STATISTICS 8E

FOR MANAGEMENT AND ECONOMICS

GERALD KELLER

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PREFACE

Businesses are increasingly using statistical techniques to convert data into information. For students preparing for the business world, it is not enough merely to focus on mastering a diverse set of statistical techniques and calculations. A course and its attendant textbook must provide a complete picture of statistical concepts and their applications to the real world. *Statistics for Management and Economics* is designed to demonstrate that statistics methods are vital tools for today's managers and economists.

To fulfill this objective requires several features that I have built into this book. First, I have included data-driven examples, exercises, and cases that demonstrate statistical applications that are and can be used by marketing managers, financial analysts, accountants, economists, operations managers, and others. Many are accompanied by large and real or realistic data sets. Second, I reinforce the applied nature of the discipline by teaching students how to choose the correct statistical technique. Third, I teach students the concepts that are essential to interpreting the statistical results.

Why I Wrote This Book

Business is complex and requires effective management to succeed. Managing complexity requires many skills. There are more competitors, more places to sell products, and more places to locate workers. As a consequence, effective decision making is more crucial than ever before. On the other hand, managers have more access to larger and more detailed data that are potential sources of information. However, to achieve this potential requires that managers know how to convert data into information. This knowledge extends well beyond the arithmetic of calculating statistics. Unfortunately, this is what most textbooks offer—a series of unconnected techniques illustrated mostly using manual calculations. This continues a pattern that goes back many years. What is required is a complete approach to applying statistical techniques.

When I started teaching statistics in 1971, books demonstrated how to calculate statistics and, in some cases, how various formulas were derived. One reason for doing so was the belief that by doing calculations by hand, students would be able to understand the techniques and concepts. When the first edition of this book was published in 1988, an important goal was to teach students to identify the correct technique. Through the next seven editions, I refined my approach to emphasize interpretation and decision making equally. I divide the solution of statistical problems into three stages and include them in every appropriate example: (1) *identify* the technique, (2) *compute* the statistics, and (3) *interpret* the results. The *compute* stage can be completed in any or all of three ways: manually (with the aid of a calculator), using Excel, and using Minitab. For those courses that wish to use the computer extensively, manual calculations can be played down or omitted completely. Conversely, those that wish to emphasize manual calculations may easily do so, and the computer solutions can be selectively introduced or skipped entirely. This approach is designed to provide maximum flexibility and leaves to the instructor the decision of if and when to introduce the computer.

I believe that my approach offers several advantages.

- Emphasis on identification and interpretation provides students with practical skills they can apply to real problems they will face whether a course uses manual or computer calculations.
- Students learn that statistics is a method of converting data into information. With 866 data files and corresponding problems that ask students to interpret statistical results, students are provided ample opportunities to practice data analysis and decision making.
- The optional use of the computer allows for larger and more realistic exercises and examples.

Placing calculations in the context of a larger problem allows instructors to focus on more important aspects of the decision problem. For example, more attention needs to be devoted to interpreting statistical results. To properly interpret statistical results requires an understanding of the probability and statistical concepts that underlie the techniques and an understanding of the context of the problems. An essential aspect of my approach is teaching students the concepts. I do so in two ways:

- First, there are 19 Java applets that allow students to see for themselves how statistical techniques are derived without going through the sometimes complicated mathematical derivations.
- Second, I have created a number of Excel worksheets that allow students to perform "what-if" analyses. Students can easily see the effect of changing the components of a statistical technique, such as the effect of increasing the sample size.

Efforts to teach statistics as a valuable and necessary tool in business and economics are made more difficult by the positioning of the statistics course in most curricula. The required statistics course in most undergraduate programs appears in the first or second year. In many graduate programs, the statistics course is offered in the first semester of a three-semester program and the first year of a two-year program. Accounting, economics, finance, human resource management, marketing, and operations management are usually taught after the statistics course. Consequently, most students will not be able to understand the general context of the statistical application. This deficiency is addressed in this book by "Applications in . . ." sections, subsections, and boxes. Illustrations of statistical applications in business with which students are unfamiliar are preceded by an explanation of the background material.

- For example, to illustrate graphical techniques, we use an example that compares the histograms of the returns on two different investments. To explain what financial analysts look for in the histograms requires an understanding that risk is measured by the amount of variation in the returns. The example is preceded by an "Applications in Finance" box that discusses how return on investment is computed and used.
- Later when I present the normal distribution, I feature another "Applications in Finance" box to show why the standard deviation of the returns measures the risk of that investment.
- Thirty-six application boxes are scattered throughout the book.

Some applications are so large that I devote an entire section or subsection to the topic. For example, in the chapter that introduces the confidence interval estimator of a proportion, I also present market segmentation. In that section, I show how the confidence

interval estimate of a population proportion can yield estimates of the sizes of market segments. In other chapters, I illustrate various statistical techniques by showing how marketing managers can apply these techniques to determine the differences that exist between market segments. There are seven such sections and two subsections in this book. The "Applications in . . ." segments provide great motivation to the student who asks, How will I ever use this technique?

New in This Edition

In the first seven editions of this book, we offered two review chapters. The first reviewed inference about one and two populations of interval and nominal data. This was originally designed to be a pre-midterm test review. The second appeared at the end of the book and was used to review all the inferential material before the final exam. I decided that in this edition two reviews were not enough. Consequently, I have six review appendixes. These appear at the ends of Chapters 13, 14, 15, 16, 17, and 19, and each provides a list of the techniques covered to that point, a flowchart, exercises, and cases.

Nonparametric statistical techniques (Chapter 19) are presented immediately after the chapter on multiple regression model building.

