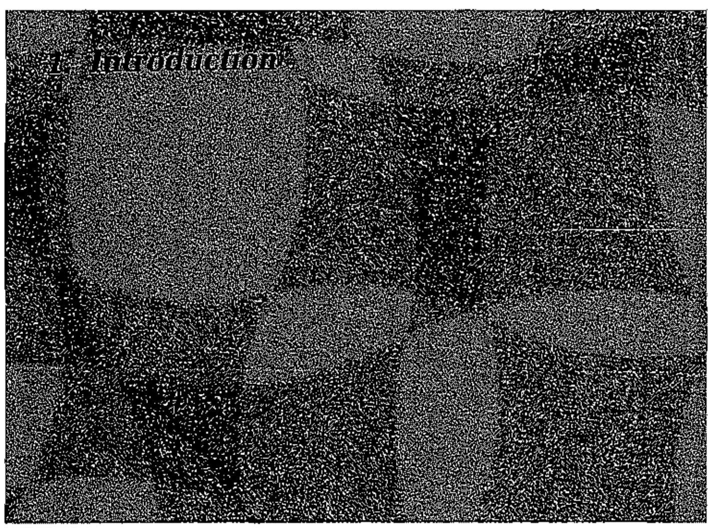
PART 1

Getting Started



1 Introduction

Numbers are very much a part of modern life. "The average high temperature in New York City for January is 37 degrees Fahrenheit." "The president's popularity is 45%, subject to an error of 3%." "After the institution of the 55 mph speed limit, highway fatalities decreased by 16.4%." "Prices are reduced in this sale by over 50%." "There were 12.5 million people enrolled in college during 1983." Numbers are just as much a part of modern life as pollution, rock and roll, miracles of medicine, and nuclear weapons. If the quality of life is to be improved in this modern world, its citizens must understand how to make sense out of numbers.

Numbers are not important in and of themselves. They are important because they help us make decisions. Decisions can be made without numbers, but if the right numbers are used, in the right way, the quality of decisions can be improved. In the purchase of a home computer, for example, one could guess which computer model is the most reliable, but one would be better informed if the statistics for repair rate were available. Knowing the numbers can help the consumer make the decision, but other factors besides repair rate are important. Ease of use, styling, and cost also contribute to sensible decision making. Numbers help people make all kinds of decisions in everyday life—what courses to take, what stereo to purchase, whether to have a surgical operation.

Numbers are essential in helping us as a society make decisions. Changes in the economy alert business and government to the need for changes in investment and tax laws. Increases in the rate of cancer point to potential causes and indicate new environmental legislation. Also, numbers obtained from Scholastic Aptitude Tests can be used to indicate how good a job schools are doing. As with individual decisions, societal decisions are not made by the numbers but rather are guided by them. The political process sets the priorities and the values. Numbers are a means to an end and not the end unto themselves.

Numbers are not only used by human beings, but they come from human beings. People attempt to monitor reality and attach numbers to objects. For instance, today's temperature is 65 degrees, dinner cost $10.41, or the last movie I saw was a "10." All these numbers refer to an object (a day, a meal or a movie), but the numbers are attached to the objects by people. Someone decided to charge $10.41 for a meal, scientists have agreed that, in a fever thermometer, so many millimeters of mercury correspond to a temperature of 98.6 degrees. Thus, although numbers seem to be cold and impersonal, they are by necessity personal. Numbers attached to objects only seem to be objective, but they are actually based on a set of social conventions. A number referring to an object is given a meaning by persons. Humans use machines and computers to assist them in assigning numbers to objects, but it is a human being, not the machine, that assigns the numbers.

Many of today's numbers come from computers. Phone bills, class registration forms, library cards, and cash registers continually bombard us with computer-generated numbers. It is becoming common practice to blame the impersonal computer for all of society's ills. People fume when a computer makes a mistake, but the error is usually caused by the person who entered the data into the computer and not by the machine itself. The numbers from a computer only *seem* impersonal. They are actually products of human thought and action, although it may be difficult to see the hand of the person who programmed the computer.

