Introduction

Methods, Material, and Moments to Remember

Statistics, Quantitative Methods, Statistical Analysis—words, phrases, and course titles that can shake the confidence of nearly any student. Let me put your mind at ease right away. Your experience with statistics doesn't have to be a horror story. In fact, your experience with statistics can be an enjoyable one—a venture into a new way of thinking and looking at the world. It's all a matter of how you approach the material.

Having taught statistics to legions of undergraduate students, I've spent a lot of time trying to understand how students react to the material and why they react the way they do. In the process, I've developed my own approach to the subject matter, and that's what I've tried to lay out in this book. As we get started, let me tell you a little more about what to expect as you work your way through this book.

First, let me explain my method. I'm committed to the idea that the subject matter of statistics can be made understandable, but I'm also convinced that it takes a method based on *repetition*. Important ideas and concepts can be introduced, but they have to be reintroduced and reemphasized if a student is to get the connection between one concept and the next. Repetition—that's the method I've used in this book, so you should be prepared for that.

At times you may wonder why you're rereading material that was emphasized at an earlier point. Indeed, you'll likely start muttering "not that again!" If that happens, enjoy the moment. It signals that you're beginning to develop a sense of familiarity with the central concepts.

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I've also tried to incorporate *simplicity* into the method—particularly in the examples I've used. Some examples will probably strike you as extremely simplistic—particularly the examples that are based on just a few cases and the ones that involve numbers with small values. I trust that simplistic examples won't offend you. The goal here is to cement a learning process, not to master complicated mathematical operations.

My experience tells me that a reliance on friendly examples, as opposed to examples that can easily overwhelm, is often the best approach. When numbers and formulas take center stage, the logic behind the material can get lost. That point, as it turns out, brings us to the essence of the material you're about to encounter.

In the final analysis, it's often the logic behind statistics that proves to be the key to success or failure. You can be presented with formulas—simple or complex—and you can, with enough time and commitment, memorize a string of them. All of that is well and good, but your ability to grasp the logic behind the formulas is a different matter altogether. I'm convinced that it's impossible to truly understand what statistics is all about unless you understand the logic behind the procedures. Consequently, it's the *logic* that I've tried to emphasize in this book.

Indeed, it's safe to say that numbers and formulas have taken a back seat in this book. Of course you'll encounter some formulas and numbers, but that's not where the emphasis is. Make no mistake about it—the emphasis in this book is on the conceptual basis behind the calculations.

There's one other thing about the material that deserves comment. Like it or not, the traditional approach to learning new material may come up short when you want to learn about statistical analysis. The reason is a simple one: The field of statistics is very different from other subjects you've studied in the past.

If, for example, you were taking a course to learn a foreign language, you'd probably figure out the goal of the course fairly early. You'd quickly sense that you'd be learning the basics of grammar and vocabulary, trying to increase your command of both over time. I suspect you'd have a similar experience if you signed up for a history course. You'd quickly sense that you were being introduced to names, dates, places, and overall context with the goal of increasing your understanding of the how and why behind events.

Unfortunately, the field of statistical analysis doesn't fit that learning model very well. You may be able to immediately sense where you're going in a lot of courses, but that's not necessarily the case in the field of statistics. In fact, my guess is that a command of statistical analysis is probably best achieved when you're willing to go along for the ride without really knowing at first where you're going. A statement like that is close to heresy in the academic world, so let me explain.

There *is* an end game to statistical analysis. People use statistical analysis to describe information and to carry out research in an objective, quantifiable way. Indeed, the realm of statistical analysis is fundamental to scientific inquiry. But the eventual application of statistical analysis requires that you first have a firm grasp of some highly abstract concepts. You can't even begin to appreciate the very special way in which scientists pose research questions if you don't have the conceptual background.

For a lot of students (indeed, most students, I suspect), it's a bit much to tackle concepts and applications at the same time. The process has to be broken down into two parts—first the conceptual understanding, and then the applications. And that's the essence of my notion that you're better off if you don't focus at the outset on where you're going. Concentrate on the conceptual basis first. Allow yourself to become totally immersed in an abstract, conceptual world, without any thought about direct applications. In my judgment, that's the best way to conquer the field of statistical analysis.

If you're the sort of student who demands an immediate application of concepts—if you don't have much tolerance for abstract ideas—let me strongly suggest that you lighten up a bit. If you're going to master statistics—even at the introductory level—you'll have to open your mind to the world of abstract thinking.

