CONTENTS

	PREFACE	xiii
1	INTRODUCTION	1
	Data Analysis	1
	What's in This Book	2
	What's with the Workshops?	3
	What's with the Math?	4
	What You'll Need	5
	What's Missing	6
PA	ART I Graphics: Looking at Data	
2	A SINGLE VARIABLE: SHAPE AND DISTRIBUTION	11
	Dot and Jitter Plots	12
	Histograms and Kernel Density Estimates	14
	The Cumulative Distribution Function	23
	Rank-Order Plots and Lift Charts	30
	Only When Appropriate: Summary Statistics and Box Plots	33
	Workshop: NumPy	38
	Further Reading	45
3	TWO VARIABLES: ESTABLISHING RELATIONSHIPS	47
	Scatter Plots	47
	Conquering Noise: Smoothing	48
	Logarithmic Plots	57
	Banking	61
	Linear Regression and All That	62
	Showing What's Important	66
	Graphical Analysis and Presentation Graphics	68
	Workshop: matplotlib	69
	Further Reading	78
4	TIME AS A VARIABLE: TIME-SERIES ANALYSIS	79
	Examples	79
	The Task	83
	Smoothing	84
	Don't Overlook the Obvious!	90
	The Correlation Function	91

	Optional: Filters and Convolutions	95
	Workshop: scipy.signal	96
	Further Reading	98
5	MORE THAN TWO VARIABLES: GRAPHICAL MULTIVARIATE A	NALYSIS 99
	False-Color Plots	100
	A Lot at a Glance: Multiplots	105
	Composition Problems	110
	Novel Plot Types	116
	Interactive Explorations	120
	Workshop: Tools for Multivariate Graphics	123
	Further Reading	125
6	INTERMEZZO: A DATA ANALYSIS SESSION	127
	A Data Analysis Session	127
	Workshop: gnuplot	136
	Further Reading	138
PA	ART II Analytics: Modeling Data	
7	GUESSTIMATION AND THE BACK OF THE ENVELOPE	141
	Principles of Guesstimation	142
	How Good Are Those Numbers?	151
	Optional: A Closer Look at Perturbation Theory and	
	Error Propagation	155
	Workshop: The Gnu Scientific Library (GSL)	158
	Further Reading	161
8	MODELS FROM SCALING ARGUMENTS	163
	Models	163
	Arguments from Scale	165
	Mean-Field Approximations	175
	Common Time-Evolution Scenarios	178
	Case Study: How Many Servers Are Best?	182
	Why Modeling?	184
	Workshop: Sage	184
	Further Reading	188
9	ARGUMENTS FROM PROBABILITY MODELS	191
	The Binomial Distribution and Bernoulli Trials	191
	The Gaussian Distribution and the Central Limit Theorem	195
	Power-Law Distributions and Non-Normal Statistics	201
	Other Distributions	206
	Optional: Case StudyUnique Visitors over Time	211
	Workshop: Power-Law Distributions	215
	Further Reading	218

10	WHAT YOU REALLY NEED TO KNOW ABOUT CLASSICAL STATISTICS	221
	Genesis	221
	Statistics Defined	223
	Statistics Explained	226
	Controlled Experiments Versus Observational Studies	230
	Optional: Bayesian Statistics—The Other Point of View	235
	•	
	Workshop: R	243
	Further Reading	249
11	INTERMEZZO: MYTHBUSTING—BIGFOOT, LEAST SQUARES,	
	AND ALL THAT	253
	How to Average Averages	253
	The Standard Deviation	256
	Least Squares	260
	Further Reading	264
	BW 111 A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
PA	RT III Computation: Mining Data	
12	SIMULATIONS	267
	A Warm-Up Question	267
	Monte Carlo Simulations	270
	Resampling Methods	276
	Workshop: Discrete Event Simulations with SimPy	280
	Further Reading	291
13	FINDING CLUSTERS	293
	What Constitutes a Cluster?	293
	Distance and Similarity Measures	298
	Clustering Methods	304
	Pre- and Postprocessing	311
	Other Thoughts	314
	A Special Case: Market Basket Analysis	316
	A Word of Warning	319
	Workshop: Pycluster and the C Clustering Library	320
	Further Reading	324
	Turmer neading	327
14	SEEING THE FOREST FOR THE TREES: FINDING	
	IMPORTANT ATTRIBUTES	327
	Principal Component Analysis	328
	Visual Techniques	337
	Kohonen Maps	339
	Workshop: PCA with R	342
	Further Reading	348
15	INTERMEZZO: WHEN MORE IS DIFFERENT	351
	A Horror Story	353
	······································	-50

	Some Suggestions	354
	What About Map/Reduce?	<i>356</i>
	Workshop: Generating Permutations	357
	Further Reading	358
PA	RT IV Applications: Using Data	
16	REPORTING, BUSINESS INTELLIGENCE, AND DASHBOARDS	361
	Business Intelligence	362
	Corporate Metrics and Dashboards	369
	Data Quality Issues	373
	Workshop: Berkeley DB and SQLite	376
	Further Reading	381
17	FINANCIAL CALCULATIONS AND MODELING	383
	The Time Value of Money	384
	Uncertainty in Planning and Opportunity Costs	391
	Cost Concepts and Depreciation	394
	Should You Care?	398
	Is This All That Matters?	399
	Workshop: The Newsvendor Problem	400
	Further Reading	403
18	PREDICTIVE ANALYTICS	405
	Introduction	405
	Some Classification Terminology	407
	Algorithms for Classification	408
	The Process	419
	The Secret Sauce	423
	The Nature of Statistical Learning	424
	Workshop: Two Do-It-Yourself Classifiers	426
	Further Reading	431
19	EPILOGUE: FACTS ARE NOT REALITY	433
A	PROGRAMMING ENVIRONMENTS FOR SCIENTIFIC COMPUTATION	
	AND DATA ANALYSIS	435
	Software Tools	435
	A Catalog of Scientific Software	437
	Writing Your Own	443
	Further Reading	444
В	RESULTS FROM CALCULUS	447
	Common Functions	448
	Calculus	460
	Useful Tricks	468

	Notation and Basic Math	472
	Where to Go from Here	479
	Further Reading	481
c	WORKING WITH DATA	485
	Sources for Data	485
	Cleaning and Conditioning	487
	Sampling	489
	Data File Formats	490
	The Care and Feeding of Your Data Zoo	492
	Skills	493
	Terminology	495
	Further Reading	497
	INDEX	#OC