If numbers are to be used intelligently, their meaning must first be comprehended. To most, numbers are not as enjoyable as a day at the beach, but if we are to survive and thrive we must learn how to make sense out of them. That is the purpose of this book: making sense out of numbers.

Essential Definitions

Social and behavioral scientists are busy measuring intelligence, recall, conformity, fear, and social status. *Measurement* is the assignment of numbers to objects using an operational definition in order to measure a variable. The following terms must be carefully distinguished: *number,* an *object,* a *variable,* and a variable's *operational definition.* A *number,* a *score,* or a *datum* is a numeric value given to an object. If someone has a temperature of 102 degrees, the number is 102. More than one number is called *data.* The *object* is the entity to which the number is attached. So for the previous example of a person with a 102 degree temperature, the object is the person. The *variable* is the construct that the researcher is attempting to measure. For this example the variable is temperature. Measurement always requires performing a series of steps. These steps are called the variable's *operational definition.* For temperature, one operational definition is the level of mercury in a thermometer that has been in the mouth of a person for two minutes.

Another example might help clarify the distinctions between number, object, variable, and operational definition. Jane receives a score of 98 on her midterm examination. The number is 98, the object is Jane, the variable is midterm examination grade, and the operational definition is the number correct on the midterm examination divided by the total number possible and then multiplied by 100. Still yet another example is that Paul's car travels at 63 miles per hour. The number or datum is 63, the object is Paul's car, the variable is speed, and the operational definition is the number of miles traveled during a time period divided by the length of the time period.

Sample and Population

Knowing that your score is 109 on an examination tells you little or nothing. If 109 is the lowest grade on the test, however, you know you are in trouble. Thus it is evident that numbers make little sense in isolation. Only when they are in groups do they have any meaning. This is the reason that numbers come in batches. In this book a set of numbers is called a sample. The term *sample* is used because the numbers are assumed to be a subset of scores from a larger group of scores. The term for the larger group of scores is *population*. So if a researcher studies the performance of rats running a maze, he or she may examine closely the behavior of a sample of ten rats. But the behaviors of the ten rats are assumed to be representative of behaviors of the larger population of laboratory rats.

From the sample data, the researcher computes quantities that are used to summarize the data. A quantity computed from sample data is called a *statistic*. In statistical work, the data are analyzed for two very different purposes. A statistic can be used either to describe the sample or to serve as a basis for drawing inferences about the population. *Descriptive statistics* concern ways of summarizing the scores of the sample. *Inferential statistics* concern using the sample data to draw conclusions about the population. So descriptive statistics refer to the description of the sample, and inferential statistics have to do with inferences about the population.

Consider a survey of 1000 voters that is to be used to predict a national election. The 1000 voters form the sample, and all those voting in the national election form the population. The characterization of the preferences of the 1000 voters in the sample involves descriptive statistics. Using these descriptions to infer about the results of the national election involves inferential statistics.

Descriptive statistics always precede inferential statistics. First the sample data are carefully analyzed and then the researcher is in position to draw inferences about the population. In Chapters 2 through 8 the methods used in descriptive statistics are presented. Chapters 9 through 18 discuss the procedures used in inferential statistics.

Level of Measurement

Numbers can provide three different types of information. First, they can be used simply to *differentiate* objects. The numbers on the players' backs when they play football or baseball are there so that the spectators can know who scored the touchdown or hit the home run. Second, numbers can be used to *rank* objects. Those objects with lower numbers have *more* (or sometimes, less) of some quantity. In that case the numbers tell how objects rate relative to each other. It is a common practice to rank order the participants after the finish of a race: first, second, third, and so on. Third, numbers can be used to *quantify* the relative difference between persons. This is done when height and weight are measured. When you lose weight you want to know the *number* of pounds that you lost and not just that you weigh less. So, there are three major uses for numbers:

1. to differentiate objects,
2. to rank objects, and
3. to quantify objects.

