

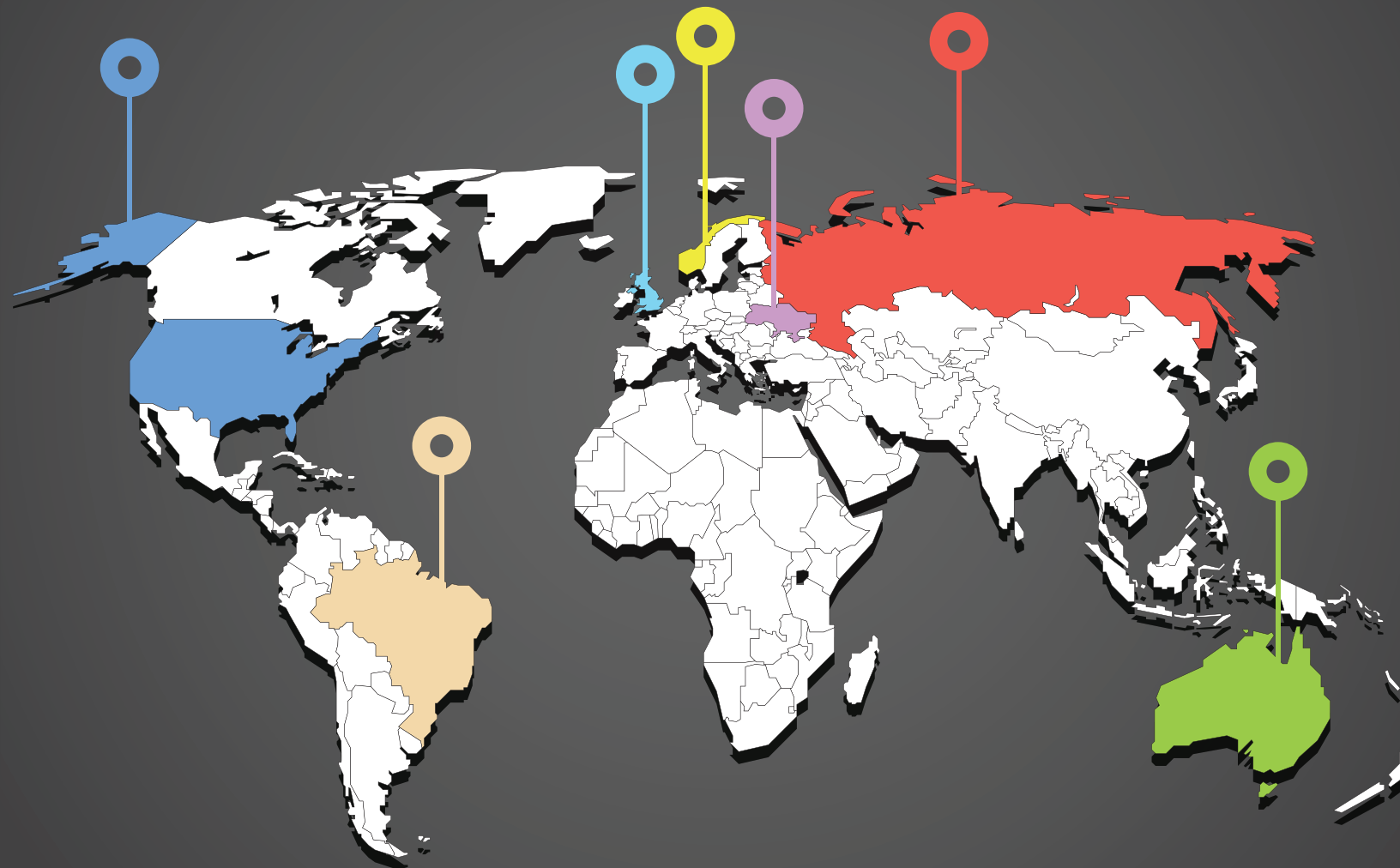
GLOBAL
EDITION



Business Statistics

THIRD EDITION

Sharpe • De Veaux • Velleman



ALWAYS LEARNING

PEARSON

Business Statistics

3rd Edition
Global Edition

Business Statistics

3rd Edition
Global Edition

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To my husband, Peter, for his patience and support

—*Noreen*

To my family

—*Dick*

To my father, who taught me about ethical business practice by his constant example as a small businessman and parent

