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First Edition
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 my newest grandchildren (George Orm Marchal, Liam Brophy Horowitz, and Eloise Larae Marchal Murray), newest son-in-law (James Miller Nicholson), and newest wife (Andrea).

William G. Marchal

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

Samuel A. Wathen
A NOTE FROM THE AUTHORS

Over the years, we have 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 *Statistical Techniques in Business and Economics* is to provide students majoring in management, marketing, finance, accounting, economics, and other fields of business administration with an introductory survey of the many applications of descriptive and inferential statistics. We focus on business applications, but we also use many exercises and examples that 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 with a delay of less than 20 minutes.

Today, skills are needed to deal with a large volume of numerical information. First, we need to be critical consumers of information presented by others. Second, we need to be able to reduce large amounts of information into a concise and meaningful form to enable us to make effective interpretations, judgments, and decisions. All students have calculators and most have either personal computers or access to personal computers in a campus lab. Statistical software, such as Microsoft Excel and Minitab, is available on these computers. The commands necessary to achieve the software results are available in Appendix C at the end of the book. 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 now 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 THIS SIXTEENTH EDITION?

We have made changes to this edition that we think you and your students will find useful and timely.

- We reorganized the chapters so that each section corresponds to a learning objective. The learning objectives have been revised.
- We expanded the hypothesis testing procedure in Chapter 10 to six steps, emphasizing the interpretation of test results.
• We have revised example/solution sections in various chapters:
  • Chapter 5 now includes a new example/solution used to demonstrate contingency tables and tree diagrams. Also the example/solution demonstrating the combination formula has been revised.
  • Chapter 6 includes a revised example/solution demonstrating the binomial distribution.
  • Chapter 15 includes a new example/solution demonstrating contingency table analysis.
• We have revised the simple regression example in Chapter 13 and increased the number of observations to better illustrate the principles of simple linear regression.
• We have reordered the nonparametric chapters to follow the traditional statistics chapters.
• We moved the sections on one- and two-sample tests of proportions, placing all analysis of nominal data in one chapter: Nonparametric Methods: Nominal Level Hypothesis Tests.
• We combined the answers to the Self-Review Exercises into a new appendix.
• We combined the Software Commands into a new appendix.
• We combined the Glossaries in the section reviews into a single Glossary that follows the appendices at the end of the text.
• We improved graphics throughout the text.
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.

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.

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, “What will I use this for?”

Self-Reviews

Self-Reviews are interspersed throughout each chapter and closely patterned after the preceding examples. They help students monitor their progress and provide immediate reinforcement for that particular technique.
Statistics in Action
Statistics in Action articles are scattered throughout the text, usually about two per chapter. They provide unique and interesting applications and historical insights in the field of statistics.

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.

Formulas
Formulas that are used for the first time are boxed and numbered for reference. In addition, a formula card is bound into 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.

Computer Output
The text includes many software examples, using Excel, MegaStat®, and Minitab.
Chapter Summary
Each chapter contains a brief summary of the chapter material, including the vocabulary and the critical formulas.

Pronunciation Key
This tool 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.

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 D at the end of the text. Many exercises are noted with a data file icon in the margin. For these exercises, there are data files in Excel format located on the text’s website, www.mhhe.com/lind16e. These files help students use statistical software to solve the exercises.

Data Set Exercises
The last several exercises at the end of each chapter are based on three large data sets. These data sets are printed in Appendix A in the text and are also on the text’s website. These data sets present the students with real-world and more complex applications.

Software Commands
Software examples using Excel, MegaStat®, and Minitab are included throughout the text. The explanations of the computer input commands are placed at the end of the text in Appendix C.
Answers to Self-Review

The worked-out solutions to the Self-Reviews are provided at the end of the text in Appendix E.

### BY SECTION

#### Section Reviews

After selected groups of chapters (1–4, 5–7, 8 and 9, 10–12, 13 and 14, 15 and 16, and 17 and 18), a Section Review is included. Much like a review before an exam, these include a brief overview of the chapters and problems for review.

#### Cases

The review also includes continuing cases and several small cases that let students make decisions using tools and techniques from a variety of chapters.