Toward that end, let me tell you in advance that I'll occasionally ask you to take a moment to seriously think about one notion or another. Knowing students the way I do, I suspect there's a chance (if only a small chance) that you'll ignore my suggestion and just move ahead. Let me warn you. The approach of trying to get from Point A to Point B as quickly as possible usually doesn't work in the field of statistics. When the time comes to really think about a concept, take whatever time is necessary.

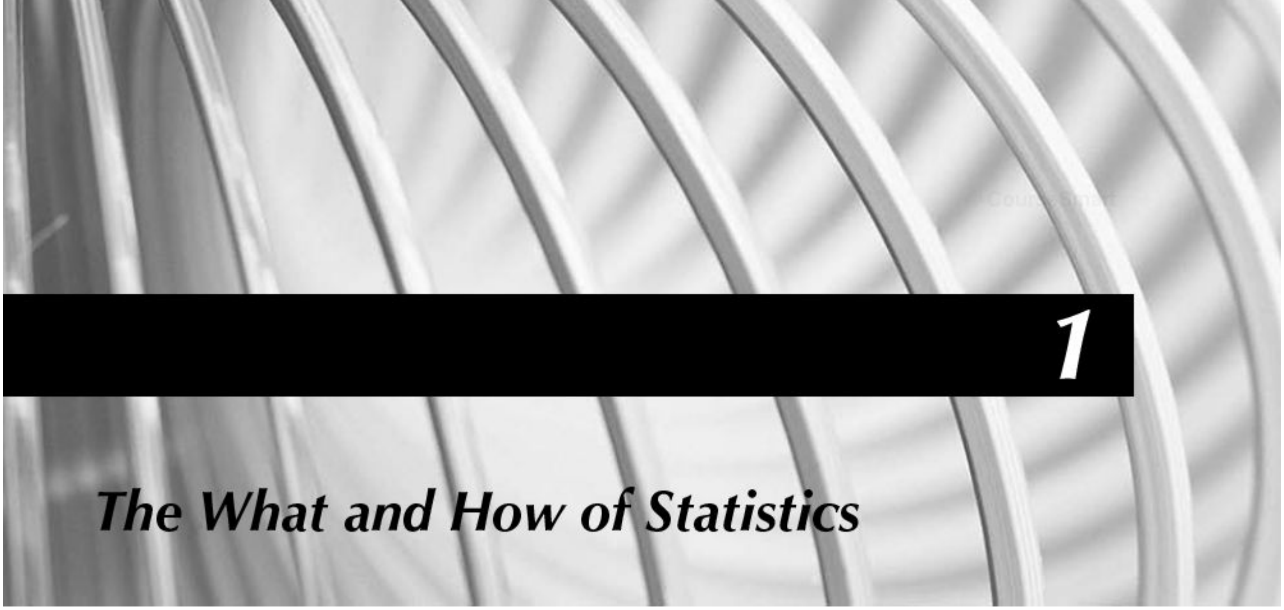
Indeed, many of my students eventually come to appreciate what I mean when I tell them that a particular concept or idea requires a "dark room moment." In short, some statistical concepts or ideas are best understood if contemplated in a room that is totally dark and void of any distractions. Those should become your moments to remember. I'm totally serious about that, so let me explain why.

Many statistical concepts are so abstract that a lot of very serious thought is required if you really want to understand them. Moreover, many of those abstract concepts turn out to be central to the statistical way of reasoning. Simply reading about the concepts and telling yourself that you'll remember what they're all about won't do it. And that's the purpose behind a dark room moment.

If I could give you a single key to the understanding of statistics, it would be this: Take the dark room moments seriously. Don't be impatient, and don't think a few dark room experiences are beneath your intellectual dignity. If I tell you that this concept or that idea may require a dark room moment, heed the warning. Head for a solitary environment—a private room, or even a closet. Turn out the lights, if need be, and undertake your contemplation in a world void of distractions. You may be amazed how it will help your understanding of the topic at hand.

Finally, I strongly urge you to deal with every table, illustration, and work problem that you encounter in this text. The illustrations and tables often contain information that can get you beyond a learning roadblock. And as to the work problems, there's no such thing as too much practice when it comes to statistical applications.

