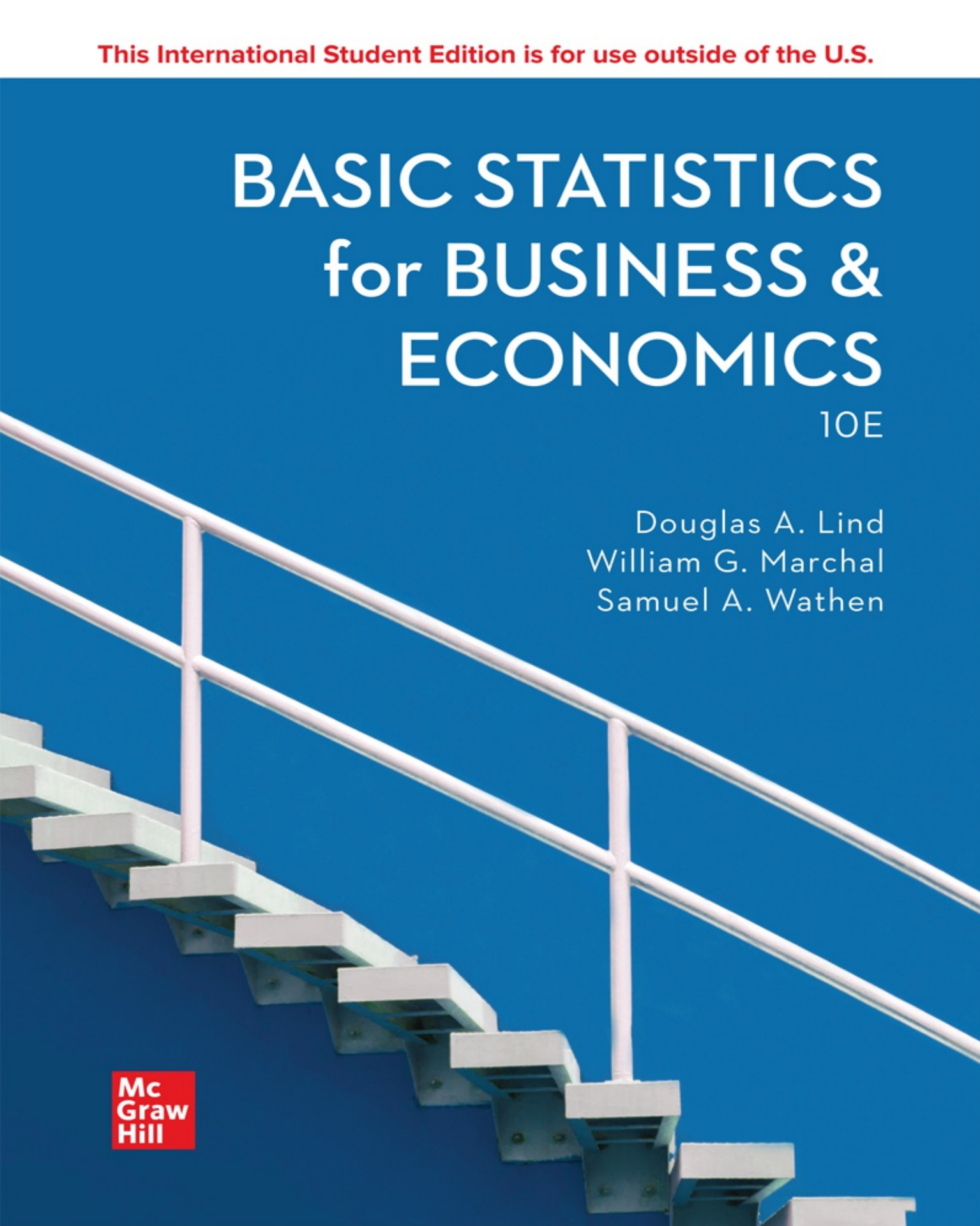


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BASIC STATISTICS for BUSINESS & ECONOMICS

10E

Douglas A. Lind
William G. Marchal
Samuel A. Wathen



Mc
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TENTH EDITION

DOUGLAS A. LIND

Coastal Carolina University and The University of Toledo

WILLIAM G. MARCHAL

The University of Toledo

SAMUEL A. WATHEN

Coastal Carolina University





BASIC STATISTICS FOR BUSINESS AND ECONOMICS

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DEDICATION

To Jane, my wife and best friend, and our sons, their wives, and our grandchildren: Mike and Sue (Steve and Courtney), Steve and Kathryn (Kennedy, Jake, and Brady), and Mark and Sarah (Jared, Drew, and Nate).

Douglas A. Lind

To Margaret Marchal Nicholson and Andrea.

William G. Marchal

To my wonderful family: Barb, Hannah, and Isaac.

Samuel A. Wathen

A NOTE FROM THE AUTHORS

Over the years, we received many compliments on this text and understand that it's a favorite among students. We accept that as the highest compliment and continue to work very hard to maintain that status.

The objective of *Basic Statistics for Business & Economics* is to provide students majoring in management, marketing, finance, accounting, economics, and other fields of business administration with an introductory survey of descriptive and inferential statistics. To illustrate the application of statistics, we use many examples and exercises that focus on business applications, but also relate to the current world of the college student. A previous course in statistics is not necessary, and the mathematical requirement is first-year algebra.

In this text, we show beginning students every step needed to be successful in a basic statistics course. This step-by-step approach enhances performance, accelerates preparedness, and significantly improves motivation. Understanding the concepts, seeing and doing plenty of examples and exercises, and comprehending the application of statistical methods in business and economics are the focus of this book.

The first edition of this text was published in 1967. At that time, locating relevant business data was difficult. That has changed! Today, locating data is not a problem. The number of items you purchase at the grocery store is automatically recorded at the checkout counter. Phone companies track the time of our calls, the length of calls, and the identity of the person called. Credit card companies maintain information on the number, time and date, and amount of our purchases. Medical devices automatically monitor our heart rate, blood pressure, and temperature from remote locations. A large amount of business information is recorded and reported almost instantly. CNN, *USA Today*, and MSNBC, for example, all have websites that track stock prices in real time.

Today, the practice of data analytics is widely applied to “big data.” The practice of data analytics requires skills and knowledge in several areas. Computer skills are needed to process large volumes of information. Analytical skills are needed to evaluate, summarize, organize, and analyze the information. Critical thinking skills are needed to interpret and communicate the results of processing the information.

Our text supports the development of basic data analytical skills. At the end of each chapter, you will find a section called Data Analytics. This section provides the instructor and student with opportunities to apply statistical knowledge and statistical software to explore several business environments. Interpretation of the analytical results is an integral part of these exercises.

A variety of statistical software is available to complement our text. Microsoft Excel includes an add-in with many statistical analyses. MegaStat is an add-in available for Microsoft Excel. Minitab and JMP are stand-alone statistical software packages available to download for either PC or Mac computers. In our text, Microsoft Excel, Minitab, and MegaStat are used to illustrate statistical software analyses. The text now includes references or links to Excel tutorials in Connect. These provide users with clear demonstrations using statistical software to create graphical and descriptive statistics and statistical analyses to test hypotheses. We use screen captures within the chapters, so the student becomes familiar with the nature of the software output.

Because of the availability of computers and software, it is no longer necessary to dwell on calculations. We have replaced many of the calculation examples with interpretative ones, to assist the student in understanding and interpreting the statistical results. In addition, we place more emphasis on the conceptual nature of the statistical topics. While making these changes, we still continue to present, as best we can, the key concepts, along with supporting interesting and relevant examples.

WHAT'S NEW IN THE TENTH EDITION?

We made several significant improvements to our text.

