

A BRIEF VERSION

Ninth Edition

Elementary Statistics

A STEP BY STEP APPROACH



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Graw
Hill

ALLAN G. BLUMAN

PROFESSOR EMERITUS

COMMUNITY COLLEGE OF ALLEGHENY COUNTY



ELEMENTARY STATISTICS: A STEP BY STEP APPROACH, A BRIEF VERSION, NINTH EDITION

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He is also author of *Elementary Statistics: A Step By Step Approach* and he was a coauthor of *Math in Our World*. In addition, he is the author of four mathematics books in the McGraw Hill DeMystified Series. They are *Pre-Algebra*, *Math Word Problems*, *Business Math*, and *Probability*.

He is married and has two sons, a granddaughter, and a grandson.

Dedication: *To Betty Bluman, Earl McPeck, and Dr. G. Bradley Seager, Jr.*

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Monkey Business
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All examples and exercises in this textbook (unless cited) are hypothetical and are presented to enable students to achieve a basic understanding of the statistical concepts explained. These examples and exercises should not be used in lieu of medical, psychological, or other professional advice. Neither the author nor the publisher shall be held responsible for any misuse of the information presented in this textbook.

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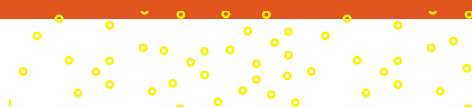
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- Bibliography



PREFACE

Approach

Elementary Statistics: A Brief Version was written as an aid in the beginning statistics course to students whose mathematical background is limited to basic algebra. The book follows a nontheoretical approach without formal proofs, explaining concepts intuitively and supporting them with abundant examples. The applications span a broad range of topics certain to appeal to the interests of students of diverse backgrounds, and they include problems in business, sports, health, architecture, education, entertainment, political science, psychology, history, criminal justice, the environment, transportation, physical sciences, demographics, and travel and leisure.

Reflecting the Diverse World Around Us

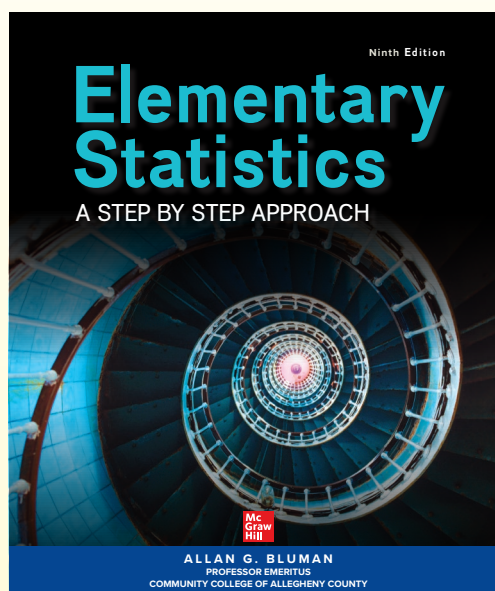
We believe in unlocking the potential of every learner at every stage of life. To accomplish that, we are dedicated to creating products that reflect, and are accessible to, all the diverse, global customers we serve. Within McGraw Hill, we foster a culture of belonging and we work with partners who share our commitment to equity, inclusion, and diversity in all forms.

The ninth edition of this text received an extensive and thorough audit to ensure that the examples, applications, and topics referenced throughout support a welcoming and sensitive experience for all learners and uphold McGraw Hill's commitment to equity, inclusion, and diversity.

About This Book

While a number of important changes have been made in the ninth edition, the learning system remains untouched and provides students with a useful framework in which to learn and apply concepts. Some of the retained features include the following:

