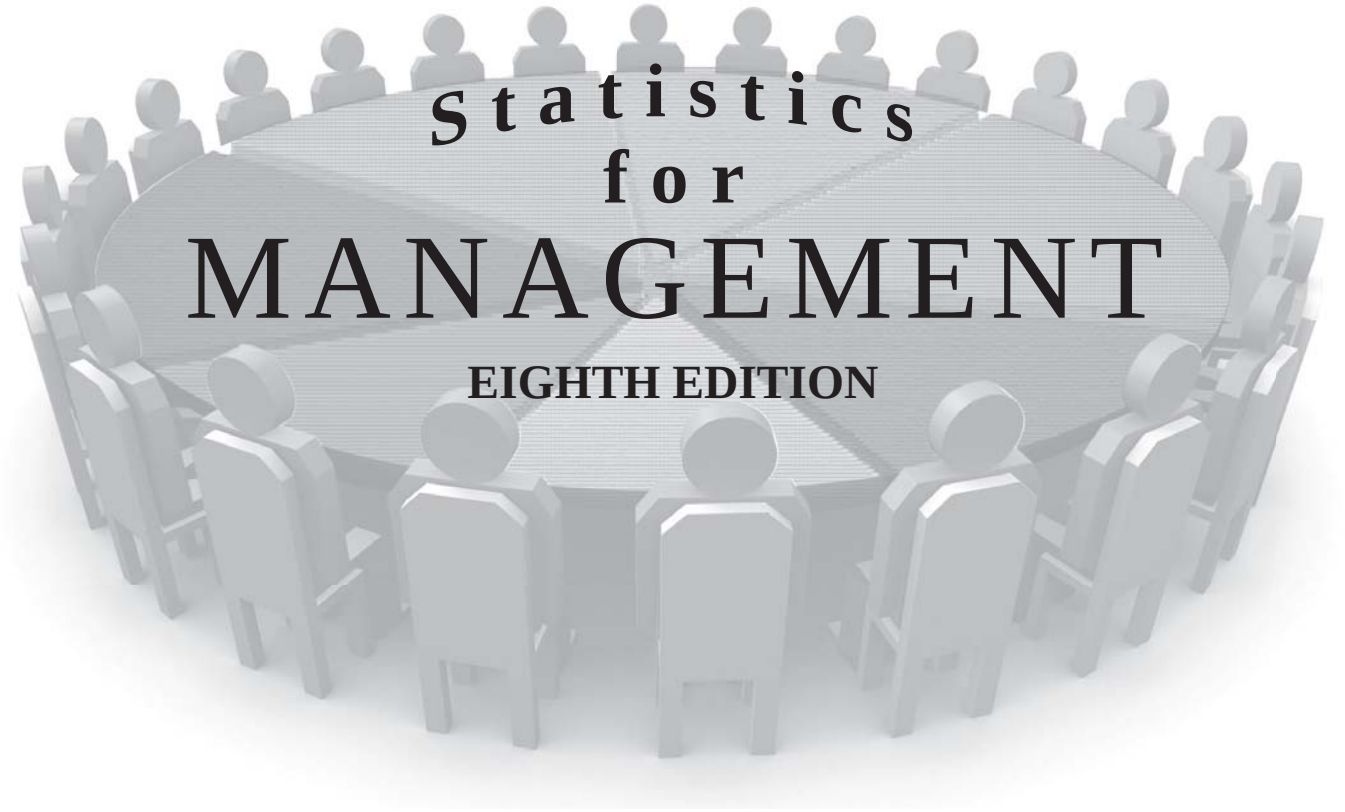
Circulation of this edition outside the Indian subcontinent is UNAUTHORIZED

Eight Edition

Statistics for Management

Richard I. Levin
David S. Rubin
Masood Husain Siddiqui
Sanjay Rastogi

Pearson



Statistics for MANAGEMENT

EIGHTH EDITION

Richard I. Levin
The University of
North Carolina at Chapel Hill

David S. Rubin
The University of
North Carolina at Chapel Hill

Masood H. Siddiqui
Jaipuria Institute of
Management, Lucknow

Sanjay Rastogi
Indian Institute of
Foreign Trade, New Delhi

Pearson

Copyright © 2017 Pearson India Education Services Pvt. Ltd

Published by Pearson India Education Services Pvt. Ltd, CIN: U72200TN2005PTC057128, formerly known as TutorVista Global Pvt. Ltd, licensee of Pearson Education in South Asia.

No part of this eBook may be used or reproduced in any manner whatsoever without the publisher's prior written consent.

This eBook may or may not include all assets that were part of the print version. The publisher reserves the right to remove any material in this eBook at any time.

ISBN 978-93-325-8118-0
eISBN

Head Office: A-8 (A), 7th Floor, Knowledge Boulevard, Sector 62, Noida 201 309, Uttar Pradesh, India.