Now, having said all of that as background, it's time to get started. Welcome to the world of statistics—in this case, *Statistics Unplugged!*



1

The What and How of Statistics

- *Before We Begin*
- *A World of Information*
- *Levels of Measurement*
- *Samples and Populations*
- *The Purposes of Statistical Analysis*
  - Descriptive Statistics
  - Inferential Statistics
- *Chapter Summary*
- *Some Other Things You Should Know*
- *Key Terms*
- *Chapter Problems*

We start our journey with a look at the question of what statisticians do and how they go about their work. In the process, we'll explore some of the fundamental elements involved in statistical analysis. We'll cover a lot of terms, and most of them will have very specific meanings. That's just the way it is in the field of statistics—specific terms with specific meanings. Most of the terms will come into play repeatedly as you work your way through this book, so a solid grasp of these first few concepts is essential.

- *Key Terms*
- *Chapter Problems*

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Before We Begin

One question that seems to be on the mind of a lot of students has to do with *relevance*—the students want to know why they have to take a course in statistics in the first place. As we begin our journey, I'll try to answer that question with a few examples. Just to get started on our relevance mission, consider the following:

Let's say that you're applying for a job. Everything about the job is to your liking. You think that you're onto something. Then you encounter the last line of the job description: *Applicants must have a basic knowledge of statistics and data analysis.*

Perhaps you're thinking about applying to graduate school in your chosen field of study. You begin your research on various graduate programs across the nation and quickly discover that there's a common thread in program requirements: *Some background in undergraduate statistics or quantitative methods is required.*

Maybe you're starting an internship with a major news organization and your first assignment is to prepare a story about political races around the state. Your supervisor hands you a stack of recent political polls, and you hit the panic button. You realize that you really don't know what is meant by the phrase *margin of error*, even though you've heard that phrase hundreds of times. You have some idea of what it means, but you don't have a clue as to its technical meaning.

Finally, maybe it is something as simple as your employer telling you that you're to attend a company *year-end review* presentation and report back. All's well until you have to comprehend all of the data and measures that are discussed in the *year-end review*. You quickly realize that your lack of knowledge about statistics or quantitative analysis has put you in a rather embarrassing situation.

Those are just a few examples that I ask you to consider as we get started. I can't promise that your doubts about the relevance of statistics will immediately disappear, but I think it's a good way to start.

A World of Information

People who rely on statistical analysis in their work spend a lot of time dealing with different types of information. One person, for example, might collect information on levels of income or education in a certain community, while another collects information on how voters plan to vote in an upcoming election. A prison psychologist might collect information on levels of aggression in inmates, while a teacher might focus on his/her latest set of student test scores. There's really no limit to the type of information subjected to statistical analysis.

Though all these examples are different, all of them share something in common. In each case, someone is collecting information on a particular *variable*—level of income, level of education, voter preference, aggression level, test score. For our purposes, a **variable** is anything that can take on a different quality or quantity; it is anything that can *vary*. Other examples might include the age of students, attitudes toward a particular social issue, the number of hours people spend watching television each week, the crime rates, in different cities, the levels of air pollution in different locations, and so forth and so on. When it comes to statistical analysis, different people may study different variables, but all of them generally rely on the same set of statistical procedures and logic.

LEARNING CHECK

Question: What is a variable?

Answer: A variable is anything that can vary; it's anything that can take on a different quality or quantity.

The information about different variables is referred to as **data,** a term that's at the center of statistical analysis. As Kachigan (1991) notes, the field of statistical analysis revolves around the "collection, organization, and interpretation of data according to well-defined procedures." When the data relative to some specific variables are assembled (and note that we say *data are* because the word *data* is actually plural), we refer to the collection or bundle of information as a **data set.** The individual pieces of information are referred to as **data points,** but taken together, the data points combine to form a data set. For example, let's say that you own a bookstore and you've collected information from 125 customers—information about each customer's age, income, occupation, marital status, and reading preferences. The entire bundle of information would be referred to as a data set. The data set would be based upon 125 cases or observations (two terms that are often used interchangeably), and it would include five variables for each case (i.e., the variables of age, income, occupation, marital status, and reading preferences). A specific piece of information—for example, the age of one customer or the educational level of one customer—would be a data point.

