STATISTICS

A Tool for Social Research

TENTH EDITION

JOSEPH F. HEALEY

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Tenth Edition

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CENGAGE Learning

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Preface

Statistics are part of the everyday language of sociology and other social sciences (including political science, social work, public administration, criminal justice, urban studies, and gerontology). These disciplines are research-based and routinely use statistics to express knowledge and to discuss theory and research. To join the conversations being conducted in these disciplines, you must be literate in the vocabulary of research, data analysis, and scientific thinking. Knowledge of statistics will enable you to understand the professional research literature, conduct quantitative research yourself, contribute to the growing body of social science knowledge, and reach your full potential as a social scientist.

Although essential, learning (and teaching) statistics can be a challenge. Students in social science statistics courses typically have a wide range of mathematical backgrounds and an equally diverse set of career goals. They are often puzzled about the relevance of statistics for them, and, not infrequently, there is some math anxiety to deal with. This text introduces statistical analysis for the social sciences while addressing these realities.

The text makes minimal assumptions about mathematical background (the ability to read a simple formula is sufficient preparation for virtually all of the material in the text), and a variety of special features help students analyze data successfully. The text has been written especially for sociology and social work programs but is sufficiently flexible to be used in any program with a social science base.

The text is written at an intermediate level and its goal is to show the relevance and value of statistics for the social sciences. I emphasize interpretation and understanding statistics in the context of social science research, but I have not sacrificed comprehensive coverage or statistical correctness. Mathematical explanations are kept at an elementary level, as is appropriate in a first exposure to social statistics. For example, I do not treat formal probability theory per se in the text.[1] Rather, the background necessary for an understanding of inferential statistics is introduced, informally and intuitively, in Chapters 5 and 6 while considering the concepts of the normal curve and the sampling distribution.

The text does not claim that statistics are "fun" or that the material can be mastered without considerable effort. At the same time, students are not overwhelmed with abstract proofs, formula derivations, or mathematical theory, which can needlessly frustrate the learning experience at this level.

[1]A presentation of probability is available at the Web site for this text for those who are interested.

Goal of the Text

The goal of this text is to develop basic statistical literacy. The statistically literate person understands and appreciates the role of statistics in the research process, is competent to perform basic calculations, and can read and appreciate the professional research literature in his or her field as well as any research reports he or she may encounter in everyday life. This goal has not changed since the first edition of this text. However, in recognition of the fact that "mere computation" has become less of a challenge in this high-tech age, this edition continues to increase the stress on interpretation and computer applications while deemphasizing computation. This will be apparent in several ways. For example, the feature called "Interpreting Statistics" has been updated. These noncomputational sections are included in about half of the chapters and present detailed examples of "what to say after the statistics have been calculated." They use real data and real research situations to illustrate the process of developing understanding, and they exemplify how statistics can be used to answer important questions. The issues addressed in these sections include recent changes in the American family, the gender gap in income, and the correlates of street crime.

Also, in recognition of the fact that modern technology has rendered hand calculation increasingly obsolete, the end-of-chapter problems feature smaller, easier-to-handle data sets, although some more challenging problems are also included. A new section, called "Using SPSS," has been added to most chapters to demonstrate how to use a computerized statistical package to produce statistics. The end-of-chapter problems now include SPSS-based exercises, and research projects using SPSS are included at the end of almost all chapters. To accommodate the increased use of SPSS, several new data sets have been added to the text and the General Social Survey data set has been updated to 2012.

A further goal of this text is to provide examples of everyday applications of statistics. Boxed features entitled "Statistics in Everyday Life" appear in each chapter and highlight the relevance of statistics in the real world.

This edition continues to focus on the development of basic statistical literacy, the three aspects of which provide a framework for discussing the additional features of this text.

1. **An Appreciation of Statistics.** A statistically literate person understands the relevance of statistics for social research, can analyze and interpret the meaning of a statistical test, and can select an appropriate statistic for a given purpose and a given set of data. This textbook develops these skills, within the constraints imposed by the introductory nature of the course, in several ways.
   - *The relevance of statistics.* Chapter 1 includes a discussion of the role of statistics in social research and stresses their usefulness as ways of analyzing and manipulating data and answering research questions. Throughout the text, each example problem is framed in the context of a research situation. A question is posed and then, with the aid of a statistic, answered. This central theme of usefulness is further reinforced by a series of "Applying Statistics" boxes, each of which illustrates some specific way statistics can be used to answer questions, and by the "Using Statistics" feature that opens every chapter.

End-of-chapter problems are labeled by the social science discipline from which they are drawn: SOC for sociology, SW for social work, PS for political science, CJ for criminal justice, PA for public administration, and GER for gerontology. Identifying problems with specific disciplines allows students to more easily see the relevance of statistics to their own academic interests. (Not incidentally, they will also see that the disciplines have a large subject matter in common.)

- *Interpreting statistics.* For most students, interpretation—saying what statistics mean—is a big challenge. The ability to interpret statistics can be developed only by exposure and experience. To provide exposure, I have been careful, in the example problems, to express the meaning of the statistic in terms of the original research question. To provide experience, the end-of-chapter problems call for an interpretation of the statistic calculated. To provide examples, many of the answers to odd-numbered computational problems in the back of the text are expressed in words as well as numbers. The "Interpreting Statistics" sections provide additional, detailed examples of how to express the meaning of statistics.
- *Using statistics: Ideas for research projects*. Appendix E offers ideas for independent data-analysis projects for students. The projects require students to use SPSS to analyze a data set. They can be assigned at intervals throughout the semester or at the end of the course. Each project provides an opportunity for students to practice and apply their statistical skills and, above all, to exercise their ability to understand and interpret the statistics they produce.

2. **Computational Competence.** Students should emerge from their first course in statistics with the ability to perform elementary forms of data analysis. While computers have made computation less of an issue today, computation is inseparable from statistics, so I have included a number of features to help students cope with these mathematical challenges.
   - *"One Step at a Time"* boxes for each statistic break down computation into individual steps for maximum clarity and ease.
   - *Extensive problem sets* are provided at the end of each chapter. For the most part, these problems use fictitious data and are designed for ease of computation.
   - *Cumulative exercises* are included after each of Parts I–IV to provide practice in choosing, computing, and analyzing statistics. These exercises present only data sets and research questions. Students must choose appropriate statistics as part of the exercise.
   - *Solutions* to odd-numbered computational problems are provided so that students may check their answers.
   - *SPSS* gives students access to the computational power of the computer. This is explained in more detail later.
3. **The Ability to Read the Professional Social Science Literature.** The statistically literate person can comprehend and critically appreciate research reports written by others. The development of this skill is a particular problem

at the introductory level because (1) the vocabulary of professional researchers is so much more concise than the language of the textbook, and (2) the statistics featured in the literature are more advanced than those covered at the introductory level. To help bridge this gap, I have included, beginning in Chapter 1, a series of boxes labeled "Reading Statistics." In each such box, I briefly describe the reporting style typically used for the statistic in question and try to alert students about what to expect when they approach the professional literature. These inserts have been updated in this edition and most include excerpts from the research literature that illustrate how statistics are actually applied and interpreted by social scientists.

Additional Features

A number of other features make the text more meaningful for students and more useful for instructors.

- *Readability and clarity.* The writing style is informal and accessible to students without ignoring the traditional vocabulary of statistics. Problems and examples have been written to maximize student interest and to focus on issues of concern and significance. For the more difficult material (such as hypothesis testing), students are first walked through an example problem before being confronted by formal terminology and concepts. Each chapter ends with a summary of major points and formulas and a glossary of important concepts. A list of frequently used formulas inside the front cover and a glossary of symbols inside the back cover can be used for quick reference.
- *Organization and coverage.* The text is divided into four parts, with most of the coverage devoted to univariate descriptive statistics, inferential statistics, and bivariate measures of association. The distinction between description and inference is introduced in the first chapter and maintained throughout the text. In selecting statistics for inclusion, I have tried to strike a balance between the essential concepts with which students must be familiar and the amount of material students can reasonably be expected to learn in their first (and perhaps only) statistics course, all the while bearing in mind that different instructors will naturally wish to stress different aspects of the subject. Thus, the text covers a full gamut of the usual statistics, with each chapter broken into subsections so that instructors may choose the particular statistics they wish to include.
- *Learning objectives.* Learning objectives are stated at the beginning of each chapter. These are intended to serve as "study guides" and to help students identify and focus on the most important material.
- *Review of mathematical skills.* A comprehensive review of all of the mathematical skills that will be used in this text is included as a Prologue. Students who are inexperienced or out of practice with mathematics can study this review early in the course and/or refer to it as needed. A self-test is included so that students can check their level of preparation for the course.

- *Statistical techniques and end-of-chapter problems are explicitly linked.* After a technique is introduced, students are directed to specific problems for practice and review. The "how-to-do-it" aspects of calculation are immediately and clearly reinforced.
- *End-of-chapter problems are organized progressively.* Simpler problems with small data sets are presented first. Often, explicit instructions or hints accompany the first several problems in a set. The problems gradually become more challenging and require more decision making by the student (e.g., choosing the most appropriate statistic for a certain situation). Thus, each problem set develops problem-solving abilities gradually and progressively.
- *Computer applications.* This text integrates SPSS, the leading social science statistics package, to help students take advantage of the power of the computer. Appendix F provides an introduction to SPSS, and demonstrations are integrated into the chapters. SPSS-based problems are included at the end of chapters, and research projects using SPSS are presented in the "You Are the Researcher" feature.
- *Realistic, up-to-date data.* The databases for computer applications in the text include a shortened version of the 2012 General Social Survey, a data set that includes census and crime data for the 50 states, and a data set that includes demographic data for 99 nations. These databases will give students the opportunity to practice their statistical skills on "real-life" data. All databases are described in Appendix G.

Additional Course Design Resources

- *Online PowerPoint® Slides.* A revised series of PowerPoint slides allows instructors to deliver class lectures and presentations discussing chapter-by-chapter content.
- *Online Instructor's Manual/Testbank.* The Instructor's Manual includes chapter summaries, a test item file of multiple-choice questions, answers to even-numbered computational problems, and step-by-step solutions to selected problems. In addition, the Instructor's Manual includes cumulative exercises (with answers) that can be used for testing purposes. To access these instructor resources, please log in to your account at **http://login.cengage.com**.
- *Aplia*™ is an online interactive learning solution that can be assigned as part of the course. Aplia integrates a variety of media and tools such as video, tutorials, practice tests, and an interactive e-book, and provides students with detailed, immediate feedback on every question. For more information about how to use Aplia in your course, please work with your local Cengage Learning Consultant.