—*Paul*

Meet the Authors



Norean Radke Sharpe (Ph.D. University of Virginia) has developed an international reputation as an educator, administrator, and consultant on assessment and accreditation. She is currently a professor at the McDonough School of Business at Georgetown University, where she is also Senior Associate Dean and Director of Undergraduate Programs. Prior to joining Georgetown, Norean taught business statistics and operations research courses to both undergraduate and MBA students for fourteen years at Babson College. Before moving into business education, she taught statistics for several years at Bowdoin College and conducted research at Yale University. Norean is coauthor of the recent text, *A Casebook for Business Statistics: Laboratories for Decision Making*, and she has authored more than 30 articles—primarily in the areas of statistics education and women in science. Norean currently serves as Associate Editor for the journal *Cases in Business, Industry, and Government Statistics*. Her scholarship focuses on business forecasting, statistics education, and student learning. She is co-founder of the DOME Foundation, a nonprofit foundation that works to increase Diversity and Outreach in Mathematics and Engineering, and she currently serves on two other nonprofit boards in the Washington, D.C. area. Norean has been active in increasing the participation of women and underrepresented students in science and mathematics for several years and has two children of her own.



Richard D. De Veaux (Ph.D. Stanford University) is an internationally known educator, consultant, and lecturer. Dick has taught statistics at a business school (Wharton), an engineering school (Princeton), and a liberal arts college (Williams). While at Princeton, he won a Lifetime Award for Dedication and Excellence in Teaching. Since 1994, he has taught at Williams College, although he returned to Princeton for the academic year 2006–2007 as the William R. Kenan Jr. Visiting Professor of Distinguished Teaching. He is currently the C. Carlisle and Margaret Tippit Professor of Statistics at Williams College. Dick holds degrees from Princeton University in Civil Engineering and Mathematics and from Stanford University in Dance Education and Statistics, where he studied with Persi Diaconis. His research focuses on the analysis of large data sets and data mining in science and industry. Dick has won both the Wilcoxon and Shewell awards from the American Society for Quality. He is an elected member of the International Statistics Institute (ISI) and a Fellow of the American Statistical Association (ASA). He currently serves on the Board of Directors of the ASA. Dick is also well known in industry, having consulted for such *Fortune* 500 companies as American Express, Hewlett-Packard, Alcoa, DuPont, Pillsbury, General Electric, and Chemical Bank. He was named the “Statistician of the Year” for 2008 by the Boston Chapter of the American Statistical Association for his contributions to teaching, research, and consulting. In his spare time he is an avid cyclist and swimmer. He also is the founder and bass for the doo-wop group the Diminished Faculty and is a frequent singer and soloist with various local choirs, including the Choeur Vittoria of Paris, France. Dick is the father of four children.



Paul F. Velleman (Ph.D. Princeton University) has an international reputation for innovative statistics education. He designed the Data Desk® software package and is also the author and designer of the award-winning ActivStats® multimedia software, for which he received the EDUCOM Medal for innovative uses of computers in teaching statistics and the ICTCM Award for Innovation in Using Technology in College Mathematics. He is the founder and CEO of Data Description, Inc. (www.datadesk.com), which supports both of these programs. He also developed the Internet site *Data and Story Library* (DASL; lib.stat.cmu.edu/DASL/), which provides data sets for teaching Statistics. Paul coauthored (with David Hoaglin) the book *ABCs of Exploratory Data Analysis*. Paul teaches Statistics at Cornell University in the Department of Statistical Sciences and in the School of Industrial and Labor Relations, for which he has been awarded the MacIntyre Prize for Exemplary Teaching. His research often focuses on statistical graphics and data analysis methods. Paul is a Fellow of the American Statistical Association and of the American Association for the Advancement of Science. Paul’s experience as a professor, entrepreneur, and business leader brings a unique perspective to the book.

Richard De Veaux and Paul Velleman have authored successful books in the introductory college and AP High School market with David Bock, including *Intro Stats*, Fourth Edition (Pearson, 2014); *Stats: Modeling the World*, Fourth Edition (Pearson, 2015); and *Stats: Data and Models*, Third Edition (Pearson, 2012).

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Preface

The question that should motivate a business student's study of Statistics should be "How can I make better decisions?"¹ As entrepreneurs and consultants, we know that in today's data-rich environment, knowledge of Statistics is essential to survive and thrive in the business world. But, as educators, we've seen a disconnect between the way business statistics is traditionally taught and the way it should be used in making business decisions. In *Business Statistics*, we try to narrow the gap between theory and practice by presenting relevant statistical methods that will empower business students to make effective, data-informed decisions.