First, the text now uses an excellent set of Excel tutorials to demonstrate how to use Excel to perform the statistical analyses in the text. Rather than referring to a set of written procedures, users will be able to view well-organized presentations that clearly demonstrate how to use the various statistical tools, functions, and analyses in Excel. The references to the tutorials are indicated by a unique icon placed in the left margin and aligned with the procedure or analysis in the text. In the eBook, these

icons will be directly linked to the tutorials. Textbook users will access the tutorials through Connect.

Second, Chapter 8 now starts with a brief discussion of the research process to establish a context for sampling and data collection. It also includes comments on ethics and biased sampling. After the description of sampling methods, a new section, “Sample Mean as a Random Variable,” demonstrates the effect of random sampling on the sample mean followed by the section, “Sampling Distribution of the Sample Mean.” The standard error of the sampling distribution is now featured in a new section. The “sampling error” concept continues to be a key item in the chapter’s discussion.

Third, starting in Chapter 9, many exercises have been restructured with multi-item responses. Reformulating these exercises will provide users with more direction to understanding the details of a particular statistical technique. As an example, compare Chapter 11, Exercise 20 before, on the left, and after, on the right.

20.  The federal government recently granted funds for a special program designed to reduce crime in high-crime areas. A study of the results of the program in eight high-crime areas of Miami, Florida, yielded the following results.

	Number of Crimes by Area							
	A	B	C	D	E	F	G	H
Before	14	7	4	5	17	12	8	9
After	2	7	3	6	8	13	3	5

Has there been a decrease in the number of crimes since the inauguration of the program? Use the .01 significance level.

20.  The federal government recently granted funds for a special program designed to reduce crime in high-crime areas. A study of the results of the program in eight high-crime areas of Miami, Florida, yielded the following results.

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Before	14	7	4	5	17	12	8	9
After	2	7	3	6	8	13	3	5

Has there been a decrease in the number of crimes since the inauguration of the program? Use the .01 significance level.
a. State the null and alternate hypotheses.
b. What is the *p*-value?
c. Is the null hypothesis rejected?
d. What is the conclusion indicated by the analysis?

HOW ARE CHAPTERS ORGANIZED TO ENGAGE STUDENTS AND PROMOTE LEARNING?

Chapter Learning Objectives

Each chapter begins with a set of learning objectives designed to provide focus for the chapter and motivate student learning. These objectives, located in the margins next to the topic, indicate what the student should be able to do after completing each section in the chapter.

Chapter Opening Exercise

A representative exercise opens the chapter and shows how the chapter content can be applied to a real-world situation.



MERRILL LYNCH recently completed a study of online investment portfolios for a sample of clients. For the 70 participants in the study, organize these data into a frequency distribution. (See Exercise 43 and **LO2-3**.)

LEARNING OBJECTIVES

When you have completed this chapter, you will be able to:

- LO2-1** Summarize qualitative variables with frequency and relative frequency tables.
- LO2-2** Display a frequency table using a bar or pie chart.
- LO2-3** Summarize quantitative variables with frequency and relative frequency distributions.
- LO2-4** Display a frequency distribution using a histogram or frequency polygon.

Introduction to the Topic

Each chapter starts with a review of the important concepts of the previous chapter and provides a link to the material in the current chapter. This step-by-step approach increases comprehension by providing continuity across the concepts.

INTRODUCTION

The United States automobile retailing industry is highly competitive. It is dominated by megadealerships that own and operate 50 or more franchises, employ over 10,000 people, and generate several billion dollars in annual sales. Many of the top dealerships are publicly owned with shares traded on the New York Stock Exchange or NASDAQ. Based on 2018 new-vehicle retail sales, the largest megadealership was AutoNation (ticker symbol AN), followed by Penske Auto Group (PAG), Group 1 Automotive Inc. (ticker symbol GPI), and Lithia Motors Inc. (LAD). (www.autonews.com/dealers/check-out-top-150-us-dealership-groups)



Justin Sullivan/Getty Images

These large corporations use statistics and analytics to summarize and analyze data and information to support their decisions. As an example, we will look at the Applewood Auto Group. It owns four dealerships and sells a wide range of vehicles. These include the popular Korean brands Kia and Hyundai, BMW and Volvo sedans and luxury SUVs, and a full line of Ford and Chevrolet cars and trucks.

Ms. Kathryn Ball is a member of the senior management team at Applewood Auto Group, which has its corporate offices adjacent to Kane Motors. She is responsible for tracking and analyzing vehicle sales and the profitability of those vehicles. Kathryn would like to summarize the profit

Example/Solution

After important concepts are introduced, a solved example is given. This example provides a how-to illustration and shows a relevant business application that helps students answer the question, “How can I apply this concept?”



EXAMPLE

The service departments at Tionesta Ford Lincoln and Sheffield Motors Inc., two of the four Applewood Auto Group dealerships, were both open 24 days last month. Listed below is the number of vehicles serviced last month at the two dealerships. Construct dot plots and report summary statistics to compare the two dealerships.

Tionesta Ford Lincoln					
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
23	33	27	28	39	26
30	32	28	33	35	32
29	25	36	31	32	27
35	32	35	37	36	30

Self-Reviews

Self-Reviews are interspersed throughout each chapter and follow Example/Solution sections. They help students monitor their progress and provide immediate reinforcement for that particular technique. Answers are in Appendix D.

SELF-REVIEW 4-2



The Quality Control Department of Plainsville Peanut Company is responsible for checking the weight of the 8-ounce jar of peanut butter. The weights of a sample of nine jars produced last hour are:

7.69 7.72 7.80 7.86 7.90 7.94 7.97 8.06 8.09

- (a) What is the median weight?
- (b) Determine the weights corresponding to the first and third quartiles.

page ix

Statistics in Action

Statistics in Action articles are scattered throughout the text, usually about two per chapter. They provide unique, interesting applications and historical insights in the field of statistics.



STATISTICS IN ACTION

If you wish to get some attention at the next gathering you attend, announce that you believe that at least two people present were born on the same date—that is, the same day of the year but not necessarily the same year. If there are 30 people in the room, the probability of a duplicate is .706. If there are 60

Definitions

Definitions of new terms or terms unique to the study of statistics are set apart from the text and highlighted for easy reference and review. They also appear in the Glossary at the end of the book.

JOINT PROBABILITY A probability that measures the likelihood two or more events will happen concurrently.

Formulas

Formulas that are used for the first time are boxed and numbered for reference. In addition, a formula card is listed in the back of the text that lists all the key formulas.

Exercises

Exercises are included after sections within the chapter and at the end of the chapter. Section exercises cover the material studied in the section. Many exercises have data files available to import into statistical software. They are indicated with the FILE icon. Answers to the odd-numbered exercises are in Appendix C.

EXERCISES

For Exercises 39–44, do the following:

- a. Compute the sample variance.
 - b. Determine the sample standard deviation.
39. Consider these values a sample: 7, 2, 6, 2, and 3.
40. The following five values are a sample: 11, 6, 10, 6, and 7.
41. **FILE** Dave's Automatic Door, referred to in Exercise 29, installs automatic garage door openers. Based on a sample, following are the times, in minutes, required to install 10 door openers: 28, 32, 24, 46, 44, 40, 54, 38, 32, and 42.
42. **FILE** The sample of eight companies in the aerospace industry, referred to in Exercise 30, was surveyed as to their return on investment last year. The results are 10.6, 12.6, 14.8, 18.2, 12.0, 14.8, 12.2, and 15.6.

Computer Output

The text includes many software examples, using Excel, MegaStat®, and Minitab. The software results are illustrated in the chapters. Instructions for the software examples are referenced in online tutorials in Connect.

