



Fifth Edition  
**Practical Business Statistics**

Andrew F. Siegel



# | C O N T E N T S |

## *P*ART I INTRODUCTION AND DESCRIPTIVE STATISTICS 1

### **CHAPTER 1** INTRODUCTION: DEFINING THE ROLE OF STATISTICS IN BUSINESS 2

- 1.1 WHY STATISTICS? 2
  - Why Should You Learn Statistics?
  - Is Statistics Difficult?
  - Does Learning Statistics Decrease Your Decision-Making Flexibility?
- 1.2 WHAT IS STATISTICS? 3
  - Statistics Looks at the Big Picture
  - Statistics Doesn't Ignore the Individual
  - EXAMPLE Data in Management 4
    - Looking at Data
    - Statistics in Management
- 1.3 THE FIVE BASIC ACTIVITIES OF STATISTICS 5
  - Designing a Plan for Data Collection
  - Exploring the Data
  - Modeling the Data
  - Estimating an Unknown Quantity
  - Hypothesis Testing
  - EXAMPLE Statistical Quality Control 9
  - EXAMPLE A New Product Launch 10
- 1.4 DATA MINING 11
  - EXAMPLE Mining U.S. Neighborhood Data for Potential Customers 13
  - EXAMPLE Mining Data to Identify People Who Will Donate to a Good Cause 15
- 1.5 WHAT IS PROBABILITY? 18
- 1.6 GENERAL ADVICE 18
- 1.7 END-OF-CHAPTER MATERIALS 19

### **CHAPTER 2** DATA STRUCTURES: CLASSIFYING THE VARIOUS TYPES OF DATA SETS 23

- 2.1 HOW MANY VARIABLES? 23
  - Univariate Data
  - Bivariate Data
  - Multivariate Data
- 2.2 QUANTITATIVE DATA: NUMBERS 27
  - Discrete Quantitative Data
  - Continuous Quantitative Data
  - Watch Out for Meaningless Numbers
  - EXAMPLE Alphabetical Order of States 28

2.3	QUALITATIVE DATA: CATEGORIES	28
	Ordinal Qualitative Data	
	Nominal Qualitative Data	
2.4	TIME-SERIES AND CROSS-SECTIONAL DATA	30
	EXAMPLE The Stock Market	30
2.5	SOURCES OF DATA, INCLUDING THE INTERNET	31
	EXAMPLE Searching the Internet for Government Data on Consumer Prices	32
	EXAMPLE Finding Home Depot Stock Market Data on Yahoo!	39
2.6	END-OF-CHAPTER MATERIALS	46
<b>CHAPTER 3</b>	<b>HISTOGRAMS: LOOKING AT THE DISTRIBUTION OF DATA</b>	<b>54</b>
3.1	A LIST OF DATA	55
	EXAMPLE Performance of Regional Sales Managers	55
	EXAMPLE Household Size	55
	The Number Line	
3.2	USING A HISTOGRAM TO DISPLAY THE FREQUENCIES	57
	EXAMPLE Mortgage Interest Rates	57
	Histograms and Bar Charts	
	EXAMPLE Starting Salaries for USC MBA Graduates	61
3.3	NORMAL DISTRIBUTIONS	62
3.4	SKewed DISTRIBUTIONS AND DATA TRANSFORMATION	64
	EXAMPLE Assets of Commercial Banks	64
	EXAMPLE Populations of States	67
	The Trouble with Skewness	
	Transformation to the Rescue	
	EXAMPLE Transforming State Populations	68
	Interpreting and Computing the Logarithm	
3.5	BIMODAL DISTRIBUTIONS	70
	EXAMPLE Money Market Yields	71
	Is It Really Bimodal?	
	EXAMPLE Rates of Computer Ownership	72
3.6	OUTLIERS	74
	Dealing with Outliers	
	EXAMPLE Did Net Earnings Increase or Decrease?	75
	EXAMPLE Changes in Television Advertising	75
3.7	DATA MINING WITH HISTOGRAMS	78
3.8	HISTOGRAMS BY HAND: STEM-AND-LEAF	80
	EXAMPLE Employees in Food Services	81
3.9	END-OF-CHAPTER MATERIALS	83
	CASE Let's Control Waste in Production	95
<b>CHAPTER 4</b>	<b>LANDMARK SUMMARIES: INTERPRETING TYPICAL VALUES AND PERCENTILES</b>	<b>97</b>
4.1	WHAT IS THE MOST TYPICAL VALUE?	98
	The Average: A Typical Value for Quantitative Data	
	EXAMPLE How Much Will Consumers Spend?	100
	EXAMPLE How Many Defective Parts?	101
	The Weighted Average: Adjusting for Importance	
	EXAMPLE Your Grade Point Average	103

