CHAPTER 13 Inductive Reasoning

If it looks like a duck, walks like a duck, and quacks like a duck, then it's a duck. This is usually good reasoning. It's probably a duck. Just don't assume that it *must* be a duck for these reasons. The line of reasoning is not sure-fire. It is strong inductive reasoning but it is not strong enough to be deductively valid. Deductive arguments are arguments judged by the deductive standard of, "Do the premises force the conclusion to be true?" Inductive arguments are arguments judged by the inductive standard of, "Do the premises make the conclusion probable?" So the strengths of inductive arguments range from very weak to very strong. With inductively strong arguments there is a small probability that the conclusion is false even if the premises are true, unlike with deductively valid arguments. An inductive argument can be affected by acquiring new premises (evidence), but a deductive argument cannot be. This chapter focuses specifically on the nature of the inductive process because inductive arguments play such a central role in our lives. We will begin with a very important and very common kind of inductive argument, generalizing from a sample. Then later we will consider the wide variety of inductive arguments.

Generalizing from a Sample

Scientists collect data not because they are in the business of gathering facts at random but because they hope to establish a generalization that goes beyond the individual facts. The scientist is in the business of sampling a part of nature and then looking for a pattern in the data that holds for nature as a whole. A sociologist collects data about murders in order to draw a general conclusion, such as "Most murders involve guns used on acquaintances." A statistician would say that the scientist has sampled some cases of murder in order to draw a general conclusion about the whole population of murders. The terms **sample** and **population** are technical terms. The population need not be people; in our example it is the set of all murders. A sample is a subset of the population. The population is the set of things you are interested in generalizing about. The sample is examined to get a clue to what the whole population is like.

The goal in drawing a generalization based on a sample is for the sample to be **representative** of the population, to be just like it. If your method of selecting the sample is likely to be unrepresentative then you are using a **biased method** and that will cause you to commit the **fallacy of biased generalization**. If you draw the conclusion that the vast majority of philosophers write about the meaning of life because the web pages of all the philosophers at your university do, then you've got a biased method of sampling philosophers' writings.

Whenever a generalization is produced by generalizing on a sample, the reasoning process (or the general conclusion itself) is said to be an **inductive generalization**. It is also called an **induction by enumeration** or an **empirical generalization**. Inductive generalizations are a kind of argument by analogy with the implicit assumption that the sample is analogous to the population. The more analogous or representative the sample, the stronger the inductive argument.

Generalizations may be statistical or non-statistical. The generalization, "Most murders involve guns," contains no statistics. Replacing the term *most* with the statistic 80 percent would transform it into a statistical generalization. The statement "80 percent of murders involve guns" is called a **simple statistical claim** because it has the form

x percent of the group G has characteristic C.

In the example, x = 80, G = murders, and C = involving guns.

A general claim, whether statistical or not, is called an inductive generalization only if it is obtained by a process of generalizing from a sample. If the statistical claim about murders were obtained by looking at police records, it *would* be an inductive generalization, but if it were deduced from a more general principle of social psychology, then it would not be an inductive generalization, although it would still be a generalization.

———CONCEPT CHECK———

Is the generalization "Most emeralds are green" a statistical generalization? Is it an inductive generalization?

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306 It is not statistical, but you cannot tell whether it is an inductive generalization just by looking. It all depends on where it came from. If it was the product of sampling, it's an

Back from the grocery store with your three cans of tomato sauce for tonight's spaghetti dinner, you open the cans and notice that the sauce in two of the cans is spoiled. You generalize and say that two-thirds of all the cans of that brand of tomato sauce on the shelf in the store are bad. Here is the pattern of your inductive generalization:

x percent of sample S has characteristic C.
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x percent of population P has characteristic C.

In this argument x = 66.7 (for two-thirds), P = all the tomato sauce cans of a particular brand from the shelf of the grocery store, S = three tomato sauce cans of that brand from the shelf of the grocery store, and C = spoiled. Alternatively, this is the pattern:

Sample S has characteristic C. So, population P has characteristic C.

where C is now not the property of being spoiled but instead is the property of being 66.7 percent spoiled. Either form is correct, but be sure you know what the C is.

The goal in taking samples is for the sample to be representative of the population it is taken from, in regard to the characteristics that are being investigated.

The more the sample represents the population, the more likely the inductive generalization is to be correct. By a **representative sample** we mean a sample that is perfectly analogous to the whole population in regard to the characteristics that are being investigated. If a population of 888 jelly beans in a jar is 50 percent black and 50 percent white, a representative sample could be just two jelly beans, one black and one white. A method of sampling that is likely to produce a non-representative sample is a **biased sampling method**. A biased sample is a non-representative sample.

The fallacy of hasty generalization occurs whenever a generalization is made too quickly, on insufficient evidence. Technically, it occurs whenever an inductive generalization is made with a sample that is unlikely to be representative. For instance, suppose Jessica says that most Americans own an electric hair dryer because most of her friends do. This would be a hasty generalization, since Jessica's friends are unlikely to represent everybody when it comes to owning hair dryers. Her sampling method shows too much bias toward her friends.

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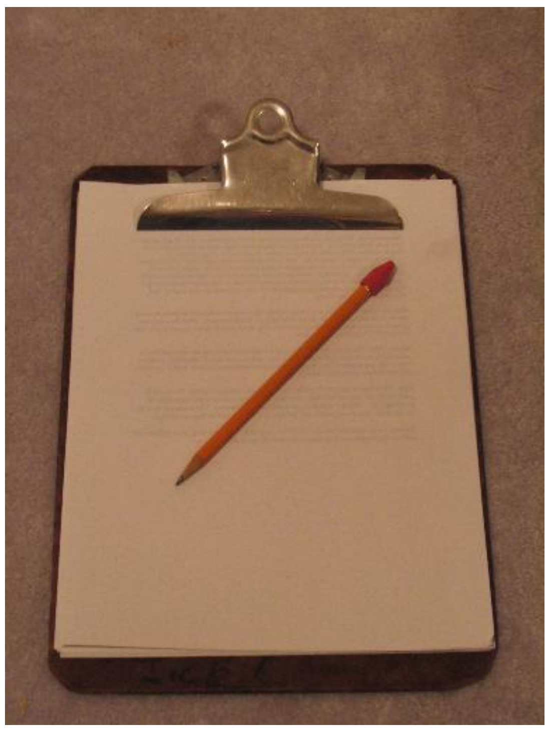
inductive generalization. If not, then it's not an inductive generalization. Either way, however, it is a generalization.

Random Sample

Statisticians have discovered several techniques for avoiding bias. The first is to obtain a random sample. When you sample at random, you don't favor any one member of the population over another. For example, when sampling tomato sauce cans, you don't pick the first three cans you see.

Definition A **random sample** is any sample obtained by using a random sampling method.

Definition A **random sampling method** is taking a sample from a target population in such a way that any member of the population has an equal chance of being chosen.



It is easy to recognize the value of obtaining a random sample, but achieving this goal can be difficult. If you want to poll students for their views on canceling the school's intercollegiate athletics program in the face of the latest school budget crisis, how do you give everybody an equal chance to be polled? Some students are less apt to want to talk with you when you walk up to them with your clipboard. If you ask all your questions in three spots on campus, you may not be giving an equal chance to students who are never at those spots. Then there are problems with the poll questions themselves. The way the questions are constructed might influence the answers you get, and so you won't be getting a random sample of students' views even if you do get a random sample of students.

Purposely not using a random sample is perhaps the main way to lie with statistics. For one example, newspapers occasionally report that students in American middle schools and high schools are especially poor at math and science when compared to students in other countries. This surprising statistical generalization is probably based on a biased sample. It is quite true that those American students taking the international standardized tests of mathematics and science achievement do score worse than foreign students. The problem is that school administrators in other countries try too hard to do well on these tests. "In many countries, to look good is very good for international prestige. Some restrict the students taking the test to elite schools," says Harold Hodgkinson, the director of the Center for Demographic Policy in Washington and a former director of the National Institute of Education. For example, whereas the United States tests almost all of its students, Hong Kong does not. By the 12th grade, Hong Kong has eliminated all but the top 3 percent of its students from taking mathematics and thus from taking the standardized tests. In Japan, only 12 percent of their 12th grade students take any mathematics. Canada has especially good test results for the same reason. According to Hodgkinson, the United States doesn't look so bad when you take the above into account.

The following passage describes a non-statistical generalization from a sample. Try to spot the conclusion, the population, the sample, and any bias.

> David went to the grocery store to get three cartons of strawberries. He briefly looked at the top layer of strawberries in each of the first three cartons in the strawberry section and noticed no fuzz on the berries. Confident that the berries in his three cartons were fuzz-free, he bought all three.

David's conclusion was that the strawberries in his cartons were not fuzzy. His conclusion was about the population of all the strawberries in the three cartons. His sample was the top layer of strawberries in each one. David is a trusting soul, isn't he? Some grocers will hide all the bad berries on the bottom. Because shoppers are aware of this potential deception, they prefer their strawberries in see-through, webbed cartons. If David had wanted to be surer of his conclusion, he should have looked more carefully at the cartons and sampled equally among bottom, middle, and side berries, too. Looking at the top strawberries is better than looking at none, and looking randomly is better than looking non-randomly.

When we sample instances of news reporting in order to draw a conclusion about the accuracy of news reports, we want our sample to be representative in regard to the characteristic of "containing a reporting error." When we sample voters about how they will vote in the next election, we want our sample to be representative in regard to the characteristic of "voting for the candidates." Here is a formal definition of the goal, which is representativeness:

Definition A sample S is a (perfectly) **representative sample** from a population P with respect to characteristic C if the percentage of S that are C is exactly equal to the percentage of P that are C.

