

FIFTH EDITION

# ELEMENTARY STATISTICS

Mario F. Triola



FIFTH EDITION

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**Mario F. Triola**

Dutchess Community College  
Poughkeepsie, New York



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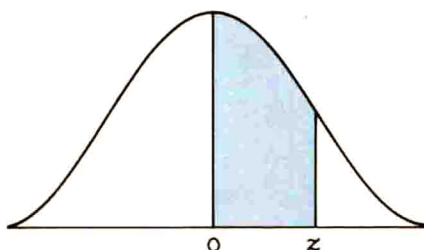
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FIFTH EDITION

# **ELEMENTARY STATISTICS**



Notes: 1. For values of  $z$  above 3.09, use 0.4999 for the area.

2.\* Use these common values that result from interpolation:

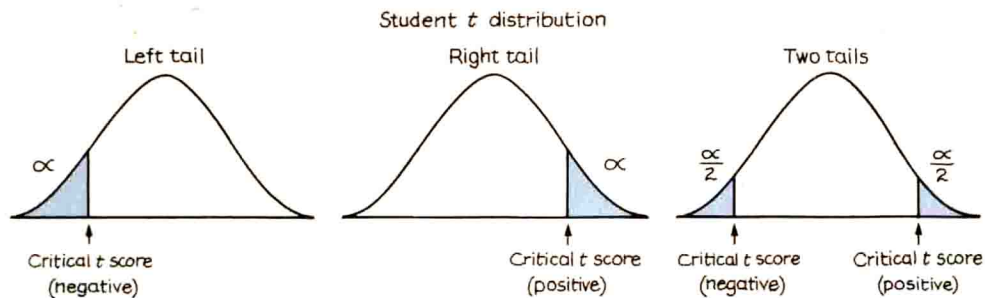
$z$ score	area
1.645	0.4500
2.575	0.4950

**TABLE A-2** The Standard Normal ( $z$ ) Distribution

$z$	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Frederick Mosteller and Robert E. K. Rourke, *Sturdy Statistics* Table A-1 (Reading, Mass.: Addison-Wesley, 1973). Reprinted with permission.





**TABLE A-3**  $t$  Distribution

Degrees of freedom	$\alpha$					
	.005	.01	.025	.05	.10	.25
	(one tail) .01 (two tails)	(one tail) .02 (two tails)	(one tail) .05 (two tails)	(one tail) .10 (two tails)	(one tail) .20 (two tails)	(one tail) .50 (two tails)
1	63.657	31.821	12.706	6.314	3.078	1.000
2	9.925	6.965	4.303	2.920	1.886	.816
3	5.841	4.541	3.182	2.353	1.638	.765
4	4.604	3.747	2.776	2.132	1.533	.741
5	4.032	3.365	2.571	2.015	1.476	.727
6	3.707	3.143	2.447	1.943	1.440	.718
7	3.500	2.998	2.365	1.895	1.415	.711
8	3.355	2.896	2.306	1.860	1.397	.706
9	3.250	2.821	2.262	1.833	1.383	.703
10	3.169	2.764	2.228	1.812	1.372	.700
11	3.106	2.718	2.201	1.796	1.363	.697
12	3.054	2.681	2.179	1.782	1.356	.696
13	3.012	2.650	2.160	1.771	1.350	.694
14	2.977	2.625	2.145	1.761	1.345	.692
15	2.947	2.602	2.132	1.753	1.341	.691
16	2.921	2.584	2.120	1.746	1.337	.690
17	2.898	2.567	2.110	1.740	1.333	.689
18	2.878	2.552	2.101	1.734	1.330	.688
19	2.861	2.540	2.093	1.729	1.328	.688
20	2.845	2.528	2.086	1.725	1.325	.687
21	2.831	2.518	2.080	1.721	1.323	.686
22	2.819	2.508	2.074	1.717	1.321	.686
23	2.807	2.500	2.069	1.714	1.320	.685
24	2.797	2.492	2.064	1.711	1.318	.685
25	2.787	2.485	2.060	1.708	1.316	.684
26	2.779	2.479	2.056	1.706	1.315	.684
27	2.771	2.473	2.052	1.703	1.314	.684
28	2.763	2.467	2.048	1.701	1.313	.683
29	2.756	2.462	2.045	1.699	1.311	.683
Large ( $z$ )	2.575	2.327	1.960	1.645	1.282	.675

**To Marc and Scott**

# Preface

## Why Study Statistics?

Modern times create modern problems. Many problems involve the collection and analysis of data in surveys, polls, quality control, market research, medical research, and standardized testing. More employers are seeking job applicants who are better prepared to use statistical methods. As one example, *The New York Times* reported that “when Motorola Inc. introduced a system of quality control at its plant in Arcade, N.Y., it found that many employees lacked the mathematical skills needed to understand the new statistics-based approach.” Jay Dean is a Senior Vice President at Young and Rubicam Advertising. In an interview with the author, he said, “If I could go back to school, I would certainly study more math, statistics, and computer science.” In another interview, David Hall told the author that, “Right now, American industry is crying out for people with an understanding of statistics and the ability to communicate its use.” David Hall is a Division Statistical Manager at the Boeing Commercial Airplane Group. As employees, employers, and as citizens we must learn at least the elementary concepts that constitute the field of statistics. This book is designed to be an interesting and readable introduction to those concepts.

