Basic Business Statistics

Concepts and Applications

14TH EDITION

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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	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)** 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)** Index numbers **(online Section 16.8)** Dashboards **(Section 17.2)**	Summary table, bar chart, pie chart, doughnut chart, Pareto chart **(Sections 2.1 and 2.3)**
Inference about one group	Confidence interval estimate of the mean **(Sections 8.1 and 8.2)** *t* test for the mean **(Section 9.2)** Chi-square test for a variance or standard deviation **(online Section 12.7)**	Confidence interval estimate of the proportion **(Section 8.3)** *Z* test for the proportion **(Section 9.4)**
Comparing two groups	Tests for the difference in the means of two independent populations **(Section 10.1)** Wilcoxon rank sum test **(Section 12.4)** Paired *t* test **(Section 10.2)** *F* test for the difference between two variances **(Section 10.4)** Wilcoxon signed ranks test **(online Section 12.8)**	*Z* test for the difference between two proportions **(Section 10.3)** Chi-square test for the difference between two proportions **(Section 12.1)** McNemar test for two related samples **(online Section 12.6)**
Comparing more than two groups	One-way analysis of variance for comparing several means **(Section 11.1)** Kruskal-Wallis test **(Section 12.5)** Randomized block design **(online Section 11.3)** Two-way analysis of variance **(Section 11.2)** Friedman rank test **(online Section 12.9)**	Chi-square test for differences among more than two proportions **(Section 12.2)**
Analyzing the relationship between two variables	Scatter plot, time series plot **(Section 2.5)** Covariance, coefficient of correlation **(Section 3.5)** Simple linear regression **(Chapter 13)** *t* test of correlation **(Section 13.7)** Time-series forecasting **(Chapter 16)** Sparklines **(Section 2.7)**	Contingency table, side-by-side bar chart, PivotTables **(Sections 2.1, 2.3, 2.6)** Chi-square test of independence **(Section 12.3)**
Analyzing the relationship between two or more variables	Colored scatter plots, bubble chart, treemap **(Section 2.7)** Multiple regression **(Chapters 14 and 15)** Dynamic bubble charts **(Section 17.2)** Regression trees **(Section 17.3)** Cluster analysis **(Section 17.5)** Multidimensional scaling **(Section 17.6)**	Multidimensional contingency tables **(Section 2.6)** Drilldown and slicers **(Section 2.7)** Logistic regression **(Section 14.7)** Classification trees **(Section 17.4)** Multiple correspondence analysis **(Section 17.6)**

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Basic Business Statistics Concepts and Applications

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Basic Business Statistics Concepts and Applications

FOURTEENTH 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 mainframe-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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Brief Contents

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Contents

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 forthcoming 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. *In this edition, seven chapters have new or revised Using Statistics scenarios.*
Emphasis on Data Analysis and Interpretation of Results	*Basic Business Statistics* 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 *Basic Business Statistics* 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 *t* 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 $a = 0.05$, 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 357):
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. The t test p-value $= 0.0598$ is greater than the level of significance, $\alpha = 0.05$.	**1.** Do not reject the null hypothesis H_0. **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

Creating a new edition of a textbook is a team effort, and we thank our Pearson Education editorial, marketing, and production teammates: Suzanna Bainbridge, Dana Bettez, Kaylee Carlson, Thomas Hayward, Deirdre Lynch, Stephanie Green, and Morgan Danna. Special thanks to the recently-retired Sherry Berg for her design and production oversight in helping to get this edition underway. (Her contributions will be missed!) And we would be remiss not to note the continuing work of Joe Vetere to prepare our screen shot illustrations and the efforts of Julie Kidd of SPi Global to ensure that this edition meets the highest standard of book production quality that is possible.

We also thank Alan Chesen of Wright State University for his diligence in being the accuracy checker for this edition and thank the following people whose comments helped us improve this edition: Mohammad Ahmadi, University of Tennessee-Chattanooga; Sung Ahn,

Washington State University; Kelly Alvey, Old Dominion University; Al Batten, University of Colorado-Colorado Springs; Alan Chesen, Wright State University; Gail Hafer, St. Louis Community College-Meramec; Chun Jin, Central Connecticut State University; Benjamin Lev, Drexel University; Lilian Prince, Kent State University; Bharatendra Rai, University of Massachusetts Dartmouth; Ahmad Vakil, St. John's University (NYC); and Shiro Withanachchi, Queens College (CUNY).

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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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MyLab™ Statistics is the leading online homework, tutorial, and assessment program for teaching and learning statistics, built around Pearson's best-selling content. MyLab Statistics 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.

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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.