With that bit of knowledge about data, data sets, and data points behind you, let's consider one more context in which you're apt to see the term, *data*. Statisticians routinely refer to **data distributions.** There are many ways to think of or define a data distribution, but here's one that's keyed to the material that you've just covered. Think of a data distribution as a listing of the values or responses associated with a particular variable in a data set. With the previous example of data collected from 125 bookstore customers as a reference, imagine that you listed the age of each customer—125 ages listed in a column. The listing would constitute a data distribution. In some situations you might want to

Simple Listing of Data	Frequency Distribution		Grouped Frequency Distribution	
Age	Age	Frequency (f)	Age Category	Frequency (f)
15	15	8	15–17	24
21	16	4	18–20	46
25	17	12	21–23	50
18	18	9	24–26	20
23	19	21		
17	20	16		
19	21	14		
22	22	18		
16	23	18		
15	24	10		
19	25	10		
24				
.				
.				
.				
Continued listing of individual cases for a total of 140 cases	Shows each value and number of times (the frequency or f) that it occurs. For example, the value 15 occurred 8 times in the distribution; the value 20 occurred 16 times in the distribution		Shows different age categories and number of times (the frequency or f) an age within a specific category is represented in the distribution. For example, the distribution contains a total of 46 cases that are within the age category of 18–20.	

Figure 1-1 Examples of Data Distributions (Based on a Distribution of Ages Recorded for a Distribution Having 140 Cases)

develop what's referred to as a **frequency distribution**—a table or graph that indicates how many times a value or response appears in a data set of values or responses. Even if you developed age categories (e.g., Under 18, 18 through 29, 30 through 39, 40 through 49, etc.), and you wrote down the number of cases that fell into each category, you'd still be constructing a frequency distribution (although you would refer to it as a *grouped* frequency distribution). For some examples of the different ways that a data distribution might appear, take a look at Figure 1-1.

LEARNING CHECK

Question: What is a data distribution?

Answer: A data distribution is a listing of values or responses associated with a particular variable in a data set.

Later on, you'll encounter a lot more information about data distributions—particularly, what you can learn about a distribution when you plot or graph the data, and what the shape of a distribution can tell you. For the moment, though, just remember the term *data,* along with *case* or *observation*. You'll see these terms over and over again.

Levels of Measurement

Closely related to variables is the concept of *levels of measurement.* Every variable is measured at a certain level, and some levels of measurement are, in a sense, more sophisticated than others. Here's an example to introduce you to the idea.

Let's say that you took a test along with 24 other students. Suppose the test scores were posted (a form of a data distribution) showing student rankings but not the actual test scores. In this case, you could determine how you did relative to the other students, but that's about all you could determine. You could easily see that you had, for example, the third highest score on the test. All you'd have to do is take a look at the list of rankings and look at your rank in comparison to the ranks of the other students. Someone would have the top or number one score, someone would have the second highest score, and so forth—right down to the person with the lowest rank (the 25th score). You'd know something about everyone's test performance—each person's rank—but you really wouldn't know much.

If, on the other hand, the actual test scores were posted, you'd have a lot more information. You might discover that you actually scored 74. The top score, for example might have been 95 and the next highest score might have been 80, so that your score of 74 was in fact the third highest. In this case, knowledge of the actual test score would tell you quite a lot.

In the first example (when all you knew were student ranks on the test), you were dealing with what's referred to as the *ordinal level of measurement.* In the second instance, you were dealing with a higher level of measurement, known as the *ratio level of measurement.* To better understand all of this, let's consider each level of measurement, from the simplest to the most complex.

The most fundamental or simplest level, **nominal level of measurement,** rests on a system of *categories*. A person's religious affiliation is an example of a nominal level variable, or a variable measured at the nominal level of measurement. If you were collecting data on that variable, you'd probably pose a fairly direct question to respondents about their religious affiliation, and you'd put their responses into different categories. You might rely on just five categories (Protestant, Catholic, Jewish, Muslim, Other), or you might use a more elaborate system of classification (maybe seven or even nine categories). How you go about setting up the system of categories is strictly up to you. There are just two requirements: The categories have to be mutually exclusive, and they must be collectively exhaustive. Let me translate.

First, it must be possible to place every case you're classifying into one category, but only one category. That's what it means to say that the categories are *mutually exclusive*. Returning to the question about religious affiliation, people could categorized as Protestant *or* Catholic *or* Jewish *or* Muslim *or* Other, depending on their responses, but they couldn't be placed into more than one category each.

Second, you have to have a category for every observation or case that you're classifying or recording. That's what it means to say that the categories are *collectively exhaustive*. In the process of classifying people according to their religious affiliations, for example, what would you do if someone said that he/she was an atheist? If you didn't have a category to handle that, then your system of categories wouldn't be collectively exhaustive. In many instances, a classification system includes the category Other for that very reason—to ensure that there's a category for every case being classified.

So much for the nominal level of measurement. Now let's look at the next level of measurement.