Changes to the Tenth Edition

The following are the most important changes to this edition:

- SPSS has been moved to a more central place in the text:
  - Almost all chapters have new sections ("Using SPSS") that illustrate how to produce the statistics covered in the chapter.

- SPSS problems have been added to the end-of-chapter problems throughout the text. In some chapters (e.g., Chapters 13 and 15), the SPSS problems replace problems using hand calculators.
- For statistics that require complex computation—such as Pearson's *r* (Chapter 13) and partial correlation, multiple correlation, and regression (Chapter 15)—explanations and examples are now SPSS-based.

- The data sets used in the text have been expanded and updated. The data sets are used throughout the text in the new "Using SPSS" sections, in the end-of-chapter problems, and in the "You Are the Researcher" projects at the end of most chapters. The data sets are available for downloading at the Web site for this text: **www.cengagebrain.com;** they include:
  - A General Social Survey (GSS) data set (*GSS2012.sav*), which has been updated to 2012.
  - A data set that includes census and crime data on the 50 states (*States.sav*).
  - A data set that includes demographic data for 99 nations (*Intl-POP.sav*).
  - A fourth data set (*CrimeTrends84-10.sav*) is used only for the graphing exercises in Chapter 2.
- Former Chapters 12 and 13 have been combined into a single chapter (Chapter 12, entitled "Bivariate Association for Nominal- and Ordinal-Level Variables"). This new chapter de-emphasizes phi and the mechanics of computation for gamma but still fully treats the analysis of association for variables organized in bivariate tables.
- To accommodate the greater attention given to SPSS and other new material, a number of statistics and techniques have been deleted, including the index of qualitative variation (IQV, formerly in Chapter 4), the computation of means, medians, and the standard deviation for grouped data, and the section on testing gamma and Spearman's rho for significance.
- Chapter 2 has been reorganized and now begins with frequency distributions.
- Boxplots have been added to Chapter 4.
- All chapters now begin with a "Using Statistics" box that cites examples of how the statistics presented in the chapter can be applied to social research and to everyday life.
- Most of the "Statistics in Everyday Life" boxes have been updated or changed.
- The "Reading Statistics" inserts have been updated.
- The data sets used for examples, in the boxed features, and in the end-of-chapter problems have been updated.
- Titles have been added to all boxed features to clarify content and purpose.
- Icons have been added to all boxed inserts to highlight their purpose and content.

Numerous other changes have been made throughout the text, most of them minor. All are intended to clarify explanations and make the material more accessible to students. As with previous editions, my goal is to offer a comprehensive, flexible, and student-oriented book that will provide a challenging first exposure to social statistics.

Acknowledgments

This text has been in development for 30 years. An enormous number of people have made contributions, both great and small, to this project and, at the risk of inadvertently omitting someone, I am bound to at least attempt to acknowledge my many debts.

Much of whatever integrity and quality this book has is a direct result of the very thorough (and often highly critical) reviews that have been conducted over the years. I am consistently impressed by the sensitivity of my colleagues to the needs of the students, and, for their assistance in preparing this edition, I would like to thank the following reviewers: Dawn Baunach, Georgia State University; Mary Bernstein, University of Connecticut; Miyuki Fukushima, Cleveland State University; Michael Gillespie, Eastern Illinois University; Melodie Hallett, San Diego State University; Bennett Judkins, Lee University; Shannon Monnat, University of Nevada, Las Vegas; and John Shandra, Stony Brook University. Whatever failings are contained in the text are, of course, my responsibility and are probably the result of my occasional decisions not to follow the advice of my colleagues.

I would like to thank the instructors who made statistics understandable to me (Professors Satoshi Ito, Noelie Herzog, and Ed Erikson) and all of my colleagues at Christopher Newport University for their support and encouragement (especially Professors F. Samuel Bauer, Stephanie Byrd, Cheryl Chambers, Robert Durel, Marcus Griffin, Mai Lan Gustafsson, Kai Heiddemann, Ruth Kernodle, Michael Lewis, Marion Manton, Eileen O'Brien, Lea Pellet, Eduardo Perez, Virginia Purtle, Andrea Timmer, and Linda Waldron). I owe a special debt of gratitude to Professor Roy Barnes of the University of Michigan–Flint for his help with the "Interpreting Statistics" feature. Also, I thank all of my students for their patience and thoughtful feedback, and I am grateful to the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd., London, for permission to reprint Appendices B, C, and D from their book *Statistical Tables for Biological, Agricultural and Medical Research* (6th edition, 1974).

Finally, I want to acknowledge the support of my family and rededicate this work to them. I have the extreme good fortune to be a member of an extended family that is remarkable in many ways and that continues to increase in size. Although I cannot list everyone, I would especially like to thank the older generation (my mother, Alice T. Healey), my wife Patricia A. Healey, the next generation (my sons, Kevin and Christopher, my daughters-in-law, Jennifer and Jessica, my step-son Christopher Schroen, and step-daughters Kate Cowell and her husband Matt and Jennifer Schroen), and the youngest generation (Benjamin, Caroline, and Isabelle Healey and Abigail Cowell).

Prologue: Basic Mathematics Review

You will probably be relieved to hear that this text, your first exposure to statistics for social science research, does not stress computation per se. While you will encounter many numbers to work with and numerous formulas to solve, the major emphasis will be on understanding the role of statistics in research and the logic we use to answer research questions empirically. You will also find that, in this text, the example problems and many of the homework problems have been intentionally simplified so that the computations will not unduly impede the task of understanding the statistics themselves.

On the other hand, you may regret to learn that there is, inevitably, some arithmetic that you simply cannot avoid if you want to master this material. It is likely that some of you haven't had any math in a long time, others have convinced themselves that they just cannot do math under any circumstances, and still others are just rusty and out of practice. All of you will find that mathematical operations that might seem complex and intimidating at first glance can be broken down into simple steps. If you have forgotten how to cope with some of these steps or are unfamiliar with these operations, this prologue is designed to ease you into the skills you will need to do all of the computations in this textbook. Also, you can use this section for review whenever you feel uncomfortable with the mathematics in the chapters to come.

Calculators and Computers

A calculator is a virtual necessity for this text. Even the simplest, least expensive model will save you time and effort and is definitely worth the investment. However, I recommend that you consider investing in a more sophisticated calculator with memories and preprogrammed functions, especially the statistical models that can compute means and standard deviations automatically. Calculators with these capabilities are available for around $20.00 to $30.00 and will almost certainly be worth the small effort it will take to learn to use them.

In the same vein, there are several computerized statistical packages (or **statpaks**) commonly available on college campuses that can further enhance your statistical and research capabilities. The most widely used of these is the Statistical Package for the Social Sciences (**SPSS**). Statistical packages like SPSS are many times more powerful than even the most sophisticated handheld calculators, and it will be well worth your time to learn how to use them because they will eventually save you time and effort.

SPSS is introduced in Appendix F of this text and is integrated into almost all the chapters. There are demonstrations that show you, step by step, how to use the program to generate the statistics covered in the chapter and end-of-chapter problems that require you to apply the program. Furthermore, the "You Are the Researcher" feature at the end of most chapters gives you the opportunity to use SPSS in some simplified social research projects.

There are many other programs that can help you calculate statistics with a minimum of effort and time. Even spreadsheet programs such as Microsoft® Excel, which is included in many versions of Microsoft Office, have some statistical capabilities. You should be aware that all of these programs (other than the simplest calculators) will require some effort to learn, but the rewards will be worth the effort.

In summary, you should find a way at the beginning of this course—with a calculator, a statpak, or both—to minimize the tedium of mere computing. This will permit you to devote maximum effort to the truly important goal of increasing your understanding of the meaning of statistics in particular and social research in general.

Variables and Symbols

Statistics are a set of techniques by which we can describe, analyze, and manipulate variables. A **variable** is a trait that can change value from case to case or from time to time. Examples of variables include height, weight, level of prejudice, and political party preference. The possible values or scores associated with a given variable might be numerous (for example, income) or relatively few (for example, gender). I will often use symbols, usually the letter X, to refer to variables in general or to a specific variable.

Sometimes we will need to refer to a specific value or set of values of a variable. This is usually done with the aid of subscripts. So the symbol X_1 (read "X-sub-one") would refer to the first score in a set of scores, X_2 ("X-sub-two") to the second score, and so forth. Also, we will use the subscript i to refer to all the scores in a set. Thus, the symbol X_i ("X-sub-i") refers to all of the scores associated with a given variable (for example, the test grades of a particular class).

Operations

You are all familiar with the four basic mathematical operations of addition, subtraction, multiplication, and division and the standard symbols ($+$, $-$, $\times$, $\div$) used to denote them. I should remind you that multiplication and division can be symbolized in a variety of ways. For example, the operation of multiplying some number a by some number b may be symbolized in (at least) six different ways:

$$\mathrm{a} \times \mathrm{b}$$
$$a \cdot b$$
$$a * b$$
$$ab$$
$$a(b)$$
$$(a)(b)$$

In this text, we will commonly use the "adjacent symbols" format (that is, *ab*), the conventional times sign (×), or adjacent parentheses to indicate multiplication. On most calculators and computers, the asterisk (*) is the symbol for multiplication.

The operation of division can also be expressed in several different ways. In this text, in addition to the standard symbol for division, we will use either of these two methods:

$$a/b \text{ or } \frac{a}{b}$$

Several formulas require us to find the square of a number. To do this, multiply the number by itself. This operation is symbolized as X^2 (read "*X* squared"), which is the same thing as $(X)(X)$. If X has a value of 4, then

$$X^2 = (X)(X) = (4)(4) = 16$$

or we could say that "4 squared is 16."

The square root of a number is the value that, when multiplied by itself, results in the original number. So the square root of 16 is 4 because (4)(4) is 16. The operation of finding the square root of a number is symbolized as

$$\sqrt{X}$$

A final operation with which you should be familiar is summation, or the addition of the scores associated with a particular variable. When a formula requires the addition of a series of scores, this operation is usually symbolized as ΣX_i. "Σ" is uppercase Greek letter sigma and stands for "the summation of." So the combination of symbols ΣX_i means "the summation of all the scores" and directs us to add all the scores for that variable. If four people had family sizes of 2, 4, 5, and 7, then the summation of these four scores for this variable could be symbolized as

$$\Sigma X_i = 2 + 4 + 5 + 7 = 18$$

The symbol Σ is an operator, just like the $+$ and $\times$ signs. It directs us to add all of the scores on the variable indicated by the *X* symbol.

There are two other common uses of the summation sign, and, unfortunately, the symbols denoting these uses are not, at first glance, sharply different from each other or from the symbol used earlier. Some careful attention to these various meanings should minimize the confusion.