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Resources for Success

MyLab™ Statistics Online Course for Basic Business Statistics by Berenson/Levine/Szabat/Stephan (requires access code for use)

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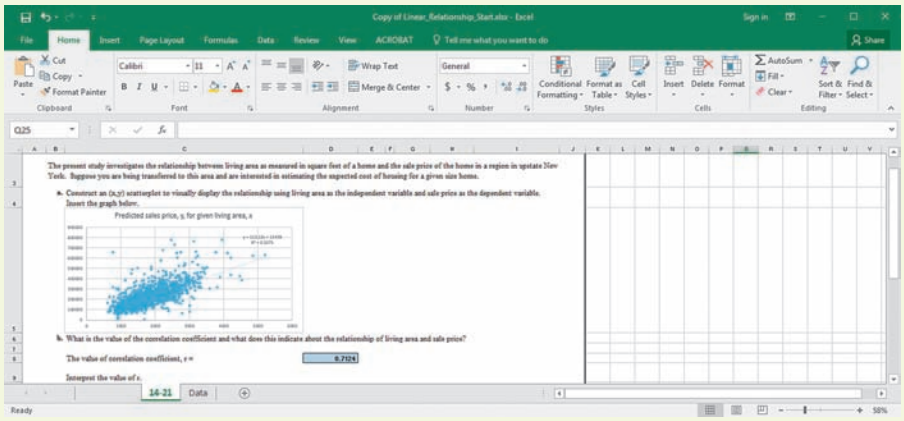
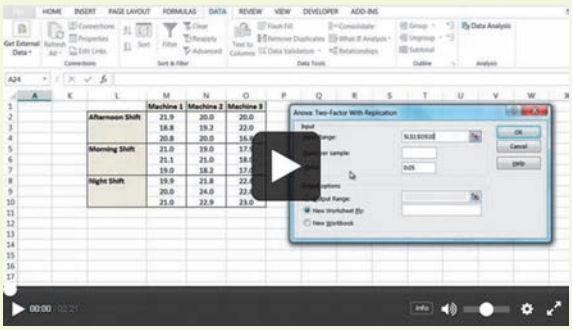
Students have the opportunity to practice important statistical skills in Excel, helping them to master key concepts and gain proficiency with the program.



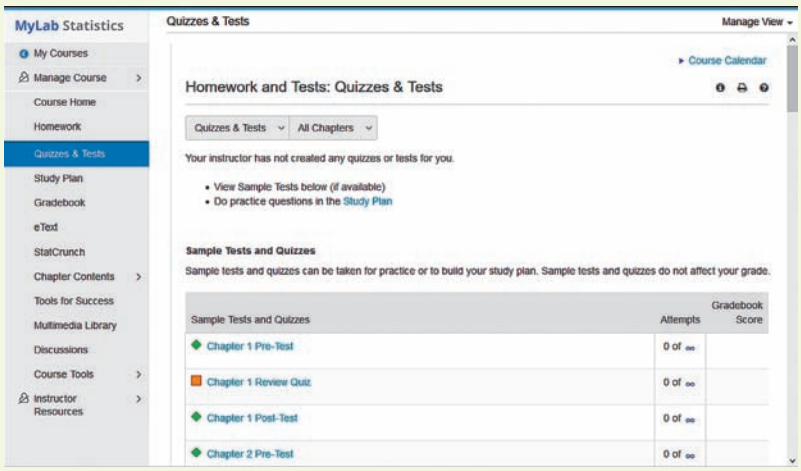


Tutorials and Study Cards for Statistical Software

Tutorials provide brief video walkthroughs and step-by-step instructional study cards on common statistical procedures such as confidence interval estimation, ANOVA, regression, and hypothesis testing. Tutorials and study cards are supplied for Excel 2013 and 2016, Excel with PHStat, JMP, and Minitab.

Diverse Question Libraries

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.



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Resources for Success

Instructor Resources

Instructor's Solutions Manual, by Alan Chesen, Wright State University, presents solutions for end-of-section and end-of-chapter problems and answers to case questions, and provides teaching tips for each chapter. The Instructor's Solutions Manual is available for download at **www.Pearson.com** or in MyLab Statistics.

Lecture PowerPoint Presentations, by Patrick Schur, Miami University (Ohio), are available for each chapter. These presentations provide instructors with individual lecture notes to accompany the text. The slides include many of the figures and tables from the textbook. Instructors can use these lecture notes as is or customize them in Microsoft PowerPoint. The PowerPoint presentations are available for download at **www.Pearson.com** or in MyLab Statistics.

