# Understandable Statistics

Brase
Brase

Seventh Edition

SEVENTH EDITION

# Understandable Statistics

## *Concepts and Methods*

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*This book is dedicated to the memory of*
*a great teacher, mathematician, and friend*

Burton W. Jones

Professor Emeritus, University of Colorado

# Preface

Welcome to the exciting world of statistics! We have written this text to make statistics accessible to everyone, including those with a limited mathematics background. Statistics affects all aspects of our lives. Whether we are testing new medical devices or determining what will entertain us, applications of statistics are so numerous that, in a sense, we are limited only by our own imagination.

## Overview

The seventh edition of *Understandable Statistics: Concepts and Methods* continues to emphasize concepts of statistics. Statistical methods are carefully presented with a focus on understanding both the *suitability of the method* and the *meaning of the result.* Statistical methods and measurements are developed in the context of applications.

We have retained and expanded features that made the first six editions of the text readable. Examples, exercises, and problems touch on applications appropriate to a broad range of interests.

Technology-based components give both students and professors additional resources. New with the seventh edition is the HM StatPass CD-ROM packaged with every text. This CD-ROM contains over 100 data sets (in Excel, Minitab, and TI-83Plus/ASCII file formats), interactive tutorial exercises for each chapter section, and the text-specific computer software package ComputerStat. The Web site for the text provides a wealth of material including course management tools, PowerPoint slides, a quizzing and tutorial program, and links to other relevant Web sites. Instructional videos covering every section of the text provide even more learning support.

## Content Changes in the Seventh Edition

With each new edition we reevaluate the scope, appropriateness, and effectiveness of the text's presentation and reflect on extensive user feedback. Revisions have been made throughout the text to clarify explanations of important concepts and to update problems.

### Sections and Organization

- Chapter 1, Getting Started, has been organized to include Section 1.2, Random Samples (formerly Section 2.1 in the sixth edition), and Section 1.3, Introduction to Experimental Design. This new section discusses data collection, experiments, observations, and randomized two-treatment experiments.
- Section 7.3, Sampling Distributions for Proportions, is a new section in Chapter 7, Introduction to Sampling Distributions. The class project illustrating the central limit theorem is now in the Using Technology section.
- Section 10.4, Inferences Concerning Regression Parameters, replaces Section 10.4 of the sixth edition. This section includes inferences for the correlation coefficient as well as for the slope of the least-squares line.



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### Table for Standard Normal Distribution (cumulative area to the left of *z*)

New with the seventh edition is a two-page table that gives the cumulative area to the left of a specified $z$ value. This type of table is easy to use and is also compatible with cumulative distribution results given on computers and calculators. The *Standard Normal Distribution Table* giving the area between 0 and $z$ that was used in previous editions is included in Appendix I with instructions for its use.

### New Topics

Brief treatments and discussions of dotplots, back-to-back stem plots, moving averages, odds, and linear combinations of two independent random variables are now included.

## Features in the Seventh Edition

### Chapter and Section Lead-ins

- NEW! *Preview Questions* at the beginning of each chapter are keyed to the sections.
- NEW! *Focus Points* at the beginning of each section describe the primary learning objectives of the section.

### Carefully Developed Pedagogy

- *Examples* show students how to select and use appropriate procedures.
- *Guided exercises* within the sections give students an opportunity to work with a new concept. Completely worked-out solutions appear beside each exercise to give immediate reinforcement.
- NEW! *Labels* for each example or guided exercise highlight the technique, concept, or process illustrated by the example or guided exercise. In addition, new labels for section and chapter problems describe the field of application and show the wide variety of subjects in which statistics are used.
- *Section and chapter problems* require the student to use all the new concepts mastered in the section or chapter. The problem sets include a variety of real-world applications with data or setting from identifiable sources. Key steps and solutions to odd-numbered problems appear at the end of the book.
- *Data Highlights* and *Linking Concepts* provide group projects and writing projects.
- *Viewpoints* are brief essays presenting diverse situations in which statistics are used.
- *Enhanced design and photos* provide improved readability.

### Technology within the Text

- NEW! *Tech Notes* within sections provide brief point-of-use instructions for the TI-83Plus calculator, Excel, and Minitab. These Notes replace the Calculator Notes of the sixth edition.
- *Using Technology* sections have been revised to show the use of Excel as well as the TI-83Plus calculator, Minitab, and ComputerStat.