	EXAMPLE	The Firm's Cost of Capital	104
	EXAMPLE	Adjusting for Misrepresentation	105
		<b>The Median: A Typical Value for Quantitative and Ordinal Data</b>	
	EXAMPLE	The Crash of October 19, 1987: Stocks Drop at Opening	108
	EXAMPLE	Personal Incomes	110
	EXAMPLE	Stages of Completion of Inventory	111
		<b>The Mode: A Typical Value Even for Nominal Data</b>	
	EXAMPLE	Voting	113
	EXAMPLE	Quality Control: Controlling Variation in Manufacturing	113
	EXAMPLE	Inventory Completion Stages Revisited	114
		<b>Which Summary Should You Use?</b>	
4.2		<b>WHAT PERCENTILE IS IT?</b>	116
		<b>Extremes, Quartiles, and Box Plots</b>	
	EXAMPLE	Executive Compensation	119
	EXAMPLE	Data Mining the Donations Database	122
		<b>The Cumulative Distribution Function Displays the Percentiles</b>	
	EXAMPLE	Business Failures	124
4.3		<b>END-OF-CHAPTER MATERIALS</b>	126
	CASE	Managerial Projections for Production and Marketing, or "The Case of the Suspicious Customer"	141
<b>CHAPTER 5</b>		<b>VARIABILITY: DEALING WITH DIVERSITY</b>	<b>144</b>
5.1		<b>THE STANDARD DEVIATION: THE TRADITIONAL CHOICE</b>	145
		<b>Definition and Formula for the Standard Deviation and the Variance</b>	
		<b>Using a Calculator or a Computer</b>	
		<b>Interpreting the Standard Deviation</b>	
	EXAMPLE	The Advertising Budget	149
	EXAMPLE	Customer Diversity	151
		<b>Interpreting the Standard Deviation for a Normal Distribution</b>	
	EXAMPLE	A Quality Control Chart for Picture-Scanning Quality	152
	EXAMPLE	Stock Market Returns Vary from Day to Day	153
	EXAMPLE	The Stock Market Crash of 1987: 19 Standard Deviations!	157
	EXAMPLE	Market Volatility before and after the Crash	158
	EXAMPLE	Diversification in the Stock Market	159
	EXAMPLE	Data Mining to Understand Variability in the Donations Database	160
		<b>The Sample and the Population Standard Deviations</b>	
5.2		<b>THE RANGE: QUICK AND SUPERFICIAL</b>	162
	EXAMPLE	Employee Salaries	163
	EXAMPLE	Duration of Hospital Stays	164
5.3		<b>THE COEFFICIENT OF VARIATION: A RELATIVE VARIABILITY MEASURE</b>	165
	EXAMPLE	Uncertainty in Portfolio Performance	166
	EXAMPLE	Employee Productivity in Telemarketing	166

- 5.4 EFFECTS OF ADDING TO OR RESCALING THE DATA 167  
 EXAMPLE Uncertainty of Costs in Japanese Yen  
 and in U.S. Dollars 168  
 EXAMPLE Total Cost and Units Produced 168  
 5.5 END-OF-CHAPTER MATERIALS 169  
 CASE Should We Keep or Get Rid of This Supplier? 184

