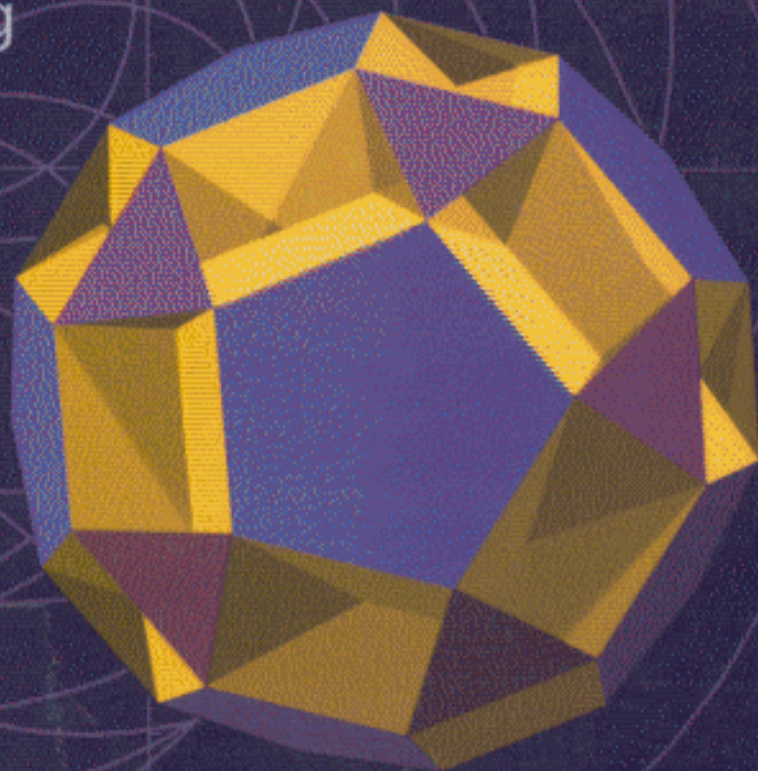


Computer Science with *Mathematica*[®]

Theory and Practice for
Science, Mathematics,
and Engineering



Soranaree University of Technology



31051000594164

Roman E. Maeder



Contents

<i>Preface</i>	ix
<i>About This Book</i>	xiii
1 Computers and Science	
1.1 From Problems to Programs	3
1.2 Computers	14
1.3 Programming Languages	18
1.4 Computer Science	23
2 Mathematica's Programming Language	
2.1 Arithmetic and Logic	27
2.2 Definitions	30
2.3 Simple Program Structures	34
2.4 Structure of Expressions	44
2.5 Help with Problems	49
2.6 Exercises	52
3 Iteration and Recursion	
3.1 The Greatest Common Divisor	57
3.2 The $3x + 1$ Problem	60
3.3 Advanced Topic: Loop Invariants	64
3.4 Application: Differential Equations	69
3.5 Exercises	76
4 Structure of Programs	
4.1 Complex Parametric Lines	81
4.2 The First Package	85
4.3 Optional Arguments	90
4.4 A Template Package	94
4.5 Exercises	96
5 Abstract Data Types	
5.1 Definition of Abstract Data Types	99
5.2 Example: Modular Numbers	102
5.3 Design of Abstract Data Types	106
5.4 Exercises	110

6	Algorithms for Searching and Sorting	
6.1	Searching Ordered Data	115
6.2	Sorting Data	121
6.3	Binary Trees	129
6.4	Exercises	138
7	Complexity of Algorithms	
7.1	Complexity of Computations	143
7.2	Example: Computing the n th Fibonacci Number	147
7.3	Special Topic: Dynamic Programming	156
7.4	Long-Integer Arithmetic and Fast Multiplication	162
7.5	Exercises	167
8	Operations on Vectors and Matrices	
8.1	Vectors and Matrices	171
8.2	Inner and Outer Products	175
8.3	Linear Algebra	185
8.4	Programs with Arrays	194
8.5	Application: Aggregation	202
8.6	Exercises	207
9	List Processing and Recursion	
9.1	Symbolic Expressions and Lists	213
9.2	List Processing	217
9.3	Exercises	223
10	Rule-Based Programming	
10.1	Pattern Matching	227
10.2	Rules and Term Rewriting	231
10.3	Simplification Rules and Normal Forms	235
10.4	Application: Trigonometric Simplifications	241
10.5	Exercises	248
11	Functions	
11.1	A Notation for Functions (λ Calculus)	255
11.2	Functions as Values	260
11.3	Example: Simulation of Shift Registers	266
11.4	Exercises	268
12	Theory of Computation	
12.1	Computable Functions	273
12.2	Models of Computation	280
12.3	Turing Machines	282
12.4	Recursive Functions Are Turing Computable	293
12.5	Exercises	299

13 Databases

13.1 Database Design	303
13.2 Relational Databases	308
13.3 Data Entry and Queries	314
13.4 Commercial Databases	319
13.5 Exercises	321

14 Object-Oriented Programming

14.1 Introduction	325
14.2 Example: Bank Accounts	327
14.3 Principles of Object-Oriented Programming	330
14.4 Application: Collections	332
14.5 Exercises	341

Appendix A Further Reading

A.1 A Guide to the Literature	345
A.2 References	347

Appendix B More Information About *Mathematica*

B.1 Computations You Can Do with <i>Mathematica</i>	353
B.2 The Code for the Illustrations in this Book	364
B.3 <i>Mathematica</i> 's Evaluation Method	368
B.4 Syntax of Operators	374

<i>Index</i>	377
------------------------	-----