Test Bank, contains true/false, multiple-choice, fill-in, and problem-solving questions based on the definitions, concepts, and ideas developed in each chapter of the text. The Test Bank is available for download at **www.Pearson.com** or in MyLab Statistics.

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 Education's online catalog.

Student Resources

Student's Solutions Manual, by Alan Chesen, Wright State University, provides detailed solutions to virtually all the even-numbered exercises and worked-out solutions to the self-test problems. (ISBN-13: 978-0-13-468504-5)

Online resources complement and extend the study of business statistics and support the content of this book. These resources include **data files** for in-chapter examples and problems, **templates and model solutions**, and **optional topics and chapters**. (See Appendix C for a complete description of the online resources.)

PHStat helps create Excel worksheet solutions to statistical problems. PHStat uses Excel building blocks to create worksheet solutions. These worksheet solutions illustrate Excel techniques and students can examine them to gain new Excel skills. Additionally, many solutions are what-if templates in which the effects of changing data on the results can be explored. Such templates are fully reusable on any computer on which Excel has been installed. PHStat requires an access code and separate download for use. PHStat access codes can be bundled with this textbook using ISBN-13: 978-0-13-468497-0.

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USING **STATISTICS**
"The Price of Admission"

It's the year 1900 and you are a promoter of theatrical productions, in the business of selling seats for individual performances. Using your knowledge and experience, you establish a selling price for the performances, a price you hope represents a good trade-off between maximizing revenues and avoiding driving away demand for your seats. You print up tickets and flyers, place advertisements in local media, and see what happens. After the event, you review your results and consider if you made a wise trade-off.

Tickets sold very quickly? Next time perhaps you can charge more. The event failed to sell out? Perhaps next time you could charge less or take out more advertisements to drive demand. If you lived over 100 years ago, that's about all you could do.

Jump ahead about 70 years. You're still a promoter but now using a computer system that allows your customers to buy tickets over the phone. You can get summary reports of advance sales for future events and adjust your advertising on radio and on TV and, perhaps, add or subtract performance dates using the information in those reports.

Jump ahead to today. You're still a promoter but you now have a fully computerized sales system that allows you to constantly adjust the price of tickets. You also can manage many more categories of tickets than just the near-stage and far-stage categories you might have used many years ago. You no longer have to wait until after an event to make decisions about changing your sales program. Through your sales system you have gained insights about your customers such as where they live, what other tickets they buy, and their appropriate demographic traits. Because you know more about your customers, you can make your advertising and publicity more efficient by aiming your messages at the types of people more likely to buy your tickets. By using social media networks and other online media, you can also learn almost immediately who is noticing and responding to your advertising messages. You might even run experiments online presenting your advertising in two different ways and seeing which way sells better.

Your current self has capabilities that allow you to be a more effective promoter than any older version of yourself. Just how much better? Turn the page.

CONTENTS

OBJECTIVES

- Statistics is a way of thinking that can lead to better decision making
- Statistics requires analytics skills and is an important part of your business education
- Recent developments such as the use of business analytics and "big data" have made knowing statistics even more critical
- The DCOVA framework guides your application of statistics
- The opportunity business analytics represents for business students

Now Appearing on Broadway ... *and* Everywhere Else

In early 2014, Disney Theatrical Productions woke up the rest of Broadway when reports revealed that its *17*-year-old production of *The Lion King* had been the top-grossing Broadway show in 2013. How could such a long-running show, whose most expensive ticket was less than half the most expensive ticket on Broadway, earn so much while being so old? Over time, grosses for a show decline and, sure enough, weekly grosses for *The Lion King* had dropped about 25% by the year 2009. But, for 2013, grosses were up 67% from 2009 and weekly grosses for 2013 typically exceeded the grosses of opening weeks in 1997, adjusted for inflation!

Heavier advertising and some changes in ticket pricing helped, but the major reason for this change was something else: combining business acumen with the systematic application of *business statistics and analytics* to the problem of selling tickets. As a producer of the newest musical at the time said, "We make educated predictions on price. Disney, on the other hand, has turned this into a science" (see reference 3).

Disney had followed the plan of action that this book presents. It had collected its daily and weekly results, and summarized them, using techniques this book introduces in the next three chapters. Disney then analyzed those results by performing experiments and tests on the data collected (using techniques that later chapters introduce). In turn, those analyses were applied to a new interactive seating map that allowed customers to buy tickets for specific seats and permitted Disney to adjust the pricing of each seat for each performance. The whole system was constantly reviewed and refined, using the semiautomated methods to which Chapter 17 will introduce you. The end result was a system that outperformed the ticket-selling methods others used.

student TIP

From other business courses, you may recognize that Disney's system uses dynamic pricing.