## PART II

### PROBABILITY 187

#### CHAPTER 6 PROBABILITY: UNDERSTANDING RANDOM SITUATIONS 188

- 6.1 AN EXAMPLE: IS IT BEHIND DOOR NUMBER 1, DOOR NUMBER 2,  
 OR DOOR NUMBER 3? 190  
 6.2 HOW CAN YOU ANALYZE UNCERTAINTY? 191  
 The Random Experiment: A *Precise* Definition  
 of a Random Situation  
 The Sample Space: A List of What *Might* Happen  
 The Outcome: What Actually Happens  
 Events: Either They Happen or They Don't  
 6.3 HOW LIKELY IS AN EVENT? 195  
 Every Event Has a Probability  
 Where Do Probabilities Come From?  
 Relative Frequency and the Law of Large Numbers  
 EXAMPLE How Variable Is Today's Extra-High-Quality  
 Production? 198  
 Theoretical Probability  
 The *Equally Likely* Rule  
 EXAMPLE Coin Tossing and Cards 199  
 EXAMPLE Gender and Hiring 199  
 EXAMPLE Defective Raw Materials 199  
 Subjective Probability  
 EXAMPLE Settling a Lawsuit 200  
 Bayesian and Non-Bayesian Analysis  
 6.4 HOW CAN YOU COMBINE INFORMATION ABOUT MORE THAN  
 ONE EVENT? 201  
 Venn Diagrams Help You See All the Possibilities  
*Not* an Event  
 The Complement (*not*) Rule  
 One Event *and* Another  
 What if Both Events Can't Happen at Once?  
 The Intersection (*and*) Rule for Mutually Exclusive Events  
 One Event *or* Another  
 The Union (*or*) Rule for Mutually Exclusive Events  
 Finding *or* from *and* and Vice Versa  
 One Event *Given* Another: Reflecting Current Information  
 The Rule for Finding a Conditional Probability  
 Given Certain Information  
 Conditional Probabilities for Mutually Exclusive Events  
 Independent Events  
 EXAMPLE Women in Executive Positions 210  
 EXAMPLE Market Efficiency 211

	The Intersection ( <i>and</i> ) Rule for Independent Events	
	EXAMPLE Risk Assessment for a Large Power Plant	211
	The Relationship between Independent and Mutually Exclusive Events	
6.5	WHAT'S THE BEST WAY TO SOLVE PROBABILITY PROBLEMS?	212
	Probability Trees	
	EXAMPLE Managing Software Support	212
	Rules for Probability Trees	
	EXAMPLE Drug Testing of Employees	214
	EXAMPLE A Pilot Project Helps Predict Success of a Product Launch	218
	EXAMPLE Solution to "Is It behind Door Number 1, 2, or 3?"	220
	Joint Probability Tables	
6.6	END-OF-CHAPTER MATERIALS	221
	CASE Whodunit? Who, If Anyone, Is Responsible for the Recent Rise in the Defect Rate?	234
<b>CHAPTER 7</b>	<b>RANDOM VARIABLES: WORKING WITH UNCERTAIN NUMBERS</b>	<b>236</b>
7.1	DISCRETE RANDOM VARIABLES	237
	EXAMPLE Profit under Various Economic Scenarios	238
	Finding the Mean and Standard Deviation	
	EXAMPLE Evaluating Risk and Return	240
7.2	THE BINOMIAL DISTRIBUTION	242
	Definition of Binomial Distribution and Proportion	
	EXAMPLE How Many Orders Are Placed? The Hard Way to Compute.	243
	Finding the Mean and Standard Deviation the Easy Way	
	EXAMPLE Recalling Advertisements	246
	Finding the Probabilities	
	EXAMPLE How Many Major Customers Will Call Tomorrow?	249
	EXAMPLE How Many Logic Analyzers to Schedule for Manufacturing?	250
7.3	THE NORMAL DISTRIBUTION	252
	Visualize Probabilities as the Area under the Curve	
	The Standard Normal Distribution $Z$ and Its Probabilities	
	Solving Word Problems for Normal Probabilities	
	The Four Different Probability Calculations	
	Be Careful: Things Need Not Be Normal!	
	EXAMPLE A Lottery (or Risky Project)	261
7.4	THE NORMAL APPROXIMATION TO THE BINOMIAL	261
	EXAMPLE High- and Low-Speed Microprocessors	264
	EXAMPLE Polling the Electorate	265
7.5	TWO OTHER DISTRIBUTIONS: THE POISSON AND THE EXPONENTIAL	266
	The Poisson Distribution	
	EXAMPLE How Many Warranty Returns?	268
	EXAMPLE How Many Phone Calls?	269
	The Exponential Distribution	
	EXAMPLE Customer Arrivals	271
7.6	END-OF-CHAPTER MATERIALS	271
	CASE The Option Value of an Oil Lease	283