The *nominal level of measurement* serves only to differentiate objects or persons. Variables for which persons are only differentiated are called *nominal* variables. Examples of nominal variables are ethnicity, gender, and psychiatric diagnostic category. Consider the categorization of persons' religious affiliations. It is possible to assign a one to those who are Protestants, a two to those who are Jewish, and a three to the Catholics. These numbers are used to differentiate the religions, but they do not rank or quantify them. Sometimes each individual receives a unique number, such as a social security number, and other times many individuals share a common number (zip code). Both zip codes and social security numbers are nominal variables.

The *ordinal level of measurement* not only differentiates the objects but also ranks them. For instance, students may be asked to rank-order a set of movies from most to least enjoyable. Records are often ranked from the least to the most popular. The "top 40" musical hits illustrate the ordinal level of measurement. At the ordinal level of measurement, the numbers show which objects have *more* of the variable than other objects, but the numbers do not say how much more.

The *interval level of measurement* presumes not only that objects can be differentiated and ranked but also that the differences can be quantified. Thus, if John weighs 198 pounds, Jim 206, and Sam 214, the amount that Sam weighs more than Jim, 8 pounds, is equal to the amount that Jim weighs more than John. The interval level of measurement differentiates, ranks, and quantifies. Table 1.1 summarizes the ways in which the three levels of measurement differ.

For variables measured at the interval level of measurement, the numbers

TABLE 1.1 **Properties of Different Levels of Measurement**

Level	Differentiate	Rank	Quantify
Nominal	Yes	No	No
Ordinal	Yes	Yes	No
Interval	Yes	Yes	Yes

are said to be in a particular unit of measurement. The *unit of measurement* defines the meaning of a difference of one point in the variable. So if a researcher measures weight, it is important to know whether the unit of measurement is pound, gram, or kilogram.

For the runner in a race, the number on his or her back is at the nominal level of measurement, the place the runner comes in is at the ordinal level, and the time it takes to complete the race is at the interval level. Another example might help in understanding the differences between the three levels of measurement. You and your classmates have different numbers. Your social security numbers differ, and those are nominal differences. You will have class ranks on the midterm exam, and those are ordinal differences. Finally, you are different ages, and those are interval differences.

Determining the level of measurement of many variables can be accomplished by common sense. It is fairly obvious that a variable such as age in years is at the interval level of measurement and that gender (male versus female) is a nominal variable. Generally, the best way to determine the level of measurement is by the procedures used to measure the variable. For instance, if subjects are asked to rank order the stimuli, then the stimuli are at the ordinal level of measurement. Most problematic is establishing that a variable is at the interval level of measurement. One can safely assume that a variable that is measured in physical units—such as time, size, and weight—is at the interval level of measurement. However, for variables whose units are quite subjective, for example, a rating of how much a person likes a movie on a scale from 1 to 10, it is not clear whether the level of measurement is the ordinal or the interval level. Some researchers prefer to be quite conservative, and claim that the level of measurement is only at the ordinal level. Most researchers, however, are willing to assume that the variable is at the interval level.

The decision concerning the level of measurement has very important consequences for the statistical analysis. The valid interpretation of many of the commonly used statistical techniques requires that a variable be measured at the interval level of measurement. There are also techniques that can be used if the variables are measured at the nominal and the ordinal levels of measurement, but these techniques tend not to be nearly as informative as those that were developed for the interval level. If one wishes to be conservative, one can always assume that the variables are at the nominal or ordinal level of measurement.

In some very special cases the same variable can be at one level for one purpose and at another level for a second purpose. Consider the variable of first letter of a person's last name. Ordinarily this would be considered a nominal variable. That is, the first letter of the last name only differentiates us from one another. However, Segal (1974) asked members of a police academy to indicate who their best friends were. Trainees at this academy were assigned dormitory rooms and to seats in classes on the basis of the alphabetic order of their last names. And so, trainees whose last names were closer alphabetically were in closer physical proximity. Segal found that persons whose names were closer together in the alphabet were more likely to be friends. In this case the first letter of one's last name, which is ordinarily a nominal variable, became an ordinal variable.