## Supplements for Students

- NEW! *HM StatPass CD-ROM.* This state-of-the-art statistics CD-ROM contains:
  - *Data Sets* for additional experimentation with Minitab, Excel, and the TI-83 Plus.
  - *ComputerStat* software designed specifically to accompany the text.
  - *Algorithmically Generated Exercises* for each chapter section, complete with optional hints, solution steps, and lessons.
- NEW! *Text-Specific Web Site* features a number of student resources, including data sets, tutorials, quizzes, a glossary, and web links. Go to http://math.college.hmco.com/students and follow the statistics links to the Brase/Brase, *Understandable Statistics, 7e* site.
- NEW! *SMARTHINKING™ Live On-line Tutoring.* Houghton Mifflin has partnered with SMARTHINKING to provide an easy-to-use and effective on-line tutoring service. A dynamic Whiteboard and Graphing Calculator function enables students and e-structors to collaborate easily. SMARTHINKING offers three levels of service:
  - *Text-Specific Tutoring* provides real-time, one-on-one instruction with a specially qualified e-structor.
  - *Questions Any Time* allows students to submit questions to the tutor outside the scheduled hours and receive a reply within 24 hours.
  - *Independent Study Resources* connect students with around-the-clock access to additional educational services, including interactive web sites, diagnostic tests, and Frequently Asked Questions posed to SMARTHINKING e-structors.
- *Technology Guide* contains information and examples for the TI-83 Plus graphing calculator, Minitab software, and the tutorial program ComputerStat.
- *Excel Guide* contains information and examples for using Excel.
- *Student Solutions Manual* provides the solutions to the odd-numbered exercises in the student textbook.
- *Lecture Videos* presented by Dana Mosely explain and reinforce the concepts for each chapter section in the textbook (in DVD or VHS formats).
- *Student Version of MINITAB (Release 12) CD-ROM* manipulates and interprets data to produce textual, graphical, and tabular results. Minitab may be packaged with the textbook. Please visit the Houghton Mifflin web site or e-mail a representative at college_math@hmco.com.

## Supplements for Instructors

- *Instructor's Annotated Edition.* Answers now appear in the margins next to *all* of the exercises in the text, while those answers involving larger graphs or tables appear in a special section at the end of the IAE. In addition, teaching comments and general pedagogical suggestions are located in the margins of this text.
- *Instructor's Resource Guide with Complete Solutions* provides the complete solutions to all exercises in the text, sample tests for each chapter, Teaching Hints,

Tips for Advanced Placement Statistics Courses, and Transparency Masters for the tables and frequently used formulas found in the seventh edition.

- NEW! *HM Testing* is designed to produce an unlimited number of tests for each chapter of the text, including cumulative tests and final exams. This computerized test generator hybrid CD-ROM, which works on both Microsoft Windows and Macintosh platforms, contains numerous algorithms as well as on-line testing and gradebook functions.
- *Test Item File* is a printed version of the computerized test bank, providing multiple-choice and free-response test items for each chapter of the text. In addition, a newly created Advanced Placement section provides test items for high school statistics instructors.
- NEW! *HM ClassPrep CD-ROM* provides a multitude of text-specific resources to enhance the classroom experience and includes files for every printed ancillary as well as PowerPoint slides. Resources can be easily accessed from the CD-ROM by chapter or resource type.
- NEW! *Text-Specific Web Site.* In addition to the resources found on the student web site, instructors can access PowerPoint presentations and classroom management features by going to http://math.college.hmco.com/instructors and following the statistics links to the Brase/Brase, *Understandable Statistics, 7e* site.

## Alternate Routes Through the Text

*Understandable Statistics: Concepts and Methods*, Seventh Edition, is designed to be flexible. It offers the professor a choice of teaching possibilities. In most one-semester courses, it is not practical to cover all the material in depth. However, depending on the emphasis of the course, the professor may choose to cover various topics. For help in topic selection, refer to the *Table of Prerequisite Material* on page 1.

- *Introducing linear regression early.* For courses requiring an early presentation of linear regression, the descriptive components of linear regression (Sections 10.1, 10.2, and 10.3) can be presented any time after Chapter 3. However, inference topics including the confidence bounds in Section 10.2 require an introduction to confidence intervals (Section 8.1) and to hypothesis testing (Sections 9.1 and 9.2).
- *Probability.* For courses requiring minimal probability, Section 4.1, What Is Probability? and the first part of Section 4.2, Some Probability Rules—Compound Events, will be sufficient.

