4th Edition

Business Statistics

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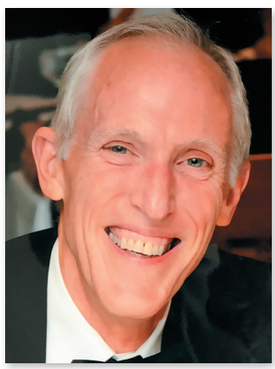
To my loving family for their patience and support
—Norean

To my father, whose daily stories informed me how the world of business really worked, and to my family, for giving me the love and support that made this book possible
—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 R. Sharpe, Ph.D., is Dean and the Joseph H. and Maria C. Schwartz Distinguished Chair at The Peter J. Tobin College of Business at St. John's University. As the chief academic officer of the Tobin College of Business, she is responsible for the curriculum for 2500 undergraduate business majors and 600 graduate students in one of seven M.S./M.B.A. programs, all supported by more than 150 faculty and staff on the Manhattan, Queens, Staten Island, and Rome, Italy, campuses. Within the Tobin College is the Center for Enterprise Risk Management, the Applied Finance Institute, and the Global Business Stewardship Center, as well as the acclaimed School of Risk Management, Insurance, and Actuarial Science.
Dr. Sharpe is an accomplished scholar, with 30 years of teaching experience at Yale University, Bowdoin College, Babson College, and Georgetown University—and with more than 30 scholarly publications in analytics and statistics education. Her research interests include time series analysis, forecasting, analytics, and women's roles in entrepreneurship in the Middle East. Dr. Sharpe earned her B.A. from Mt. Holyoke College, her M.S. from the University of North Carolina, and her Ph.D. in Systems Engineering from the University of Virginia.



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 where he studied statistics with Persi Diaconis and dance with Inga Weiss. His research focuses on the analysis of large datasets 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). Dick was elected Vice President of the ASA in 2018 and will serve from 2019 to 2021. 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. In his spare time he is an avid cyclist and swimmer, 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. Data Description also developed and maintains the Internet site *Data and Story Library* (DASL; **dasl.datadescription.com**), which provides all of the datasets used in this text as well as many others useful for teaching statistics, and the statistics conceptual tools at **astools.datadesk.com**. Paul coauthored (with David Hoaglin) the book *ABCs of Exploratory Data Analysis*. Paul is Emeritus Professor of Statistical Sciences, at Cornell University where he was awarded the MacIntyre Prize for Exemplary Teaching. Paul earned his M.S. and Ph.D. from Princeton University, where he studied with John Tukey. 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. He was a member of the working group that developed the GAISE 2016 guidelines for teaching statistics. 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*, Fifth Edition (Pearson, 2018); *Stats: Modeling the World*, Fifth Edition (Pearson, 2019); and *Stats: Data and Models*, Fourth Edition (Pearson, 2016).

Special Contributor

Eric M. Eisenstein (Ph.D. Wharton School of Business) is an internationally known educator, researcher, and consultant. Eric has taught at multiple business schools, including Wharton, Cornell's Johnson School, ESADE, and Temple University's Fox School of Business. At Fox, he serves as the Director of the MS in Business Analytics in the department of Statistical Science, Director of Graduate Programs in the department of Marketing and Supply Chain Management, and Chair of the Undergraduate Program (curriculum) Committee. Eric teaches data analytics, quantitative strategy, and marketing. His research focuses on the psychology of expertise, how to improve decision making, and strategic analytics. Prior to becoming an academic, Eric worked at Mercer Management Consulting (now Oliver Wyman) where he focused on management of technology and marketing research in the financial services and telecommunications industries. His teams won the outstanding team award three times consecutively; clients invested over $30 million based on the recommendations of his teams, and the teams' strategic recommendations affected more than $10 billion in revenue and $2 billion in profits. He continues to consult and serve on the board of numerous companies and charities. Eric earned his Ph.D. in Applied Economics and an M.A. in Statistics at the Wharton School of Business, University of Pennsylvania and graduated from the Management and Technology dual degree program at the University of Pennsylvania, where he concurrently earned a B.S. in Economics from Wharton and a B.S. in Computer Systems Engineering from the School of Engineering and Applied Science. He is the proud father to three children.