- Over **1200 exercises** are located at the end of major sections within each chapter.
- **Hypothesis-Testing Summaries** found at the end of Chapter 9 (z , t , χ^2 , and F tests for testing means, proportions, and variances) and Chapter 11 (correlation, chi-square, and ANOVA) show students the different types of hypotheses and the types of tests to use.
- A **Data Bank containing real data** listing various attributes (educational level, cholesterol level, sex, etc.) for 100 people and several additional data sets using real data are included and referenced in various exercises and projects throughout the book.
- An updated **Important Formulas appendix** containing the formulas and the z , t , χ^2 , and PPMC tables is included with this textbook.
- End-of-chapter **Summaries, Important Terms, and Important Formulas** give students a concise summary of the chapter topics and provide a good source for quiz or test preparation.
- **Review Exercises** are found at the end of each chapter.
- Special sections called **Data Analysis** require students to work with a data set to perform various statistical tests or procedures and then summarize the results. The data are included in the Data Bank in Appendix B.
- **Chapter Quizzes**, found at the end of each chapter, include multiple-choice, true/false, and completion questions along with exercises to test students' knowledge and comprehension of chapter content.
- The **Appendixes** provide students with extensive reference tables, a glossary, and answers to all quiz questions and



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odd-numbered exercises. Additional Online Appendixes include algebra review, an outline for report writing, Bayes' theorem, and an alternative method for using the standard normal distribution. These can also be found in the online resources.

- The **Applying the Concepts** feature is included in all sections and gives students an opportunity to think about the new concepts and apply them to examples and scenarios similar to those found in newspapers, magazines, and radio and television news programs.

Changes in the Ninth Edition

Global Changes

- Replaced over 100 examples with new or updated ones and over 550 new or updated exercises.
- Updated the Technology Tips sections.
- Renumbered statistical tables in Appendix A.
- Most exercises include the TI answers along with the answers that use the tables in the book.

Chapter Changes

Chapter 1

- New Statistics Today example.
- New statistical examples to introduce how statistics are used today.

Chapter 2

- Updated Statistics Today example.

Chapter 5

- Section 5–3 now includes solving problems using the combination formula in addition to the binomial formula.

Chapters 7, 8, and 9

- These chapters have been revised to allow professors who want to teach proportions before means to do so. They should cover the first sections of these chapters and then skip to the proportions sections, and then do the means sections. For those who prefer to teach means before proportions, just follow the sequence of the book.

Chapters 8, 9, 10, and 11

- These chapters allow professors to teach hypothesis testing using the P -value. It should be noted that some P -values obtained by technology may differ from those in the book since the calculations of P -values depend on the number of decimal places the technology uses to compute the test values.

Acknowledgments

It is important to acknowledge the many people whose contributions have gone into the Ninth Edition of *Elementary Statistics*. Very special thanks are due to Rachel Webb of Portland State University, who updated the Index of Applications, wrote some new exercises, made changes for inclusion and diversity, and updated the technology sections throughout, and to Yolanda Parker of Tarrant County College, who accuracy checked the manuscript.

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—Allan G. Bluman

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A STEP BY STEP APPROACH

Each chapter begins with an **outline**, a **list of learning objectives**, and a feature titled **Statistics Today**; in which a real-life problem shows students the relevance of the material. This problem is solved near the end of the chapter using statistical techniques presented in the chapter.

Confidence Intervals and Sample Size

STATISTICS TODAY

Stress and the College Student

A recent poll conducted by the mtvU/Associated Press found that 85% of college students reported that they experience stress daily. The study said, "It is clear that being stressed is a fact of life on college campuses today."

The study also reports that 74% of students' stress comes from school work, 71% from grades, and 62% from financial woes. The report stated that 2240 undergraduate students were selected and that the poll has a margin of error of $\pm 3.0\%$.

In this chapter you will learn how to make a true estimate of a parameter, what is meant by the margin of error, and whether or not the sample size was large enough to represent all college students.

See Statistics Today—Revisited at the end of this chapter for more details.

7



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OUTLINE

- Introduction
- 7-1 Confidence Intervals
- 7-2 Confidence Intervals for the Mean When σ Is Known
- 7-3 Confidence Intervals for the Mean When σ Is Unknown
- 7-4 Confidence Intervals and Sample Size for Proportions
- 7-5 Confidence Intervals for Variances and Standard Deviations
- Summary

OBJECTIVES

After completing this chapter, you should be able to:

- 1 Find the confidence interval for the mean when σ is known.
- 2 Determine the minimum sample size for finding a confidence interval for the mean.
- 3 Find the confidence interval for the mean when σ is unknown.
- 4 Find the confidence interval for a proportion.
- 5 Determine the minimum sample size for finding a confidence interval for a proportion.
- 6 Find a confidence interval for a variance and a standard deviation.