FTF.1 Think Differently About Statistics

The "Using Statistics" scenario suggests, and the Disney example illustrates, that modern-day information technology has allowed businesses to apply statistics in ways that could not be done years ago. This scenario and example reflect how this book teaches you about statistics. In these first two pages, you may notice

- the lack of calculation details and "math."
- the emphasis on enhancing business methods and management decision making.
- that none of this seems like the content of a middle school or high school statistics class you may have taken.

You may have had some prior knowledge or instruction in *mathematical statistics*. This book discusses *business statistics*. While the boundary between the two can be blurry, business statistics emphasizes business problem solving and shows a preference for using software to perform calculations.

One similarity that you might notice between these first two pages and any prior instruction is *data*. **Data** are the facts about the world that one seeks to study and explore. Some data are unsummarized, such as the facts about a single ticket-selling transaction, whereas other facts, such as weekly ticket grosses, are **summarized**, derived from a set of unsummarized data. While you may think of data as being numbers, such as the cost of a ticket or the percentage that weekly grosses have increased in a year, do not overlook that data can be non-numerical as well, such as ticket-buyer's name, seat location, or method of payment.

Statistics: A Way of Thinking

Statistics are the methods that allow you to work with data effectively. Business statistics focuses on interpreting the results of applying those methods. You interpret those results to help you enhance business processes and make better decisions. Specifically, business statistics provides you with a formal basis to summarize and visualize business data, reach conclusions about that data, make reliable predictions about business activities, and improve business processes.

You must apply this way of thinking correctly. Any "bad" things you may have heard about statistics, including the famous quote "there are lies, damned lies, and statistics" made famous by Mark Twain, speak to the errors that people make when either misusing statistical methods or mistaking statistics as a substitution for, and not an enhancement of, a decision-making process. (Disney Theatrical Productions' success was based on *combining* statistics with business acumen, not *replacing* that acumen.)

DCOVA Framework To minimize errors, you use a framework that organizes the set of tasks that you follow to apply statistics properly. The five tasks that comprise the **DCOVA framework** are:

- **D**efine the data that you want to study to solve a problem or meet an objective.
- **C**ollect the data from appropriate sources.
- **O**rganize the data collected, by developing tables.
- **V**isualize the data collected, by developing charts.
- **A**nalyze the data collected, to reach conclusions and present those results.

You must always do the **D**efine and **C**ollect tasks before doing the other three. The order of the other three varies and sometimes all three are done concurrently. In this book, you will learn more about the **D**efine and **C**ollect tasks in Chapter 1 and then be introduced to the **O**rganize and **V**isualize tasks in Chapter 2. Beginning with Chapter 3, you will learn methods that help complete the **A**nalyze task. Throughout this book, you will see specific examples that apply the DCOVA framework to specific business problems and examples.

Analytical Skills More Important than Arithmetic Skills The business preference for using software to automate statistical calculations maximizes the importance of having analytical skills while it minimizes arithmetic skills. With software, you perform calculations faster and more accurately than if you did those calculations by hand, minimizing the need for advanced arithmetic skills. However, with software you can *also* generate inappropriate or meaningless results if you have not fully understood a business problem or goal under study or if you use that software without a proper understanding of statistics.

Therefore, using software to create results that help solve business problems or meet business goals is *always* intertwined with using a framework. And using software does not mean memorizing long lists of software commands or how-to operations, but knowing how to review, modify, and possibly create software solutions. If you can analyze what you need to do and have a general sense of what you need, you can always find instructions or illustrative sample solutions to guide you. (This book provides detailed instructions *as well as* sample solutions for every statistical activity discussed in end-of-chapter software guides and through the use of various downloadable files and sample solutions.)

If you were introduced to using software in an application development setting or an introductory information systems class, do not mistake building applications from scratch as being a necessary skill. A "smart" smartphone user knows how to use apps such as Facebook, Instagram, YouTube, Google Maps, and Gmail effectively to communicate or discover and use information and has no idea how to construct a social media network, create a mapping system, or write an email program. Your approach to using the software in this book should be the same as that smart user. Use your analytical skills to focus on being an effective user and to understand *conceptually* what a statistical method or the software that implements that method does.

Statistics: An Important Part of Your Business Education

Until you read these pages, you may have seen a course in business statistics solely as a required course with little relevance to your overall business education. In just two pages, you have learned that statistics is a way of thinking that can help enhance your effectiveness in business—that is, applying statistics correctly is a fundamental, global skill in your business education.

