

GLOBAL
EDITION



Basic Business Statistics

Concepts and Applications

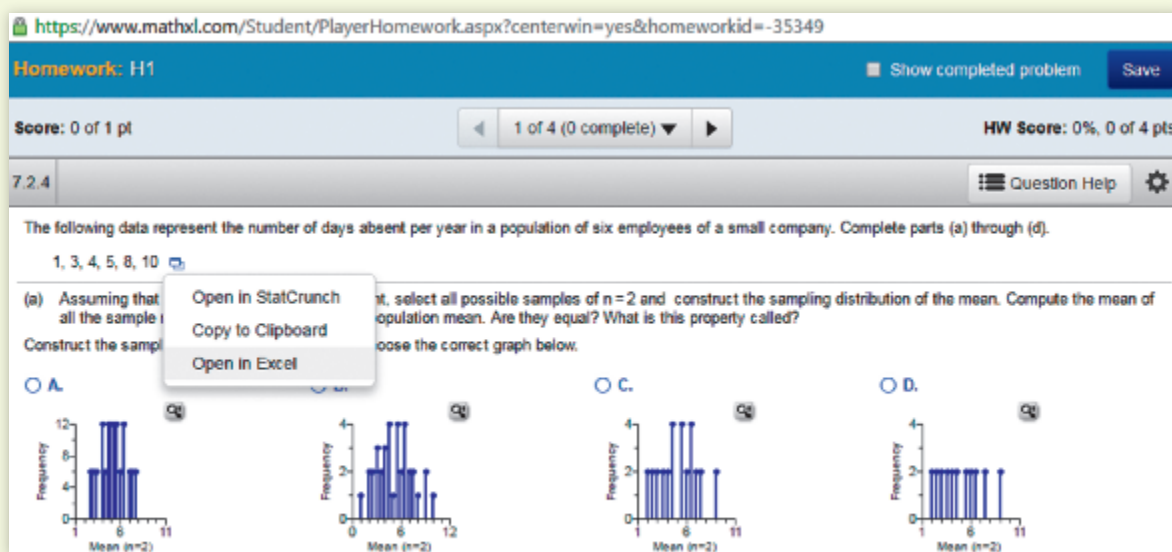
FOURTEENTH EDITION

Mark L. Berenson • David M. Levine
Kathryn A. Szabat • David F. Stephan



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Homework: H1 Show completed problem Save

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7.2.4 Question Help Settings

The following data represent the number of days absent per year in a population of six employees of a small company. Complete parts (a) through (d).

1, 3, 4, 5, 8, 10

(a) Assuming that all the sample... Construct the sampling distribution of the mean. Select all possible samples of $n=2$ and construct the sampling distribution of the mean. Compute the mean of each sample. Are they equal? What is this property called? Choose the correct graph below.

A. B. C. D.

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Search Tweets! What's trending now?