## *P*ART III STATISTICAL INFERENCE **285**

- CHAPTER 8** RANDOM SAMPLING: PLANNING AHEAD FOR DATA GATHERING **286**
- 8.1 POPULATIONS AND SAMPLES 287  
 What Is a Representative Sample?  
 A Sample Statistic and a Population Parameter
- 8.2 THE RANDOM SAMPLE 291  
 Selecting a Random Sample  
 Sampling by Shuffling the Population  
 EXAMPLE Auditing 294  
 EXAMPLE A Pilot Study of Large Paper and Forest Products Firms 295
- 8.3 THE SAMPLING DISTRIBUTION AND THE CENTRAL LIMIT THEOREM 296  
 EXAMPLE How Much Do Shoppers Spend? 300  
 EXAMPLE Consistency in Bubble Gum Production 301
- 8.4 A STANDARD ERROR IS AN *ESTIMATED* STANDARD DEVIATION 302  
 How Close Is the Sample Average to the Population Mean?  
 EXAMPLE Shopping Trips 304  
 Correcting for Small Populations  
 EXAMPLE Quality of the Day's Production 307  
 The Standard Error of the Binomial Proportion  
 EXAMPLE A Consumer Survey 309
- 8.5 OTHER SAMPLING METHODS 309  
 The Stratified Random Sample  
 EXAMPLE Adjusting for Sophistication of the Consumer 311  
 EXAMPLE The Price of a Typical Suit in a Department Store 313  
 The Systematic Sample
- 8.6 END-OF-CHAPTER MATERIALS 316  
 CASE Can This Survey Be Saved? 329
- CHAPTER 9** CONFIDENCE INTERVALS: ADMITTING THAT ESTIMATES ARE NOT EXACT **331**
- 9.1 THE CONFIDENCE INTERVAL FOR A POPULATION MEAN OR A POPULATION PERCENTAGE 333  
 The *t* Table and the *t* Distribution  
 The Widely Used 95% Confidence Interval  
 EXAMPLE Controlling the Average Thickness of Paper 339  
 EXAMPLE Internet Usage Polling (a Binomial Situation) 341  
 Other Confidence Levels  
 EXAMPLE Average Selling Price as Determined through Rebates 344  
 EXAMPLE Yield of a Manufacturing Process 346
- 9.2 ASSUMPTIONS NEEDED FOR VALIDITY 347  
 Random Sampling  
 EXAMPLE Forecasting Interest Rates 348  
 Normal Distribution  
 EXAMPLE Data Mining to Understand the Average Donation Amount 351

- 9.3 INTERPRETING A CONFIDENCE INTERVAL 353
  - Which Event Has a 95% Probability?
  - Your Lifetime Track Record
- 9.4 ONE-SIDED CONFIDENCE INTERVALS 354
  - Be Careful! You Can't Always Use a One-Sided Interval
  - Computing the One-Sided Interval
  - EXAMPLE The Savings of a New System 356
  - EXAMPLE Travel Costs 357
- 9.5 PREDICTION INTERVALS 357
  - EXAMPLE How Long until Your Order Is Filled? 359
- 9.6 END-OF-CHAPTER MATERIALS 360
  - CASE Promising Results from a Specialty Catalog Survey 373

**CHAPTER 10****HYPOTHESIS TESTING: DECIDING BETWEEN REALITY AND COINCIDENCE 374**

- 10.1 HYPOTHESES ARE NOT CREATED EQUAL! 375
  - The Null Hypothesis
  - The Research Hypothesis
  - What Will the Result Tell You?
  - Examples of Hypotheses
- 10.2 TESTING THE POPULATION MEAN AGAINST A KNOWN REFERENCE VALUE 378
  - Using Confidence Intervals: The Easy Way
  - EXAMPLE Does the "Yield-Increasing" Additive Really Work? 380
  - EXAMPLE Should Your Company Sponsor the Olympics? 382
  - EXAMPLE Pushing the Limits of Production (a Binomial Situation) 384
  - The  $t$  Statistic: Another Way, Same Answer
- 10.3 INTERPRETING A HYPOTHESIS TEST 388
  - Errors: Type I and Type II
  - Assumptions Needed for Validity
  - Hypotheses Have No Probabilities of Being True or False
  - Statistical Significance and Test Levels
  - $p$ -Values
- 10.4 ONE-SIDED TESTING 394
  - EXAMPLE Launching a New Product 396
  - How to Perform the Test
  - EXAMPLE Launching a New Product, Revisited 398
  - EXAMPLE Will Costs Go Down? 399
  - EXAMPLE Can You Create Value by Changing Your Firm's Name? 401
- 10.5 TESTING WHETHER OR NOT A NEW OBSERVATION COMES FROM THE SAME POPULATION 402
  - EXAMPLE Is This System under Control? 403
- 10.6 TESTING TWO SAMPLES 404
  - The Paired  $t$  Test
  - EXAMPLE Reactions to Advertising 405
  - EXAMPLE Data Mining to Compare Current to Previous Donations 406
  - The Unpaired  $t$  Test