Of course, students should come away from their statistics course knowing how to think statistically and how to apply statistics methods with modern technology. But they must also be able to communicate their analyses effectively to others. When asked about statistics education, a group of CEOs from *Fortune* 500 companies recently said that although they were satisfied with the technical competence of students who had studied statistics, they found the students' ability to communicate their findings to be woefully inadequate.

Our Plan, Do, Report rubric provides a structure for solving business problems that mimics the correct application of statistics to solving real business problems. Unlike many other books, we emphasize the often neglected thinking (Plan) and communication (Report) steps in problem solving in addition to the methodology (Do). This approach requires up-to-date, real-world examples and data. So we constantly strive to illustrate our lessons with current business issues and examples.

What's New in This Edition?

We've been delighted with the reaction to previous editions of *Business Statistics*. We've streamlined the third edition further to help students focus on the central material. And, of course, we continue to update examples and exercises so that the story we tell is always tied to the ways Statistics informs modern business practice.

- **Recent data.** We teach with real data whenever possible, so we've updated data throughout the book. New examples reflect current stories in the news and recent economic and business events. The brief cases have been updated with new data and new contexts.
- **Improved organization.** We have retained our "data first" presentation of topics because we find that it provides students with both motivation and a foundation in real business decisions on which to build an understanding.
 - Chapters 1–4 have been streamlined to cover collecting, displaying, summarizing, and understanding data in four chapters. We find that this provides students with a solid foundation to launch their study of probability and statistics.
 - Chapters 5–9 introduce students to randomness and probability models. They then apply these new concepts to sampling. This provides a gateway to the core material on statistical inference. We've moved the discussion of probability trees and Bayes' rule into these chapters.
 - Chapters 10–14 cover inference for both proportions and means. We introduce inference by discussing proportions because most students are better acquainted with proportions reported in surveys and news stories. However, this edition ties in the discussion of means immediately so students can appreciate that the reasoning of inference is the same in a variety of contexts.
 - Chapters 15–19 cover regression-based models for decision making.
 - Chapters 20–24 discuss special topics that can be selected according to the needs of the course and the preferences of the instructor.

¹Unfortunately, not the question most students are asking themselves on the first day of the course.

- **Streamlined design.** Our goal has always been an accessible text. This edition sports a new design that clarifies the purpose of each text element. The major theme of each chapter is more linear and easier to follow without distraction. Supporting material is clearly boxed and shaded, so students know where to focus their study efforts.
- **Enhanced Technology Help with expanded Excel 2013 coverage.** We've updated Technology Help and added detailed instructions for Excel 2013 to almost every chapter.
- **Updated Ethics in Action features.** We've updated more than half of our Ethics in Action features. Ethically and statistically sound alternative approaches to the questions raised in these features and a link to the American Statistical Association's Ethical Guidelines are now presented in the Instructor's Solutions Manual, making the Ethics features suitable for assignment or class discussion.
- **Updated examples to reflect the changing world.** The time since our last revision has seen marked changes in the U.S. and world economies. This has required us to update many of our examples. Our chapter on time series was particularly affected. We've reworked those examples and discussed the real-world challenges of modeling economic and business data in a changing world. The result is a chapter that is more realistic and useful.
- **Increased focus on core material.** Statistics in practice means making smart decisions based on data. Students need to know the methods, how to apply them, and the assumptions and conditions that make them work. We've tightened our discussions to get students there as quickly as possible, focusing increasingly on the central ideas and core material.

Our Approach

Statistical Thinking

For all of our improvements, examples, and updates in this edition of *Business Statistics* we haven't lost sight of our original mission—writing a modern business statistics text that addresses the importance of *statistical thinking* in making business decisions and that acknowledges how Statistics is actually used in business.

Statistics is practiced with technology, and this insight informs everything from our choice of forms for equations (favoring intuitive forms over calculation forms) to our extensive use of real data. But most important, understanding the value of technology allows us to focus on teaching statistical thinking rather than calculation. The questions that motivate each of our hundreds of examples are not “How do you find the answer?” but “How do you think about the answer?”, “How does it help you make a better decision?”, and “How can you best communicate your decision?”