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A ROADMAP FOR SELECTING A STATISTICAL METHOD

| Data Analysis Task | For Numerical Variables | For Categorical Variables |
|---|---|--|
| Describing a group or several groups | <p>Ordered array, stem-and-leaf display, frequency distribution, relative frequency distribution, percentage distribution, cumulative percentage distribution, histogram, polygon, cumulative percentage polygon (Sections 2.2, 2.4)</p> <p>Mean, median, mode, geometric mean, quartiles, range, interquartile range, standard deviation, variance, coefficient of variation, skewness, kurtosis, boxplot, normal probability plot (Sections 3.1, 3.2, 3.3, 6.3)</p> <p>Index numbers (online Section 16.8)</p> <p>Dashboards (Section 17.2)</p> | <p>Summary table, bar chart, pie chart, doughnut chart, Pareto chart (Sections 2.1 and 2.3)</p> |
| Inference about one group | <p>Confidence interval estimate of the mean (Sections 8.1 and 8.2)</p> <p>t test for the mean (Section 9.2)</p> <p>Chi-square test for a variance or standard deviation (online Section 12.7)</p> | <p>Confidence interval estimate of the proportion (Section 8.3)</p> <p>Z test for the proportion (Section 9.4)</p> |
| Comparing two groups | <p>Tests for the difference in the means of two independent populations (Section 10.1)</p> <p>Wilcoxon rank sum test (Section 12.4)</p> <p>Paired t test (Section 10.2)</p> <p>F test for the difference between two variances (Section 10.4)</p> <p>Wilcoxon signed ranks test (online Section 12.8)</p> | <p>Z test for the difference between two proportions (Section 10.3)</p> <p>Chi-square test for the difference between two proportions (Section 12.1)</p> <p>McNemar test for two related samples (online Section 12.6)</p> |
| Comparing more than two groups | <p>One-way analysis of variance for comparing several means (Section 11.1)</p> <p>Kruskal-Wallis test (Section 12.5)</p> <p>Randomized block design (online Section 11.3)</p> <p>Two-way analysis of variance (Section 11.2)</p> <p>Friedman rank test (online Section 12.9)</p> | <p>Chi-square test for differences among more than two proportions (Section 12.2)</p> |
| Analyzing the relationship between two variables | <p>Scatter plot, time series plot (Section 2.5)</p> <p>Covariance, coefficient of correlation (Section 3.5)</p> <p>Simple linear regression (Chapter 13)</p> <p>t test of correlation (Section 13.7)</p> <p>Time-series forecasting (Chapter 16)</p> <p>Sparklines (Section 2.7)</p> | <p>Contingency table, side-by-side bar chart, PivotTables (Sections 2.1, 2.3, 2.6)</p> <p>Chi-square test of independence (Section 12.3)</p> |
| Analyzing the relationship between two or more variables | <p>Colored scatter plots, bubble chart, treemap (Section 2.7)</p> <p>Multiple regression (Chapters 14 and 15)</p> <p>Dynamic bubble charts (Section 17.2)</p> <p>Regression trees (Section 17.3)</p> <p>Cluster analysis (Section 17.5)</p> <p>Multidimensional scaling (Section 17.6)</p> | <p>Multidimensional contingency tables (Section 2.6)</p> <p>Drilldown and slicers (Section 2.7)</p> <p>Logistic regression (Section 14.7)</p> <p>Classification trees (Section 17.4)</p> <p>Multiple correspondence analysis (Section 17.6)</p> |

Basic Business Statistics

Concepts and Applications

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FOURTEENTH EDITION
Global Edition

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*To our spouses and children,
Rhoda, Marilyn, Mary, Kathy, Lori, Sharyn, and Mark*

*and to our parents, in loving memory,
Nat, Ethel, Lee, Reuben, Mary, William, Ruth and Francis J.*

About the Authors



Kathryn Szabat, David Levine, Mark Berenson, and David Stephan

Mark L. Berenson, David M. Levine, Kathryn A. Szabat, and David F. Stephan are all experienced business school educators committed to innovation and improving instruction in business statistics and related subjects.

Mark L. Berenson is Professor of Information Management and Business Analytics at Montclair State University and also Professor Emeritus of Information Systems and Statistics at Baruch College. He currently teaches graduate and undergraduate courses in statistics and in operations management in the School of Business and an undergraduate course in international justice and human rights that he co-developed in the College of Humanities and Social Sciences.

Berenson received a B.A. in economic statistics and an M.B.A. in business statistics from City College of New York and a Ph.D. in

business from the City University of New York. Berenson's research has been published in *Decision Sciences Journal of Innovative Education*, *Review of Business Research*, *The American Statistician*, *Communications in Statistics*, *Psychometrika*, *Educational and Psychological Measurement*, *Journal of Management Sciences and Applied Cybernetics*, *Research Quarterly*, *Stats Magazine*, *The New York Statistician*, *Journal of Health Administration Education*, *Journal of Behavioral Medicine*, and *Journal of Surgical Oncology*. His invited articles have appeared in *The Encyclopedia of Measurement & Statistics* and *Encyclopedia of Statistical Sciences*. He has coauthored numerous statistics texts published by Pearson.