- EXAMPLE Gender Discrimination and Salaries 409  
 EXAMPLE Your Productivity versus Theirs 411  
 10.7 END-OF-CHAPTER MATERIALS 412  
 CASE So Many Ads, So Little Time 431

## **PART IV** REGRESSION AND TIME SERIES **433**

### **CHAPTER 11** CORRELATION AND REGRESSION: MEASURING AND PREDICTING RELATIONSHIPS **434**

- 11.1 EXPLORING RELATIONSHIPS USING SCATTERPLOTS AND CORRELATIONS 435  
 The Scatterplot Shows You the Relationship  
 Correlation Measures the Strength of the Relationship  
 The Formula for the Correlation  
 The Various Types of Relationships  
 EXAMPLE Measuring Internet Site Usage: Nielsen//NetRatings 440  
 EXAMPLE Mergers 442  
 EXAMPLE Mortgage Rates and Fees 443  
 No Relationship  
 EXAMPLE "Momentum" and the Stock Market 445  
 Nonlinear Relationship  
 EXAMPLE Index Options 448  
 EXAMPLE Yield and Temperature 449  
 Unequal Variability  
 EXAMPLE Optical Cable 451  
 Clustering  
 EXAMPLE Inflation-Indexed Bonds 453  
 Outliers  
 EXAMPLE Number Produced and Cost 455  
 Correlation Is Not Causation  
 EXAMPLE Food Store and Restaurant Spending 457  
 11.2 REGRESSION: PREDICTION OF ONE THING FROM ANOTHER 458  
 A Straight Line Summarizes a Linear Relationship  
 Straight Lines  
 Finding a Line Based on Data  
 EXAMPLE Fixed and Variable Costs 463  
 EXAMPLE Territory and Sales 466  
 How Useful Is the Line?  
 The Standard Error of Estimate: How Large Are the Prediction Errors?  
 $R^2$ : How Much Is Explained?  
 Confidence Intervals and Hypothesis Tests for Regression  
 The Linear Model Assumption Defines the Population  
 Standard Errors for the Slope and Intercept  
 Confidence Intervals for Regression Coefficients  
 EXAMPLE Variable Costs of Production 473  
 Testing whether the Relationship Is Real or Coincidence  
 Other Methods of Testing the Significance of a Relationship  
 Computer Output for the Production Cost Data

	EXAMPLE	Momentum in the Stock Market Revisited	475
	EXAMPLE	Mining the Donations Database to Predict Dollar Amounts	477
		Other Tests of a Regression Coefficient	
		A New Observation: Uncertainty and the Confidence Interval	
		The Mean of Y: Uncertainty and the Confidence Interval	
		Regression Can Be Misleading	
		The Linear Model May Be Wrong	
		Predicting Intervention from Observed Experience Is Difficult	
		The Intercept May Not Be Meaningful	
		Explaining Y from X versus Explaining X from Y	
		A Hidden "Third Factor" May Be Helpful	
11.3	END-OF-CHAPTER MATERIALS		489
	CASE	Just One More Production Step: Is It Worthwhile?	512
<b>CHAPTER 12</b>	<b>MULTIPLE REGRESSION: PREDICTING ONE FACTOR FROM SEVERAL OTHERS</b>		<b>514</b>
12.1	INTERPRETING THE RESULTS OF A MULTIPLE REGRESSION		516
	EXAMPLE	Magazine Ads	517
		Regression Coefficients and the Regression Equation	
		Interpreting the Regression Coefficients	
		Predictions and Prediction Errors	
		How Good Are the Predictions?	
		Typical Prediction Error: Standard Error of Estimate	
		Percent Variation Explained: $R^2$	
		Inference in Multiple Regression	
		Assumptions	
		Is the Model Significant? The $F$ Test or $R^2$ Test	
		Tables of Critical Values for Testing $R^2$	
		Which Variables Are Significant? A $t$ Test for Each Coefficient	
		Other Tests for a Regression Coefficient	
		Which Variables Are Explaining the Most?	
		Comparing the Standardized Regression Coefficients	
		Comparing the Correlation Coefficients	
12.2	PITFALLS AND PROBLEMS IN MULTIPLE REGRESSION		540
		Multicollinearity: Are the Explanatory Variables Too Similar?	
	EXAMPLE	Predicting Market Value from Assets and Employees	543
		Variable Selection: Are You Using the Wrong Variables?	
		Prioritizing the List of X Variables	
		Automating the Variable Selection Process	
		Model Misspecification: Does the Regression Equation Have the Wrong Form?	
		Exploring the Data to See Nonlinearity or Unequal Variability	
		Using the Diagnostic Plot to Decide if You Have a Problem	
		Using Percent Changes to Model an Economic Time Series	
	EXAMPLE	Predicting Dividends from Sales of Nondurable and Durable Goods	556
12.3	DEALING WITH NONLINEAR RELATIONSHIPS AND UNEQUAL VARIABILITY		557

