

Contents

Preface	ix
---------------	----

PART I: Using *Mathematica* Interactively 1

Chapter 1. Getting Started with Mathematica	3
1.1 Starting Mathematica	5
1.2 The In[]'s and Out[]'s of <i>Mathematica</i>	7
1.3 Using On-Line Help	11
1.4 Using Palettes to Enter Formulae	15
1.5 Notation Conventions.....	19
1.6 Saving Your Work and Quitting	26
1.7 A Quick Tour of Some Commands.....	28
1.8 Using the Standard Packages.....	29
1.9 Summary	30
1.10 Exercises.....	32
Chapter 2. Numerical Capabilities	37
2.1 Arithmetic Operations.....	37
2.2 Types of Numbers	38
2.3 Random Numbers.....	46
2.4 Numerical Precision	50
2.5 Integer Functions.....	56
2.6 Finding Roots of Equations	61
2.7 Numerical Integration	68

2.8	Numerical Differential Equations.....	74
2.9	Summary.....	86
2.10	Exercises.....	89
Chapter 3. Symbolic Capabilities		93
3.1	Manipulating and Simplifying Expressions.....	93
3.2	Trigonometry.....	104
3.3	Solving Equations.....	109
3.4	Differential Calculus.....	115
3.5	Series.....	121
3.6	Integral Calculus.....	131
3.7	Symbolic Sums, Products, and Limits.....	133
3.8	Symbolic Differential Equations.....	135
3.9	Summary.....	138
3.10	Exercises.....	145
Chapter 4. Plotting Functions		151
4.1	Two-Dimensional Plots.....	151
4.2	Changing the Appearance of Plots.....	154
4.3	Combining Plots.....	160
4.4	Parametric, Implicit and Polar Plots.....	167
4.5	Frames, Grids, Backgrounds and Licks.....	172
4.6	Inserting Annotations to a Plot.....	177
4.7	Three Dimensional Plots.....	181
4.8	Contour Plots and Density Plots.....	189
4.9	Summary.....	192
4.10	Exercises.....	196
Chapter 5. Visualizing Data		201
5.1	Plotting Data in Two Dimensions.....	202
5.2	Error Plots.....	209
5.3	Log Plots.....	211
5.4	Bar Charts and Pie Charts.....	214
5.5	Two-Dimensional Fields.....	216
5.6	Summary.....	220
5.7	Exercises.....	222
Chapter 6. Data Manipulation and Analysis		225
6.1	Lists and Nested Lists As Data Structures.....	226
6.2	Reordering and Partitioning Data.....	226

6.3	Inserting, Replacing, and Deleting Elements	231
6.4	Selecting Subsets of the Data	234
6.5	Counting and Binning Elements	233
6.6	Mapping Functions over Data	243
6.7	Statistical Analyses	246
6.8	Curve Fitting	253
6.9	Data Interpolation	258
6.10	Summary	265
6.11	Exercises	268

Chapter 7. Getting Around with Notebooks **273**

7.1	Initialization Cells	275
7.2	Default Output Form for Formulae	276
7.3	Interacting with Outputs	277
7.4	Cell Brackets	279
7.5	Menus in Notebooks	280
7.6	Summary	284
7.7	Exercises	285

PART II: Programming **287**

Chapter 8. Writing Your Own Programs **289**

8.1	A Simple Program	290
8.2	Multi-Line Programs	292
8.3	Localizing Variables	293
8.4	Programs with Multiple Calling Patterns	295
8.5	Logical Operators and Tests	296
8.6	Conditional Execution	300
8.7	Adding Usage Messages	304
8.8	Adding Error Messages	305
8.9	Summary	306
8.10	Exercises	309

Chapter 9. Rule-Based Programming **313**

9.1	Local Rewrite Rules	314
9.2	Rules Don't Always Work As Expected	318
9.3	Controlling How Rules Are Applied	321
9.4	Types of Patterns	322

9.5	Uses of Patterns.....	334
9.6	Summary.....	343
9.7	Exercises.....	346
Chapter 10. Functional Programming		351
10.1	Nesting Function Calls.....	352
10.2	Recursive Functions.....	353
10.3	Anonymous (Pure) Functions.....	354
10.4	Variants of Map.....	356
10.5	Apply.....	362
10.6	Select.....	363
10.7	Functional Alternatives to Loops.....	364
10.8	Summary.....	369
10.9	Exercises.....	371
Chapter 11. Procedural Programming		377
11.1	Arrays.....	378
11.2	Counter Variables.....	379
11.3	Loops and Iteration.....	380
11.4	Conditionals.....	386
11.5	Summary.....	391
11.6	Exercises.....	392
Chapter 12. Graphics, Animation and Sound		397
12.1	Two-Dimensional Graphics Primitives.....	398
12.2	Setting Styles for Graphics Primitives.....	402
12.3	Three-Dimensional Graphics Primitives.....	407
12.4	Creating Animations.....	413
12.5	Creating Sounds.....	416
12.6	Summary.....	418
12.7	Exercises.....	420
Chapter 13. Writing Interactive Programs		427
13.1	Asking Questions and Getting Replies.....	428
13.2	Strings.....	429
13.3	Checking a User's Answer.....	433
13.4	Managing User Interaction.....	434
13.5	Summary.....	436
13.6	Exercises.....	438

Chapter 14. Notation, Buttons, and Palettes	441
14.1 Special Notation	442
14.2 Defining Buttons	445
14.3 Creating Palettes	449
14.4 Summary	452
14.5 Exercises	454

PART III: Building larger Applications **455**

Chapter 15. Speeding Up Your Programs	457
15.1 Timing Your Programs	458
15.2 Avoid Exact Arithmetic	459
15.3 Avoid Evaluating Data Structures	460
15.4 Avoid the Procedural Style	461
15.5 Compile Numerical Functions	462
15.6 Summary	468
15.7 Exercises	470

Chapter 16. Writing Your Own Packages	473
16.1 Why Write a Package?	474
16.2 Contexts	474
16.3 Package Style	477
16.4 Loading Packages	482
16.5 Accidental Shadowing	484
16.6 Summary	486
16.7 Exercises	487

Chapter 17. Working with Files	489
17.1 Telling <i>Mathematica</i> where to Look	490
17.2 Importing Data from Files	491
17.3 Exporting Data	496
17.4 Low-Level File Interaction	497
17.5 Exporting Special Formats	499
17.6 Exporting Graphics	503
17.7 Exporting HTML Files	504
17.8 Exporting Function Definitions	506
17.9 Searching the Contents of a File	508

17.10 Summary.....	513
17.11 Exercises	515

Chapter 18. Example Applications **519**

18.1 Monte Carlo Simulations	520
18.2 Cryptography	528

Appendices

A. Answers to Odd-Numbered Exercises	537
B. Suggestions for Further Reading	601
C. Index	609