Contents

Preface

The question that should motivate a business student's study of statistics should be "Even without perfect information, 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 authors, 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 made some changes to the organization of the fourth edition to help students focus on the essentials and think about the data-rich world they will find in the workplace. 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. When a historical dataset is especially good at illuminating a pedagogical point, we have, from time to time, chosen pedagogy over recency.
- **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 5–7 introduce students to randomness and probability models. We've moved the discussion of probability trees and Bayes' rule into these chapters.
    - Chapters 8 and 9 cover data collection by survey and by designed experiments. New discussions here address technology-enabled sampling, online data, and Big Data. We've moved the discussion of experiments up front because of the increased importance of online testing, but we've

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

moved the analysis of such designs (ANOVA), which many instructors find difficult to cover in a first course, to the online Chapter 25.
  - Chapters 10–15 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. We've added an optional discussion of bootstrapping. This may help students' intuition about inference as well as providing a relatively new modern method.
  - Chapters 16–19 cover regression-based models for decision making.
  - Chapter 20 discusses time series methods.
  - Chapter 21 is a newly expanded discussion of data mining and Big Data.
  - Chapters 22–24 discuss special topics that can be selected according to the needs of the course and the preferences of the instructor.
- **Streamlined design.** Our goal has always been a readable text. This edition sports a new design that clarifies the purpose of each text element. The major theme of each chapter is linear and easy to follow without distraction. Supporting material is clearly boxed and shaded, so students know where to focus their study efforts.
- **Enhanced Technology Help.** We've updated Technology Help (now called Tech Support) in almost every chapter.
- **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 selection of course content reflects the wisdom of the GAISE2016 report adopted by the American Statistical Association as a standard for introductory statistics teaching. Our "In Practice" elements have all been re-structured to reflect real-world business challenges. The result is a text that is 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 redesigned "In Practice" elements in each chapter have been recast as conversations between managers and analysts to emphasize the business relevance of each method and its importance in making good business decisions.

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. 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 focused our discussions even more clearly 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 2016 (Guidelines for Assessment and Instruction in Statistics Education) Report, which emerged from extensive studies of how students best learn Statistics (**www.amstat.org/asa/files/pdfs/GAISE/GaiseCollege_Full.pdf**). The GAISE Report was extensively revised in 2016 to reflect the evolution of technology and new wisdom about teaching statistics. The new recommendations have been officially adopted and recommended by the American Statistical Association and urge (among other detailed suggestions) that statistics education should:

1. Teach statistical thinking.
2. Focus on conceptual understanding.
3. Integrate real data with a context and a purpose.
4. Foster active learning.
5. Use technology to explore concepts and analyze data.
6. Use assessments to improve and evaluate student learning.

In this sense, this book is thoroughly modern.

Syllabus Flexibility

To be effective, a course must fit comfortably with the instructor's preferences. The early chapters—Chapters 1–15—cover core material that will be part of most introductory courses. Chapters 16–20—multiple regression, model building, and time series. Analysis of Variance—may be included in an introductory course, but our organization provides flexibility in the order and choice of specific topics. Chapters 21–25 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 Chapter 16. (But we urge you to teach it where it appears.) Chapter 4 now includes an early glimpse of multiple regression (as advised by GAISE 2016). We urge you not to skip that discussion.
- Chapter 19, Building Multiple Regression Models, must follow the introductory material on multiple regression in Chapter 18.
- Chapters 20 and 25, Time Series Analysis and ANOVA, require material on multiple regression from Chapter 18.

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

- Chapter 15, Inference for Counts: Chi-Square Tests
- Chapter 21, Introduction to Big Data and Data Mining
- Chapter 22, Quality Control
- Chapter 23, Nonparametric Methods
- Chapter 24, Decision Making and Risk

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 the website, formatted for various technologies.

Case Studies. Throughout the book we present Case Studies. Students are given realistically large datasets 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 datasets 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

In Practice. Almost every section of every chapter includes focused examples that illustrate and apply the concepts or methods of that section to a real-world business context. Each one now ends with a specific written report. They are now structured as conversations between a manager and an analyst or employee with the requirement that a report be made to the manager. This format helps to frame the issues in a practical way.

