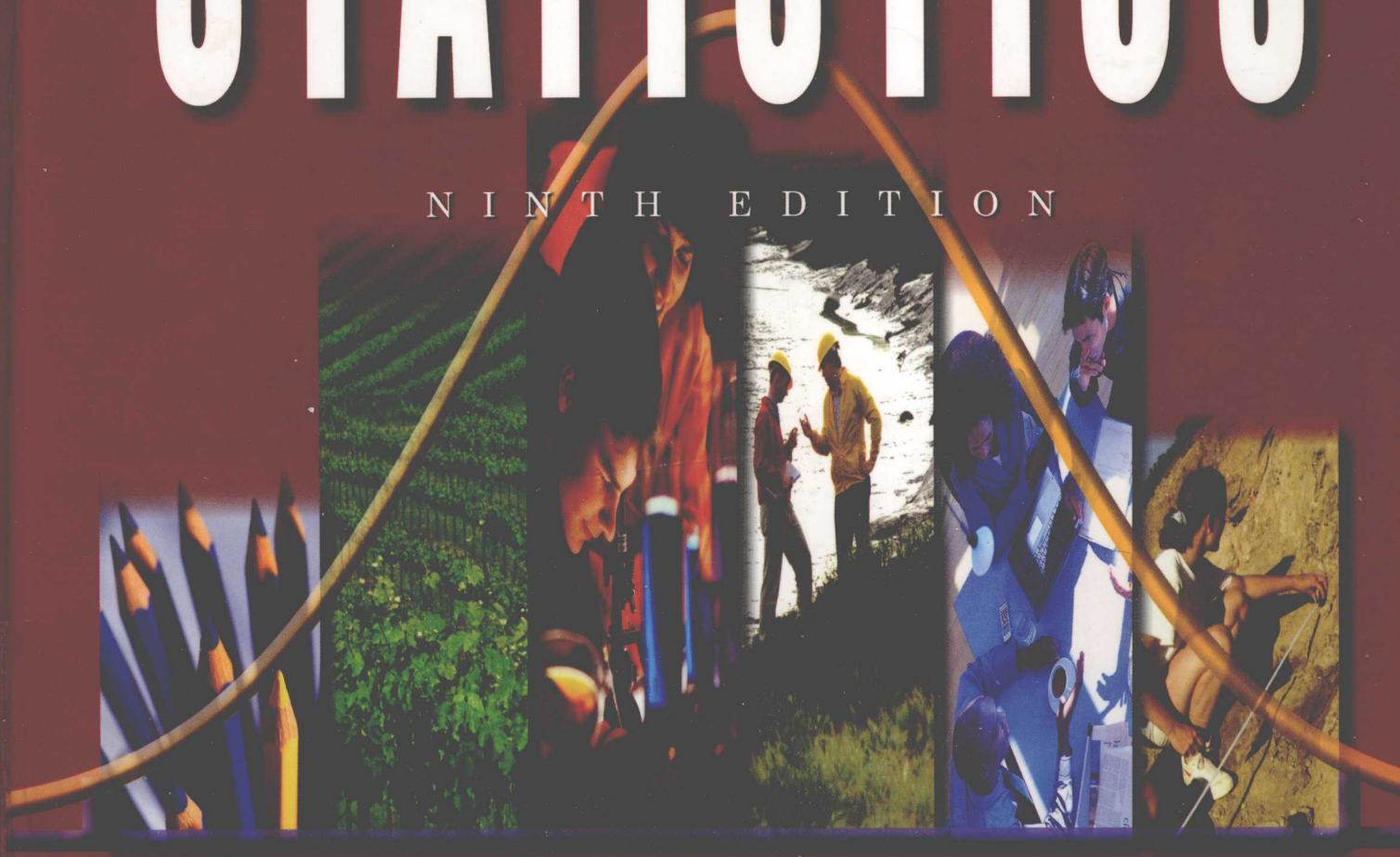
ELEMENTARY

STATISTICS

Updated Edition

Updates for the latest technology.