APPLEWOOD AUTO GROUP							
	A	B	C	D	E	F	G
1	Age	Profit	Location	Vehicle-Type	Previous		Profit
2	21	\$1,387	Tionesta	Sedan	0		
3	23	\$1,754	Sheffield	SUV	1	Mean	1843.17
4	24	\$1,817	Sheffield	Hybrid	1	Standard Error	47.97
5	25	\$1,040	Sheffield	Compact	0	Median	1882.50
6	26	\$1,273	Kane	Sedan	1	Mode	1915.00
7	27	\$1,529	Sheffield	Sedan	1	Standard Deviation	643.63
8	27	\$3,082	Kane	Truck	0	Sample Variance	414256.61
9	28	\$1,951	Kane	SUV	1	Kurtosis	-0.22
10	28	\$2,692	Tionesta	Compact	0	Skewness	-0.24
11	29	\$1,342	Kane	Sedan	2	Range	2998
12	29	\$1,206	Sheffield	Sedan	0	Minimum	294
13	30	\$443	Kane	Sedan	3	Maximum	3292
14	30	\$1,621	Sheffield	Truck	1	Sum	331770
15	30	\$754	Olean	Sedan	2	Count	180

Source: Microsoft Excel

HOW DOES THIS TEXT REINFORCE STUDENT LEARNING?

BY CHAPTER

Chapter Summary

Each chapter contains a brief summary of the chapter material, including vocabulary, definitions, and critical formulas.

CHAPTER SUMMARY		
I.	A random variable is a numerical value determined by the outcome of an experiment.	
II.	A probability distribution is a listing of all possible outcomes of an experiment and the probability associated with each outcome.	
A.	A discrete probability distribution can assume only certain values. The main features are:	
1.	The sum of the probabilities is 1.00.	
2.	The probability of a particular outcome is between 0.00 and 1.00.	
3.	The outcomes are mutually exclusive.	
B.	A continuous distribution can assume an infinite number of values within a specific range.	
III.	The mean and variance of a discrete probability distribution are computed as follows.	
A.	The mean is equal to:	
	$\mu = \sum [xP(x)]$	(6-1)
B.	The variance is equal to:	
	$\sigma^2 = \sum [(x - \mu)^2 P(x)]$	(6-2)

Pronunciation Key

This section lists the mathematical symbol, its meaning, and how to pronounce it. We believe this will help the student retain the meaning of the symbol and generally enhance course communications.

PRONUNCIATION KEY		
SYMBOL	MEANING	PRONUNCIATION
$P(A)$	Probability of A	P of A
$P(\sim A)$	Probability of not A	P of not A
$P(A \text{ and } B)$	Probability of A and B	P of A and B
$P(A \text{ or } B)$	Probability of A or B	P of A or B
$P(A B)$	Probability of A given B has happened	P of A given B
${}_nP_r$	Permutation of n items selected r at a time	Pnr
${}_nC_r$	Combination of n items selected r at a time	Cnr

Chapter Exercises

Generally, the end-of-chapter exercises are the most challenging and integrate the chapter concepts. The answers and worked-out solutions for all odd-numbered exercises are in Appendix C. Many exercises are noted with a data file icon. For these exercises, there are data files in Excel format located

on the text's website, www.mhhe.com/Lind10e. These files help students use statistical software to solve the exercises.

CHAPTER EXERCISES

21. According to the local union president, the mean gross income of plumbers in the Salt Lake City area follows the normal probability distribution with a mean of \$45,000 and a population standard deviation of \$3,000. A recent investigative reporter for KYAK TV found, for a sample of 120 plumbers, the mean gross income was \$45,500. At the .10 significance level, is it reasonable to conclude that the mean income is not equal to \$45,000? Determine the p -value.

22. **FILE** Rutter Nursery Company packages its pine bark mulch in 50-pound bags. From a long history, management knows that the distribution of bag weights is normally distributed with a population standard deviation of 3 pounds per bag. At the end of each day, Jeff Rutter, the production manager, weighs 10 bags and computes the mean weight of the sample. Following are the weights of 10 bags from today's production.

45.6 47.7 47.6 46.3 46.2 47.4 49.2 55.8 47.5 48.5

a. Can Mr. Rutter conclude that the mean weight of the bags is less than 50 pounds? Use the .01 significance level.

b. In a brief report, tell why Mr. Rutter can use the z -distribution as the test statistic.

c. Compute the p -value.

23. A new weight-watching company, Weight Reducers International, advertises that those who join will lose an average of 10 pounds after the first 2 weeks. The population standard deviation is 2.8 pounds. A random sample of 50 people who joined the weight reduction program revealed a mean loss of 9 pounds. At the .05 level of significance,

Data Analytics

The goal of the Data Analytics sections is to develop analytical skills. The exercises present a real-world context with supporting data. The data sets are printed in Appendix A and available to download from the text's website www.mhhe.com/Lind10e. Statistical software is required to analyze the data and respond to the exercises. Each data set is used to explore questions and discover findings that relate to a real-world context. For each business context, a story is uncovered as students progress from Chapters 1 to 15.

DATA ANALYTICS

(The data for these exercises are available at the text website: www.mhhe.com/lind10e.)

52. Refer to the North Valley Real Estate data, which report information on homes sold during the last year.

a. The mean selling price (in \$ thousands) of the homes was computed earlier to be \$357.0, with a standard deviation of \$160.7. Use the normal distribution to estimate the percentage of homes selling for more than \$500,000. Compare this to the actual results. Is price normally distributed? Try another test. If price is normally distributed, how many homes should have a price greater than the mean? Compare this to the actual number of homes. Construct a frequency distribution of price. What do you observe?

b. The mean days on the market is 30 with a standard deviation of 10 days. Use the normal distribution to estimate the number of homes on the market more than 24 days.

Software Tutorials

References to tutorials demonstrating how to use Excel to compute various statistics and perform statistical analyses are included throughout the text. See an example of the icon to the right.



Answers to Self-Review

The worked-out solutions to the Self-Reviews are provided in Appendix D.

6-1 a.

Number of Spots	Probability
1	$\frac{1}{6}$
2	$\frac{1}{6}$
3	$\frac{1}{6}$
4	$\frac{1}{6}$
5	$\frac{1}{6}$
6	$\frac{1}{6}$
Total	$\frac{6}{6} = 1.00$

Practice Test

The Practice Test is intended to give students an idea of content that might appear on a test and how the test might be structured. The Practice Test includes both objective questions and problems covering the material studied in the material studied in the section.

PRACTICE TEST

There is a practice test at the end of each chapter. The tests are in two parts. The first part includes 10 to 15 objective questions, usually in a fill-in-the-blank format. The second part includes problems. In most cases, it should take 30 to 45 minutes to complete the test. The problems will require a calculator. Check your answers against those provided in Appendix C in the back of the book.

Part 1—Objective

1. The science of collecting, organizing, presenting, analyzing, and interpreting data to assist in making more effective decisions is referred to as _____.
2. Methods of organizing, summarizing, and presenting data in an enlightening way are called _____.