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. When we present the mathematical underpinnings of the statistical methods and concepts, we set proofs, derivations, and justifications apart from the narrative. In this way, 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.

From Learning to Earning. Each chapter ends with a From Learning to Earning summary that includes learning objectives and definitions of terms introduced in the chapter. Students should use these as study guides. We encourage them to take this opportunity to see the "big picture" of the chapter and see how it applies to making business decisions.

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 available on the book's companion website, in a variety of formats. We pair the exercises so that each odd-numbered exercise (with answer in 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 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 available at the online Data and Story Library (DASL) at **dasl.datadescription.com** and on the companion website, **www.pearsonhighered.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 MyLab Statistics course.

Tech Support. 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 the Tech Support sections at the end of each chapter, we summarize what students can find in the most common software, often with annotated output. In updating for this edition, we offer extended guidance for Excel 2016, and start-up pointers for Minitab, SPSS, JMP, StatCrunch, R, and XLStat, 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.

Get the Most Out of MyLab Statistics

Pearson MyLab

MyLab™ Statistics is the leading online homework, tutorial, and assessment program for teaching and learning statistics, built around Pearson's best-selling content. MyLab Stats helps students and instructors improve results; it provides engaging experiences and personalized learning for each student so learning can happen in any environment. Plus, it offers flexible and time-saving course management features to allow instructors to easily manage their classes while remaining in complete control, regardless of course format.

Preparedness

One of the biggest challenges in many mathematics and statistics courses is making sure students are adequately prepared with the prerequisite skills needed to successfully complete their course work. Pearson offers a variety of content and course options to support students with just-in-time remediation and key-concept review.

- Build homework assignments, quizzes, and tests to support your course learning outcomes. From Getting Ready (GR) questions to the Conceptual Question Library (CQL), we have your assessment needs covered from the mechanics to the critical understanding of Statistics. The exercise libraries include technology-led instruction, including new Excel-based exercises, and learning aids to reinforce your students' success.
- Using proven, field-tested technology, auto-graded Excel Projects allow instructors to seamlessly integrate Microsoft® Excel® content into their course without having to manually grade spreadsheets. Students have the opportunity to practice important statistical skills in Excel, helping them to master key concepts and gain proficiency with the program.

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Resources for Success

Pearson MyLab

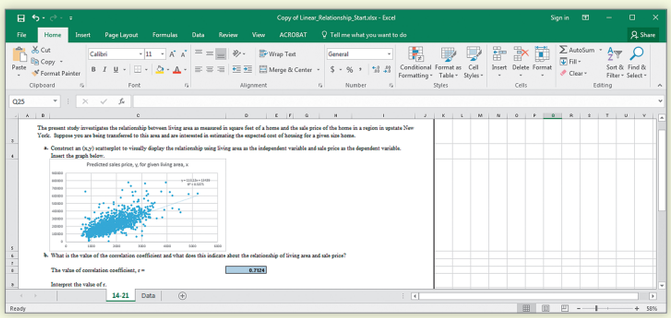
MyLab Statistics Online Course for Business Statistics, Fourth Edition, by Sharpe/De Veaux/Velleman

(access code required)

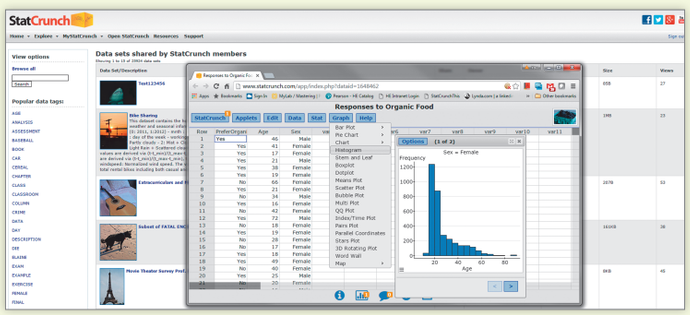
MyLab™ Stats is available to accompany Pearson's market leading text offerings. To give students a consistent tone, voice, and teaching method each text's flavor and approach is tightly integrated throughout the accompanying MyLab Statistics course, making learning the material as seamless as possible.