A sample S is less representative of P according to the degree to which the percentage of S that are C deviates from the percentage of P that are C.

If you are about to do some sampling, what can you do to improve your chances of getting a representative sample? The answer is to follow these four procedures, if you can:

1. Pick a random sample.
2. Pick a large sample.
3. Pick a diverse sample.
4. Pick a stratified sample.

We've already discussed how to obtain a random sample. After we explore the other procedures, we'll be in a better position to appreciate why some random samples are to be avoided.

——CONCEPT CHECK——

Which is the strongest and which is the weakest argument? The four arguments differ only in their use of the words *random* and *about*.

a. Twenty percent of a random sample of our university's students want library fines to be lower; so, 20 percent of our university's students want library fines to be lower.

b. Twenty percent of a sample of our university's students want library fines to be lower; so, 20 percent of our university's students want library fines to be lower.

c. Twenty percent of a random sample of our university's students want library fines to be lower; so, about 20 percent of our university's students want library fines to be lower.

a. Twenty percent of a sample of our university's students want library fines to be lower; so, about 20 percent of our university's students want library fines to be lower.

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307 Answer (c) is strongest and (b) is the weakest. The word about in the conclusions of (c) and (d) make their conclusions less precise and thus more likely to be true, all other things being equal. For this reason, arguments (c) and (d) are better than arguments (a) and (b). Within each of these pairs, the argument whose premises speak about a random sample is better than the one whose premises don't speak about this. So (c) is better than (d), and (b) is worse than (a). Answers (d) and (b) are worse because you lack information about whether the samples are random; however, not being told whether they are random does not permit you to conclude that they are not random.

———CONCEPT CHECK———

For the following statistical report, (a) identify the sample, (b) identify the population, (c) discuss the quality of the sampling method, and (d) find other problems either with the study or with your knowledge of the study.

> Voluntary tests of 25,000 drivers throughout the United States showed that 25 percent of them use some drug while driving and that 85 percent use no drugs at all while driving. The conclusion was that 25 percent of U.S. drivers do use drugs while driving. A remarkable conclusion. The tests were taken at random times of the day at randomly selected freeway restaurants.

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Sample Size

If you hear a TV commercial say that four out of five doctors recommend the pain reliever in the drug being advertised, you might be impressed with the drug. However, if you learn that only five doctors were interviewed, you would be much less impressed. Sample size is important.

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308 (a) The sample is 25,000 U.S. Drivers, (b) The population is U.S. drivers, (c) The sample size is large enough, but it is not random, for four reasons: (1) Drivers who do not stop at roadside restaurants did not have a chance of being sampled, (2) the study overemphasized freeway drivers rather than other drivers, (3) it overemphasized volunteers, (4) it overemphasized drivers who drive at 4 a.m. (d) The most obvious error in the survey, or in the report of the survey, is that 25 percent plus 85 percent is greater than 100 percent. Even though the survey said these percentages are approximate, the 110 percent is still too high. Also, the reader would like more information in order to assess the quality of the study. In particular, how did the study decide what counts as a drug, that is, how did it operationalize the concept of a drug? Are these drugs: Aspirin? Caffeine? Vitamins? Alcohol? Only illegal drugs? Did the questionnaire ask whether the driver had ever used drugs while driving, or had ever used drugs period? Did the pollster do the sampling on one day or over many days? Still, lack of information about the survey is not necessarily a sign of error in the survey itself.

Why? The answer has to do with the fact that estimations based on sampling are inductive and thus inherently risky. The larger the sample, the better its chance of being free of distortions from unusually bad luck during the selection of the sample.

To maximize the information you can get about the population, you will want to increase your sample size. Nevertheless, you usually face practical limits on the size; sampling might be expensive, difficult, or both.

In creating the government census, it is extremely difficult to contact and count those people who live temporarily on the couch at a friend's apartment and those who live in their cars and have no address and those who are moving to a new job in a different state. You can make good estimates about these people, but if you're required to disregard anyone you haven't talked to during your census taking, then you'll under-represent these sorts of people in your census results. People who complain that the government census will make an educated guess about how many people live in a city even if they haven’t counted all of the people, never seem to complain when their doctor samples their own blood rather than takes all of it to examine.

So, when is your sample size big enough for your purposes? This is a fascinating and difficult question. To illustrate, suppose you are interested in selling mechanical feeding systems to the farmers in your state. You would like to know what percentage of them do not already own a mechanical feeding system — they will be your potential customers. Knowing that this sort of information has never been collected, you might try to collect it yourself by contacting the farmers. Since it would be both difficult and expensive to contact every single farmer, you would be interested in getting your answer from a sample of small size. If you don't care whether your estimate of the percentage of farmers without a mechanical feeding system is off by plus or minus 10 percent, you can sample many fewer farmers than if you need your answer to be within 1 percent of the (unknown) correct answer. Statisticians would express this same point by saying that a 10 percent **margin of error** requires a smaller sample size than a 1 percent margin of error.

Let's suppose you can live with the 10 percent. Now, how sure do you need to be that your estimate will fall into that interval of plus or minus 10 percent? If you need only to be 90 percent sure, then you will need a much smaller sample size then if you need to be 97 percent sure. Statisticians would express this same point by saying that a 90 percent **confidence level** requires a smaller sample size than a 97 percent confidence level. Just exactly how much smaller is a matter of intricate statistical theory that we won't go into here, although we will explore some specific examples later.

A margin of error is a margin of safety. Sometimes we can be specific and quantify this margin, that is, put a number on it such as 6%. We can say that our sampling showed that the percentage of farmers without a mechanical feeding system is 60 percent plus or minus 6 percent. Sometimes we express the idea vaguely by saying that the percentage is about 60 percent. At any rate, whether we can be specific or not, the greater the margin of error we can permit, the smaller the sample size we need. This result is an instance of the principle that the less specific the conclusion of our argument, the stronger the argument.

This chapter will have more to say about sample size, but first we need to consider other ways of improving the sampling process.

Sample Diversity

In addition to selecting a random, large sample, you can also improve your chances of selecting a representative sample by sampling a wide variety of members of the population. That is, aim for diversity─so that diversity in the sample is just like the diversity in the population. If you are interested in how Ohio citizens will vote in the next election, will you trust a pollster who took a random sample and ended up talking only to white, female voters? No. Even though those 50 white women were picked at random, you know you want to throw them out and pick 50 more. You want to force the sample to be diverse. The greater the diversity of relevant characteristics in your sample, the better the inductive generalization, all other things being equal.

Because one purpose of getting a large, random sample is to get one that is sufficiently diverse, if you already know that the population is homogeneous — that is, not especially diverse — then you don't need a big sample, or a particularly random one. For example, in 1906 the Chicago physicist R. A. Millikan measured the electric charge on electrons in his newly invented oil-drop device. His measurements clustered around a precise value for the electron's charge. Referring to this experiment, science teachers tell students that all electrons have this same charge. Yet Millikan did not test all electrons; he tested only a few and then generalized from that sample. His sample was very small and was not selected randomly. Is this grounds for worry about whether untested electrons might have a different charge? Did he commit the fallacy of hasty generalization? No, because physical theory at the time said that all electrons should have the same charge. There was absolutely no reason to worry that Tuesday's electrons would be different from Wednesday's, or that English elections would be different from American ones. However, if this theoretical backup weren't there, Millikan's work with such a small, nonrandom sample would have committed the fallacy of hasty generalization. The moral: Relying on background knowledge about a population's lack of diversity can reduce the sample size needed for the generalization, and it can reduce the need for a random sampling procedure.

When you are sampling electrons, if you’ve seen one you’ve seen them all, so to speak. The diversity just isn't there, unlike with, say, Republican voters, who vary greatly from each other. If you want to sample Republican voters' opinions, you can't talk to one and assume that his or her opinions are those of all the other Republicans. Republicans are heterogeneous—the fancy term for not being diverse.

A group having considerable diversity in the relevant factors affecting the outcome of interest is said to be a heterogeneous group. A group with a relatively insignificant amount of diversity is said to be a **homogeneous** group. For example, in predicting the outcome of measuring the average height of two groups, Americans and Japanese, the diversity of American ethnicity makes Americans a heterogeneous group compared to the more homogeneous Japanese group. It is easier to make predictions for homogeneous groups than for heterogeneous groups.

Being homogeneous is relative, however. The Japanese might be more homogeneous than Americans relative to measurements about height, but the Japanese might be more heterogeneous than Americans when it comes to attitudes about socialism and about how to care for infants.

——CONCEPT CHECK——

The most important goal in sampling is

a. randomness
b. representativeness
c. diversity
d. large sample size

——[309]

——CONCEPT CHECK——

Suppose you know the average height of Japanese men and of American men. If you randomly pick a hundred Japanese businessmen, you can be more sure of their average height than you can be if you pick American businessmen. Explain why.

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309 b

310 The variety of the Japanese data is less than that of the American data because Japan is a more homogeneous society. The American people are more ethnically diverse and so are more genetically diverse, and genes affect human growth. Suppose the average Japanese man is 5' 5", and the average American man is 5' 8". Then the point the message is making is that the average

Stratified Samples

In addition to seeking a large, random, diverse sample, you can improve your chances of getting a representative sample by stratifying the sample. In the example in the Concept Check about taking the drug tests at random times, there was a mistake made because many more drivers are on the road at, say, 5 p.m. than at 5 a.m. Random sampling on times would be biased in favor of the 5 a.m. drivers. To remove this bias, the sampling method should take advantage of this knowledge of who drives when by **stratifying** according to time of day. For example, if you know that 30 percent of drivers are on the road from 5 p.m. to 6 p.m. and 3% are on the road from 5 a.m. to 6 a.m., then make sure that 30 percent of the sampled drivers are randomly picked from 5 p.m. to 6 p.m. and only 3 percent from 5 a.m. to 6 a.m. Do the same for the other driving times if you know the percentages for those other times.