In the section of this book dealing with descriptive statistics, Chapters 2 through 7 consider primarily variables measured at the interval level of measurement. Chapter 8 concerns the description of variables measured at the nominal and ordinal levels of measurement. In the inferential section, Chapters 10 through 18, the variable of prime importance is measured at the interval level in all chapters but 17 and 18. Inferential issues for nominal variables are considered in Chapter 17 and ordinal variables in Chapter 18.

It is common to consider a fourth level of measurement as well. At the *ratio level of measurement* it is permissible to compute the ratio between two measurements. For example, it might be said that John weighs twice as much as Sally. A key feature of the ratio level of measurement is that the value of zero is theoretically meaningful. However, the interpretation of no statistical technique discussed in this text requires that the variables be measured at the ratio level, and interval-level statistics are appropriate for ratio measurements.

Mathematical Necessities

The purpose of this text is to help the student to understand better the meaning of numbers. To make sense out of numbers it is necessary to perform mathematical operations on them. Fortunately, most of the mathematics employed is at the high school level.

Rounding

The data in statistics are usually stated as integer values—for instance, the number of bar presses, dollars earned annually, or the number correct on a test. Sometimes a number may have many decimal places and some of the trailing digits must be dropped to round the number. There are two decisions:

1. How many decimal places should be reported?
2. What is to be reported for the last digit?

These decisions must be made whenever computations are performed in data analysis. After dividing or taking a square root, the resulting number may have many trailing digits.

A good rule of thumb is to report a result of calculations to two more digits than the original data. So if the original data were integers or whole numbers, the result would be reported to two decimal places—that is, to the nearest hundredth. Because many statistics involve finding small differences between large numbers, one should use as many digits as possible during intermediate calculations. Minimally, during computations four more digits than the original data (twice as many as the number of digits to be reported) should be used. Any numerical result that is compared to a number in a table should be computed to at least as many digits as there are in the table.

After having decided on the number of digits to report, there is still the decision about what to do with the last digit. This decision concerns rounding. In rounding, one begins by examining the remaining quantity after the digit that is to be rounded. So if the number to be rounded is 4.3256 and the result is to be rounded to the nearest hundredth, then the remaining quantity is 56. If that quantity is greater than 50, one rounds up and less than 50 one rounds down. If the quantity number is exactly 50, then one rounds to the nearest *even* number. The numbers below are rounded to the nearest hundredth, as follows:

12.12123 is rounded to 12.12
12.12759 is rounded to 12.13
12.124 is rounded to 12.12
12.12507 is rounded to 12.13
12.12500 is rounded to 12.12
12.13500 is rounded to 12.14

When there is one number to be rounded that is exactly 5, it is not uncommon for there to be many such numbers. To avoid substantial rounding error, one should consider including another significant digit before rounding. For instance, instead of rounding to two decimal places, one rounds to three decimal places.

Proportions, Percentages, and Odds

If you take a multiple-choice test and get 24 correct out of 30 questions, there are a number of ways to express how well you did on the test. You could compute the proportion of the items that you successfully completed. That would be 24 divided by 30 or .80. Because decimal points can be confusing, the proportion is often multiplied by 100 to obtain the percentage of correct items: 100% × .80 = 80%. Finally the odds of answering a question correctly can be computed. To compute this, the number correct, 24, is divided by the number incorrect: 24/6 = 4. In brief, the proportion of correct answers is .80, the percentage is 80, and the odds of answering a question correctly are 4 to 1, or 4.