New! Auto-Graded Excel Grader Projects

Using proven, field-tested technology, auto-graded Excel Projects allow instructors to seamlessly integrate Microsoft® Excel® content into their course without having to manually grade spreadsheets.



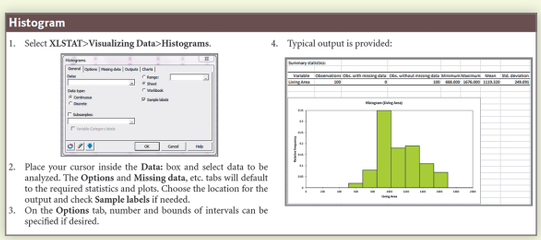
StatCrunch



StatCrunch, a powerful, web-based statistical software, is integrated into MyLab, so students can quickly and easily analyze datasets from their text and exercises. In addition, MyLab includes access to **www.StatCrunch.com**, the full web-based program where users can access tens of thousands of shared datasets, create and conduct online surveys, interact with a full library of applets, and perform complex analyses using the powerful statistical software.

Technology Tutorials and Study Cards

Excel® tutorials provide brief video walk-throughs and step-by-step instructional study cards on common statistical procedures such as Confidence Intervals, ANOVA, Simple & Multiple Regression, and Hypothesis Testing. Tutorials will capture methods in Microsoft Windows Excel® 2010, 2013, and 2016 versions.



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Resources for Success

Instructor Supplements

Instructor's Edition contains answers to all exercises. (ISBN-13: 978-0-13-468758-2; ISBN-10: 0-13-468758-2)

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 to qualified instructors through Pearson's online catalog at **www.pearson.com/us/higher-education** or within MyLab Statistics.

Online Test Bank (download only), by Dirk Tempelaar, Maastricht University, includes chapter quizzes and part-level tests. Available to qualified instructors through Pearson's online catalog at **www.pearson.com/us/higher-education** or within MyLab Statistics.

Instructor's Solutions Manual (download only), by Linda Dawson, University of Washington, contains detailed solutions to all of the exercises. The Instructor's Solutions Manual is available to qualified instructors through Pearson's online catalog at **www.pearson.com/us/higher-education** or within MyLab Statistics.

TestGen® Computerized Test Bank (**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, allowing instructors to 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 test bank are available for download from Pearson's online catalog at **www.pearson.com/us/higher-education**. Test Forms (download only) are also available from the online catalog.

PowerPoint Lecture Slides: Free to qualified adopters, this classroom lecture presentation software is geared specifically to the sequence and philosophy of *Business Statistics*. Key graphics from the book are included to help bring the statistical concepts alive in the classroom. These files are available to qualified instructors through Pearson's online catalog at **www.pearson.com/us/higher-education** or within MyLab Statistics.

Learning Catalytics™ is a web-based engagement and assessment tool. As a "bring-your-own-device" direct response system, Learning Catalytics offers a diverse library of dynamic question types that allow students to interact with and think critically about statistical concepts. As a real-time resource, instructors can take advantage of critical teaching moments both in the classroom and through assignable and gradable homework.

Student Resources

Business Statistics, for-sale student edition. (ISBN-13: 978-0-13-470521-7; ISBN-10: 0-13-470521-1)

Student's Solutions Manual, by Linda Dawson, University of Washington, provides detailed, worked-out solutions to odd-numbered exercises. (ISBN-13: 978-0-13-470548-4; ISBN-10: 0-13-470548-3)

Study Cards for Business Statistics Software: This series of study cards, available for Excel 2016 with DAT: 0-13-457679-9; Excel 2016 with XLSTAT: 0-13-457683-7; StatCrunch: 0-13-397513-4, R: 0-13-522870-0; and R Studio: 0-13-522869-7 provides students with easy step-by-step guides to the most common business statistics software.