Suppose you are planning a poll to learn how Ohio citizens will vote in the next presidential election. You can use your knowledge of politics to help pick the best sample. You already have specific political information that the race of a voter is apt to affect how he or she will vote. Suppose you also know that, even though Ohio citizens are 65 percent white and 30 percent black, the expected voters will be 70 percent white and 25 percent black.[311] You can use

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of the 100 Japanese men you pick will be closer to 5'5" than will the average of the 100 American men be to 5'8".

311 These numbers are not reliable.

all this information about the voting population to take a better sample by making sure that your random sample contains exactly 70 percent white voters and exactly 25 percent black voters. If your poll actually were to contain 73 percent white voters, you would be well advised to randomly throw away some of the white voters' responses until you get the number down to 70 percent. The resulting stratification on race will improve the chances that your sample is representative. Stratification on the voters' soft drink preference would not help, however.

The definition of stratification uses the helpful concept of a variable. Roughly speaking, a variable is anything that comes in various types or amounts. There are different types of races, so race is a variable; there are different amounts of salaries, so salary is a variable; and so forth. Each type or amount of the variable is called a possible value of the variable. White and black are two values of the race variable. Suppose a population (say, of people) could be divided into different groups or strata, according to some variable characteristic (such as race). Suppose each group's members have the same value for that variable (for example, all the members of one group are black, all the members of another group are white, and so on). Suppose a sample is taken under the requirement that the percentage that has a given value (black) of the variable (race) must be the same as the known percentage of the value for the population as a whole. If so, then a **stratified sample** has been taken from that population, and the sample is said to be stratified on that variable.

Stratification is a key to reducing sample size, thereby saving time and money. If you want to know how people are going to vote for the Republican candidate in the next presidential election, talking to only one randomly selected voter would obviously be too small a sample. However, getting a big enough sample is usually less of a problem than you migh t expect when you pay careful attention to stratification on groups that are likely to vote similarly. Most nonprofessionals believe that tens of thousands of people would need to be sampled. I asked my next-door neighbor how many he thought would be needed, and he said, "Oh, at least a hundred thousand." Surprisingly, 500 would be enough if the sample were stratified on race, income, employment type, political party, and other important variables. This 500 figure assumes the pollster need only be 95 percent sure that the results aren't off by more than 2 percent. If you can live with a greater margin of error than 2 percent and less confidence than 95%, then you can use a much smaller sample size.

The most important variables affecting voting are the voters' party, race, sex, income, and age. The more of these variables there are, the bigger the sample must be to make sure that enough voters representative of each value get polled. If the pollster has no idea what the variables are that will influence the results, he or she cannot know whether the sample is diverse in regard to these variables, so a very large sample will be needed. For example, if you wanted to know what percentage of jelly beans in an opaque jar are lime or licorice flavored, then all you can do is shake the jar and take as big a sample as you can.

———CONCEPT CHECK———

Your quality control engineer conducts a weekly inspection of your company's new beverage. He gathers a random sample of 100 bottles produced on Mondays or Tuesdays. Over several weeks, at most he finds one or two sampled bottles each week to be faulty. So you conclude that your manufacturing process is doing well on an average every week, since your goal was to have at least 98 percent of the beverage be OK.

Suppose, however, that the quality control engineer knows that your plant produces an equal amount of the beverage on each weekday and that it produces beverages only on weekdays. Describe the best way for the quality control engineer to improve the sampling by paying attention to stratification.

a. Sample one beverage from each weekday.

b. Pick a larger and more random sample.

c. Take an equal number of samples on Saturdays and Sundays as well.

d. Make sure that 20 percent of the sample comes from each weekday.

b. Sample more of the bottles that will be delivered to your most valued customers.

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Statistical Significance

Frequently, the conclusions of inductive generalizations are simple statistical claims. Our premise is "x percent of the sample is la-de-da." From this we conclude, "The same percent of the population is, too." When the argument is inductively strong, statisticians say the percent is **statistically significant**. A statistically significant statistic is one that probably is not due to chance. The number need not be significant in the sense of being important; that is the non-technical sense of the word *significant*.

Suppose you are interested in determining the percentage of left-handers in the world, and you aren't willing to trust the results of other people who have guess at this percentage. Unless you have some deep insight into the genetic basis of left-handedness, you will have to obtain your answer from sampling. You will have to take a sample and use the fraction of people in your sample who are left-handed as your guess of the value of the target number. The target number is what statisticians call a **parameter**. The number you use to guess the parameter is called the **statistic**. Your statistic will have to meet higher standards the more confident you must be that it is a reliable estimate of the parameter.

312 Answer (d). The suggestion in (b) would be good to do, but it has nothing to do with stratification.

I once told my seven-year-old son Joshua that he was unusual because he was left-handed. That surprised him, so he decided to check out whether I was correct. In the sophisticated terminology of mathematical statistics, we'd say Joshua's goal was to determine whether a certain parameter, the percentage of left-handers in the whole world, is much less than 50 percent. Here is what Joshua did to acquire a statistic to use to estimate the parameter. He said, "You're left-handed, Dad. Mom and my little sister aren't. That is two and two." What Joshua had just done, more or less, was to take a sample of four from the vast population of the Earth, discover that two of the four are left-handed, and then calculate the statistic of 50 percent as his guess of the parameter. A statistician would say that Joshua's statistic is not significant because the sample is too small. If Joshua were to take a larger sample, the resultant statistical claim would be more believable.

So Joshua set out to get a bigger sample. He asked all the children in his class at school whether they were left-handed. Two out of twenty-two. He also went around the neighborhood asking whomever he could. The new result from home, school, and neighborhood was seven left-handers out of thirty-seven. This statistic is more apt to be significant, and it is much less than 50 percent. The moral here is that the bigger the sample size, the more confident you can be that the calculated statistic is statistically significant. The more sampling, the less likely that the result is due to chance. Patterns that appear in small samples might disappear as the sample size grows; they might be shown to be **coincidental**. Significant patterns and significant statistics are those that are likely not to be accidental or coincidental; they are likely to be found to hold true on examination of more of the target population.

We still haven't answered the question of whether Joshua's statistic of 7/37 is statistically significant. Is it? It definitely is a better guess than 2/4, but to compute whether it is significant requires some sophisticated reasoning involving complex formulas about margins of error and levels of confidence, which we won't pursue here. We can, however, sketch three features of the answer.

First, the margin of error: We need to decide just how accurate we want our guess to be. Can we be satisfied with an accuracy of plus or minus 10 percent, or do we need a smaller margin, say plus or minus 1 percent? Second, the confidence level. Are we willing to be only 95 percent sure that we have the right answer, even allowing for the margin of error? Or must we be 99 percent sure? All other things being equal, the more confident we need to be, the less significant will be the statistics we have gathered. Third, how biased was the sampling? Was it random? Was it diverse? Population size is not normally something that needs to be taken into account if the population is large compared to the sample size.

In very large populations, the statistic for a relatively small sample will be statistically significant based on the size of the sample, not on the size of the population.

Designing a Paired Comparison Test

Suppose you own a food business and are considering marketing what your researcher/cook says is a better version of one of your old food products say, a vegetarian burrito. The main factor in your decision will be whether your customers will like the taste of the new product better than the taste of the old one. You can make your marketing decision by guessing, by letting your cook choose, by asking advice from your friends, or by some other method. You decide to use another method: ask your own customers which of the two vegetarian burritos they like best. Why not? If the customers in your sample prefer the new product, you will believe that the whole population will, too, and you will replace the old product with the new one.

A good way to do this testing would be to use a procedure called **paired comparison**. In this kind of test, you remove the identifying labels from the old and new burrito products and then give a few tasters the pairs of products in random orders. That is, some tasters get to taste the new burrito first; some, the old one first. In neither case are they told which product they are tasting. Then ask your taster/judges which product they like better. If a great many of them like the new one better than the old one, you can go with the new product.

How many tasters do you need in order to get useful results? And if most of the tasters like the new product but many do not, then how much disagreement can you accept and still be sure your customers generally will like the new product better? If three out of five tasters say the new product is better but two out of five disagree, would a conclusion that over half your customers would prefer the new burrito product be a statistically significant result? These are difficult questions, but they have been studied extensively by statisticians, and the answers are clear.

Before those difficult questions can be answered, you need to settle another issue. How sure do you have to be that your tasters' decision is correct, in the sense of accurately representing the tastes of the general population of your customers? If you need to be 99 percent sure, you will need more tasters than if you need only to be 95 percent sure. Let's suppose you decide on 95 percent. Then, if you have, say, twenty tasters, how many of them would have to prefer the new product before you can be 95 percent sure that your customers will like the new product better, too? If your taster-judges are picked randomly from among your population of customers and aren't professionals in the tasting business, then statistical theory says you would need at least 75 percent (fifteen) of your twenty judges to prefer the new product. However, if you had more judges, you wouldn't need this much agreement. For example, with sixty judges, you would need only 65 percent (thirty-nine) of your judges to give a positive response in order for you to be confident that your customers will prefer the new product. What this statistic of thirty-nine out of sixty means is that even if twenty-one out of your sixty judges were to say that your new burrito is awful, you could be 95 percent sure that most consumers would disagree with them. Yet many business persons who are not versed in such statistical reasoning would probably worry unnecessarily about their new burrito if twenty-one of sixty testers disliked the product.

