## Contents

Preface · xi

### 1 Programming with Mathematica · 1

1.1 Introduction to programming · 2
   Your first Mathematica program · Programming paradigms · Creating programs

1.2 Getting started · 8
   Starting and running Mathematica · Mathematical expressions · Functions · Lists · Semicolons · Alternative input syntax · Comments · Exercises

1.3 Getting help · 14
   Errors · Getting out of trouble · Function information · Documentation

1.4 Notes and further reading · 18

### 2 The Mathematica language · 19

2.1 Expressions · 20
   Atoms · Normal expressions · Display of expressions · Evaluation of expressions · Compound expressions · Nesting expressions · Exercises

2.2 Numbers · 33
   Types of numbers · Digits and number bases · Random numbers · Exercises

2.3 Definitions · 41
   Defining variables and functions · Immediate vs. delayed assignments · Compound functions · Functions with multiple definitions · Exercises

2.4 Predicates and Boolean operations · 49
   Predicates · Relational and logical operators · Exercises

2.5 Attributes · 55
   Listable · Hold attributes · Protected · Exercises

2.6 Notes and further reading · 57
# Table of Contents

3 Lists and associations · 59
   3.1 Creating and displaying lists · 60
      List structure and syntax · List construction · Displaying lists · Arrays · Exercises
   3.2 Testing and measuring lists · 69
      Testing a list · Measuring lists · Exercises
   3.3 Operations on lists · 72
      Extracting elements · Applying functions to lists · Rearranging lists · List component assignment · Multiple lists · Exercises
   3.4 Associations · 84
      Creating and displaying associations · Operations on associations · Creating a bibliography · Exercises
   3.5 Differences from other languages · 90
   3.6 Notes and further reading · 93

4 Patterns and rules · 95
   4.1 Patterns · 96
      Blanks · Pattern matching by type · Explicit pattern matching · Structured patterns · Sequence pattern matching · Conditional pattern matching · Shorthand notation · Alternatives · Repeated patterns · Functions that use patterns · Exercises
   4.2 Transformation rules · 111
      Creating and using replacement rules · Applying transformation rules · Exercises
   4.3 Examples · 116
      Counting coins · Filtering and extracting data · Perimeter · Triangle area · Finding parts of expressions · Sorting a list · Sunspot activity · Exercises
   4.4 Notes and further reading · 131

5 Functions · 133
   5.1 Functions for manipulating expressions · 134
      Map · Apply · Thread and MapThread · Listability · Inner and Outer · Select and Pick · Exercises
   5.2 Iterating functions · 146
      Nest · FixedPoint · NestWhile · Fold · Exercises
   5.3 Recursive functions · 152
      Fibonacci numbers · Thinking recursively · Dynamic programming · Exercises
   5.4 Loops and flow control · 159
      Conditional functions · Piecewise-defined functions · Which and Switch · Argument checking · Do and For loops · While loops · Exercises
   5.5 Pure functions · 176
      Syntax of pure functions · Multiple arguments · Pure predicate functions · Indexing with pure functions · Newton revisited · Example: searching for attributes · Exercises
### Contents

5.6 Examples · 190  
*Hamming distance · The Josephus problem · Protein interaction networks · Operating on arrays · Enumerating binary matrices · Clustering data · Exercises*

5.7 Notes and further reading · 208

6 Programs · 209  
6.1 Scoping constructs · 210  
*Localizing names: Module · Localizing values: Block · Localizing constants: With · Matrix manipulation · Exercises*

6.2 Options and messages · 217  
*Options · Messages · Exercises*

6.3 Examples · 223  
*Sieve of Eratosthenes · Radius of gyration · Lag plots · Random walks · Exercises*

6.4 Notes and further reading · 241

7 Strings · 243  
7.1 Structure and syntax · 244  
*Display of strings · Testing strings · Measuring strings · Character codes · Exercises*

7.2 Operations on strings · 247  
*Basic string operations · Strings vs. lists · Encoding text · Anagrams · Exercises*

7.3 String patterns · 255  
*Finding subsequences with strings · Alternatives · Exercises*

7.4 Regular expressions · 261  
*Constractions · Exercises*

7.5 Examples · 267  
*Abecedarian words · Random strings · Partitioning strings · DNA sequence analysis · Displaying DNA sequences · Blanagrams · Exercises*

7.6 Notes and further reading · 281

8 Graphics and visualization · 283  
8.1 The graphics language · 284  
*Primitives · Directives · Options · Three-dimensional graphics · Structure of built-in graphics functions · Exercises*

8.2 Dynamic graphics · 292  
*Manipulate and locators · Dynamic building blocks · Exercises*

8.3 Efficient structures · 303  
*Multi-objects · GraphicsComplex · Numeric vs. symbolic expressions · Exercises*
### Table of Contents

8.4 Examples · 314
   - Root plots · Venn diagrams · Dot plots · Hypocycloids · Space-filling plots · Simple closed paths · Points in a polygon · Triangle centers · Exercises

8.5 Notes and further reading · 343

9 Program optimization · 345
   9.1 Efficient programs · 346
      - Low-level vs. high-level functions · Pattern matching · Reducing size of computation · Symbolic vs. numeric computation · Listability · Packed arrays · Pure functions · Built-in pure functions · Exercises

9.2 Parallel processing · 366
   - Basic examples · Profiling · Exercises

9.3 Compiling · 372
   - Compile · Compiling to C · Exercises

9.4 Notes and further reading · 378

10 Packages · 379
   10.1 Working with packages · 379
      - Loading and using packages · Package location

10.2 Creating packages · 382
   - Contexts · Package framework · Creation and deployment

10.3 RandomWalks package · 389
   - Package source code · Running the package · Exercises

10.4 Notes and further reading · 394

Bibliography · 395

Index · 405