Over the years, Berenson has received several awards for teaching and for innovative contributions to statistics education. In 2005, he was the first recipient of the Catherine A. Becker Service for Educational Excellence Award at Montclair State University and, in 2012, he was the recipient of the Khubani/Telebrands Faculty Research Fellowship in the School of Business.

David Levine, Professor Emeritus of Statistics and CIS at Baruch College, CUNY, is a nationally recognized innovator in statistics education for more than three decades. Levine has coauthored 14 books, including several business statistics textbooks; textbooks and professional titles that explain and explore quality management and the Six Sigma approach; and, with David Stephan, a trade paperback that explains statistical concepts to a general audience. Levine has presented or chaired numerous sessions about business education at leading conferences conducted by the Decision Sciences Institute (DSI) and the American Statistical Association, and he and his coauthors have been active participants in the annual DSI Data, Analytics, and Statistics Instruction (DASI) mini-conference. During his many years teaching at Baruch College, Levine was recognized for his contributions to teaching and curriculum development with the College's highest distinguished teaching honor. He earned B.B.A. and M.B.A. degrees from CCNY, and a Ph.D. in industrial engineering and operations research from New York University.

As Associate Professor of Business Systems and Analytics at La Salle University, **Kathryn Szabat** has transformed several business school majors into one interdisciplinary major that better supports careers in new and emerging disciplines of data analysis including analytics. Szabat strives to inspire, stimulate, challenge, and motivate students through innovation and curricular enhancements, and shares her coauthors' commitment to teaching excellence and the continual improvement of statistics presentations. Beyond the classroom she has provided statistical advice to numerous business, nonbusiness, and academic communities, with particular interest in the areas of education, medicine, and nonprofit capacity building. Her research activities have led to journal publications, chapters in scholarly books, and conference presentations. Szabat is a member of the American Statistical Association (ASA), DSI, Institute for Operation Research and Management Sciences (INFORMS), and DSI DASI. She received a B.S. from SUNY-Albany, an M.S. in statistics from the Wharton School of the University of Pennsylvania, and a Ph.D. degree in statistics, with a cognate in operations research, from the Wharton School of the University of Pennsylvania.

Advances in computing have always shaped **David Stephan's** professional life. As an undergraduate, he helped professors use statistics software that was considered advanced even though it could compute *only* several things discussed in Chapter 3, thereby gaining an early appreciation for the benefits of using software to solve problems (and perhaps positively influencing his grades). An early advocate of using computers to support instruction, he developed a prototype of a main-frame-based system that anticipated features found today in Pearson's MathXL and served as special assistant for computing to the Dean and Provost at Baruch College. In his many years teaching at Baruch, Stephan implemented the first computer-based *classroom*, helped redevelop the CIS curriculum, and, as part of a FIPSE project team, designed and implemented a multimedia learning environment. He was also nominated for teaching honors. Stephan has presented at SEDSI and DSI DASI (formerly MSMESB) mini-conferences, sometimes with his coauthors. Stephan earned a B.A. from Franklin & Marshall College and an M.S. from Baruch College, CUNY, and completed the instructional technology graduate program at Teachers College, Columbia University.

For all four coauthors, continuous improvement is a natural outcome of their curiosity about the world. Their varied backgrounds and many years of teaching experience have come together to shape this book in ways discussed in the Preface.

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Preface

As business statistics evolves and becomes an increasingly important part of one's business education, how business statistics gets taught and what gets taught becomes all the more important.

We, the authors, think about these issues as we seek ways to continuously improve the teaching of business statistics. We actively participate in Decision Sciences Institute (DSI), American Statistical Association (ASA), and Data, Analytics, and Statistics Instruction and Business (DASI) conferences. We use the ASA's Guidelines for Assessment and Instruction (GAISE) reports and combine them with our experiences teaching business statistics to a diverse student body at several universities.

When writing for introductory business statistics students, five principles guide us.