In the current data-driven environment of business, you need the general analytical skills that allow you to work with data and interpret analytical results regardless of the discipline in which you work. No longer is statistics only for accounting, economics, finance, or other disciplines that directly work with numerical data. As the Disney example illustrates, the decisions you make will be increasingly based on data and not on your gut or intuition supported by past experience. Having a well-balanced mix of statistics, modeling, and basic technical skills as well as managerial skills, such as business acumen and problem-solving and communication skills, will best prepare you for the workplace today … *and* tomorrow (see reference 1).

FTF.2 Business Analytics: The Changing Face of Statistics

Of the recent changes that have made statistics an important part of your business education, the emergence of the set of methods collectively known as business analytics may be the most significant change of all. **Business analytics** combine traditional statistical methods with methods from management science and information systems to form an interdisciplinary tool that supports fact-based decision making. Business analytics include

- statistical methods to analyze and explore data that can uncover previously unknown or unforeseen relationships.
- information systems methods to collect and process data sets of all sizes, including very large data sets that would otherwise be hard to use efficiently.
- management science methods to develop optimization models that support all levels of management, from strategic planning to daily operations.

In the Disney Theatrical Productions example, statistical methods helped determine pricing factors, information systems methods made the interactive seating map and pricing analysis possible, and management science methods helped adjust pricing rules to match Disney's goal of sustaining ticket sales into the future. Other businesses use analytics to send custom mailings to their customers, and businesses such as the travel review site tripadvisor.com use analytics to help optimally price advertising as well as generate information that makes a persuasive case for using that advertising.

Generally, studies have shown that businesses that actively use business analytics and combine that use with data-guided management see increases in productivity, innovation, and competition (see reference 1). Chapter 17 introduces you to the statistical methods typically used in business analytics and shows how these methods are related to statistical methods that the book discusses in earlier chapters.

"Big Data"

Big data are collections of data that cannot be easily browsed or analyzed using traditional methods. Big data implies data that are being collected in huge volumes, at very fast rates or velocities (typically in near real time), and in a variety of forms that can differ from the structured forms such as records stored in files or rows of data stored in worksheets that businesses use every day. These attributes of volume, velocity, and variety (see reference 5) distinguish big data from a "big" (large) set of data that contains numerous records or rows of similar data. When combined with business analytics and the basic statistical methods discussed in this book, big data presents opportunities to gain new management insights and extract value from the data resources of a business (see reference 8).

Unstructured data Big data may also include **unstructured data**, data that has an irregular pattern and contain values which are not comprehensible without additional automated or manual interpretation. Unstructured data takes many forms such as unstructured text, pictures, videos, and audio tracks, with unstructured text, such as social media comments, getting the most immediate attention today for its possible use in customer, branding, or marketing analyses.

Unstructured data can be adapted for use with a number of methods, such as regression, which this book illustrates with conventional, structured files and worksheets. Unstructured data may require one to perform data collection and preparation tasks beyond those tasks that Chapter 1 discusses. While those tasks are beyond the scope of this book, Chapter 17 does include a small example that uses unstructured text to illustrate some of these differences one would face using unstructured data.

FTF.3 Starting Point for Learning Statistics

Statistics has its own vocabulary and learning the precise meanings, or **operational definitions**, of several basic terms provides a start to understanding the statistical methods that this book discusses. For example, *in statistics*, a **variable** defines a characteristic, or property, of an item or individual that can vary among the occurrences of those items or individuals. For example, for the item "book," variables would include the title and number of chapters, as these facts can vary from book to book. For a given book, these variables have a specific value. For *this* book, the value of the title variable would be "Basic Business Statistics," and "20" would be the value for the number of chapters variable. Note that a statistical variable is not an algebraic variable, which serves as a stand-in to represent one value in an algebraic statement and could never take a non-numerical value such as "Basic Business Statistics."

Using the definition of variable, data, in its statistical sense, can be defined as the set of values associated with one or more variables. In statistics, each value for a specific variable is a single fact, not a list of facts. For example, what would be the value of the variable author for this book? Without this rule, you might say that the single list "Berenson, Levine, Szabat, Stephan" is the value. However, applying this rule, one would say that the variable has four separate values: "Berenson", "Levine", "Stephan", and "Szabat". This distinction of using only *single-value data* has the practical benefit of simplifying the task of entering data for software analysis.

Using the definitions of data and variable, the definition of statistics can be restated as the methods that analyze the data of the variables of interest. The methods that primarily help summarize and present data comprise **descriptive statistics**. Methods that use data collected from a small group to reach conclusions about a larger group comprise **inferential statistics**. Chapters 2 and 3 introduce descriptive methods, many of which are applied to support the inferential methods that the rest of the book presents.