Our focus on statistical thinking ties the chapters of the book together. An introductory Business Statistics course covers an overwhelming number of new terms, concepts, and methods, and it is vital that students see their central core: how we can understand more about the world and make better decisions by understanding what the data tell us. From this perspective, it is easy to see that the patterns we look for in graphs are the same as those we think about when we prepare to make inferences. And it is easy to see that the many ways to draw inferences from data are several applications of the same core concepts. And it follows naturally that when we extend these basic ideas into more complex (and even more realistic) situations, the same basic reasoning is still at the core of our analyses.

Our Goal: Read This Book!

The best textbook in the world is of little value if it isn't read. Here are some of the ways we made *Business Statistics* more approachable:

- **Readability.** We strive for a conversational, approachable style, and we introduce anecdotes to maintain interest. Instructors report (to their amazement) that their students read ahead of their assignments voluntarily. Students tell us (to *their* amazement) that they actually enjoy the book. In this edition, we've tightened our discussions to be more focused on the central ideas we want to convey.
- **Focus on assumptions and conditions.** More than any other textbook, *Business Statistics* emphasizes the need to verify assumptions when using statistical procedures. We reiterate this focus throughout the examples and exercises. We make every effort to provide templates that reinforce the practice of checking these assumptions and conditions, rather than rushing through the computations. Business decisions have consequences. Blind calculations open the door to errors that could easily be avoided by taking the time to graph the data, check assumptions and conditions, and then check again that the results and residuals make sense.
- **Emphasis on graphing and exploring data.** Our consistent emphasis on the importance of displaying data is evident from the first chapters on understanding data to the sophisticated model-building chapters at the end. Examples often illustrate the value of examining data graphically, and the Exercises reinforce this. Good graphics reveal structures, patterns, and occasional anomalies that could otherwise go unnoticed. These patterns often raise new questions and inform both the path of a resulting statistical analysis and the business decisions. Hundreds of new graphics found throughout the book demonstrate that the simple structures that underlie even the most sophisticated statistical inferences are the same ones we look for in the simplest examples. This helps tie the concepts of the book together to tell a coherent story.
- **Consistency.** We work hard to avoid the “do what we say, not what we do” trap. Having taught the importance of plotting data and checking assumptions and conditions, we are careful to model that behavior throughout the book. (Check the Exercises in the chapters on multiple regression or time series and you'll find us still requiring and demonstrating the plots and checks that were introduced in the early chapters.) This consistency helps reinforce these fundamental principles and provides a familiar foundation for the more sophisticated topics.
- **The need to read.** In this book, important concepts, definitions, and sample solutions are not always set aside in boxes. The book needs to be read, so we've tried to make the reading experience enjoyable. The common approach of skimming for definitions or starting with the exercises and looking up examples just won't work here. (It never did work as a way to learn about and understand Statistics.)

Coverage

The topics covered in a Business Statistics course are generally mandated by our students' needs in their studies and in their future professions. But the *order* of these topics and the relative emphasis given to each is not well established. *Business Statistics* presents some topics sooner or later than other texts. Although many chapters can be taught in a different order, we urge you to consider the order we have chosen.

We've been guided in the order of topics by the fundamental goal of designing a coherent course in which concepts and methods fit together to provide a new understanding of

how reasoning with data can uncover new and important truths. Each new topic should fit into the growing structure of understanding that students develop throughout the course. For example, we teach inference concepts with proportions first and then with means. Most people have a wider experience with proportions, seeing them in polls and advertising. And by starting with proportions, we can teach inference with the Normal model and then introduce inference for means with the Student's t distribution.

We introduce the concepts of association, correlation, and regression early in *Business Statistics*. Our experience in the classroom shows that introducing these fundamental ideas early makes Statistics useful and relevant even at the beginning of the course. By Chapter 4, students can discuss relationships among variables in a meaningful way. Later in the semester, when we discuss inference, it is natural and relatively easy to build on the fundamental concepts learned earlier and enhance them with inferential methods.

GAISE Report

We've been guided in our choice of what to emphasize by the GAISE (Guidelines for Assessment and Instruction in Statistics Education) Report, which emerged from extensive studies of how students best learn Statistics (www.amstat.org/education/gaise/). Those recommendations, now officially adopted and recommended by the American Statistical Association, urge (among other detailed suggestions) that Statistics education should:

1. Emphasize statistical literacy and develop statistical thinking.
2. Use real data.
3. Stress conceptual understanding rather than mere knowledge of procedures.
4. Foster active learning.
5. Use technology for developing conceptual understanding and analyzing data.
6. Make assessment a part of the learning process.

In this sense, this book is thoroughly modern.