	Transforming to a Linear Relationship: Interpreting the Results	
	EXAMPLE Magazine Ads Transformed and Interpreted	560
	Fitting a Curve with Polynomial Regression	
	EXAMPLE Optimizing the Yield of a Production Process	563
	Modeling Interaction between Two $X$ Variables	
	EXAMPLE Mining the Donations Database to Predict Dollar Amounts from Combinations of the Other Variables	567
12.4	INDICATOR VARIABLES: PREDICTING FROM CATEGORIES	570
	Interpreting and Testing Regression Coefficients for Indicator Variables	
	EXAMPLE Estimating the Impact of Gender on Salary after Adjusting for Experience	572
	Separate Regressions	
12.5	END-OF-CHAPTER MATERIALS	576
	CASE Controlling Quality of Production	595
<b>CHAPTER 13</b>	<b>REPORT WRITING: COMMUNICATING THE RESULTS OF A MULTIPLE REGRESSION</b>	<b>598</b>
13.1	HOW TO ORGANIZE YOUR REPORT	600
	The Executive Summary Paragraph	
	The Introduction Section	
	The Analysis and Methods Section	
	The Conclusion and Summary Section	
	Including References	
	The Appendix Section	
13.2	HINTS AND TIPS	604
	Think about Your Audience	
	What to Write First? Next? Last?	
	Other Sources	
13.3	EXAMPLE: A QUICK PRICING FORMULA FOR CUSTOMER INQUIRIES	605
13.4	END-OF-CHAPTER MATERIALS	612
<b>CHAPTER 14</b>	<b>TIME SERIES: UNDERSTANDING CHANGES OVER TIME</b>	<b>617</b>
14.1	AN OVERVIEW OF TIME-SERIES ANALYSIS	618
	EXAMPLE The Stock Market Is a Random Walk	619
	EXAMPLE Radio, TV, and Computer Store Sales Have Enjoyed Steady Growth	621
	EXAMPLE Total Retail Sales Show Growth and Seasonal Variation	623
	EXAMPLE Interest Rates	625
14.2	TREND-SEASONAL ANALYSIS	626
	EXAMPLE Ford Motor Company Automotive Sales	628
	Trend and Cyclic: The Moving Average	
	Seasonal Index: The Average Ratio-to-Moving-Average Indicates Seasonal Behavior	
	Seasonal Adjustment: The Series Divided by the Seasonal Index	
	Long-Term Trend and Seasonally Adjusted Forecast: The Regression Line	

- Forecast: The Seasonalized Trend
- 14.3 MODELING CYCLIC BEHAVIOR USING BOX-JENKINS ARIMA PROCESSES 638
- A Random Noise Process Has No Memory: The Starting Point
- An Autoregressive (AR) Process Remembers Where It Was
- A Moving-Average (MA) Process Has a Limited Memory
- The Autoregressive Moving-Average (ARMA) Process Combines AR and MA
- EXAMPLE Forecasting the Unemployment Rate Using an ARMA Process 645
- A Pure Integrated (I) Process Remembers Where It Was and Then Moves at Random
- The Autoregressive Integrated Moving-Average (ARIMA) Process Remembers Its Changes
- 14.4 END-OF-CHAPTER MATERIALS 651

