

10 E INTRODUCTORY

statistics



Neil A. Weiss

Introductory
STATISTICS

10TH EDITION

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Introductory STATISTICS

10TH EDITION

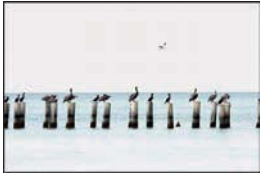
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On the cover: Pelicans are large, social water birds found primarily along coastlines. They are best known for their aerial dives and elastic throat pouch with which they catch fish. According to the **National Geographic Society**, pelicans live for about 10 to 25 years in the wild. On average, they are 5.8 ft long, have a wingspan of 10 ft, and weigh 30 lb. Although, in North America, the brown pelican is endangered, populations have somewhat recovered after decades of population decline from the deleterious effects of pesticides, such as DDT, on egg survival.

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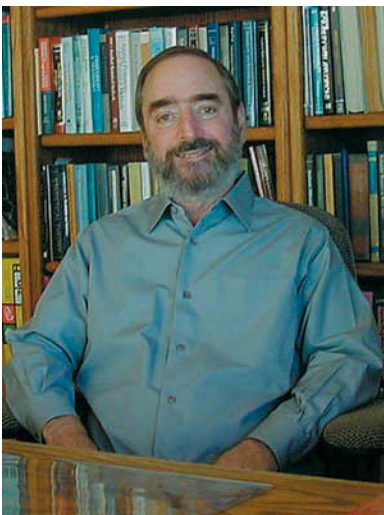
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About the Author



Neil A. Weiss received his Ph.D. from UCLA and subsequently accepted an assistant professor position at Arizona State University (ASU), where he was ultimately promoted to the rank of full professor. Dr. Weiss has taught statistics, probability, and mathematics—from the freshman level to the advanced graduate level—for more than 30 years.

In recognition of his excellence in teaching, Dr. Weiss received the *Dean's Quality Teaching Award* from the ASU College of Liberal Arts and Sciences. He has also been runner-up twice for the *Charles Wexler Teaching Award* in the ASU School of Mathematical and Statistical Sciences. Dr. Weiss's comprehensive knowledge and experience ensures that his texts are mathematically and statistically accurate, as well as pedagogically sound.

In addition to his numerous research publications, Dr. Weiss is the author of *A Course in Probability* (Addison-Wesley, 2006). He has also authored or coauthored books in finite mathematics, statistics, and real analysis, and is currently working on a new book on applied regression analysis and the analysis of variance. His texts—well known for their precision, readability, and pedagogical excellence—are used worldwide.

Dr. Weiss is a pioneer of the integration of statistical software into textbooks and the classroom, first providing such integration in the book *Introductory Statistics* (Addison-Wesley, 1982). He and Pearson Education continue that spirit to this day.

In his spare time, Dr. Weiss enjoys walking, studying and practicing meditation, and playing hold'em poker. He is married and has two sons.

Dedicated to Aaron and Greg

Contents

Preface xi
Supplements xvi
Technology Resources xvii
Data Sources xix

PART I

Introduction

CHAPTER 1 The Nature of Statistics 1
Case Study: Top Films of All Time 1
1.1 Statistics Basics 2 • 1.2 Simple Random Sampling 9 • 1.3 Other Sampling Designs* 17 • 1.4 Experimental Designs* 25
Chapter in Review 31 • Review Problems 31 • Focusing on Data Analysis 34 • Case Study Discussion 34 • Biography 34

PART II

Descriptive Statistics

CHAPTER 2 Organizing Data 36
Case Study: World's Richest People 36
2.1 Variables and Data 37 • 2.2 Organizing Qualitative Data 42 • 2.3 Organizing Quantitative Data 52 • 2.4 Distribution Shapes 75 • 2.5 Misleading Graphs* 83
Chapter in Review 87 • Review Problems 88 • Focusing on Data Analysis 91 • Case Study Discussion 91 • Biography 92

CHAPTER 3 Descriptive Measures 93
Case Study: The Beatles' Song Length 93
3.1 Measures of Center 94 • 3.2 Measures of Variation 105 • 3.3 Chebyshev's Rule and the Empirical Rule* 117 • 3.4 The Five-Number Summary; Boxplots 125 • 3.5 Descriptive Measures for Populations; Use of Samples 139
Chapter in Review 150 • Review Problems 150 • Focusing on Data Analysis 153 • Case Study Discussion 154 • Biography 154

*Indicates optional material.

PART III

Probability, Random Variables,
and Sampling Distributions

- CHAPTER 4 Probability Concepts 156**
Case Study: Texas Hold'em 156
 4.1 Probability Basics **157** • 4.2 Events **164** • 4.3 Some Rules of Probability **173** • 4.4 Contingency Tables; Joint and Marginal Probabilities* **179** • 4.5 Conditional Probability* **185** • 4.6 The Multiplication Rule; Independence* **193** • 4.7 Bayes's Rule* **201** • 4.8 Counting Rules* **208**
 Chapter in Review 218 • Review Problems 218 • Focusing on Data Analysis 221 • Case Study Discussion 222 • Biography 222
- CHAPTER 5 Discrete Random Variables* 223**
Case Study: Aces Wild on the Sixth at Oak Hill 223
 5.1 Discrete Random Variables and Probability Distributions* **224** • 5.2 The Mean and Standard Deviation of a Discrete Random Variable* **231** • 5.3 The Binomial Distribution* **238** • 5.4 The Poisson Distribution* **251**
 Chapter in Review 258 • Review Problems 259 • Focusing on Data Analysis 261 • Case Study Discussion 261 • Biography 261
- CHAPTER 6 The Normal Distribution 262**
Case Study: Chest Sizes of Scottish Militiamen 262
 6.1 Introducing Normally Distributed Variables **263** • 6.2 Areas under the Standard Normal Curve **274** • 6.3 Working with Normally Distributed Variables **280** • 6.4 Assessing Normality; Normal Probability Plots **290** • 6.5 Normal Approximation to the Binomial Distribution* **296**
 Chapter in Review 303 • Review Problems 304 • Focusing on Data Analysis 306 • Case Study Discussion 306 • Biography 306
- CHAPTER 7 The Sampling Distribution of the Sample Mean 307**
Case Study: The Chesapeake and Ohio Freight Study 307
 7.1 Sampling Error; the Need for Sampling Distributions **308** • 7.2 The Mean and Standard Deviation of the Sample Mean **313** • 7.3 The Sampling Distribution of the Sample Mean **319**
 Chapter in Review 326 • Review Problems 327 • Focusing on Data Analysis 329 • Case Study Discussion 329 • Biography 329

PART IV

Inferential Statistics

- CHAPTER 8 Confidence Intervals for One Population Mean 331**
Case Study: Bank Robberies: A Statistical Analysis 331
 8.1 Estimating a Population Mean **332** • 8.2 Confidence Intervals for One Population Mean When σ Is Known **338** • 8.3 Confidence Intervals for One Population Mean When σ Is Unknown **352**
 Chapter in Review 363 • Review Problems 363 • Focusing on Data Analysis 366 • Case Study Discussion 366 • Biography 366

*Indicates optional material.

CHAPTER 9 Hypothesis Tests for One Population Mean 367

Case Study: Gender and Sense of Direction 367

9.1 The Nature of Hypothesis Testing 368 • 9.2 Critical-Value Approach to Hypothesis Testing 376 • 9.3 *P*-Value Approach to Hypothesis Testing 381 • 9.4 Hypothesis Tests for One Population Mean When σ Is Known 387 • 9.5 Hypothesis Tests for One Population Mean When σ Is Unknown 399 • 9.6 The Wilcoxon Signed-Rank Test* 407 • 9.7 Type II Error Probabilities; Power* 422 • 9.8 Which Procedure Should Be Used?*

Chapter in Review 433 • Review Problems 433 • Focusing on Data Analysis 437 • Case Study Discussion 437 • Biography 437

CHAPTER 10 Inferences for Two Population Means 438

Case Study: Dexamethasone Therapy and IQ 438

10.1 The Sampling Distribution of the Difference between Two Sample Means for Independent Samples 439 • 10.2 Inferences for Two Population Means, Using Independent Samples: Standard Deviations Assumed Equal 446 • 10.3 Inferences for Two Population Means, Using Independent Samples: Standard Deviations Not Assumed Equal 458 • 10.4 The Mann–Whitney Test* 470 • 10.5 Inferences for Two Population Means, Using Paired Samples 485 • 10.6 The Paired Wilcoxon Signed-Rank Test* 498 • 10.7 Which Procedure Should Be Used?*