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Resources for Success

Technology Resources

MyLab Statistics Online Course (access code required) MyLab™ Statistics is the teaching and learning platform that empowers you to reach *every* student. By combining trusted author content with digital tools and a flexible platform, MyLab Statistics personalizes the learning experience and improves results for each student. With MyLab Statistics and StatCrunch®, an integrated web-based statistical software program, students learn the skills they need to interact with data in the real world. Learn more about MyLab Statistics at **pearson.com/mylab/statistics**.

Used by nearly one million students a year, MyLab Statistics is the world's leading online program for teaching and learning statistics. MyLab Statistics delivers assessment, tutorials, and multimedia resources that provide engaging and personalized experiences for each student, so learning can happen in any environment. Each course is developed to accompany Pearson's best-selling content, authored by thought leaders across the statistics curriculum, and can be easily customized to fit any course format.

Methods for teaching statistics are continuously evolving to provide today's students with the skills they need to interact with data in the real world. In addition, statistics students are coming to the classroom with a wide range of backgrounds and learner styles. The flexibility to build a course that fits instructors' individual course formats and every student's needs—with a variety of content options and multimedia resources all in one place—has made MyLab Statistics the market-leading solution for teaching and learning statistics since its inception.

Thanks to feedback from instructors and students from more than 10,000 institutions, MyLab Statistics continues to transform—delivering new content, innovative learning resources, and platform updates to support students and instructors, today and in the future.

Deliver Trusted Content

You deserve teaching materials that meet your own high standards for your course. That's why Pearson partners with highly respected authors to develop interactive content and course-specific resources that you can trust—and that keep your students engaged.

Tutorial Exercises with Multimedia Learning Aids: The homework and practice exercises in MyLab Statistics align with the exercises in the textbook, and they regenerate algorithmically to give students unlimited opportunity for practice and mastery. Exercises offer immediate helpful feedback, guided solutions, sample problems, animations, videos, and eText clips for extra help at point-of-use.

Auto-Graded Excel Projects: Using proven, field-tested technology, auto-graded Excel Projects let you seamlessly integrate Microsoft® Excel® content into your course without having to manually grade spreadsheets. Students can practice important statistical skills in Excel, helping them master key concepts and gain proficiency with the program. They simply download a spreadsheet, work live on a statistics problem in Excel, and then upload that file back into the MyLab. Within minutes, they receive a report that provides personalized, detailed feedback to pinpoint where they went wrong in the problem.

StatCrunch: MyLab Statistics integrates the web-based statistical software, StatCrunch, within the online assessment platform so that students can easily analyze datasets from exercises and the text. In addition, MyLab Statistics includes access to **www.StatCrunch.com**, a website where users can access tens of thousands of shared datasets, conduct online surveys, perform complex analyses using the powerful statistical software, and generate compelling reports.

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.

Empower Each Learner

Each student learns at a different pace. Personalized learning pinpoints the precise areas where each student needs practice, giving all students the support they need—when and where they need it—to be successful.

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Pearson MyLab

- **Study Plan:** Acts as a tutor, providing personalized recommendations for each of your students based on his or her ability to master the learning objectives in your course. This allows students to focus their study time by pinpointing the precise areas they need to review, and allowing them to use customized practice and learning aids—such as videos, eText, tutorials, and more—to get them back on track. Using the report available in the Gradebook, you can tailor course lectures to prioritize the content where students need the most support, offering you better insight into classroom and individual performance.
- With the **Companion Study Plan Assignments** you can now assign the Study Plan as a prerequisite to a test or quiz, guiding students through the concepts they need to master.
- **Getting Ready for Statistics:** A library of questions now appears within each MyLab Statistics course to offer the developmental math topics students need for the course. These can be assigned as a prerequisite to other assignments, if desired.

Conceptual Question Library: In addition to algorithmically regenerated questions that are aligned with your textbook, there is a library of 1,000 Conceptual Questions available in the assessment manager that require students to apply their statistical understanding.

Teach the Course Your Way

Your course is unique. So whether you'd like to build your own assignments, teach multiple sections, or set prerequisites, MyLab gives you the flexibility to easily create *your* course to fit *your* needs.