## *P*ART V METHODS AND APPLICATIONS 667

- CHAPTER 15 ANOVA: TESTING FOR DIFFERENCES AMONG MANY SAMPLES, AND MUCH MORE 668**
- 15.1 USING BOX PLOTS TO LOOK AT MANY SAMPLES AT ONCE 669
- EXAMPLE Comparing the Quality of Your Suppliers' Products 670
- 15.2 THE *F* TEST TELLS YOU IF THE AVERAGES ARE SIGNIFICANTLY DIFFERENT 672
- The Data Set and Sources of Variation
- The Assumptions
- The Hypotheses
- The *F* Statistic
- The *F* Table
- The Result of the *F* Test
- Computer Output: The One-Way ANOVA Table
- 15.3 THE LEAST-SIGNIFICANT-DIFFERENCE TEST: WHICH PAIRS ARE DIFFERENT? 684
- 15.4 MORE ADVANCED ANOVA DESIGNS 687
- Variety Is the Spice of Life
- Two-Way ANOVA
- Three-Way and More
- Analysis of Covariance (ANCOVA)
- Multivariate Analysis of Variance (MANOVA)
- How to Read an ANOVA Table
- EXAMPLE The Effect of Price Changes and Product Type on Grocery Sales 690
- EXAMPLE Jokes in the Workplace 691
- 15.5 END-OF-CHAPTER MATERIALS 692
- CHAPTER 16 NONPARAMETRICS: TESTING WITH ORDINAL DATA OR NONNORMAL DISTRIBUTIONS 702**
- 16.1 TESTING THE MEDIAN AGAINST A KNOWN REFERENCE VALUE 704
- The Sign Test

	The Hypotheses	
	The Assumption	
	EXAMPLE Comparing Local to National Family Income	708
16.2	TESTING FOR DIFFERENCES IN PAIRED DATA	708
	Using the Sign Test on the Differences	
	The Hypotheses	
	The Assumption	
	EXAMPLE Rating Two Advertisements	710
16.3	TESTING TO SEE IF TWO UNPAIRED SAMPLES ARE SIGNIFICANTLY DIFFERENT	711
	The Procedure Is Based on the Ranks of All of the Data	
	The Hypotheses	
	The Assumptions	
	EXAMPLE Fixed-Rate and Adjustable-Rate Mortgage Applicants	713
16.4	END-OF-CHAPTER MATERIALS	716
<b>CHAPTER 17</b>	<b>CHI-SQUARED ANALYSIS: TESTING FOR PATTERNS IN QUALITATIVE DATA</b>	<b>726</b>
17.1	SUMMARIZING QUALITATIVE DATA BY USING COUNTS AND PERCENTAGES	727
17.2	TESTING IF POPULATION PERCENTAGES ARE EQUAL TO KNOWN REFERENCE VALUES	729
	The Chi-Squared Test for Equality of Percentages	
	EXAMPLE Quality Problems Categorized by Their Causes	732
17.3	TESTING FOR ASSOCIATION BETWEEN TWO QUALITATIVE VARIABLES	734
	The Meaning of Independence	
	The Chi-Squared Test for Independence	
	EXAMPLE Is Your Market Segmented?	736
17.4	END-OF-CHAPTER MATERIALS	741
<b>CHAPTER 18</b>	<b>QUALITY CONTROL: RECOGNIZING AND MANAGING VARIATION</b>	<b>751</b>
18.1	PROCESSES AND CAUSES OF VARIATION	754
	The Pareto Diagram Shows Where to Focus Attention	
18.2	CONTROL CHARTS AND HOW TO READ THEM	757
	The Control Limits Show if a Single Observation Is Out of Control	
	How to Spot Trouble Even within the Control Limits	
18.3	CHARTING A QUANTITATIVE MEASUREMENT WITH $\bar{X}$ AND $R$ CHARTS	760
	EXAMPLE Net Weight of Dishwasher Detergent	762
18.4	CHARTING THE PERCENT DEFECTIVE	766
	EXAMPLE Filling Out Purchase Orders	768
18.5	END-OF-CHAPTER MATERIALS	770
<b>APPENDIX A</b>	<b>EMPLOYEE DATABASE</b>	<b>781</b>
<b>APPENDIX B</b>	<b>DONATIONS DATABASE</b>	<b>783</b>
<b>APPENDIX C</b>	<b>SELF-TEST: SOLUTIONS TO SELECTED PROBLEMS AND DATABASE EXERCISES</b>	<b>787</b>

**APPENDIX D** STATISTICAL TABLES **801**

**APPENDIX E** STATPAD QUICK REFERENCE GUIDE **825**

GLOSSARY **831**

INDEX **843**