#### 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 section.

### A REVIEW OF CHAPTERS 1–4

This section is a review of the major concepts and terms introduced in Chapters 1–4. Chapter 1 began by describing the meaning and purpose of statistics. Next we described the different types of variables and the four levels of measurement. Chapter 2 was concerned with describing a set of observations by organizing it into a frequency distribution and then portraying the frequency distribution as a histogram or a frequency polygon. Chapter 3 began by describing measures of location, such as the mean, weighted mean, median, geometric mean, and mode. This chapter also included measures of dispersion, or spread. Discussed in this section were the range, variance, and standard deviation. Chapter 4 included several graphing techniques such as dot plots, box plots, and scatter diagrams. We also discussed the coefficient of skewness, which reports the lack of symmetry in a set of data.

### CASES

#### A. Century National Bank

The following case will appear in subsequent review sections. Assume that you work in the Planning Department of the Century National Bank and report to Ms. Lamberg. You will need to do some data analysis and prepare a short written report. Remember, Mr. Selig is the president of the bank, so you will want to ensure that your report is complete and accurate. A copy of the data appears in Appendix A.E.

Century National Bank has offices in several cities in the Midwest and the southeastern part of the United States. Mr. Dan Selig, president and CEO, would like to know the characteristics of his checking account customers. What is the balance of a typical customer? How many other bank services do the checking account customers use? Do the customers use the ATM service? If so, how often? What about debit cards? Who uses them, and how often are they used?

#### B. Wildcat Plumbing Supply Inc.: Do We Have Gender Differences?

Wildcat Plumbing Supply has served the plumbing needs of Southwest Arizona for more than 40 years. The company was founded by Mr. Terrence St. Julian and is run today by Mr. Dan Selig, president and CEO. The company employs the following employees:

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Hours Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tim</td>
<td>Male</td>
<td>45</td>
</tr>
<tr>
<td>Sarah</td>
<td>Female</td>
<td>30</td>
</tr>
<tr>
<td>John</td>
<td>Male</td>
<td>50</td>
</tr>
<tr>
<td>Lisa</td>
<td>Female</td>
<td>35</td>
</tr>
<tr>
<td>Mike</td>
<td>Male</td>
<td>40</td>
</tr>
<tr>
<td>Linda</td>
<td>Female</td>
<td>32</td>
</tr>
</tbody>
</table>

The company wants to know if there is a gender difference in the number of hours worked. Use a significance level of 0.05 to determine if there is a gender difference.

### Practice Test

There is a practice test at the end of each review section. The tests are in two parts. The first part contains several objective questions, usually in a fill-in-the-blank format. The second part is problems. In most cases, it should take 30 to 45 minutes to complete the test. The problems require a calculator. Check the answers in the Answer Section in the back of the book.

#### Part 1—Objective

1. The science of collecting, organizing, presenting, analyzing, and interpreting data to assist in making effective decisions is called ________.
2. Methods of organizing, summarizing, and presenting data in an informative way are called ________.
3. The entire set of individuals or objects of interest or the measurements obtained from all individuals or objects of interest are called the ________.
4. List the two types of variables ________.

#### Practice Problems

1. ________
2. ________
3. ________
4. ________

#### Practice Problems

1. ________
2. ________
3. ________
4. ________
WHAT TECHNOLOGY CONNECTS STUDENTS TO BUSINESS STATISTICS?

MCGRaw-HILL CONNECT®
BUSINESS STATISTICS


McGraw-Hill Connect® Business Statistics is an online assignment and assessment solution that connects students with the tools and resources they’ll need to achieve success. McGraw-Hill Connect® Business Statistics helps prepare students for their future by enabling faster learning, more efficient studying, and higher retention of knowledge.

McGraw-Hill Connect® Business Statistics Features

Connect® Business Statistics offers a number of powerful tools and features to make managing assignments easier, so faculty can spend more time teaching. With Connect Business Statistics, students can engage with their coursework anytime and anywhere, making the learning process more accessible and efficient. Connect® Business Statistics offers you the features described below.

Simple Assignment Management

With Connect® Business Statistics, creating assignments is easier than ever, so you can spend more time teaching and less time managing. The assignment management function enables you to

- Create and deliver assignments easily with selectable end-of-chapter questions and test bank items.
- Streamline lesson planning, student progress reporting, and assignment grading to make classroom management more efficient than ever.
- Go paperless with the eBook and online submission and grading of student assignments.