Help students see the relevance of statistics to their own careers by using examples from the functional areas that may become their areas of specialization. Students need to learn statistics in the context of the functional areas of business. We present each statistics topic in the context of areas such as accounting, finance, management, and marketing and explain the application of specific methods to business activities.

Emphasize interpretation and analysis of statistical results over calculation. We emphasize the interpretation of results, the evaluation of the assumptions, and the discussion of what should be done if the assumptions are violated. We believe that these activities are more important to students' futures and will serve them better than focusing on tedious manual calculations.

Give students ample practice in understanding how to apply statistics to business. We believe that both classroom examples and homework exercises should involve actual or realistic data, using small and large sets of data, to the extent possible.

Familiarize students with the use of data analysis software. We integrate using Microsoft Excel, JMP, and Minitab into all statistics topics to illustrate how software can assist the business decision making process. (Using software in this way also supports our second point about emphasizing interpretation over calculation).

Provide clear instructions to students that facilitate their use of data analysis software. We believe that providing such instructions assists learning and minimizes the chance that the software will distract from the learning of statistical concepts.

What's New in This Edition?

This fourteenth edition of *Basic Business Statistics* features many passages rewritten in a more concise style that emphasize definitions as the foundation for understanding statistical concepts. In addition to changes that readers of past editions have come to expect, such as new examples and Using Statistics case scenarios and an extensive number of new end-of-section or end-of-chapter problems, the edition debuts:

- **A First Things First Chapter** that builds on the previous edition's novel Important Things to Learn First Chapter by using real-world examples to illustrate how developments such as the increasing use of business analytics and "big data" have made knowing and understanding statistics that much more critical. This chapter is available as complimentary online download, allowing students to get a head start on learning.

- **JMP Guides** that provide detailed, hands-on instructions for using JMP to illustrate the concepts that this book teaches. JMP provides a starting point for continuing studies in business statistics and business analytics and features visualizations that are easy to construct and that summarize data in innovative ways. The JMP Guides join the Excel and Minitab Guides, themselves updated to reflect the most recent editions of those programs.
- **Tabular Summaries** that state hypothesis test and regression example results along with the conclusions that those results support now appear in Chapters 9 through 15.
- **An All-New Business Analytics Chapter (Chapter 17)** that makes extensive use of JMP and Minitab to illustrate predictive analytics for prediction, classification, clustering, and association as well as explaining what text analytics does and how descriptive and prescriptive analytics relate to predictive analytics. This chapter benefits from the insights the coauthors have gained from teaching and lecturing on business analytics as well as research the coauthors have done for a companion title on business analytics for Fall 2018.

Continuing Features that Readers Have Come to Expect

This edition of *Basic Business Statistics* continues to incorporate a number of distinctive features that has led to its wide adoption over the previous editions. Table 1 summaries these carry-over features:

TABLE 1 Distinctive Features Continued in the Fourteenth Edition

| Feature | Details |
|--|--|
| Using Statistics Business Scenarios | A Using Statistics scenario that highlights how statistics is used in a business functional area begins each chapter. Each scenario provides an applied context for learning in its chapter. End-of-chapter “Revisited” sections reinforces the statistical methods that a chapter discusses and apply those methods to the questions raised in the scenario. <i>In this edition, seven chapters have new or revised Using Statistics scenarios.</i> |
| Emphasis on Data Analysis and Interpretation of Results | <i>Basic Business Statistics</i> was among the first business statistics textbooks to focus on interpretation of the results of a statistical method and not on the mathematics of a method. This tradition continues, now supplemented by JMP results complimenting the Excel and Minitab results of recent prior editions. |
| Software Integration | Software instructions in this book feature chapter examples and were personally written by the authors, who collectively have over one hundred years experience teaching the application of software to business. Software usage also features templates and applications developed by the authors that minimize the frustration of using software while maximizing statistical learning |
| Opportunities for Additional Learning | Student Tips, LearnMore bubbles, and Consider This features extend student-paced learning by reinforcing important points or examining side issues or answering questions that arise while studying business statistics such as “What is so ‘normal’ about the normal distribution?” |
| Highly Tailorable Context | With an extensive library of separate online topics, sections, and even two full chapters, instructors can combine these materials and the opportunities for additional learning to meet their curricular needs. |
| Software Flexibility | With modularized software instructions, instructors and students can switch among Excel, Excel with PHStat, JMP, and Minitab as they use this book, taking advantage of the strengths of each program to enhance learning. |

