

BUSINESS ANALYTICS

COMMUNICATING WITH NUMBERS

Mc Graw Hill Sanjiv Jaggia Kevin Lertwachara Alison Kelly Leida Chen

For Sale in India, Pakistan, Nepal, Bangladesh, Sri Lanka and Bhutan only

C	HAPTER 1 NTRODUCTION TO BUSINESS	3.3	Other Data Visualization Methods A Scatterplot with a Categorical Variable 86 A Bubble Plot 89 A Heat Map 90 Options for Advanced Visualizations 93		
A	NALYTICS 2	3.4	Writing with Big Data 94		
1.	Analytics 4		endix 3.1: Getting Started with Tableau 96		
1.	Types of Data 8	СНА	PTER 4		
	Primary and Secondary Data 9 Cross-Sectional and Time Series Data 9 Structured and Unstructured Data 10 Big Data 12	PROBABILITY AND PROBABILITY DISTRIBUTIONS 104			
1.3	Variables and Scales of Measurement 15 The Measurement Scales 16	4.1	Probability Concepts and Probability Rules 106 Events 106		
1.4	Data Sources and File Formats 20 Fixed-Width Format 21 Delimited Format 21		Assigning Probabilities 108 Rules of Probability 108		
1.5	eXtensible Markup Language 22 HyperText Markup Language 22 JavaScript Object Notation 23 Writing with Big Data 25	4.2	The total Probability Rule, Bayes' Theorem, and Extensions 114 The Total Probability Rule 114 The Bayes' Theorem 114		
			Extensions of the Total Probability Rule and Bayes' Theorem 116		
	MMARY MEASURES 28	4.3	Random Variables and Discrete Probability Distributions 119		
2.1	Measures of Location 31		The Discrete Probability Distribution 120 Summary Measures of a Discrete Random Variable		
2.2	Measures of Central Location 31 Other Measures of Location 36 Measures of Dispersion, Shape,	4.4	The Binomial and the Poisson Distributions 122 The Binomial Distribution 122		
	and Association 38 Measures of Dispersion 38	4.5	The Normal Distribution 125		
2.2	Measures of Shape 42 Measures of Association 43	4.6	The Normal Distribution 129 Writing with Data 134		
2.3	Detecting Outliers 47 Writing with Big Data 54				
	William Dig Data 54		HAPTER 5		
CHA	PTED 0	STA	TISTICAL INFERENCE 138		
	PTER 3	5.1	Sampling Distributions 140		
	A VISUALIZATION 58		The Sampling Distribution of the Sample Mean 140		
3.1	Methods to Visualize a Single Variable 60		The Sampling Distribution of the Sample Proportion 144		
	Methods to Visualize a Categorical Variable 60 Methods to Visualize a Numerical Variable 64 A Line Chart 69 Cautionary Comments When Constructing or Interpreting Charts or Graphs 71	5.2	Estimation 147 Confidence Interval for the Population Mean μ 149 Confidence Interval for the Population Proportion p 152		
.2	Methods to Visualize the Relationship between Two Variables 76 Methods to Visualize the Relationship between Two Categorical Variables 76 A Method to Visualize the Relationship	5.3	Hypothesis Testing 155 Hypothesis Test for the Population Mean # 158		
		5,4	More Hypothesis Tests 167 Hypothesis Test for the Population Proportion p 164 Hypothesis Test for the Population Proportion p 164		
	Two Numerical Variables 82	5.5	Hypothesis Test for μ_D 171 Writing with Data 177		

CHAPTER 6

DE	CD	ECC	ION	ANIA	IYSIS	100
RF	Lak	-33	IUJIVI	ANA		180

6.1	The Linear Regression Model 182	
	The Components of the Linear Regressio	n
	Model 182	
	Estimating the Linear Regression Model	185
	Interval Estimates for the Response	
	Variable 189	
	Categorical Variables with Multiple	
	Categories 192	

- 6.2 Model Selection 197
 Goodness-of-Fit Measures 197
 Tests of Significance 201
 Reporting Regression Results 207
- 6.3 Model Assumptions and Common Violations 213
 Residual Plots 213
- 6.4 Writing with Big Data 225

CHAPTER 7

MORE TOPICS IN REGRESSION ANALYSIS 228

- 7.1 Regression Models with
 Interaction Variables 230
 The Interaction of Two Dummy Variables 230
 The Interaction of a Dummy Variable and a
 Numerical Variable 232
 The Interaction of Two Numerical Variables 234
- 7.2 Regression Models for Nonlinear
 Relationships 241
 The Quadratic Regression Model 241
 Regression Models with Logarithms 244
 Comparing Linear and Log-Transformed
 Regression Models 251
- 7.3 Cross-Validation Methods 255
 The Holdout Method 256
 The k-Fold Cross-Validation Method 259
- 7.4 Writing with Big Data 262

 Appendix 7.1: The Caret Package in R for the k-fold Cross-Validation Method 265

CHAPTER 8

LOGISTIC REGRESSION 268

- 8.1 The Linear Probability Model and The Logistic Regression Model 270
 The Linear Probability Model 270
 The Logistic Regression Model 271
- 8.2 Odds and Accuracy Rate 277
 The Odds of an Event 279
 Accuracy of Binary Choice Models 281
 Other Performance Measures and Imbalanced Data 283
- 8.3 Cross-Validation of Binary Choice Models 285
 The Holdout Cross-Validation Method 285
 The k-Fold Cross-Validation Method 289
- 8.4 Writing with Big Data 293