Appendix 19 provides a complete list of all the statistical techniques (not including forecasting and statistical process control, a flowchart, review exercises, and cases).

The last chapter is now Chapter 23, which is a brief summary of the book and a list of the 12 statistical concepts needed by students after the final exam.

Chapters 2 and 4 now feature more real data. These include the following:

1. The question of global warming (monthly temperature anomalies from three sources dating back to 1880 and carbon-dioxide readings)
2. Updated team payrolls and the number of team wins in baseball, football, basketball, and hockey
3. The actual prices of gasoline and oil, allowing students to see whether real prices have risen and the relationship between the price of oil and the price of gasoline
4. The market model has been moved from Chapter 17 (in the 7th edition) to Chapter 4 with actual data from the NYSE, NASDAQ, and the TSE

I've created many new examples and exercises. Here are the numbers for the 8th edition: textbook: 153 solved examples, 1,768 exercises, 34 cases, 841 data sets (with code names and permanent names); 35 CD appendixes: 37 solved examples, 98 exercises, and 25 data sets for a grand total of 190 worked examples, 1,866 exercises, 34 cases, and 866 data sets.

GUIDED BOOK TOUR

Data-Driven: The Big Picture

Solving statistical problems begins with a problem and data. The ability to select the right method by problem objective and data type is **a valuable tool for business.** Since business decisions are driven by data, students will leave this course equipped with the tools they need to make effective, informed decisions in all areas of the business world.

EXAMPLE 13.4

DATA
Xm13-04

Comparing Salary Offers for Finance and Marketing MBA Majors, Part 1

In the last few years a number of web-based companies that offer job placement services have been created. The manager of one such company wanted to investigate the job offers recent MBAs were obtaining. In particular, she wanted to know whether finance majors were being offered higher salaries than marketing majors. In a preliminary study, she randomly sampled 50 recently graduated MBAs, half of whom majored in finance and half in marketing. From each she obtained the highest salary offer (including benefits). These data are listed here. Can we infer that finance majors obtain higher salary offers than do marketing majors among MBAs?

Highest Salary Offer Made to Finance Majors

61,228	51,836	20,620	73,356	84,186	79,782	29,523	80,645	76,125
62,531	77,073	86,705	70,286	63,196	64,358	47,915	86,792	75,155
65,948	29,392	96,382	80,644	51,389	61,955	63,573		

Highest Salary Offer Made to Marketing Majors

73,361	36,956	63,627	71,069	40,203	97,097	49,442	75,188	59,854
79,816	51,943	35,272	60,631	63,567	69,423	68,421	56,276	47,510
58,925	78,704	62,553	81,931	30,867	49,091	48,843		

SOLUTION

IDENTIFY

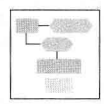
The objective is to compare two populations of interval data. The parameter is the difference between two means $\mu_1 - \mu_2$ (where μ_1 = mean highest salary offer to finance majors and μ_2 = mean highest salary offer to marketing majors). Because we want to

Identify the Correct Technique

Examples introduce the first crucial step in this three-step (Identify-Compute-Interpret) approach. Every example's solution begins by examining the data type and problem objective and then identifying the right technique to solve the problem.

Factors That Identify the t-Test and Estimator of μ_D

1. **Problem objective:** Compare two populations
2. **Data type:** Interval
3. **Descriptive measurement:** Central location
4. **Experimental design:** Matched pairs



Factors That Identify . . . boxes are found in each chapter after a technique or concept has been introduced. These boxes allow students to see a technique's essential requirements and give them a way to easily review their understanding. These essential requirements are revisited in the review appendixes, where they are illustrated in flowcharts.

APPENDIX 14 / REVIEW OF CHAPTERS 12 TO 14

The number of techniques introduced in Chapters 12 to 14 is up to 23. As we did in Appendix 13, we provide a table of the techniques with formulas and required conditions, a flowchart to help you identify the correct technique, and 18 exercises to give you practice in how to choose the appropriate method. The table and the flowchart have been amended to include the three analysis of variance techniques introduced in this chapter and the three multiple comparison methods.

TABLE **A14.1** Summary of Statistical Techniques in Chapters 12 to 14

t-test of μ
Estimator of μ (including small population estimator of μ and large and small population estimators of $N\mu$)
χ^2-test of σ^2
Estimator of σ^2
z-test of p
Estimator of p (including small population estimator of p and large and small population estimators of Np)
Equal-variances t-test of $\mu_1 - \mu_2$
Equal-variances estimator of $\mu_1 - \mu_2$
Unequal-variances t-test of $\mu_1 - \mu_2$
Unequal-variances estimator of $\mu_1 - \mu_2$
t-test of μ_D
Estimator of μ_D
F-test of σ_1^2/σ_2^2
Estimator of σ_1^2/σ_2^2
z-test of $p_1 - p_2$ (Case 1)
z-test of $p_1 - p_2$ (Case 2)
Estimator of $p_1 - p_2$
One-way analysis of variance (including multiple comparisons)
Two-way (randomized blocks) analysis of variance
Two-factor analysis of variance

Review of Descriptive Techniques shows how the different types of data can be described graphically. Exercises on the CD-ROM let students practice what they've learned.