When you move to the **ordinal level of measurement,** an important element appears: the notion of *order.* For example, you might ask people to tell you something about their educational level. Let's say you give people the following response options: less than high school graduate, high school graduate, some college, college graduate, post–college graduate. In this instance, you can say that you've collected your data on the variable Level of Education at the ordinal level. You'll then have some notion of order to work with in your analysis. You'll know, for example, that the people who responded "some college" have less education than those who answered "college graduate." You won't know exactly how much less, but you will have some notion of order—of *more than* and *less than*.

If, on the other hand, you asked students in your class to tell you what time they usually awaken each morning, you'd be collecting data at the **interval level of measurement.** The key element in this level of measurement is the notion of *equal intervals*. For example, the difference between 9:15 AM and 9:30 AM is the same as the difference between 7:45 AM and 8:00 AM—15 minutes.

The final level of measurement—the **ratio level of measurement**—has all the properties of the interval level of measurement, along with one additional feature: The ratio level has a true or known *zero point*. It's a minor point, but one that you should understand.

To say that a variable is measured at the ratio level of measurement means that the variable could actually assume a value of 0 and that the value of 0 is, in a sense, legitimate. For example, if you asked students how much money they spent each week on entertainment, it is possible for some to say that they don't spend any money on entertainment. In other words, a response of 0 is possible. In this case, the 0 is "legitimate" because it really represents an absence of entertainment spending. In the process of research, it isn't necessary for you to actually have an observation in your distribution that is recorded as a 0 to say that you are working with data measured at the ratio level. All that's necessary is that a 0 response or observation be possible. When you're dealing ment. Others simply refer to the **interval/ratio level of measurement**—the practice we'll follow.

LEARNING CHECK

Question: What are the different levels of measurement?
Answer: The different levels of measurement are nominal, ordinal, interval, and ratio. Some statisticians combine the last two levels and use the term *interval/ratio,* since there's no real practical difference between the two.

My guess is that you're still wondering what the real point of this discussion is. The answer will have more meaning down the road, but here's the answer anyway: It's very common for students to complete a course in statistics, only to discover that they never quite grasped how to determine which statistical procedure to use in what situation. Indeed, many students slug their way through a course, memorizing different formulas, never having the faintest idea why one statistical procedure is selected over another. The answer, as it turns out, often relates to the level of measurement of the variables being analyzed. Some statistical procedures work with nominal or ordinal data, but other procedures may require interval/ratio data. Other factors also come into play when you're deciding which statistical procedure to use, but the level of measurement is a major element.

All of this will become more apparent later on. For the moment, let's return to some more of the fundamental elements in statistical analysis.

Samples and Populations

Samples and *populations*—these terms go to the heart of statistical analysis. We'll start with the larger of the two and work from there. In the process, we'll encounter some of the other terms you've already met in the previous section.

Here's a straightforward way to think about the term *population:*

population or universe. If you were interested in the grade point averages of students enrolled for six hours or more at a particular university, then all the students who met the criteria (that is, all students enrolled for six hours or more at the university) would constitute the population.

When you think about it, of course, you'll realize that the population of registered voters is constantly changing, just as the population of students enrolled for six hours is apt to be constantly changing. Every day, more people may register to vote, and others may be removed from the voter rolls because they have died or moved to another community. By the same token, some students may drop a course or two (thus falling below the six-hour enrollment criterion), and some students may drop out of school altogether.

Once you begin to understand the idea that a population can change (or is potentially in a state of constant flux), you're on your way to understanding the fundamentally theoretical nature of statistical analysis. Think of it this way: You want to know something about a population, but there's a good chance that you can never get a totally accurate picture of the population simply because it is constantly changing. So, you can think of a population as a collection of all possible cases, recognizing the fact that what constitutes the population may be changing.

Not only are populations often in a constant state of flux, but practically speaking, you can't always have access to an entire population for study. Matters of time and cost often get in the way—so much so that it becomes impractical to work with a population. As a result, you're very apt to turn to a sample as a substitute for the entire population.

Unfortunately, a sample is one of those concepts that many people fail to truly grasp. Indeed, many people are inclined to dismiss any information gained from a sample as being totally useless. Cuzzort and Vrettos (1996), however, are quick to point out how the notion of a sample stacks up against knowledge in general:

> There is no need to apologize for the use of samples in statistics. To focus on the limitations of sampling as a criticism of statistical procedures is absurd. The reason is evident. All human knowledge, in one way or another, is knowledge derived from a sampling of the world around us.