Chapter in Review 508 • Review Problems 509 • Focusing on Data Analysis 511 • Case Study Discussion 511 • Biography 511

CHAPTER 11 Inferences for Population Standard Deviations* 513

Case Study: Speaker Woofer Driver Manufacturing 513

11.1 Inferences for One Population Standard Deviation* 514 • 11.2 Inferences for Two Population Standard Deviations, Using Independent Samples* 527

Chapter in Review 541 • Review Problems 541 • Focusing on Data Analysis 543 • Case Study Discussion 543 • Biography 543

CHAPTER 12 Inferences for Population Proportions 544

Case Study: Arrested Youths 544

12.1 Confidence Intervals for One Population Proportion 545 • 12.2 Hypothesis Tests for One Population Proportion 557 • 12.3 Inferences for Two Population Proportions 561

Chapter in Review 573 • Review Problems 573 • Focusing on Data Analysis 575 • Case Study Discussion 575 • Biography 575

CHAPTER 13 Chi-Square Procedures 576

Case Study: Eye and Hair Color 576

13.1 The Chi-Square Distribution 577 • 13.2 Chi-Square Goodness-of-Fit Test 578 • 13.3 Contingency Tables; Association 587 • 13.4 Chi-Square Independence Test 597 • 13.5 Chi-Square Homogeneity Test 606

Chapter in Review 613 • Review Problems 614 • Focusing on Data Analysis 617 • Case Study Discussion 617 • Biography 617

*Indicates optional material.

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PART V

Regression, Correlation, and ANOVA

- CHAPTER 14 **Descriptive Methods in Regression and Correlation** 618
Case Study: Healthcare: Spending and Outcomes 618
 14.1 Linear Equations with One Independent Variable 619 • 14.2 The Regression Equation 624 • 14.3 The Coefficient of Determination 638 • 14.4 Linear Correlation 645
 Chapter in Review 653 • Review Problems 654 • Focusing on Data Analysis 655 • Case Study Discussion 656 • Biography 656
- CHAPTER 15 **Inferential Methods in Regression and Correlation** 657
Case Study: Shoe Size and Height 657
 15.1 The Regression Model; Analysis of Residuals 658 • 15.2 Inferences for the Slope of the Population Regression Line 670 • 15.3 Estimation and Prediction 678 • 15.4 Inferences in Correlation 688 • 15.5 Testing for Normality**
 Chapter in Review 694 • Review Problems 694 • Focusing on Data Analysis 696 • Case Study Discussion 696 • Biography 697
- CHAPTER 16 **Analysis of Variance (ANOVA)** 698
Case Study: Self-Perception and Physical Activity 698
 16.1 The F -Distribution 699 • 16.2 One-Way ANOVA: The Logic 701 • 16.3 One-Way ANOVA: The Procedure 707 • 16.4 Multiple Comparisons* 720 • 16.5 The Kruskal–Wallis Test* 728
 Chapter in Review 738 • Review Problems 738 • Focusing on Data Analysis 740 • Case Study Discussion 741 • Biography 741

PART VI

Multiple Regression and Model Building; Experimental Design and ANOVA**

- MODULE A **Multiple Regression Analysis** A-0
Case Study: Automobile Insurance Rates A-0
 A.1 The Multiple Linear Regression Model A-1 • A.2 Estimation of the Regression Parameters A-6 • A.3 Inferences Concerning the Utility of the Regression Model A-21 • A.4 Inferences Concerning the Utility of Particular Predictor Variables A-31 • A.5 Confidence Intervals for Mean Response; Prediction Intervals for Response A-37 • A.6 Checking Model Assumptions and Residual Analysis A-47
 Module in Review A-59 • Review Problems A-59 • Focusing on Data Analysis A-62 • Case Study Discussion A-63 • Answers to Selected Exercises A-65 • Index A-68
- MODULE B **Model Building in Regression** B-0
Case Study: Automobile Insurance Rates—Revisited B-0
 B.1 Transformations to Remedy Model Violations B-1 • B.2 Polynomial Regression Model B-32 • B.3 Qualitative Predictor Variables B-64 •

*Indicates optional material.

**Indicates optional material on the WeissStats site.

B.4 Multicollinearity **B-98** • B.5 Model Selection: Stepwise Regression **B-122** • B.6 Model Selection: All-Subsets Regression **B-147** • B.7 Pitfalls and Warnings **B-160**
 Module in Review B-164 • Review Problems B-164 • Focusing on Data Analysis B-179 • Case Study Discussion B-179 • Answers to Selected Exercises B-182 • Index B-188

MODULE C Design of Experiments and Analysis of Variance C-0

Case Study: Dental Hygiene: Which Toothbrush? C-0

C.1 Factorial Designs **C-1** • C.2 Two-Way ANOVA: The Logic **C-7** • C.3 Two-Way ANOVA: The Procedure **C-20** • C.4 Two-Way ANOVA: Multiple Comparisons **C-43** • C.5 Randomized Block Designs **C-57** • C.6 Randomized Block ANOVA: The Logic **C-61** • C.7 Randomized Block ANOVA: The Procedure **C-71** • C.8 Randomized Block ANOVA: Multiple Comparisons **C-92** • C.9 Friedman’s Nonparametric Test for the Randomized Block Design **C-98**

Module in Review C-108 • Review Problems C-109 • Focusing on Data Analysis C-114 • Case Study Discussion C-114 • Answers to Selected Exercises C-115 • Index C-121

Appendixes

Appendix A	Statistical Tables	A-1
Appendix B	Answers to Selected Exercises	A-23
	Index	I-1
	Photo Credits	C-1

WeissStats Resource Site (brief contents)

Note: Visit the WeissStats Resource Site at www.pearsonhighered.com/weiss-stats for detailed contents.

Additional Sections	JMP Concept Discovery Modules
Additional Statistical Tables	Minitab Macros
Applets	Procedures Booklet
Data Sets	Regression-ANOVA Modules
Data Sources	StatCrunch Reports
Focus Database	Technology Basics
Formulas	TI Programs

*indicates optional material

Preface

Using and understanding statistics and statistical procedures have become required skills in virtually every profession and academic discipline. The purpose of this book is to help students master basic statistical concepts and techniques and to provide real-life opportunities for applying them.

Audience and Approach

Introductory Statistics is intended for one- or two-semester courses or for quarter-system courses. Instructors can easily fit the text to the pace and depth they prefer. Introductory high school algebra is a sufficient prerequisite.

Although mathematically and statistically sound (the author has also written books at the senior and graduate levels), the approach does not require students to examine complex concepts. Rather, the material is presented in a natural and intuitive way. Simply stated, students will find this book's presentation of introductory statistics easy to understand.

About This Book

Introductory Statistics presents the fundamentals of statistics, featuring data production and data analysis. Data exploration is emphasized as an integral prelude to statistical inference.

This edition of *Introductory Statistics* continues the book's tradition of being on the cutting edge of statistical pedagogy, technology, and data analysis. It includes hundreds of new and updated exercises with real data from journals, magazines, newspapers, and websites.

The following Guidelines for Assessment and Instruction in Statistics Education (GAISE), funded and endorsed by the American Statistical Association, are supported and adhered to in *Introductory Statistics*:

- Emphasize statistical literacy and develop statistical thinking.
- Use real data.
- Stress conceptual understanding rather than mere knowledge of procedures.
- Foster active learning in the classroom.
- Use technology for developing conceptual understanding and analyzing data.
- Use assessments to improve and evaluate student learning.

Changes in the Tenth Edition

The goal for this edition was to create an even more flexible and user-friendly book, to provide several new step-by-step procedures for making statistical analyses easier to apply, to add a fourth category of exercises, to expand the use of technology for developing understanding and analyzing data, and to refurbish the exercises. Several important revisions are presented as follows.

New! New Case Studies. Fifty percent of the chapter-opening case studies have been replaced.

New! New and Revised Exercises. This edition contains more than **3000** high-quality exercises, which far exceeds what is found in typical introductory statistics books. Over 35% of the exercises are new, updated, or modified.

New! WeissStats Resource Site. The WeissStats Resource Site (aka WeissStats site) provides an extensive array of resources for both instructors and students, including additional topics, applets, all data sets from the book in multiple formats, a procedures booklet, and technology appendixes. In addition to several new items, the site offers universal access to those items formerly included on the WeissStats CD. Refer to the table of contents for a brief list of the contents of the WeissStats site or visit the site at www.pearsonhighered.com/weiss-stats. *Note:* Resources for instructors only are available on the Instructor Resource Center at www.pearsonhighered.com/irc.