Statistical theory also indicates how much agreement among the judges would be required to raise your confidence level from 95 percent to 99 percent. To be 99 percent sure that your customers would prefer the new product to the old, you would need seventeen positive responses from your twenty judges, or forty-one positive responses from sixty judges.

Let's try another example. You recently purchased a new service station (gas station) and have decided on an advertising campaign both to increase your visibility in the community and to encourage new customers to use the station. You plan to advertise a free gift to every customer purchasing $10 or more of gasoline any time during the next two weeks. The problem now is to select the gift. You have business connections enabling you to make an inexpensive purchase of a large supply of either six-packs of Pepsi or engraved ballpoint pens with the name of a local sports team. You could advertise that you will give away free Pepsi, or else you could advertise that you will give away the pens. The cost to you would be the same. You decide to choose between the two on the basis of what you predict your potential customers would prefer. To do this, you could, and should, use a paired comparison test. You decide you would like to be 95 percent sure of the result before you select the gift. You randomly choose twenty potential customers and offer them their choice of free Pepsi or a free ballpoint pen. Ten are told they can have the Pepsi or the pen; ten are told they can have the pen or the Pepsi. You analyze the results. Three customers say they don't care which gift they get. Five say that they strongly prefer Pepsi to the pen because they don't like the sports team. Six say they would be happy with either gift but would barely prefer the Pepsi. Four customers choose Pepsi because they have enough pens. The rest choose pens with no comment. From this result, can you be confident that it would be a mistake to go with the ballpoint pen?

Yes, you can be sure it would be a mistake. Your paired comparison test shows fifteen of twenty prefer Pepsi. At the 95 percent confidence level, you can be sure that over 50 percent of your customers would prefer the Pepsi. By the way, this information about numbers is for illustrative purposes. You as a student aren't in a statistics class, so you won't be quizzed on making these calculations. But if you did own that service station you should use a paired comparison test and get some number advice by looking up the info on the Internet or by asking somebody who has taken a statistics class.

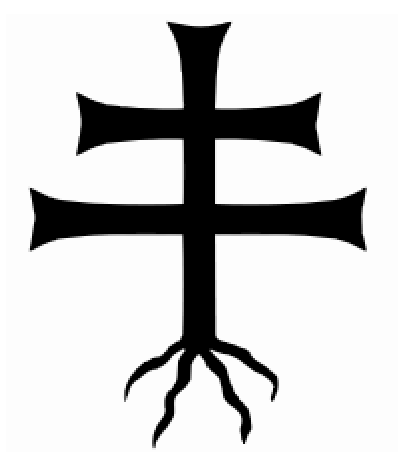
Suppose you learn that your favorite TV program was canceled because the A. C. Nielsen Corporation reported to CBS that only 25 percent of the viewers were tuned to your program last week. CBS wanted a 30 percent program in that time slot. You then learn more about the Nielsen test. Nielsen polled 400 viewers, 100 of whom said they were watching your program. Knowing that the United States has 100 million TV sets, you might be shocked by CBS's making a major financial decision based on the simple statistical claim that 100 out of 400 viewers prefer your program. Can this statistic really tell CBS anything significant about your program? Yes, it can, provided CBS can live with a 2 percent error. Nielsen and CBS can be 95 percent confident that the statistics from a sample of 400 will have an error of only plus or minus 2 percent.

Obstacles to Collecting Reliable Data

So far in our discussion of significant statistics, we have worried about how to make decisions using *reliable* information from a sample of our population. To obtain significant statistics we try to obtain a representative sample by getting one that is diverse, random, and large. A major obstacle to obtaining a representative sample is that **unreliable data** too easily creep into our sample.

If you own a radio station and decide that over 80% of your listeners like that song by singer Katy Perry because over 80% of those who texted your station (about whether they like that song) said they liked it, then you've made a too risky assumption. Those who texted you weren't selected at random from your pool of listeners; they selected themselves. **Self-selection** is a biased selection method that is often a source of unreliable data.

There is the notorious problem of lying to pollsters. The percentage of polled people who say they've voted in the election is usually higher than the percentage of people who actually did. More subtly, people may practice self-deception, honestly responding "yes" to questions such as "Are you sticking to your diet?" when they aren't. Another problem facing us pollsters is that even though we want diversity in our sample, the data from some groups in the population may be easier to obtain than from other groups, and we may be tempted to favor ease over diversity. For example, when counting Christians worldwide, it is easier for us to get data from churches of people who speak some languages rather than others and who are in some countries rather than others and who are in modern cities rather than remote villages.



There are other obstacles to collecting reliable data. Busy and more private people won't find the time to answer our questions. Also, pollsters occasionally fail to notice the difference between asking "Do you favor Jones or Smith?" and "Do you favor Smith or Jones?" The moral is that natural obstacles and sloppy methodology combine to produce unreliable data and so to reduce the significance of our statistics.

Varieties of Inductive Arguments

We have just completed our analysis of our one kind of inductive argument, generalizing from a sample. There are other kinds. The study of inductive logic is more complex than deductive logic, and it is not as well developed. It consists merely of several independent topical areas that focus on a particular kind of inductive argument. This section of the chapter briefly introduces the different kinds. Some inductive arguments are of more than one kind.

Argument from Authority

Suppose a high school science teacher says to you,

> The scientists I've read agree that Neptune is a cold planet compared to Mars, Earth, and Venus. So, Neptune is definitely a cold planet.

This argument from authority does not jump to conclusions. The high school teacher offers expert testimony although it is secondhand. It might be called *hearsay* in a courtroom, but it is reasonable grounds for accepting the conclusion. So, the conclusion follows with probability.

But with how much probability? Nobody knows, not even the scientists. Nobody can say authoritatively whether the conclusion is 85 percent probable or instead 90 percent probable. All they can properly say is that the appeal to authority makes the conclusion a safe bet because the proper authorities have been consulted, they have been quoted correctly, and it is well known that the experts do not significantly disagree with each other about this.

The conclusion of the following argument is not such a safe bet:

> The scientists say astral travel is impossible. That is, our spiritual bodies can't temporarily leave our physical bodies and travel to other places. So they say. However, my neighbor and several of her friends told me they separately traveled to Egypt while their physical bodies were asleep last night. They visited the pyramids. These people are sincere and reliable. Therefore, the scientists are wrong about astral travel.

Is this a successful inductive argument? The arguer asks us to accept stories from his neighbor and her friends. These anecdotes are pitted against the claims of the scientists. Which should you believe? Scientists have been wrong many times before; couldn't they be wrong here, too? Yes, they could, but it wouldn't be a good bet. If you had some evidence that could convincingly show the scientists to be wrong, then you, yourself, would likely soon become a famous scientist. You should be cautious about jumping to the conclusion that the scientists are wrong. The stories are so extraordinary that you really need extraordinarily good evidence to believe them. The only evidence in favor of the stories is the fact that the neighbors and friends, who are presumed to be reasonable, agree on their stories and the fact that several times in history other persons also have claimed to be astral travelers.

The neighbor might say that she does have evidence that could convincingly show the scientists to be wrong but that she couldn't get a fair hearing from the scientists because their minds are closed to these possibilities of expanding their consciousness. Yes, the scientists probably would give her the brush-off, but by and large the scientific community is open to new ideas. She wouldn't get the scientists' attention because they are as busy as the rest of us, and they don't want to spend much time on unproductive projects. However, if the neighbor were to produce some knowledge about the Egyptian pyramids that she probably couldn't have gotten until she did her astral traveling, then the scientists would look more closely at what she is saying. Until then, she will continue to be ignored by the establishment.

Egypt's Giza Pyramid

Most of what we know we got from believing what the experts said, either firsthand or, more likely, secondhand. Not being experts ourselves, our problem is to be careful about sorting out the claims of experts from the other claims that bombard us, while being aware of the possibility that experts are misinterpreted, that on some topics they disagree, and that occasionally they themselves cannot be trusted to speak straightforwardly. Sensitive to the possibility of misinterpreting experts, we prefer firsthand testimony to secondhand, and secondhand to third hand. Sensitive to disagreement among the experts, we prefer unanimity and believe that the greater the consensus, the stronger the argument from authority.

Also, we are sensitive to when the claim is made and to what else is known about the situation. For example, a man returning from a mountaintop might say to you, "Wow, from there the world looks basically flat." Twenty anecdotes from twenty such people who independently climbed the same mountain do not make it twenty times more likely that the world *is* flat. You can't trust the twenty stories because you know there is much better evidence to be had. However, in the days when the Egyptians were building their pyramids, the twenty anecdotes would actually have made it more reasonable to believe that the world is flat, although even then it wouldn't have been twenty times more.

What is reasonable to believe at any time depends on the evidence available at that time.

It's important to resist the temptation to conclude that in ancient times people lived on a flat world but that now they live on a round one. This is just mumbo jumbo; the world stayed the same—it was people's beliefs about the world that changed. Do not overemphasize the power of the mind to shape the world.

Argument from Analogy

Dear sir,

A woman's composing of music is like a dog's walking on its hind legs. It is not done well, but you are surprised to find it done at all.

Yours truly,

Mr. C. Pig

This joke uses an argument from analogy. The unfamiliar world of electricity can be explained by showing how electricity in a wire behaves analogously to water flowing through a pipe. Analogies help with description, too. We envision a rolling ball when we hear that presidential candidate Roosevelt had momentum going into the New Hampshire primary.