Syllabus Flexibility

But to be effective, a course must fit comfortably with the instructor's preferences. The early chapters—Chapters 1–14—present core material that will be part of any introductory course. Chapters 15–20—multiple regression, time series, model building, and Analysis of Variance—may be included in an introductory course, but our organization provides flexibility in the order and choice of specific topics. Chapters 21–24 may be viewed as “special topics” and selected and sequenced to suit the instructor or the course requirements.

Here are some specific notes:

- Chapter 4, Correlation and Linear Regression, may be postponed until just before covering regression inference in Chapters 15 and 16. (But we urge you to teach it where it appears.)
- Chapter 18, Building Multiple Regression Models, must follow the introductory material on multiple regression in Chapter 17.
- Chapter 19, Time Series Analysis, requires material on multiple regression from Chapter 17.
- Chapter 20, Design and Analysis of Experiments and Observational Studies, may be taught before the material on regression—at any point after Chapter 13.

The following topics can be introduced in any order (or omitted) after basic inference has been covered:

- Chapter 14, Inference for Counts: Chi-Square Tests
- Chapter 21, Quality Control
- Chapter 22, Nonparametric Methods
- Chapter 23, Decision Making and Risk
- Chapter 24, Introduction to Data Mining

Continuing Features

A textbook isn't just words on a page. A textbook is many elements that come together to form a big picture. The features in *Business Statistics* provide a real-world context for concepts, help students apply these concepts, promote problem solving, and integrate technology—all of which help students understand and see the big picture of Business Statistics.

Providing Real-World Context

Motivating Vignettes. Each chapter opens with a motivating vignette, often taken from the authors' consulting experiences. Companies featured include Amazon.com, Zillow.com, Keen Inc., and Whole Foods Market. We analyze data from or about the companies in the motivating vignettes throughout the chapter.

Brief Cases. Each chapter includes one or more Brief Cases that use real data and ask students to investigate a question or make a decision. Students define the objective, plan the process, complete the analysis, and report a conclusion. Data for the Brief Cases are available on and website, formatted for various technologies.

Case Studies. Each of the five parts of the book ends with a Case Study. Students are given realistically large data sets and challenged to respond to open-ended business questions using the data. Students can bring together methods they have learned throughout the book to address the issues raised. Students will have to use a computer to work with the large data sets that accompany these Case Studies.

What Can Go Wrong? In each chapter, What Can Go Wrong? highlights the most common statistical errors and the misconceptions about Statistics. The most common mistakes for the new user of Statistics often involve misusing a method—not miscalculating a statistic. One of our goals is to arm students with the tools to detect statistical errors and to offer practice in debunking misuses of Statistics, whether intentional or not.

Applying Concepts

For Examples. Almost every section of every chapter includes a focused example that illustrates and applies the concepts or methods of that section to a real-world business context.

Step-by-Step Guided Examples. The answer to a statistical question is almost never just a number. Statistics is about understanding the world and making better decisions with data. Guided Examples model a thorough solution in the right column with commentary in the left column. The overall analysis follows our innovative **Plan, Do, Report** template. Each analysis begins with a clear question about a business decision and an examination of the data (**Plan**), moves to calculating the selected statistics (**Do**), and finally concludes with a **Report** that specifically addresses the question. To emphasize that our goal is to address

the motivating question, we present the **Report** step as a business memo that summarizes the results in the context of the example and states a recommendation if the data are able to support one. To preserve the realism of the example, whenever it is appropriate, we include limitations of the analysis or models in the concluding memo, as one should in making such a report.

By Hand. Even though we encourage the use of technology to calculate statistical quantities, we recognize the pedagogical benefits of occasionally doing a calculation by hand. The By Hand boxes break apart the calculation of some of the simpler formulas and help the student through the calculation of a worked example.

Reality Check. We regularly offer reminders that Statistics is about understanding the world and making decisions with data. Results that make no sense are probably wrong, no matter how carefully we think we did the calculations. Mistakes are often easy to spot with a little thought, so we ask students to stop for a reality check before interpreting results.

Notation Alert. Throughout this book, we emphasize the importance of clear communication. Proper notation is part of the vocabulary of Statistics, but it can be daunting. We've found that it helps students when we are clear about the letters and symbols statisticians use to mean very specific things, so we've included Notation Alerts whenever we introduce a special notation that students will see again.

Math Boxes. In many chapters, we present the mathematical underpinnings of the statistical methods and concepts. We set proofs, derivations, and justifications apart from the narrative, so the underlying mathematics is there for those who want greater depth, but the text itself presents the logical development of the topic at hand without distractions.