New! Chebyshev's Rule and the Empirical Rule. A new (optional) section of Chapter 3 has been added that is dedicated to an examination of Chebyshev's rule and the empirical rule. The empirical rule is further examined in Chapter 6 when the normal distribution is discussed.

New! Quartiles. The method for calculating quartiles has been modified to make it more easily accessible to students. Furthermore, a dedicated procedure that provides a step-by-step method for finding the quartiles of a data set has been included.

Revised! Distribution Shapes. The material on distribution shapes in Section 2.4 has been significantly modified

and clarified. Students will find this revised approach easier to understand and apply.

Revised! Regression Analysis. Major improvements have been made to the chapter on Descriptive Methods in Regression and Correlation. These improvements include a comprehensive discussion of scatterplots, a simpler introduction to the least-squares criterion, and easier introductory examples for the regression equation, the sums of squares and coefficient of determination, and the linear correlation coefficient.

Expanded! Warm-up Exercises. In this edition, hundreds of “warm-up” exercises have been added. These exercises provide context-free problems that allow students to concentrate solely on the relevant concepts before moving on to applied exercises.

Expanded! Density Curves. The discussion of density curves has been significantly expanded and now includes several examples and many more exercises.

Expanded! Type II Error Probabilities and Power. Section 9.7, which covers Type II error probabilities and power, has undergone major revision, including increased visuals and the addition of procedures for calculating Type II error probabilities and for constructing power curves.

Note: See the Technology section of this preface for a discussion of technology additions, revisions, and improvements.

Hallmark Features and Approach

Chapter-Opening Features. Each chapter begins with a general description of the chapter, an explanation of how the chapter relates to the text as a whole, and a chapter outline. A classic or contemporary case study highlights the real-world relevance of the material.

End-of-Chapter Features. Each chapter ends with features that are useful for review, summary, and further practice.

- *Chapter Reviews.* Each chapter review includes *chapter objectives*, a list of *key terms* with page references, and *review problems* to help students review and study the chapter. Items related to optional materials are marked with asterisks, unless the entire chapter is optional.
- *Focusing on Data Analysis.* This feature lets students work with large data sets, practice technology use, and discover the many methods of exploring and analyzing data. For details, see the introductory Focusing on Data Analysis section on page 34 of Chapter 1.
- *Case Study Discussion.* At the end of each chapter, the chapter-opening case study is reviewed and discussed in light of the chapter’s major points, and then problems are presented for students to solve.
- *Biographical Sketches.* Each chapter ends with a brief biography of a famous statistician. Besides being of general interest, these biographies teach students about the development of the science of statistics.

Formula/Table Card. The book’s detachable formula/table card (FTC) contains all the formulas and many of the tables that appear in the text. The FTC is helpful for quick-reference purposes; many instructors also find it convenient for use with examinations.

Procedure Boxes, Index, and Booklet. To help students learn how to perform statistical analyses, easy-to-follow, step-by-step procedures have been provided. Each step is highlighted and presented again within the illustrating example. This approach shows how the procedure is applied and helps students master its steps. Additionally:

- A *Procedure Index* (located near the front of the book) provides a quick and easy way to find the right procedure for performing any statistical analysis.
- A *Procedures Booklet* (available in the Procedures Booklet section of the WeissStats Resource Site) provides a convenient way to access any required procedure.


ASA/MAA–Guidelines Compliant. *Introductory Statistics* follows American Statistical Association (ASA) and Mathematical Association of America (MAA) guidelines, which stress the interpretation of statistical results, the contemporary applications of statistics, and the importance of critical thinking.


Populations, Variables, and Data. Through the book’s consistent and proper use of the terms *population*, *variable*, and *data*, statistical concepts are made clearer and more unified. This strategy is essential for the proper understanding of statistics.

Data Analysis and Exploration. Data analysis is emphasized, both for exploratory purposes and to check assumptions required for inference. Recognizing that not all readers have access to technology, the book provides ample opportunity to analyze and explore data without the use of a computer or statistical calculator.

Parallel Critical-Value/ P -Value Approaches. Through a parallel presentation, the book offers complete flexibility in the coverage of the critical-value and P -value approaches to hypothesis testing. Instructors can concentrate on either approach, or they can cover and compare both approaches. The dual procedures, which provide both the critical-value and P -value approaches to a hypothesis-testing method, are combined in a side-by-side, easy-to-use format.

Interpretations. This feature presents the meaning and significance of statistical results in everyday language and highlights the importance of interpreting answers and results.

 **You Try It!** This feature, which follows most examples, allows students to immediately check their understanding by working a similar exercise.

 **What Does It Mean?** This margin feature states in “plain English” the meanings of definitions, formulas, key facts, and some discussions—thus facilitating students’ understanding of the formal language of statistics.

Examples and Exercises

Real-World Examples. Every concept discussed in the text is illustrated by at least one detailed example. Based on real-life situations, these examples are interesting as well as illustrative.

Real-World Exercises. Constructed from an extensive variety of articles in newspapers, magazines, statistical abstracts, journals, and websites, the exercises provide current, real-world applications whose sources are explicitly cited.

New to this edition, a fourth category of exercises has been added, namely, Applying the Concepts and Skills. As a consequence, the exercise sets are now divided into the following four categories:

- *Understanding the Concepts and Skills* exercises help students master the basic concepts and skills explicitly discussed in the section. These exercises consist of two types: (1) Non-computational problems that test student understanding of definitions, formulas, and key facts; (2) “warm-up” exercises, which require only simple computations and provide context-free problems that allow students to concentrate solely on the relevant concepts before moving on to applied exercises. For pedagogical reasons, it is recommended that warm-up exercises be done without the use of a statistical technology.
- *Applying the Concepts and Skills* exercises provide students with an extensive variety of applied problems that hone student skills with real-life data. These exercises can be done with or without the use of a statistical technology, at the instructor’s discretion.
- *Working with Large Data Sets* exercises are intended to be done with a statistical technology and let students apply and interpret the computing and statistical capabilities of Minitab®, Excel®, the TI-83/84 Plus®, or any other statistical technology.
- *Extending the Concepts and Skills* exercises invite students to extend their skills by examining material not necessarily covered in the text. These exercises include many critical-thinking problems.

Notes: An exercise number set in cyan indicates that the exercise belongs to a group of exercises with common instructions. Also, exercises related to optional materials are marked with asterisks, unless the entire section is optional.

Data Sets. In most examples and exercises, both raw data and summary statistics are presented. This practice gives a more realistic view of statistics and lets students solve problems by computer or statistical calculator. More than **1000** data sets are included, many of which are new or updated. All data sets are available in multiple formats in the Data Sets section of the WeissStats Resource Site, www.pearsonhighered.com/weiss-stats.

Technology

Parallel Presentation. The book’s technology coverage is completely flexible and includes options for use of Minitab, Excel, and the TI-83/84 Plus. Instructors can concentrate on one technology or cover and compare two or more technologies.

Updated! The Technology Center. This in-text, statistical-technology presentation discusses three of the most popular applications—Minitab, Excel, and the TI-83/84 Plus graphing calculators—and includes step-by-step instructions for the implementation of each of these applications. The Technology Centers are integrated as optional material and reflect the latest software releases.

Updated! Technology Appendixes. The appendixes for Excel, Minitab, and the TI-83/84 Plus have been updated to correspond to the latest versions of these three statistical technologies. These appendixes introduce the three statistical technologies, explain how to input data, and discuss how to perform other basic tasks. They are entitled *Getting Started with ...* and are located in the Technology Basics section of the WeissStats Resource Site, www.pearsonhighered.com/weiss-stats.

Expanded! Built-in Technology Manuals. The Technology Center features (in the book) and the technology appendixes (on the WeissStats site) make it unnecessary for students to purchase technology manuals. Students who will be using Minitab, Excel, or the TI-83/84 Plus to solve exercises should study the appropriate technology appendix(es) before commencing with The Technology Center sections.

Expanded! TI Programs. The TI-83/84 Plus does not have built-in applications for a number of the statistical analyses discussed in the book. So that users of the TI-83/84 Plus can do such analyses with their calculators, the author has made available TI programs. Those programs are obtainable from the TI Programs section of the WeissStats Resource Site.

Computer Simulations. Computer simulations, appearing in both the text and the exercises, serve as pedagogical aids for understanding complex concepts such as sampling distributions.