Analogies can be used in arguing. A woman without a man is like a fish without a bicycle. This joke would be making a radical feminist comment, because hidden between the lines is an argument for why women don't need men. The joke is intended to counter the conclusion of someone who would say that a woman without a man is like a fish out of water.

Here is a more serious example of an argument by analogy. Suppose that for several months a scientist gives experimental drug D to a variety of dogs confined to cages. A group of similar caged dogs do not receive the drug. The scientist then tests to see whether the dogs receiving drug D are more cardiovascularly fit than the ones not receiving the drug. The scientist checks blood pressure, stamina, and other physiological measures. The scientist's initial conclusion is that dogs that get the drug are no more cardiovascularly fit than the other dogs. The scientist's final conclusion is that, for humans, taking drug D will be no substitute for getting lots of exercise, as far as cardiovascular fitness is concerned. This argument uses what analogy? Let's figure it out. Here is the argument in standard form:

> Dogs are like humans in many ways.
> Dogs cannot use drug D as a substitute for exercise.
> \---
> Humans cannot use drug D as a substitute for exercise.

The conclusion follows with probability. However, we could rewrite the first premise so that the conclusion follows with certainty:

> Dogs are like humans when it comes to deciding whether drugs can be a substitute for exercise.
> Dogs cannot use drug D as a substitute for exercise.
> \---
> Humans cannot use drug D as a substitute for exercise.

This argument is deductive. Which of the two ways of treating the argument is better? It is hard to tell and doesn't make much difference. The scientist is more likely to have intended inductive standards to apply; at least we shall assume this from now on. But what is more important to see is that both ways of analyzing the argument depend on accepting the analogy between people and dogs. If the analogy is unacceptable, the argument breaks down. Scientists get into serious disputes about whether testing drugs on rats, dogs, and rabbits gives reliable information about how these drugs will affect human beings. These disputes are about analogy.

To generalize, the simplest inductive arguments from analogy have the following form:

> As are analogous to Bs in several respects.
>
> As have characteristic C.
>
> ____________________________
>
> Bs have characteristic C.

A characteristic is a property or quality. In the drug-testing example, A = dogs, B = humans, and C = the characteristic of not being able to use drug D as a substitute for exercise. If A's have characteristic C but B's do not, the analogy between A and B is a faulty analogy as far as C is concerned.

Analogies are often stated without using the words *analogous to* and *like*. Persuading a terrorist to defect is supposed to be analogous to converting the child from watching TV to doing her homework. The key to seeing the analogy is in noting the word *akin*. Is this a faulty analogy? The average reader is not in a position to tell. Only people who are familiar both with persuading a terrorist to defect and with raising children would be in a position to say However, notice that in this passage the analogy is not used to draw some conclusion, as it is in the earlier analogies we have discussed. The analogy is used merely to *explain* the process of persuading a terrorist. The passage contains an explanatory analogy but not an argument by analogy. If it were to contain an argument by analogy, it would probably say that because the conversion of the child requires such and such, therefore persuading a terrorist does, too.

———CONCEPT CHECK———

Arguments from analogy have the following logical form: A is analogous to B in important ways. A has property C. So, B has property C, too. What would the letters A, B, and C represent in the following argument by analogy?

> I am a vegetarian, and I believe it's morally wrong to cook live shrimp. After all, it would be wrong for someone to toss you into a pan of boiling water, wouldn't it?

———[313]

313 A = people, B = shrimp, C = the characteristic of it being morally incorrect to cook them by tossing them alive into a pan of boiling water.

Advertising that uses testimonials often promotes an argument by analogy. Take the Hollywood beauty who testifies to the TV viewer: "I got a silicone breast implant from Dr. Wrigley, and I got the lead part in a commercial. His plastic surgery can help you, too."[314] You, the female viewer, are being asked implicitly to accept the analogy with your own situation and conclude that the surgery will get you what you want. But as a logical reasoner you will confront the analogy directly by thinking something like this: "That's fine for her, but I'm not trying to get a part in a commercial, so realistically what does her testimony have to do with me in my situation?"

By criticizing the analogy in the argument that the TV program encourages you to create, you are using the technique of pointing out the **disanalogies**. The disanalogies are the differences, the ways in which the two are not analogous. We point out disanalogies when we say, "Yes, they're alike, but not in the important ways." We are apt, also, to use this method in response to the analogy between people and shrimp by pointing out that we are not like shrimp in terms of sensitivity to pain, or intelligence, or moral worth.

A second method of attacking an argument by analogy is to **extend the analogy**. We do this when we find other ways the two things are similar and then draw obviously unacceptable conclusions from this similarity. For example, we can attack the argument that uses the analogy between people and dogs by saying, "Dogs are like people in other ways, too. For example, we both like to eat meat. Since dogs enjoy their meat raw, you won't mind eating your hamburger raw tonight, will you?" When the original advocate of the cardiovascular argument answers, "No, we aren't that much like dogs," you can respond with "I agree, so how can you be so sure we are like dogs when it comes to taking drug D?"

Let's now analyze a complicated argument by analogy. You might have had the honor of getting involved in the following unpleasant discussion with Mario about white women marrying black men. During the conversation, Mario said:

> A dog breeder wouldn't think of mixing different breeds, so the human race should not be mongrelized by interracial breeding. You accept my argument, or aren't you logical? Of course you accept it; you aren't some kind of pervert. Besides, you are not a dog breeder, so you are in no position to doubt what I say.

Let's cool down and analyze this volcanic eruption. Mario's statement, "The human race should not be mongrelized by interracial breeding," is loaded language filled with negative connotations. A less loaded replacement would be, "The human race should not produce children of parents from different races." The argument is primarily based on an analogy. The analogy is between having puppies of different breeds and having children of different races. There are important disanalogies to notice. Our background knowledge tells us that the purpose of dog breeding is to improve and retain the characteristics of the breed. The purpose of having children is not normally to improve and retain the racial characteristics of each parent. Did your parents have you primarily for design purposes? A second difficulty with the

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314 This testimonial commits the post hoc fallacy.

analogy is that even if mixing breeds produces mongrels that are of lesser quality in terms of winning blue ribbons in dog shows, it doesn't follow that mixing races produces children who are of lesser quality. In most societies, the citizens do believe that races shouldn't mix and that when they do they produce children who are "inferior," but this belief is based only on custom; there is no biological reason to believe that such children are physically or mentally inferior to their parents.

Mario was also mistaken in saying that if you lack expert knowledge about dog breeding, you should not doubt his claim. Our criticism of his analogy was based on common sense, not on any expert knowledge. His threatening to label you a "pervert" and not "logical" if you reject his argument is itself just name calling or intimidation. From a logical-reasoning perspective these threats do nothing positive for his position. If Mario were your boss, his attacks might convince you not to say you disagree with him, but his reasons shouldn't actually convince you to agree with him.

———CONCEPT CHECK———

Evaluate this argument by analogy from 1940:

> Armies are like people. If you cut off the head, the body may thrash around a bit, but very soon it quits fighting. So, a good way to win this European war against the Nazis and Fascists would be to concentrate all our energies on killing Hider and Mussolini.

———[315]

315 There is no doubt that if you cut off someone's head, the person will soon stop fighting. The problem is whether there is a message here for how to win World War II against the German and Italian armies led by Hitler and Mussolini, respectively. To some extent armies are like people. They eat, they sleep, they move, they fight. On the other hand, to some extent armies are not like people. They are composed of more than one person, they can be in many places at once, and a new head can easily be appointed, and so forth. The most important disanalogy, however, is that the person without a head has to stop fighting, but an army without a supreme leader does not have to stop fighting. Maybe the two armies would stop fighting if their supreme leaders were killed, but the argument by analogy does not provide a strong reason for this conclusion. In short, a person without a head has no brains; an army without a head still has the brains of its officer corps and individual soldiers. A much better case could be made for killing the supreme leader if it could be shown that, throughout history, armies have stopped fighting when their supreme leaders have been killed.

Induction from Past to Future (Prediction)

As goes the past, so goes the future. That is a common style of inductive argument. Here is an example:

> The record book shows that the American track teams have won more meets than the Australian track teams. So, the Americans can be expected to dominate the Australians in future track meets.

This is an induction by analogy because it depends on the claim that the future will be analogous to the past in certain ways. Not all past patterns can be justifiably projected to hold in the future. The chicken assumes that the hand that has fed it will continue to feed it in the future, but one day that hand will wring its neck. One of the principal problems of science is to discover which patterns are projectible into the future and which are not. No easy task.

Arguments from past patterns to future patterns depend on a crucial premise: If we are ignorant of any reason that a past pattern should not continue, then it probably will continue.

The principles of reasoning that this section has applied to inductions from the past to the future also apply to inductions from the past to the present and to inductions from the present to the future.

Appeal to a Typical Example

If you like the first pineapple you eat, you don't have to eat forty-seven more pineapples to figure out whether you like pineapples. One example is enough. Similarly, if you are given a meal of lung fish and discover that it tastes awful, you might argue by analogy that you won't like eating any other lung fish if it is prepared the same way. This inference makes use of the assumption that one lung fish is like any other as far as taste is concerned, especially if the preparation is similar. You assume that your one lung fish is a typical example of lung fish. In doing so, do you commit the fallacy of jumping to conclusions? No, but you would do so if you did not implicitly rely on background information. You use your background information that kinds of food don't usually change their taste radically from one meal to another. Without this background information, you really ought to try some more examples of lung fish before concluding that you don't like this seafood.

This example about lung fish is a special kind of argument from analogy; the argument relies on the fact that nearly all the members of a group are analogous to some typical member of the group. We will call this kind of argument by analogy an "induction by appeal to a typical example."