TABLE 1 Distinctive Features Continued in the Fourteenth Edition (*continued*)

| Feature | Details |
|---|--|
| End-of-Section and End-of-Chapter Reinforcements | “Exhibits” summarize key processes throughout the book. “Key Terms” provides an index to the definitions of the important vocabulary of a chapter. “Learning the Basics” questions test the basic concepts of a chapter. “Applying the Concepts” problems test the learner’s ability to apply those problems to business problems. For the more quantitatively-minded, “Key Equations” list the boxed number equations that appear in a chapter. |
| Innovative Cases | End-of-chapter cases include a case that continues through many chapters as well as “Digital Cases” that require students to examine business documents and other information sources to sift through various claims and discover the data most relevant to a business case problem as well as common misuses of statistical information. (Instructional tips for these cases and solutions to the Digital Cases are included in the Instructor’s Solutions Manual.) |
| Answers to Even-Numbered Problems | An appendix provides additional self-study opportunities by provides answers to the “Self-Test” problems and most of the even-numbered problems in this book. |
| Unique Excel Integration | Many textbooks feature Microsoft Excel, but <i>Basic Business Statistics</i> comes from the authors who originated both the Excel Guide workbooks that illustrate model solutions, developed Visual Explorations that demonstrate selected basic concepts, and designed and implemented PHStat, the Pearson statistical add-in for Excel that places the focus on statistical learning. (See Appendix H for a complete summary of PHStat.) |

Chapter-by-Chapter Changes Made for This Edition

Because the authors believe in continuous quality improvement, *every* chapter of *Basic Business Statistics* contains changes to enhance, update, or just freshen this book. Table 2 provides a chapter-by-chapter summary of these changes.

TABLE 2
Chapter-by-Chapter
Change Matrix

| Chapter | Using Statistics Changed | JMP Guide | Problems Changed | Selected Chapter Changes |
|---------|--------------------------------|--------------|---------------------|--|
| FTF | • | • | n.a. | Think Differently About Statistics Starting Point for Learning Statistics |
| 1 | • | • | 40% | Data Cleaning Other Data Preprocessing Tasks |
| 2 | | • | 60% | Organizing a Mix of Variables Visualizing A Mix of Variables Filtering and Querying Data Reorganized categorical variables discussion. Expanded data visualization discussion. New samples of 379 retirement funds and 100 restaurant meal costs for examples. |
| 3 | | • | 50% | New samples of 379 retirement funds and 100 restaurant meal costs for examples. Updated NBA team values data set. |

| Chapter | Using Statistics Changed | JMP Guide | Problems Changed | Selected Chapter Changes |
|---------|--------------------------|-----------|------------------|--|
| 4 | | • | 43% | Basic Probability Concepts rewritten. Bayes' theorem example moved online |
| 5 | | • | 60% | Section 5.1 and Binomial Distribution revised. Covariance of a Probability Distribution and The Hypergeometric Distribution moved online. |
| 6 | • | • | 33% | Normal Distribution rewritten. The Exponential Distribution moved online. |
| 7 | | • | 47% | Sampling Distribution of the Proportion rewritten. |
| 8 | | • | 40% | Confidence Interval Estimate for the Mean revised. Revised "Managing Ashland MultiComm Services" continuing case. |
| 9 | | • | 20% | Chapter introduction revised. Section 9.1 rewritten. New Section 9.4 example. |
| 10 | • | • | 45% | New Effect Size (online). Using Statistics scenario linked to Chapter 11 and 17. New paired <i>t</i> test and the difference between two proportions examples. |
| 11 | • | • | 20% | New Using Statistics scenario data. The Randomized Block Design moved online. |
| 12 | | • | 42% | Extensive use of new tabular summaries. Revised "Managing Ashland MultiComm Services" continuing case. |
| 13 | | • | 46% | Chapter introduction revised. Section 13.2 revised. |
| 14 | | • | 30% | Section 14.1 revised. Section 14.3 reorganized and revised. New dummy variable example. Influence Analysis moved online. |
| 15 | | • | 37% | Using Transformations in Regression Models rewritten and expanded. Model Building rewritten |
| 16 | • | • | 67% | Chapter introduction reorganized and revised. All-new chapter examples. |
| 17 | • | | 42% | All-new chapter. Predictive analytics discussion expanded. Uses JMP and Minitab extensively. |
| 18 | | | 47% | |

