

CONTENTS IN DETAIL

ACKNOWLEDGMENTS	XV
------------------------	-----------

INTRODUCTION	XVII
---------------------	-------------

The Problem with School Math	xviii
About This Book	xx
Who Should Use This Book	xxi
What's in This Book?	xxi
Downloading and Installing Python	xxii
Starting IDLE	xxiii
Installing Processing	xxiii

PART I: HITCHIN' UP YOUR PYTHON WAGON

1	
DRAWING POLYGONS WITH THE TURTLE MODULE	3

Python's turtle Module	4
Importing the turtle Module	4
Moving Your Turtle	5
Changing Directions	6
Repeating Code with Loops	7
Using the for Loop	7
Using a for Loop to Draw a Square	9
Creating Shortcuts with Functions	9
Using Variables to Draw Shapes	11
Using Variables in Functions	11
Variable Errors	12
Equilateral Triangles	13
Writing the triangle() Function	13
Making Variables Vary	14
Summary	17

2 MAKING TEDIOUS ARITHMETIC FUN WITH LISTS AND LOOPS 19

Basic Operators	20
Operating on Variables	20
Using Operators to Write the average() Function	21
Mind the Order of Operations!	21
Using Parentheses with Operators	22
Data Types in Python	22
Integers and Floats	22
Strings	23
Booleans	24
Checking Data Types	25
Using Lists to Store Values	25
Adding Items to a List	26
Operating on Lists	26
Removing Items from a List	27
Using Lists in Loops	27
Accessing Individual Items with List Indices	28
Accessing Index and Value with enumerate()	29
Indices Start at Zero	29
Accessing a Range of List Items	30
Finding Out the Index of an Item	30
Strings Use Indices, Too	31
Summation	32
Creating the running_sum Variable	32
Writing the mySum() Function	33
Finding the Average of a List of Numbers	34
Summary	35

3 GUESSING AND CHECKING WITH CONDITIONALS 37

Comparison Operators	38
Making Decisions with if and else Statements	38
Using Conditionals to Find Factors	39
Writing the factors.py Program	40
The Wandering Turtle	41
Creating a Number-Guessing Game	43
Making a Random Number Generator	44
Taking User Input	44
Converting User Input to Integers	45
Using Conditionals to Check for a Correct Guess	45
Using a Loop to Guess Again!	46
Tips for Guessing	47
Finding Square Roots	48
Applying the Number-Guessing Game Logic	48
Writing the squareRoot() Function	49
Summary	50

PART 2: RIDING INTO MATH TERRITORY

4 TRANSFORMING AND STORING NUMBERS WITH ALGEBRA 53

Solving First-Degree Equations	54
Finding the Formula for First-Degree Equations	55
Writing the equation() Function	56
Using print() Instead of return	57
Solving Higher-Degree Equations	58
Using quad() to Solve Quadratic Equations	59
Using plug() to Solve a Cubic Equation	60
Solving Equations Graphically	61
Getting Started with Processing	61
Creating Your Own Graphing Tool	63
Graphing an Equation	69
Using Guess and Check to Find the Roots	73
Writing the guess() Function	73
Summary	75

5 TRANSFORMING SHAPES WITH GEOMETRY 77

Drawing a Circle	78
Specifying Location Using Coordinates	79
Transformation Functions	80
Translating Objects with translate()	80
Rotating Objects with rotate()	83
Drawing a Circle of Circles	84
Drawing a Circle of Squares	85
Animating Objects	86
Creating the t Variable	86
Rotating the Individual Squares	87
Saving Orientation with pushMatrix() and popMatrix().	88
Rotating Around the Center	89
Creating an Interactive Rainbow Grid	89
Drawing a Grid of Objects	90
Adding the Rainbow Color to Objects	91
Drawing Complex Patterns Using Triangles	93
A 30-60-90 Triangle	94
Drawing an Equilateral Triangle	96
Drawing Multiple Rotating Triangles	98
Phase-Shifting the Rotation	99
Finalizing the Design	100
Summary	102