Statistic

The previous section uses *statistics* in the sense of a collective noun, a noun that is the name for a collection of things (methods in this case). The word statistics also serves as the plural form of the noun statistic, as in "one uses methods of descriptive statistics (collective noun) to generate descriptive statistics (plural of the singular noun)." In this sense, a **statistic** refers to a value that summarizes the data of a particular variable. (More about this in coming chapters.) In the Disney Theatrical Productions example, the statement "for 2013, weekly grosses were up 67% from 2009" cites a statistic that summarizes the variable weekly grosses using the 2013 data—all 52 values.

When someone warns you of a possible unfortunate outcome by saying, "Don't be a statistic!" you can always reply, "I can't be." *You* always represent one value and a *statistic* always summarizes multiple values. For the statistic "87% of our employees suffer a workplace accident," you, as an employee, will either have suffered or have not suffered a workplace accident. The "have" or "have not" value contributes to the statistic but cannot be the statistic. A statistic can facilitate preliminary decision making. For example, would you immediately accept a position at a company if you learned that 87% of their employees suffered a workplace accident? (Sounds like this might be a dangerous place to work and that further investigation is necessary.)

Can Statistics (*pl.*, statistic) Lie?

The famous quote "lies, damned lies, and statistics" actually refers to the plural form of *statistic* and does not refer to statistics, the field of study. Can any statistic "lie"? No, faulty or invalid statistics can only be produced through willful misuse of statistics or when DCOVA framework tasks are done incorrectly. For example, many statistical methods are valid only if the data being analyzed have certain properties. To the extent possible, you test the assertion that the data have those properties, which in statistics are called *assumptions*. When an assumption is *violated*, shown to be invalid for the data being analyzed, the methods that require that assumption should not be used.

For the inferential methods that this book discusses in later chapters, you must always look for logical causality. **Logical causality** means that you can plausibly claim something directly causes something else. For example, you wear black shoes today and note that the weather is sunny. The next day, you again wear black shoes and notice that the weather continues to be sunny. The third day, you change to brown shoes and note that the weather is rainy. The fourth day, you wear black shoes again and the weather is again sunny. These four days seem to suggest a strong pattern between your shoe color choice and the type of weather you experience. You begin to think if you wear brown shoes on the fifth day, the weather will be rainy. Then you realize that your shoes cannot plausibly influence weather patterns, that your shoe color choice cannot *logically cause* the weather. What you are seeing is mere coincidence. (On the fifth day, you do wear brown shoes and it happens to rain, but that is just another coincidence.)

You can easily spot the lack of logical causality when trying to correlate shoe color choice with the weather, but in other situations the lack of logical causality may not be so easily seen. Therefore, relying on such correlations by themselves is a fundamental misuse of statistics. When you look for patterns in the data being analyzed, you must *always* be thinking of logical causes. Otherwise, you are misrepresenting your results. Such misrepresentations sometimes cause people to wrongly conclude that all statistics are "lies." Statistics (*pl.*, statistic) are not lies or "damned lies." They play a significant role in *statistics*, the way of thinking that can enhance your decision making and increase your effectiveness in business.

FTF.4 Starting Point for Using Software

Because software plays an important role in the application of business statistics, this book uses Excel, JMP, and Minitab to help explain and illustrate statistical concepts and methods. All three programs require knowledge of basic user interface skills, operations, and vocabulary that Table FTF.1 summarizes.

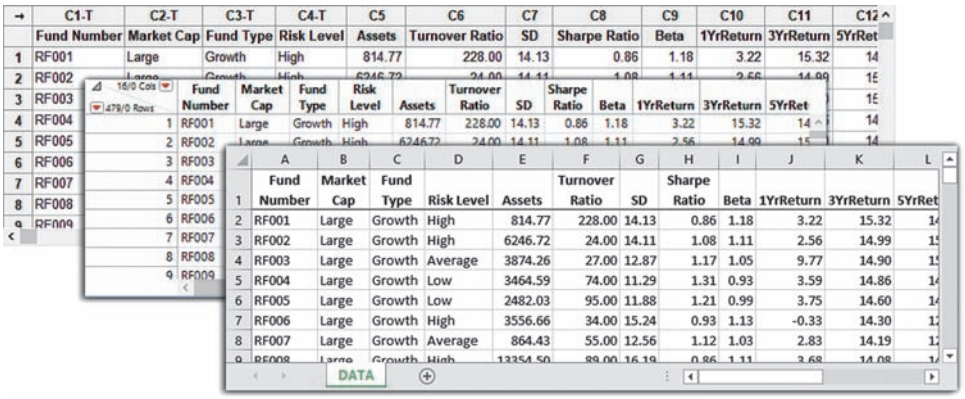
TABLE FTF.1
Basic Computing Knowledge

Skill or Operation	Specifics
Identify and use standard window objects	Title bar, minimize/resize/close buttons, scroll bars, mouse pointer, menu bars or ribbons, dialog box, window subdivisions such as areas, panes, or child windows
Identify and use common dialog box items	Command button, list box, drop-down list, edit box, option button, check box, tabs (tabbed panels)
Mouse operations	Click, called select in some list or menu contexts and check or clear in some check box contexts; double-click; right-click to make a shortcut menu appear; drag and drag-and-drop