Interactive StatCrunch Reports. Sixty-four StatCrunch reports have been written specifically for *Introductory Statistics*. Each report corresponds to a statistical analysis covered in the book. These interactive reports, keyed to the book with a StatCrunch icon, explain how to use StatCrunch online statistical software to solve problems previously solved by hand in the book. Go to www.statcrunch.com, choose **Explore ▼ Groups**, and search “Weiss Introductory Statistics 10/e” to access the

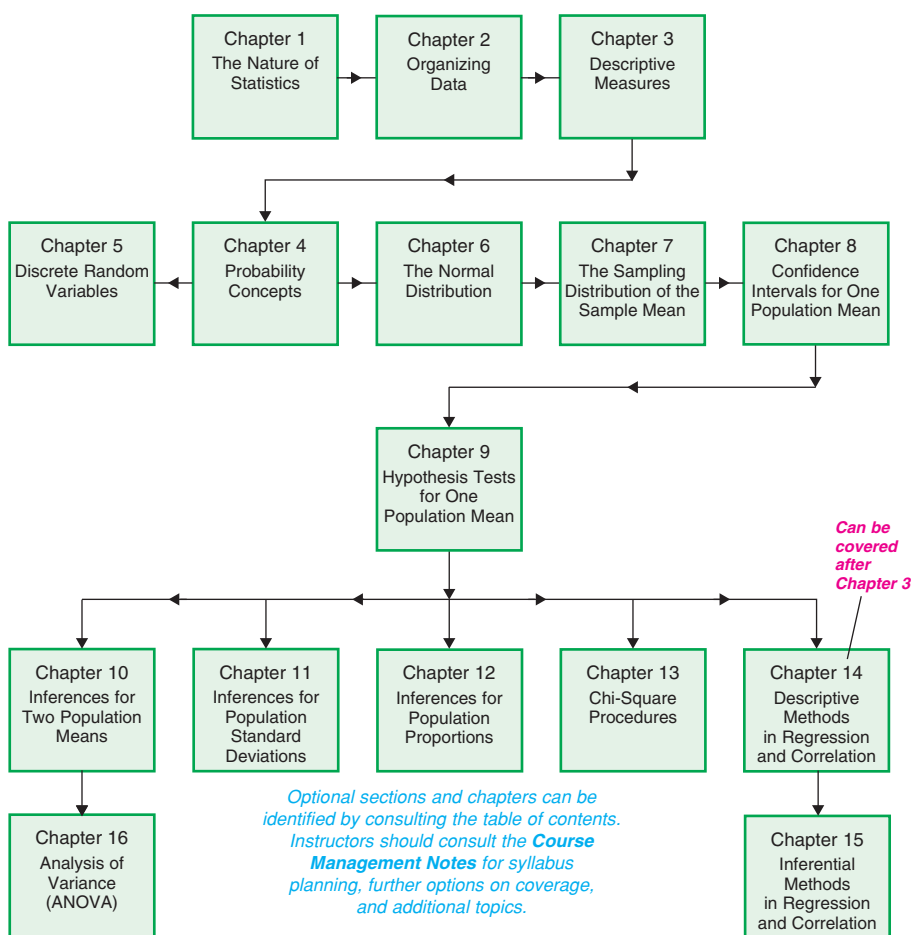
StatCrunch Reports. Alternatively, you can access these reports from the document Access to StatCrunch Reports.pdf, which is in the StatCrunch section of the WeissStats Resource Site. *Note:* Analyzing data in StatCrunch requires a MyStatLab or StatCrunch account.

APPLET **Java Applets.** Twenty-one Java applets have been custom written for *Introductory Statistics*. These applets, keyed to the book with an applet icon, give students additional interactive activities for the purpose of clarifying statistical concepts in an interesting and fun way. The applets

are available from the Applets section of the WeissStats Resource Site.

Organization

Introductory Statistics offers considerable flexibility in choosing material to cover. The following flowchart indicates different options by showing the interdependence among chapters; the prerequisites for a given chapter consist of all chapters that have a path that leads to that chapter.



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Data Sources

- Istock1
A Handbook of Small Data Sets
A. C. Nielsen Company
AAA Foundation for Traffic Safety
AAMC Faculty Roster
AAUP Annual Report on the Economic Status of the Profession
ABC Global Kids Study
ABCNEWS Poll
ABCNews.com
About.com Pediatrics
Accident Facts
ACT High School Profile Report
ACT, Inc.
Acta Ophthalmologica
AFI's 100 Years... 100 Movies — 10th Anniversary Edition
Agricultural Marketing Service
Agricultural Research Service
AHA Hospital Statistics
Air Travel Consumer Report
Alcohol Consumption and Related Problems: Alcohol and Health Monograph 1
All About Diabetes
Alliance for Cervical Cancer Protection
Alzheimer's Care Quarterly
American Association of University Professors
American Community Survey
American Council of Life Insurers
American Demographics
American Diabetes Association
American Express Retail Index
American Film Institute
American Hospital Association
American Hospital Association Annual Survey
American Housing Survey for the United States
American Industrial Hygiene Association Journal
American Journal of Applied Sciences
American Journal of Clinical Nutrition
American Journal of Obstetrics and Gynecology
American Journal of Physical Anthropology
American Journal of Political Science
American Laboratory
American Scientist
American Statistical Association
American Statistician
American Veterinary Medical Association
American Wedding Study
America's Families and Living Arrangements
America's Network Telecom Investor Supplement
Amstat News
Amusement Business
Analytical Chemistry
Analytical Services Division Transport Statistics
Animal Action Report
Animal Behaviour
Annals of Epidemiology
Anthropometric Reference Data for Children and Adults
Appetite
Applied Psychology in Criminal Justice
Aquaculture
Aquatic Biology
Arbitron
Archives of Physical Medicine and Rehabilitation
Arizona Chapter of the American Lung Association
Arizona Department of Revenue
Arizona Republic
Arizona Residential Property Valuation System
Arizona State University
Arizona State University Enrollment Summary
Arthritis Today
Asian Import
Associated Newspapers Ltd
Associated Press
Association of American Medical Colleges
Association of American Universities
Atlantic Oceanographic & Meteorological Laboratory
Atlantic Hurricane Database
Auckland University of Technology
Augusta National Golf Club
Australian Journal of Rural Health
Australian Journal of Zoology
Auto Trader
Avis Rent-A-Car
Baltimore Ravens
BARRON'S
Baseball Almanac
BBC News Magazine
Beachbody, LLC
Beer Institute Annual Report
Behavior Research Center
Behavioral Ecology and Sociobiology
Behavioral Risk Factor Surveillance System Summary Prevalence Report
Behavioural Pharmacology
Bell Systems Technical Journal
Biofuel Transportation Database
Biological Conservation
Biology of Sex Differences
Biometrics
Biometrika
BioScience
Board of Governors of the Federal Reserve System
Boston Athletic Association
Boston Globe
Box Office Mojo
Boyce Thompson Southwestern Arboretum
Brewer's Almanac
Bride's Magazine
British Bankers' Association
British Journal of Educational Psychology
British Journal of Haematology
British Journal of Visual Impairment
British Medical Journal
Brokerage Report
Bureau of Crime Statistics and Research of Australia
Bureau of Economic Analysis
Bureau of Educational and Cultural Affairs
Bureau of Justice Statistics
Bureau of Justice Statistics Special Report
Bureau of Labor Statistics
Business Times
Buyers of New Cars
California Agriculture
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Car Shopping Trends Report
CareerBuilder
CBS News
Celebrity Net Worth
Cellular Telecommunications & Internet Association
Census of Agriculture
Centers for Disease Control and Prevention
Central Election Commission of the Russian Federation