A **sample** is simply a portion of a population. Let's say you know there are 4,329 registered voters in your community (at least there are 4,329 registered voters at a particular time). For a variety of reasons (such as time or cost), you may not be able to question all of them. Therefore, you're likely to question just a portion of them—for example, 125 registered voters. The 125 registered voters would then constitute your sample.

Maybe you want to take a snapshot look at student attitudes on a particular issue, and let's say you've defined your population as all the students enrolled for six hours or more. Even if you could freeze the population, so to speak, and just consider the students enrolled for six or more hours at a particular time (recognizing that the population could change at any moment), you might not be able to question all the students. Because time or the cost of a total canvass might stand in your way, you'd probably find yourself working with a portion of the population—a sample, let's say, of 300 students.

As you might suspect, a central notion about samples is the idea of their being representative. To say that a sample is representative is to say that the sample mirrors the population in important respects. For example, imagine a population that has a male/female split, or ratio, of 60%/40% (60% male and 40% female). If a sample of the population is representative, you'd expect it to have a male/female split very close to 60%/40%. Your sample may not reflect a perfect 60%/40% split, but it would probably be fairly close. You could, if you wanted to, take a lot of different samples, and each time you might get slightly different results, but most would be close to the 60%/40% split. Later on, you'll encounter a more in-depth discussion of the topic of sampling, and of this point in particular. For the moment, though, let's just focus on the basics with a few more examples.

Let's say you're an analyst for a fairly large corporation. Let's assume you have access to all the employee records, and you've been given the task of conducting a study of employee salaries. In that case, you could reasonably consider the situation as one of having the population on hand. In truth, there's always the possibility that workers may retire, quit, get fired, get hired, and so on. But let's assume that your task is to get a picture of the salary distribution on a particular day. In a case such as this, you'd have the population available, so you wouldn't need to work with just a sample.

To take a different example, let's say your task is to survey customer attitudes. Even if you define your population as all customers who'd made a purchase from your company in the last calendar year, it's highly unlikely that you could reach all the customers. Some customers may have died or moved, and not every customer is going to cooperate with your survey. There's also the matter of time and expense. Add all of those together, and you'd probably find yourself working with a sample. You'd have to be content with an analysis of a portion of the population, and you'd have to live with the hope that the sample was representative.

Assuming you've grasped the difference between a sample and a population, now it's time to look at the question of what statistical analysis is all about. We'll start with a look at the different reasons why people rely on statistical analysis. In the process, you'll begin to discover why the distinction between a sample and population is so important in statistical analysis.

LEARNING CHECK

Question: What is a population?

Answer: A population is all possible cases that meet certain criteria; it is sometimes referred to as the universe.

LEARNING CHECK

Question: What is a sample?
Answer: A sample is a portion of the population or universe.

The Purposes of Statistical Analysis

Statisticians make a distinction between two broad categories of statistical analysis. Sometimes they operate in the world of *descriptive statistics;* other times they work in the world of *inferential statistics.* Statisticians make other distinctions between different varieties of statistical analysis, but for our purposes, this is the major one: descriptive statistics versus inferential statistics.

Descriptive Statistics

Whether you realize it or not, the world of descriptive statistics is a world you already know, at least to some extent. **Descriptive statistics** are used to *summarize* or *describe* data from samples and populations. A good example is one involving your scores in a class. Let's say you took a total of 10 different tests throughout a semester. To get an idea of your overall test performance, you'd really have a couple of choices.

You could create a data distribution—a listing of your 10 test scores—and just look at it with the idea of getting some intuitive picture of how you're doing. As an alternative, though, you could calculate the average. You could add the scores together and divide by 10, producing what statisticians refer to as the *mean* (or more technically, the arithmetic mean). The calculation of the mean would represent the use of descriptive statistics. The mean would allow you to summarize or describe your data.

Another example of descriptive statistics is what you encounter when the daily temperature is reported during the evening weather segment on local television. The weathercaster frequently reports the low and high temperature for the day. In other words, you're given the *range*—another descriptive statistic that summarizes the temperatures throughout the day. The range may not be a terribly sophisticated measure, but it's a summary measure, nonetheless. Just like the mean, the range is used to summarize or describe some data.

LEARNING CHECK

Question: How are descriptive statistics used?
Answer: Descriptive statistics are used to describe or summarize data distributions.