Registered Office: 4th Floor, Software Block, Elnet Software City, TS 140, Block 2 & 9, Rajiv Gandhi Salai, Taramani, Chennai 600 113, Tamil Nadu, India.
Fax: 080-30461003, Phone: 080-30461060
www.pearson.co.in, Email: companysecretary.india@pearson.com

Contents

Preface xi

CHAPTER 1 Introduction 1

1.1 Why Should I Take This Course and Who Uses Statistics Anyhow? 2

1.2 History 3

1.3 Subdivisions Within Statistics 4

1.4 A Simple and Easy-to-Understand Approach 4

1.5 Features That Make Learning Easier 5

1.6 Surya Bank—Case Study 6

CHAPTER 2 Grouping and Displaying Data to Convey Meaning: Tables and Graphs 13

2.1 How Can We Arrange Data? 14

2.2 Examples of Raw Data 17

2.3 Arranging Data Using the Data Array and the Frequency Distribution 18

2.4 Constructing a Frequency Distribution 27

2.5 Graphing Frequency Distributions 38

Statistics at Work 58

Chapter Review 59

Flow Chart: Arranging Data to Convey Meaning 72

CHAPTER 3 Measures of Central Tendency and Dispersion in Frequency Distributions 73

3.1 Summary Statistics 74

3.2 A Measure of Central Tendency: The Arithmetic Mean 77

3.3 A Second Measure of Central Tendency: The Weighted Mean 87
3.4 A Third Measure of Central Tendency: The Geometric Mean 92
3.5 A Fourth Measure of Central Tendency: The Median 96
3.6 A Final Measure of Central Tendency: The Mode 104
3.7 Dispersion: Why It is Important? 111
3.8 Ranges: Useful Measures of Dispersion 113
3.9 Dispersion: Average Deviation Measures 119
3.10 Relative Dispersion: The Coefficient of Variation 132
3.11 Descriptive Statistics Using MsExcel & SPSS 136
Statistics at Work 140
Chapter Review 141
Flow Charts: Measures of Central Tendency and Dispersion 151

CHAPTER 4 Probability I: Introductory Ideas 153

4.1 Probability: The Study of Odds and Ends 154
4.2 Basic Terminology in Probability 155
4.3 Three Types of Probability 157
4.4 Probability Rules 164
4.5 Probabilities Under Conditions of Statistical Independence 170
4.6 Probabilities Under Conditions of Statistical Dependence 179
4.7 Revising Prior Estimates of Probabilities: Bayes' Theorem 188
Statistics at Work 196
Chapter Review 197
Flow Chart: Probability I: Introductory Ideas 206

CHAPTER 5 Probability Distributions 207

5.1 What is a Probability Distribution? 208
5.2 Random Variables 212
5.3 Use of Expected Value in Decision Making 218
5.4 The Binomial Distribution 222
5.5 The Poisson Distribution 230