If you found anything new to you in this table, download and review a complimentary copy of the online pamphlet *Basic Computing Skills* and make its study your starting point. (Appendix C discusses how and from where you download online materials.)

Otherwise, a starting point with software begins with review of basic data and document operations. Excel, JMP, and Minitab all use **worksheets** to display the contents of a data set and as the means to enter or edit data. (JMP calls its worksheets **data tables**.) Worksheets are tabular arrangements of data, in which the intersections of rows and columns form **cells**, boxes into which you make individual entries. One places the data for a variable into the cells of a column such that each column contains the data for a different variable, if more than one variable is under study. By convention, one uses the cell in the initial row to enter names of the variables (variable columns). JMP and Minitab provide a special unnumbered row for entering variable names; in Excel, one must use row 1 for this purpose, which can sometimes lead to inadvertent errors. Figure FTF.1 shows the similarities and this key difference among the worksheets of the three programs.

FIGURE FTF.1
Minitab, JMP, and Excel worksheets



	C1-T	C2-T	C3-T	C4-T	C5	C6	C7	C8	C9	C10	C11	C12
	Fund Number	Market Cap	Fund Type	Risk Level	Assets	Turnover Ratio	SD	Sharpe Ratio	Beta	1YrReturn	3YrReturn	5YrRet
1	RF001	Large	Growth	High	814.77	228.00	14.13	0.86	1.18	3.22	15.32	14
2	RF002											
3	RF003											
4	RF004											
5	RF005											
6	RF006											
7	RF007											
8	RF008											
9	RF009											

	A	B	C	D	E	F	G	H	I	J	K	L
	Fund Number	Market Cap	Fund Type	Risk Level	Assets	Turnover Ratio	SD	Sharpe Ratio	Beta	1YrReturn	3YrReturn	5YrRet
2	RF001	Large	Growth	High	814.77	228.00	14.13	0.86	1.18	3.22	15.32	14
3	RF002	Large	Growth	High	6246.72	24.00	14.11	1.08	1.11	2.56	14.99	15
4	RF003	Large	Growth	Average	3874.26	27.00	12.87	1.17	1.05	9.77	14.90	15
5	RF004	Large	Growth	Low	3464.59	74.00	11.29	1.31	0.93	3.59	14.86	14
6	RF005	Large	Growth	Low	2482.03	95.00	11.88	1.21	0.99	3.75	14.60	14
7	RF006	Large	Growth	High	3556.66	34.00	15.24	0.93	1.13	-0.33	14.30	12
8	RF007	Large	Growth	Average	864.43	55.00	12.56	1.12	1.03	2.83	14.19	12
9	RF008	Large	Growth	High	13354.50	89.00	16.19	0.86	1.11	3.68	14.08	14

DATA

studentTIP
Many of the Excel solutions as well as selected JMP and Minitab solutions that this book presents exist as templates that simplify the production of results and serve as models for learning more about using formulas in the three programs.

Generally, entries in each cell are single data values that can be text or numbers. All three programs also permit **formulas**, instructions to process data, to compute cell values. Formulas can include **functions** that simplify certain arithmetic tasks or provide access to advanced processing or statistical features. Formulas play an important role in designing **templates**, *reusable* solutions that have been previously audited and verified. However, JMP and Minitab allow only *column* formulas that define calculations for all the cells in a column, whereas Excel allows only *cell* formulas that define calculations for individual cells.

All three programs save worksheet data and results as one file, called a **workbook** in Excel and a **project** in JMP and Minitab. JMP and Minitab also allows the saving of individual worksheets or results as separate files, whereas Excel always saves a workbook even if the workbook contains (only) one worksheet. Both JMP and Minitab can open the data worksheets of an Excel workbook, making the Excel workbook a universal format for sharing of files that contain only data, such as the set of data files for use with this book that Appendix C documents. Table FTF.2 summarizes some of the various file formats that the three programs use.

studentTIP
Appendix D provides some technical information for add-ins appropriate for use with this book.