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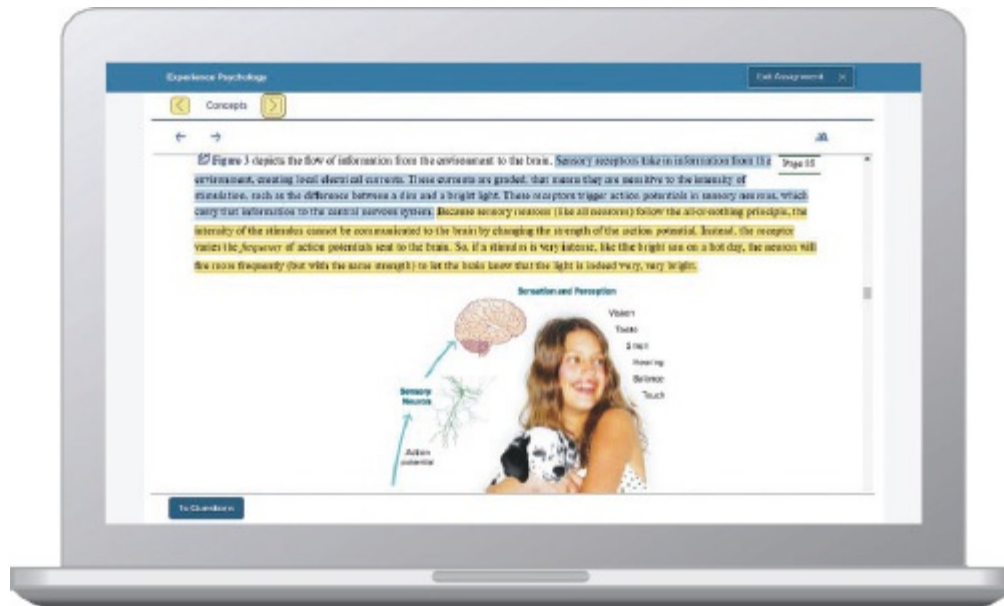
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Laptop: McGraw Hill; Woman/dog: George Doyle/Getty Images

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“I really liked this app—it made it easy to study when you don't have your textbook in front of you.”

- Jordan Cunningham, Eastern Washington University



Calendar: owattaphotos/Getty Images

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Top: Jenner Images/Getty Images, Left: Hero Images/Getty Images, Right: Hero Images/Getty Images

ADDITIONAL RESOURCES

INSTRUCTOR LIBRARY

The Connect[®] Instructor Library is your repository for additional resources to improve student engagement in and out of class. You can select and use any asset that enhances your lecture, including:

- **Solutions Manual** The Solutions Manual, carefully revised by the authors, contains solutions to all basic, intermediate, and challenge problems found at the end of each chapter.
- **Test Bank** The Test Bank, revised by Wendy Bailey of Troy University, contains hundreds of true/false, multiple choice and short-answer/discussions, updated based on the revisions of the authors. The level of difficulty varies, as indicated by the easy, medium, and difficult labels.
- **PowerPoint Presentations** Prepared by Stephanie Campbell of Mineral Area College, the presentations contain exhibits, tables, key points, and summaries in a visually stimulating collection of slides.
- **Excel Templates** There are templates for various end-of-chapter problems that have been set as Excel spreadsheets—all denoted by an icon. Students can easily download the files, save them, and use the data to solve end-of-chapter problems.

MEGASTAT[®] FOR MICROSOFT EXCEL[®]

MegaStat[®] by J. B. Orris of Butler University is a full-featured Excel statistical analysis add-in that is available on the MegaStat website at www.mhhe.com/megastat (for purchase). MegaStat works with recent versions of Microsoft Excel[®] (Windows and Mac OS X). See the website for details on supported versions.

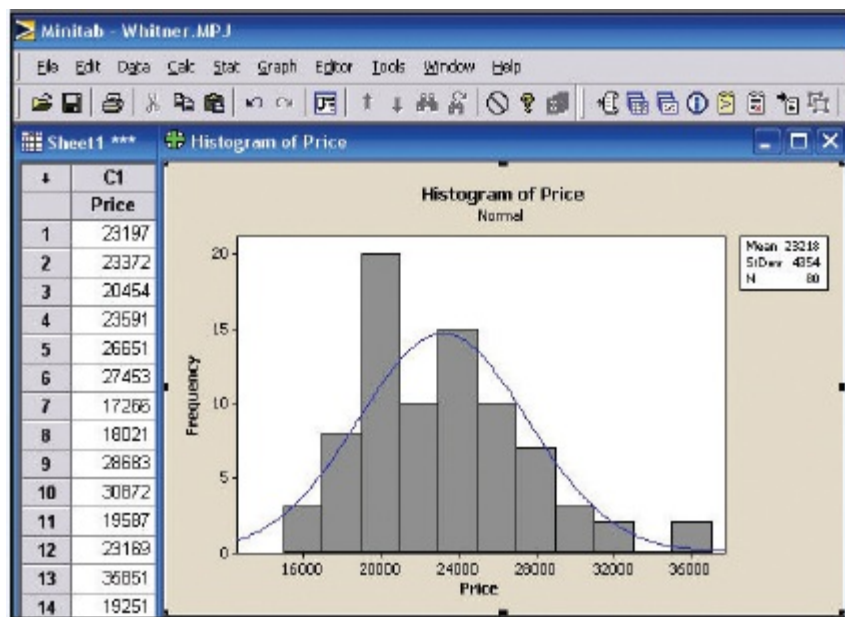
Once installed, MegaStat will always be available on the Excel add-ins ribbon with no expiration date or data limitations. MegaStat performs statistical analyses within an Excel workbook. When a MegaStat menu item is selected, a dialog box pops up for data selection and options. Since MegaStat is an easy-to-use extension of Excel, students can focus on learning statistics without being distracted by the software. Ease-of-use features include Auto Expand for quick data selection and Auto Label detect.

MegaStat does most calculations found in introductory statistics textbooks, such as computing descriptive statistics, creating frequency distributions, and computing probabilities as well as hypothesis testing, ANOVA, chi-square analysis, and regression analysis (simple and multiple). MegaStat output is carefully formatted and appended to an output worksheet.

Video tutorials are included that provide a walkthrough using MegaStat for typical business statistics topics. A context-sensitive help system is built into MegaStat and a User's Guide is included in PDF format.

MINITAB®/SPSS®/JMP®

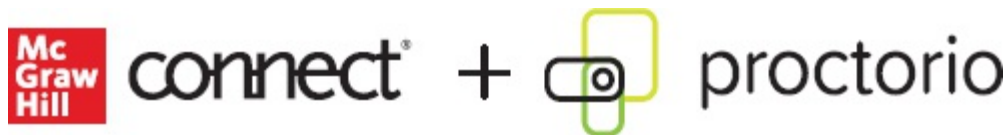
Minitab®, Minitab® Express, SPSS®, and JMP® Student Edition are software products that are available to help students solve the exercises with data files. Each software product can be packaged with any McGraw Hill business statistics text.



Source: Minitab

page xv

REMOTE PROCTORING & BROWSER-LOCKING CAPABILITIES



New remote proctoring and browser-locking capabilities, hosted by Proctorio within Connect, provide control of the assessment environment by enabling security options and verifying the identity of the student.

Seamlessly integrated within Connect, these services allow instructors to control students' assessment experience by restricting browser activity, recording students' activity, and verifying students are doing their own work.

Instant and detailed reporting gives instructors an at-a-glance view of potential academic integrity concerns, thereby avoiding personal bias and supporting evidence-based claims.

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Keith Lowe
Jacksonville State University
Ed Pappanastos
Troy University
Germain N. Pichop
Oklahoma City Community College
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ENHANCEMENTS TO *BASIC STATISTICS FOR BUSINESS & ECONOMICS*, 10E

CHAPTER 1 What Is Statistics?

- Updated graphic on data analytics.
- Updated examples.
- Newly revised Ethics and Statistics section.
- New exercise 17 requiring statistical software.
- Updated exercise 19.

CHAPTER 2 Describing Data: Frequency Tables, Frequency Distributions, and Graphic Presentation

- Updated examples.
- Updated exercises 33, 38, 47, 48.
- New exercise 44 using extensive data from the pizza industry requiring statistical software.