5.6 The Normal Distribution: A Distribution of a Continuous Random Variable 238

5.7 Choosing the Correct Probability Distribution 254

Statistics at Work 255

Chapter Review 256

Flow Chart: Probability Distribution 264

CHAPTER 6 Sampling and Sampling Distributions 267

6.1 Introduction to Sampling 268

6.2 Random Sampling 271

6.3 Non-random Sampling 279

6.4 Design of Experiments 282

6.5 Introduction to Sampling Distributions 286

6.6 Sampling Distributions in More Detail 289

6.7 An Operational Consideration in Sampling: The Relationship Between Sample Size and Standard Error 302

Statistics at Work 308

Chapter Review 309

Flow Chart: Sampling and Sampling Distributions 314

CHAPTER 7 Estimation 315

7.1 Introduction 316

7.2 Point Estimates 319

7.3 Interval Estimates: Basic Concepts 324

7.4 Interval Estimates and Confidence Intervals 329

7.5 Calculating Interval Estimates of the Mean from Large Samples 332

7.6 Calculating Interval Estimates of the Proportion from Large Samples 336

7.7 Interval Estimates Using the *t* Distribution 341

7.8 Determining the Sample Size in Estimation 351

Statistics at Work 357

Chapter Review 358

Flow Chart: Estimation 363

CHAPTER 8 Testing Hypotheses: One-sample Tests 365

8.1 Introduction 366

8.2 Concepts Basic to the Hypothesis-testing Procedure 367

8.3 Testing Hypotheses 371

8.4 Hypothesis Testing of Means When the Population Standard Deviation is Known 379

8.5 Measuring the Power of a Hypothesis Test 388

8.6 Hypothesis Testing of Proportions: Large Samples 391

8.7 Hypothesis Testing of Means When the Population Standard Deviation is Not Known 397

Statistics at Work 404

Chapter Review 404

Flow Chart: One-Sample Tests of Hypotheses 410

CHAPTER 9 Testing Hypotheses: Two-sample Tests 411

9.1 Hypothesis Testing for Differences Between Means and Proportions 412

9.2 Tests for Differences Between Means: Large Sample Sizes 414

9.3 Tests for Differences Between Means: Small Sample Sizes 420

9.4 Testing Differences Between Means with Dependent Samples 431

9.5 Tests for Differences Between Proportions: Large Sample Sizes 441

9.6 Prob Values: Another Way to Look at Testing Hypotheses 450

Statistics at Work 455

Chapter Review 456

Flow Chart: Two-Sample Tests of Hypotheses 463

CHAPTER 10 Quality and Quality Control 465

10.1 Introduction 466

10.2 Statistical Process Control 468

10.3 $\bar{x}$ Charts: Control Charts for Process Means 470

10.4 R Charts: Control Charts for Process Variability 481

10.5 p Charts: Control Charts for Attributes 487

10.6 Total Quality Management 494

10.7 Acceptance Sampling 500

Statistics at Work 508

Chapter Review 509

Flow Chart: Quality and Quality Control 515

CHAPTER 11 Chi-Square and Analysis of Variance 517

11.1 Introduction 518

11.2 Chi-Square as a Test of Independence 519

11.3 Chi-Square as a Test of Goodness of Fit: Testing the Appropriateness of a Distribution 534

11.4 Analysis of Variance 542

11.5 Inferences About a Population Variance 568

11.6 Inferences About Two Population Variances 576

Statistics at Work 583

Chapter Review 584

Flow Chart: Chi-Square and Analysis of Variance 594

CHAPTER 12 Simple Regression and Correlation 595

12.1 Introduction 596

12.2 Estimation Using the Regression Line 603

12.3 Correlation Analysis 629

12.4 Making Inferences About Population Parameters 643

12.5 Using Regression and Correlation Analyses: Limitations, Errors, and Caveats 650

Statistics at Work 653

Chapter Review 653

Flow Chart: Regression and Correlation 662

CHAPTER 13 Multiple Regression and Modeling 663

13.1 Multiple Regression and Correlation Analysis 664

13.2 Finding the Multiple-Regression Equation 665

13.3 The Computer and Multiple Regression 674

13.4 Making Inferences About Population Parameters 684

13.5 Modeling Techniques 703

Statistics at Work 719

Chapter Review 720

Flow Chart: Multiple Regression and Modeling 731

CHAPTER 14 Nonparametric Methods 733

14.1 Introduction to Nonparametric Statistics 734

14.2 The Sign Test for Paired Data 736

14.3 Rank Sum Tests: The Mann–Whitney *U* Test and the Kruskal–Wallis Test 744

14.4 The One-sample Runs Test 758

14.5 Rank Correlation 767

14.6 The Kolmogorov–Smirnov Test 779

Statistics at Work 786

Chapter Review 787

Flow Chart: Nonparametric Methods 800

CHAPTER 15 Time Series and Forecasting 803

15.1 Introduction 804

15.2 Variations in Time Series 804

15.3 Trend Analysis 806

15.4 Cyclical Variation 818

15.5 Seasonal Variation 824

15.6 Irregular Variation 833

15.7 A Problem Involving All Four Components of a Time Series 834

15.8 Time-Series Analysis in Forecasting 844

Statistics at Work 844

Chapter Review 846

Flow Chart: Time Series 853

CHAPTER 16 Index Numbers 855

16.1 Defining an Index Number 856

16.2 Unweighted Aggregates Index 860

16.3 Weighted Aggregates Index 865

16.4 Average of Relatives Methods 874

16.5 Quantity and Value Indices 881

16.6 Issues in Constructing and Using Index Numbers 886

Statistics at Work 887

Chapter Review 888

Flow Chart: Index Numbers 896

CHAPTER 17 Decision Theory 897

17.1 The Decision Environment 898

17.2 Expected Profit Under Uncertainty: Assigning Probability Values 899

17.3 Using Continuous Distributions: Marginal Analysis 908

17.4 Utility as a Decision Criterion 917

17.5 Helping Decision Makers Supply the Right Probabilities 921

17.6 Decision-Tree Analysis 925

Statistics at Work 938

Chapter Review 939

Appendix Tables 949

Bibliography 973

Index 977

This page is intentionally left blank

Preface

An Opportunity for New Ideas

Writing a new edition of our textbook is an exciting time. In the two years that it takes to complete it, we get to interact with a number of adopters of our text, we benefit from the many thoughtful comments of professors who review the manuscript, our students here at the University of North Carolina at Chapel Hill always have a lot of good ideas for change, and our team at Prentice Hall organizes the whole process and provides a very high level of professional input. Even though this is the eighth edition of our book, our original goal of writing the most teacher- and student-friendly textbook in business statistics still drives our thoughts and our writing in this revision.

What Has Made This Book Different through Various Editions?

Our philosophy about what a good business statistics textbook ought to be hasn't changed since the day we started writing the first edition, twenty years ago. At that time and up through this edition, we have always strived to produce a textbook that met these four goals:

- *We think a beginning business statistics textbook ought to be intuitive and easy to learn from.* In explaining statistical concepts, we begin with what students already know from their life experience and we enlarge on this knowledge by using intuitive ideas. Common sense, real-world ideas, references, patient explanations, multiple examples, and intuitive approaches all make it easier for students to learn.
- *We believe a beginning business statistics textbook ought to cover all of the topics any teacher might wish to build into a two-semester or a two-quarter course.* Not every teacher will cover every topic in our book, but we offer the most complete set of topics for the consideration of anyone who teaches this course.
- *We do not believe that using complex mathematical notation enhances the teaching of business statistics; and our own experience suggests that it may even make learning more difficult.* Complex mathematical notation belongs in advanced courses in mathematics and statistics (and we do use it there), but not here. This is a book that will make and keep you comfortable even if you didn't get an A in college algebra.
- *We believe that a beginning business statistics textbook ought to have a strong real-world focus.* Students ought to see in the book what they see in their world every day. The approach we use, the exercises we have chosen for this edition, and the continuing focus on using statistics to solve business problems all make this book very relevant. We use a large number of real-world problems, and our

explanations tend to be anecdotal, using terms and references that students read in the newspapers, see on TV, and view on their computer monitors. As our own use of statistics in our consulting practices has increased, so have the references to how and why it works in our textbook. This book is about actual managerial situations, which many of the students who use this book will face in a few years.