What Have We Learned? Each chapter ends with a What Have We Learned? summary that includes learning objectives and definitions of terms introduced in the chapter. Students can think of these as study guides.

Promoting Problem Solving

Just Checking. Throughout each chapter we pose short questions to help students check their understanding. The answers are at the end of the exercise sets in each chapter to make them easy to check. The questions can also be used to motivate class discussion.

Ethics in Action. Statistics is not just plugging numbers into formulas; most statistical analyses require a fair amount of judgment. Ethics in Action vignettes—updated for this edition—in each chapter provide a context for some of the judgments needed in statistical analyses. Possible errors, a link to the American Statistical Association's Ethical Guidelines, and ethically and statistically sound alternative approaches are presented in the Instructor's Solutions Manual.

Section Exercises. The exercises for each chapter begin with straightforward exercises targeted at the topics in each section. These are designed to check understanding of specific topics. Because they are labeled by section, it is easy to turn back to the chapter to clarify a concept or review a method.

Chapter Exercises. These exercises are designed to be more realistic than Section Exercises and to lead to conclusions about the real world. They may combine concepts and methods from different sections, and they contain relevant, modern, and real-world

questions. Many come from news stories; some come from recent research articles. The exercises marked with a **T** indicate that the data are provided at the book's companion website, www.pearsonglobaleditions.com/sharpe in a variety of formats. We pair the exercises so that each odd-numbered exercise (with the answer at the back of the book) is followed by an even-numbered exercise on the same Statistics topic. Exercises are roughly ordered within each chapter by both topic and by level of difficulty.

Integrating Technology

Data and Sources. Most of the data used in examples and exercises are from real-world sources and whenever we can, we include URLs for Internet data sources. The data we use are usually on the companion website, www.pearsonglobaleditions.com/sharpe.

Videos with Optional Captioning. Videos, featuring the *Business Statistics* authors, review the high points of each chapter. The presentations feature the same student-friendly style and emphasis on critical thinking as the textbook. In addition, 10 *Business Insight Videos* feature Deckers, Southwest Airlines, Starwood, and other companies and focus on statistical concepts as they pertain to the real world. Videos are available with captioning. They can also be viewed from within the online MyStatLab course.

Technology Help. In business, Statistics is practiced with computers using a variety of statistics packages. In Business-school Statistics classes, however, Excel is the software most often used. In Technology Help at the end of each chapter, we summarize what students can find in the most common software, often with annotated output. Updated for this edition, we offer extended guidance for Excel 2013, and start-up pointers for Minitab, SPSS, and JMP, formatted in easy-to-read bulleted lists. This advice is not intended to replace the documentation for any of the software, but rather to point the way and provide start-up assistance.

Student Supplements

Business Statistics, for-sale student edition.

Study Cards for Business Statistics Software: This series of study cards, available for Excel 2013 with XLSTAT, Excel 2013 with Data Analysis Toolpak, Minitab, JMP, SPSS, and StatCrunch provide students with easy step-by-step guides to the most common business statistics software.

Instructor Supplements

Instructor's Resource Guide (download only), written by the authors, contains chapter-by-chapter comments on the major concepts, tips on presenting topics (and what to avoid), teaching examples, suggested assignments, basic exercises, and web links and lists of other resources. Available within MyStatLab or at www.pearsonglobaleditions.com/sharpe.

Online Test Bank (download only), by Linda Dawson, University of Washington, and Rose Sebastianelli, University of Scranton, includes chapter quizzes and part level tests. The Test Bank is available at www.pearsonglobaleditions.com/sharpe.

Instructor's Solutions Manual (download only), by Linda Dawson, University of Washington and Rose Sebastianelli, University of Scranton, contains detailed solutions to all of the exercises. The Instructor's Solutions Manual is available at www.pearsonglobaleditions.com/sharpe.

Technology Resources

MyStatLab™ Online Course (access code required)

MyStatLab from Pearson is the world's leading online resource in statistics, integrating interactive homework, assessment, and media in a flexible, easy-to-use format. MyStatLab is a course management system that delivers proven results in helping individual students succeed.

MyStatLab can be implemented successfully in any environment—lab-based, hybrid, fully online, traditional—and demonstrates the quantifiable difference that integrated usage has on student retention, subsequent success, and overall achievement.