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When it comes to studying, time is precious. Connect® Business Statistics helps students learn more efficiently by providing feedback and practice material when they need it, where they need it. When it comes to teaching, your time is also precious. The grading function enables you to

- Have assignments scored automatically, giving students immediate feedback on their work and side-by-side comparisons with correct answers.
- Access and review each response; manually change grades or leave comments for students to review.
- Reinforce classroom concepts with practice tests and instant quizzes.

Instructor Library

The Connect® Business Statistics 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.

Student Study Center

The Connect® Business Statistics Student Study Center is the place for students to access additional resources. The Student Study Center

- Offers students quick access to lectures, practice materials, eBooks, and more.
- Provides instant practice material and study questions, easily accessible on the go.
LearnSmart

Students want to make the best use of their study time. The LearnSmart adaptive self-study technology within Connect® Business Statistics provides students with a seamless combination of practice, assessment, and remediation for every concept in the textbook. LearnSmart’s intelligent software adapts to every student response and automatically delivers concepts that advance the student’s understanding while reducing time devoted to the concepts already mastered. The result for every student is the fastest path to mastery of the chapter concepts.

- Applies an intelligent concept engine to identify the relationships between concepts and to serve new concepts to each student only when he or she is ready.
- Adapts automatically to each student, so students spend less time on the topics they understand and practice more those they have yet to master.
- Provides continual reinforcement and remediation, but gives only as much guidance as students need.
- Integrates diagnostics as part of the learning experience.
- Enables you to assess which concepts students have efficiently learned on their own, thus freeing class time for more applications and discussion.

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Connect® Business Statistics keeps instructors informed about how each student, section, and class is performing, allowing for more productive use of lecture and office hours. The progress-tracking function enables you to

- View scored work immediately and track individual or group performance with assignment and grade reports.
- Access an instant view of student or class performance relative to learning objectives.
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McGraw-Hill Connect® Plus Business Statistics


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Tegrity Campus is a service that makes class time available 24/7 by automatically capturing every lecture in a searchable format for students to review when they study and complete assignments. With a simple one-click start-and-stop process, you capture all computer screens and corresponding audio. Students can replay any part of any class with easy-to-use browser-based viewing on a PC or Mac.

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To learn more about Tegrity watch a two-minute Flash demo at http://tegritycampus.mhhe.com.

ASSURANCE OF LEARNING READY
Many educational institutions today are focused on the notion of assurance of learning, an important element of some accreditation standards. Statistical Techniques in Business & Economics is designed specifically to support your assurance of learning initiatives with a simple, yet powerful solution.

Each test bank question for Statistical Techniques in Business & Economics maps to a specific chapter learning objective listed in the text. You can use our test bank software, EZ Test and EZ Test Online, or Connect® Business Statistics to easily query for learning objectives that directly relate to the learning objectives for your course. You can then use the reporting features of EZ Test to aggregate student results in similar fashion, making the collection and presentation of assurance of learning data simple and easy.

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At McGraw-Hill, we understand that getting the most from new technology can be challenging. That’s why our services don’t stop after you purchase our products. You can e-mail our product specialists 24 hours a day to get product-training online. Or you can search our knowledge bank of frequently asked questions on our support website. For customer support, call 800-331-5094, e-mail hmsupport@mcgraw-hill.com, or visit www.mhhe.com/support. One of our technical support analysts will be able to assist you in a timely fashion.
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 descriptive statistics, frequency distributions, and probability calculations as well as hypothesis testing, ANOVA chi-square, and regression (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® Student Version 14, SPSS® Student Version 18.0, and JMP® Student Edition Version 8 are software tools that are available to help students solve the business statistics exercises in the text. Each can be packaged with any McGraw-Hill business statistics text.
WHAT RESOURCES ARE AVAILABLE FOR INSTRUCTORS?

ONLINE LEARNING CENTER:
www.mhhe.com/lind16e

The Online Learning Center (OLC) provides the instructor with a complete Instructor’s Manual in Word format, the complete Test Bank in both Word files and computerized EZ Test format, Instructor PowerPoint slides, text art files, an introduction to ALEKS®, an introduction to McGraw-Hill Connect Business Statistics™, and more.