The first set of symbols is ΣX^2, which means "the sum of the squared scores." This quantity is found by *first* squaring each of the scores and *then* adding the squared scores together. A second common set of symbols will be $(\Sigma X_i)^2$, which means "the sum of the scores, squared." This quantity is found by *first* summing the scores and *then* squaring the total.

These distinctions might be confusing at first, so let's use an example to help clarify the situation. Suppose we had a set of three scores: 10, 12, and 13. So

$$X_i = 10, 12, 13$$

The sum of these scores is

$$\Sigma X_i = 10 + 12 + 13 = 35$$

The sum of the squared scores would be

$$\Sigma X^2 = (10)^2 + (12)^2 + (13)^2 = 100 + 144 + 169 = 413$$

Take careful note of the order of operations here. First the scores are squared one at a time, and then the squared scores are added. This is a completely different operation from squaring the sum of the scores:

$$(\Sigma X_i)^2 = (10 + 12 + 13)^2 = (35)^2 = 1225$$

To find this quantity, first the scores are summed and then the total of all the scores is squared. The squared sum of the scores (1225) is *not* the same as the sum of the squared scores (413).

In summary, the operations associated with each set of symbols can be summarized as follows:

Symbol	Operations
ΣX_i	Add the scores
ΣX_i^2	First square the scores and then add the squared scores
$(\Sigma X_i)^2$	First add the scores and then square the total

Operations with Negative Numbers

A number can be either positive (if it is preceded by a + sign or by no sign at all) or negative (if it is preceded by a − sign). Positive numbers are greater than 0, and negative numbers are less than 0. It is very important to keep track of signs because they will affect the outcome of virtually every mathematical operation. This section briefly summarizes the relevant rules for dealing with negative numbers.

First, adding a negative number is the same as subtraction. For example,

$$3 + (-1) = 3 - 1 = 2$$

Second, subtraction changes the sign of a negative number:

$$3 - (-1) = 3 + 1 = 4$$

Note the importance of keeping track of signs here. If you neglected to change the sign of the negative number in the second expression, you would get the wrong answer.

For multiplication and division, you need to be aware of various combinations of negative and positive numbers. Ignoring the case of all positive numbers, this leaves several possible combinations. A negative number times a positive number results in a negative value:

$$(-3)(4) = -12$$
$$(3)(-4) = -12$$

A negative number multiplied by a negative number is always positive:

$$(-3)(-4) = 12$$

Division follows the same patterns. If there is a negative number in the calculations, the answer will be negative. If both numbers are negative, the answer will be positive. So

$$\frac{-4}{2} = -2$$

and

$$\frac{4}{-2} = -2$$

but

$$\frac{-4}{-2} = 2$$

Negative numbers do not have square roots, because multiplying a number by itself cannot result in a negative value. Squaring a negative number always results in a positive value (see the multiplication rules earlier).

Accuracy and Rounding Off

A possible source of confusion in computation involves accuracy and rounding off. People work at different levels of precision and, for this reason alone, may arrive at different answers to problems. This is important because our answers can be at least slightly different if you work at one level of precision and I (or your instructor or your study partner) work at another. You may sometimes think you've gotten the wrong answer when all you've really done is round off at a different place in the calculations or in a different way.

There are two issues here: when to round off and how to round off. My practice is to work in as much accuracy as my calculator or statistics package will allow and then round off to two places of accuracy (two places beyond, or to the right of, the decimal point) only at the very end. If a set of calculations is lengthy and requires the reporting of intermediate sums or subtotals, I will round the subtotals off to two places as I go.

In terms of how to round off, begin by looking at the digit immediately to the right of the last digit you want to retain. If you want to round off to 100ths (two places beyond the decimal point), look at the digit in the 1000ths place (three places beyond the decimal point). If that digit is 5 or more, round up. For example, 23.346 would round off to 23.35. If the digit to the right is less than 5, round down. So, 23.343 would become 23.34.

Let's look at an additional example of how to follow these rules of rounding. If you are calculating the mean value of a set of test scores and your calculator shows a final value of 83.459067 and you want to round off to two places, look at the digit three places beyond the decimal point. In this case the value is 9 (greater than 5), so we would round the second digit beyond the decimal point up and report the mean as 83.46. If the value had been 83.453067, we would have reported our final answer as 83.45.

Formulas, Complex Operations, and the Order of Operations

A mathematical formula is a set of directions, stated in general symbols, for calculating a particular statistic. To "solve a formula," you replace the symbols with the proper values and then perform a series of calculations. Even the most complex formula can be simplified by breaking the operations down into smaller steps.

Working through the steps requires some knowledge of general procedure and the rules of precedence of mathematical operations. This is because the order in which you perform calculations may affect your final answer. Consider the following expression:

$$2 + 3(4)$$

If you add first, you will evaluate the expression as

$$5(4) = 20$$

but if you multiply first, the expression becomes

$$2 + 12 = 14$$

Obviously, it is crucial to complete the steps of a calculation in the correct order.

The basic rules of precedence are to find all squares and square roots first, then do all multiplication and division, and finally complete all addition and subtraction. So the expression

$$8 + 2 \times 2^2/2$$

would be evaluated as

$$8 + 2 \times \frac{4}{2} = 8 + \frac{8}{2} = 8 + 4 = 12$$

The rules of precedence may be overridden by parentheses. Solve all expressions within parentheses before applying the rules stated earlier. For most formulas in this text, the order of calculations will be controlled by the parentheses. Consider the following expression:

$$(8 + 2) - \frac{4}{(5 - 1)}$$

Resolving the parenthetical expressions first, we would have

$$(8 + 2) - \frac{4}{(5 - 1)} = (10) - \frac{4}{4} = 10 - 1 = 9$$

A final operation you will encounter in some formulas in this text involves denominators of fractions that themselves contain fractions. In this situation, solve the fraction in the denominator first and then complete the division. For example,

$$\frac{15 - 9}{6/2}$$

would become

$$\frac{15 - 9}{6/2} = \frac{6}{3} = 2$$

When you are confronted with complex expressions such as these, don't be intimidated. If you're patient with yourself and work through them step by step, beginning with the parenthetical expressions, even the most imposing formulas can be managed.

Exercises

You can use the following problems as a self-test on the material presented in this review. If you can handle these problems, you're ready to do all of the arithmetic in this text. If you have difficulty with any of these problems, please review the appropriate section of this prologue. You might also want to use this section as an opportunity to become more familiar with your calculator. The answers are given immediately following these exercises, along with commentary and some reminders.

1. Complete each of the following:
 a. $17 \times 3 =$
 b. $17(3) =$
 c. $(17)(3) =$
 d. $17/3 =$
 e. $(42)^2 =$
 f. $\sqrt{113} =$

2. For the set of scores (X_i) of 50, 55, 60, 65, and 70, evaluate each of the following expressions:
 $\Sigma X_i =$
 $\Sigma X_i^{\mathbf{2}} =$
 $(\Sigma X_i)^{\mathbf{2}} =$

3. Complete each of the following:
 a. $17 + (-3) + (4) + (-2) =$
 b. $(-27)(54) =$
 c. $(-14)(-100) =$
 d. $-34/(-2) =$
 e. $322/(-11) =$
 f. $\sqrt{-2} =$
 g. $(-17)^2 =$

4. Round off each of the following to two places beyond the decimal point:
 a. 17.17532
 b. 43.119
 c. 1076.77337
 d. 32.4641152301
 e. 32.4751152301

5. Evaluate each of the following:
   a. $(3 + 7)/10 =$
   b. $3 + 7/10 =$
   c. $\dfrac{(4 - 3) + (7 + 2)(3)}{(4 + 5)(10)} =$
   d. $\dfrac{22 + 44}{15/3} =$

Answers to Exercises

1. **a.** 51 **b.** 51 **c.** 51
(The obvious purpose of these first three problems is to remind you that there are several different ways of expressing multiplication.)
d. 5.67 (Note the rounding off.) **e.** 1764 **f.** 10.63

2. The first expression is "the sum of the scores," so this operation would be

$$\Sigma X_i = 50 + 55 + 60 + 65 + 70 = 300$$

The second expression is the "sum of the squared scores." So

$$\Sigma X_i^2 = (50)^2 + (55)^2 + (60)^2 + (65)^2 + (70)^2$$
$$\Sigma X_i^2 = 2500 + 3025 + 3600 + 4225 + 4900$$
$$\Sigma X_i^2 = 18{,}250$$

The third expression is "the sum of the scores, squared":

$$(\Sigma X_i)^2 = (50 + 55 + 60 + 65 + 70)^2$$
$$(\Sigma X_i)^2 = (300)^2$$
$$(\Sigma X_i)^2 = 90{,}000$$

Remember that ΣX_i^2 and $(\Sigma X_i)^2$ are two completely different expressions with very different values.

3. **a.** 16
b. −1458
c. 1400
d. 17
e. −29.27
f. Your calculator probably gave you some sort of error message for this problem, because negative numbers do not have square roots.
g. 289

4. **a.** 17.18 **b.** 43.12 **c.** 1076.77
d. 32.46 **e.** 32.48

5. **a.** 1 **b.** 3.7 (Note the importance of parentheses.) **c.** 0.31
d. 13.2

1 Introduction

LEARNING OBJECTIVES

By the end of this chapter, you will be able to

1. Describe the limited but crucial role of statistics in social research.
2. Distinguish among three applications of statistics and identify situations in which each is appropriate.
3. Distinguish between discrete and continuous variables and cite examples of each.
4. Identify and describe three levels of measurement and cite examples of variables from each.

USING STATISTICS

One of the most important themes of this text is that statistics are useful tools for analyzing and understanding information and for communicating our conclusions to others. To stress this theme, each chapter will begin with a list of situations in which statistics can be (and should be) applied to good advantage. In this introductory chapter, we will focus on the most general examples, but in the rest of the text, this section will highlight the usefulness of the specific statistics presented in that chapter.

Statistics can be used to

- Demonstrate the connection between smoking and cancer
- Measure political preferences, including the popularity of specific candidates for office
- Track attitudes about gay marriage, abortion, and other controversial issues over time
- Compare the cost of living (housing prices and rents, the cost of groceries and gas, health care, and so forth) between different localities (cities, states, and even nations)

Why Study Statistics?

Students sometimes wonder about the value of studying statistics. What, after all, do numbers and formulas have to do with understanding people and society? The value of statistics will become clear as we move from chapter to chapter but, for now, we can demonstrate the importance of statistics by considering **research** or disciplined and careful inquiries. Scientists conduct research to answer questions, examine ideas, and test theories. Research can take numerous forms, and statistics are relevant for **quantitative research** projects, or projects that collect information in the form of numbers or **data**. **Statistics** are mathematical techniques used by social scientists to analyze data in order to answer questions and test theories.