- Central Intelligence Agency
Chance
Characteristics of New Housing
Chemical & Pharmaceutical Bulletin
Chesapeake Biological Laboratory
Climates of the World
Climatology of the United States
Clinical Journal of Sports Medicine
Clinical Linguistics and Phonetics
CNBC
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College Board
College Entrance Examination Board
College-Bound Seniors Total Group Profile Report
Communications Industry Forecast & Report
Compendium of Federal Justice Statistics
Conde Nast Bridal Group
Congressional Directory
Consumer Expenditure Survey
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Contributions to Boyce Thompson Institute
Controlling Road Rage: A Literature Review and Pilot Study
Crime in the United States
Criminal Justice and Behavior
CTIA—The Wireless Association
Current Housing Reports
Current Population Reports
Current Population Survey
Daily Mail
Daily Racing Form
Dallas Mavericks Roster
Data from the National Health Interview Survey
DataGenetics
Dave Leip's Atlas of U.S. Presidential Elections
Deep Sea Research Part I: Oceanographic Research Papers
Demographic Profiles
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Department of Information Resources and Communications
Desert Samaritan Hospital
Dietary Guidelines for Americans
Dietary Reference Intakes
Digest of Education Statistics
Discover
Early Medieval Europe
Eastern Mediterranean Health Journal
Ecology
Economic Development Corporation Report
Edinburgh Medical and Surgical Journal
Edison Research
Edmunds.com
Educational Attainment in the United States
Educational Research
Educational Testing Service
eMarketer
Employment and Earnings
Energy Information Administration
Environmental Geology
ESPN
ESPN MLB Scoreboard
Estimates of School Statistics Database
Everyday Health Network
Experimental Agriculture
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Family & Intimate Partner Violence Quarterly
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Federal Bureau of Investigation
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Federal Reserve System
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Financial Planning
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FlightStats On-time Performance Report Summary
Florida Department of Environmental Protection
Florida State Center for Health Statistics
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Footwear News
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Forest Mensuration
Fortune Magazine
Friends of the Earth
Fuel Economy Guide
Gallup
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Geography
Georgia State University
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Golf.com
Governors' Political Affiliations & Terms of Office
Graduating Student and Alumni Survey
GRE Guide to the Use of Scores
Hanna Properties
Harris Interactive
Harris Poll
Harvard University
Heredity
Higher Education Research Institute
Highway Construction Safety and the Aging Driver
Highway Statistics
Hilton Hotels Corporation
Hirslanden Clinic
Historical Income Tables
HIV Surveillance Report
Hollywood Demographics
Homestyle Pizza
Hospital Statistics
HuffPost
HuffPost Style
Human Biology
Hydrobiologia
Income, Individual Income Tax Returns
Income, Poverty and Health Insurance Coverage in the United States
Indiewire
Industry Research
Infoplease
Information Please Almanac
Injury Facts
Inside MS
Institute of Medicine of the National Academy of Sciences
Insurance Institute for Highway Safety
Internal Revenue Service
International Association of Amusement Parks and Attractions.
International Classification of Diseases
International Communications Research
International Data Base
International Journal of Obesity
International Journal of Public Health
Iowa Agriculture Experiment Station
Iowa State University
Japan Automobile Manufacturer's Association
Japan Statistics Bureau
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Joint Committee on Printing
Journal of Abnormal Psychology
Journal of Advertising Research
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Journal of Anaesthesiology Clinical Pharmacology
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Journal of Applied Ecology
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Journal of Applied Psychology
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Journal of Applied Social Psychology
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Journal of Chemical Ecology
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Journal of Experimental Social Psychology
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Journal of Forensic Identification
Journal of Gerontology Series A: Biological Sciences and Medical Sciences
Journal of Health, Population and Nutrition
Journal of Herpetology
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 Medical College of Wisconsin Eye Institute
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 National Cancer Institute
 National Center for Education Statistics
 National Center for Health Statistics
 National Center on Addiction and Substance Abuse at Columbia University
 National Collegiate Athletic Association
 National Constitution Center
National Corrections Reporting Program
 National Education Association
 National Football League
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 Pew Research Center
 PGA TOUR
Philosophical Magazine
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U.S. Department of Agriculture
U.S. Department of Commerce
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U.S. Department of Education
U.S. Department of Energy
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U.S. Department of Housing and Urban Development
U.S. Department of Justice
U.S. Energy Information Administration
U.S. Environmental Protection Agency
U.S. Federal Highway Administration
U.S. Geological Survey
U.S. National Center for Health Statistics
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U.S. Naturalizations
U.S. News and World Report
U.S. Overseas Loans and Grants
U.S. Postal Service
U.S. Substance Abuse and Mental Health Services Administration
U.S. Women's Open
Ultrasound in Medicine and Biology
Uniform Crime Reports
United States Pharmacopeia
University of Delaware
University of Helsinki
University of Malaysia
University of Maryland
University of Nevada, Las Vegas
Urban Studies
USA TODAY
Usability News
Utah Behavioral Risk Factor Surveillance System (BRFSS) Local Health District Report
Vegetarian Journal
Vegetarian Resource Group
VentureOne Corporation
Veronis Suhler Stevenson
Vital and Health Statistics
Vital Statistics of the United States
Wall Street Journal
Washington Post
Weatherwise
Weekly Retail Gasoline and Diesel Prices
Wichita Eagle
Wikipedia
WIN-Gallup International
Women and Cardiovascular Disease Hospitalizations
Women's Health Initiative
WONDER database
World Almanac
World FactBook
World Meteorological Association
World Radiation Center
World Series History
www.house.gov
YAHOO News
Yahoo! Contributor Network
Year-End Industry Shipment and Revenue Statistics
YouGov
Zillow.com
Zogby International

The Nature of Statistics

CHAPTER OBJECTIVES

What does the word *statistics* bring to mind? To most people, it suggests numerical facts or data, such as unemployment figures, farm prices, or the number of marriages and divorces. Two common definitions of the word *statistics* are as follows:

1. [used with a plural verb] facts or data, either numerical or nonnumerical, organized and summarized so as to provide useful and accessible information about a particular subject.
2. [used with a singular verb] the science of organizing and summarizing numerical or nonnumerical information.

Statisticians also analyze data for the purpose of making generalizations and decisions. For example, a political analyst can use data from a portion of the voting population to predict the political preferences of the entire voting population, or a city council can decide where to build a new airport runway based on environmental impact statements and demographic reports that include a variety of statistical data.

In this chapter, we introduce some basic terminology so that the various meanings of the word *statistics* will become clear to you. We also examine two primary ways of producing data, namely, through sampling and experimentation. We discuss sampling designs in Sections 1.2 and 1.3 and experimental designs in Section 1.4.

CHAPTER OUTLINE

- 1.1 Statistics Basics
- 1.2 Simple Random Sampling
- 1.3 Other Sampling Designs*
- 1.4 Experimental Designs*

CASE STUDY

Top Films of All Time



Honoring the 10th anniversary of its award-winning series, the **American Film Institute** (AFI) again conducted

a poll of 1500 film artists, critics, and historians, asking them to pick their 100 favorite films from a list of 400. The films on the list were made between 1915 and 2005.

After tallying the responses, AFI compiled a list representing the top 100 films. *Citizen Kane*, made in 1941, again finished in first place, followed by *The Godfather*, which was made in 1972. The following table shows the top 40 finishers in the poll. [SOURCE: Data from *AFI's 100 Years... 100 Movies — 10th Anniversary Edition*. Published by the American Film Institute.]

Rank	Film	Year	Rank	Film	Year
1	Citizen Kane	1941	21	Chinatown	1974
2	The Godfather	1972	22	Some Like It Hot	1959
3	Casablanca	1942	23	The Grapes of Wrath	1940
4	Raging Bull	1980	24	E.T. The Extra-Terrestrial	1982
5	Singin' in the Rain	1952	25	To Kill a Mockingbird	1962
6	Gone with the Wind	1939	26	Mr. Smith Goes to Washington	1939
7	Lawrence of Arabia	1962	27	High Noon	1952
8	Schindler's List	1993	28	All About Eve	1950
9	Vertigo	1958	29	Double Indemnity	1944
10	The Wizard of Oz	1939	30	Apocalypse Now	1979
11	City Lights	1931	31	The Maltese Falcon	1941
12	The Searchers	1956	32	The Godfather Part II	1974
13	Star Wars	1977	33	One Flew Over the Cuckoo's Nest	1975
14	Psycho	1960	34	Snow White and the Seven Dwarfs	1937
15	2001: A Space Odyssey	1968	35	Annie Hall	1977
16	Sunset Blvd.	1950	36	The Bridge on the River Kwai	1957
17	The Graduate	1967	37	The Best Years of Our Lives	1946
18	The General	1927	38	The Treasure of the Sierra Madre	1948
19	On the Waterfront	1954	39	Dr. Strangelove	1964
20	It's a Wonderful Life	1946	40	The Sound of Music	1965

Armed with the knowledge that you gain in this chapter, you will be

asked to further analyze this AFI poll at the end of the chapter.

1.1 Statistics Basics

You probably already know something about statistics. If you read newspapers, surf the Web, watch the news on television, or follow sports, you see and hear the word *statistics* frequently. In this section, we use familiar examples such as baseball statistics and voter polls to introduce the two major types of statistics: **descriptive statistics** and **inferential statistics**. We also introduce terminology that helps differentiate among various types of statistical studies.

Descriptive Statistics

Each spring in the late 1940s, President Harry Truman officially opened the major league baseball season by throwing out the “first ball” at the opening game of the Washington Senators. We use the 1948 baseball season to illustrate the first major type of statistics, descriptive statistics.