The following argument also tries to make its point by giving only one example, expecting the reader to accept the generalization from that example. What is typical of what here?

> Although it is true that intending to do something usually does not bring about the same consequences as doing it, morally it seems no different. Suppose I intend to kill my rich uncle for my inheritance. I am hiding in his house behind the door, with my axe in my hand, waiting for him to enter, but as he walks up the front porch steps, he has a heart attack and dies. Hey, it's my lucky day! I get the inheritance and I don't even have to clean the blood off my axe. Surely you will say that the fact that I did not carry out my intention to kill my uncle does not absolve me morally, for had he entered the house I would have killed him. Whether or not I actually killed him, I'm still immoral. It seems, therefore, that the intention is always as wrong as the action.[316]

The main generalization the author wants the reader to accept is that all cases of intending to kill are as wrong as actually killing. The strategy of the argument is to present a single case, suggest that it is an example in which the generalization applies, and then imply that the example is perfectly typical and thus that the generalization holds for all cases. The arguer is

316 This example was suggested by Angela Scripa.

counting on the fact that the audience will be reminded from their own experience that the example is typical.

To evaluate the quality of this argument we need to ask ourselves whether this really is an example. Is the case of the potential axe murder really an example in which the person would be just as immoral whether he or she followed through with the crime or not? Second, even if it is an example, is it really typical of all other cases of intention to commit a crime?

———CONCEPT CHECK———

Which of the following arguments is an induction by analogy, using an appeal to a typical example?

a. John is a typical example of a farmer. He doesn't wear a suit to work. He understands about raising animals, planting crops, building fences, and so on. Yet all farmers are going to suffer with this new legislation, so John is, too.

b. We checked it out for ourselves. After drilling the right-size hole in the plastic, we poured the liquid hydrofluoric acid down the hole onto the steel and noticed that a perfectly circular hole in the steel appeared within a minute. So, hydrofluoric acid will always react with steel, at least if the acid is a liquid.

c. All boa constrictors are reptiles, and Matt Rasmussen's pet boa constrictor is a typical one, so it's a reptile, too.

———[317]

Argument Based on Signs

Here is an example: There's a railroad crossing sign ahead on the highway, so there's a railroad crossing ahead.

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317 Answer (b). The phrase typical example in answer (a) isn't enough reason to say that the passage is an induction by analogy, using an appeal to a typical example. Only (b) makes use of the example being typical. Arguments (a) and (c) would continue to be strong even if the example were atypical. Also, argument (b) is inductive, whereas arguments (a) and (c) are deductively valid.

Causal Inference

Here is an example of a causal inference that is not inductive. Drinking a cup of vodka causes people to get drunk within ten minutes. Ten or fifteen minutes ago he drank a cup of vodka. So, he's drunk by now. The conclusion follows with certainty, doesn't it?

Here is an example of a causal inference that *is* inductive. A screwdriver is a mixed drink of vodka and orange juice. I've never noticed anybody walking funny after they've drunk plain orange juice, but everybody I've seen who has drunk two screwdrivers within a half hour has walked sort of wobbly when they've stood up. I think drinking vodka affects a person's ability to walk.

The next chapter is devoted to this type of inductive argument.

Inference to the Best Explanation

The berry pie is missing from the windowsill where it was cooling off this afternoon while it was raining. Now it's evening, and there's mud on the neighbor's shoes and a smirk on her berry-stained face. There's no indication anyone other than the neighbor took the pie. So, the best explanation of all this is that the neighbor took the pie.

That inductive argument was an inference to the best explanation. The next two chapters will explore in more detail this kind of inductive argument.

Induction from the General to the Specific

If you knew that most swans are white, would guess that the next swan you see will be white or won't be white? You'd guess that it will be white. This is an inductive argument, but its premise is a general statement, and its conclusion is a specific statement. The fact that this kind of argument is inductive refutes the common misunderstanding (perpetuated in old textbooks) that all inductive arguments reason from the specific to the general.

———CONCEPT CHECK———

Consider the following induction from a general statement to a specific one:

> Twenty-five percent of U.S. drivers use drugs. The drummer in that band is a U. S. driver. So, the drummer uses drugs.

(a) Assess the inductive strength of this argument. (b) Comment on how the strength would be affected if you were to learn that seventy percent of drummers use drugs, and all drummers are drivers. (c) Suppose you later learn that the drummer especially likes polka music and that people who like polka music rarely use drugs. Now how likely is it that the drummer uses drugs?

———[318]

How New Information Affects an Argument's Strength

An inductive argument should be assessed by looking at all the available, relevant information. (This principle is sometimes called the **Principle of Total Information**.) If relevant information has been covered up, or if it is newly acquired, this can affect the strength of the argument. Let's look at an example argument and then consider how you should change your estimate of its strength when new information becomes available.

> Harold needs to have his rugs cleaned, and his friend Veronica reports that Ajax Carpet Service did an excellent job on her rugs. From this, Harold concludes that Ajax will do an equally good job on his own rugs. He has no other information about Ajax Carpet Service or Veronica's rugs; so he satisfies the Principle of Total Information.

Harold's argument has a certain inductive strength. We are interested in how the following new facts should affect its strength. Should it strengthen the argument, weaken the argument, or have no effect on the strength of the argument? Assess each new fact assuming it is the only change made to the original argument.

a. Veronica hired Ajax several times, and Ajax always did an excellent job.

> *answer*: This new information strengthens Harold's argument because it's now known that Veronica has an even better "track record" of good results with the Ajax Carpet Service, so it's even more likely that Harold will get the same good results.

b. Veronica's rugs are wool, and Harold's are nylon.

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318 (a) It is weak because 25 percent is less than half, (b) Now you should raise your estimate of how likely it is that the drummer uses drugs, closer to 70 than to 25. (c) This third factor complicates the situation even more. Now the likelihood the drummer uses drugs should drop from your estimate in part (b).

answer: This weakens Harold's original argument. There is new information about a relevant factor that is present for Veronica but missing for Harold, so Harold can be less sure Ajax will work out OK for him. The analogy between their two situations is worse, so relying on the analogy will produce a weaker argument.

c. Veronica's carpets never had any stains on them before they were cleaned, but Harold's have several large stains.

answer: This weakens the argument. There is new information about a relevant factor that is present for Veronica but missing for Harold, so Harold can be less sure Ajax will work out OK for him.

d. Harold knows of six additional people who have had their carpets cleaned by Ajax, and all six have been very pleased.

answer: The inductive strength goes up. The past track record of good jobs by Ajax is even better and since it's with a variety of people it should be more likely to work for Harold whose cleaning situation might be even more like one of those additional situations than it is like Veronica's situation.

e. Harold changes his conclusion to state that Ajax will get his carpets *approximately* as clean as it has gotten Veronica's.

answer: Stronger. The conclusion is now vaguer and thus more likely to be true. It's easier to hit a big target than a small one.

f. One of Ajax's employees published a new novel.

answer: This information is irrelevant, so the strength of Harold's original argument is unchanged.

g. Ajax has recently undergone a change in management.

answer: Weaker. A change in management might mean a change in chemicals, or a change in workers, so now Harold can't be as sure that things will go as they did back at Veronica's.

h. The Environmental Protection Agency recently banned the cleaning solution Ajax has used for many years.

answer: Weaker. The use of the cleaning solution may have been what made Veronica happy with Ajax's work, so a possibly relevant factor has been altered, and this weakens the argument.

Let’s work through another set of examples about revising our assessment about the strength of an argument. Here is another problem about arguing from the past to the future. Suppose you are trying to decide whether the highway you plan to take to visit your grandparents on Christmas Eve will be covered with snow. You gather the relevant evidence from your memory:

> Every Christmas Eve in the past, the highway to my grandparents has been snow-covered.

Nobody has said anything that would suggest the highway conditions this Christmas Eve will be any different than in the past. On the basis of these reasons, you conclude:

> This Christmas Eve, the highway to my grandparents will be snow-covered.

This argument is deductively invalid. Nevertheless, it is a moderately strong inductive argument if the premises are true. The argument depends crucially on the premise that on every Christmas Eve in the past the highway has been snow-covered. Suppose you can't be very sure this is true. If so, this doubt about your key premise should also cause some doubt about your conclusion. For that reason alone, you should put less faith in your conclusion. The principle of logical reasoning that this example illustrates is the following:

> Apportion the strength of your belief in the conclusion to the strength of your belief in the premises.

Let's take a closer look at revising potentially good inductive arguments that go from data about the past to a prediction about the future. Suppose you have collected the following data: the San Francisco 49ers football team has won five of its last six games. Here is a conclusion that could be drawn from that data: The San Francisco 49ers will win their next football game. This argument would be strengthened if the conclusion were to hedge a little and state that the 49ers "might win" their next football game. It would be worsened if the conclusion were that the 49ers will win their next *three* games.

Would the original argument be improved, weakened, or unaffected if you were to add the premise that the last six 49ers games were all against different teams? It would be improved because the premises would then show that the team has the ability to win against a variety of opponents, not just one or two. If you were to learn, however, that the price of rice in China was rising on days when the 49ers played their last six games but will be sinking on the day of their next game, the argument would be unaffected. If you were to learn that their last six games were played outdoors during warm, clear weather but that their next game will be played against the Chicago Bears outdoors in cold, snowy weather, the argument would be weakened because you know that playing conditions can affect the outcome of a game played outdoors.

Logical reasoners arguing from the past to the future need to be especially sensitive to the variety of the past data. For example, here are two inductions from past statistics to future performance, yet one is a better induction than the other. Why? Notice the variability in the scores.