NINTH EDITION



MARIO F. TRIOLA

ELEMENTARY

STATISTICS

NINTH EDITION

MARIO F. TRIOLA

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To Marc and Scott

Preface

About This Book

Although much of this Ninth Edition of ***Elementary Statistics*** has been updated, the major objective remains the same: Provide the best possible introductory statistics book for both students and professors. This goal is realized through factors that include a friendly writing style, content that reflects the important features of a modern introductory statistics course, the use of the latest technology, interesting and real data sets, an abundance of pedagogical components, and an unmatched battery of supplements. This text reflects recommendations and guidelines from the American Statistical Association, the Mathematical Association of America, the American Mathematical Association of Two-Year Colleges, and the National Council of Teachers of Mathematics.

Audience/Prerequisites

Elementary Statistics is written for students majoring in any field. Although the use of algebra is minimal, students should have completed at least a high school or college elementary algebra course. In many cases, underlying theory is included, but this book does not stress the mathematical rigor more suitable for mathematics majors. Because the many examples and exercises cover a wide variety of different and interesting statistical applications, ***Elementary Statistics*** is appropriate for students pursuing majors in a wide variety of disciplines ranging from the social sciences of psychology and sociology to areas such as education, the allied health fields, business, economics, engineering, the humanities, the physical sciences, journalism, communications, and liberal arts.

Technology

Elementary Statistics, Ninth Edition, can be used easily without reference to any specific technology. Many instructors continue to use editions of this book with students using nothing more than a variety of different scientific calculators. However, for those who choose to supplement the course with specific technology, both in-text and supplemental materials are available.

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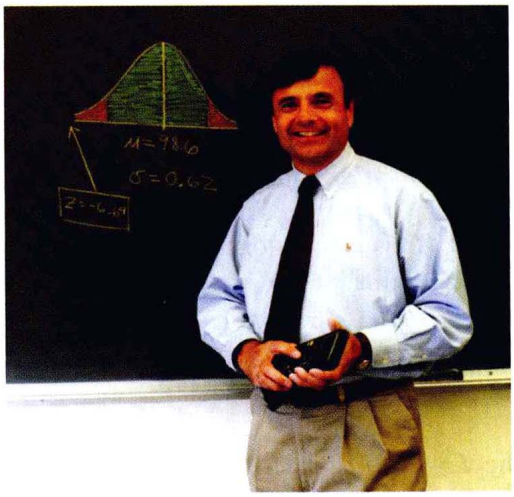
Organization Changes

- In Chapter 5, Sections 5-3 and 5-4 from the Eighth Edition (nonstandard normal distributions) are now combined in Section 5-3. This change is motivated by the new format of Table A-2, which makes it easier for students to work with normal distributions.
- In Chapter 5 there is a new Section 5-4 describing "Sampling Distributions and Estimators."
- In Chapters 6, 7, and 8, confidence intervals and hypothesis testing procedures now begin with *proportions*, which students generally find more interesting than means. Also, the procedures for working with proportions are simpler, allowing students to better focus on the new methods of inferential statistics.
- Section 6-4 from the Eighth Edition (Sample Size Required to Estimate μ) is now included in Section 6-3 (Estimating a Population Mean: σ Known) along with confidence intervals for estimating a population mean μ.
- Because instructors include the topic of statistical process control less frequently than the topic of nonparametric statistics, those two topics have been switched so that Chapter 12 now covers methods of nonparametric statistics and Chapter 13 covers statistical process control.

Content Changes

- **Procedures** In Chapters 6, 7, and 8 there is a change from "$n > 30$" to "σ known" as a key criterion for choosing between the normal and t distributions. This change reflects the common practice used by working professionals, it provides more accurate results, and it is better for students moving on to other statistics courses, yet it is not much more difficult than using the "$n > 30$" criterion.
- **Tables** There is a new format for the important normal distribution in Table A-2: Cumulative areas from the left are now listed on two pages. Students generally find this format easier to use. Table A-3 has been expanded to include more of the larger sample sizes for the Student t distribution.
- **Notation** In hypothesis testing, the symbols $\geq$ and $\leq$ are no longer used in expressions of the null hypothesis. For claims about a specific value of a parameter, only the equal symbol $=$ is used. This change reflects the practice used by the overwhelming majority of professionals who use methods of statistics and report findings in professional journals.
- **Data Sets** Appendix B now includes 30 data sets (instead of 20), including 14 that are new.
- **Icons** Technology icons are now used to identify exercises based on larger data sets from Appendix B, which are best completed by using software or a TI-83 Plus or TI-84 Plus calculator.
- **Interpreting Results** Throughout the book there is even greater emphasis on *interpreting* results. Instead of simply obtaining answers, the implications and consequences of answers are considered. For example, when discussing proba-