New Features in This Edition to Make Teaching and Learning Easier

Each of our editions and the supplements that accompanied them contained a complete set of pedagogical aids to make teaching business statistics more effective and learning it less painful. With each revision, we added new ideas, new tools, and new helpful approaches. This edition begins its own set of new features. Here is a quick preview of the twelve major changes in the eighth edition:

- End-of-section exercises have been divided into three subsets: *Basic Concepts, Applications*, and *Self-Check Exercises*. The Basic Concepts are those exercises without scenarios, Applications have scenarios, and the Self-Check Exercises have worked-out solutions right in the section.
- The set of Self-Check Exercises referenced above is found at the end of each chapter section except the introductory section. Complete *Worked-Out Answers* to each of these can be found at the end of the applications exercises in that section of the chapter.
- *Hints and Assumptions* are short discussions that come at the end of each section in the book, just before the end-of-section exercises. These review important assumptions and tell why we made them, they give students useful hints for working the exercises that follow, and they warn students of potential pitfalls in finding and interpreting solutions.
- The number of real-world examples at the end-of-chapter *Review and Application Exercises* have been doubled, and many of the exercises from the previous edition have been updated. The content and language of the problems have been modified to have local touch and more business applications.
- Most of the hypothesis tests in Chapters 8 and 9 are done using the standardized scale.
- The scenarios for a quarter of the exercises in this edition have been rewritten.
- Over a hundred new exercises appear in this edition.
- All of the large, multipage data sets have been moved to the data disk, which is available with this book.
- The material on *exploratory data analysis* has been significantly expanded.
- The design of this edition has been completely changed to represent the state of the art in easy-to-follow pedagogy.
- Instructions are provided to handle the data using computer software such as MS Excel and SPSS.
- A Comprehensive Case "*Surya Bank Pvt. Ltd.*" has been added along with the live data. The questions related to this case has been put at the end of each chapter in order to bring more clarity in Statistical Applications in real-life scenarios.

Successful Features Retained from Previous Editions

In the time between editions, we listen and learn from teachers who are using our book. The many adopters of our last edition reinforced our feeling that these time-tested features should also be a part of the new edition:

- Chapter *learning objectives* are prominently displayed in the chapter opening.
- The more than 1,500 *on-page notes* highlight important material for students.

- Each chapter begins with a *real-world problem*, in which a manager must make a decision. Later in the chapter, we discuss and solve this problem as part of the teaching process.
- Each chapter has a section entitled *review of Terms Introduced* in the chapter.
- An *annotated review of all Equations Introduced* is a part of every chapter.
- Each chapter has a comprehensive *Chapter Concepts Test* using multiple pedagogies.
- A *flow chart* (with numbered page citations) in Chapters 2–16 organizes the material and makes it easier for students to develop a logical, sequential approach to problem solving.
- Our *Statistics at Work* sections in each chapter allow students to think conceptually about business statistics without getting bogged down with data. This learning aid is based on the continuing story of the "Loveland Computer Company" and the experiences of its employees as they bring more and more statistical applications to the management of their business.

Teaching Supplements to the Eighth Edition

The following supplements to the text represent the most comprehensive, classroom-tested set of supplementary teaching aids available in business statistics books today. Together they provide a powerful instructor-focused package.

- An *Instructor's Solutions Manual* containing worked-out solutions to all of the exercises in the book.
- A comprehensive online *Test Bank Questions.*
- A complete set of *Instructor Lecture Notes*, developed in *Microsoft Powerpoint*.

It Takes a Lot of People to Make a Book

Our part in the process of creating a new edition is to present ideas that we believe work in the classroom. The Prentice Hall team takes these ideas and makes them into a book. Of course, it isn't that easy.

The whole process starts with our editor, Tom Tucker, who rides herd on the process from his office in St. Paul. Tom is like a movie director; he makes sure everybody plays his or her part and that the entire process moves forward on schedule. Tom guides the project from the day we begin to discuss a eighth edition until the final book version appears on his desk. Without Tom, we'd be rudderless.

Then comes Kelli Rahlf, our production supervisor from Carlisle Publishers Services. In conjunction with Katherine Evancie, our Prentice Hall Production Manager, she manages the thousands of day-to-day activities that must all be completed before a book is produced. Together they move the rough manuscript pages through the editing and printing process, see that printed pages from the compositor reach us, keep us on schedule as we correct and return proofs, work with the bindery and the art folks, and do about a thousand other important things we never get to see but appreciate immensely.