The formulas for proportion, percentage, and odds are as follows, where n is the number correct and m the number incorrect:

$$\text{proportion correct} = \frac{n}{n + m}$$

$$\text{percentage correct} = 100 \times \text{proportion}$$

$$\text{odds of being correct} = \frac{n}{m}$$

The odds can be derived from the proportion and from the percentage as follows:

$$\text{odds} = \frac{\text{proportion}}{1 - \text{proportion}} = \frac{\text{percentage}}{100 - \text{percentage}}$$

Alternatively, the proportion and the percentage can be derived from the odds; that is,

$$\text{proportion} = \frac{\text{odds}}{\text{odds} + 1}$$

$$\text{percentage} = 100\left[\frac{\text{odds}}{\text{odds} + 1}\right]$$

Squares and Square Roots

In statistical work it is often necessary to square numbers and to compute square roots. Recall that a number squared equals the number times itself. The term X squared is denoted by X^2. Thus, 6 squared is symbolized as 6^2 and is 6 times 6, or 36. The square root of a number times the square root of the same number equals the number. Thus, the square root of 9 (3) times the square root of 9 (3) equals 9. The square root of a number X is symbolized by the radical sign: $\sqrt{X}$. The square root of a negative number yields an imaginary solution, so one ordinarily does not attempt this computation. Also, the square root of X^2 equals either $+X$ or $-X$. In statistical work, only the positive square root is normally considered.

Logarithms

A bit more complicated than squares and square roots are logarithms—or, as they are more commonly and simply called, *logs*. A logarithm is said to have a base. The logarithms that you probably learned about in high school are called common logarithms and their base is 10. The logarithm of X for base 10 is defined as the number Y that satisfies the equation

$$X = 10^Y$$

So if $X = 100$, then $Y = 2$ because

$$100 = 10^2$$

It is said that 2 is the log of 100 with a base of 10.

The antilog of a number is that quantity whose logarithm would produce the number. For instance, 100 is the antilog of the number 2 with a base of 10.

In scientific work it is more common not to use 10 as the base but to use a special number e. The number e, like the number $\pi(3.14\ldots)$, which is used to compute the diameters and areas of circles, has unique mathematical properties. Both π and e have an infinite number of trailing digits. The value of e to three decimal places is 2.718. The number 2.718 can be used to approximate e. The number e is very useful in accounting. Say I had X dollars and I found a banker who would give me a 100% interest rate compounded instantaneously. At the end of the period I would have X times e dollars. The number e is also very useful in demography in projecting population growth.

Logarithms to the base e are called *natural logarithms* and they are usually symbolized as $\ln(X)$. If the common log of a number is known, one can convert the common log into the natural log. The formula for doing so is

$$\ln(X) \approx 2.303 \log_{10}(X)$$

In words, the natural logarithm of a number approximately equals 2.303 times the common logarithm of a number.

There are a number of facts about logarithms that hold regardless of base. First, it should be noted that the logs of zero or a negative number are not defined, regardless of the base. Second, the log of the product of two numbers equals the sum of the logs of the two numbers. This second fact explains how a calculator or a computer might multiply two numbers. It could multiply by adding the logs of two numbers and then taking the antilog.

Because logarithms are difficult to determine, they are usually tabled. Logarithms are available on many hand-held calculators and almost all computers. On calculators common logs are usually denoted as $\log(X)$ and natural (base e) logs are usually denoted as $\ln(X)$.

Summation Sign

Many times in statistical work it is necessary to add a set of scores. For instance, suppose the sum of the following ten numbers is needed: 76, 83, 41, 96, 38, 71, 87, 39, 66, and 99. Their sum can be denoted as

$$76 + 83 + 41 + 96 + 38 + 71 + 87 + 39 + 66 + 99$$

but that takes up too much space, and so simplification is needed. First, let X_1 stand for 76, X_2 for 83, and so on. The sum of the ten numbers can be represented by

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9 + X_{10}$$

This is more compactly represented by

$$\sum_{i=1}^{n} X_i$$

which is read as the sum of the X's. The symbol Σ is called a *summation sign*. The terms below ($i = 1$) and above (n) the summation sign mean that the X's are summed from X_1 to X_n. The terms $i = 1$ and the n that are below and above the summation sign are generally omitted and implicitly understood when the intent is to add *all* of the numbers in the set. The symbol Σ is a Greek capital letter sigma which sounds like an "s." The first letter of sum is an "s," and so a Greek "s" is used to stand for sum. The symbol ΣX is read as "sum all the X's."