About the author

Mario F. Triola is a Professor Emeritus of Mathematics at Dutchess Community College, where he has taught statistics for over 30 years. Marty is the author of *Essentials of Statistics*, *Elementary Statistics Using Excel*, *Mathematics in the Modern World*, and *Survey of Mathematics*. He is a co-author of *Statistical Reasoning for Everyday Life, Business Statistics,* and *Introduction to Technical Mathematics*. He designed the original STATDISK statistical software package, and he has written several manuals and workbooks for technology supporting statistics education. Outside of the classroom, Marty's consulting work includes the mathematical design of casino slot machines and fishing rods, and he has worked with attorneys in determining probabilities in paternity lawsuits, identifying salary inequities based on gender, and analyzing disputed election results. Marty has testified as an expert witness in New York State Supreme Court for an election dispute involving a former student. Marty was a recent writing team member of the Project Coalition with NASA and the American Mathematics Association of Two-Year Colleges.

When he's not working, Marty enjoys travel, golf, tennis, running, hiking, and anything that flies. He has a commercial pilot's license with an instrument rating, and has flown airplanes, helicopters, sail planes, hang gliders, and hot air balloons. His passion for flying has included parachute jumps, flying in a Goodyear blimp, and parasailing.

The Text and Academic Authors Association has awarded Mario F. Triola a "Texty" for Excellence for his work on *Elementary Statistics*.

About This Updated Edition

Some major improvements in technology have been implemented since the first printing of the Ninth Edition of *Elementary Statistics*. Although this Updated Edition includes the same examples, exercises, and statistical content as the original Ninth Edition, it also includes changes to reflect the following recent changes in technology.

Texas Instruments Calculators

The original printing of the Ninth Edition of *Elementary Statistics* includes many references to the TI-83 Plus calculator. The instructions, screen displays, programs, and the APP (application) for the TI-83 Plus calculator also apply to each of these calculators, which may also be used with this book:

- TI-83 Plus Silver Edition
- TI-84 Plus
- TI-84 Plus Silver Edition

Throughout this book, references to the *TI-83 Plus* calculator also apply to any of the above listed calculators.

The TI-89, TI-89 Titanium, TI-92 Plus, and Voyager 2000 have the ability to download the "Statistics with List Editor" application, so these calculators can have at least as much statistics functionality as the TI-83 Plus and TI-84 Plus family of calculators. However, procedures for using the "Statistics with List Editor" application are generally different from the calculator procedures described in this book. Consequently, the TI-89, TI-89 Titanium, TI-92 Plus, and Voyager 2000 calculators could be used for many procedures in this book, but instructions, screen displays, the data application, and programs are not compatible with this book.

Minitab

The original printing of the Ninth Edition of *Elementary Statistics* was based on Minitab Release 13. This Updated Edition includes updates for the newer Minitab Release 14. Among other improvements, Minitab Release 14 now includes more opportunities for using summary statistics, such as the sample size, sample mean, and sample standard deviation.

STATDISK

The original printing of the Ninth Edition of *Elementary Statistics* was based on STATDISK version 9.0, but dramatic improvements are now included in STATDISK version 9.5.2. (Check the Web site http://www.aw.com/triola for the latest version of STATDISK.) This Updated Edition includes updated instructions for using the latest version of STATDISK, which will be version 9.5.2 or later.

bility in Chapter 3, instead of simply finding probability values, we interpret them by differentiating between events that are usual and those that are unusual. With hypothesis testing, we don't simply end with a conclusion of rejecting or failing to reject a null hypothesis, we proceed to state a practical conclusion that addresses the real issue. Students are encouraged to *think* about the implications of results instead of cranking out cookbook results that make no real sense.