## Audience

This book is an introduction to elementary statistics for students majoring in any field except mathematics. A strong mathematics background is not necessary, but students should have completed a high school algebra course. Although underlying theory is included, this book does not stress the mathematical rigor more suitable for mathematics majors.

In this book, strong emphasis is placed on interesting, clear, and readable writing. Because the many examples and exercises cover a wide variety of



different applications, this book is appropriate for many disciplines. The previous editions have been used successfully by hundreds of thousands of majors in psychology, sociology, business, computer science, data processing, biology, education, engineering technology, fine arts, humanities, history, social science, nursing, health, economics, ecology, agriculture, and many others.

## Changes in the Fifth Edition

This fifth edition of *Elementary Statistics* includes all the basic features of previous editions. In response to extensive surveys, almost every section has been modified to some extent. One new feature is the **Writing Projects** near the end of each chapter. They are designed to assist the growing number of instructors who try to help improve critical thinking and writing skills by implementing a “writing across the curriculum” philosophy. Another new feature is the **Videotape** program recommendations at the end of each chapter. We recommend programs from the series *Against All Odds: Inside Statistics*. For information about acquiring these programs, call 1-800-LEARNER.

Our **Feature Interviews** are another new addition to the text. They highlight discussions with professionals who use statistics on the job. These interesting interviews demonstrate the relevance of statistics to students’ future careers.

### Beginning-of-Chapter Features

- List of **chapter sections** along with brief descriptions of their contents
- **Chapter problem**
- **Overview** of the chapter, including statement of chapter objectives

### End-of-Chapter Features

- **Vocabulary list** of important terms introduced in the chapter (A glossary of terms is in Appendix D.)
- **Review** of the chapter
- Summary list of important **formulas**
- **Review Exercises**
- **Computer Projects**
- **Applied Projects**

- **Writing Projects**
- **Videotapes:** recommended program from the series *Against All Odds: Inside Statistics*

### Major Content Changes

- New section in Chapter 1: **Statistical Experiments and Sampling**
- New section in Chapter 2: **Exploratory Data Analysis**
- New section in Chapter 11: **Two-Way Analysis of Variance**
- Analysis of variance is now included as a separate chapter.
- Chapters 6 and 7 have been interchanged so that “Estimates and Sample Sizes” now precedes “Testing Hypotheses.” Chapters 6 and 7 are designed so that you can cover them in any order.
- Confidence intervals are now included in Chapter 8, “Inferences from Two Samples.”
- **Bootstrap methods** and **Statistical Process Control** are now discussed.

### Exercises

- This text now has more than 1600 exercises, many of them involving **real-world data**.
- Exercises are arranged in order of increasing difficulty. Also, exercises are divided into groups A and B, with B types involving more difficult concepts or a stronger mathematical background. In some cases, B exercises introduce a new concept.
- In addition to the regular exercises, there are twenty-two **Computer Projects**, forty-two **Applied Projects**, and thirty **Writing Projects**.

### Other Features

- The **flowcharts** help clarify the more complicated procedures.
- Appendix D contains an expanded **glossary** of important terms.
- Appendix F contains **answers** to all the odd-numbered exercises.
- A **symbol table** is included on the front inside cover for quick and easy reference to key symbols.
- Copies of Tables A-2 and A-3 are included in the rear inside cover for quick and easy reference.
- A detachable **formula/table card** is enclosed for use throughout the course.
- There are now more than 100 of the very popular **margin essays**, including 30 new ones. These short essays illustrate uses of statistics in very real and practical applications. The following is a sample of some of the topics covered.

*Biology:* Were Mendel's experimental data manipulated?  
*Business:* How airlines save money by using sampling to determine revenues from split-ticket sales  
*Criminology:* How probability is used by forensic experts to prosecute criminals  
*Drugs:* How the Salk vaccine was tested  
*Ecology:* How a Florida statistical study led to regulations that protect manatees  
*Engineering:* How probability is used to make systems more reliable with redundancy of components  
*Entertainment:* How it takes seven shuffles before a deck of cards is completely mixed  
*Gambling:* Why some lottery number combinations are better choices than others  
*Medicine:* How studies often use male subjects only, so that effects on women are often left unknown  
*Public Policy:* How a statistical analysis showed that the death penalty doesn't deter murders  
*Sports:* What happened to the 0.400 hitters in baseball?  
*Surveys:* How one firm used invisible ink to identify respondents in a "confidential" survey

## Computers

This text can be used without any reference to computers. For those who choose to supplement the course with computers, we have included **computer projects** at the end of each chapter.