What is so important about learning how to manipulate data? On one hand, some of the most important and enlightening works in the social sciences do not utilize statistics at all. There is nothing magical about data and statistics. The mere presence of numbers guarantees nothing about the quality of a scientific inquiry.

On the other hand, data can be the most trustworthy information available to the researcher and, consequently, deserve special attention. Data that have been carefully collected and thoughtfully analyzed can be the strongest, most objective foundations for building theory and enhancing our understanding of the social world.

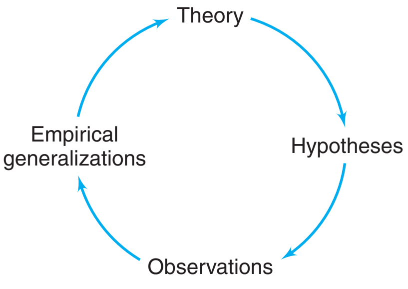
Let us be very clear about one point: It is never enough merely to gather data (or, for that matter, any kind of information). Even the most carefully collected numerical information does not and cannot speak for itself. The researcher must be able to use statistics effectively to organize, evaluate, and analyze the data. Without a good understanding of statistical analysis, the researcher will be unable to make sense of the data. Without an appropriate application of statistics, data are useless.

Statistics are an indispensable tool for the social sciences. They provide the scientist with some of the most useful techniques for evaluating ideas and testing theory. The next section describes the relationships among theory, research, and statistics in more detail.

The Role of Statistics in Scientific Inquiry

Figure 1.1 graphically represents the role of statistics in the research process. The diagram is based on the thinking of Walter Wallace and illustrates a useful conception of how any scientific enterprise grows and develops. One point the diagram makes is that scientific theory and research continually shape each other.

FIGURE 1.1 The Wheel of Science



Source: Adapted from Walter Wallace, *The Logic of Science in Sociology* (Chicago: Aldine-Atherton, 1971).

Statistics are one of the most important means by which research and theory interact. Let's take a closer look at the process.

A JOURNEY THROUGH THE SCIENTIFIC PROCESS

Because Figure 1.1 is circular, with no beginning or end, we could start our journey at any point. For the sake of convenience, let's begin at the top, with theory, and follow the arrows around the circle. A **theory** is an explanation of the relationships among phenomena. People naturally (and endlessly) wonder about problems in society (such as prejudice, poverty, child abuse, and serial murders), and they develop explanations ("low levels of education cause prejudice") in their attempts to understand. Unlike our everyday, informal explanations, scientific theory is subject to a rigorous testing process. Let's take prejudice as an example to illustrate how the research process works.

Theory. Why are some people prejudiced against other groups? One possible answer to this question is provided by a theory of prejudice stated over 50 years ago by social psychologist Gordon Allport and tested on a number of occasions since that time.[1]

The theory states that prejudice will decrease in situations in which members of different groups have equal status and cooperate with each other to work toward mutual goals. The more equal and cooperative the contact, the more likely people will see each other as individuals and not as representatives of a particular group. For example, we might predict that members of a racially mixed athletic team who work together to achieve victory will experience a decline in prejudice. On the other hand, when different groups compete for jobs, housing, or other resources, prejudice will tend to increase. Allport's theory is not a complete explanation of prejudice, of course, but it will serve to illustrate a sociological theory.

Variables and Causation. Note that Allport's theory is stated in terms of causal relationships between two variables. A **variable** is any trait that can change values from case to case; examples include gender, age, income, and political party affiliation. A theory may identify some variables as causes and others as effects or results. In the language of science, the causes are **independent variables** and the effects or results are **dependent variables**. In our theory, equal-status contact would be the independent variable (or the cause) and prejudice would be the dependent variable (the result or effect). In other words, the theory argues that prejudice *depends on* (or is caused by) the extent to which a person participates in equal-status, cooperative contacts with members of other groups.

[1]Allport, Gordon, 1954. *The Nature of Prejudice*. Reading, MA: Addison-Wesley. This theory is often called "the contact hypothesis." For recent attempts to test this theory, see: McLaren, Lauren. 2003. "Anti-Immigrant Prejudice in Europe: Contact, Threat Perception, and Preferences for the Exclusion of Migrants." *Social Forces*, 81:909–937; Pettigrew, Thomas. 1997. "Generalized Intergroup Contact Effects on Prejudice." *Personality and Social Psychology Bulletin*, 23:173–185; and Pettigrew, T. F., Tropp, L. R., Wagner, U., & Christ, O. 2011. "Recent advances in intergroup contact theory." International Journal of Intercultural Relations, 35: 271–280.

Diagrams can be a useful way of representing the relationships between variables:

$$\text{Equal-status contact} \rightarrow \text{Prejudice}$$
$$\text{Independent variable} \rightarrow \text{Dependent variable}$$
$$X \rightarrow Y$$

The arrow represents the direction of the causal relationship, and X and Y are general symbols for the independent and dependent variables, respectively.

Hypotheses. So far, we have a theory of prejudice and independent and dependent variables. Is the theory true or false? To find out, we need to compare our theory with the facts; we need to do some research. Our next steps would be to define our terms and ideas. One problem we often face in research is that theories are complex and abstract, and we need to be very specific to conduct a valid test. Often, we do this by deriving a hypothesis from the theory: A **hypothesis** is a statement about the relationship between variables that is specific and exact.

For example, if we wished to test Allport's theory, we would have to say exactly what we mean by prejudice and we would need to describe "equal-status, cooperative contact" in detail. We would also review the research literature to help develop and clarify our definitions and our understanding of these concepts.

As our hypothesis takes shape, we begin the next step of the research process, during which we decide exactly how we will gather data. We must decide how cases will be selected and tested, how variables will be measured, and a host of related matters. Ultimately, these plans will lead to the observation phase (the bottom of the wheel of science), where we actually measure social reality. Before we can do this, we must have a very clear idea of what we are looking for and a well-defined strategy for conducting the search.

Making Observations and Using Statistics. To test Allport's theory of prejudice, we might begin with people from different racial or ethnic groups. We might place some subjects in cooperative situations and others in competitive situations. We would need to measure levels of prejudice before and after each type of contact. We might do this by administering a survey that asks subjects to agree or disagree with statements such as "Greater efforts must be made to racially integrate the public school system." Our goal would be to see whether the people exposed to the cooperative-contact situations actually become less prejudiced.

Now, finally, we come to the use of statistics in our research. During the observation phase, we will collect a great deal of numerical information or data. If we have a sample of 100 people, we will have 200 completed surveys measuring prejudice: 100 completed before the contact situation and 100 filled out afterward. Try to imagine dealing with 200 completed surveys. If we ask each respondent just five questions to measure their prejudice, we will have a total of 1000 separate pieces of information to deal with. What will we do? We'll have to organize and analyze this information, and statistics will become very helpful at this point. They will supply us with many ideas about "what to do" with the data. We will begin to look at some of the options in the next chapter; for now, let me stress two points about statistics.

First, statistics are crucial. Simply put, without statistics, quantitative research is impossible. We need statistics to analyze data and to shape and refine our theories of the social world.

Second, and somewhat paradoxically, the role of statistics is limited. As Figure 1.1 makes clear, scientific research proceeds through several mutually interdependent stages. Statistics become directly relevant only at the end of the observation stage. Before any statistical analysis can be legitimately applied, however, earlier phases must have been successfully completed. If the researcher has asked poorly conceived questions or has made serious errors of design or method, then even the most sophisticated statistical analysis is valueless. As useful as they can be, statistics cannot substitute for rigorous conceptualization, detailed and careful planning, or creative use of theory. Statistics cannot salvage a poorly conceived or designed research project. They cannot make sense out of garbage.

On the other hand, inappropriate statistical applications can limit the usefulness of an otherwise carefully done project. Only by successfully completing *all* phases of the process can a quantitative research project hope to contribute to understanding. A reasonable knowledge of the uses and limitations of statistics is as essential to the education of the social scientist as is training in theory and methodology.

Empirical Generalizations. Our statistical analysis would focus on assessing our theory, but we would also look for other trends in the data. For example, if we found that equal-status, cooperative contact reduces prejudice in general, we might go on to ask whether the pattern applies to males as well as to females and to the well educated as well as to the poorly educated. As we probed the data, we might begin to develop some generalizations based on the empirical patterns we observe. For example, what if we found that contact reduced prejudice for younger respondents but not for older respondents? Could it be that younger people are less "set in their ways" and have attitudes and feelings that are more open to change? As we developed tentative explanations, we would begin to revise or elaborate the theory that guides the research project.

STATISTICS
IN EVERYDAY LIFE

Push Polls

Political campaigns sometimes use "push polls" to sway public opinion. These polls are designed to influence opinions, sometimes by starting or circulating rumors and innuendo. For example, they may try to brand an opponent as untrustworthy by asking questions like "Would you still support the candidate if you found out that he is an alcoholic?" Even when completely fabricated, such a question can create negative associations in the minds of voters. Statistics may be used to "analyze" data gathered by push polls (or by marketing campaigns that use similar techniques), but the results have little or no scientific validity.

A New Theory? If we changed our theory because of our empirical generalizations, a new research project would probably be needed to test the revised theory, and the wheel of science would begin to turn again. We (or perhaps other researchers) would go through the entire process once again with this new—and, hopefully, improved—theory. This second project might result in further revisions that would require still more research, and the wheel of science would continue to turn as long as scientists were able to suggest revisions or develop new insights. Every time the wheel turned, our understanding of the phenomenon under consideration would (hopefully) improve.

Summary: The Dialog Between Theory and Research. This description of the research process does not include white-coated, clipboard-carrying scientists who, in a blinding flash of inspiration, discover some fundamental truth about reality and shout "Eureka!" The truth is that, in the normal course of science, we rarely are in a position to declare a theory true or false. Rather, evidence will gradually accumulate over time, and ultimate judgments of truth will be the result of many years of hard work, research, and debate.

Let's briefly review our imaginary research project. We began with a theory and examined the various stages of the research project that would be needed to test that theory. We wound up back at the top of the wheel, ready to begin a new project guided by a revised theory. We saw how theory can motivate research and how our observations might cause us to revise theory and, thus, motivate a new research project: Theory stimulates research and research shapes theory. This constant interaction is the lifeblood of science and the key to enhancing our understanding of the social world.