A GUIDE TO STATISTICAL TECHNIQUES

Problem Objectives

DATA TYPES	Describe a Population	Compare Two Populations	Compare Two or More Populations	Analyze Relationship between Two Variables
Interval	Histogram **Section 2.3** Ogive **Section 2.3** Stem-and-leaf **Section 2.3** Box plot **Section 4.3** Mean, median, and mode **Section 4.1** Range, variance, and standard deviation **Section 4.2** Percentiles and quartiles **Section 4.3** t-test and estimator of a mean **Section 12.1** Chi-squared test and estimator of a variance **Section 12.2**	Equal-variances t-test and estimator of the difference between two means: independent samples **Section 13.1** Unequal-variances t-test and estimator of the difference between two means: independent samples **Section 13.1** t-test and estimator of mean difference **Section 13.3** F-test and estimator of ratio of two variances **Section 13.4** Wilcoxon rank sum test **Section 19.1** Wilcoxon signed rank sum test **Section 19.2**	One-way analysis of variance **Section 14.1** LSD multiple comparison method **Section 14.2** Tukey's multiple comparison method **Section 14.2** Two-way analysis of variance **Section 14.4** Two-factor analysis of variance **Section 14.5** Kruskal-Wallis test **Section 19.3** Friedman test **Section 19.4**	Scatter diagram **Section 2.6** Covariance **Section 4.4** Coefficient of correlation **Section 4.4** Coefficient of determination **Section 4.4** Least squares line **Section 4.4** Simple linear regression and correlation **Chapter 16** Spearman rank correlation **Section 19.5**
Nominal	Frequency distribution **Section 2.2** Bar chart **Section 2.2** Pie chart **Section 2.2** Line chart **Section 2.4** z-test and estimator of a proportion **Section 12.3** Chi-squared goodness-of-fit test **Section 15.1**	z-test and estimator of the difference between two proportions **Section 13.5** Chi-squared test of a contingency table **Section 15.2**	Chi-squared test of a contingency table **Section 15.2**	Cross-classification table **Section 2.5** Chi-squared test of a contingency table **Section 15.2**
Ordinal	Box plot **Section 4.3** Median **Section 4.1** Percentiles and quartiles **Section 4.3**	Wilcoxon rank sum test **Section 19.1** Sign test **Section 19.2**	Kruskal-Wallis test **Section 19.3** Friedman test **Section 19.4**	Spearman rank correlation **Section 19.5**

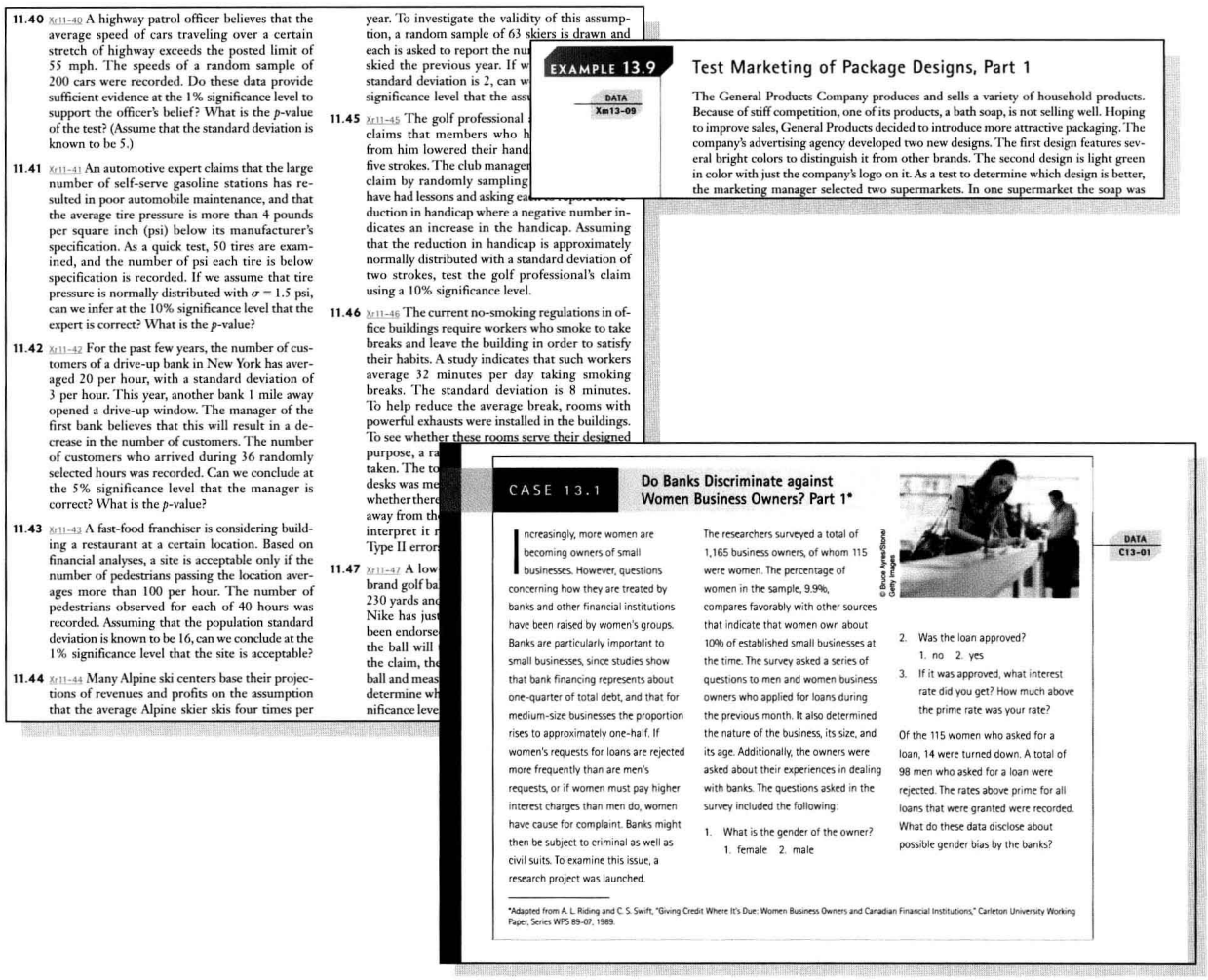
A Guide to Statistical Techniques, found on the inside front cover of the text, pulls everything together into one useful table that helps students identify which technique to perform based on the problem objective and data type.