Appendix B discusses the basic document operations of opening, saving, and printing documents, the specifics of which slightly differ among the three programs and further explains file formats as necessary.

TABLE FTF.2
Excel, JMP, and Minitab file formats

File Type	Excel	JMP	Minitab
All-in-one-file	**.xlsx** (workbook)	**.jmpprj** (project)	**.mpj** (project)
Single worksheet	**.xlsx** (see discussion)	**.jmp**	**.mtw**
Results only	**n.a.**	**.jrp** (report), **.jmpappsource** (dashboard)	**.mgf** (graph)
Macro or add-in (simplifies user operations)	**.xlsm**, **.xlam**	**.jsl**, **.jmpaddin**	**.mtb**, **.mac**

student TIP

Check the student download web page for this book for more information about PHStat and JMP and Minitab macros and add-ins that may be available for download.

Using Software Properly

Learning to use software *properly* can be hard as software has limited ways to provide feedback for user actions that are invalid operations. In addition, no software will ever know if you are following proper procedures for using that software. The principles that Exhibit FTF.1 list will assist you and should govern your use of software with this book. These principles will minimize your chance of making errors and lessen the frustration that often occurs when these principles are unknown or overlooked by a user.

EXHIBIT FTF.1

Principles of Using Software Properly

Ensure that software is properly updated. Many users that manage their own computers often overlook the importance of ensuring that all installed software is up to date.

Understand the basic operational tasks. Take the time to master the tasks of starting the software, loading and entering data, and how to select or choose commands in a general way.

Understand the statistical concepts that a software procedure uses. Not understanding those concepts can cause you to make wrong choices in the software and can make interpreting software results difficult.

Know how to review software use for errors. Review and verify that the proper data preparation procedures (see Chapter 1) have been applied to the data before analysis. Verify that you have selected the correct procedures, commands, and software options. For any information that you entered for results labeling purposes, verify that no typographical errors exist.

Seek reuse of preexisting solutions to solve new problems. Build solutions from scratch only as necessary, particularly if using Excel in which errors can be most easily made. Some solutions, and almost all Excel solutions that this book presents, exist as models or templates that can *and should* be reused because such reuse models best practice.

Understand how to organize and present information from the results that the software creates. Think about the best ways to arrange and label your data. Consider ways to enhance or reorganize results that will facilitate communication with others.

Use self-identifying names, especially for the files that you create and save. Naming files Document 1, Document 2, and so on, will not help you later when you seek to retrieve a file for review and study.

In addition, also look for ways in which you can simplify the user interface of the software you use. If using Excel with this book, consider using PHStat, supplied separately or as part of a bundle by Pearson. PHStat simplifies the user interface by providing a consistent dialog box driven interface that minimizes keystrokes and mouse selections. If using JMP and Minitab, look for macro and add-ins that simplify command sequences or automate repetitive activities.

Software instruction conventions and notation The instructions that appear in the end-of-chapter software guides and certain appendices use a set of conventions and notation that Table FTF.3 summarizes. These conventions provide a concise and clear way of expressing specific user activities.

TABLE FTF.3 Conventions That This Book Uses

Convention	Example
Names of special keys appear capitalized and in boldface	Press **Enter**. Press **Command** or **Ctrl**.
Key combinations appear in boldface, with key names linked using this symbol: +	Enter the formula and press **Ctrl+Enter**. Press **Ctrl+C**.
Menu or Ribbon selections appear in boldface and sequences of consecutive selections are shown using this symbol: ➔	Select **File ➔ New** Select **PHStat ➔ Descriptive Statistics ➔ Boxplot**.
Target of mouse operations appear in boldface	Click **OK**. Select **Attendance** and then click the **Y button**.
Entries and the location of where entries are made appear in boldface	Enter **450** in cell **B5**. Add **Temperature** to the **Construct Model Effects** list.
Variables in data files that the text names appear capitalized	This file contains the Fund Type, Assets, and Expense Ratio variables.
Placeholders that express a general case appear in italics and may also appear in boldface as part of a function definition	**AVERAGE (*cell range of variable*)** Replace *cell range of variable* with the cell range that contains the Asset variable.
Names of data files that sections or problems refer to explicitly appear in a special font, but names of files in instructions appear in boldface	Retirement Funds Open the **Retirement Funds workbook**.
When current versions of Excel and Minitab differ in their user interface, alternate instructions for older versions appear in a second color immediately following the primary instructions	In the Select Data Source display, click the icon inside the **Horizontal (Category) axis labels** box. Click **Edit** under the **Horizontal (Categories) Axis Labels** heading.

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KEY TERMS