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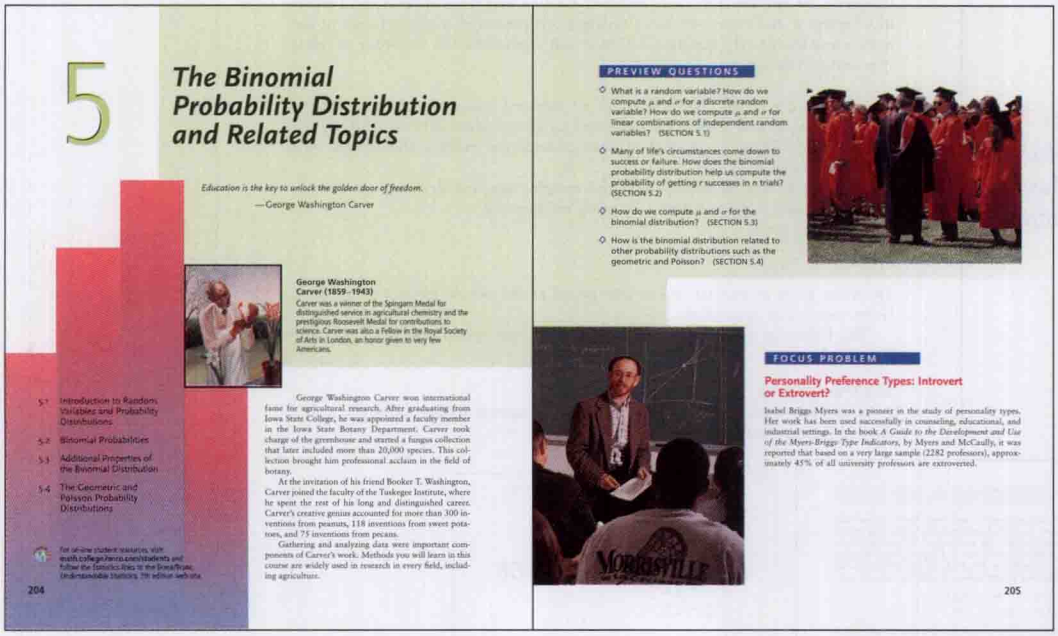
*Charles Henry Brase*
*Corrinne Pellillo Brase*

# A User's Guide to Features

The seventh edition of *Understandable Statistics* includes a variety of features designed to enhance a student's understanding by providing overviews and summaries of concepts and methods, interesting real-world problems using real data sets, and information about using technology. The newly enhanced design highlights important features and provides visual interest.

Key features of the text are described on the following pages. New features have been added to the seventh edition, while other hallmark features have been retained.


5

The Binomial Probability Distribution and Related Topics

*Education is the key to unlock the golden door of freedom.*
—George Washington Carver



**George Washington Carver (1859–1943)**
Carver was a winner of the Spingarn Medal for distinguished service in agricultural chemistry and the prestigious Roosevelt Medal for contributions to science. Carver was also a Fellow in the Royal Society of Arts in London, an honor given to very few Americans.

5.1 Introduction to Random Variables and Probability Distributions
5.2 Binomial Probabilities
5.3 Additional Properties of the Binomial Distribution
5.4 The Geometric and Poisson Probability Distributions

For on-line student resources, visit math.college.hmco.com/students and follow the Eymatics links to the Triola/Triola, Understandable Statistics, 7th edition website.

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George Washington Carver won international fame for agricultural research. After graduating from Iowa State College, he was appointed a faculty member in the Iowa State Botany Department. Carver took charge of the greenhouse and started a fungus collection that later included more than 20,000 species. This collection brought him professional acclaim in the field of botany.

At the invitation of his friend Booker T. Washington, Carver joined the faculty of the Tuskegee Institute, where he spent the rest of his long and distinguished career. Carver's creative genius accounted for more than 300 inventions from peanuts, 118 inventions from sweet potatoes, and 75 inventions from pecans.

Gathering and analyzing data were important components of Carver's work. Methods you will learn in this course are widely used in research in every field, including agriculture.

PREVIEW QUESTIONS

- What is a random variable? How do we compute $\mu$ and $\sigma$ for a discrete random variable? How do we compute $\mu$ and $\sigma$ for linear combinations of independent random variables? (SECTION 5.1)
- Many of life's circumstances come down to success or failure. How does the binomial probability distribution help us compute the probability of getting $r$ successes in $n$ trials? (SECTION 5.2)
- How do we compute $\mu$ and $\sigma$ for the binomial distribution? (SECTION 5.3)
- How is the binomial distribution related to other probability distributions such as the geometric and Poisson? (SECTION 5.4)





FOCUS PROBLEM

**Personality Preference Types: Introvert or Extrovert?**

Isabel Briggs Myers was a pioneer in the study of personality types. Her work has been used successfully in counseling, educational, and industrial settings. In the book *A Guide to the Development and Use of the Myers-Briggs Type Indicators*, by Myers and McCaully, it was reported that based on a very large sample (2282 professors), approximately 45% of all university professors are extroverted.