The dialog between theory and research occurs at many levels and in multiple forms. Statistics are one of the most important links between these two realms. Statistics permit us to analyze data, to identify and probe trends and relationships, to develop generalizations, and to revise and improve our theories. As you will see throughout this text, statistics are limited in many ways. They are also an indispensable part of the research enterprise, an essential tool for conducting research and shaping theory. *(For practice in describing the relationship between theory and research and the role of statistics in research, see problems 1.1 and 1.2.)*

The Goals of This Text

Clearly, statistics are a crucial part of social science research and every social scientist needs some training in statistical analysis. In this section, we address how much training is necessary and the purpose of that training.

First, this textbook takes the view that statistics are tools: useful, but not ends in themselves. Thus, we will not take a "mathematical" approach to the subject, although we will cover enough material so that you can develop a basic understanding of why statistics do what they do. Instead, statistics will be presented as tools that can be used to answer important questions, and our focus will be on how these techniques are applied in the social sciences.

Second, you will soon become involved in advanced coursework in your major fields of study, and you will find that much of the professional literature assumes at least basic statistical literacy. Furthermore, after graduation, many of you will find yourselves in positions—either in a career or in graduate school—where some understanding of statistics will be very helpful or perhaps even required. Very few of you will become statisticians per se, but you must have a grasp of statistics in order to read and critically appreciate the research literature of your discipline. As a student in the social sciences and in many careers related to the social sciences, you simply cannot realize your full potential without a background in statistics.

Within these constraints, this textbook is an introduction to statistics as they are utilized in the social sciences. The general goal of the text is to develop an appreciation—a healthy respect—for statistics and their place in the research process. You should emerge from this experience with the ability to use statistics intelligently and to know when other people have done so—and when they have not! You should be familiar with the advantages and limitations of the more commonly used statistical techniques, and you should know which techniques are appropriate for a given purpose. Finally, you should develop sufficient statistical and computational skills and enough experience in the interpretation of statistics to be able to carry out some elementary forms of data analysis by yourself.

Descriptive and Inferential Statistics

As noted earlier, statistics are tools used to analyze data and answer research questions. Two general classes of statistical techniques, introduced in this section, are available to accomplish this task.

DESCRIPTIVE STATISTICS

The first class of techniques, known as **descriptive statistics**, is relevant in several different situations:

1. When a researcher needs to summarize or describe the distribution of a single variable. These statistics are called *univariate* ("one variable") descriptive statistics.
2. When the researcher wishes to describe the relationship between two or more variables. These statistics are called *bivariate* ("two variable") or *multivariate* (more than two variable) descriptive statistics.

Univariate Descriptive Statistics. Many of these statistics are probably familiar to you. For example, percentages, averages, and graphs can all be used to describe single variables.

To illustrate the usefulness of univariate descriptive statistics, consider the following problem: Suppose you wanted to summarize the income distribution of a community of 10,000 families. How would you do it? Obviously, you couldn't simply list all the incomes and let it go at that. You would want to use some summary measures of the overall distribution—perhaps a graph, an average, or the

STATISTICS
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Using Descriptive Statistics
American society is increasingly connected to the Internet. In 2011, about 78% of all American adults used the Internet at least occasionally—a dramatic increase from 53% in 2000. However, connectedness is very dependent on social class: 96% of the most affluent Americans used the Internet vs. only 63% of the least affluent. What are the implications of this pattern? Are the less affluent being left behind? Will their lower use of this increasingly essential resource affect the education and job prospects of their children and thus perpetuate their lower income over the generations? What additional information would you need to answer these questions?

Source: U.S. Bureau of the Census. 2012. *Statistical Abstract of the United States: 2012*. Available at http://www.census.gov/prod/2011pubs/12statab/infocomm.pdf.

percentage of incomes that are low, moderate, or high. Whatever method you choose, its function is to reduce these thousands of items of information into a few clear, concise, and easily understood numbers. The process of using a few numbers to summarize many, called **data reduction**, is the basic goal of univariate descriptive statistics. Part I of this text is devoted to these statistics.

Bivariate and Multivariate Descriptive Statistics. The second type of descriptive statistics is designed to help us understand the relationship between two or more variables. These statistics, called **measures of association**, allow us to quantify the strength and direction of a relationship. We can use these statistics to investigate two matters of central theoretical and practical importance to any science: causation and prediction. Measures of association help us disentangle the connections between variables and trace the ways in which some variables might affect others. We can also use them to predict scores on one variable from scores on another.

For example, suppose you were interested in the relationship between two variables—amount of study time and grades—and had gathered data from a group of college students. By calculating the appropriate measure of association, you could determine the strength of the relationship and its direction. Suppose you found a strong, positive relationship. This would indicate that "study time" and "grade" were closely related (strength of the relationship) and that as one increased in value, the other also increased (direction of the relationship). You could make predictions from one variable to the other ("the longer the study time, the higher the grade").

Measures of association can give us valuable information about relationships between variables and help us understand how one variable causes another. One important point to keep in mind about these statistics, however, is that they cannot, by themselves, *prove* that two variables are causally related. Even if a measure of association shows a very strong relationship between study time and grades, we cannot conclude that one variable causes the other. Correlation is not the same thing as causation, and the mere existence of a correlation cannot prove that a causal relationship exists between variables. We will consider bivariate associations or correlations in Part III of this text, and we will cover multivariate analysis in Part IV.

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Using Inferential Statistics
In 2012, a sample of 3008 adult Americans was asked about gay marriage. About 47% were in favor of allowing gays and lesbians to marry legally (up from 31% in 2004) and 43% were opposed (down from 60% in 2004). Some say that American society is polarized on the issue of gay marriage. Do these statistics support that view? How?

Source: Pew Research Center. Available at http://www.people-press.org/2012/04/25/more-support-for-gun-rights-gay-marriage-than-in-2008-or-2004/1/.

INFERENTIAL STATISTICS

This second class of statistical techniques becomes relevant when we wish to generalize to a **population**, the total collection of all cases in which the researcher is interested and wishes to understand better. Examples of possible populations would be voters in the United States, all parliamentary democracies, or all unemployed people in Atlanta.

Populations can theoretically range from enormous ("all humanity") to quite small (all sophomores on your campus) but are usually fairly large. Social scientists almost never have the resources or time to test every case in a population, hence the need for **inferential statistics**. This class of techniques involves using information from **samples** (carefully chosen subsets of the population) to make inferences about populations. Because they have fewer cases, samples are cheaper to assemble, and—if the proper techniques are followed—generalizations based on samples can be very accurate representations of populations.

Many of the concepts and procedures involved in inferential statistics may be unfamiliar, but most of us are experienced consumers of inferential statistics—most familiarly, perhaps, in the form of public-opinion polls and election projections. When a public-opinion poll reports that 42% of the American electorate plans to vote for a certain presidential candidate, it is essentially reporting a generalization to a population ("the American electorate"—which numbers over 130 million people) from a carefully drawn sample (usually between 1000 and 3000 respondents). Inferential statistics will occupy our attention in Part II of this book. *(For practice in describing different statistical applications, see problems 1.3 and 1.7.)*

Discrete and Continuous Variables

In the next chapter, you will begin to encounter the many statistics available to the social scientist. One aspect of using statistics that can be puzzling is deciding when to use which statistic. You will learn specific guidelines as you go along, but I will introduce some basic and general guidelines at this point. The first of these concerns discrete and continuous variables; the second, covered in the next section, concerns level of measurement.

DISCRETE VARIABLES

A variable is said to be **discrete** if it has a basic unit of measurement that cannot be subdivided. For example, number of people per household is a discrete variable. The basic unit is people, a variable that will always be measured in whole numbers; you'll never find 2.7 people living in a specific household. The scores of discrete variables will be 0, 1, 2, 3, or some other whole integer. Other examples of discrete variables include number of siblings, children, or cars. To measure these variables, we count the number of units (people, cars, siblings) for each case (household, person) and record results in whole numbers.

CONTINUOUS VARIABLES

A variable is **continuous** if it has scores that can be subdivided infinitely (at least theoretically). One example of a continuous variable is time, which can be measured in minutes, seconds, milliseconds (thousandths of a second), nanoseconds (billionths of a second), or even smaller units. In a sense, when we measure a continuous variable, we are always approximating and rounding off the scores. We could report somebody's time in the 100-yard dash as 10.7 seconds or 10.732451 seconds, but, because time can be infinitely subdivided, we will never be able to report the exact time elapsed. Because we cannot work with infinitely long numbers, we must report the scores on continuous variables as if they were discrete.

The scores of discrete and continuous variables may look the same even though we measure and process them differently. This distinction is one of the most basic in statistics and will be one of the criteria we use to choose among various statistics and graphs. *(For practice in distinguishing between discrete and continuous variables, see problems 1.4 through 1.9.)*

Level of Measurement

A second basic and very important guideline for the selection of statistics is the **level of measurement**, or the mathematical nature of the variables under consideration. Some variables, such as age and income, have numerical scores (years, dollars) and can be analyzed in a variety of ways, using many different statistics. For example, we could summarize these variables with a mean or average and make statements like "The average income of residents of this city is $43,000" or "The average age of students on this campus is 19.7."

Other variables, such as gender and zip code, have "scores" that are really just labels, not numbers at all, and we have fewer options for analyzing them. The average would be meaningless as a way of describing these variables. Your personal zip code might *look* like a number, but it is merely an arbitrary label that happens to be expressed in digits. These "numbers" cannot be added or divided, and statistics like the average zip code of a group of people are pointless.

Level of measurement is crucial because our statistical analysis must match the mathematical characteristics of our variables. One of the first steps in any quantitative research project is to determine the level of measurement of our variables, and we will consider the level of measurement of variables throughout this text and each time a statistical technique is introduced.

There are three levels of measurement. In order of increasing sophistication, they are nominal, ordinal, and interval-ratio. Each will be discussed separately.

THE NOMINAL LEVEL OF MEASUREMENT

Variables measured at the nominal level (such as gender) have non-numerical "scores" or categories. Other examples of variables at this level include zip code, political party affiliation, and religious preference. Statistical analysis with nominal-level variables is limited to comparing the relative sizes of the categories and making statements such as "There are more females than males in this dorm" or "The most common zip code on this campus is 20158."

Let's look at some examples of nominal-level variables and take a moment to consider some terminology. Earlier in this chapter, we defined a variable as any trait that can vary from case to case. A variable consists of categories or scores—the traits that can vary. We "measure" a variable (e.g., gender) by classifying a case into one of the categories (e.g., male or female) or assigning a score to it. Several examples of nominal-level variables and their scores or categories are presented in Table 1.1.