- **Learning Catalytics:** Generate class discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics. MyLab Statistics now provides Learning Catalytics™—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.
- **LMS Integration:** You can now link Blackboard Learn™, Brightspace® by D2L®, Canvas™, or Moodle® to the MyLabs. Access assignments, rosters, and resources, and synchronize grades with your LMS gradebook. For students, single sign-on provides access to all the personalized learning resources that make studying more efficient and effective.

Improve Student Results

When you teach with MyLab, student performance improves. That's why instructors have chosen MyLab for over 15 years, touching the lives of more than 50 million students.

MathXL Online Course (access code required)

Part of the world's leading collection of online homework, tutorial, and assessment products, MathXL® delivers assessment and tutorial resources that provide engaging and personalized experiences for each student. Each course is developed to accompany Pearson's best-selling content, authored by thought leaders across the math curriculum, and can be easily customized to fit any course format.

With MathXL, instructors can:

- Create, edit, and assign online homework and tests using algorithmically generated exercises correlated at the objective level to the textbook.
- Create and assign their own online exercises and import TestGen tests for added flexibility.
- Maintain records of all student work tracked in MathXL's online gradebook.

With MathXL, students can:

- Take chapter tests in MathXL and receive personalized study plans and/or personalized homework assignments based on their test results.
- Use the study plan and/or the homework to link directly to tutorial exercises for the objectives they need to study.
- Access supplemental animations and video clips directly from selected exercises.

MathXL is available to qualified adopters. For more information, visit our web site at **www.mathxl.com** or contact your Pearson representative.

StatCrunch

Integrated directly into MyLab Statistics, StatCrunch® is powerful web-based statistical software that allows users to perform complex analyses, share datasets, and generate compelling reports of their data.

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Pearson MyLab

The vibrant online community offers tens of thousands of shared datasets for students to analyze.

- **Collect.** Users can upload their own data to StatCrunch or search a large library of publicly shared datasets, spanning almost any topic of interest. Datasets from the text and from online homework exercises can also be accessed and analyzed in StatCrunch. An online survey tool allows users to quickly collect data via web-based surveys.
- **Crunch.** A full range of numerical and graphical methods allows users to analyze and gain insights from any dataset. 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.

StatCrunch is also available by itself to qualified adopters. It can be accessed on your laptop, smartphone, or tablet when you visit the StatCrunch website from your device's browser. For more information, visit the StatCrunch 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, allowing instructors to 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 test bank are available for download from Pearson's Instructor Resource Center at **www.pearsonhighered.com/irc**.

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 MyLab Statistics and in the Instructor Resource Center at **www.pearsonhighered.com/irc**.

Foster student engagement and peer-to-peer learning

Generate class discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics.

MyLab™ Math and MyLab Statistics now provide Learning Catalytics™—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.

Instructors, you can:

- Pose a variety of open-ended questions that help your students develop critical thinking skills.
- Monitor responses to find out where students are struggling.
- Use real-time data to adjust your instructional strategy and try other ways of engaging your students during class.
- Manage student interactions by automatically grouping students for discussion, teamwork, and peer-to-peer learning.

XLSTAT™ for Pearson

Used by leading businesses and universities, XLSTAT 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. XLSTAT is compatible with all Excel versions. Available for bundling with the text as ISBN-13: 978-0-321-75940-5; ISBN-10: 0-321-75940-0. Standalone: ISBN-13: 978-0-321-75932-0; ISBN-10: 0-321-75932-X

Minitab and Minitab Express™

Minitab and Minitab Express™ make learning statistics easy and provide students with a skill set that's in demand in today's data-driven workforce. Bundling Minitab software with educational materials ensures students have access to the software they need in the classroom, around campus, and at home. And having the latest version of Minitab ensures that students can use the software for the duration of their course. Access Card only; not sold as standalone: ISBN 13: 978-0-13-445640-9; ISBN 10: 0-13-445640-8.

JMP Student Edition

JMP Student Edition is an easy-to-use, streamlined version of JMP desktop statistical discovery software from SAS Institute, Inc., and is available for bundling with the text. Access Card only; not sold as standalone: ISBN-13: 978-0-13-467979-2; ISBN-10: 0-13-467979-2.

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Note: Page numbers followed by n indicate footnotes.

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