EZ TEST

All test bank questions are available in an EZ Test electronic format. Included are a number of multiple-choice, true/false, and short-answer questions and problems. The answers to all questions are given, along with a rating of the level of difficulty, chapter goal the question tests, Bloom’s taxonomy question type, and the AACSB knowledge category.

WebCT/Blackboard/eCollege

All of the material in the Online Learning Center is also available in portable WebCT, Blackboard, or eCollege content “cartridges” provided free to adopters of this text.
ALEKS is an assessment and learning program that provides individualized instruction in Business Statistics, Business Math, and Accounting. Available online, ALEKS interacts with students much like a skilled human tutor, with the ability to assess precisely a student’s knowledge and provide instruction on the exact topics the student is most ready to learn. By providing topics to meet individual students’ needs, allowing students to move between explanation and practice, correcting and analyzing errors, and defining terms, ALEKS helps students to master course content quickly and easily.

ALEKS also includes a new instructor module with powerful, assignment-driven features and extensive content flexibility. ALEKS simplifies course management and allows instructors to spend less time with administrative tasks and more time directing student learning. To learn more about ALEKS, visit www.aleks.com.

ONLINE LEARNING CENTER:
www.mhhe.com/lind16e
The Online Learning Center (OLC) provides students with the following content:

- Quizzes
- PowerPoints
- Data sets/files
- Appendixes
- Chapter 20

BUSINESS STATISTICS CENTER (BSC):
www.mhhe.com/bstat
The BSC contains links to statistical publications and resources, software downloads, learning aids, statistical websites and databases, and McGraw-Hill product websites and online courses.
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ENHANCEMENTS TO STATISTICAL TECHNIQUES IN BUSINESS & ECONOMICS, 16E

MAJOR CHANGES MADE TO INDIVIDUAL CHAPTERS:

CHAPTER 1 What Is Statistics?
- New photo and chapter opening exercise on the Nook Color sold by Barnes & Noble.
- New introduction with new graphic showing the increasing amount of information collected and processed with new technologies.
- New ordinal scale example based on rankings of states based on business climate.
- The chapter includes several new examples.
- Chapter is more focused on the revised learning objectives and improving the chapter’s flow.
- Revised exercise 17 is based on economic data.

CHAPTER 2 Describing Data: Frequency Tables, Frequency Distributions, and Graphic Presentation
- Revised Self-Review 2–3 to include data.
- Updated the company list in revised exercise 38.
- New or revised exercises 45, 47, and 48.

CHAPTER 3 Describing Data: Numerical Measures
- Reorganized chapter based on revised learning objectives.
- Replaced the mean deviation with more emphasis on the variance and standard deviation.
- Updated statistics in action.

CHAPTER 4 Describing Data: Displaying and Exploring Data
- Updated exercise 22 with 2012 New York Yankee player salaries.

CHAPTER 5 A Survey of Probability Concepts
- New explanation of odds compared to probabilities.
- New exercise 21.
- New example/solution for demonstrating contingency tables and tree diagrams.
- New contingency table exercise 31.
- Revised example/solution demonstrating the combination formula.

CHAPTER 6 Discrete Probability Distributions
- Revised the section on the binomial distribution.
- Revised example/solution demonstrating the binomial distribution.
- Revised Self-Review 6–4 applying the binomial distribution.
- New exercise 10 using the number of “underwater” loans.
- New exercise using a raffle at a local golf club to demonstrate probability and expected returns.

CHAPTER 7 Continuous Probability Distributions
- Updated Statistics in Action.
- Revised Self-Review 7–2 based on daily personal water consumption.
- Revised explanation of the Empirical Rule as it relates to the normal distribution.

CHAPTER 8 Sampling Methods and the Central Limit Theorem
- New example of simple random sampling and the application of the table of random numbers.
- The discussions of systematic random, stratified random, and cluster sampling have been revised.
- Revised exercise 44 based on the price of a gallon of milk.