EXAMPLE 1.1 Descriptive Statistics



The 1948 Baseball Season In 1948, the Washington Senators (Nationals) played 153 games, winning 56 and losing 97. They finished seventh in the American League and were led in hitting by Bud Stewart, whose batting average was .279. Baseball statisticians compiled these and many other statistics by organizing the complete records for each game of the season.

Although fans take baseball statistics for granted, much time and effort is required to gather and organize them. Moreover, without such statistics, baseball would be much harder to follow. For instance, imagine trying to select the best hitter in the American League given only the official score sheets for each game. (More than 600 games were played in 1948; the best hitter was Ted Williams, who led the league with a batting average of .369.)

The work of baseball statisticians is an illustration of *descriptive statistics*.

DEFINITION 1.1

Descriptive Statistics

Descriptive statistics consists of methods for organizing and summarizing information.

Descriptive statistics includes the construction of graphs, charts, and tables and the calculation of various descriptive measures such as averages, measures of variation, and percentiles. We discuss descriptive statistics in detail in Chapters 2 and 3.

Inferential Statistics

We use the 1948 presidential election to introduce the other major type of statistics, inferential statistics.

EXAMPLE 1.2 Inferential Statistics



The 1948 Presidential Election In the fall of 1948, President Truman was concerned about statistics. The **Gallup Poll** taken just prior to the election predicted that he would win only 44.5% of the vote and be defeated by the Republican nominee, Thomas E. Dewey. But the statisticians had predicted incorrectly. Truman won more than 49% of the vote and, with it, the presidency. The Gallup Organization modified some of its procedures and has correctly predicted the winner ever since.

Political polling provides an example of inferential statistics. Interviewing everyone of voting age in the United States on their voting preferences would be expensive and unrealistic. Statisticians who want to gauge the sentiment of the entire **population** of U.S. voters can afford to interview only a carefully chosen group of a few thousand voters. This group is called a **sample** of the population. Statisticians analyze the information obtained from a sample of the voting population to make inferences (draw conclusions) about the preferences of the entire voting population. Inferential statistics provides methods for drawing such conclusions.

The terminology just introduced in the context of political polling is used in general in statistics.

DEFINITION 1.2

Population and Sample

Population: The collection of all individuals or items under consideration in a statistical study.

Sample: That part of the population from which information is obtained.

Figure 1.1 on the following page depicts the relationship between a population and a sample from the population.

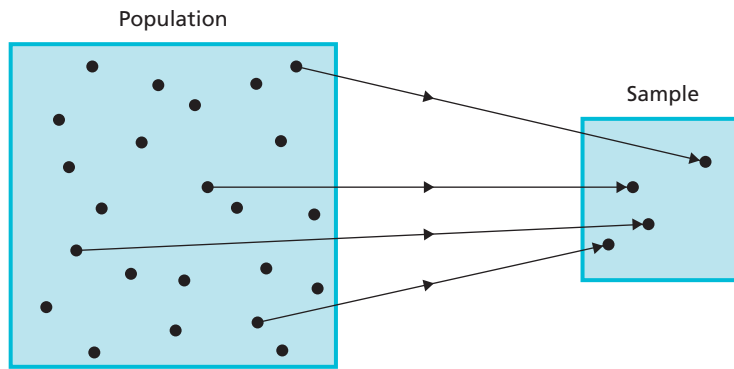
Now that we have discussed the terms *population* and *sample*, we can define *inferential statistics*.

DEFINITION 1.3

Inferential Statistics

Inferential statistics consists of methods for drawing and measuring the reliability of conclusions about a population based on information obtained from a sample of the population.

FIGURE 1.1
Relationship between population and sample



Descriptive statistics and inferential statistics are interrelated. You must almost always use techniques of descriptive statistics to organize and summarize the information obtained from a sample before carrying out an inferential analysis. Furthermore, as you will see, the preliminary descriptive analysis of a sample often reveals features that lead you to the choice of (or to a reconsideration of the choice of) the appropriate inferential method.

Classifying Statistical Studies

As you proceed through this book, you will obtain a thorough understanding of the principles of descriptive and inferential statistics. In this section, you will classify statistical studies as either descriptive or inferential. In doing so, you should consider the purpose of the statistical study.

If the purpose of the study is to examine and explore information for its own intrinsic interest only, the study is descriptive. However, if the information is obtained from a sample of a population and the purpose of the study is to use that information to draw conclusions about the population, the study is inferential.

Thus, a descriptive study may be performed either on a sample or on a population. Only when an inference is made about the population, based on information obtained from the sample, does the study become inferential.

Examples 1.3 and 1.4 further illustrate the distinction between descriptive and inferential studies. In each example, we present the result of a statistical study and classify the study as either descriptive or inferential. Classify each study yourself before reading our explanation.

EXAMPLE 1.3 Classifying Statistical Studies

The 1948 Presidential Election Table 1.1 displays the voting results for the 1948 presidential election.

TABLE 1.1
Final results of the 1948 presidential election

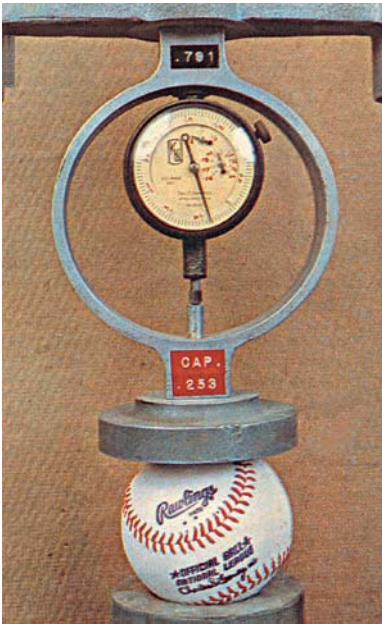
Ticket	Votes	Percentage
Truman–Barkley (Democratic)	24,179,345	49.7
Dewey–Warren (Republican)	21,991,291	45.2
Thurmond–Wright (States Rights)	1,176,125	2.4
Wallace–Taylor (Progressive)	1,157,326	2.4
Thomas–Smith (Socialist)	139,572	0.3



Exercise 1.7
on page 7

Classification This study is descriptive. It is a summary of the votes cast by U.S. voters in the 1948 presidential election. No inferences are made.

EXAMPLE 1.4 Classifying Statistical Studies



You try it!

Exercise 1.9
on page 7

Testing Baseballs For the 101 years preceding 1977, the major leagues purchased baseballs from the Spalding Company. In 1977, that company stopped manufacturing major league baseballs, and the major leagues then bought their baseballs from the Rawlings Company.

Early in the 1977 season, pitchers began to complain that the Rawlings ball was “livelier” than the Spalding ball. They claimed it was harder, bounced farther and faster, and gave hitters an unfair advantage. Indeed, in the first 616 games of 1977, 1033 home runs were hit, compared to only 762 home runs hit in the first 616 games of 1976.

Sports Illustrated magazine sponsored a study of the liveliness question and published the results in the article “They’re Knocking the Stuffing Out of It” (*Sports Illustrated*, June 13, 1977, pp. 23–27) by L. Keith. In this study, an independent testing company randomly selected 85 baseballs from the current (1977) supplies of various major league teams. It measured the bounce, weight, and hardness of the chosen baseballs and compared these measurements with measurements obtained from similar tests on baseballs used in 1952, 1953, 1961, 1963, 1970, and 1973.

The conclusion was that “...the 1977 Rawlings ball is livelier than the 1976 Spalding, but not as lively as it could be under big league rules, or as the ball has been in the past.”

Classification This study is inferential. The independent testing company used a sample of 85 baseballs from the 1977 supplies of major league teams to make an inference about the population of all such baseballs. (An estimated 360,000 baseballs were used by the major leagues in 1977.)

The *Sports Illustrated* study also shows that it is often not feasible to obtain information for the entire population. Indeed, after the bounce and hardness tests, all of the baseballs sampled were taken to a butcher in Plainfield, New Jersey, to be sliced in half so that researchers could look inside them. Clearly, testing every baseball in this way would not have been practical.

The Development of Statistics

Historically, descriptive statistics appeared before inferential statistics. Censuses were taken as long ago as Roman times. Over the centuries, records of such things as births, deaths, marriages, and taxes led naturally to the development of descriptive statistics.

Inferential statistics is a newer arrival. Major developments began to occur with the research of Karl Pearson (1857–1936) and Ronald Fisher (1890–1962), who published their findings in the early years of the twentieth century. Since the work of Pearson and Fisher, inferential statistics has evolved rapidly and is now applied in a myriad of fields.

Familiarity with statistics will help you make sense of many things you read in newspapers and magazines and on the Internet. For instance, could the *Sports Illustrated* baseball test (Example 1.4), which used a sample of only 85 baseballs, legitimately draw a conclusion about 360,000 baseballs? After working through Chapter 9, you will understand why such inferences are reasonable.