Appendix 8.1: The Caret Package in R for the k-fold Cross-Validation Method 295

CHAPTER 9

FORECASTING WITH TIME SERIES DATA 298

9.1	The Forecasting Process for
	Time Series 300
	Forecasting Methods 301
	Model Selection Criteria 301

- 9.2 Simple Smoothing Techniques 302
 The Moving Average Technique 303
 The Simple Exponential Smoothing Technique 305
- 9.3 Linear Regression Models for Trend and Seasonality 309
 The Linear Trend Model 309
 The Linear Trend Model with Seasonality 311
 A Note on Causal Models for Forecasting 313
- 9.4 Nonlinear Regression Models for Trend and Seasonality 315
 The Exponential Trend Model 315
 The Polynomial Trend Model 318
 Nonlinear Trend Models with Seasonality 319
- 9.5 Data Partitioning and Model Selection 323
- 9.6 Advanced Exponential Smoothing
 Methods 328
 The Holt Exponential Smoothing Method 328
 The Holt-Winters Exponential Smoothing
 Method 331
- 9.7 Writing with Data 334

CHAPTER 10

INTRODUCTION TO DATA MINING 338

- 10.1 Data Mining Overview 340
 The Data Mining Process 340
 Supervised and Unsupervised Data Mining 342
- 10.2 Similarity Measures 344
 Similarity Measures for Numerical Variables 345
 Similarity Measures for Categorical Variables 349
- 10.3 Performance Evaluation 353

 Data Partitioning 353

 Performance Measures for Classification Models 356

 Selecting Cutoff Values 359

 Performance Charts for Classification Models 361

 Performance Evaluation for Prediction Models 367
- 10.4 Principal Component Analysis 372
- 10.5 Writing with Big Data 383

CHAPTER 11

SUPERVISED DATA MINING: k-NEAREST NEIGHBORS AND NAÏVE BAYES 386

- 11.1 Introduction to Supervised Data Mining 388
 Comparison of Supervised Data Mining
 Techniques 389
- 11.2 The k-Nearest Neighbors Method 390
- **11.3** The Naïve Bayes Method 409
 Transforming Numerical into Categorical Values 418
- 11.4 Writing with Big Data 424

CHAPTER 12

SUPERVISED DATA MINING: DECISION TREES 428

- Introduction to Classification and Regression Trees (CART) 430 Classification and Regression Trees (CART) 430
- Classification Trees 433 Developing Classification Tree Models 433 12.2
- 12.3 Regression Trees 458 Developing Regression Tree Models 459
- Ensemble Tree Models 472 12.4
- 12.5 Writing with Big Data 488

CHAPTER 13

UNSUPERVISED DATA MINING 492

- 13.1 Hierarchical Cluster Analysis 494 An Overview of Cluster Analysis 494 Agglomerative Clustering 496 Agglomerative Clustering with Mixed Data 504
- 13.2 k-Means Cluster Analysis 510
- 13.3 Association Rule Analysis 519
- 13.4 Writing with Big Data 531

CHAPTER 14

SPREADSHEET MODELING 536

- Spreadsheet Modeling 538 Developing a Spreadsheet Model 539
- 14.2 Spreadsheet Engineering and an Influence Diagram 543
- 14.3 What-If Analysis 551 A Data Table 551 Goal Seek 554 Scenario Manager 555
- **Avoiding and Detecting Errors in** Spreadsheet Models 560 Common Spreadsheet Model Errors 560 Model Auditing 563
- 14.5 Writing with Data 567

CHAPTER 15

RISK ANALYSIS AND SIMULATION 572

- 15.1 Overview of Prescriptive Analytics 574
- Risk and Risk Analysis 574 Conducting Risk Analysis 575 Using Random Variables to Model Risk and Uncertainty 578

CHAPTER 16

15.3

15.4

OPTIMIZATION: LINEAR **PROGRAMMING**

Monte Carlo Simulation

Writing with Data 601

- **Maximization Problems In Linear** 16.1 Programming 606 Formulating a Maximization Problem 606 Solving a Maximization Problem 608
- Minimization Problems in Linear 16.2 Programming 622
- Special Cases in Linear Programming 16.3 Multiple Optimal Solutions 628 Infeasibility 629 Unboundedness 629
- Writing with Data 630 16.4

CHAPTER 17

MORE APPLICATIONS IN **OPTIMIZATION**

- Optimization with Integer Programming 636 17.1
- 17.2 Other Applications of Linear and Integer Programming 642 Capital Budgeting 642 Transportation Problems Assignment Problems 649 Workforce Scheduling 652 Facility Locations 656
- **Optimization with Nonlinear** 17.3 Programming 663
- 17.4 Writing with Data 670

APPENDIXES

- APPENDIX Data Management and Wrangling 674
- **APPENDIX** Big Data Sets: Variable Description B and Data Dictionary 721
- APPENDIX C Getting Started with Excel and Excel Add-Ins 728
- APPENDIX D Getting Started with R 733
- **APPENDIX** E Answers to Selected Exercises 741

Index 763