Note that there is a number assigned to each of the categories in Table 1.1 (e.g., 1 for Protestant, 2 for Catholic, etc.), as is commonly done in quantitative research, especially when the data are being prepared for computer analysis. Recall that, for nominal-level variables, these "numbers" are just labels and cannot be treated mathematically: They cannot be added, divided, or otherwise manipulated. The categories or scores do not make up a mathematical scale; they are different from each other but not "more or less" or "higher or lower" than each other. Males and females differ in terms of gender, but neither category has more or less gender than the other. In the same way, a zip code of 54398 is different from but not "higher" than a zip code of 13427.

Nominal variables are rudimentary, but there are criteria that we need to observe in order to measure them adequately. These criteria, in fact, apply to variables measured at all levels. They are stated in Table 1.2 and illustrated in Table 1.3. We consider and illustrate the criteria one at a time.

The first criterion ("mutually exclusive") means that there can be no overlap between categories and no confusion or ambiguity about where a case belongs. To illustrate, consider Scale A in Table 1.3, which violates this principle because of the overlap between the categories "Protestant" and "Episcopalian."

The second criterion ("exhaustive") means that there must be a place for every case or score. Scale B in Table 1.3 violates this criterion because there is no category for people who have no religious affiliation and for those who belong to

TABLE 1.1 Some Examples of Nominal-Level Variables and Their Categories

Variables →	Gender	Political Party Preference	Religious Preference
Categories →	1 Male	1 Democrat	1 Protestant
	2 Female	2 Republican	2 Catholic
		3 Other	3 Jew
		4 Independent	4 None
			5 Other

TABLE 1.2 Criteria for Stating the Categories of Variables

The categories of variables must	
1.	Be mutually exclusive (Each case must fit into one and only one category.)
2.	Be exhaustive (There must be a category for every case.)
3.	Include elements that are similar (The cases in each category must be similar to each other.)

TABLE 1.3 Four Scales for Measuring Religious Affiliation

Scale A	Scale B	Scale C	Scale D
Protestant	Protestant	Protestant	Protestant
Episcopalian	Catholic	Non-Protestant	Catholic
Catholic	Jew		Jew
Jew			None
None			Other
Other			

religions other than the three stated. Often, we meet this criterion by including an "Other" category (as in Scale D).

The third criterion ("similar") means that the categories should include cases that are truly comparable. To put it another way, we should avoid lumping apples with oranges. There are no hard-and-fast guidelines for judging whether a category includes similar items. The researcher must make that decision in terms of the specific purpose of the research, and categories that are too broad for some purposes may be perfectly adequate for others. Scale C in Table 1.3 violates this criterion because it uses a category (Non-Protestant, which would include Catholics, Jews, Buddhists, Atheists, and so forth) that seems too broad for meaningful research.

Scale D in Table 1.3 is probably the most common way religious preference has been measured in North America, and this scale would be adequate in many situations. However, it may be too general for some research purposes. For example, an investigation focused on moral questions such as support for legal abortion would probably have to distinguish among the various Protestant denominations, and an effort to document religious diversity certainly would need to add categories for Buddhists, Muslims, and numerous other religious faiths.

THE ORDINAL LEVEL OF MEASUREMENT

Variables measured at the ordinal level are more sophisticated than nominal-level variables. They have scores or categories that can be ranked from high to low, so, in addition to classifying cases into categories, we can describe the categories in terms of "more or less" with respect to each other. Thus, with ordinal-level variables, not only can we say that one case is different from another; we can also say that one case is higher or lower, more or less than another.

TABLE 1.4 Measuring Socioeconomic Status

If you were asked to describe yourself, into which of the following classes would you say you belong?

Score	*Class*
1	Lower class
2	Working class
3	Middle class
4	Upper class

For example, the variable socioeconomic status is usually measured at the ordinal level, often using categories such as those in Table 1.4. Individual cases can be compared in terms of the categories into which they are classified. Thus, an individual classified as a 4 (upper class) would be ranked higher than an individual classified as a 2 (working class), and a lower-class person (1) would rank lower than a middle-class person (3). Other variables that are usually measured at the ordinal level include attitude and opinion scales, such as those that measure prejudice, alienation, or political conservatism.

The major limitation of the ordinal level of measurement is that the scores have no absolute or objective meaning: They only represent position with respect to other scores. We can distinguish between high and low scores, but the distance between the scores cannot be described in precise terms. Thus, in terms of the scale shown in Table 1.4, although we know that a social class score of 4 is more than a score of 2, we do not know whether it is twice as much as 2.

Our options for statistical analysis with ordinal-level variables are limited by the fact that we don't know the exact distances from score to score. For example, addition (and other mathematical operations) assumes that the intervals between scores are exactly equal. If the distances from score to score are not equal, 2 + 2 might equal 3 or 5 or even 15.

Strictly speaking, statistics such as the average, or mean (which requires that the scores be added together and then divided by the number of scores), are not permitted with ordinal-level variables. The most sophisticated mathematical operation fully justified with an ordinal variable is ranking categories and cases (although, as we will see, it is not unusual for social scientists to take liberties with this criterion).

THE INTERVAL-RATIO LEVEL OF MEASUREMENT[2]

The scores of variables measured at the interval-ratio level are actual numbers that can be analyzed with all possible statistical techniques. This means that we can add or multiply the scores, compute averages or square roots, or perform any other mathematical operation.

There are two crucial differences between ordinal-level and interval-ratio–level variables. First, interval-ratio–level variables have equal intervals from score

[2] Many statisticians distinguish between the interval level (equal intervals) and the ratio level (true zero point). I find the distinction unnecessarily cumbersome in an introductory text and will treat these two levels as one.

to score. For example, age is an interval-ratio variable because the unit of measurement (years) has equal intervals (the distance from year to year is 365 days). Similarly, if we ask people how many siblings they have, we would produce a variable with equal intervals: Two siblings are 1 more than 1, and 13 is 1 more than 12.

Second, interval-ratio variables have true zero points. That is, the score of 0 for these variables is not arbitrary; it indicates the absence or complete lack of whatever is being measured. For example, the variable "number of siblings" has a true zero point because it is possible to have no siblings at all. Similarly, it is possible to have 0 years of education, no income at all, a score of 0 on a multiple-choice test, and to be 0 years old (although not for very long). Other examples of interval-ratio variables include number of children, life expectancy, and years married. All mathematical operations are permitted for variables measured at the interval-ratio level.

ONE STEP AT A TIME | **Determining the Level of Measurement of a Variable***

Step	*Operation*
1.	Inspect the scores of the variable *as they are actually stated*, keeping in mind the definitions of the three levels of measurement (see Table 1.5).
2.	Change the order of the scores. Do they still make sense? If the answer is *yes*, the variable is **nominal**. If the answer is *no*, proceed to step 3.

Illustration: Gender is a nominal variable, and its scores can be stated in any order:

1. Male
2. Female

or

1. Female
2. Male

The two statements of the scores are equally sensible. For a nominal-level variable, no score is higher or lower than any other score, and the order in which they are stated is arbitrary.

3.	Is the distance between the scores unequal or undefined? If the answer is *yes*, the variable is **ordinal**. If the answer is *no*, proceed to step 4.

Illustration: Consider the following scale, which measures support for capital punishment.

1. Strongly support
2. Somewhat support
3. Neither support nor oppose
4. Somewhat oppose
5. Strongly oppose

People who "strongly" support the death penalty are more in favor than people who " somewhat" support it, but the distance from one level of support to the next (from a score of 1 to a score of 2) is undefined. We do not have enough information to ascertain how much more or less one score is than another.

4.	If you answered *no* in steps 2 and 3, the variable is **interval-ratio**. Variables at this level have scores that are actual numbers: They have an order with respect to each other and are a defined, equal distance apart. They also have a true zero point. Examples of interval-ratio variables include age, income, and number of siblings.

*This system for determining level of measurement was suggested by Professor Michael G. Bisciglia, Louisiana State University.

READING STATISTICS: Introduction

By this point in your education, you have developed an impressive array of skills for reading words. Although you may sometimes struggle with a difficult idea or stumble over an obscure meaning, you can comprehend virtually any written work that you are likely to encounter.

As you continue your education in the social sciences, you must develop an analogous set of skills for reading numbers and statistics. To help you reach a reasonable level of literacy in statistics, I have included a series of boxed inserts in this text titled "Reading Statistics." These discuss how statistical results are typically presented in the professional literature; many include an example from the professional literature.

As you will see, professional researchers use a reporting style that is quite different from the statistical language you will find in this text. Space in research journals is expensive, and the typical research project requires the analysis of many variables. Thus, a large volume of information must be summarized in very few words. Researchers may express in a word or two a result or an interpretation that will take us a paragraph or more to state.

Because this is an introductory textbook, I have been careful to break down the computation and logic of each statistic and to explain what we are doing when we use statistics. In this text we will never be concerned with more than a few variables at a time. We will be able to take pages or even entire chapters to develop a statistical idea or concept. Thus, a major purpose of these boxed inserts will be to summarize how our comparatively long-winded (but more careful) vocabulary is translated into the concise language of the professional researcher.

When you have difficulty reading words, you consult reference books (especially dictionaries) to help you analyze the elements (words) of the passage. When you have difficulty reading statistics, you should do exactly the same thing. I hope you will find this text a valuable reference book, but if you learn enough to be able to use any source to help you read statistics, this text will have fulfilled one of its major goals.

SOME FINAL POINTS

Table 1.5 summarizes the discussion of the three levels of measurement. Note that the number of permitted mathematical operations increases as we move from nominal to ordinal to interval-ratio levels of measurement. Ordinal-level variables are more sophisticated and flexible than nominal-level variables, and interval-ratio–level variables permit the broadest range of mathematical operations.

Let us end this section by making four points. The first stresses the importance of level of measurement, and the next three discuss some common points of confusion in applying this concept.

1. Knowing the level of measurement of a variable is crucial because it tells us which statistics are appropriate and useful. Not all statistics can be used with all variables. As shown in Table 1.5, different statistics require different mathematical operations. For example, computing an average requires addition and division, and finding a median (or middle score) requires that the scores be ranked from high to low. Addition and division are appropriate only for interval-ratio–level variables, and ranking is possible only for variables that are at least ordinal in level of measurement. Your first step in dealing with a variable and selecting appropriate statistics is *always* to determine its level of measurement.

TABLE 1.5 Basic Characteristics of the Three Levels of Measurement

Levels	Examples	Measurement Procedures	Mathematical Operations Permitted
Nominal	Gender, race, religion, marital status	Classification into categories	Counting number in each category, comparing sizes of categories
Ordinal	Social class, attitude and opinion scales	Classification into categories *plus* ranking of categories with respect to each other	All of the above *plus* judgments of "greater than" and "less than"
Interval-Ratio	Age, number of children, income	All of the above *plus* description of scores in terms of equal units	All of the above *plus* all other mathematical operations (addition, subtraction, multiplication, division, square roots, etc.)