CHAPTER 3 Describing Data: Numerical Measures

- Updated examples.
- Revised example/solution showing the calculation of the sample mean.
- Revised example/solution showing the calculation of the sample standard deviation.
- Updated Statistics in Action with most recent Major League Baseball data.
- The section of the relative positions of the mean, median, and mode as well as the concept of skewness have been rewritten with new illustrations.
- Updated exercises 21, 23, 25, 61, 64.

CHAPTER 4 Describing Data: Displaying and Exploring Data

- Updated examples.
- Revised section on computing quartiles.
- Box plots are generated with Excel with accompanying Connect tutorial.
- Updated exercise 16 with Washington Nationals salary data.
- Updated Self-Review 4–5 to include data.
- A new section on the correlation coefficient added to the major section, “Describing the Relationship between Two Variables.”

- Exercises 17, 18, and 32 provide data and ask the user to produce scatter plots with statistical software.
- New exercise 24.

CHAPTER 5 A Survey of Probability Concepts

- Updated examples.
- New exercises 80, 83.
- Updated exercises 9, 10, 52.
- Revised example/solution showing the calculation of empirical probability.
- New “Principles of Counting” example/solution based on blood type.

CHAPTER 6 Discrete Probability Distributions

- Updated examples.
- New exercises 9, 10, 17, 18, 24, 43, 54, 55, 56, 57.
- Updated exercises 5, 7, 8, 24.
- New example/solution using the binomial distribution to predict purchase behavior with debit and credit cards.

CHAPTER 7 Continuous Probability Distributions

- New opening page and exercise.
- Revised example/solution demonstrating the uniform probability distribution.
- For all uniform distribution examples and exercises, users are asked to compute the mean and standard deviation.
- Updated and revised exercises 1, 2, 5, 7, 8, 11, 12, 28.
- New exercises 15, 19, 20, 31, 32, 37, 39, 43, 51, 53.
- Added emphasis on defining the probability of a particular value of a continuous random variable to be zero.

CHAPTER 8 Sampling, Sampling Methods, and the Central Limit Theorem

- New chapter title: “Sampling, Sampling Methods, and the Central Limit Theorem.”
- New section titled: “Research and Sampling.” This section now introduces the idea of sampling by discussing the research process (i.e., posing a research question, collecting data, processing the data, and making data-based inferences and conclusions). The section also discusses ethical guidelines for selecting representative samples from populations.
- Revised Self-Review 8–1.
- Revised Statistics in Action about biased sampling.
- New section: “Sample Mean as a Random Variable.”
- Revised example/solution demonstrating sampling, the sample mean as a random variable, and the meaning and interpretation of sampling error.
- New section: “Standard Error of the Mean.”
- New Exercises 14, 15, 16.

- Updated exercises 12, 13, 18, 19, 20, 21, 25, 26, 31, 32, 36.

CHAPTER 9 Estimation and Confidence Intervals

- Introduction now connects Chapter 8 to Chapter 9 by discussing how sample data are used to estimate population parameters.
- More emphasis placed on the margin of error in the calculation and interpretation of a confidence interval.
- Revised example/solution demonstrating the calculation and interpretation of a confidence interval estimating a population mean.
- Revised example/solution demonstrating the calculation and interpretation of a confidence interval estimating a population proportion.
- Revised example/solution demonstrating the margin of error in computing a sample size.
- New exercises 17, 37, 38, 39, 40, 41, 42.
- Updated exercises 5, 11, 12, 19, 22, 25, 28, 29, 31, 33, 37, 38, 39, 40, 41, 42, 43, 46, 47, 50, 53.

CHAPTER 10 One-Sample Tests of Hypothesis

- The chapter now relies on statistical software to compute p -values.
- Revised example/solution demonstrating the hypothesis-testing procedure with added emphasis on the significance level and the Type I error probability.
- Revised Self-Review 10–1.
- Revised section titled “ p -Value in Hypothesis Testing.”
- Revised Self-Review 10–2.
- Revised example/solutions demonstrating hypothesis testing with the t -statistic.
- New exercises 29, 30.

CHAPTER 11 Two-Sample Tests of Hypothesis

- Revised explanation comparing independent and dependent sampling.
- Updated exercises 4, 9.
- Exercises 17–46 are now structured with multi-item responses providing users with directed questions.

CHAPTER 12 Analysis of Variance

- Revised Self-Review 12–2.
- Revised Self-Review 12–3.
- Updated exercises 1–6, 9, 10, 13, 14, 21, 22, 23, 24, 26, 27, 28, 31.
- New Statistics in Action illustrating ANOVA.

CHAPTER 13 Correlation and Linear Regression

- Chapter encourages users to compute p -Values with statistical software including online p -Value

calculators.

- New exercises 17, 35, 41, 43.
- Updated exercises 36, 47, 48, 49, 51, 52, 57, 58, 59.

CHAPTER 14 Multiple Regression Analysis

- New Statistics in Action describing spurious correlation.
- Updated exercises 1, 2, 24, 25, 26, 28.

CHAPTER 15 Nonparametric Methods: Nominal Level Hypothesis Tests

- Revised chapter opening page.
- Revised example/solution testing two population proportions.
- New exercises 24, 44.
- Updated exercise 29.

BRIEF CONTENTS

- 1 What Is Statistics? 1
- 2 Describing Data: Frequency Tables, Frequency Distributions, and Graphic Presentation 19
- 3 Describing Data: Numerical Measures 53
- 4 Describing Data: Displaying and Exploring Data 89
- 5 A Survey of Probability Concepts 119
- 6 Discrete Probability Distributions 158
- 7 Continuous Probability Distributions 189
- 8 Sampling, Sampling Methods, and the Central Limit Theorem 215
- 9 Estimation and Confidence Intervals 249
- 10 One-Sample Tests of Hypothesis 281
- 11 Two-Sample Tests of Hypothesis 310
- 12 Analysis of Variance 346
- 13 Correlation and Linear Regression 378
- 14 Multiple Regression Analysis 431
- 15 Nonparametric Methods: Nominal Level Hypothesis Tests 482

Appendixes:

Data Sets, Tables, Answers 515

Glossary 589

Index 593

CONTENTS

A Note from the Authors vi

1 **What Is Statistics?** 1

Introduction 2

Why Study Statistics? 2

What Is Meant by Statistics? 3

Types of Statistics 4

Descriptive Statistics 4

Inferential Statistics 5

Types of Variables 6

Levels of Measurement 7

Nominal-Level Data 7

Ordinal-Level Data 8

Interval-Level Data 9

Ratio-Level Data 10

EXERCISES 11

Ethics and Statistics 12

Basic Business Analytics 12

Chapter Summary 14

Chapter Exercises 14

Data Analytics 17

Practice Test 17

2 **Describing Data: FREQUENCY TABLES, FREQUENCY**

DISTRIBUTIONS, AND GRAPHIC PRESENTATION 19

Introduction	20
Constructing Frequency Tables	20
Relative Class Frequencies	21
Graphic Presentation of Qualitative Data	22
EXERCISES	26
Constructing Frequency Distributions	27
Relative Frequency Distribution	31
EXERCISES	32
Graphic Presentation of a Distribution	33
Histogram	33
Frequency Polygon	36
EXERCISES	38
Cumulative Distributions	39
EXERCISES	42
Chapter Summary	43
Chapter Exercises	44
Data Analytics	51
Practice Test	51

3 Describing Data: NUMERICAL MEASURES 53

Introduction	54
Measures of Location	54
The Population Mean	55
The Sample Mean	56
Properties of the Arithmetic Mean	57
EXERCISES	58
The Median	59
The Mode	61
Software Solution	63
EXERCISES	63
The Relative Positions of the Mean, Median, and Mode	65
EXERCISES	67
The Weighted Mean	67
EXERCISES	69