What Does It Mean?

An understanding of statistical reasoning and of the basic concepts of descriptive and inferential statistics has become mandatory for virtually everyone, in both their private and professional lives.

Observational Studies and Designed Experiments

Besides classifying statistical studies as either descriptive or inferential, we often need to classify them as either *observational studies* or *designed experiments*. In an **observational study**, researchers simply observe characteristics and take measurements, as in a sample survey. In a **designed experiment**, researchers impose

treatments and controls (discussed in Section 1.4) and then observe characteristics and take measurements. Observational studies can reveal only *association*, whereas designed experiments can help establish *causation*.

Note that, in an observational study, someone is observing data that already exist (i.e., the data were there and would be there whether someone was interested in them or not). In a designed experiment, however, the data do not exist until someone does something (the experiment) that produces the data. Examples 1.5 and 1.6 illustrate some major differences between observational studies and designed experiments.

EXAMPLE 1.5 An Observational Study

Vasectomies and Prostate Cancer Approximately 450,000 vasectomies are performed each year in the United States. In this surgical procedure for contraception, the tube carrying sperm from the testicles is cut and tied.

Several studies have been conducted to analyze the relationship between vasectomies and prostate cancer. The results of one such study by E. Giovannucci et al. appeared in the paper “A Retrospective Cohort Study of Vasectomy and Prostate Cancer in U.S. Men” (*Journal of the American Medical Association*, Vol. 269(7), pp. 878–882).

Dr. Giovannucci, study leader and epidemiologist at Harvard-affiliated Brigham and Women’s Hospital, said that “. . . we found 113 cases of prostate cancer among 22,000 men who had a vasectomy. This compares to a rate of 70 cases per 22,000 among men who didn’t have a vasectomy.”

The study shows about a 60% elevated risk of prostate cancer for men who have had a vasectomy, thereby revealing an association between vasectomy and prostate cancer. But does it establish causation: that having a vasectomy causes an increased risk of prostate cancer?

The answer is no, because the study was observational. The researchers simply observed two groups of men, one with vasectomies and the other without. Thus, although an association was established between vasectomy and prostate cancer, the association might be due to other factors (e.g., temperament) that make some men more likely to have vasectomies and also put them at greater risk of prostate cancer.

You try it!

Exercise 1.19
on page 8

EXAMPLE 1.6 A Designed Experiment

Folic Acid and Birth Defects For several years, evidence had been mounting that folic acid reduces major birth defects. Drs. A. E. Czeizel and I. Dudas of the National Institute of Hygiene in Budapest directed a study that provided the strongest evidence to date. Their results were published in the paper “Prevention of the First Occurrence of Neural-Tube Defects by Periconceptional Vitamin Supplementation” (*New England Journal of Medicine*, Vol. 327(26), p. 1832).

For the study, the doctors enrolled 4753 women prior to conception and divided them randomly into two groups. One group took daily multivitamins containing 0.8 mg of folic acid, whereas the other group received only trace elements (minute amounts of copper, manganese, zinc, and vitamin C). A drastic reduction in the rate of major birth defects occurred among the women who took folic acid: 13 per 1000, as compared to 23 per 1000 for those women who did not take folic acid.

In contrast to the observational study considered in Example 1.5, this is a designed experiment and does help establish causation. The researchers did not simply observe two groups of women but, instead, randomly assigned one group to take daily doses of folic acid and the other group to take only trace elements.

You try it!

Exercise 1.21
on page 8

Exercises 1.1

Understanding the Concepts and Skills

1.1 Define the following terms:

- Population
- Sample

1.2 What are the two major types of statistics? Describe them in detail.

1.3 Identify some methods used in descriptive statistics.

1.4 Explain two ways in which descriptive statistics and inferential statistics are interrelated.

1.5 Define the following terms:

- Observational study
- Designed experiment

1.6 Fill in the following blank: Observational studies can reveal only association, whereas designed experiments can help establish _____.

Applying the Concepts and Skills

In Exercises 1.7–1.12, classify each of the studies as either descriptive or inferential. Explain your answers.

1.7 TV Viewing Times. Data from a sample of Americans yielded the following estimates of average TV viewing time per month for all Americans 2 years old and older. The times are in hours and minutes; Q1 stands for first quarter. [SOURCE: *The Cross-Platform Report*, Quarter 1, 2011. Published by *The Nielsen Company*, © 2011.]

Viewing method	Q1 2011	Q1 2010	Change (%)
Watching TV in the home	158:47	158:25	0.2
Watching timeshifted TV	10:46	9:36	12.2
DVR playback	26:14	25:48	1.7
Using the Internet on a computer	25:33	25:54	−1.4
Watching video on the Internet	4:33	3:23	34.5
Mobile subscribers watching video on a mobile phone	4:20	3:37	20.0

1.8 Professional Athlete Salaries. From the *Statistical Abstract of the United States* and the article “Average Salaries in the NBA, NFL, MLB and NHL” by J. Dorish, published on the *Yahoo! Contributor Network*, we obtained the following data on average professional athletes’ salaries for the years 2005 and 2011.

Sport	Average salary (\$millions)	
	2005	2011
Baseball (MLB)	2.48	3.31
Basketball (NBA)	4.04	5.15
Football (NFL)	1.40	1.90

1.9 Home Sales. *Zillow.com* is an online database that provides real estate information for U.S. homes that are for rent or sale. It also presents statistics on recently sold homes. The following table gives various information on all homes sold in several different cities across the United States for the month of September 2012.

City	Price per square foot	Sale to list price ratio	% foreclosure re-sales
Scottsdale, AZ	\$167	0.973	12.43%
Washington, DC	\$436	0.990	2.88%
San Francisco, CA	\$636	1.026	6.55%
Las Vegas, NV	\$ 74	1.000	19.45%
Nashville, TN	\$106	0.973	18.09%

1.10 Drug Use. The *U.S. Substance Abuse and Mental Health Services Administration* collects and publishes data on nonmedical drug use, by type of drug and age group, in *National Survey on Drug Use and Health*. The following table provides data for the years 2003 and 2008. The percentages shown are estimates for the entire nation based on information obtained from a sample (NA, not available).

Type of drug	Percentage, 18–25 years old			
	Ever used		Current user	
	2003	2008	2003	2008
Any illicit drug	60.5	56.6	20.3	19.6
Marijuana and hashish	53.9	50.4	17.0	16.5
Cocaine	15.0	14.4	2.2	1.5
Hallucinogens	23.3	17.7	1.7	1.7
Inhalants	14.9	10.4	0.4	0.3
Any psychotherapeutic	29.0	29.2	6.0	5.9
Alcohol	87.1	85.6	61.4	61.2
“Binge” alcohol use	NA	NA	41.6	41.8
Cigarettes	70.2	64.2	40.2	35.7
Smokeless tobacco	22.0	20.3	4.7	5.4
Cigars	45.2	41.4	11.4	11.3

1.11 Dow Jones Industrial Averages. From the *Stock Performance Guide*, published online by *1stock1* on the website *1Stock1.com*, we found the closing values of the Dow Jones Industrial Averages as of the end of December for the years 2004 through 2013.

Year	Closing
2004	10,783.01
2005	10,717.50
2006	12,463.15
2007	13,264.82
2008	8,776.39
2009	10,428.05
2010	11,577.51
2011	12,217.56
2012	13,104.14
2013	16,576.66

1.12 In-Demand College Majors. In a June 2013 article, published online by **The Street**, B. O’Connell discussed the results of a survey on opportunities for graduating college students. In one aspect of the survey, the following percentage estimates were reported on which college majors were in demand among U.S. firms. [SOURCE: “The Most In-Demand College Majors This Year.” Published by **Career-Builder**, LLC, © 2013.]

Major	Percentage of U.S. firms
Business studies	31%
Computer sciences	24%
Engineering	17%
Health care sciences	10%
Engineering technologies	9%
Math and statistics	9%
Communications	7%
Education	7%
Science technology	6%
Liberal arts	6%

1.13 Thoughts on Evolution. In an article titled “Who has designs on your student’s minds?” (*Nature*, Vol. 434, pp. 1062–1065), author G. Brumfiel postulated that support for Darwinism increases with level of education. The following table provides percentages of U.S. adults, by educational level, who believe that evolution is a scientific theory well supported by evidence.

Education	Percentage
Postgraduate education	65%
College graduate	52%
Some college education	32%
High school or less	20%

- Do you think that this study is descriptive or inferential? Explain your answer.
- If, in fact, the study is inferential, identify the sample and population.