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## Preview Questions

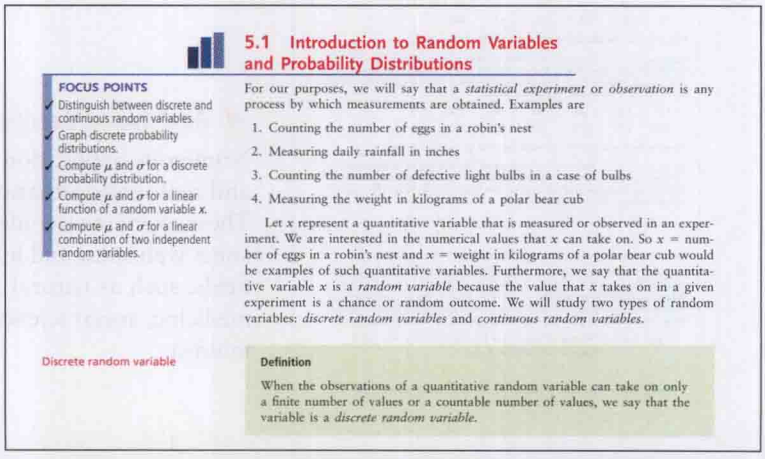
Newly designed chapter openers now contain a helpful list of Preview Questions that focus on the main objectives of the chapter. Section references appear next to each question to show students where they will learn the answers to develop an understanding of these topics.

## Focus Problems

"What kinds of problems will this chapter help me solve?" The Focus Problems motivate students by showing examples of work they can do once they have mastered the skills in the chapter. A Focus Problem appears in each chapter opener.

## Focus Points

Located at the beginning of each section, Focus Points briefly list the main objectives of the section for easy review and reference.



5.1 Introduction to Random Variables and Probability Distributions

FOCUS POINTS

- Distinguish between discrete and continuous random variables.
- Graph discrete probability distributions.
- Compute $\mu$ and $\sigma$ for a discrete probability distribution.
- Compute $\mu$ and $\sigma$ for a linear function of a random variable $x$.
- Compute $\mu$ and $\sigma$ for a linear combination of two independent random variables.

For our purposes, we will say that a *statistical experiment* or *observation* is any process by which measurements are obtained. Examples are

1. Counting the number of eggs in a robin's nest
2. Measuring daily rainfall in inches
3. Counting the number of defective light bulbs in a case of bulbs
4. Measuring the weight in kilograms of a polar bear cub

Let $x$ represent a quantitative variable that is measured or observed in an experiment. We are interested in the numerical values that $x$ can take on. So $x$ = number of eggs in a robin's nest and $x$ = weight in kilograms of a polar bear cub would be examples of such quantitative variables. Furthermore, we say that the quantitative variable $x$ is a *random variable* because the value that $x$ takes on in a given experiment is a chance or random outcome. We will study two types of random variables: *discrete random variables* and *continuous random variables*.

Discrete random variable

**Definition**

When the observations of a quantitative random variable can take on only a finite number of values or a countable number of values, we say that the variable is a *discrete random variable*.

## Guided Exercises

These unique exercises appear after selected examples in the text. Each Guided Exercise encourages students to examine and analyze a problem similar to the preceding example. Completely worked-out solutions appear beside each exercise to give immediate reinforcement in the learning process. In this way, students have a chance to work through and learn a new concept before being presented with additional concepts.

**GUIDED EXERCISE 2**

***Using a sample space***

Professor Gutierrez is making up a final exam for a course in literature of the Southwest. He wants the last three questions to be of the true–false type. To guarantee that the answers do not follow his favorite pattern, he lists all possible true–false combinations for three questions on slips of paper and then picks one at random from a hat.

(a) Finish listing the outcomes in the given sample space. ⇨ The missing outcomes are FFT and FFF.