More Data Sets

A total of 866 data sets available on the CD-ROM provide ample practice. These data sets often contain real or realistic data, are typically large, and are formatted for Excel, Minitab, SPSS, SAS, JMP IN, and ASCII.

DATA C13-01

Prevalent use of data in examples, exercises, and cases is highlighted by the accompanying data icon, which alerts students to go to the CD.



11.40 Xr11-40 A highway patrol officer believes that the average speed of cars traveling over a certain stretch of highway exceeds the posted limit of 55 mph. The speeds of a random sample of 200 cars were recorded. Do these data provide sufficient evidence at the 1% significance level to support the officer's belief? What is the *p*-value of the test? (Assume that the standard deviation is known to be 5.)

11.41 Xr11-41 An automotive expert claims that the large number of self-serve gasoline stations has resulted in poor automobile maintenance, and that the average tire pressure is more than 4 pounds per square inch (psi) below its manufacturer's specification. As a quick test, 50 tires are examined, and the number of psi each tire is below specification is recorded. If we assume that tire pressure is normally distributed with $\sigma = 1.5$ psi, can we infer at the 10% significance level that the expert is correct? What is the *p*-value?

11.42 Xr11-42 For the past few years, the number of customers of a drive-up bank in New York has averaged 20 per hour, with a standard deviation of 3 per hour. This year, another bank 1 mile away opened a drive-up window. The manager of the first bank believes that this will result in a decrease in the number of customers. The number of customers who arrived during 36 randomly selected hours was recorded. Can we conclude at the 5% significance level that the manager is correct? What is the *p*-value?

11.43 Xr11-43 A fast-food franchiser is considering building a restaurant at a certain location. Based on financial analyses, a site is acceptable only if the number of pedestrians passing the location averages more than 100 per hour. The number of pedestrians observed for each of 40 hours was recorded. Assuming that the population standard deviation is known to be 16, can we conclude at the 1% significance level that the site is acceptable?

11.44 Xr11-44 Many Alpine ski centers base their projections of revenues and profits on the assumption that the average Alpine skier skis four times per

EXAMPLE 13.9

DATA Xm13-09

Test Marketing of Package Designs, Part 1

The General Products Company produces and sells a variety of household products. Because of stiff competition, one of its products, a bath soap, is not selling well. Hoping to improve sales, General Products decided to introduce more attractive packaging. The company's advertising agency developed two new designs. The first design features several bright colors to distinguish it from other brands. The second design is light green in color with just the company's logo on it. As a test to determine which design is better, the marketing manager selected two supermarkets. In one supermarket the soap was

CASE 13.1

Do Banks Discriminate against Women Business Owners? Part 1*

Increasingly, more women are becoming owners of small businesses. However, questions concerning how they are treated by banks and other financial institutions have been raised by women's groups. Banks are particularly important to small businesses, since studies show that bank financing represents about one-quarter of total debt, and that for medium-size businesses the proportion rises to approximately one-half. If women's requests for loans are rejected more frequently than are men's requests, or if women must pay higher interest charges than men do, women have cause for complaint. Banks might then be subject to criminal as well as civil suits. To examine this issue, a research project was launched.

The researchers surveyed a total of 1,165 business owners, of whom 115 were women. The percentage of women in the sample, 9.9%, compares favorably with other sources that indicate that women own about 10% of established small businesses at the time. The survey asked a series of questions to men and women business owners who applied for loans during the previous month. It also determined the nature of the business, its size, and its age. Additionally, the owners were asked about their experiences in dealing with banks. The questions asked in the survey included the following:

1. What is the gender of the owner?
   1. female 2. male

© Bruce Ayres/Stone/Getty Images

2. Was the loan approved?
   1. no 2. yes
3. If it was approved, what interest rate did you get? How much above the prime rate was your rate?

Of the 115 women who asked for a loan, 14 were turned down. A total of 98 men who asked for a loan were rejected. The rates above prime for all loans that were granted were recorded. What do these data disclose about possible gender bias by the banks?

DATA C13-01

*Adapted from A. L. Riding and C. S. Swift, "Giving Credit Where It's Due: Women Business Owners and Canadian Financial Institutions," Carleton University Working Paper, Series WPS 89-07, 1989.

Flexible to Use

Although many texts today incorporate the use of the computer, ***Statistics for Management and Economics*** is designed for maximum flexibility and ease of use for both instructors and students. To this end, parallel illustration of both manual and computer printouts is provided throughout the text. This approach **allows you to choose** which, if any, computer program to use. Regardless of the method or software you choose, the output and instructions that you need are provided! Also, instructions for both SPSS and JMP IN can be found on the Keller Online Book Companion Website at http://www.academic.cengage.com/bstatistics/keller.

Compute the Statistics

Once the correct technique has been identified, examples take students to the next level within the solution by asking them to compute the statistics.

Manual calculation of the problem is presented first in each "Compute" section of the examples.

Step-by-step instructions in the use of **Excel** and **Minitab** immediately follow the manual presentation. Instructions appear in the book with the printouts—there's no need to incur the extra expense for separate software manuals. SPSS and JMP IN are also available at no cost on the Keller companion Website.