Inferential Statistics

We'll cover more of the fundamentals of descriptive statistics a little later on, and my guess is that you'll find them to be far easier to digest than you may have anticipated. For the moment, though, let's turn to the world of inferential statistics. Since that's the branch of statistical analysis that usually presents the greatest problem for students, it's essential that you get a solid understanding. We'll ease into all of that with a discussion about the difference between *statistics* and *parameters.*

As it turns out, statisticians throw around the term *statistics* in a lot of different ways. Since the meaning of the term depends on how it's used, the situation is ripe for confusion. In some cases, the exact use of the term isn't all that important, but there's one case in which it is of major consequence. Let me explain.

Statisticians make a distinction between *sample statistics* and *population parameters.* Here's an example to illustrate the difference between the two ideas. Imagine for a moment that you've collected information from a sample of 2000 adults (defined as people age 18 or over) throughout the United States—men and women, people from all over the country. Let's also assume that you have every reason to believe it is representative of the total population of adults, in the sense that it accurately reflects the distribution of age and other important characteristics in the population.

Now suppose that, among other things, you have information on how many hours each person in the sample spent viewing television last week. It would be a simple matter to calculate an average for the sample (the average number of hours spent viewing television). Let's say you determined that the average for your sample was 15.4 hours per week. Once you did that, you would have calculated a summary characteristic of the sample—a summary measure (the average) that tells you something about the sample. And that is what statisticians mean when they use the expression *sample statistic.* In other words, a **statistic** is a characteristic of a sample. You could also calculate the range for your sample. Let's say the viewing habits range from 0 hours per week to 38.3 hours per week. Once again, the range—the range from 0 to 38.3—would be a summary characteristic of your sample. It would be a sample statistic.

Now let's think for a moment about the population from which the sample was taken. It's impossible to collect the information from each and every member of the population (millions of people age 18 or over), but there is, in fact, an average or mean television viewing time for that population. The fact that you can't get to all the people in the population to question them doesn't take away from the reality of the situation.

The average or mean number of hours spent viewing television for the entire population is a characteristic of the population. By the same token, there is a range for the population as a whole, and it too is a characteristic of the population. That's what statisticians mean when they use the expression *population parameter.* In other words, a **parameter** is a characteristic of the population.

This notion that there are characteristics of a population (such as the average or the range) that we can't get at directly is a notion that statisticians live with every day. In one research situation after another, statisticians are faced with the prospect of having to rely on sample data to make inferences about the population. And that's what the branch of statistics known as **inferential statistics** is all about—using sample statistics to make inferences about population parameters. If you have any doubt about that, simply think about all the research results that you hear reported on a routine basis.

It's hard to imagine, for example, that a political pollster is only interested in the results of a sample of 650 likely voters. He/she is obviously interested in generalizing about (making inferences to) a larger population. The same is true if a researcher studies the dating habits of a sample of 85 college students or looks at the purchasing habits of a sample of 125 customers. The researcher isn't interested in just the 85 students in the sample. Instead, the researcher is really interested in generalizing to a larger population—the population of college students in general. By the same token, the researcher is interested in far more than the responses of 125 customers. The 125 responses may be interesting, but the real interest has to do with the larger population of customers in general. All of this—plainly stated—is what inferential statistics are all about. They're the procedures we use to "make the leap" from a sample to a population.

LEARNING CHECK

Question: How are inferential statistics used?
Answer: Inferential statistics are used to make statements about a population, based upon information from a sample; they're used to make inferences.

Question: What is the difference between a statistic and a parameter, and how does this difference relate to the topic of inferential statistics?
Answer: A statistic is a characteristic of a sample; a parameter is a characteristic of a population. Sample statistics are used to make inferences about population parameters.

As you'll soon discover, that's where the hitch comes in. As it turns out, you can't make a direct leap from a sample to a population. There's something that gets in the way—something that statisticians refer to as *sampling error*. For example, you can't calculate a mean value for a sample and automatically assume that the mean you calculated for your sample is equal to the mean of the population. After all, someone could come along right behind you, take a different sample, and get a different sample mean—right? It would be great if every sample taken from the same population yielded the same mean (or other statistic, for that matter)—but that's not the way the laws of probability work. Different samples are apt to yield different means.

We'll eventually get to a more in-depth consideration of sampling error and how it operates to inhibit a direct leap from sample to population. First, though, let's turn our attention to some of those summary measures that were mentioned earlier. For that, we'll go to the next chapter.

Chapter Summary

Whether you realize it or not, you've done far more than just dip your toe into the waters of statistical analysis. You've actually encountered some very important concepts—ideas such as data distributions, levels of measurement, samples, populations, statistics, parameters, description, and inference. That's quite a bit, so feel free to take a few minutes to think about the different ideas. Most of the ideas you just encountered will come into play time and time again on our statistical journey, so take the time to digest the material.