TTT FTT TFT _____

TTF FTF TFF _____

(b) What is the probability that all three items will be false? Use the formula ⇨ There is only one outcome, FFF, favorable to all false, so

$$P(\text{all F}) = \frac{\text{No. of favorable outcomes}}{\text{Total no. of outcomes}} \qquad P(\text{all F}) = \frac{1}{8}$$

(c) What is the probability that exactly two items will be true? ⇨ There are three outcomes that have exactly two true items: TTF, TFT, and FTT. Thus,

$$P(\text{two T}) = \frac{\text{No. of favorable outcomes}}{\text{Total no. of outcomes}} = \frac{3}{8}$$

where $SS_x = \Sigma(x - \mu)^2 = \Sigma x^2 - \frac{(\Sigma x)^2}{N}$ ◆

…t the standard deviation (sample or population) is a measure of …will use the standard deviation extensively in later chapters. In Chapter 6 we will use it to study standard $z$ values and areas under normal curves. In Chapters 8 and 9 we will use it to study the inferential statistics topics of estimation and testing. The standard deviation will appear again in our study of regression and correlation.

## Tech Notes

Tech Notes provide optional information about using the TI-83Plus graphing calculator, Excel, Minitab, and the text-specific program ComputerStat.

**TECH NOTE** Most scientific or business calculators have a statistics mode, and provide the mean and sample standard deviation directly. The TI-83Plus, Excel, and Minitab provide the median and several other measures as well.

Many technologies display only the sample standard deviation $s$. You can quickly compute $\sigma$ if you know $s$ by using the formula

$$\sigma = s\sqrt{\frac{n-1}{n}}$$

The mean given in displays can be interpreted as the sample mean $\bar{x}$ or the population mean $\mu$ as appropriate.

The following three displays show output for the hybrid rose data of Guided Exercise 3.

*TI-83Plus Display*

Press **STAT ➤ CALC ➤ 1:1-Var Stats.** $S_x$ is the sample standard deviation. $\sigma_x$ is the population standard deviation.

```
1-Var Stats
x̄=6
Σx=48
Σx²=296
Sx=1.069044968
σx=1
↓n=8
```

**SECTION 3.1 PROBLEMS**

1. *Agriculture: Growing Season* The average length of the growing season is often measured in average number of frost-free days. The front range of Colorado (Fort Collins, Boulder, Denver, Colorado Springs, Pueblo) was studied by J. F. Benci and T. B. McKee, from the Department of Atmospheric Science at Colorado State University. Based on data from their Climatology Report No. 77-3, different locations in the Colorado front range had the following average number of frost-free days per year:

   156 161 152 162 144 153
   148 157 168 157 161 157

   Compute the mean, median, and mode. Write a brief description of the meaning of these numbers from the point of view of a gardener.

2. *Baseball: Home Runs* Babe Ruth was the American League Home Run Champion 12 times (during the period from 1918 to 1931). The number of home runs he hit to earn the 12 titles were

   11 29 54 59 41 46
   47 60 54 46 49 46

   Find the mean, median, and mode of the number of home runs.

3. *Environmental Studies: Death Valley* How hot does it get in Death Valley? The following data are taken from a study conducted by the National Park System, of which Death Valley is a unit. The ground temperatures (°F) were taken from May to November in the vicinity of Furnace Creek.

   146 152 168 174 180 178 179
   180 178 178 168 165 152 144

   Compute the mean, median, and mode for these ground temperatures.

4. *Ecology: Wolf Packs* How large is a wolf pack? The following information is from a random sample of winter wolf packs in regions of Alaska, Minnesota, Michigan, Wisconsin, Canada, and Finland. (Source: *The Wolf*, by L. D. Mech, University of Minnesota Press.) Winter pack size:

   13 10 7 5 7 7 2 4 3
   2 3 15 4 4 2 8 7 8

   Compute the mean, median, and mode for the size of winter wolf packs.

5. *Medical: Injuries* The Grand Canyon and the Colorado River are beautiful, rugged, and sometimes dangerous. Thomas Myers is a physician at the park clinic in Grand Canyon Village. Dr. Myers has recorded (for a 5-year period) the number of visitor injuries at different landing points for commercial boat trips down the Colorado River in both the upper and lower Grand Canyon (Source: *Fateful Journey* by Myers, Becker, Stevens).

   **Upper Canyon: Number of Injuries per Landing Point Between North Canyon and Phantom Ranch**

   2 3 1 1 3 4 6 9 3 1 3

   **Lower Canyon: Number of Injuries per Landing Point Between Bright Angel and Lava Falls**

   8 1 1 0 6 7 2 14 3 0 1 13 2 1

## Real-World Exercises

Numerous application problems utilizing real data and real-world situations are included in the text. These exercises use identifiable sources, including some web sites, and also cover a wide range of fields, such as natural science, business, economics, medicine, social science, archaeology, and consumer interest.