COMPUTE

MANUALLY

From the data we determine

$$\sum x_i = 1{,}254{,}240 \quad \text{and} \quad \sum x_i^2 = 9{,}232{,}718{,}166$$

Thus,

$$\bar{x} = \frac{\sum x_i}{n} = \frac{1{,}254{,}240}{209} = 6{,}001$$

and

$$s^2 = \frac{\sum x_i^2 - \frac{(\sum x_i)^2}{n}}{n-1} = \frac{9{,}232{,}718{,}166 - \frac{(1{,}254{,}240)^2}{209}}{209-1} = 8{,}201{,}144$$

EXCEL

	A	B	C	D
1	t-Estimate: Mean			
2				
3				Taxes
4	Mean			6001
5	Standard Deviation			2864
6	LCL			5611
7	UCL			6392

INSTRUCTIONS

1. Type or import the data into one column. (Open Xm12-02.)
2. Click **Add-Ins, Data Analysis Plus,** and **t-Estimate: Mean.**
3. Specify the **Input Range** (A1:A210) and α (.05).

If you know the sample mean, sample standard deviation, and sample size, you can use the **t-Estimate_Mean** worksheet in the **Estimators** workbook, which can also be employed for what-if analyses.

MINITAB

One-Sample T: Taxes

Variable	N	Mean	StDev	SE Mean	95% CI
Taxes	209	6001	2864	198	(5611, 6392)

INSTRUCTIONS

1. Type or import the data into one column. (Open Xm12-02.)
2. Click **Stat, Basic Statistics,** and **1-Sample t . . . .**
3. Select or type the variable name in the **Samples in columns** box (Taxes) and click **Options . . . .**
4. Specify the **Confidence level** (.95) and **not equal** for the **Alternative.**

Appendix A provides summary statistics that allow students to solve applied exercises with data files by hand. Offering unparalleled flexibility, this feature allows virtually *all* exercises to be solved by hand!

APPENDIX A

Data File Sample Statistics

Chapter 10
10.30 $\bar{x} = 252.38$
10.31 $\bar{x} = 1810.16$
10.32 $\bar{x} = 12.10$
10.33 $\bar{x} = 10.21$
10.34 $\bar{x} = .510$
10.35 $\bar{x} = 26.81$
10.36 $\bar{x} = 19.28$
10.37 $\bar{x} = 15.00$
10.38 $\bar{x} = 585,063$
10.39 $\bar{x} = 14.98$
10.40 $\bar{x} = 27.19$

Chapter 11
11.35 $\bar{x} = 5065$
12.88 $n(1) = 518, n(2) = 132$
12.89 $n(1) = 48, n(2) = 31, n(3) = 45, n(4) = 269, n(5) = 1984$
12.90 $n(1) = 81, n(2) = 47, n(3) = 167, n(4) = 146, n(5) = 34$
12.91 $n(1) = 63, n(2) = 125, n(3) = 45, n(4) = 87$
12.92 $n(1) = 418, n(2) = 536, n(3) = 882$
12.93 $n(1) = 290, n(2) = 35$
12.94 $n(1) = 72, n(2) = 77, n(3) = 37, n(4) = 50, n(5) = 176$
12.95 $n(1) = 289, n(2) = 51$
12.98 $\bar{x} = 229.18, s = 67.36, n = 500$
12.101 $\bar{x} = 313.47, s = 55.53, n = 100$
13.25 General: $\bar{x}_1 = 53.05, s_1 = 3.06, n_1 = 79$; Pediatrics: $\bar{x}_2 = 51.67, s_2 = 3.64, n_2 = 91$
13.26 Applied: $\bar{x}_1 = 130.93, s_1 = 31.99, n_1 = 100$; Contacted: $\bar{x}_2 = 126.14, s_2 = 26.00, n_2 = 100$
13.27 New: $\bar{x}_1 = 73.60, s_1 = 15.60, n_1 = 20$; Existing: $\bar{x}_2 = 69.20, s_2 = 15.06, n_2 = 20$
13.28 Fixed: $\bar{x}_1 = 60,245, s_1 = 10,506, n_1 = 90$; Commission: $\bar{x}_2 = 63,563, s_2 = 10,755,90$

CD APPENDIX F / Hypergeometric Distribution

A hypergeometric experiment is an experiment where a sample of n items is taken without replacement from a finite population of N items, each of which is classified as a success or a failure. (If the sampling is done with replacement the experiment is binomial.) Let k = number of successes and $(N\text{-}k)$ is the number of failures in the population.

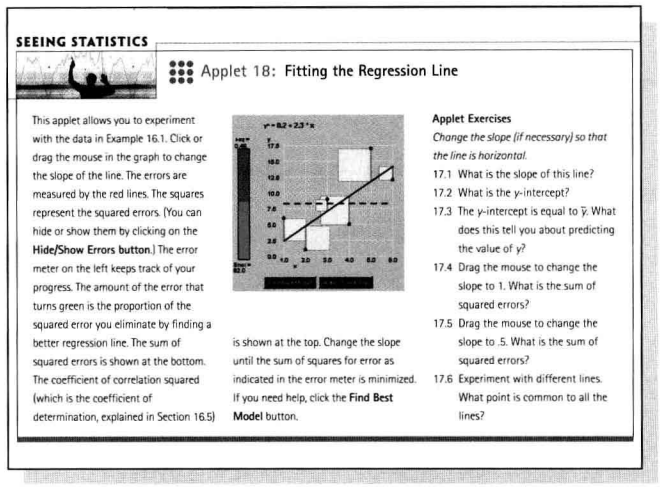
Hypergeometric Random Variable
The **hypergeometric random variable** is the number of success in a hypergeometric experiment.