Flexible Syllabus

The organization of this book reflects the preferences of most statistics instructors, but there are two common variations that can be easily used with this Ninth Edition:

- **Early coverage of correlation/regression:** Some instructors prefer to cover the basics of correlation and regression early in the course, such as immediately following the topics of Chapter 2. *Sections 9-2 (Correlation) and 9-3 (Regression) can be covered early in the course.* Simply omit the subsection in Section 9-2 clearly identified as "Formal Hypothesis Test (Requires Coverage of Chapter 7)."
- **Minimum probability:** Some instructors feel strongly that coverage of probability should be extensive, while others feel just as strongly that coverage should be kept to a bare minimum. Instructors preferring minimum coverage can include Section 3-2 while skipping the remaining sections of Chapter 3, as they are not essential for the chapters that follow. Many instructors prefer to cover only the fundamentals of probability along with the basics of the addition rule and multiplication rule, and the coverage of the multiplication rule (Sections 3-4 and 3-5) now offers that flexibility.

Exercises

There are over 1500 exercises—more than *58 percent of them new!* In response to requests by users of the previous edition, there are now more of the simpler exercises that are based on small data sets. Many more of the exercises require interpretation of results. Because exercises are of such critical importance to any statistics book, great care has been taken to ensure their usefulness, relevance, and accuracy. Three statisticians have read carefully through the final stages of the book to verify accuracy of the text material and exercise answers. Exercises are arranged in order of increasing difficulty by dividing them into two groups: (1) Basic Skills and Concepts and (2) Beyond the Basics. The Beyond the Basics exercises address more difficult concepts or require a somewhat stronger mathematical background. In a few cases, these exercises also introduce a new concept.

Real data: *64% of the exercises use real data.* Because the use of real data is such an important consideration for students, hundreds of hours have been devoted to finding real, meaningful, and interesting data. In addition to the real data included throughout the book, many exercises refer to the 30 data sets listed in Appendix B.

Hallmark Features

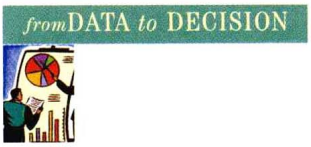
Beyond an interesting and accessible (and sometimes humorous) writing style, great care has been taken to ensure that each chapter of ***Elementary Statistics*** will help students understand the concepts presented. The following features are designed to help meet that objective:

- **Chapter-opening features:** A list of chapter sections previews the chapter for the student; a chapter-opening problem, using real data, then motivates the chapter material; and the first section is a chapter overview that provides a statement of the chapter's objectives.
- **End-of-chapter features:**

  A **Chapter Review** summarizes the key concepts and topics of the chapter;

  Review Exercises offer practice on the chapter concepts and procedures;

  Cumulative Review Exercises reinforce earlier material;

  From Data to Decision: Critical Thinking is a capstone problem that requires critical thinking and a writing component;

  Cooperative Group Activities encourage active learning in groups;

  Technology Projects are for use with STATDISK, Minitab, Excel, or a TI-83 Plus or TI-84 Plus calculator;

  Internet Projects involve students with Internet data sets and, in some cases, applets.
- **Margin Essays:** The text includes 120 margin essays, which illustrate uses and abuses of statistics in real, practical, and interesting applications. Topics include "Do Boys or Girls Run in the Family?," "Accuracy of Vote Counts," "Test of Touch Therapy," and "Picking Lottery Numbers."
- **Flowcharts:** These appear throughout the text to simplify and clarify more complex concepts and procedures.
- **Statistical Software:** STATDISK, Minitab, Excel and TI-83 Plus (or TI-84 Plus) instructions and output appear throughout the text.
- **Real Data Sets:** These are used extensively throughout the entire book. Appendix B lists 30 data sets, 14 of which are new. These data sets are provided in printed form in Appendix B, and in electronic form on the Web site and the CD bound in the back of the book. The data sets include such varied topics as ages of Queen Mary stowaways, alcohol and tobacco use in animated children's movies, eruptions of the Old Faithful geyser, diamond prices and characteristics, and movie financial and rating data.
- **Interviews:** Every chapter of the text includes author-conducted interviews with professional men and women in a variety of fields who use statistics in their day-to-day work.
- **Quick-Reference Endpapers:** Table A-2 (the normal distribution) is reproduced on the front inside cover pages, and Table A-3 (t distribution) is reproduced on the back inside cover page. A symbol table is included at the back of the book for quick and easy reference to key symbols.
- **Detachable Formula/Table Card:** This insert, organized by chapter, gives students a quick reference for studying, or for use when taking tests (if allowed by the instructor).