Why Study Dispersion?	69
Range	70
Variance	70
EXERCISES	72
Population Variance	73
Population Standard Deviation	75
EXERCISES	76
Sample Variance and Standard Deviation	76
Software Solution	78
EXERCISES	78
Interpretation and Uses of the Standard Deviation	79
Chebyshev's Theorem	79
The Empirical Rule	79
EXERCISES	81
Ethics and Reporting Results	81
Chapter Summary	82
Chapter Exercises	83
Data Analytics	87
Practice Test	87

4 **Describing Data** **DISPLAYING AND EXPLORING DATA**

89

Introduction	90
Dot Plots	90
EXERCISES	92
Measures of Position	93
Quartiles, Deciles, and Percentiles	93
EXERCISES	97
Box Plots	97
EXERCISES	100
Skewness	101
EXERCISES	104

Describing the Relationship between Two Variables	105
Correlation Coefficient	106
Contingency Tables	108
EXERCISES	110
Chapter Summary	111
Chapter Exercises	112
Data Analytics	117
Practice Test	118
5 A Survey of Probability Concepts	119
Introduction	120
What Is a Probability?	121
Approaches to Assigning Probabilities	123
Classical Probability	123
Empirical Probability	124
Subjective Probability	126
EXERCISES	127
Rules of Addition for Computing Probabilities	128
Special Rule of Addition	128
Complement Rule	130
The General Rule of Addition	131
EXERCISES	133
Rules of Multiplication to Calculate Probability	134
Special Rule of Multiplication	134
General Rule of Multiplication	136
Contingency Tables	137
Tree Diagrams	141
EXERCISES	143
Principles of Counting	144
The Multiplication Formula	144
The Permutation Formula	146
The Combination Formula	148
EXERCISES	149
Chapter Summary	150

Chapter Exercises	151
Data Analytics	156
Practice Test	157

6 Discrete Probability Distributions 158

Introduction	159
What Is a Probability Distribution?	159
Random Variables	161
Discrete Random Variable	162
Continuous Random Variable	163
The Mean, Variance, and Standard Deviation of a Discrete Probability Distribution	163
Mean	163
Variance and Standard Deviation	164
EXERCISES	166
Binomial Probability Distribution	167
How Is a Binomial Probability Computed?	169
Binomial Probability Tables	171
EXERCISES	174
Cumulative Binomial Probability Distributions	175
EXERCISES	177
Poisson Probability Distribution	177
EXERCISES	182
Chapter Summary	182
Chapter Exercises	183
Data Analytics	187
Practice Test	187

7 Continuous Probability Distributions 189

Introduction	190
The Family of Uniform Probability Distributions	190
EXERCISES	193
The Family of Normal Probability Distributions	194

The Standard Normal Probability Distribution	197
Applications of the Standard Normal Distribution	198
The Empirical Rule	198
EXERCISES	200
Finding Areas under the Normal Curve	201
EXERCISES	204
EXERCISES	206

EXERCISES	209
Chapter Summary	209
Chapter Exercises	210
Data Analytics	213
Practice Test	214

8 **Sampling, Sampling Methods, and the Central Limit Theorem** 215

Introduction	216
Research and Sampling	216
Sampling Methods	217
Simple Random Sampling	217
Systematic Random Sampling	220
Stratified Random Sampling	221
Cluster Sampling	222
EXERCISES	223
Sample Mean as a Random Variable	225
Sampling Distribution of the Sample Mean	226
EXERCISES	230
The Central Limit Theorem	231
Standard Error of the Mean	237
EXERCISES	237
Using the Sampling Distribution of the Sample Mean	239
EXERCISES	241
Chapter Summary	241

Chapter Exercises	242
Data Analytics	247
Practice Test	248

9 Estimation and Confidence Intervals 249

Introduction	250
Point Estimate for a Population Mean	250
Confidence Intervals for a Population Mean	251
Population Standard Deviation, Known σ	251
A Computer Simulation	256
EXERCISES	258
Population Standard Deviation, σ Unknown	259
EXERCISES	266
A Confidence Interval for a Population Proportion	267
EXERCISES	270
Choosing an Appropriate Sample Size	270
Sample Size to Estimate a Population Mean	271
Sample Size to Estimate a Population Proportion	272
EXERCISES	274
Chapter Summary	274
Chapter Exercises	275
Data Analytics	279
Practice Test	280

10 One-Sample Tests of Hypothesis 281

Introduction	282
What Is Hypothesis Testing?	282
Six-Step Procedure for Testing a Hypothesis	283
Step 1: State the Null Hypothesis (H_0) and the Alternate Hypothesis (H_1)	283
Step 2: Select a Level of Significance	284
Step 3: Select the Test Statistic	286
Step 4: Formulate the Decision Rule	286
Step 5: Make a Decision	287

Step 6: Interpret the Result	287
One-Tailed and Two-Tailed Hypothesis Tests	288
Hypothesis Testing for a Population Mean: Known Population Standard Deviation	290
A Two-Tailed Test	290
A One-Tailed Test	293
p -Value in Hypothesis Testing	294
EXERCISES	296
Hypothesis Testing for a Population Mean: Population Standard Deviation Unknown	297
EXERCISES	300
A Statistical Software Solution	301
EXERCISES	303
Chapter Summary	304
Chapter Exercises	305
Data Analytics	308
Practice Test	309

11 **Two-Sample Tests of Hypothesis** 310

Introduction	311
Two-Sample Tests of Hypothesis: Independent Samples	311
EXERCISES	316
Comparing Population Means with Unknown Population Standard Deviations	317
Two-Sample Pooled Test	317
EXERCISES	321
Unequal Population Standard Deviations	323
EXERCISES	326
Two-Sample Tests of Hypothesis: Dependent Samples	327
Comparing Dependent and Independent Samples	330
EXERCISES	333
Chapter Summary	334

Chapter Exercises 336

Data Analytics 344

Practice Test 345

12 **Analysis of Variance** 346

Introduction 347

Comparing Two Population Variances 347

The *F*-Distribution 347

Testing a Hypothesis of Equal Population Variances 348

EXERCISES 352

ANOVA: Analysis of Variance 352

ANOVA Assumptions 353

The ANOVA Test 354

EXERCISES 361

Inferences about Pairs of Treatment Means 362

EXERCISES 365

Chapter Summary 367

Chapter Exercises 368

Data Analytics 375

Practice Test 376

13 **Correlation and Linear Regression** 13

Introduction 379

What Is Correlation Analysis? 379

The Correlation Coefficient 382

EXERCISES 387

Testing the Significance of the Correlation Coefficient 389

EXERCISES 392

Regression Analysis 393

Least Squares Principle 393

Drawing the Regression Line 396

EXERCISES 399

Testing the Significance of the Slope 401

EXERCISES 403

Evaluating a Regression Equation's Ability to Predict 404

The Standard Error of Estimate 404

The Coefficient of Determination 405

EXERCISES 406

Relationships among the Correlation Coefficient, the Coefficient of Determination, and the Standard Error of Estimate 406

EXERCISES 408

Interval Estimates of Prediction 409

Assumptions Underlying Linear Regression 409

Constructing Confidence and Prediction Intervals 410

EXERCISES 413

Transforming Data 413

EXERCISES 416

Chapter Summary 418

Chapter Exercises 420

Data Analytics 429

Practice Test 430

14 Multiple Regression Analysis 431

Introduction 432

Multiple Regression Analysis 432

EXERCISES 436

Evaluating a Multiple Regression Equation 438

The ANOVA Table 438

Multiple Standard Error of Estimate 439

Coefficient of Multiple Determination 440

Adjusted Coefficient of Determination 441

EXERCISES 442

Inferences in Multiple Linear Regression 442

Global Test: Testing the Multiple Regression Model 442

Evaluating Individual Regression Coefficients 445

EXERCISES 448

Evaluating the Assumptions of Multiple Regression 449

Linear Relationship 450

Variation in Residuals Same for Large and Small $\hat{y}$ Values	451
Distribution of Residuals	452
Multicollinearity	452
Independent Observations	454
Qualitative Independent Variables	455
Stepwise Regression	458
EXERCISES	460
Review of Multiple Regression	461