2. The distinction made earlier between discrete and continuous variables is a concern only for interval-ratio–level variables. Nominal- and ordinal-level variables are almost always discrete. That is, researchers typically measure these variables by asking respondents to select the single category that best describes them, as illustrated in Table 1.6. The scores of these survey items, as they are stated here, are discrete because respondents must select only one category and because these scores cannot be subdivided.

Interval-ratio variables can be either discrete (number of times you've been divorced, which must be a whole integer) or continuous (age, which could be measured to the nanosecond, or even more precisely). Remember that, since we cannot work with infinitely long numbers, continuous interval-ratio variables have to be rounded off and reported as if they were discrete. The distinction between discrete and continuous variables relates more to our options for appropriate statistics or graphs than to the appearance of the variables.

3. In determining level of measurement, always examine the way in which the scores of the variable are *actually stated*. This is particularly a problem with variables that are interval-ratio but that have been measured at the ordinal level.

TABLE 1.6 Measuring a Nominal Variable (Marital Status) and an Ordinal Variable (Support for Capital Punishment) as Discrete Variables

What is your marital status? Are you presently:		*Do you support the death penalty for persons convicted of homicide?*	
Score	*Category*	*Score*	*Category*
1	Married	1	Strongly support
2	Divorced	2	Somewhat support
3	Separated	3	Neither support nor oppose
4	Widowed	4	Somewhat oppose
5	Single	5	Strongly oppose

TABLE 1.7 Measuring Income at the Ordinal Level

Score	Income Range
1	Less than $24,999
2	$25,000 to $49,999
3	$50,000 to $99,999
4	$100,000 or more

To illustrate, consider income as a variable. If we asked respondents to list their exact income in dollars, we would generate scores that are interval-ratio in level of measurement. Measured in this way, the variable would have a true zero point (no income at all) and equal intervals from score to score (1 dollar). It is more convenient for respondents, however, simply to check the appropriate category from a list of income ranges, as in Table 1.7. The four scores or categories in Table 1.7 are ordinal in level of measurement because they are unequal in size. It is common for researchers to sacrifice precision (income in actual dollars) for the convenience of the respondents. You should be careful to look at the way in which the variable is measured before making a decision about its level of measurement.

4. There is a mismatch between the variables that are usually of most interest to social scientists (race, gender, marital status, attitudes, and opinions) and the most powerful and interesting statistics (such as the mean). The former are typically nominal or ordinal in level of measurement, but the more sophisticated statistics require measurement at the interval-ratio level.

This mismatch creates some very real difficulties for social science researchers. On one hand, researchers will want to measure variables at the highest, most precise level of measurement possible. If income is measured in exact dollars, for example, researchers can make very precise descriptive statements about the differences between people: "Ms. Smith earns $12,547 more than Mr. Jones." If the same variable is measured in broad, unequal categories, such as those in Table 1.7, comparisons between individuals would be less precise and provide less information: "Ms. Smith earns more than Mr. Jones."

On the other hand, given the nature of the disparity, researchers are more likely to treat variables as if they were higher in level of measurement than they actually are. In particular, variables measured at the ordinal level, especially when they have many possible categories or scores, are often treated as if they were interval-ratio and are analyzed with the more powerful, flexible, and interesting statistics available at the higher level. This practice is common, but researchers should be cautious in assessing statistical results and developing interpretations when the level of measurement criterion has been violated.

In conclusion, level of measurement is a very basic characteristic of a variable, and we will always consider it when presenting statistical procedures. Level of measurement is also a major organizing principle for the material that follows, and you should make sure that you are familiar with these guidelines. *(For practice in determining the level of measurement of a variable, see problems 1.4 through 1.9.)*

SUMMARY

1. The purpose of statistics is to organize, manipulate, and analyze data so that researchers can test theories and answer questions. Along with theory and methodology, statistics are a basic tool used by social scientists to enhance their understanding of the social world.
2. There are two general classes of statistics. Descriptive statistics are used to summarize the distribution of a single variable and the relationships between two or more variables. We use inferential statistics to generalize to populations from random samples.
3. Variables may be either discrete or continuous. They may be measured at any of three different levels. At the nominal level, we can compare category sizes. At the ordinal level, scores can be ranked from high to low. At the interval-ratio level, all mathematical operations are permitted. Interval-ratio–level variables can be either discrete or continuous. Variables at the nominal or ordinal level are almost always discrete.

GLOSSARY

Continuous variable. A variable with a unit of measurement that can be subdivided infinitely.

Data. Information expressed as numbers.

Data reduction. Summarizing many scores with a few statistics.

Dependent variable. A variable that is identified as an effect or outcome. The dependent variable is thought to be caused by the independent variable.

Descriptive statistics. The branch of statistics concerned with (1) summarizing the distribution of a single variable or (2) measuring the relationship between two or more variables.

Discrete variable. A variable with a basic unit of measurement that cannot be subdivided.

Hypothesis. A specific statement, derived from a theory, about the relationship between variables.

Independent variable. A variable that is identified as a cause. The independent variable is thought to cause the dependent variable.

Inferential statistics. The branch of statistics concerned with making generalizations from samples to populations.

Level of measurement. The mathematical characteristic of a variable and the major criterion for selecting statistical techniques. Variables can be measured at any of three levels, each permitting certain mathematical operations and statistical techniques. The characteristics of the three levels are summarized in Table 1.5.

Measures of association. Statistics that summarize the strength and direction of the relationship between variables.

Population. The total collection of all cases in which the researcher is interested.

Quantitative research. Research projects that collect data or information in the form of numbers.

Research. Any process of gathering information systematically and carefully to answer questions or test theories. Statistics are useful for research projects that collect numerical information or data.

Sample. A carefully chosen subset of a population. In inferential statistics, information is gathered from a sample and then generalized to a population.

Statistics. A set of mathematical techniques for organizing and analyzing data.

Theory. A generalized explanation of the relationship between two or more variables.

Variable. Any trait that can change values from case to case.

PROBLEMS

1.1 In your own words, describe the role of statistics in the research process. Using the "wheel of science" as a framework, explain how statistics link theory with research.

1.2 Find a research article in any social science journal. Choose an article on a subject of interest to you, and don't worry about being able to understand all of the statistics that are reported.

a. How much of the article is devoted to statistics?

b. Is the research based on a sample from some population? How large is the sample? How were subjects or cases selected? Can the findings be generalized to some population?

c. What variables are used? Which are independent and which are dependent? For each variable, determine the level of measurement and whether the variable is discrete or continuous.
d. What statistical techniques are used? Try to follow the statistical analysis and see how much you can understand. Save the article and read it again after you finish this course and see if you do any better.

1.3 Distinguish between descriptive and inferential statistics. Describe a research situation that would use each type.

1.4 For each of the following items from a public-opinion survey, indicate the level of measurement and whether the variable will be discrete or continuous. *(HINT: Remember that only interval-ratio–level variables can be continuous.)*
a. In what country were you born? ___________
b. What is your age? ___________
c. How many years of school have you completed? ___________
d. What is your occupation? ___________
e. If you were asked to use one of these four names for your social class, in which would you say you belonged?
___________ Upper ___________ Middle
___________ Working ___________ Lower
f. What is your grade-point average? ___________
g. What is your major? ___________
h. The only way to deal with the drug problem is to legalize all drugs.
________ Strongly agree
________ Agree
________ Undecided
________ Disagree
________ Strongly disagree
i. What is your astrological sign? ___________
j. How many brothers and sisters do you have? ___________

1.5 Following are brief descriptions of how researchers measured a variable. For each situation, determine the level of measurement of the variable and whether it is continuous or discrete.
a. **Race or ethnicity**. Check all that apply:
________ Black
________ White
________ Hispanic
________ Asian or Pacific Islander
________ Native American
________ Other (Please specify: ________)
b. **Honesty.** Subjects were observed as they passed by a spot where an apparently lost wallet was lying. The wallet contained money and complete identification. Subjects were classified into one of the following categories:
________ Returned the wallet with money
________ Returned the wallet but kept the money
________ Did not return the wallet
c. **Social class.** What was your family situation when you were 16 years old?
________ Very well off compared to other families
________ About average
________ Not so well off
d. **Education.** How many years of schooling have you completed? ________
e. **Racial integration on campus.** Students were observed during lunchtime at the cafeteria for a month. The number of students sitting with students of other races was counted for each meal period.
f. **Number of children.** How many children have you ever had? ________
g. **Student seating patterns in classrooms.** On the first day of class, instructors noted where each student sat. Seating patterns were remeasured every two weeks until the end of the semester. Each student was classified as:
________ Same seat as at last measurement
________ Adjacent seat
________ Different seat, not adjacent
________ Absent
h. **Physicians per capita.** The number of physicians was counted in each of 50 cities. The researchers used population data to compute the number of physicians per capita.
i. **Physical attractiveness.** A panel of ten judges rated each of 50 photos of a mixed-race sample of males and females for physical attractiveness on a scale from 0 to 20, with 20 being the highest score.
j. **Number of accidents.** The number of traffic accidents per year for each of 20 intersections was recorded. Also, each accident was rated as:
________ Minor damage, no injuries
________ Moderate damage, personal injury requiring hospitalization
________ Severe damage and injury

1.6 For each research project listed here, identify the variables and classify them in terms of level of measurement, and whether they are discrete or continuous. Is each variable independent or dependent?
a. For a research project in a political science course, a student collected information for

50 nations. She used infant mortality rates as a measure of quality of life and the percentage of all adults who are permitted to vote as a measure of democratization. Her hypothesis was that quality of life is higher in more democratic nations.

b. A highway engineer wonders whether increasing the speed limit on a heavily traveled highway will result in more accidents. He plans to collect information on traffic volume, number of accidents, and number of fatalities for the six-month periods before and after the speed limit is changed.

c. Students are planning a program to promote "safe sex" and awareness of other health concerns on campus. To measure the effectiveness of the program, they plan to survey students about their knowledge of safe sex practices before and after the program.

d. A graduate student asks 500 female students whether they have experienced any sexual harassment on campus. Each student is asked to estimate the frequency of these incidents as either "often, sometimes, rarely, or never." The researcher also gathers data on age and major to see whether there is any connection between these variables and frequency of sexual harassment.

e. A supervisor in the solid waste management division of city government is assessing two different methods of trash collection. One area of the city is served by trucks with two-man crews who do "backyard" pickups, and the rest of the city is served by "high-tech" single-person trucks with curbside pickup. The assessment measures include the number of complaints received from the two different areas over a six-month period, the amount of time per day required to service each area, and the cost per ton of trash collected.

f. Does tolerance for diversity vary by race or ethnicity? Samples of white, black, Asian, Hispanic, and Native Americans have been given a survey that measures their interest in and appreciation of cultures other than their own.

g. States have drastically cut their budgets for mental health care. Will this increase the number of homeless people? A researcher contacts a number of agencies serving the homeless in each state and develops an estimate of the size of the homeless population before and after the cuts.

h. The adult bookstore near campus has been raided and closed by the police. Your social research class has decided to poll a sample of students to find out: whether he or she supports the store's closing, how many times each has visited the store, and whether he or she agrees that "pornography causes sexual assaults on women." The class also collects information on the gender, political philosophy, and major of the students.