A very helpful group of teachers reviewed the manuscript for the eighth edition and took the time to make very useful suggestions. We are happy to report that we incorporated most of them. This process gives the finished book a student–teacher focus we could not achieve without them; for their effort, we are grateful. The reviewers for this edition were Richard P. Behr, Broome Community College; Ronald L. Coccari, Cleveland State University; V. Reddy Dondeti, Norfolk State University; Mark Haggerty, Clarion University; Robert W. Hull, Western Illinois University; James R. Schmidt, University of Nebraska-Lincoln; and Edward J. Willies.

We use statistical tables in the book that were originally prepared by other folks, and we are grateful to the literary executor of the late Sir Ronald Fisher, F.R.S., to Dr Frank Yates, F.R.S., and to Longman

Group, Ltd., London, for pemrission to reprint tables from their book *Statistical Tables for Biological, Agricultural and Medical Research*, sixth edition, 1974.

Dr David O. Robinson of the Hass School of Business, Berkeley University, contributed a number of real-world exercises, produced many of the problem scenario changes, and as usual, persuaded us that it would be considerably less fun to revise a book without him.

Kevin Keyes provided a large number of new exercises, and Lisa Klein produced the index. To all of these very important, hard-working folks, we are grateful.

We are glad it is done and now we look forward to hearing from you with your comments about how well it works in your classroom. Thank you for all your help.

Richard I. Levin
David S. Rubin

I want to express my heartfelt and sincere gratitude towards my mother, Late Mrs Ishrat Sultana, my wife, Uzma, my son Ashar, family members, and friends. I also want to express my sincere thanks to my statistics teachers, colleagues, and Jaipuria Institute of Management, Lucknow, for their help and support in completion of this task.

Masood H. Siddiqui

I owe a great deal to my teachers and colleagues from different management institutes for their support, encouragement, and suggestions. Sincere thanks to my student, Ashish Awasthi, for helping me in preparing the snapshots for SPSS and Microsoft Excel, to my assistant, Kirti Yadav, for helping me in preparing the manuscript. Finally, I would like to express my gratitude to my parents, special thanks to my wife, Subha, and my kids, Sujay and Sumedha, for their love, understanding, and constant support.

Sanjay Rastogi

1 Introduction

LEARNING OBJECTIVES

After reading this chapter, you can understand:

- To examine who really uses statistics and how statistics is used
- To provide a very short history of the use of statistics
- To present a quick review of the special features of this book that were designed to make learning statistics easier for you

CHAPTER CONTENTS

1.1 Why should I Take This Course and Who Uses Statistics Anyhow? 2

1.2 History 3

1.3 Subdivisions within Statistics 4

1.4 A Simple and Easy-to-Understand Approach 4

1.5 Features That Make Learning Easier 5

1.6 Surya Bank—Case Study 6

1.1 WHY SHOULD I TAKE THIS COURSE AND WHO USES STATISTICS ANYHOW?

Every 4 years, Americans suffer through an affliction known as the presidential election. Months before the election, television, radio, and newspaper broadcasts inform us that "a poll conducted by XYZ Opinion Research shows that the Democratic (or Republican) candidate has the support of 54 percent of voters with a margin of error of plus or minus 3 percent." What does this statement mean? What is meant by the term *margin of error?* Who has actually done the polling? How many people did they interview and how many should they have interviewed to make this assertion? Can we rely on the truth of what they reported? Polling is a big business and many companies conduct polls for political candidates, new products, and even TV shows. If you have an ambition to become president, run a company, or even star in a TV show, you need to know something about statistics and statisticians.

It's the last play of the game and the Giants are behind by 4 points; they have the ball on the Chargers' 20-yard line. The Chargers' defensive coordinator calls time and goes over to the sidelines to speak to his coach. The coach knows that because a field goal won't even tie the game, the Giants will either pass or try a running play. His statistical assistant quickly consults his computer and points out that in the last 50 similar situations, the Giants have passed the ball 35 times. He also points out to the Chargers' coach that two-thirds of these passes have been short passes, right over center. The Chargers' coach instructs his defensive coordinator to expect the short pass over center. The ball is snapped, the Giants' quarterback does exactly what was predicted and there is a double-team Charger effort there to break up the pass. Statistics suggested the right defense.

The Food and Drug Administration is in final testing of a new drug that cures prostate cancer in 80 percent of clinical trials, with only a 2 percent incidence of undesirable side effects. Prostate cancer is the second largest medical killer of men and there is no present cure. The Director of Research must forward a finding on whether to release the drug for general use. She will do that only if she can be more than 99 percent certain that there won't be any significant difference between undesirable side effects in the clinical tests and those in the general population using the drug. There are statistical methods that can provide her a basis for making this important decision.

The Community Bank has learned from hard experience that there are four factors that go a long way in determining whether a borrower will repay his loan on time or will allow it to go into default. These factors are (1) the number of years at the present address, (2) the number of years in the present job, (3) whether the applicant owns his own home, and (4) whether the applicant has a checking or savings account with the Community Bank. Unfortunately, the bank doesn't know the individual effect of each of these four factors on the outcome of the loan experience. However, it has computer files full of information on applicants (both those who were granted a loan and those who were turned down) and knows, too, how each granted loan turned out. Sarah Smith applies for a loan. She has lived at her present address 4 years, owns her own home, has been in her current job only 3 months, and is not a Community Bank depositor. Using statistics, the bank can calculate the chance that Sarah will repay her loan on time if it is granted.