One basic theorem for summation signs is

$$\sum k = nk$$

where n is the number of terms that are summed and k is a constant, such as 2.0. In words, summing a constant n times equals n times the constant.

A second theorem is

$$\sum(X + Y) = \sum X + \sum Y$$

In words, sum of the sums of two sets of numbers equals the sum of the sums of the sets added separately. It is easy to verify the truth of this theorem. Consider the scores of four persons on the variables X and Y:

Person	X	Y	$X + Y$
1	9	12	21
2	13	11	24
3	6	9	15
4	10	8	18
Total	38	40	78

The sum of the X's or ΣX equals 38, and the sum of the Y's or ΣY equals 40. It is then true that $\Sigma X + \Sigma Y$ equals 78. The sum of $X + Y$ also equals 78.

It is important that ΣX^2 be clearly distinguished from $(\Sigma X)^2$. The term ΣX^2 is the sum of the squared numbers: square first, then sum. The term $(\Sigma X)^2$ is sum of all the numbers, which is then squared: sum first, then square. So if the set of numbers is 4, 7, and 9, ΣX^2 equals $16 + 49 + 81$ or 146, and $(\Sigma X)^2$ equals $(4 + 7 + 9)^2$ or $(20)^2$ or 400.

Using a Calculator in Statistical Work

The analysis of data is aided by the use of a calculator, and it has become an indispensable tool in statistical work. Even with the increasing availability of computers, a calculator remains a very important tool in data analysis. A calculator eases the burden of tedious computation. Before purchasing a calculator you should consider the following facts.

1. The calculator should be able to handle large numbers, up to 99,999,999 at least. When balancing a checkbook, most people do not need eight digits, but in data analysis numbers that large are often encountered. Even though the data may have only a few digits, certain computations requiring summing and squaring can easily result in large numbers.
2. A calculator should have a square root key. Looking up square roots in tables creates too much rounding error, and computing them by hand is time-consuming.

For this text, it is helpful to have a calculator that has a memory key. This key can be used to store intermediate values to many significant digits. It is also desirable for the calculator to have a key for logarithms. Preferably the calculator has a natural logarithm key (ln). If there is only a key for common logs (log), then one can first compute the common log and then multiply by 2.303 to obtain the approximate natural log value.

It is possible to purchase, at greater cost, calculators that perform some of the statistical methods described in this book. However, for the beginner these calculators can create problems because it may be quite difficult to determine whether an error has been made. After completing this course, you might consider purchasing one of these more sophisticated calculators.

There are a number of helpful hints that can increase the accurracy in your computation:

1. Because most rounding error is introduced by square root, division, and logarithm operations, one should perform them as late as possible in a calculation.
2. Save preliminary computations in the calculator's memory or, if that is not possible, on a piece of paper. So if you make a mistake near the end of the calculation, you do not have to start all over.
3. All calculations should be repeated to check for errors.
4. On many calculators you must hit the equal sign to complete the calculations. Make certain that you have hit the equal sign when you have completed the calculation. If you fail to do so, your final result may be incorrect.
5. Before beginning the calculations, hit the clear key. If you fail to do so, prior calculations may carry over to the next set of calculations.

Summary

Numbers are part of modern life. They help us in making decisions in our own lives and in decisions made by society. Persons create the numbers, not machines.

A number refers to an object or a person and is assigned to that object or person by a set of rules, called the *operational definition*. The *variable* is the construct that the researcher is attempting to measure. A set of numbers is called a *sample*, which in turn is part of a larger set called the *population*. Procedures that summarize the sample data are called *descriptive statistics*, and procedures used to draw conclusions about the population are called *inferential statistics*.

The number can be measured at one of three levels. At the *nominal* level the numbers only differentiate the objects. Examples of nominal variables are gender, ethnicity, and political party. At the *ordinal* level the numbers differentiate and rank the objects. An example of an ordinal variable is the order of finish in a race. At the *interval* level the numbers differentiate, rank, and quantify the objects. Examples of interval variables are weight, height, and age. For a statistic to be properly interpreted, it must be measured at the appropriate level of measurement. The level of measurement for a given variable is determined by theory and experience.