1.7 For each of the following research situations, identify the level of measurement of all variables and indicate whether they are discrete or continuous. Also, decide which statistical applications are used: descriptive statistics (single variable), descriptive statistics (two or more variables), or inferential statistics. Remember that it is quite common for a given situation to require more than one type of application.

a. The administration of your university is proposing a change in parking policy. You select a random sample of students and ask each one how strongly they favor or oppose the change. You then use the results to estimate the support for the change in the entire student body.

b. You ask everyone in your social research class for their highest letter grade in any math course and their grade (percentage of items correct) on a recent statistics test. You compare the two sets of scores to see whether there is a relationship.

c. Your aunt is running for mayor and hires you to question a random sample of voters about their concerns. Specifically, she wants to use this information to characterize the entire city in terms of political party affiliation, gender, and what percentage favor widening of the main street in town.

d. Several years ago, a state reinstituted the death penalty for first-degree homicide. Did this reduce the homicide rate? A researcher has gathered information on the number of homicides in the state for the two-year periods before and after the change.

e. A local automobile dealer is concerned about customer satisfaction. He mails a survey form to all customers for the past year and asks whether they are satisfied, very satisfied, or not satisfied with their purchases.

1.8 For each of the first 20 items in the General Social Survey (see Appendix G), indicate the level of measurement and whether the variable is continuous or discrete.

1.9 Identify all variables in the research situations listed below and classify them by their level of measurement. Which variables are independent and which are dependent?

a. A researcher is wondering about racial preferences in dating among college students and asks a large sample of undergraduates about their own racial self-identification. She then asks the respondents to rank some racial-ethnic categories (stated as: white, black, Latino, Asian) in terms of desirability as potential dates.

b. For high school students, does GPA affect sexual activity? A sample has been interviewed about the number of different romantic relationships they have had, the number of times they have had sexual intercourse, and their high school grade-point average.

c. Several hundred voting precincts across the nation have been classified in terms of percentage of minority voters, voting turnout, and percentage of local elected officials who are members of minority groups. Do precincts with higher percentages of minority voters have lower turnout? Do precincts with higher percentages of minority elected officials have higher turnout?

d. As nations become more affluent (as measured by per capita income), does the percentage of children enrolled in school increase? Is this relationship different for boys and girls?

e. Does the level of support for gun control vary by number of years of schooling? Does this relationship vary by gender, region of the country, or political party preference? Support for gun control was measured by a five-point scale that ranged from "strongly in favor" to "strongly opposed."

YOU ARE THE RESEARCHER

Introduction

The best way—maybe the only way—to learn statistics and to appreciate their importance is to apply and use them. This includes selecting the correct statistic for a given purpose, doing the calculations, and interpreting the result. I have included extensive end-of-chapter problems to give you multiple opportunities to select and calculate statistics and say what they mean. Most of these problems have been written so that they can be solved with just a simple hand calculator. I've purposely kept the number of cases unrealistically low so that the tedium of lengthy calculations would not interfere with the learning process. These problems present an important and useful opportunity to develop your statistical skills.

As important as they are, these end-of-chapter problems are simplified and several steps removed from the complex realities of social science research. To provide a more realistic statistical experience, I have included a feature called "You Are the Researcher," in which you will walk through many of the steps of a research project, making decisions about how to apply your growing knowledge of research and statistics and interpreting the statistical output you generate.

To conduct these research projects, you will analyze a shortened version of the 2012 General Social Survey (GSS). Please visit **www.cengagebrain.com.** The GSS is a public-opinion poll that has been conducted on nationally representative samples of citizens of the United States since 1972. The full survey includes hundreds of questions covering a broad range of social and political issues. The version supplied with this text has a limited number of variables and cases but is still actual, "real-life" data, so you have the opportunity to practice your statistical skills in a more realistic context.

Even though the version of the GSS that we use for this text is shortened, it is still a large data set, with almost 1500 respondents and 49 variables, too large for even the most advanced hand calculator. To analyze the GSS, you will learn how to use a computerized statistical package called the Statistical Package for the Social Sciences (SPSS). A statistical package is a set of computer programs designed to analyze data. The advantage of these packages is that, because the programs are already written, you can capitalize on the power of the computer with minimal computer literacy and virtually no programming experience. Be sure to read Appendix F before attempting any data analysis.

In most of the research exercises, which begin in Chapter 2, you will make the same kinds of decisions as do professional researchers and move through some of the steps of a research project. You will select variables and statistics, generate and analyze output, and express your conclusions. When you finish these exercises, you will be well prepared to conduct your own research project (within limits, of course) and perhaps make a contribution to the ever-growing social science research literature.

Part I Descriptive Statistics

Part I consists of four chapters, each devoted to a different application of univariate descriptive statistics. Chapter 2 covers "basic" descriptive statistics, including frequency distributions, percentages, ratios, rates, and graphs. This material is relatively elementary and at least vaguely familiar to most people. Although these statistics are "basic," they are not necessarily simple or obvious, and the explanations and examples should be considered carefully before attempting the end-of-chapter problems or using them in actual research.

Chapters 3 and 4 cover measures of central tendency and dispersion, respectively. Measures of central tendency describe the typical case or average score (e.g., the mean), while measures of dispersion describe the amount of variety or diversity among the scores (e.g., the range, or the distance from the high score to the low score). These two types of statistics are presented in separate chapters to stress the point that centrality and dispersion are independent, separate characteristics of a variable. You should realize, however, that both measures are necessary and commonly reported together, along with some of the statistics presented in Chapter 2. To reinforce this idea, many of the problems at the end of Chapter 4 require the computation of a measure of central tendency from Chapter 3.

Chapter 5 is a pivotal chapter in the flow of the text. It takes some of the statistics from Chapters 2 through 4 and applies them to the normal curve, a concept of great importance in statistics. The normal curve is a line chart (see Chapter 2) that can be used to describe the position of scores using means (Chapter 3) and standard deviations (Chapter 4). Chapter 5 also uses proportions and percentages (Chapter 2).

In addition to its role in descriptive statistics, the normal curve is a central concept in inferential statistics, the topic of Part II of this text. Thus, Chapter 5 ends the presentation of univariate descriptive statistics and lays essential groundwork for the material to come.

2 Basic Descriptive Statistics
Tables, Percentages, Ratios and Rates, and Graphs

LEARNING OBJECTIVES

By the end of this chapter, you will be able to

1. Explain how descriptive statistics can make data understandable.
2. Construct and analyze frequency distributions for variables at each of the three levels of measurement.
3. Compute and interpret percentages, proportions, ratios, rates, and percentage change.
4. Analyze bar and pie charts, histograms, and line graphs.
5. Use SPSS to generate frequency distributions and analyze the output.

USING STATISTICS

The statistical techniques presented in this chapter are used to summarize the scores on a single variable. They can be used to

- Organize information into easy-to-read tables, charts, and graphs
- Express the percentage of people in a community that belong to various religions, including people with no religious preference and atheists
- Express the structure of opinion on controversial issues (e.g., the strength of opposition to cohabitation or support for gun control) and track changes over time
- Report changes in the crime rate from year to year

Research results do not speak for themselves. Researchers use statistics to organize and manipulate data so that their meaning can be understood by their readers. The purpose of descriptive statistics is to clarify and express research findings effectively.

In this chapter, we consider some commonly used techniques for presenting research results, including tables, percentages, rates, and graphs. These univariate descriptive statistics are not mathematically complex (although they are not as simple as they might seem at first glance), but they can be extremely useful tools for organizing and analyzing results and communicating conclusions.

Very often, the first step in a quantitative research project is to examine the variables and see how scores are distributed. One of the most useful ways to do this is to construct tables, or **frequency distributions**, that report the number of cases in each category, for all variables. These tables can be used with variables at any level of measurement. We will begin with nominal-level variables and consider not only frequency distributions but also some statistics that can increase the clarity of results.

Frequency Distributions for Nominal-Level Variables

Constructing frequency distributions for nominal-level variables is typically very straightforward. Count the number of times each category or score of the variable occurs and display the frequencies in table format. Table 2.1, for example, displays the distribution of gender for 113 respondents.

Note that the table has a title and clearly labeled categories, and it reports the total number of cases (*N*) at the bottom of the frequency column. These items must be included in *all* frequency distributions.

For some tables, the researcher might have to make some choices about the number of categories to be included. For example, recall Table 1.3, which displayed several different ways of measuring religious affiliation in North America. As we noted in Chapter 1, it is probably most common to use five categories (see Scale D of Table 1.3) to display this variable, but what if a researcher wanted to emphasize the diversity of religions? We could do this by expanding the "Other" category and including more religions. But where do we stop? There are hundreds—maybe thousands—of different religions in the United States. Increasing the number of categories will present a more accurate picture of religious diversity, but clarity and ease of communication may suffer.

Tables 2.2 and 2.3 illustrate the choices that sometimes have to be made. Table 2.2 uses the "standard" five categories to display religious membership in the United States today. Table 2.3 presents more detail by adding the three largest "Other" religions. Note that the number of categories could be further increased by including more "Other" religions or by subdividing the Protestant category into the various denominations (Methodist, Lutheran, Episcopalian, and so forth).

At what point do we have "enough" detail? When does the picture presented by the table become too cluttered, too complex, and unclear? These are questions that must be answered in the context of the purpose of the research project. If you wanted to stress the numerical predominance of Protestants in the United States, Table 2.2 might be preferred. On the other hand, if you wanted to stress the diversity of religious affiliations, Table 2.3 would be preferable. There are no hard-and-fast rules, and the choice between greater detail (more categories) and more clarity (fewer categories) may be confronted with variables at all three levels of measurement.

TABLE 2.1 Gender (fictitious data)

Gender	Frequency
Males	53
Females	60
	$N = 113$