The word *statistics* means different things to different folks. To a football fan, statistics are rushing, passing, and first down numbers; to the Chargers' coach in the second example, statistics is the chance that the Giants will throw the short pass over center. To the manager of a power station, statistics are the amounts of pollution being released into the atmosphere. To the Food and Drug Administrator in our third example, statistics is the likely percentage of undesirable effects in the general population using the new prostate drug. To the Community Bank in the fourth example, statistics is the chance that Sarah

will repay her loan on time. To the student taking this course, statistics are the grades on your quizzes and final exam in the course.

Each of these people is using the word correctly, yet each person uses it in a different way. All of them are using statistics to help them make decisions; you about your grade in this course, and the Chargers' coach about what defense to call for the final play of the game. Helping you learn why statistics is important and how to use it in your personal and professional life is the purpose of this book.

Benjamin Disraeli once said, "There are three kinds of lies: lies, damned lies, and statistics." This rather severe castigation of statistics, made so many years ago, has come to be a rather apt description of many of the statistical deceptions we encounter in our everyday lives. Darrell Huff, in an enjoyable little book, *How to Lie with Statistics,* noted that "the crooks already know these tricks; honest men must learn them in self-defense." One goal of this book is to review some of the common ways statistics are used incorrectly.

How to lie with statistics

1.2 HISTORY

The word *statistik* comes from the Italian word *statista* (meaning "statesman"). It was first used by Gottfried Achenwall (1719–1772), a professor at Marlborough and Göttingen. Dr. E. A. W. Zimmerman introduced the word *statistics* into England. Its use was popularized by Sir John Sinclair in his work *Statistical Account of Scotland 1791–1799.* Long before the eighteenth century, however, people had been recording and using data.

Origin of the word

Official government statistics are as old as recorded history. The Old Testament contains several accounts of census taking. Governments of ancient Babylonia, Egypt, and Rome gathered detailed records of populations and resources. In the Middle Ages, governments began to register the ownership of land. In A.D. 762, Charlemagne asked for detailed descriptions of church-owned properties. Early in the ninth century, he completed a statistical enumeration of the serfs attached to the land. About 1086, William the Conqueror ordered the writing of the *Domesday Book,* a record of the ownership, extent, and value of the lands of England. This work was England's first statistical abstract.

Early government records

Because of Henry VII's fear of the plague, England began to register its dead in 1532. About this same time, French law required the clergy to register baptisms, deaths, and marriages. During an outbreak of the plague in the late 1500s, the English government started publishing weekly death statistics. This practice continued, and by 1632, these *Bills of Mortality* listed births and deaths by sex. In 1662, Captain John Graunt used 30 years of these *Bills* to make predictions about the number of people who would die from various diseases and the proportions of male and female births that could be expected. Summarized in his work *Natural and Political Observations . . . Made upon the Bills of Mortality,* Graunt's study was a pioneer effort in statistical analysis. For his achievement in using past records to predict future events, Graunt was made a member of the original Royal Society.

An early prediction from statistics

The history of the development of statistical theory and practice is a lengthy one. We have only begun to list the people who have made significant contributions to this field. Later we will encounter others whose names are now attached to specific laws and methods. Many people have brought to the study of statistics refinements or innovations that, taken together, form the theoretical basis of what we will study in this book.

1.3 SUBDIVISIONS WITHIN STATISTICS

Managers apply some statistical technique to virtually every branch of public and private enterprise. These techniques are so diverse that statisticians commonly separate them into two broad categories: *descriptive statistics* and *inferential statistics.* Some examples will help us understand the difference between the two.

Descriptive statistics

Suppose a professor computes an average grade for one history class. Because statistics describe the performance of that one class but do not make a generalization about several classes, we can say that the professor is using *descriptive* statistics. Graphs, tables, and charts that display data so that they are easier to understand are all examples of descriptive statistics.

Inferential statistics

Now suppose that the history professor decides to use the average grade achieved by one history class to estimate the average grade achieved in all ten sections of the same history course. The process of estimating this average grade would be a problem in *inferential* statistics. Statisticians also refer to this category as *statistical inference.* Obviously, any conclusion the professor makes about the ten sections of the course is based on a generalization that goes far beyond the data for the original history class; the generalization may not be completely valid, so the professor must state how likely it is to be true. Similarly, statistical inference involves generalizations and statements about the *probability* of their validity.

Decision theory

The methods and techniques of statistical inference can also be used in a branch of statistics called *decision theory.* Knowledge of decision theory is very helpful for managers because it is used to make decisions under conditions of uncertainty when, for example, a manufacturer of stereo sets cannot specify precisely the demand for its products or when the chairperson of the English department at your school must schedule faculty teaching assignments without knowing precisely the student enrollment for next fall.

1.4 A SIMPLE AND EASY-TO-UNDERSTAND APPROACH

For students, not statisticians

This book is designed to help you get the feel of statistics: what it is, how and when to apply statistical techniques to decision-making situations, and how to interpret the results you get. Because we are not writing for professional statisticians, our writing is tailored to the backgrounds and needs of college students, who probably accept the fact that statistics can be of considerable help to them in their future occupations but are probably apprehensive about studying the subject.