EXAMPLE 8-6 Cost of College Tuition

A researcher wishes to test the claim that the average cost of tuition and fees at a four-year public college is greater than \$5700. She selects a random sample of 36 four-year public colleges and finds the mean to be \$5950. The population standard deviation is \$659. Is there evidence to support the claim at $\alpha = 0.05$? Use the P -value method.

Source: Based on information from the College Board.

SOLUTION

Step 1 State the hypotheses and identify the claim.

$$H_0: \mu = \$5700 \quad \text{and} \quad H_1: \mu > \$5700 \text{ (claim)}$$

Step 2 Compute the test statistic.

$$z = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}} = \frac{5950 - 5700}{659 / \sqrt{36}} = 2.28$$

Step 3 Find the P -value. Using Table A-4 in Appendix A, find the corresponding area under the normal distribution for $z = 2.28$. It is 0.9887. Subtract this value for the area from 1.0000 to find the area in the right tail.

$$1.0000 - 0.9887 = 0.0113$$

Hence, the P -value is 0.0113. (The P -value from the calculator is 0.0114.)

Hundreds of examples with detailed solutions serve as models to help students solve problems on their own. Examples are solved by using a step by step explanation, and illustrations provide a clear display of results.

Numerous **Procedure Tables** summarize processes for students' quick reference.

Procedure Table Solving Hypothesis-Testing Problems (Traditional Method)

- Step 1** State the hypotheses and identify the claim.
- Step 2** Find the critical value(s) from the appropriate table in Appendix A.
- Step 3** Compute the test statistic.
- Step 4** Make the decision to reject or not reject the null hypothesis.
- Step 5** Summarize the results.

Critical Thinking sections at the end of each chapter challenge students to apply what they have learned to new situations while deepening conceptual understanding.

Critical Thinking Challenges

The power of a test ($1 - \beta$) can be calculated when a specific value of the mean is hypothesized in the alternative hypothesis; for example, let $H_0: \mu = 50$ and let $H_1: \mu = 52$. To find the power of a test, it is necessary to find the value of β . This can be done by the following steps:

- Step 1** For a specific value of α find the corresponding value of \bar{X} , using $z = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$, where μ is the hypothesized value given in H_0 . Use a right-tailed test.
- Step 2** Using the value of \bar{X} found in step 1 and the value

Step 3 Subtract this area from 0.5000. This is the value of β .

- Step 4** Subtract the value of β from 1. This will give you the power of a test. See Figure 8–41.
1. Find the power of a test, using the hypotheses given previously and $\alpha = 0.05$, $\sigma = 3$, and $n = 30$.
 2. Select several other values for μ in H_1 and compute the power of the test. Generalize the results.

Technology
TI-84 Plus
 Step by Step

Step by Step
Binomial Random Variables

To find the probability for a binomial variable: Press **2nd** (**DISTR**) then **A** (**ALPHA MATH**) for **binompdf**. The form is **binompdf**(n, p, X). On some calculators, you will have a menu showing "trials" (n), " p ", and x -value (X). After inputting the values, you will select **PASTE** and press **ENTER**. This will then show **binompdf**(n, p, X) for the values you entered.

Example: $n = 20$, $X = 5$, $p = .05$ (Example 5–20a from the text)
`binompdf(20,.05,5)`, then press **ENTER** for the probability.

Example: $n = 20$, $X = 0, 1, 2, 3$, $p = .05$ (Example 5–20b from the text).
`binompdf(20,.05,{0,1,2,3})`, then press **ENTER**.
 The calculator will display the probabilities in a list. Use the arrow keys to view the entire display.

`binompdf(20,.05,5)`
 .002244646

`binompdf(20,.05,{0,1,2,3})`
 { .3554853224 .3...

`binompdf(20,.05,13)`
 .0535821478

Technology Step by Step

boxes instruct students how to use Excel, TI-84 Plus graphing calculators, and MINITAB to solve the types of problems covered in the section. Numerous computer or calculator screens are displayed as well as numbered steps.