> Bob scored 10, 5, and 15 points in his three previous basketball games (an average of 10 points per game). So, he will score about 10 points next game.

> Bob scored 10, 9, and 11 points in his three previous basketball games (an average of 10 points per game). So, he will score about 10 points next game.

The first argument is worse. This is because of the variety of Bob's scores. The less variety in the past data, the better.

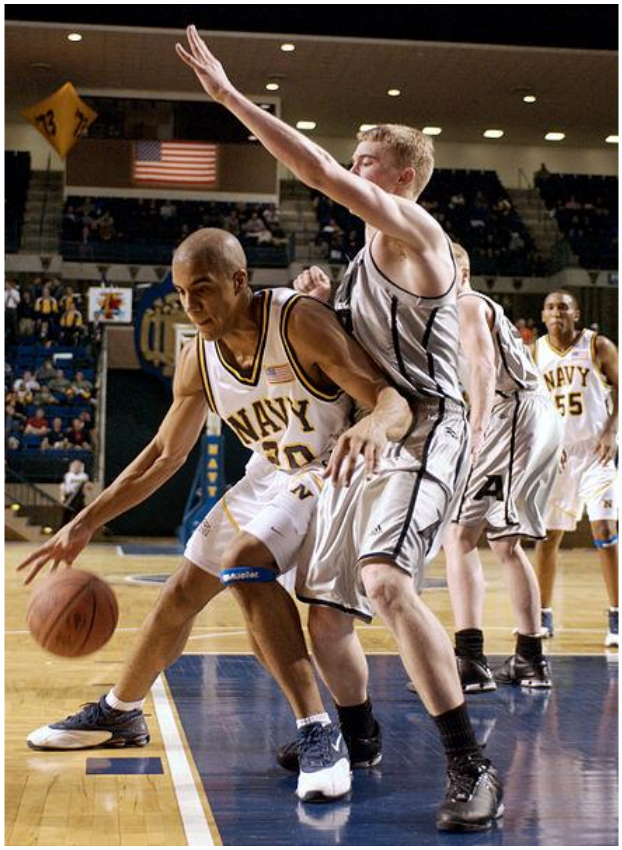
On the other hand, the more variety in the relevant past conditions affecting the data, the better. That is, the more diversity among the relevant factors, the better. For example, regarding the second argument about Bob, if you learned that he had had a slight cold during the first game and that some of the games were on indoor courts but others were on outdoor courts, you could be surer of the conclusion than if you lacked this information.

However, a relevant factor lacking in the past but existing in the future lowers the quality of the argument. For example, if you were to learn that Bob will play the next game with a sore ankle (and he didn't have a sore ankle during the previous games), you know that he is less likely to score about 10 points.

> Past diversity of conditions is a plus; future diversity is a minus.

———CONCEPT CHECK———

Here is an argument from the past to the future:



The Kings have played the Lakers in basketball three times this year, and each time the difference in their two scores has been under six points. So, their next game against each other should have a point spread of under six points.

The past performance of the Kings is analogous to their future performance. Below you are given various modifications of the above argument. Treating each modification separately from the others, determine whether the alteration produces a stronger argument, produces a weaker argument, or has no effect on its strength.

a. Change "three times" to "thirteen times."

b. Their next game should have a point spread of exactly five points.

c. The Lakers lost to the Pistons yesterday but beat the Knicks last week.

d. Although there is a home court advantage, the three games were alternated between the two teams' home courts.

e. For the last three games against the Lakers, the starting center for the Kings has been Causewell, but he was hurt in a skiing accident today and won't be starting against the Lakers.

f. The Lakers have played the Kings only once.

g. In all previous games between the two, the announcer from the local TV station has drunk a beer during the game, but next time he won't drink.

h. In two of the three previous games between the Kings and the Lakers, the difference in their two scores was under six points, but in one it was over six.

i. In all previous games between the two, the Kings starting center was high on cocaine, but next time the center won't be.

[319]

Statistics and Probability

Even when we are dealing with statistically significant statistics, we critical thinkers have to be on our guard not to be bamboozled by statistics. Which would you prefer, a drink that is 96% fat-free or one that is 4% fat? Most of us would prefer the first one, but we aren't thinking critically here, because there is no difference in the two.

[319] Here is how the modifications will affect the argument:

a. Stronger. A better track record makes for a more reliable prediction.

b. Weaker. A more precise conclusion is harder to defend.

c. No effect. Those games shouldn't affect how the Lakers will do against a different team, namely the Kings.

d. Stronger. The added diversity (variability) of the relevant conditions in the past makes it more likely that the pattern will hold into the future.

e. Weaker. A relevant condition that held in the past is now known not to be holding in the future, so the conclusion is now more chancy.

f. Weaker. There is not much of a pattern now.

g. No effect. The mental state of the announcer is not relevant.

h. Weaker. There is now more variety in the past data, so the inductive argument will be weaker.

i. Weaker. A relevant past condition no longer will hold, and thus the analogy between past and future is weakened.

———CONCEPT CHECK———

If you look at the speed people are driving when they get in auto accidents, you will find that a much higher percentage of accidents occur at speeds below 70 miles per hour than at speeds over 100 miles per hour. Therefore, to be safe you should try to drive over 100 miles per hour.

You do want to be safe, don't you? Or maybe you prefer living on "the edge." Or maybe you saw through my silly recommendation about driving over 100 miles per hour. Can you say what is wrong with the reasoning other than that it is silly?

———[320]

Let's turn from statistics to probability. Probability involves putting a number on the chance of an event taking place. The custom is that probability numbers must be on a scale from zero to one, which zero meaning the event definitely won't occur and one meaning it definitely will. Most probabilities we are interested in fall somewhere between these two extremes.

Consider a game involving dice. When we roll a fair die, there are six possible outcomes, all equally likely. Suppose we are interested in the probability of getting a 5. That means that exactly one of the six possible outcomes is classed as a success, giving a probability of 1/6. The fundamental principle here is straightforward. The probability of a successful outcome is always the ratio:

Number of successful outcomes divided by the total number of outcomes,
so long as every outcome is equally likely. If the outcomes are not equally likely, the math gets complicated.

Gamblers who bet on the outcome of the role of a fair die sometimes make the mistake of thinking that if after ten or twenty rolls, a five has come up less than 1/6 of the time, then a five is "due," meaning that on the next roll a five is more likely than 1/6. This mistake in reasoning is called the *gambler's fallacy*. A five has the same probability regardless of the history of the die.

But all this was on the assumption that the die was "fair." Let's relax that assumption. Suppose someone shows you a coin with a head and a tail on it. You watch him flip it ten times and all ten times it comes up heads. What is the probability that it will come up heads on the eleventh flip? Let's consider what three people would say.

A person who commits the gambler's fallacy would tell you, "Tails is more likely than heads, since things have to even out and tails is due to come up."

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320 About the speeding, very few people drive that fast, so naturally there are few accidents at that speed; but the chances of having an accident when driving at that speed are astronomical compared to driving within the speed limit.

A math student would tell you, "We can't predict the future from the past; individual trials are uncorrelated. So, the odds are still even."

A professional gambler would say, "There must be something wrong with the coin or the way it is being flipped. I wouldn't bet with the guy flipping it. However, on an even bet I'd bet someone else who isn't a friend of the guy doing the flipping that heads will come up again."

The professional gambler is the most sensible of these three people.

We make all sorts of probability judgments without putting any numbers on those probabilities. Looking at a woman walking out of a parking garage, we correctly say it's more probable that she's a bank clerk than that she's a bank clerk from Florida even though we have no good idea what the probability number is. But if we noticed that she had just walked away from her car that has Florida license plates, then we'd say it's more probable that she's a bank clerk from Florida than that she's a bank clerk not from Florida.

——CONCEPT CHECK——

Is it more probable that she's a bank clerk from Florida than that she's poor and lives in Florida and works as a clerk in a bank?

——[321]

Review of Major Points

Inductive arguments are more common than deductive arguments, and they are more difficult to analyze, but logical reasoners need to be able to handle both kinds of argument. The quality of an inductive argument is always a matter of degree, unlike the quality of deductive arguments. In this chapter we considered the value of anecdotal evidence and reviewed some of the problems with arguments that appeal to the opinions of authorities. We examined several types of inductive argumentation, giving the most attention to generalizing from a sample. Generalizing from a sample is also called inductive generalization. To improve your chances of obtaining a representative sample, you should get a random, large, and diverse sample when you can. Arguments by analogy are attacked by finding disanalogies and by extending the analogy in unexpected directions. Finally, we introduced the problem of re-assessing the strength of an inductive argument when new information becomes available. We took a short foray into the mine field of statistics and noticed some ways people can lie with statistics. We introduced the subject of probability and learned to avoid the gambler's fallacy, and to judge

321 Yes. It is more probable that she has two characteristics than that she has those two plus another one.

that it is more probable that any two events will occur than that these two plus a third will occur.