Chapter Summary	467
Chapter Exercises	469
Data Analytics	479
Practice Test	480

15 **Nonparametric Methods: NOMINAL LEVEL HYPOTHESIS TESTS** 482

Introduction	483
Test a Hypothesis of a Population Proportion	483
EXERCISES	486
Two-Sample Tests about Proportions	487
EXERCISES	491
Goodness-of-Fit Tests: Comparing Observed and Expected Frequency Distributions	492
Hypothesis Test of Equal Expected Frequencies	492
EXERCISES	497
Hypothesis Test of Unequal Expected Frequencies	499
Limitations of Chi-Square	500
EXERCISES	502
Contingency Table Analysis	503
EXERCISES	506
Chapter Summary	507
Chapter Exercises	508

Data Analytics 513

Practice Test 514

APPENDIXES 515

Appendix A: Data Sets 516

Appendix B: Tables 524

*Appendix C: Answers to Odd-Numbered Chapter Exercises & Solutions to
Practice Test* 537

Appendix D: Answers to Self-Review 580

Glossary 589

Index 593

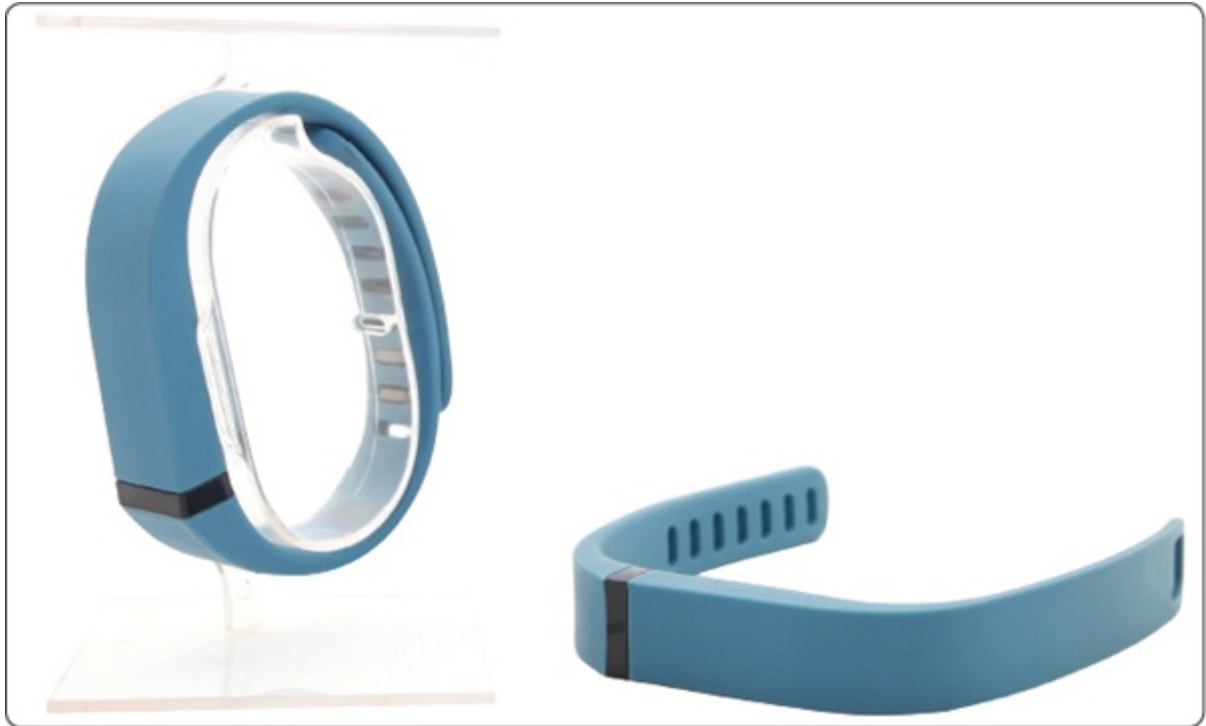
Key Formulas 605

Areas under the Normal Curve 609

Basic Statistics for **BUSINESS & ECONOMICS**

What Is Statistics?

1



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BEST BUY sells Fitbit wearable technology products that track a person's physical activity and sleep quality. The Fitbit technology collects daily information on a person's number of steps so that a person can track calories burned. The information can be synced with a cell phone and displayed with a Fitbit app. Assume you know the daily number of Fitbit Flex 2 units sold last month at the Best Buy store in Collegeville, Pennsylvania. Describe a situation where the number of units sold is considered a sample. Illustrate a second situation where the number of units sold is considered a population. (See Exercise 11 and **LO1-3**.)

LEARNING OBJECTIVES

When you have completed this chapter, you will be able to:

- LO1-1** Explain why knowledge of statistics is important.
- LO1-2** Define statistics and provide an example of how statistics is applied.
- LO1-3** Differentiate between descriptive and inferential statistics.
- LO1-4** Classify variables as qualitative or quantitative, and discrete or continuous.
- LO1-5** Distinguish among nominal, ordinal, interval, and ratio levels of measurement.
- LO1-6** List the values associated with the practice of statistics.

INTRODUCTION

Suppose you work for a large company and your supervisor asks you to decide if a new version of a smartphone should be produced and sold. You start by thinking about the product's innovations and new features. Then, you stop and realize the consequences of the decision. The product will need to make a profit, so the pricing and the costs of production and distribution are all very important. The decision to introduce the product is based on many alternatives. So how will you know? Where do you start?



Gregor Schuster/Getty Images

Without experience in the industry, beginning to develop an intelligence that will make you an expert is essential. You select three other people to work with and meet with them. The conversation focuses on what you need to know and what information and data you need. In your meeting, many questions are asked. How many competitors are already in the market? How are smartphones priced? What design features do competitors' products have? What features does the market require? What do customers want in a smartphone? What do customers like about the existing products? The answers will be based on business intelligence consisting of data and information collected through customer surveys, engineering analysis, and market research. In the end, your presentation to support your decision regarding the introduction of a new smartphone is based on the statistics that you use to summarize and organize your data, the statistics that you use to compare the new product to existing products, and the statistics to estimate future sales, costs, and revenues. The statistics will be the focus of the conversation that you will have with your supervisor about this very important decision.

As a decision maker, you will need to acquire and analyze data to support your decisions. The purpose of this text is to develop your knowledge of basic statistical techniques and methods and how to apply them to develop the business and personal intelligence that will help you make decisions.

WHY STUDY STATISTICS?

LO1-1

Explain why knowledge of statistics is important.



Courtesy of Domo, Inc.

If you look through your university catalogue, you will find that statistics is required for many college programs. As you investigate a future career in accounting, economics, human resources, finance, business analytics, or other business area, you also will discover that statistics is required as part of these college programs. So why is statistics a requirement in so many disciplines?