We discard mathematical proofs in favor of intuitive ones. You will be guided through the learning process by reminders of what you already know, by examples with which you can identify, and by a step-by-step process instead of statements such as “it can be shown” or “it therefore follows.”

Symbols are simple and explained

As you thumb through this book and compare it with other basic business statistics textbooks, you will notice a minimum of mathematical notation. In the past, the complexity of the notation has intimidated many students, who got lost in the symbols even though they were motivated and intellectually capable of understanding the ideas. Each symbol and formula that is used is explained in detail, not only at the point at which it is introduced, but also in a section at the end of the chapter.

No math beyond simple algebra is required

If you felt reasonably comfortable when you finished your high school algebra course, you have enough background to understand *everything* in this book. Nothing beyond basic algebra is assumed or used. Our goals are for you to be comfortable as you learn and for you to get a good intuitive grasp of statistical concepts and techniques. As a future manager, you will need to know when statistics can help your decision process and which tools to use. If you do need statistical help, you can find a statistical expert to handle the details.

Text problem cover a wide variety of situations

The problems used to introduce material in the chapters, the exercises at the end of each section in the chapter, and the chapter review exercises are drawn from a wide variety of situations you are already familiar with or are likely to confront quite soon. You will see problems involving all facets of the private sector of our economy: accounting, finance, individual and group behavior, marketing, and production. In addition, you will encounter managers in the public sphere coping with problems in public education, social services, the environment, consumer advocacy, and health systems.

In each problem situation, a manager is trying to use statistics creatively and productively. Helping you become comfortable doing exactly that is our goal.

1.5 FEATURES THAT MAKE LEARNING EASIER

In our preface, we mentioned briefly a number of learning aids that are a part of this book. Each has a particular role in helping you study and understand statistics, and if we spend a few minutes here discussing the most effective way to use some of these aids, you will not only learn more effectively, but will gain a greater understanding of how statistics is used to make managerial decisions.

Margin Notes Each of the more than 1,500 margin notes highlights the material in a paragraph or group of paragraphs. Because the notes briefly indicate the focus of the textual material, you can avoid having to read through pages of information to find what you need. Learn to read down the margin as you work through the textbook; in that way, you will get a good sense of the flow of topics and the meaning of what the text is explaining.

Application Exercises The Chapter Review Exercises include Application Exercises that come directly from real business/economic situations. Many of these are from the business press; others come from government publications. This feature will give you practice in setting up and solving problems that are faced every day by business professionals. In this edition, the number of Application Exercises has been doubled.

Review of Terms Each chapter ends with a glossary of every new term introduced in that chapter. Having all of these new terms defined again in one convenient place can be a big help. As you work through a chapter, use the glossary to reinforce your understanding of what the terms mean. Doing this is easier than going back in the chapter trying to find the definition of a particular term. When you finish studying a chapter, use the glossary to make sure you understand what each term introduced in the chapter means.

Equation Review Every equation introduced in a chapter is found in this section. All of them are explained again, and the page on which they were first introduced is given. Using this feature of the book is a very effective way to make sure you understand what each equation means and how it is used.

Chapter Concepts Test Using these tests is a good way to see how well you understand the chapter material. As a part of your study, be sure to take these tests and then compare your answers with those in the back of the book. Doing this will point out areas in which you need more work, especially before quiz time.

Statistics at Work In this set of cases, an employee of Loveland Computers applies statistics to managerial problems. The emphasis here is not on numbers; in fact, it's hard to find any numbers in these cases. As you read each of these cases, focus on what the problem is and what statistical approach might help find a solution; forget the numbers temporarily. In this way, you will develop a good appreciation for identifying problems and matching solution methods with problems, without being bogged down by numbers.

Flow Chart The flow charts at the end of the chapters will enable you to develop a systematic approach to applying statistical methods to problems. Using them helps you understand where you begin, how you proceed, and where you wind up; if you get good at using them, you will not get lost in some of the more complex word problems instructors are fond of putting on tests.

From the Textbook to the Real World Each of these will take you no more than 2 or 3 minutes to read, but doing so will show you how the concepts developed in this book are used to solve real-world problems. As you study each chapter, be sure to review the "From the Textbook to the Real World" example; see what the problem is, how statistics solves it, and what the solution adds in value. These situations also generate good classroom discussion questions.

Classification of Exercises This feature is new with this edition of the book. The exercises at the end of each section are divided into three categories: basic concepts to get started on, application exercises to show how statistics is used, and self-check exercises with worked-out answers to allow you to test yourself.

Self-Check Exercises with Worked-Out Answers A new feature in this edition. At the beginning of most sets of exercises, there are one or two self-check exercises for you to test yourself. The worked-out answers to these self-check exercises appear at the end of the exercise set.

Hints and Assumptions New with this edition, these provide help, direction, and things to avoid before you begin work on the exercises at the end of each section. Spending a minute reading these saves lots of time, frustration, and mistakes in working the exercises.