- **CD-ROM:** The CD-ROM was prepared by Mario F. Triola and is packaged with every new copy of the text; it includes the data sets (except for Data Set 4) from Appendix B in the textbook. These data sets are stored as text files, Minitab worksheets, SPSS files, SAS files, Excel workbooks, and a TI-83 Plus application. The CD also includes programs for the TI-83 Plus® graphing calculator, STATDISK Statistical Software (Version 9.5.2 or later), and the Excel Add-In, which is designed to enhance the capabilities of Excel's statistics programs.

STATDISK

Minitab

Excel

TI-83 Plus

Supplements

The student and instructor supplements packages are intended to be the most complete and helpful learning system available for the introductory statistics course. Instructors should contact their local Addison-Wesley sales representative, or e-mail the company directly at exam@aw.com for examination copies.

For the Instructor

- ***Annotated Instructor's Edition,*** by Mario F. Triola, contains answers to all exercises in the margin, plus recommended assignments, and teaching suggestions. ISBN: 0-321-14963-7 (Student for-sale edition ISBN 0-201-77570-0).
- ***Instructor's Solutions Manual,*** by Mario F. Triola and Milton Loyer, contains solutions to all the exercises and sample course syllabi. ISBN: 0-321-12212-7.
- *New* **MyMathLab.com** is a complete online course that integrates interactive multimedia instruction with the textbook content. MyMathLab can be customized easily to suit the needs of students and instructors, and it provides a comprehensive and efficient online course management system that allows for diagnosis, assessment, and tracking of students' progress. MyMathLab has numerous useful features:

  Fully interactive textbooks are built in CourseCompass, a version of Blackboard™ designed specifically for Addison-Wesley.

  Chapter and section folders from the textbook contain a wide range of instructional content: software tools (such as STATDISK and the Excel Add-In), video clips, flash animations, and the data sets and formula table card from the text.

  Hyperlinks take you directly to online testing, diagnosis, tutorials, and gradebooks in MathXL for Statistics, Addison-Wesley's tutorial and testing system.

  Instructors can create, copy, edit, assign, and track all tests for their course, as well as track student tutorial and testing performance.

  With push-button ease, instructors can remove, hide, or annotate Addison-Wesley preloaded content, add their own course documents, or change the order in which material is presented.

  Using the communications tools found in MyMathLab, instructors can hold online office hours, host a discussion board, create communication groups within their class, send e-mail, and maintain a course calendar.

For more information, visit www.mymathlab.com or contact your Addison-Wesley sales representative for a demonstration.

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- **Testing System:** Great care has been taken to ensure the strongest possible testing system for the new edition of ***Elementary Statistics*.** Not only is there a printed test bank, there is also a computerized test generator, **TestGen4.0 and Quizmaster3.0.,** that lets you view and edit test-bank questions, transfer them to tests, and print in a variety of formats. The program also offers many options for organizing and displaying test banks and tests. A built-in random number and test generator makes **TestGen-EQ** ideal for creating multiple versions of tests and provides more possible test items than printed test-bank questions. Powerful search and sort functions let the instructor easily locate questions and arrange them in the preferred order. Users can export tests as text files so they can be viewed with a Web browser. Additionally, tests created with TestGen can be used with **QuizMaster,** which enables students to take exams on a computer network. QuizMaster automatically grades the exams, stores results on disk, and allows the instructor to view or print a variety of reports for individual students, classes, or courses. **Printed Testbank** ISBN: 0-321-12214-3; TestGen-EQ for Mac and Windows ISBN: 0-321-12213-5.
- **PowerPoint® Lecture Presentation CD:** Free to qualified adopters, this classroom lecture presentation software is geared specifically to the sequence and philosophy of ***Elementary Statistics.*** Key graphics from the book are included. These slides are also available on the Triola Web site at www.aw.com/info/Triola. Mac and Windows ISBN: 0-321-12215-1.