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## Viewpoints ▶

These brief illustrated essays show the broad scope of statistical applications to a variety of human experiences and endeavors. In many cases, Internet web site URLs are provided for students interested in a further explanation of topics. The Viewpoint feature is located immediately before most section problem sets and chapter problem sets.

VIEWPOINT

### *The First Measured Century*

The 20th century saw measurements of aspects of American life that had never been systematically studied before. Social conditions involving crime, sex, food, fun, religion, and work have been numerically investigated. The measurements and survey responses taken over the entire century reveal unsuspected statistical trends. *The First Measured Century* is a book by Caplow, Hicks, and Wattenberg. It is also a PBS documentary available on video. For more information, visit the Brase/Brase statistics site at http://math.college.hmco.com/students and find the link to the PBS first measured century documentary.

## ▼ End-of-Chapter Material

The following features are included at the end of each chapter: a brief chapter **Summary**, a list of **Important Words & Symbols** grouped by section for easy review, and **Chapter Review Problems.**



FIGURE 2-28

Back-to-Back Stem Plot Showing Annual Salaries (in thousands of dollars) for Full Professors in California and in New York

9 | 4 | 5 represents $49,000 for California and $45,000 for New York

| California | | New York |
|---|---|---|
| 9 | 4 | 5 6 8 |
| 9 6 3 0 | 5 | 0 1 1 5 6 |
| 9 3 0 0 0 | 6 | 0 1 1 3 4 5 6 9 9 9 |
| 7 7 7 6 6 5 5 5 5 0 | 7 | 2 2 4 5 5 6 |
| 9 7 5 5 3 | 8 | 2 5 6 |
| 5 4 4 3 | 9 | 3 5 7 |
| 4 2 | 10 | 0 3 |
| 3 2 | 11 | |
| 6 2 | 12 | 0 0 |

*back-to-back stem plot* showing the depths of artifact locations at two different archaeological sites. These sites are from similar geographic locations. Notice that the stems are in the center of the diagram. The leaves for Site I artifact depths are shown to the left of the stem, while the leaves for Site II are to the right of the stem (see *Mombres Mogollon Archaeology* by A. I. Woosley and A. J. McIntyre, University of New Mexico Press).

(a) What are the least and greatest depths of artifact finds at Site I? at Site II?
(b) Describe the data distribution of depths of artifact finds at Site I and at Site II.
(c) At Site II, there is a gap in the depths at which artifacts were found. Does the Site II data distribution suggest that there might have been a period of no occupation?

13. *Education: Professors' Salaries* Figure 2-28 is a *back-to-back stem plot* showing the average annual salaries (in thousands of dollars) of full professors in California universities compared to New York universities (Source: *The Chronicle of Higher Education*. For more information, visit the Brase/Brase statistics site at http://math.college.hmco.com/students and find the link to the *Chronicle of Higher Education*.
(a) What are the low and high average salaries for professors in California? in New York?
(b) Which state has a greater number of average salaries in the $60,000 range? in the $70,000 range?
(c) In general, which state, California or New York, would you say had higher average salaries for professors in colleges and universities?

### SUMMARY

Organizing and presenting data are the main purposes of that part of statistics called descriptive statistics. In this chapter, we have studied bar graphs, Pareto charts, circle graphs, time plots, histograms, relative-frequency histograms, frequency polygons, ogives, and stem-and-leaf displays. From the viewpoint of future applications, histograms are the most important because the area under a bar can represent the likelihood of data values falling into that class. Histograms and stem-and-leaf displays both reveal distribution properties such as uniformity, symmetry, or skewness.



### IMPORTANT WORDS & SYMBOLS

**Section 2.1**
Bar graph
Pareto chart
Pie chart or circle graph
Time plot
Time series

**Section 2.2**
Frequency
Frequency distribution
Class width
Class, lower limit, upper limit
Class frequency
Class midpoint
Class mark
Frequency table
Class boundaries
Histogram
Relative-frequency table
Relative-frequency histogram
Symmetric distribution
Uniform distribution
Skewed left
Skewed right
Bimodal distribution
Frequency polygon
Line graph
Cumulative frequency
Ogive
Dotplot

**Section 2.3**
EDA
Stem
Leaf
Stem-and-leaf display
Back-to-back stem plot

VIEWPOINT

### *"This land is your land, This land is my land"**
—Woody Guthrie

But who actually owns the forest? On many maps, forest land (including national forests) is colored green. Such maps give the impression that vast areas of the western United States are public land. This is not the case! *USA Today* gave the following information about ownership of U.S. timber lands: state/local, 17%; federal, 10%; forest industry, 14%; and private nonindustry, 59%. Organize these data for better visual presentation using a Pareto chart and a circle graph.