A hypergeometric random variable is a discrete random variable that can take on any one of the values $0, 1, 2, \ldots, n$. The hypergeometric probability distribution can be derived using the multiplication, addition, and complement rules or more easily by applying a probability tree.

In addition, **CD Appendixes** are included on the CD-ROM. There are 35 appendixes covering such topics as the hypergeometric distribution, index numbers, and more detailed instructions for Excel and Minitab.

Flexible Learning

For visual learners, the **Seeing Statistics** feature refers to online Java applets developed by Gary McClelland of the University of Colorado, which use the interactive nature of the Web to illustrate key statistical concepts. With 19 applets and 82 follow-up exercises, students can explore and interpret statistical concepts, leading them to greater intuitive understanding. All Seeing Statistics applets can be found on the accompanying CD-ROM.


SEEING STATISTICS

Applet 18: Fitting the Regression Line

This applet allows you to experiment with the data in Example 16.1. Click or drag the mouse in the graph to change the slope of the line. The errors are measured by the red lines. The squares represent the squared errors. (You can hide or show them by clicking on the **Hide/Show Errors button**.) The error meter on the left keeps track of your progress. The amount of the error that turns green is the proportion of the squared error you eliminate by finding a better regression line. The sum of squared errors is shown at the bottom. The coefficient of correlation squared (which is the coefficient of determination, explained in Section 16.5) is shown at the top. Change the slope until the sum of squares for error as indicated in the error meter is minimized. If you need help, click the **Find Best Model** button.

Applet Exercises

Change the slope (if necessary) so that the line is horizontal.

17.1 What is the slope of this line?

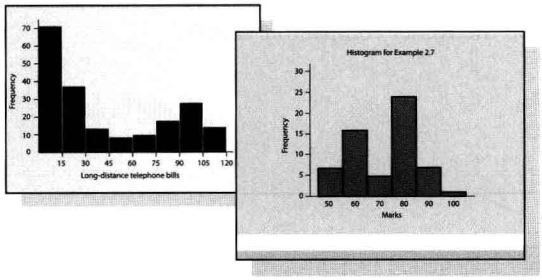
17.2 What is the y-intercept?

17.3 The y-intercept is equal to $\bar{y}$. What does this tell you about predicting the value of y?

17.4 Drag the mouse to change the slope to 1. What is the sum of squared errors?

17.5 Drag the mouse to change the slope to .5. What is the sum of squared errors?

17.6 Experiment with different lines. What point is common to all the lines?



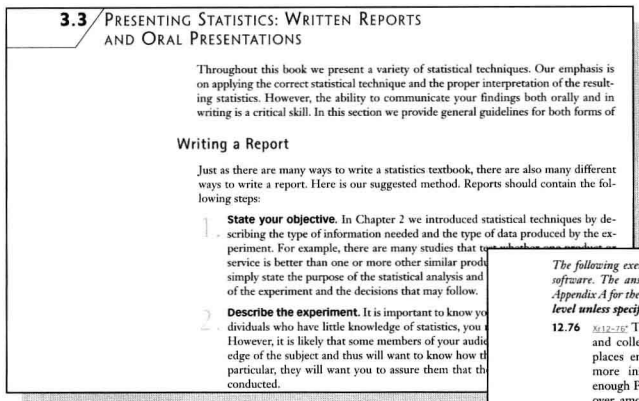
Ample use of graphics provides students many opportunities to see statistics in all its forms. In addition to manually presented figures throughout the text, Excel and Minitab graphic outputs are given for students to compare to their own results.

APPLIED: BRIDGING THE GAP

In the real world, it is not enough to know *how* to generate the statistics. To be truly effective, a business person must also know how to **interpret and articulate** the results. Furthermore, students need a framework to understand and apply statistics **within a realistic setting** by using realistic data in exercises, examples, and case studies.

Interpret the Results

Examples round out the final component of the Identify-Compute-Interpret approach by asking students to interpret the results in the context of a business-related decision. This final step motivates and shows how statistics is used in everyday business situations.



3.3 PRESENTING STATISTICS: WRITTEN REPORTS AND ORAL PRESENTATIONS

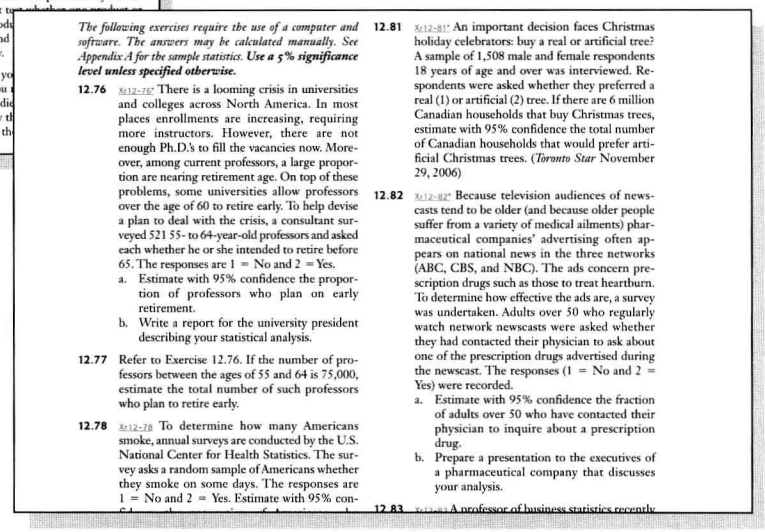
Throughout this book we present a variety of statistical techniques. Our emphasis is on applying the correct statistical technique and the proper interpretation of the resulting statistics. However, the ability to communicate your findings both orally and in writing is a critical skill. In this section we provide general guidelines for both forms of

Writing a Report

Just as there are many ways to write a statistics textbook, there are also many different ways to write a report. Here is our suggested method. Reports should contain the following steps:

1. **State your objective.** In Chapter 2 we introduced statistical techniques by describing the type of information needed and the type of data produced by the experiment. For example, there are many studies that t... service is better than one or more other similar prod... simply state the purpose of the statistical analysis and ... of the experiment and the decisions that may follow.
2. **Describe the experiment.** It is important to know yo... dividuals who have little knowledge of statistics, you ... However, it is likely that some members of your audi... edge of the subject and thus will want to know how t... particular, they will want you to assure them that th... conducted.

