

Contents

The Preface: How to Use This Book	xi
Chapter 1. Welcome to Sage!	1
1.1. Using Sage as a Calculator	1
1.2. Using Sage with Common Functions	7
1.3. Using Sage for Trigonometry	16
1.4. Using Sage to Graph 2-Dimensionally	21
1.5. Matrices and Sage, Part 1	33
1.6. Making Your Own Functions in Sage	45
1.7. Using Sage to Manipulate Polynomials	50
1.8. Using Sage to Solve Problems Symbolically	53
1.9. Using Sage as a Numerical Solver	62
1.10. Getting Help When You Need It	70
1.11. Using Sage to Take Derivatives	74
1.12. Using Sage to Calculate Integrals	76
1.13. Sharing the Results of Your Work	93
1.14. A Technicality about Functions	99
Chapter 2. Fun Projects Using Sage	103
2.1. Microeconomics: Computing a Selling Price	104
2.2. Biology: Clogged Arteries and Poiseuille's Law	109
2.3. Industrial Optimization: Shipping Taconite	112
2.4. Chemistry: Balancing Reactions with Matrices	115
2.5. Physics: Ballistic Projectiles	120
2.6. Cryptology: Pollard's $p - 1$ Attack on RSA	127
2.7. Mini-Project on Electric Field Vector Plots	135
2.8. Environmental Science: Lead and Motherboards	136
2.9. Macroeconomics: Leontief Input-Output Analysis	141
Chapter 3. Advanced Plotting Techniques	155
3.1. Annotating Graphs for Clarity	155
3.2. Graphs of Some Hyperactive Functions	163

3.3.	Polar Plotting	164
3.4.	Graphing an Implicit Function	170
3.5.	Contour Plots and Level Sets	173
3.6.	Parametric 2D Plotting	180
3.7.	Vector Field Plots	182
3.8.	Log-Log Plots	189
3.9.	The Removed Section	191
Chapter 4.	Advanced Features of Sage	193
4.1.	Using Sage with Multivariable Functions and Equations	193
4.2.	Working with Large Formulas in Sage	195
4.3.	Derivatives and Gradients in Multivariate Calculus	200
4.4.	Matrices and Sage, Part 2	201
4.5.	Vector Operations	211
4.6.	Working with the Integers and Number Theory	213
4.7.	Some More Commands in Sage	224
4.8.	Calculating Limits Expressly	227
4.9.	Scatter Plots in Sage	228
4.10.	Making Your Own Regressions in Sage	232
4.11.	Computing in Octal? Binary? And Hexadecimal?	234
4.12.	Can Sage Do Sudoku?	236
4.13.	Measuring the Speed of Sage	236
4.14.	Huge Numbers and Sage	237
4.15.	Using Sage and L ^A T _E X, Part 1	240
4.16.	Matrices and Sage, Part 3	241
4.17.	Computing Taylor or MacLaurin Polynomials	251
4.18.	Minimizations and Lagrange Multipliers	254
4.19.	Infinite Sums and Series	260
4.20.	Continued Fractions in Sage	264
4.21.	Systems of Inequalities and Linear Programming	266
4.22.	Differential Equations	273
4.23.	Laplace Transforms	285
4.24.	Vector Calculus in Sage	288
4.25.	Using Sage and L ^A T _E X, Part 2	300
4.26.	Complex Numbers and Sage	305
Chapter 5.	Programming in Sage and Python	317
5.1.	Repetition without Boredom: The <code>for</code> Loop	319
5.2.	Writing Subroutines	331
5.3.	Loops and Newton's Method	339
5.4.	An Introduction to Control Flow	354
5.5.	More Concepts in Flow Control	363
5.6.	<code>while</code> Loops versus <code>for</code> Loops	370
5.7.	How Arrays and Lists Work	381

5.8. Simulations: The Monte Carlo Method	387
5.9. Some Intermediate-Level Techniques	402
5.10. Where Do You Go from Here?	411
Chapter 6. Building Interactive Webpages with Sage	417
6.1. The Six-Stage Process for Building Interacts	419
6.2. The Tangent-Line Interact	420
6.3. A Challenge: The Sine Wave Interact	428
6.4. Another Challenge: The Optimal Aquarium Interact	429
6.5. Selectors and Checkboxes	430
6.6. The Definite Integral Interact	431
Appendix A. What to Do When Frustrated!	433
Appendix B. Transitioning to SageMathCloud	443
B.1. What Is SageMathCloud?	443
B.2. Getting Started in SageMathCloud	444
B.3. Other Cloud Features	445
Appendix C. Translating Python 2 to Python 3	447
C.1. Changes in the Syntax of <code>print</code>	448
C.2. Changes in the Behavior of <code>range</code>	450
C.3. Unicode versus ASCII	451
C.4. Unrelated but Contemporaneous Changes	452
Acknowledgments for the Second Edition	455
Acknowledgments for the First Edition	461
Bibliography	467
Index	471