*Words and Music by Woody Guthrie TRO © Copyright 1956(Renewed) 1958(Renewed) Ludlow Music, Inc. New York, New York. Used by permission.

### CHAPTER REVIEW PROBLEMS

1. *Cars: Fuel Economy* The Focus Problem at the beginning of Chapter 2 shows you two graphics [Figure 2-1(a) and (b)] displaying the same information regarding fuel economy standards for autos. Review the criteria given in the Focus Problem for producing good graphs (from Edward R. Tufte, *The Visual Display of Quantitative Information*). Look at the graph in Figure 2-1(a). Is it essentially a bar graph? Explain. What are some of the flaws of Figure 2-1(a) as a bar graph? Next, examine Figure 2-1(b), which shows the same information. Is it essentially a time plot? Explain. In what ways does the second graph seem to display the information in a clearer manner?

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14. *General: Multiplication Rule* A coin is tossed six times. Use the multiplication rule of counting to determine the number of possible head–tail sequences that can occur.

15. *General: Combination Lock* To open a combination lock, you turn the dial to the right and stop at a number; then you turn it to the left and stop at a second number. Finally, you turn it back to the right and stop at a third number. If you used the correct sequence of numbers, the lock opens. If the dial of the lock contains 10 numbers, 0 through 9, use the multiplication rule to determine the number of different combinations possible for the lock. (*Note:* The same number can be reused.)

16. *General: Combination Lock* You have a combination lock. Again, to open it you turn the knob to the right and stop at a first number; then you turn it to the left and stop at a second number. Finally, you turn it to the right and stop at a third number. Suppose you remember that the three numbers for your lock are 2, 9, and 5, but you don't remember the order in which the numbers occur. How many permutations of these three numbers are possible?

DATA HIGHLIGHTS: GROUP PROJECTS

Break into small groups and discuss the following topics. Organize a brief outline in which you summarize the main points of your group discussion.

1. Look at Figure 4-13, "Peeking at workers' e-mail." What group of people was surveyed? Estimate the probability that an executive selected at random from the survey population works at a company that uses e-mail. Estimate the probability that an executive peeks at employee e-mail, given that the company uses e-mail. Compute the probability that an executive from the survey population works at a company that uses e-mail *and* peeks at the employees' e-mail.

FIGURE 4-13

USA SNAPSHOTS®

A look at statistics that shape the nation

Peeking at workers' e-mail

Nearly 80% of executives say their company uses e-mail; 36% say they peek at employees' mail. Percentage who say an employer has a right to read anything in the company's electronic communication system:

Yes 75%

No 23%

Uncertain/ refused 2%

Source: Society for Human Resource Management survey of human resource executives

By Anne R. Carey and Merry E. Mullins, USA TODAY

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...lnerable knees." What is the ...olves knee problems? Of those ...full knee replacement. Com... ...d at random involves a knee ...look at the probability distribution for ages of patients requiring full knee replacement. Medicare insurance coverage begins when a person reaches age 65. What is the probability that the age of a person receiving a knee replacement is 65 or older?

LINKING CONCEPTS: WRITING PROJECTS

Discuss each of the following topics in class or review the topics on your own. Then write a brief but complete essay in which you summarize the main points. Please include formulas as appropriate.