New coverage of writing reports and creating presentations in Chapter 3 sets up exercises that ask students to articulate their findings to nonstatisticians.



The following exercises require the use of a computer and software. The answers may be calculated manually. See Appendix A for the sample statistics. ***Use a 5% significance level unless specified otherwise.***

12.76 X12-76* There is a looming crisis in universities and colleges across North America. In most places enrollments are increasing, requiring more instructors. However, there are not enough Ph.D.'s to fill the vacancies now. Moreover, among current professors, a large proportion are nearing retirement age. On top of these problems, some universities allow professors over the age of 60 to retire early. To help devise a plan to deal with the crisis, a consultant surveyed 521 55- to 64-year-old professors and asked each whether he or she intended to retire before 65. The responses are 1 = No and 2 = Yes.
a. Estimate with 95% confidence the proportion of professors who plan on early retirement.
b. Write a report for the university president describing your statistical analysis.

12.77 Refer to Exercise 12.76. If the number of professors between the ages of 55 and 64 is 75,000, estimate the total number of such professors who plan to retire early.

12.78 X12-78 To determine how many Americans smoke, annual surveys are conducted by the U.S. National Center for Health Statistics. The survey asks a random sample of Americans whether they smoke on some days. The responses are 1 = No and 2 = Yes. Estimate with 95% con-

12.81 X12-81* An important decision faces Christmas holiday celebrators: buy a real or artificial tree? A sample of 1,508 male and female respondents 18 years of age and over was interviewed. Respondents were asked whether they preferred a real (1) or artificial (2) tree. If there are 6 million Canadian households that buy Christmas trees, estimate with 95% confidence the total number of Canadian households that would prefer artificial Christmas trees. (*Toronto Star* November 29, 2006)

12.82 X12-82* Because television audiences of newscasts tend to be older (and because older people suffer from a variety of medical ailments) pharmaceutical companies' advertising often appears on national news in the three networks (ABC, CBS, and NBC). The ads concern prescription drugs such as those to treat heartburn. To determine how effective the ads are, a survey was undertaken. Adults over 50 who regularly watch network newscasts were asked whether they had contacted their physician to ask about one of the prescription drugs advertised during the newscast. The responses (1 = No and 2 = Yes) were recorded.
a. Estimate with 95% confidence the fraction of adults over 50 who have contacted their physician to inquire about a prescription drug.
b. Prepare a presentation to the executives of a pharmaceutical company that discusses your analysis.

12.83 X12-83 A professor of business statistics recently

An Applied Approach

With **Applications in . . .** sections and boxes, ***Statistics for Management and Economics*** now includes 45 **applications** (in finance, marketing, operations management, human resources, economics, and accounting) highlighting how statistics is used in those professions. For example, "Applications in Accounting: Auditing" shows how statistics are used to estimate several parameters in auditing and uses a real application (GAO). An optional section, "Applications in Professional Sports: Baseball" contains a subsection on the success of the Oakland Athletics.

In addition to sections and boxes, **Applications in . . . exercises** can be found within the exercise sections to further reinforce the big picture.

4.5 (OPTIONAL) APPLICATIONS IN PROFESSIONAL SPORTS: BASEBALL

In the chapter-opening example we provided the payrolls and the number of wins from the 2006 season. We discovered that there is a weak positive linear relationship between number of wins and payroll. The strength of the linear relationship tells us that some teams with large payrolls are not successful on the field, whereas some teams with small payrolls win a large number of games. It would appear that while the amount of money teams spend is a factor, another factor is *how* teams spend their money. In this section we will analyze the five seasons between 2002 and 2006 to see how small-payroll teams succeed.

Professional sports in North America is a multibillion dollar business. The cost of a new franchise in baseball, football, basketball, and hockey is often in the hundreds of millions of dollars. Although some teams are financially successful during losing sea-

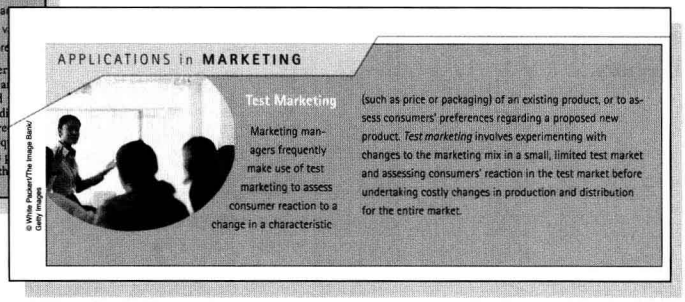
APPLICATIONS in **HUMAN RESOURC**

Severance Pay

© Xavier Borgohi/ The Image Bank/Getty Images

In most firms the entire issue of compensation falls into the domain of the human resources manager. The manager must ensure that the method used to determine compensation contributes to the firm's objectives. Moreover, the firm needs to ensure that discrimination or bias of any kind is not a factor. Another function of the personnel manager is to develop severance packages for employees whose services are no longer needed because of downsizing or merger. The size and nature of severance is rarely pa... any working agreement and must be determined by a v... of factors. Regression analysis is often useful in this are...