1.6 SURYA BANK—CASE STUDY

SURYA BANK PVT. LTD. was incorporated in the first quarter of the Twentieth Century in Varanasi, by a group of ambitious and enterprising Entrepreneurs. Over the period of time, the Bank with its untiring customer services has earned a lot of trust and goodwill of its customers. The staff and the management of the bank had focused their attention on the customers from the very inceptions of the bank. It is the practice of the bank that its staff members would go out to meet the customers of various walks of life and enquire about their banking requirements on the regular basis. It was due to the bank's strong belief in the need for innovation, delivering the best service and demonstrating responsibility that had helped the bank in growing from strength to strength.

The bank had only 6 branches till 1947. Post-independence, the bank expanded and now has 198 full-fledged branches across the North, North-West and Central India, dotted across the rural, semi-urban and urban areas.

SURYA BANK PVT. LTD. concentrated on its efforts to meet the genuine requirements of the different sectors of business and was forthcoming in giving loans to the needy & weaker sections of the society. The bank also has a sound portfolio of advances consisting of wide basket of retail finance. As a matter of policy, SURYA BANK PVT. LTD. gives loans to a large spectrum of retail businessmen.

In 2011, the bank had a net-profit of ₹ 26.3 crores. The total income of the bank has been steadily increasing over the past one decade from ₹ 188.91 crores in 2000 to ₹ 610.19 crores in 2011. The financial results of the bank are given below:

SURYA BANK FINANCIAL RESULTS

Sl. No.	Financial Year	Net Profit	Total Income	Operating Expenses
1	2000	10.24	188.91	35.62
2	2001	5.37	203.28	49.03
3	2002	9.33	240.86	50.97
4	2003	14.92	258.91	97.42
5	2004	17.07	250.07	99.20
6	2005	–20.1	204.19	80.72
7	2006	10.39	237.33	86.68
8	2007	16.55	280.64	96.52
9	2008	33.01	361.51	95.23
10	2009	58.17	486.67	114.74
11	2010	23.92	625.94	194.10
12	2011	26.30	610.19	202.14

SURYA BANK PVT. LTD. is one of the first private sector banks in India to introduce a massive computerization at branch level. The bank adopted modernization and computerization as early as 1990. All its 198 branches are computerized. The bank operates around 400 ATMs across northern India. This computerization has enabled the bank to render better and efficient service to its customers.

The bank is implementing new technology in core bank on an ongoing basis so as to achieve higher customer satisfaction and better retention to the customers. The bank has embarked upon a scheme of total branch automation with centralized Data Base System to integrate all its branches. This scheme has helped the bank to implement newer banking modes like internet banking, cyber banking and mobile banking etc, which has helped the customers to access the banking account from their place of work. The bank in its endeavor to provide quality service to its customers has been constantly improvising its services for the satisfaction of its customers. To better understand the customers' needs and wants and of its customers and the level of satisfaction with respect to the services provided to its customers, Surya Bank has conducted a survey of the bank customers to understand their opinions/perceptions with respect to the services provided by the bank.

NOTE: This case is prepared for class discussion purpose only. The information provided is hypothetical, but the questionnaire and the data set are real.

Questionnaire

Q. 1 Do You have an account in any bank, If yes name of the bank ……
……

Q. 2 Which type of account do you have,

- Saving ☐
- Current ☐
- Both ☐

Q. 3 For how long have had the bank account

- < 1 year ☐
- 2-3 year ☐
- 3-5 year ☐
- 5-10 year ☐
- >10 year ☐

Q. 4 Rank the following modes in terms of the extent to which they helped you know about e-banking services on scale 1 to 4

	Least important	Slightly important	Important	Most important
(a) Advertisement				
(b) Bank Employee				
(c) Personal enquiry				
(d) Friends or relative				

Q. 5 How frequently do you use e-banking

- Daily ☐
- 2-3 times in a week ☐
- Every week ☐
- Fort nightly ☐
- Monthly ☐
- Once in a six month ☐
- Never ☐

Q. 6 Rate the add-on services which are available in your e-banking account on scale 1 to 5

	Highly unavailable	Available	Moderate	Available	Highly available
(a) Seeking product & rate information					
(b) Calculate loan payment information					
(c) Balance inquiry					
(d) Inter account transfers					
(e) Lodge complaints					
(f) To get general information					
(g) Pay bills					
(h) Get in touch with bank					

Q. 7 Rate the importance of the following e-banking facilities while selecting a bank on the scale 1 to 4

	Least important	Slightly important	If important	Most important
(a) Speed of transaction				
(b) Reliability				
(c) Ease of use				
(d) Transparency				
(e) 24×7 any time banking				
(f) Congestion				
(g) Lower amount transactions are not possible				
(h) Add on services and schemes				
(i) Information retrieval				
(j) Ease of contact				
(k) Safety				
(l) Privacy				
(m) Accessibility				

Q. 8 Rate the level of satisfaction of the following e-banking facilities of your bank on the scale 1 to 4

	Highly dissatisfied	Dissatisfied	Satisfied	Highly satisfied
(a) Speed of transaction				
(b) Reliability				
(c) Ease of use				
(d) Transparency				
(e) 24×7 any time banking				
(f) Congestion				
(g) Lower amount transactions are not possible				
(h) Add on services and schemes				
(i) Information retrieval				
(j) Ease of contact				
(k) Safety				
(l) Privacy				
(m) Accessibility				