A major driver of the requirement for statistics knowledge is the technologies available for capturing data. Examples include the technology that Google uses to track how Internet users access websites. As people use Google to search the Internet, Google records every search and then uses these data to sort and prioritize the results for future Internet searches. One recent estimate indicates that Google processes 20,000 terabytes of information per day. Big-box retailers like Target, Walmart, Kroger, and others scan every purchase and use the data to manage the distribution of products, to make decisions about marketing and sales, and to track daily and even hourly sales. Police departments collect and use data to provide city residents with maps that communicate information about crimes

committed and their location. Every organization is collecting and using data to develop knowledge and intelligence that will help people make informed decisions, and track the implementation of their decisions. The graphic to the left shows the amount of data generated every minute (www.domo.com). A good working knowledge of statistics is useful for summarizing and organizing data to provide information that is useful and supportive of decision making. Statistics is used to make valid comparisons and to predict the outcomes of decisions.

In summary, there are at least three reasons for studying statistics: (1) data are collected everywhere and require statistical knowledge to make the information useful, (2) statistical techniques page 3 are used to make professional and personal decisions, and (3) no matter what your career, you will need a knowledge of statistics to understand the world and to be conversant in your career. An understanding of statistics and statistical methods will help you make more effective personal and professional decisions.

WHAT IS MEANT BY STATISTICS

LO1-2

Define statistics and provide an example of how statistics is applied.



STATISTICS IN ACTION

A feature of our textbook is called *Statistics in Action*. Read each one carefully to get an appreciation of the wide application of statistics in management, economics, nursing, law enforcement, sports, and other disciplines.

- In 2019, *Forbes* published a list of the richest Americans. Jeff Bezos of Amazon is the richest. His net worth is estimated at \$114 billion. Bill Gates ranks second. Before Bezos, Gates held the title for 24 years. (www.forbes.com)
- In 2019, the four largest privately owned American companies, ranked by revenue, were Cargill, Koch Industries, Albertsons, and Deloitte. (www.forbes.com)
- In the United States according to September 2019 data, a typical high school graduate earns \$730 per week, a typical college graduate with a bachelor's degree earns \$1,198 per week, and a typical college graduate with a master's degree earns \$1,434 per week. (www.bls.gov/emp/chart-unemployment-earnings-education.htm)

This question can be rephrased in two, subtly different ways: what are statistics and what is statistics? To answer the first question, a statistic is a number used to communicate a piece of information. Examples of statistics are:

- The inflation rate is 2.3%.
- Your grade point average is 3.5.
- The price of a new Tesla Model S sedan is \$81,190.

Each of these statistics is a numerical fact and communicates a very limited piece of information that is not very useful by itself. However, if we recognize that each of these statistics is part of a larger discussion, then the question “what **is** statistics” is applicable. Statistics is the set of knowledge and

skills used to organize, summarize, and analyze data. The results of statistical analysis will start interesting conversations in the search for knowledge and intelligence that will help us make decisions. For example:

- The inflation rate for the calendar year was 2.3%. By applying statistics we could compare this year's inflation rate to the past observations of inflation. Is it higher, lower, or about the same? Is there a trend of increasing or decreasing inflation? Is there a relationship between interest rates and government bonds?
- Your grade point average (GPA) is 3.5. By collecting data and applying statistics, you can determine the required GPA to be admitted to the Master of Business Administration program at the University of Chicago, Harvard, or the University of Michigan. You can determine the likelihood that you would be admitted to a particular program. You may be interested in interviewing for a management position with Procter & Gamble. What GPA does Procter & Gamble require for college graduates with a bachelor's degree? Is there a range of acceptable GPAs?
- You are budgeting for a new car. You would like to own an electric car with a small carbon footprint. The price, according to Kelley Blue Book, for a 2020 Tesla Model S sedan is \$81,190. By collecting additional data and applying statistics, you can analyze the alternatives. For example, another choice is a hybrid car that runs on both gas and electricity. A 2020 Toyota Prius Prime can be purchased for about \$27,750. Another hybrid, the 2020 Chevrolet Bolt EV, costs \$37,495. What are the differences in the cars' specifications? What additional information can be collected and summarized so that you can make a good purchase decision?

Another example of using statistics to provide information to evaluate decisions is the distribution and market share of Frito-Lay products. Data are collected on each of the Frito-Lay product lines. These data include the market share and the pounds of product sold. Statistics is used to present this information in a bar chart in Chart 1–1. It clearly shows Frito-Lay's dominance in the potato, corn, and tortilla chip markets. It also shows the absolute measure of pounds of each product line consumed in the United States.

These examples show that statistics is more than the presentation of numerical information. Statistics is about collecting and processing information to create a conversation, to stimulate additional questions, and to provide a basis for making decisions. Specifically, we define **statistics** as:

STATISTICS The science of collecting, organizing, presenting, analyzing, and interpreting data to assist in making more effective decisions.

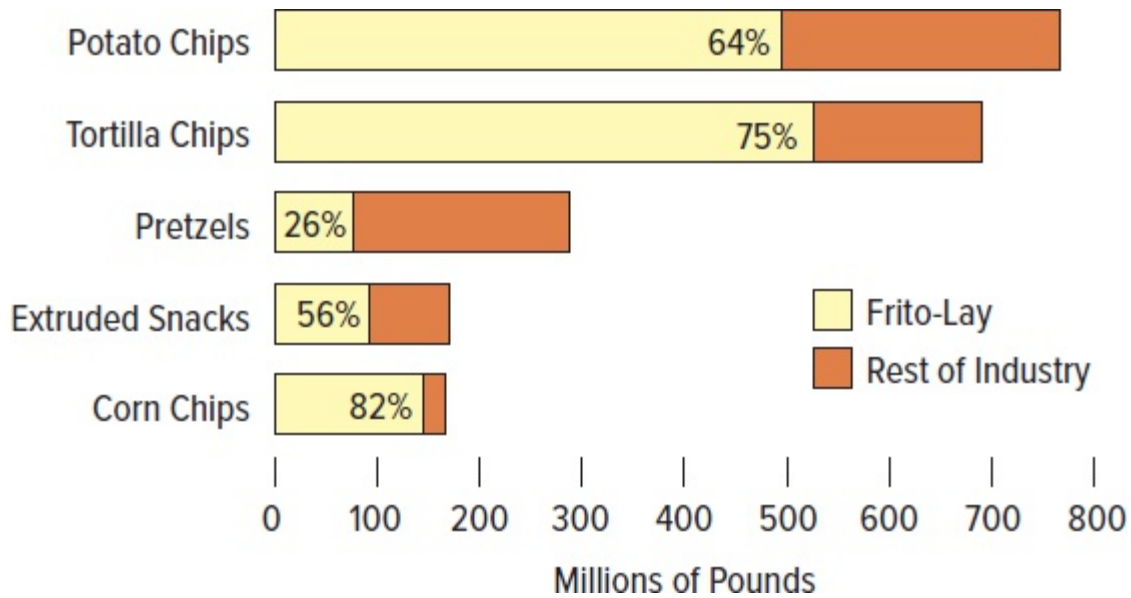


CHART 1-1 Frito-Lay Volume and Share of Major Snack Chip Categories in U.S. Supermarkets

In this book, you will learn the basic techniques and applications of statistics that you can use to support your decisions, both personal and professional. To start, we will differentiate between descriptive and inferential statistics.

TYPES OF STATISTICS

LO1-3

Differentiate between descriptive and inferential statistics.

When we use statistics to generate information for decision making from data, we use either descriptive statistics or inferential statistics. Their application depends on the questions asked and the type of data available.

Descriptive Statistics

Masses of unorganized data—such as the census of population, the weekly earnings of thousands of computer programmers, and the individual responses of 2,000 registered voters regarding their choice for president of the United States—are of little value as is. However, descriptive statistics can be used to organize data into a meaningful form. We define **descriptive statistics** as:

DESCRIPTIVE STATISTICS Methods of organizing, summarizing, and presenting data in an informative way.

The following are examples that apply descriptive statistics to summarize a large amount of data and provide information that is easy to understand.