Serious About Writing Improvements

Ever review a textbook that reads the same as an edition from years ago? Or read a preface that claims writing improvements but offers no evidence? Among the writing improvements in this edition of *Basic Business Statistics*, the authors have turned to tabular summaries to guide readers to reaching conclusions and making decisions based on statistical information. The authors believe that this writing improvement, which appears in Chapters 9 through 15, not only adds clarity to the purpose of the statistical method being discussed but better illustrates the role of statistics in business decision-making processes. Judge for yourself using the sample from Chapter 10 Example 10.1.

Previously, part of the solution to Example 10.1 was presented as:

You do not reject the null hypothesis because $t_{STAT} = -1.6341 > -1.7341$. The p -value (as computed in Figure 10.5) is 0.0598. This p -value indicates that the probability that $t_{STAT} < -1.6341$ is equal to 0.0598. In other words, if the population means are equal, the probability that the sample mean delivery time for the local pizza restaurant is at least 2.18 minutes faster than the national chain is 0.0598. Because the p -value is greater than $\alpha = 0.05$, there is insufficient evidence to reject the null hypothesis. Based on these results, there is insufficient evidence for the local pizza restaurant to make the advertising claim that it has a faster delivery time.

In this edition, we present the equivalent solution (on page 389):

Table 10.4 summarizes the results of the pooled-variance t test for the pizza delivery data using the calculation above (*not shown in this sample*) and Figure 10.5 results. Based on the conclusions, local branch of the national chain and a local pizza restaurant have similar delivery times. Therefore, as part of the last step of the DCOVA framework, you and your friends exclude delivery time as a decision criteria when choosing from which store to order pizza.

TABLE 10.4

Pooled-variance t test summary for the delivery times for the two pizza restaurants

| Result | Conclusions |
|---|--|
| The $t_{STAT} = -1.6341$ is greater than -1.7341 . | 1. Do not reject the null hypothesis H_0 . |
| The t test p -value = 0.0598 is greater than the level of significance, $\alpha = 0.05$. | 2. Conclude that insufficient evidence exists that the mean delivery time is lower for the local restaurant than for the branch of the national chain. |
| | 3. There is a probability of 0.0598 that $t_{STAT} < -1.6341$. |

A Note of Thanks

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Contact Us!

Please email us at authors@davidlevinestatistics.com or tweet us @**BusStatBooks** with your questions about the contents of this book. Please include the hashtag #BBS14 in your tweet or in the subject line of your email. We also welcome suggestions you may have for a future edition of this book. And while we have strived to make this book as error-free as possible, we also appreciate those who share with us any perceived problems or errors that they encounter.

If you need assistance using software, please contact your academic support person or Pearson Support at support.pearson.com/getsupport/. They have the resources to resolve and walk you through a solution to many technical issues in a way we do not.

As you use this book, be sure to make use of the "Resources for Success" that Pearson Education supplies for this book (described on the following pages). We also invite you to visit bbs14.davidlevinestatistics.com (bit.ly/2xwQoBT), where we may post additional information or new content as necessary.

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