CHAPTER 9 Estimation and Confidence Intervals
- New Statistics in Action describing EPA fuel economy.
- New separate section on point estimates.
- Integration and application of the central limit theorem.
- A revised simulation demonstrating the interpretation of confidence level.
- New presentation on using the t table to find z values.
- A revised discussion of determining the confidence interval for the population mean.
- Expanded section on calculating sample size.
- New exercise 12 (milk consumption).

CHAPTER 10 One-Sample Tests of Hypothesis
- New example/solution involving airport parking.
- Revised software solution and explanation of p-values.
- New exercises 17 (daily water consumption) and 19 (number of text messages by teenagers).
- Conducting a test of hypothesis about a population proportion is moved to Chapter 15.
- New example introducing the concept of hypothesis testing.
- Sixth step added to the hypothesis testing procedure emphasizing the interpretation of the hypothesis test results.

CHAPTER 11 Two-Sample Tests of Hypothesis
- New introduction to the chapter.
- Section of two-sample tests about proportions moved to Chapter 15.
• Changed subscripts in example/solution for easier understanding.
• Updated exercise with 2012 New York Yankee player salaries.

CHAPTER 12 Analysis of Variance
• New introduction to the chapter.
• New exercise 24 using the speed of browsers to search the Internet.
• Revised exercise 33 comparing learning in traditional versus online courses.
• New section on Comparing Two Population Variances.
• New example illustrating the comparison of variances.
• Revised section on two-way ANOVA with interaction with new examples and revised example/solution.
• Revised the names of the airlines in the one-way ANOVA example.
• Changed the subscripts in example/solution for easier understanding.
• New exercise 30 (flight times between Los Angeles and San Francisco).

CHAPTER 13 Correlation and Linear Regression
• Rewrote the introduction section to the chapter.
• The data used as the basis for the North American Copier Sales example/solution used throughout the chapter has been changed and expanded to 15 observations to more clearly demonstrate the chapter’s learning objectives.
• Revised section on transforming data using the economic relationship between price and sales.
• New exercises 35 (transforming data), 36 (Masters prizes and scores), 43 (2012 NFL points scored versus points allowed), 44 (store size and sales), and 61 (airline distance and fare).

CHAPTER 14 Multiple Regression Analysis
• Rewrote the section on evaluating the multiple regression equation.
• More emphasis on the regression ANOVA table.
• Enhanced the discussion of the $p$-value in decision making.
• More emphasis on calculating the variance inflation factor to evaluate multicollinearity.

CHAPTER 15 Nonparametric Methods: Nominal Level Hypothesis Tests
• Moved and renamed chapter.
• Moved one-sample and two-sample tests of proportions from Chapters 10 and 11 to Chapter 15.
• New example introducing goodness-of-fit tests.
• Removed the graphical methods to evaluate normality.
• Revised section on contingency table analysis with a new example/solution.
• Revised Data Set exercises.

CHAPTER 16 Nonparametric Methods: Analysis of Ordinal Data
• Moved and renamed chapter.
• New example/solution and self-review demonstrating a hypothesis test about the median.
• New example/solution demonstrating the rank-order correlation.

CHAPTER 17 Index Numbers
• Moved chapter to follow nonparametric statistics.
• Updated dates, illustrations, and examples.
• Revised example/solution demonstrating the use of the Production Price Index to deflate sales dollars.
• Revised example/solution demonstrating the comparison of the Dow Jones Industrial Average and the Nasdaq using indexing.
• New self-review about using indexes to compare two different measures over time.
• Revised Data Set Exercise.

CHAPTER 18 Time Series and Forecasting
• Moved chapter to follow nonparametric statistics and index numbers.
• Updated dates, illustrations, and examples.
• Revised section on the components of a time series.
• Revised graphics for better illustration.

CHAPTER 19 Statistical Process Control and Quality Management
• Updated 2012 Malcolm Baldrige National Quality Award winners.
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2 Describing Data: Frequency Tables, Frequency Distributions, and Graphic Presentation 17
3 Describing Data: Numerical Measures 50
4 Describing Data: Displaying and Exploring Data 93 Review Section
5 A Survey of Probability Concepts 131
6 Discrete Probability Distributions 173
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20 An Introduction to Decision Theory On the website: www.mhhe.com/lind16e

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