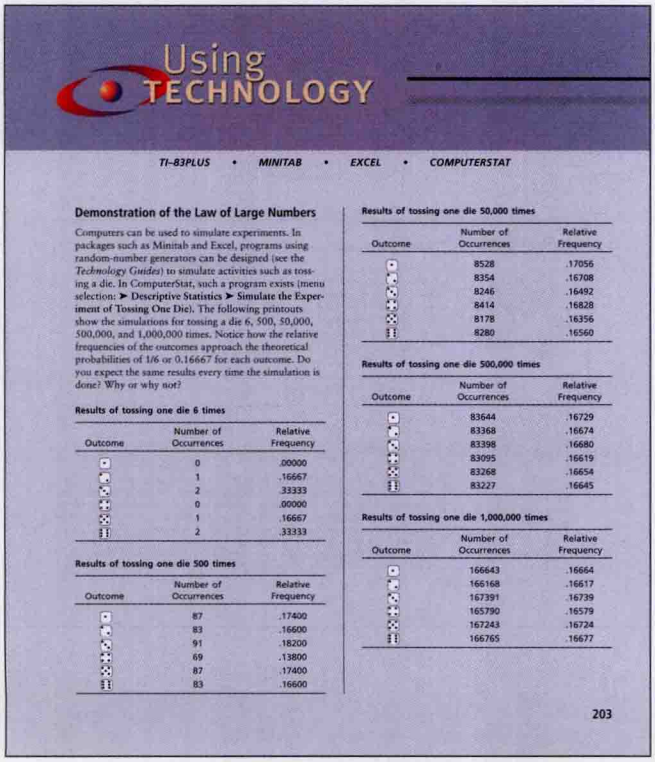
1. Discuss the following concepts and give examples from everyday life where you encounter each concept. *Hint:* For instance, consider the "experiment" of arriving for class. Some possible outcomes are not arriving (that is, missing class), arriving on time, and arriving late.
   (a) Sample space.
   (b) Probability assignment to a sample space. In your discussion, be sure to include answers to the following questions.
      (i) Is there more than one valid way to assign probabilities to a sample space? Explain and give an example.
      (ii) How can probabilities be estimated by relative frequencies? How could probabilities be computed if events are equally likely?

## Data Highlights: Group Projects ▶

These in-depth projects give students an additional opportunity to practice their skills by asking them to solve problems using appropriate methods from the chapter. Newspapers, magazines, and journals are the sources for these projects.

## Linking Concepts: Writing Projects ▶

These questions help students extend and integrate their thinking to develop a broader conceptual understanding of statistics. Students are asked to discuss and write about key concepts from the chapter and related topics from prior chapters.



Using TECHNOLOGY

*TI-83PLUS • MINITAB • EXCEL • COMPUTERSTAT*

**Demonstration of the Law of Large Numbers**

Computers can be used to simulate experiments. In packages such as Minitab and Excel, programs using random-number generators can be designed (see the *Technology Guides*) to simulate activities such as tossing a die. In ComputerStat, such a program exists (menu selection: ▶ Descriptive Statistics ▶ Simulate the Experiment of Tossing One Die). The following printouts show the simulations for tossing a die 6, 500, 50,000, 500,000, and 1,000,000 times. Notice how the relative frequencies of the outcomes approach the theoretical probabilities of 1/6 or 0.16667 for each outcome. Do you expect the same results every time the simulation is done? Why or why not?

**Results of tossing one die 6 times**

| Outcome | Number of Occurrences | Relative Frequency |
|---|---|---|
| ⚀ | 0 | .00000 |
| ⚁ | 1 | .16667 |
| ⚂ | 2 | .33333 |
| ⚃ | 0 | .00000 |
| ⚄ | 1 | .16667 |
| ⚅ | 2 | .33333 |

**Results of tossing one die 500 times**

| Outcome | Number of Occurrences | Relative Frequency |
|---|---|---|
| ⚀ | 87 | .17400 |
| ⚁ | 83 | .16600 |
| ⚂ | 91 | .18200 |
| ⚃ | 69 | .13800 |
| ⚄ | 87 | .17400 |
| ⚅ | 83 | .16600 |

**Results of tossing one die 50,000 times**

| Outcome | Number of Occurrences | Relative Frequency |
|---|---|---|
| ⚀ | 8528 | .17056 |
| ⚁ | 8354 | .16708 |
| ⚂ | 8246 | .16492 |
| ⚃ | 8414 | .16828 |
| ⚄ | 8178 | .16356 |
| ⚅ | 8280 | .16560 |

**Results of tossing one die 500,000 times**

| Outcome | Number of Occurrences | Relative Frequency |
|---|---|---|
| ⚀ | 83644 | .16729 |
| ⚁ | 83368 | .16674 |
| ⚂ | 83398 | .16680 |
| ⚃ | 83095 | .16619 |
| ⚄ | 83268 | .16654 |
| ⚅ | 83227 | .16645 |

**Results of tossing one die 1,000,000 times**

| Outcome | Number of Occurrences | Relative Frequency |
|---|---|---|
| ⚀ | 166643 | .16664 |
| ⚁ | 166168 | .16617 |
| ⚂ | 167391 | .16739 |
| ⚃ | 165790 | .16579 |
| ⚄ | 167243 | .16724 |
| ⚅ | 166765 | .16677 |

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## ◀ Using Technology

These features have been revised for this edition to include information on using the TI-83Plus graphing calculator, Excel, Minitab, and ComputerStat to solve statistical problems.

# Contents

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