A percentage is 100 times a proportion. The odds are a proportion divided by one minus the proportion. The logarithm of a number is defined as that exponent for a base that equals the number. The base used in scientific work is e, which equals approximately 2.718. The summation sign Σ is commonly used to denote the sum of a set of numbers.

Problems

1. For each of the following, identify the number, object, and variable.

   a. a score of 76 for John on the midterm
   b. $6.98 for a Rolling Stones album
   c. 28 EPA estimated mileage for the 1986 Ford Tempo
   d. Mary, a brown-eyed person
   e. Sue, the third person to arrive at the party
   f. soft drink A, which has 40 calories
   g. Joe, whose telephone area code is 202
   h. the Conolly building with 44 floors

2. State the level of measurement for the following variables.

   a. heartbeats in a one-minute period
   b. blood type
   c. birth order (e.g., firstborn, second-born)

d. rating a movie from one to ten
e. age
f. ethnicity (e.g., black, white, Hispanic)
g. army rank (e.g., captain, lieutenant)
h. eye color (e.g., blue, brown)

3. Compute the following and round to the nearest hundredth.

   a. $\ln(67)$ b. $\ln(.55)$
   c. $(\sqrt{15})(6.1)^2\ln(15)$ d. $71/\ln(.01)$

4. One person's mood is measured for 20 straight days. The 20 numbers can be treated as a sample. For this example, what are the objects?

5. Round the following numbers to the nearest hundredth.

   a. .524 b. −.325 c. .835 d. .5251
   e. −.483 f. −.12563 g. −.130 h. .355

6. Harrison (1980) studied reactions to offers of aid. The eight subjects in the experimental condition were offered help on a boring task. They subsequently rated on an eleven-point scale how uncomfortable they expected to feel in future interactions with the person who had offered help. The results are given below. A higher score indicates more discomfort.

   10 1 3 5 3 7 7 3

   Find the following quantities.

   a. ΣX b. ΣX^2 c. $(\Sigma X)^2$
   d. $\Sigma(X - 1)$ e. $\Sigma X - 1$ f. $\Sigma(X - 1)^2$

7. Cutrona (1982) asked 162 college freshmen what events or situations triggered loneliness. The percentage of responses in each category is listed below.

Category	*Percent*
A. Leaving family and friends	40
B. Breakup of relationship	15
C. Problems with friends	11
D. Family problems	9
E. Academic difficulties	11
F. Living in isolation	6
G. Fraternity or sorority rejection	3
H. Medical problems	2
I. Birthday forgotten	1

   a. Compute the proportion of responses in each category.
   b. Compute the odds of a response occurring in each category. Round the odds to two decimal places.

8. A researcher has 20 male subjects study a list of 40 words for five minutes. They are then asked to recall the 40 words. The researcher develops a memory score, which is the percentage of words correctly recalled. Identify

   a. the objects
   b. the data
   c. the variable
   d. the operational definition
   e. the units of measurement

9. Round the following numbers to the nearest tenth.

   a. .6666 b. –.333 c. .66 d. .55
   e. –.450 f. –.451 g. –.4501 h. .4999

10. Compute natural logarithms of the following numbers and round the result to the nearest thousandth.

    a. 15 b. 21 c. .33 d. .19
    e. 2.718 f. 1.000 g. 10.00 h. .3333

11. Consider a set of houses on one side of the street with the following addresses.

    101, 121, 141, 181, 201, 221, 223

    At what level of measurement are these numbers?

12. For the following sample of numbers,

    1, 6, 7, 4, 3, 6, 4

    compute

    a. ΣX b. ΣX^2 c. $(\Sigma X)^2$
    d. $\Sigma(X - 1)$ e. $\Sigma X - 1$ f. $\Sigma(X - 1)^2$