MyStatLab's comprehensive online gradebook automatically tracks students' results on tests, quizzes, homework, and in the study plan. Instructors can use the gradebook to provide positive feedback or intervene if students have trouble. Gradebook data can be easily exported to a variety of spreadsheet programs, such as Microsoft Excel. You can determine which points of data

you want to export, and then analyze the results to determine success.

MyStatLab provides engaging experiences that personalize, stimulate, and measure learning for each student. In addition to the resources below, each course includes a full interactive online version of the accompanying textbook.

- **Tutorial Exercises with Multimedia Learning Aids:** The homework and practice exercises in MyStatLab align with the exercises in the textbook, and most regenerate algorithmically to give students unlimited opportunity for practice and mastery. Exercises offer immediate helpful feedback, including guided solutions, sample problems, animations, and videos.
- **Adaptive Study Plan:** Pearson now offers an optional focus on adaptive learning in the study plan to allow students to work on just what they need to learn when it makes the most sense to learn it. The adaptive study plan maximizes students' potential for understanding and success.
- **Additional Question Libraries:** In addition to algorithmically regenerated questions that are aligned with your textbook, MyStatLab courses come with two additional question libraries. **450 Getting Ready for Statistics** questions cover the developmental math topics students need for the course. These can be assigned as a prerequisite to other assignments, if desired. The **1000 Conceptual Question Library** requires students to apply their statistical understanding.
- **StatCrunch®:** MyStatLab includes web-based statistical software, StatCrunch, within the online assessment platform so that students can analyze data sets from exercises and the text. In addition, MyStatLab includes access to www.StatCrunch.com, a web site where users can access tens of thousands of shared data sets, conduct online surveys, perform complex analyses using the powerful statistical software, and generate compelling reports.
- **Integration of Statistical Software:** We make it easy to copy our data sets, both from the ebook and the MyStatLab questions, into software such as StatCrunch, Minitab, Excel, and more. Students have access to a variety of support tools—Technology Instruction Videos, Technology Study Cards, and Manuals for select titles—to learn how to use statistical software.
- **Business Insight Videos:** Ten engaging videos show managers at top companies using statistics in their everyday work. Assignable questions encourage debate and discussion.
- **StatTalk Videos:** Fun-loving statistician Andrew Vickers takes to the streets of Brooklyn, New York, to demonstrate important statistical concepts through interesting stories and real-life events. This series of 24 videos includes available assessment questions and an instructor's guide.

StatCrunch®

StatCrunch is powerful web-based statistical software that allows users to perform complex analyses, share data sets, and generate compelling reports of their data. The vibrant online community offers tens of thousands data sets for students to analyze.

- **Collect.** Users can upload their own data to StatCrunch or search a large library of publicly shared data sets, spanning almost any topic of interest. An online survey tool allows users to collect data via web-based surveys.
- **Crunch.** A full range of numerical and graphical methods allows users to analyze and gain insights from any data set. Interactive graphics help users understand statistical concepts, and are available for export to enrich reports with visual representations of data.
- **Communicate.** Reporting options help users create a wide variety of visually appealing representations of their data.

Full access to StatCrunch is available with a MyStatLab kit, and StatCrunch is available by itself to qualified adopters. For more information, visit our website at www.StatCrunch.com, or contact your Pearson representative.

TestGen®

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank

of questions developed to cover all the objectives of the text. TestGen is algorithmically based, so instructors can create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions. The software and testbank are available for download from Pearson Education's online catalog.

PowerPoint® Lecture Slides

PowerPoint® Lecture Slides provide an outline to use in a lecture setting, presenting definitions, key concepts, and figures from the text. These slides are available within MyStatLab and in the Instructor Resource Center at www.pearson-globaleditions.com/sharpe.

XLStat for Pearson

XLStat for Pearson is an Excel® add-in that offers a wide variety of functions to enhance the analytical capabilities of Microsoft Excel, making it the ideal tool for your everyday data analysis and statistics requirements. Developed in 1993, XLStat is used by leading businesses and universities around the world. XLStat is compatible with all Excel versions from version 97 to version 2013 (except Mac 2008) including PowerPC and Intel-based Mac systems. For more information, visit www.pearsonhighered.com/xlstat/.

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1

Data and Decisions

E-Commerce

E-Commerce and mobile commerce have dramatically changed the way the world shops. Online shoppers can buy clothes, food, even cars with the click of a mouse and a digital swipe of their credit card—24 hours a day, 7 days a week. Companies now reach their customers in ways no one could even imagine just a generation ago. Online sales in some sectors, such as clothing and electronics, already account for over 15% of total sales, which is about double what it was five years ago. U.S. adults, on average, currently spend about \$1200 a year online, but some projections put that number at nearly \$2000 a year by 2016.

