# Elementary Statistics A STEP BY STEP APPROACH

Tenth Edition



ALLAN G. BLUMAN **PROFESSOR EMERITUS COMMUNITY COLLEGE OF ALLEGHENY COUNTY** 

## CONTENTS

Preface ix

#### CHAPTER



## The Nature of Probability and Statistics 1

Introduction 2

- Descriptive and Inferential Statistics 3 1–1
- 1–2 Variables and Types of Data 6
- 1–3 Data Collection and Sampling Techniques 11 Random Sampling 12 Systematic Sampling 12 Stratified Sampling 13 Cluster Sampling 14

Other Sampling Methods 14

- Experimental Design 18 Observational and Experimental Studies 18 Uses and Misuses of Statistics 21
- 1-5 Computers and Calculators 26 Summary 33

## CHAPTER 2





## **Frequency Distributions** and Graphs 41

Introduction 42

- 2–1 Organizing Data 42 Categorical Frequency Distributions 43 Grouped Frequency Distributions 44
- 2-2 Histograms, Frequency Polygons, and Ogives 57

The Histogram 57

The Frequency Polygon 58

The Ogive 59

Relative Frequency Graphs 61

Distribution Shapes 63

2-3 Other Types of Graphs 74

Bar Graphs 75

Pareto Charts 77

The Time Series Graph 78

The Pie Graph 80

Dotplots 83

Stem and Leaf Plots 83

Misleading Graphs 86

Summary 100

#### APTER





### Data Description 109

Introduction 110

3–1 Measures of Central Tendency 111

The Mean 111

The Median 114

The Mode 116

The Midrange 118

The Weighted Mean 119

Distribution Shapes 121

3–2 Measures of Variation 127

Range 129

Population Variance and Standard Deviation 129

Sample Variance and Standard Deviation 132

Variance and Standard Deviation for Grouped

Data 135

Coefficient of Variation 137

Range Rule of Thumb 138

Chebyshev's Theorem 139

The Empirical (Normal) Rule 141

Linear Transformation of Data 142

Measures of Position 148 3-3

Standard Scores 148

All examples and exercises in this textbook (unless cited) are hypothetical and are presented to enable students to achieve a basic understanding of the statistical concepts explained. These examples and exercises should not be used in lieu of medical, psychological, or other professional advice. Neither the author nor the publisher shall be held responsible for any misuse of the information presented in this textbook.



Percentiles 149
Quartiles and Deciles 155
Outliers 157

**3–4** Exploratory Data Analysis *168 The Five-Number Summary and Boxplots 168*Summary 177

#### CHAPTER





# Probability and Counting Rules 185

Introduction 186

- 4–1 Sample Spaces and Probability 186
  Basic Concepts 186
  Classical Probability 189
  Complementary Events 192
  Empirical Probability 194
  Law of Large Numbers 196
  Subjective Probability 196
  Probability and Risk Taking 196
- **4–2** The Addition Rules for Probability *201*
- 4–3 The Multiplication Rules and Conditional Probability 213

  The Multiplication Rules 213

  Conditional Probability 217

  Probabilities for "At Least" 220
- **4–4** Counting Rules 226
  The Fundamental Counting Rule 227
  Factorial Notation 229
  Permutations 229
  Combinations 232
- **4–5** Probability and Counting Rules *242* Summary *246*

#### CHAPTER





# Discrete Probability Distributions 257

Introduction 258

- **5–1** Probability Distributions *258*
- **5–2** Mean, Variance, Standard Deviation, and Expectation *265 Mean 265*

Variance and Standard Deviation 267 Expectation 269

- **5–3** The Binomial Distribution *275*
- 5–4 Other Types of Distributions 289
  The Multinomial Distribution 289
  The Poisson Distribution 291
  The Hypergeometric Distribution 293
  The Geometric Distribution 295
  Summary 303

#### CHAPTER





## The Normal Distribution 311

Introduction 312

- 6–1 Normal Distributions 312
  The Standard Normal Distribution 315
  Finding Areas Under the Standard Normal
  Distribution Curve 316
  A Normal Distribution Curve as a Probability
  Distribution Curve 318
- **6–2** Applications of the Normal Distribution *328*Finding Data Values Given Specific

  Probabilities *332*Determining Normality *334*
- 6–3 The Central Limit Theorem 344

  Distribution of Sample Means 344

  Finite Population Correction Factor (Optional) 350
- **6–4** The Normal Approximation to the Binomial Distribution 354
  Summary *361*