FOR THE STUDENT

- **MathXL for Statistics** is a Web site that provides students with online homework, testing, and tutorial help. Students can take chapter tests correlated to the textbook, receive individualized study plans based on those test results, work practice problems and receive feedback on which text examples or exercises to review further, and take tests again to gauge their progress. Instructors can assign homework or customize tests using the online test bank or upload any tests they created using Addison-Wesley's TestGen testing software. All student test results, homework, study plans, and practice work are tracked and viewable in an online gradebook. The site is free to qualified adopters when an access code is bundled with a new text. MathXL for Statistics is also available as part of MyMathLab.com.
- **Videos** are designed to supplement many sections in the book, with some topics presented by the author. The videos feature all technologies in the book. This is an excellent resource for students who have missed class or wish to review a topic. It is also an excellent resource for instructors involved with distance learning, individual study, or self-paced learning programs. **Videotapes** ISBN: 0-321-12209-7; **Digital Video Tutor** (CD-ROM version) ISBN: 0-321-12231-3.
- **Triola *Elementary Statistics* Web Site:** This Web site may be accessed at http://www.aw.com/triola, and provides Internet projects keyed to every chapter of the text, and the book's data sets as they appear on the CD.
- ***Student's Solutions Manual,*** by Milton Loyer (Penn State University), provides detailed, worked-out solutions to all odd-numbered text exercises. ISBN: 0-321-12217-8.

The following technology manuals include instructions on and examples of the technology's use. Each one has been written to correspond with the text.

- ***Excel® Student Laboratory Manual and Workbook,*** written by Johanna Halsey and Ellena Reda (Dutchess Community College). ISBN: 0-321-12206-2.
- ***Minitab® Student Laboratory Manual and Workbook,*** written by Mario F. Triola. ISBN: 0-321-12205-4.
- ***SAS Student Laboratory Manual and Workbook,*** written by Joseph Morgan (DePaul University). ISBN: 0-321-12727-7.
- ***SPSS® Student Laboratory Manual and Workbook,*** written by Roger Peck (California State University, Bakersfield). ISBN: 0-321-12207-0.
- ***STATDISK Student Laboratory Manual and Workbook,*** written by Mario F. Triola. ISBN: 0-321-12216-X.
- ***TI-83 Plus® Companion to Elementary Statistics,*** by Marla Bell (Kennesaw State University). ISBN: 0-321-12208-9.
- **Triola Version of *ActivStats*®,** developed by Paul Velleman and Data Description, Inc., provides complete coverage of introductory statistics topics on CD-ROM, using a full range of multimedia. *ActivStats* integrates video, simulation, animation, narration, text, and interactive experiments, World Wide Web access, and Data Desk®, a statistical software package. Homework problems and data sets from the text are included on the CD-ROM. *ActivStats* for Windows and Macintosh ISBN: 0-201-77139-X. Also available in versions for Excel, JMP, Minitab and SPSS. See your Addison-Wesley sales representative for details or check the Web site at www.aw.com/activstats.
- ***Addison-Wesley Tutor Center:*** Free tutoring is available to students who purchase a new copy of the Ninth Edition of ***Elementary Statistics*** when bundled with an access code. The Addison-Wesley Math Tutor Center is staffed by qualified statistics and mathematics instructors who provide students with tutoring on text examples and any exercise with an answer in the back of the book. Tutoring assistance is provided by toll-free telephone, fax, e-mail, and whiteboard technology—which allows tutors and students to actually see the problems worked while they "talk" in real time over the Internet. This service is available five days a week, seven hours a day. For more information, please contact your Addison-Wesley sales representative.
- ***The Student Edition of Minitab*** is a condensed version of the professional release of Minitab Statistical Software. It offers students the full range of Minitab's statistical methods and graphical capabilities, along with worksheets that can include up to 5000 data points. It comes with a user's manual that includes case studies and hands-on tutorials, and is perfect for use in any introductory statistics course, including those in the life and social sciences. The currently available Student Edition is ***Student Edition of Minitab, Release 12 for Windows 95/98 NT.*** ISBN: 0-201-39715-3.

Any of these products can be purchased separately, or bundled with Addison-Wesley texts. Instructors can contact local sales representatives for details on purchasing and bundling supplements with the textbook or contact the company at exam@aw.com for examination copies of any of these items.

Acknowledgments

The success of ***Elementary Statistics*** is due to the efforts of many dedicated professionals. I wish to express my most sincere thanks to Deirdre Lynch, Christine O'Brien, Greg Tobin, Peggy McMahon, Barbara Atkinson, Brenda Bravener, Yolando Cossio, Karen Guardino, Jen Kerber, Sara Anderson, Keren Blankfeld, Joe Vetere, Joanne Ha, Weslie Lewis, Janet Nuciforo, and the entire Addison-Wesley staff.

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I also take great pride in thanking my wife, Ginny, and my sons Marc and Scott for their help and encouragement.

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