17.5 X17-05 When one company buys another ... pany, it is not unusual that some workers a... minated. The severance benefits offered ... laid-off workers are often the subject of di... Suppose that the Laurier Company re... bought the Western Company and subseq... terminated 20 of Western's employees. As ... the buyout agreement, it was promised th...



APPLICATIONS in **MARKETING**

Test Marketing

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Marketing managers frequently make use of test marketing to assess consumer reaction to a change in a characteristic (such as price or packaging) of an existing product, or to assess consumers' preferences regarding a proposed new product. *Test marketing* involves experimenting with changes to the marketing mix in a small, limited test market and assessing consumers' reaction in the test market before undertaking costly changes in production and distribution for the entire market.

SSA Envelope Plan

DATA Xm11-00

Federal Express (FedEx) sends invoices to customers requesting payment within 30 days. The bill lists an address and customers are expected to use their own envelopes to return their payments. Currently the mean and standard deviation of the amount of time taken to pay bills are 24 days and 6 days, respectively. The chief financial officer (CFO) believes that including a stamped self-addressed (SSA) envelope would decrease the amount of time. She calculates that the improved cash flow from a 2-day decrease in the payment period would pay for the costs of the envelopes and stamps. Any further decrease in the payment period would generate a profit. To test her belief, she randomly selects 220 customers and includes a stamped self-addressed envelope with their invoices. The numbers of days until payment is received were recorded. Can the CFO conclude that the plan will be profitable?

© Mark Richards/PhotoEdit

After we've introduced the required tools, we'll return to this question and answer it. (See page 358).

Chapter-opening examples and solutions present compelling discussions of how the techniques and concepts introduced in that chapter are applied to real-world problems. These examples are then revisited with a solution as each chapter unfolds, applying the methodologies introduced in the chapter.

SSA Envelope Plan: Solution

© Mark Richards/PhotoEdit

IDENTIFY

The objective of the study is to draw a conclusion about the mean payment period. Thus, the parameter to be tested is the population mean μ. We want to know whether there is enough statistical evidence to show that the population mean is less than 22 days. Thus, the alternative hypothesis is

H_1: $\mu < 22$

The null hypothesis is

H_0: $\mu = 22$

The test statistic is the only one we've presented thus far. It is

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

COMPUTE

MANUALLY

To solve this problem manually we need to define the rejection region, which requires us to specify a significance level. A 10% significance level is deemed to be appropriate. (We'll discuss our choice later.)

CASE 13.1 Do Banks Discriminate against Women Business Owners? Part 1*

© Bruce Ayres/Stone/Getty Images

Increasingly, more women are becoming owners of small businesses. However, questions concerning how they are treated by banks and other financial institutions have been raised by women's groups. Banks are particularly important to small businesses, since studies show that bank financing represents about one-quarter of total debt, and that for

The researchers surveyed a total of 1,165 business owners, of whom 115 were women. The percentage of women in the sample, 9.9%, compares favorably with other sources that indicate that women own about 10% of established small businesses at the time. The survey asked a series of questions to men and women business owners who applied for loans during

2. Was the loan approved?
   1. no 2. yes
3. If it was approved, what interest rate did you get? How much above

Many of the **examples, exercises, and cases are based on actual studies** performed by statisticians and published in journals, newspapers, and magazines, or presented at conferences. Many data files were re-created to produce the original results.

A total of 1,866 exercises, many of them new or updated, offer ample practice for students to use statistics in an applied context.

CHAPTER SUMMARY

The analysis of variance allows us to test for differences between populations when the data are interval. The analyses of the results of three different experimental designs were presented in this chapter. They were the one-way analysis of variance. The second experimental design also defines the treatments on the basis of one factor. However, the randomized block design uses data gathered by observing the results of a matched or blocked experiment (two-way analysis of variance). The third design is the two-factor experiment wherein the treatments are defined as the combinations of the levels of two factors. All the analyses of variance are based on partitioning the total sum of squares into sources of variation from which the mean squares and *F*-statistics are computed.

Additionally, we introduced three multiple comparison methods, which allow us to determine which means differ in the one-way analysis of variance.

Finally, we described an important application in operations management that employs the analysis of variance.

IMPORTANT TERMS

Analysis of variance 514
Treatment means 514
One-way analysis of variance 514
Response variable 516
Responses 516
Experimental units 516
Factor 516
Level 516
Between-treatments variation 516
Sum of squares for treatments (SST) 516
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Randomized block design 539
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Random effects analysis of variance 540
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Complete factorial experiment 551
Replicate 551
Balanced 551

RESOURCES

Learning Resources

Student's Suite CD-ROM (ISBN 0-324-56950-5). Included with every new copy of the text, this learning tool includes interactive concept simulation exercises from *Seeing Statistics*, *Data Analysis Plus* add-in, as well as a new Treeplan add-in, 866 data sets, optional topics, and 35 CD appendixes.

Companion Website accessible via www.academic.cengage.com/bstatistics/keller. At the site, select "Student Book Companion Sites," where you will find the link to the *Statistics for Management and Economics 8e* Companion Website among the introductory statistics titles. View a host of resources, including SPSS and JMP software instruction and data sets, relevant links and resources, and more.

Student Solutions Manual (ISBN: 0-324-56953-X). Students can check their understanding with this manual, which includes worked solutions of even-numbered exercises from the text.

Teaching Resources

For a complete listing of our extensive instructor resources, please go to www.academic.cengage.com or contact your local Thomson sales representative.

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BRIEF CONTENTS