#### CHAPTER

#### 7



# Confidence Intervals and Sample Size 369

Introduction 370

- **7–1** Confidence Intervals for the Mean When  $\sigma$  Is Known 370

  Confidence Intervals 371

  Sample Size 377
- **7–2** Confidence Intervals for the Mean When  $\sigma$  Is Unknown 383

**7–3** Confidence Intervals and Sample Size for Proportions *390* 

Confidence Intervals 391

Sample Size for Proportions 393

7-4 Confidence Intervals for Variances and Standard Deviations 398Summary 406

#### CHAPTER





Hypothesis Testing 413

Introduction 414

- **8–1** Steps in Hypothesis Testing—Traditional Method *414*
- **8–2** z Test for a Mean 426
  P-Value Method for Hypothesis Testing 430
- **8–3** *t* Test for a Mean 442
- **8–4** *z* Test for a Proportion *453*
- **8–5**  $\chi^2$  Test for a Variance or Standard Deviation *461*
- 8-6 Additional Topics Regarding Hypothesis Testing 474 Confidence Intervals and Hypothesis Testing 474 Type II Error and the Power of a Test 476 Summary 479

#### CHAPTER





Testing the
Difference Between
Two Means, Two
Proportions, and
Two Variances 487

Introduction 488

- **9–1** Testing the Difference Between Two Means: Using the *z* Test *488*
- **9–2** Testing the Difference Between Two Means of Independent Samples: Using the *t* Test 499
- **9–3** Testing the Difference Between Two Means: Dependent Samples *507*
- **9–4** Testing the Difference Between Proportions *519*

9–5 Testing the Difference Between Two Variances 528Summary 539

#### CHAPTER

#### 10



Correlation and Regression 547

Introduction 548

- **10–1** Scatter Plots and Correlation *548* Correlation *552*
- 10–2 Regression 563
  Line of Best Fit 564
  Determination of the Regression Line
  Equation 565
- 10–3 Coefficient of Determination and Standard Error of the Estimate 580

  Types of Variation for the Regression Model 580

  Residual Plots 582

  Coefficient of Determination 583

  Standard Error of the Estimate 584
- 10–4 Multiple Regression (Optional) 590
  The Multiple Regression Equation 591
  Testing the Significance of R 593
  Adjusted R<sup>2</sup> 594
  Summary 599

Prediction Interval 587

#### CHAPTER

## 11



Other Chi-Square Tests 607

Introduction 608

- **11–1** Test for Goodness of Fit 608

  Test of Normality (Optional) 614
- 11–2 Tests Using Contingency Tables 622
  Test for Independence 622
  Test for Homogeneity of Proportions 628
  Summary 638

#### CHAPTER 1



## Analysis of Variance 645

Introduction 646

- 12-1 One-Way Analysis of Variance 646
- **12–2** The Scheffé Test and the Tukey Test 658 Scheffé Test 658 Tukey Test 659
- **12–3** Two-Way Analysis of Variance *662* Summary *676*

#### CHAPTER

13



# Nonparametric Statistics 685

Introduction 686

- 13–1 Advantages and Disadvantages of Nonparametric Methods 686

  Advantages 686

  Disadvantages 686

  Ranking 687
- 13-2 The Sign Test 689
  Single-Sample Sign Test 689
  Paired-Sample Sign Test 691
- 13-3 The Wilcoxon Rank Sum Test 698
- 13-4 The Wilcoxon Signed-Rank Test 703
- 13-5 The Kruskal-Wallis Test 708
- 13–6 The Spearman Rank Correlation Coefficient and the Runs Test 715

  Rank Correlation Coefficient 715

  The Runs Test 718

  Summary 729

#### CHAPTER 14



# Sampling and Simulation 737

Introduction 738

**14–1** Common Sampling Techniques *738* 

Random Sampling 739

Systematic Sampling 742

Stratified Sampling 744

Cluster Sampling 746

Other Types of Sampling Techniques 746

- 14-2 Surveys and Questionnaire Design 753
- **14–3** Simulation Techniques and the Monte Carlo Method *756*

The Monte Carlo Method 756 Summary 762

#### APPENDICES

- A Tables 769
- B Data Bank 794
- C Glossary 801
- Selected Answers SA-1

Index I-1

#### ADDITIONAL TOPICS ONLINE

(www.mhhe.com/bluman)

Algebra Review

Writing the Research Report

Bayes' Theorem

Alternate Approach to the Standard Normal Distribution

Bibliography