6 CREATING OSCILLATIONS WITH TRIGONOMETRY 103

Using Trigonometry for Rotations and Oscillations	105
Writing Functions to Draw Polygons	106
Drawing a Hexagon with Loops	107
Drawing an Equilateral Triangle	109
Making Sine Waves	110
Leaving a Trail	113
Using Python's Built-in enumerate() Function	114
Creating a Spirograph Program	116
Drawing the Smaller Circle	117
Rotating the Smaller Circle	117
Making Harmonographs	120
Writing the harmonograph Program	121
Filling the List Instantly	123
Two Pendulums Are Better Than One	124
Summary	126

7 COMPLEX NUMBERS 127

The Complex Coordinate System	128
Adding Complex Numbers	129
Multiplying a Complex Number by i	130
Multiplying Two Complex Numbers	131
Writing the magnitude() Function	132
Creating the Mandelbrot Set	132
Writing the mandelbrot() Function	135
Adding Color to the Mandelbrot Set	139
Creating the Julia Set	141
Writing the julia() Function	141
Summary	143

8 USING MATRICES FOR COMPUTER GRAPHICS AND SYSTEMS OF EQUATIONS 145

What Is a Matrix?	146
Adding Matrices	146
Multiplying Matrices	147
Order Matters in Matrix Multiplication	151
Drawing 2D Shapes	151
Transforming Matrices	154
Transposing Matrices	156
Rotating Matrices in Real Time	160
Creating 3D Shapes	161
Creating the Rotation Matrix	162
Solving Systems of Equations with Matrices	166
Gaussian Elimination	167
Writing the gauss() Function	168
Summary	172

PART 3: BLAZING YOUR OWN TRAIL

9 BUILDING OBJECTS WITH CLASSES 175

Bouncing Ball Program	177
Making the Ball Move	178
Making the Ball Bounce Off the Wall	179
Making Multiple Balls Without Classes	181
Creating Objects Using Classes	182
Grazing Sheep Program	186
Writing the Class for the Sheep	186
Programming Sheep to Move Around	187
Creating the energy Property	189
Creating Grass Using Classes	189
Making the Grass Brown when Eaten	192
Giving Each Sheep a Random Color	194
Programming Sheep to Reproduce	196
Letting the Grass Regrow	197
Providing an Evolutionary Advantage	198
Summary	200

10 CREATING FRACTALS USING RECURSION 201

The Length of a Coastline	202
What Is Recursion?	203
Writing the factorial() Function	203
Building a Fractal Tree	204
Koch Snowflake	209
Writing the segment() Function	210
Sierpinski Triangle	214
Square Fractal	216
Dragon Curve	220
Summary	224

11 CELLULAR AUTOMATA 225

Creating a Cellular Automaton	226
Writing a Cell Class	228
Resizing Each Cell	230
Making a CA Grow	231
Putting the Cells into a Matrix	232
Creating the Cell List	233
Python Lists Are Strange	234
List Index Notation	235
Letting Your CA Grow Automatically	238
Playing the Game of Life	238
The Elementary Cellular Automaton	241
Summary	246

12 SOLVING PROBLEMS USING GENETIC ALGORITHMS 247

Using a Genetic Algorithm to Guess Phrases 248
 Writing the makeList() Function 248
 Testing the makeList() Function 249
 Writing the score() Function 250
 Writing the mutate() Function 250
 Generating a Random Number 251
Solving the Traveling Salesperson Problem (TSP) 254
 Using Genetic Algorithms 254
 Writing the calcLength() Method 260
 Testing the calcLength() Method 261
 Random Routes 262
 Applying the Phrase-Guessing Mutation Idea 265
 Mutating Two Numbers in a List 265
 Crossing Over to Improve Routes 269
Summary 271

INDEX 273