.7 | Setting Defaults | 552 |
| 29.8 | Publishing | 553 |
| 29.9 | Summary | 554 |
| 30 | <i>Handle Graphics</i> | 555 |
| 30.1 | Objects | 555 |
| 30.2 | Object Handles | 557 |
| 30.3 | Object Properties | 557 |
| 30.4 | Get and Set | 558 |
| 30.5 | Finding Objects | 566 |
| 30.6 | Selecting Objects with the Mouse | 568 |
| 30.7 | Position and Units | 569 |
| 30.8 | Default Properties | 572 |
| 30.9 | Common Properties | 575 |
| 30.10 | Plot Objects | 577 |
| 30.11 | Group Objects | 578 |
| 30.12 | Annotation Axes | 580 |
| 30.13 | Linking Objects | 581 |
| 30.14 | New Plots | 582 |
| 30.15 | Callbacks | 583 |
| 30.16 | M-file Examples | 584 |
| 30.17 | Summary | 591 |

| | |
|--|------------|
| 31 MATLAB Classes and Object-Oriented Programming | 595 |
| 31.1 Overloading | 597 |
| 31.2 Class Creation | 603 |
| 31.3 Subscripts | 618 |
| 31.4 Converter Functions | 629 |
| 31.5 Precedence, Inheritance, and Aggregation | 630 |
| 31.6 Handle Classes | 632 |
| 32 Examples, Examples, Examples | 633 |
| 32.1 Vectorization | 633 |
| 32.2 JIT-Acceleration | 636 |
| 32.3 The Birthday Problem | 636 |
| 32.4 Up-Down Sequence | 641 |
| 32.5 Alternating Sequence Matrix | 647 |
| 32.6 Vandermonde Matrix | 652 |
| 32.7 Repeated Value Creation and Counting | 655 |
| 32.8 Differential Sums | 665 |
| 32.9 Structure Manipulation | 673 |
| 32.10 Inverse Interpolation | 676 |
| 32.11 Polynomial Curve Fitting | 684 |
| 32.12 Nonlinear Curve Fitting | 692 |
| 32.13 Circle Fitting | 701 |
| 32.14 Laminar Fluid Flow in a Circular Pipe | 706 |
| 32.15 Projectile Motion | 712 |
| 32.16 Bode Plots | 723 |
| 32.17 Inverse Laplace Transform | 734 |
| 32.18 Picture-in-a-Picture Zoom | 740 |
| Appendix A MATLAB Release Information | 747 |
| Appendix B MATLAB Function Information | 805 |
| Index | 851 |