The trend in online shopping is worldwide. The amount Australians spend online is expected to grow by \$10B in the next five years. The research firm Forrester estimates that global digital retailing is headed toward 15 to 20% of total sales worldwide in the near future.

A few generations ago, many store owners knew their customers well. With that knowledge, they could personalize their suggestions, guessing which items that particular customer might like. Online marketers rely on similar information about customers and potential customers to make decisions. But in today's digital age retailers never meet their customers, so, that information has to be obtained in other ways. How do today's companies know which ads to place on your browser or what order to list the websites from your search? How do marketers know what to advertise and to whom?

The answer is ...

Data.



1.1 What Are Data?

“Data is king at Amazon. Clickstream and purchase data are the crown jewels at Amazon. They help us build features to personalize the website experience.”

—RONNY KOHAVI,
FORMER DIRECTOR OF DATA
MINING AND
PERSONALIZATION,
AMAZON.COM

“It is the mark of a truly intelligent person to be moved by statistics.”

—GEORGE BERNARD SHAW

Q: What is Statistics?

A: Statistics is a way of reasoning, along with a collection of tools and methods, designed to help us understand the world.

Q: What are statistics?

A: Statistics (plural) are quantities calculated from data.

Q: So what is data?

A: You mean, “what *are* data?” Data is the plural form. The singular is datum.

Q: So, what are data?

A: Data are values along with their context.

Businesses have always relied on data for planning and to improve efficiency and quality. Now, more than ever before, businesses rely on the information in data to compete in the global marketplace. Every time you make an online purchase, much more information is actually captured than just the details of the purchase itself. What pages did you search in order to get to your purchase? How much time did you spend looking at each? Companies use this information to make decisions about virtually all phases of their business, from inventory to advertising to website design. These data are recorded and stored electronically, in vast digital repositories called **data warehouses**.

In the past few decades these data warehouses have grown enormously in size, but with the use of powerful computers, the information contained in them is accessible and used to help make decisions. The huge capacity of these warehouses has given rise to the term **Big Data** to describe data sets so large that traditional methods of storage and analysis are inadequate. Even though the data amounts are huge, some decisions can be made quickly. When you pay with your credit card, for example, the information about the transaction is transmitted to a central computer where it is processed and analyzed. A decision whether to approve or deny your purchase is made and transmitted back to the point of sale, all within a few seconds. But data alone can’t help you make better business decisions. You must be able to summarize, model, and understand what the data can tell you. That collection of tools and its associated reasoning is what we call “Statistics.”

Statistics plays a role in making sense of our complex world in an astonishing number of ways. Statisticians assess the risk of genetically engineered foods or of a new drug being considered by the Food and Drug Administration (FDA). Statisticians predict the number of new cases of AIDS by regions of the country or the number of customers likely to respond to a sale at the supermarket. And statisticians help scientists, social scientists, and business leaders understand how unemployment is related to environmental controls, whether enriched early education affects the later performance of school children, and whether vitamin C really prevents illness. Whenever you have data and a need to understand the world or make an informed decision, you need Statistics.

If we want to analyze student perceptions of business ethics (a question we’ll come back to in a later chapter), should we administer a survey to every single university student in the United States—or, for that matter, in the world? Well, that wouldn’t be very practical or cost-effective. Instead, we can try to obtain survey responses from a smaller, representative group of students. Statistics can help us make the leap from a smaller sample of data we have at hand to an understanding of the world at large. We talk about the specifics of sampling in Chapter 8, and the theme of generalizing from the specific to the general is one that we revisit throughout this book. We hope this text will empower *you* to draw conclusions from data and make valid business decisions in response to such questions as:

- Will the new design of our website increase click-through rates and result in more sales?
- What is the effect of advertising on sales?
- Do aggressive, “high-growth” mutual funds really have higher returns than more conservative funds?
- Is there a seasonal cycle in your firm’s revenues and profits?
- What is the relationship between shelf location and cereal sales?
- Do students around the world perceive issues in business ethics differently?
- Are there common characteristics about your customers and why they choose your products?—and, more importantly, are those characteristics the same among those who aren’t your customers?

Our ability to answer questions such as these and make sound business decisions with data depends largely on our ability to understand *variation*. That may not be the