Applying the Concepts are end-of-section exercises that reinforce the concepts explained in the section. They give students an opportunity to think about the concepts and apply them to hypothetical examples similar to real-life ones.

Applying the Concepts 4–5

Counting Rules and Probability

One of the biggest problems for students when doing probability problems is to decide which formula or formulas to use. Another problem is to decide whether two events are independent or dependent. Use the following problem to help develop a better understanding of these concepts.

Assume you are given a five-question multiple-choice quiz. Each question has 5 possible answers: A, B, C, D, and E.

1. How many events are there?
2. Are the events independent or dependent?
3. If you guess at each question, what is the probability that you get all of them correct?
4. What is the probability that a person guesses answer A for each question?

Data Projects

1. **Business and Finance** Select a pizza restaurant and a sandwich shop. For the pizza restaurant look at the menu to determine how many sizes, crust types, and toppings are available. How many different pizza types are possible? For the sandwich shop determine how many breads, meats, veggies, cheeses, sauces, and condiments are available. How many different sandwich choices are possible?
2. **Sports and Leisure** When poker games are shown on television, there are often percentages displayed that show how likely it is that a certain hand will win.

Investigate how these percentages are determined. Show an example with two competing hands in a Texas Hold 'Em game. Include the percentages that each hand will win after the deal, the flop, the turn, and the river.

3. **Technology** A music player or music organization program can keep track of how many different artists are in a library. First note how many different artists are in your music library. Then find the probability that if 25 songs are selected at random, none will have the same artist.

Data Projects, which appear at the end of each chapter, further challenge students' understanding and application of the material presented in the chapter. Many of these require the student to gather, analyze, and report on real data.

SUPPLEMENTS



McGraw Hill ALEKS is a course assistant that helps math and chemistry instructors forge Constructive Learning Paths for their students—blending personalized modules with instructor-driven assignments to ensure every student always has another block to build on their knowledge base. ALEKS gives instructors the flexibility to assign homework, share curated content such as videos, review student progress, and provide student support anytime, anywhere. Instructors can identify what their students know and don't know and, from there, ALEKS will deliver customized practice until they truly get it. In other words, with ALEKS by your side, learning more is a given.



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Among the supplements is a computerized test bank using the algorithm-based testing software TestGen® to create customized exams quickly. Hundreds of text-specific, open-ended, and multiple-choice questions are included in the question bank.

MegaStat®

MegaStat® is a statistical add-in for Microsoft Excel, handcrafted by J. B. Orris of Butler University. When MegaStat is installed, it appears as a menu item on the Excel menu bar and allows you to perform statistical analysis on data in an Excel workbook. The MegaStat plug-in can be purchased at www.mhhe.com/megastat.

TI-84 Plus Graphing Calculator Manual

This friendly, practical manual teaches students to learn about statistics and solve problems by using these calculators while following examples from the text.

Excel Manual

This resource, specially designed to accompany the text, provides additional practice in applying the chapter concepts while using Excel.

RStudio Manual

This new resource introduces students to the R programming language and RStudio, an integrated development environment for data visualization. Each chapter has corresponding examples of how to use the coding language to solve problems and visualize data sets.

Corequisite Workbook

A comprehensive corequisite workbook accompanying this text is available to download in the McGraw Hill resources area of ALEKS.

Guided Student Notes

Guided notes provide instructors with the framework of day-by-day class activities for each section in the book. Each lecture guide can help instructors make more efficient use of class time and can help keep students focused on active learning. Students who use the lecture guides have the framework of well-organized notes that can be completed with the instructor in class.

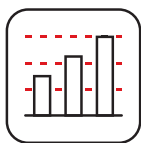
Lecture and Exercise Videos

Videos address concepts and problem-solving procedures to help students comprehend topics throughout the text. They show students how to work through selected exercises, following methodology employed in the text.

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Students start your course with varying levels of preparedness. Some will get it quickly. Some won't. ALEKS is a course assistant that helps you meet each student where they are and provide the necessary building blocks to get them where they need to go. You determine the assignments and the content, and ALEKS will deliver customized practice until your students truly get it.

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