1.14 Big-Banks Break-up. A nationwide survey of 1000 U.S. adults, conducted in March 2013 by **Rasmussen Reports** (field work by **Pulse Opinion Research, LLC**), found that 50% of respondents favored a plan to break up the 12 megabanks, which then controlled about 69% of the banking industry.

- Identify the population and sample for this study.
- Is the percentage provided a descriptive statistic or an inferential statistic? Explain your answer.

1.15 Genocide. The document “American Attitudes about Genocide” provided highlights of a nationwide poll with 1000 participants. The survey, conducted by **Penn Schoen Berland** between June 30 and July 10, 2012, revealed that “66% of respondents believe that genocide is preventable.”

- Is the statement in quotes an inferential or a descriptive statement? Explain your answer.
- Based on the same information, what if the statement had been “66% of Americans believe that genocide is preventable”?

1.16 Vasectomies and Prostate Cancer. Refer to the vasectomy/prostate cancer study discussed in Example 1.5 on page 6.

- How could the study be modified to make it a designed experiment?
- Comment on the feasibility of the designed experiment that you described in part (a).

In Exercises 1.17–1.22, state whether the investigation in question is an observational study or a designed experiment. Justify your answer in each case.

1.17 The Salk Vaccine. In the 1940s and early 1950s, the public was greatly concerned about polio. In an attempt to prevent this disease, Jonas Salk of the University of Pittsburgh developed a polio vaccine. In a test of the vaccine’s efficacy, involving nearly 2 million grade-school children, half of the children received the Salk vaccine; the other half received a placebo, in this case an injection of salt dissolved in water. Neither the children nor the doctors performing the diagnoses knew which children belonged to which group, but an evaluation center did. The center found that the incidence of polio was far less among the children inoculated with the Salk vaccine. From that information, the researchers concluded that the vaccine would be effective in preventing polio for all U.S. school children; consequently, it was made available for general use.

1.18 Do Left-Handers Die Earlier? According to a study published in the *Journal of the American Public Health Association*, left-handed people do not die at an earlier age than right-handed people, contrary to the conclusion of a highly publicized report done 2 years earlier. The investigation involved a 6-year study of 3800 people in East Boston older than age 65. Researchers at **Harvard University** and the **National Institute of Aging** found that the “lefties” and “righties” died at exactly the same rate. “There was no difference, period,” said Dr. J. Guralnik, an epidemiologist at the institute and one of the coauthors of the report.

1.19 Sex, Sleep, and PTSD. In the article, “One’s Sex, Sleep, and Posttraumatic Stress Disorder” (*Biology of Sex Differences*, Vol. 3, No. 29, pp. 1–7), I. Kobayashi et al. study the relationship between one’s sex, sleep patterns, and posttraumatic stress disorder (PTSD) after trauma exposure. The authors report that women have a higher lifetime prevalence of PTSD as well as a greater risk of developing PTSD following trauma exposure. Relationships between sleep and physical health have been documented in a number of studies, and the authors explore the possibility that disruptive sleep habits are common among people with PTSD and also a possible risk factor for the development of PTSD. A questionnaire of men and women with and without PTSD produced data on their sleep habits.

1.20 Aspirin and Cardiovascular Disease. In the article by P. Ridker et al. titled “A Randomized Trial of Low-dose Aspirin in the Primary Prevention of Cardiovascular Disease in Women” (*New England Journal of Medicine*, Vol. 352, pp. 1293–1304), the researchers noted that “We randomly assigned 39,876 initially healthy women 45 years of age or older to receive 100 mg of aspirin or placebo on alternate days and then monitored them for 10 years for a first major cardiovascular event (i.e., nonfatal myocardial infarction, nonfatal stroke, or death from cardiovascular causes).”

1.21 Heart Failure. In the paper “Cardiac-Resynchronization Therapy with or without an Implantable Defibrillator in Advanced Chronic Heart Failure” (*New England Journal of Medicine*, Vol. 350, pp. 2140–2150), M. Bristow et al. reported the results of a study of methods for treating patients who had advanced heart failure due to ischemic or nonischemic cardiomyopathies. A total of 1520 patients were randomly assigned in a 1:2:2 ratio to receive optimal pharmacologic therapy alone or in combination with either a pacemaker or a pacemaker–defibrillator combination. The patients were then observed until they died or were hospitalized for any cause.

1.22 Starting Salaries. The **National Association of Colleges and Employers** (NACE) compiles information on salary offers to new college graduates and publishes the results in *Salary Survey*.

Extending the Concepts and Skills

1.23 Ballistic Fingerprinting. In an on-line press release, ABCNews.com reported that "...73 percent of Americans...favor a law that would require every gun sold in the United States to be test-fired first, so law enforcement would have its fingerprint in case it were ever used in a crime."

- Do you think that the statement in the press release is inferential or descriptive? Can you be sure?
- Actually, ABCNews.com conducted a telephone survey of a random national sample of 1032 adults and determined that 73% of them favored a law that would require every gun sold in the United States to be test-fired first, so law enforcement would have its fingerprint in case it were ever used in a crime. How would you rephrase the statement in the press release to make clear that it is a descriptive statement? an inferential statement?

1.24 Causes of Death. The [National Center for Health Statistics](http://NationalCenterforHealthStatistics.gov) published the following data on the leading causes of death in 2010 in [National Vital Statistics Reports](http://NationalVitalStatisticsReports.gov). Deaths are classified according to the tenth revision of the [International Classification of Diseases](http://InternationalClassificationofDiseases.org). Rates are per 100,000 population.

Rank	Cause of death	Rate
1	Diseases of the heart	193.6
2	Malignant neoplasms	186.2
3	Chronic lower respiratory diseases	44.7
4	Cerebrovascular diseases	41.9
5	Accidents (unintentional injuries)	39.1
6	Alzheimer's disease	27.0
7	Diabetes mellitus	22.4

Do you think that these rates are descriptive statistics or inferential statistics? Explain your answer.

1.25 Medical Testing on Animals. In its Summer 2013 *Animal Action Report*, the [National Anti-Vivisection Society](http://NationalAnti-VivisectionSociety.org) stated that "59% of Americans between the ages of 18 and 29 oppose medical testing on animals." The percentage of 59% was computed from sample data.

- Identify the population under consideration.
- Identify the sample under consideration.
- Is the statement in quotes descriptive or inferential?
- If you wanted to make it clear that the the percentage of 59% was computed from sample data, how would you rephrase the statement in quotes?

1.26 Lobbying Congress. In the special report, "Bitter Pill: Why Medical Bills Are Killing Us" (*TIME*, Vol. 181, No. 8, 2013), S. Brill presented an in-depth investigation of hospital billing practices that reveals why U.S. health care spending is out of control. One of the many statistics provided in the report is that, during the period from 1998 through 2012, the pharmaceutical and health-care-products industries and organizations representing doctors, hospitals, nursing homes, health services, and HMOs spent \$5.36 billion lobbying Congress.

- Under what conditions would the \$5.36 billion lobbying-expenditure figure be a descriptive statistic? Explain your answer.
- Under what conditions would the \$5.36 billion lobbying-expenditure figure be an inferential statistic? Explain your answer.

1.2 Simple Random Sampling

Throughout this book, we present examples of organizations or people conducting studies: A consumer group wants information about the gas mileage of a particular make of car, so it performs mileage tests on a sample of such cars; a teacher wants to know about the comparative merits of two teaching methods, so she tests those methods on two groups of students. This approach reflects a healthy attitude: To obtain information about a subject of interest, plan and conduct a study.

Suppose, however, that a study you are considering has already been done. Repeating it would be a waste of time, energy, and money. Therefore, before planning and conducting a study, do a literature search. You do not necessarily need to go through the entire library or make an extensive Internet search. Instead, you might use an information collection agency that specializes in finding studies on specific topics.

Census, Sampling, and Experimentation

If the information you need is not already available from a previous study, you might acquire it by conducting a **census**—that is, by obtaining information for the entire population of interest. However, conducting a census may be time consuming, costly, impractical, or even impossible.

Two methods other than a census for obtaining information are **sampling** and **experimentation**. In much of this book, we concentrate on sampling. However, we introduce experimentation in Section 1.4, discuss it sporadically throughout the text, and examine it in detail in the chapter *Design of Experiments and Analysis of Variance* (Module C) in the Regression-ANOVA Modules section on the WeissStats site.

If sampling is appropriate, you must decide how to select the sample; that is, you must choose the method for obtaining a sample from the population. Because the

What Does It Mean?

You can often avoid the effort and expense of a study if someone else has already done that study and published the results.