As a means to that end, let me suggest that you spend some of your free time thinking about different research ideas—things you might like to study, assuming you had the time and resources. Maybe you're interested in how the amount of time that students spend studying for a test relates to test performance. That's as good a place to start as any. Think about how you'd define your *population*. Mull over how you'd get a *sample* to study. Think about how you'd measure a *variable* such as time spent studying. Think about how you'd record the information on the variable of test performance. Would you record the actual test score (an interval/ratio *level of measurement*), or would you just record the letter grade—A, B, C, D, or F (an ordinal level of measurement)?

Later on, you might think about another research situation. Maybe there are questions you'd like to ask about voters or work environments or family structures or personality traits. Those are fine, too. All's fair in the world of research. Just let the ideas bubble to the surface. All you have to do is start looking at the world in a little different way—thinking in terms of variables and levels of measurement and samples and all the other notions you've just encountered. When you do that, you may be amazed at just how curious about the world you really are.

Some Other Things You Should Know

At the outset of your statistical education, you deserve to know something about the field of statistical analysis in general. Make no mistake about it; the field of statistical analysis constitutes a discipline unto itself. It would be impossible to cover the scope of statistics in one introductory text or course, just as it would be impossible to cover the sweep of western history or chemistry in one effort. Some people become fascinated with statistics to the point that they pursue graduate degrees in the field. Many people, with enough training and experience, carve out professional careers that revolve around the field of statistical analysis. In short, it is an area of significant opportunity.

Whether you take the longer statistical road remains to be seen. Right now, the focus should be on the immediate—your first encounter with the field. Fortunately, the resources to assist you are present in spades. For example, Cengage (the publisher of this text) has an excellent website available and easily accessible for your use. Let me encourage you to visit it at the following URL:

www.cengage.com/psychology/caldwell

Libraries and bookstores also have additional resources—other books you may want to consult if some topic grabs your attention or seems to be a stumbling block. My experience tells me that it pays to consider several sources on the same topic—particularly when the subject matter has to do with statistical analysis. The simple act of consulting several sources introduces you to the fact that you'll likely find different approaches to symbolic notation in the field of statistics, as well as different approaches to the presentation of formulas. Beyond that, one author's approach may not suit you, but another's may offer the words that unlock the door. There's hardly a lack of additional information available. What's needed is simply the will to make use of it when necessary. In the world of statistical analysis, there's a rule of thumb that never seems to fail: If a good resource is available, give it a look.

Key Terms

data
data distribution
data point
data set
descriptive statistics
frequency distribution
inferential statistics
interval level of measurement
interval/ratio level of measurement
nominal level of measurement
ordinal level of measurement
parameter
population
ratio level of measurement
sample
statistic
universe
variable

Chapter Problems

Fill in the blanks with the correct answer.

1. A researcher is trying to determine if there's a difference between the performance of liberal arts majors and business majors on a current events test. The variables the researcher is studying are __________ and __________. (Provide names for the variables.)
2. A researcher is studying whether or not men and women differ in their attitudes toward abortion. The variables the researcher is studying are __________ and __________. (Provide names for the variables.)

3. The level of measurement based upon mere categories—categories that are mutually exclusive and collectively exhaustive—is referred to as the _________ level of measurement.
4. The level of measurement that has all the properties of the nominal level of measurement, plus the notion of order is referred to as the _________ level of measurement.
5. The level of measurement at which mathematical operations can be carried out is referred to as the _________ level of measurement.
6. A researcher collects information on the political party affiliation of people at a local community meeting. The information on party affiliation (Republican, Democrat, Independent, or Other) is said to be measured at the _________ level of measurement.
7. A researcher collects information on the number of absences each worker has had over the past year. He/she has the exact number of days absent from work. That information would be an example of a variable (absences) measured at the _________ level of measurement.
8. Participants in a research study have been classified as lower, middle, or upper class in terms of their socioeconomic status. We can say that the variable of social class has been measured at the _________ level of measurement.
9. A researcher wants to make some statements about the 23,419 students at a large university and collects information from 500 students. The sample has _________ members, and the population has _________ members.
10. A statistic is a characteristic of a _________; a parameter is a characteristic of a _________.
11. In the world of inferential statistics, sample _________ are used to make inferences about population _________.
12. _________ statistics are used to describe or summarize data; _________ statistics are used to make inferences about a population.