Contents

Preface **1**

1 Introduction **1**
1.1 Goals of the course . . . 1
1.2 Suggestions to students . . . 1
1.3 Structure of the text . . . 2
1.4 Notation and conventions . . . 3
1.5 Topics covered in the course . . . 5
1.6 Principles of program design . . . 6

I The MATLAB programming environment **7**

2 The Command Window **9**
2.1 Configuration Preferences . . . 9
2.2 Command-line session in the Command Window . . . 10
2.3 Computing $\sqrt{5}$ using Newton's algorithm . . . 11
2.4 Manually iterating Newton algorithm . . . 12
2.5 What the current implementation accomplishes . . . 15
2.6 Shortcomings of the current implementation . . . 15
2.7 Topics covered in this chapter . . . 15

3 The Edit Window **17**
3.1 Creating an M-file in the Edit Window (NewtonAlg2.m) . . . 17
3.2 Introduction to the Debugger . . . 21
3.3 An improved version (NewtonAlg3.m) . . . 24
3.4 What the current implementation accomplishes . . . 28
3.5 Shortcomings of the current implementation . . . 29
3.6 Topics covered in this chapter . . . 29

4 The Help Browser and Command/Edit Windows revisited **31**
4.1 Navigating the MATLAB documentation . . . 31
4.2 Script Files: The Command Window is dead; Long live the Edit Window . . . 33

www.decagonpress.com

4.3 Debugging: The Command Window still lives . . . 36
4.4 Topics covered in this chapter . . . 37

II Writing a simple MATLAB program 39

5 Displaying Output 41
5.1 Formatting numeric output (NewtonAlg4.m) . . . 41
5.2 Elimination of the hardwired values (NewtonAlg5.m) . . . 47
5.3 Formatting table output (NewtonAlg6.m) . . . 48
5.4 What the current implementation accomplishes . . . 49
5.5 Shortcomings of the current implementation . . . 49
5.6 Topics covered in this chapter . . . 49

6 Conditionals and Flow control 51
6.1 Logical (Boolean) expressions . . . 52
6.2 Conditional statements . . . 53
6.3 The full-blown if-elseif-else-end statement . . . 58
6.4 More control: for-loops and while-loops . . . 60
6.5 Topics covered in this chapter . . . 63

7 Arrays I 65
7.1 Using arrays for storage (NewtonAlg7.m) . . . 65
7.2 What the current implementation accomplishes . . . 71
7.3 Shortcomings of the current implementation . . . 71
7.4 Topics covered in this chapter . . . 71

8 Arrays II 73
8.1 Array initialization . . . 73
8.2 Array operations . . . 76
8.3 Performance: for-loop vs. array-operation vs. built-in implementations . . . 78
8.4 Topics covered in this chapter . . . 85

9 Arrays III 87
9.1 Accessing array elements . . . 87
9.2 Using arrays to represent mathematical functions . . . 89
9.3 Topics covered in this chapter . . . 93

10 Plotting I 95
10.1 Plotting a collection of data points in the plane . . . 95
10.2 Controlling the appearance of plots . . . 99
10.3 Plotting parametric curves in the plane . . . 105
10.4 Topics covered in this chapter . . . 108

www.decompress.com

11 Computing $\sqrt{5}$: NewtonAlg.m **109**
11.1 The order of convergence of iterative numerical algorithms . . . 109
11.2 Applying plotting techniques to numerical investigations . . . 111
11.3 Topics covered in this chapter . . . 114

III Writing a complex MATLAB program **115**

12 Functions I **117**
12.1 A simple example of a user-defined function . . . 118
12.2 Passing arguments and returning values . . . 120
12.3 Implementing NewtonAlg as a function (NewtonAlg10.m) . . . 126
12.4 Topics covered in this chapter . . . 128

13 Functions II **129**
13.1 Tolerance as a terminating condition (NewtonAlg12.m) . . . 129
13.2 A complex program (Main.m, Tabulate.m, NewtonAlg13.m) . . . 134
13.3 Topics covered in this chapter . . . 141

14 Functions III **143**
14.1 Calling functions indirectly using function handles . . . 145
14.2 Adapting NewtonAlg to any equation (ScalarNewton.m) . . . 147
14.3 Subfunctions (RootFinder.m) . . . 149
14.4 Topics covered in this chapter . . . 153

15 Arrays IV **155**
15.1 Multi-dimensional arrays and Matrix Algebra . . . 155
15.2 Topics covered in this chapter . . . 166

16 Arrays V **167**
16.1 The empty array and dynamic allocation . . . 167
16.2 Cell arrays . . . 170
16.3 Topics covered in this chapter . . . 173

17 Sharing Data I **175**
17.1 Global variables and callbacks (OdeMain.m) . . . 175
17.2 GUI programming (OdeGui.m) . . . 178
17.3 Structures . . . 184
17.4 Topics covered in this chapter . . . 188

18 Sharing Data II **189**
18.1 MAT-files (CompareAXeqB.m) . . . 189
18.2 Lookup tables (Pascal.m) . . . 195
18.3 Topics covered in this chapter . . . 199

www.cacagoodness.com

19 Plotting II **201**
19.1 Plotting parameterized curves in three dimensions . . . 201
19.2 Rotations and Projections (HelixMain.m) . . . 203
19.3 Object-oriented programming (SliderGui.m) . . . 206
19.4 Topics covered in this chapter . . . 211

20 Plotting III **213**
20.1 Graphing the function $z = F(x, y)$ (GraphZ.m) . . . 214
20.2 Plotting surfaces in three dimensions (Paraboloid.m) . . . 217
20.3 Plotting trajectories of a constrained dynamical system (Gravity.m) . . . 227
20.4 Topics covered in this chapter . . . 234

21 Systems of nonlinear equations **235**
21.1 Generalizing scalar equations . . . 235
21.2 Vectorizing the Newton algorithm for systems (VectorNewton.m) . . . 237
21.3 A root-finder for two dimensional systems (Nonlinear2dSolver.m) . . . 240
21.4 Topics covered in this chapter . . . 245

www.decagonpress.com