We also have two different levels of software available.

- **STATDISK** is an easy-to-use statistical software package that does not require any previous computer experience. Developed as a supplement specifically for this textbook, STATDISK is available for the IBM PC, Macintosh, and the Apple IIe systems. This software is provided at no cost to colleges who adopt this text.
- **STATDISK Student Laboratory Workbook** includes instructions on the use of the STATDISK software package. It also includes experiments to be conducted by students.

The STATDISK software and the STATDISK Student Laboratory Workbook have been designed so that instructors can assign computer experiments without using classroom time that may be quite limited. STATDISK includes a wide variety of programs that can be used throughout the course, and the experiments do more than number crunch or duplicate text exercises. They include concepts that can be discovered through computer use. This text includes several sample displays that result from the use of STATDISK.

For those who wish to use **Minitab**, we have included Minitab displays throughout the text. Appendix C summarizes key components of Minitab.

- The Data Sets in Appendix B are now available on disk for use with Minitab and STATDISK.

- **Minitab Student Laboratory Workbook**, designed specifically for this text, includes instructions and examples of Minitab use. It also includes experiments to be conducted by students.
- **Student Edition of Minitab, 2e** is available from Addison-Wesley for the price of a textbook. Based on Version 8.1, it includes program software with data sets developed by Minitab, Inc. and a comprehensive user's manual with tutorials and a reference section written by Robert L. Schaefer of Miami University, Oxford, Ohio, and Elizabeth Farber of Bucks County Community College in Newtown, Pennsylvania.

## Acknowledgments

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structor's Guide. I also wish to extend my thanks to Lisa Moller, John Walker, Diane Honigberg, Barbara Piercecchi, and the entire Addison-Wesley staff. Finally, I thank Ginny, Marc, and Scott for their support, encouragement, and assistance.

## Supplements

- **Annotated Instructor's Edition** by Mario Triola (contains teaching suggestions and answers in the margins)
- **STATDISK** software for the IBM PC, Version 3.0 (also includes the Appendix B data files)
- **STATDISK** software for the Apple IIe
- **STATDISK** software for the Macintosh (also includes the Appendix B data files)
- **STATDISK Student Laboratory Workbook**
- **Minitab Student Laboratory Workbook**
- **Data Disk** with Appendix B data files for use with Minitab
- **Student Edition of Minitab** (software and manual)—New edition
- **Student Solutions Manual** by Donald K. Mason (provides detailed, worked-out solutions to odd-numbered exercises)
- **Instructor's Guide and Solutions Manual** (includes all answers, detailed solutions to the even-numbered answers, printed test bank, data sets, transparency masters, sample course syllabi)
- **Computer Test Generator** for the IBM PC is available from Addison-Wesley

## To the Student

I strongly recommend the use of a calculator. You should have one that can be used for finding square roots. Such calculators usually have a key labeled  $\sqrt{x}$ . Also, it should use algebraic logic instead of chain logic. You can identify the type of logic by pressing the buttons

$$2 + 3 \times 4 =$$

If the result is 14, the calculator uses algebraic logic. If the result is 20, the calculator uses chain logic and it is not very suitable for a statistics course. Some inexpensive calculators can directly compute the mean, standard deviation, correlation coefficient, and the slope and intercept values of a regression line. Such keys are usually identified as Mean or  $\bar{x}$ ; S. Dev, SD, or  $\sigma_{n-1}$ ; Corr or r; Slope; and Intcp.

I also recommend that you read the overview carefully when you begin a chapter. Read the next section quickly to get a general idea of the material; reread it carefully. Try the exercises. If you encounter difficulty, return to the section and work some of the examples in the text so that you can compare your solution to the one given.

When working on assignments, first attempt the earlier odd-numbered exercises. Check your answers with Appendix F and verify that you are correct before moving on to the other exercises. Keep in mind that neat and well-organized written assignments tend to produce better results. When you finish a chapter, check the review section to make sure that you didn't miss any major topics. Before taking tests, do the review exercises at the end of the chapters. In addition to helping you review, this will help you cope with a variety of different problems.

You might consider purchasing the *Student Solutions Manual* for this text. Written by Donald K. Mason of Elmhurst College, it gives detailed solutions to many of the odd-numbered text exercises.

M. F. T.  
LaGrange, New York  
December 1991

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