Glossary

appeal to a typical example Drawing a conclusion about a population from the characteristics of a single example believed to be typical.

biased sample A non-representative sample.

biased sampling method A method of taking a sample that is likely to be non-representative.

biased generalization A generalization produced by relying on a biased sampling method.

coincidental pattern A pattern in data that appears by accident. A coincidental pattern would not persist if more data were acquired.

confidence level The percentage of confidence we need that the value of our statistic agrees with the target parameter, given the acceptable margin of error. For example, are we willing to be only 95 percent sure that we have the right answer, even allowing for the margin of error? Or must we be 99 percent sure?

disanalogies The ways in which two things are not analogous.

diversity Variety.

extend the analogy To point out additional ways in which two analogous things are alike.

fallacy of hasty generalization Jumping to conclusions when the conclusion is a generalization from the evidence.

fallacy of jumping to conclusions Drawing a conclusion prematurely or with insufficient evidence, even if the conclusion turns out to be true.

faulty analogy Claiming that two things are analogous with respect to some characteristic when in fact they aren't analogous.

gambler's fallacy Assuming that an event is due or has a higher probability of occurring because it has occurred very much in the past, when it is should be known that the probability doesn't change over time.

heterogeneous group A group having considerable diversity in the relevant factors affecting the outcome of interest. For predicting the shape of a randomly picked snowflake, snowflakes are a heterogeneous group.

homogeneous group A group with an insignificant amount of diversity in the relevant factors affecting the outcome of interest. For predicting either the color or the melting point of a randomly picked snowflake, snowflakes are a homogeneous group.

inductive generalization Generalizing on a sample; also called induction by enumeration and empirical generalization.

margin of error A limitation on the accuracy of a measurement; it is the interval around the parameter that the statistic falls within.

parameter The target number in a measurement—that is, the true value of the characteristic being measured.

population The set or group whose characteristics are the focus of the measurement or inductive generalization. The population need not be a group of people; when a quality control engineer samples cereal boxes to measure their freshness, the population is the cereal boxes.

principle of total information When assessing the strength of an argument for a conclusion, use all the information that is relevant and available.

random sample Any sample obtained by using a random sampling method.

random sampling method Taking a sample from a target population in such a way that any member of the population has an equal chance of being chosen.

representative sample Less formally, a sample having the same characteristics as the population. More formally, a sample S is a perfectly representative sample from a population P with respect to characteristic C if the percentage of S that are C is exactly equal to the percentage of P that are C. A sample S is less representative of P according to the degree to which the percentage of S that are C deviates from the percentage of P that are C.

sample The subset of the population used to estimate the characteristics of the population.

simple statistical claim A claim that has the form "x percent of the group G has characteristic C."

statistic The number used as the estimate of the parameter.

statistically significant A statistic that probably does not occur by chance.

stratified sample A sample that is divided into strata or categories.

typical example A single member that has the same characteristics as the population as a whole, in the sense that if it were the only member in a sample, the sample would be a representative sample of the population.

variable Anything that comes in various types or amounts. There are different types of races, so race is a variable; there are different amounts of salaries, so salary is a variable; and so forth.

value of a variable Each type or amount of a variable. For example, Caucasian is a possible value of the race variable; $30,000 would be the value of the salary variable for a person who makes $32,500 per year if the salary variable indicates annual salary only to the nearest $10,000.

Exercises

Generalizing from a Sample

1. Evaluate the following reasoning. In answering, specify the conclusion, say whether the conclusion follows, and explain why.

> This survey of major corporate executives indicates that 60 percent of those sampled believe that some American businesses often engage in price fixing. Therefore, if you were to pick in the same way five of the surveyed major corporate executives, you could reasonably expect that three of them would believe that some American businesses often engage in price fixing.

2. If some members of the target population did not have an equal chance to be selected into the sample, then the sample *must* be non-representative of the population.

> a. true b. false

3. Rank the following three arguments in order of their strength, strongest first:

> (1) Our local newspaper's film reviewer liked the film; so it's a good bet that everyone else will, too.
>
> (2) Everyone else liked the film, so it's a good bet that our local newspaper's film reviewer will, too.
>
> (3) Everyone liked the film, so it's a good bet that our local newspaper's film reviewer did, too.
>
> a. 123

b. 32 1

c. 2 13

d. 3 12

e. 2 3 1

■ 4. Is a large random sample that is stratified on all the relevant characteristics in the population always representative of the population? Why?[322]

■ 5. Why aren't all representative samples random? You may assume that any sample is less than the whole population being sampled.[323]

6. For the following statistical report, (a) identify the sample, (b) identify the population, and (c) discuss bias and the representativeness of the sample, mentioning sample size, stratification, and so on.

> The *State Hornet*, the State University student newspaper, conducted a survey by asking students a series of questions. The survey was conducted at noon in front of the University Union and involved 450 students out of a student body of 26,000. The interviewers were careful to get a sample with a racial, sexual, and age breakdown similar to that of the university as a whole. In the survey, 70 percent of the students interviewed said they opposed mixing sexes on the same floor of the dormitories. The newspaper presented the results of its survey in an article headlined "Majority of Student Body Opposes Mixing Sexes on Same Floor of Dorms."

Suppose that in response to this passage, Smith remarks, "There are several problems with this survey. For instance, the "70" is pseudoprecise, and just how do you tell from a distance what someone's age is?" (d) Discuss this response.

■ 7. After a gun control law was passed in the state of Washington, the murder rate in Washington dropped from 4.3 percent per thousand to 3.4 percent per thousand. If this drop is statistically significant, then

a. the drop is not due to random variation in the population of murders.

---

322 No. Such a sampling procedure won't guarantee a correct conclusion. Only a deductive argument will do that. Generalizing from sampling less than 100 percent of the population is always risky.

323 Getting a random sample is one of several methods that will help get a representative sample, but a representative sample can also be obtained by luck.

b. the difference between 4.3 percent and 3.4 percent is due to chance.

c. the difference between 4.3 percent and 3.4 percent is too small to be important statistically.

d. the difference between 4.3 percent and 3.4 percent either is due to chance or is too small to be important statistically, but not both, and you cannot tell which from the information given.[324]

8. For the following statistical report, (a) identify the sample and its size, (b) identify the population, and (c) discuss how the sampling could have been improved by stratifying on time (but don't mention other ways to improve it).

> In an effort to determine U.S. truck driver attitudes about the new requirements, the Council for Population Studies asked U.S. truck drivers whether they thought the same smog requirements that automobile drivers must meet should apply to truck drivers as well. Of the several thousand who responded to the survey, most indicated that they believed trucks should be exempt from the automobile smog regulations. The voluntary survey was taken at random times of the twenty-four hour day at randomly selected truck stops throughout the United States.

■ 9. Hannah is getting sick and tired of following Ricardo's advice. Every time he has recommended a film for her to see, she has been disappointed in the film. Once she even walked out before the film had ended. She decides that this time she is not going to go see "The Rise of Dracula" which Ricardo's has just recommended.

In Hannah's reasoning, what percentage of the items in the past have had the property in question that she is considering projecting into the future?

a. 25%
b. 20%
c. 100%
d. 0%
e. can't tell[325]

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324 Answer (a).

325 Answer (c). 100% of the times in the past when she has taken his advice, she has been unhappy with the advice. She infers that this pattern will continue into the future and that she will also be unhappy again with the new advice. The proper6ty in question is the disappointing character of the film that is recommended by Ricardo.

10. Examine the following dialogue, paying attention to the quality of the reasoning. Then answer the questions that follow.

Lesley: I think little Sam will soon be having dreams of giant needles.

Rico: What? Have you been reading the tabloids again?

Lesley: No, but his school says all elementary and pre-school kids should be vaccinated for measles.

Rico: Who is sick? Do you know anybody with measles?

Lesley: No, but they *might* get sick. Evidently somebody high up thinks there's a chance. The school recommended the shots in a leaflet Sam brought home this afternoon.

Rico: What will this latest suggestion of theirs cost us?

Lesley: I don't know. That's a problem. We have to find a clinic, make the appointment, and all that. The leaflet recommended ten clinics in the county.

Rico: It may not be worth all the trouble. I don't know anybody in the last ten years who has ever gotten measles. Besides, can't you still get the disease even if you take the vaccine for protection? Do they say it's perfect? Can't the vaccine itself give you the disease? Shouldn't we consider all this?

Lesley: Well, the leaflet said something about a scientific report in some medical journal. Here it is. It says, "The new vaccine uses a live form of the measles virus that is expected to be the cause of most cases of measles in the U.S. over the next few years. However, the virus is weakened so it is very unlikely to cause a real case of the measles. In order to show that measles can be prevented in children, medical professors Carolyn Owen, Mary Pittman Lindemann, and Linda Bomstad gave injections last year to 1,244 children who had been admitted to Chicago hospitals for non-life-threatening problems. 622 received the vaccine; the rest of the children received an injection that looked identical but was actually a harmless placebo, just salt water. The nurses administering the injections were not told which children were getting which kind of injection. Seven months later, only one of those who received the vaccine had gotten measles, but 45 of the group whose injections contained no vaccine had been diagnosed as having the disease." How does that sound to you?

Rico: OK, the shot will help keep Sam safe, but I'd still like to know what it costs.

Lesley: Well, you go call a clinic and ask them.

Rico: You're better at dealing with bureaucracies. You call.

a. What is the main issue in this conversation?

b. Rico implicitly makes an inductive generalization based on some statistics. What is the target population?

c. Describe the sample, but do not evaluate the sampling procedure itself.

d. Any problems with the sampling procedure? Comment on stratification of the sample.

e. What did this study say or show about how to cure measles in a child once the child has gotten the disease?

f. Is Rico being illogical anywhere in the conversation? If so, where and why?

■ 11. Could this be true? "I was trying to learn about the population, but my totally unbiased sampling method produced what I later learned was a non-representative sample."[326]

12. About 95 percent of the sample of 94 resistors taken from the approximately 1,500 resistors in Tuesday's output at the factory are of good enough quality to be sold. From this information about the 94 resistors, which of the following statements about the 1,500 is most likely to be true?

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326 This could well be true. Being unbiased only promotes the production of a representative sample; it won't guarantee it.

a. All of Tuesday's total output of resistors work OK.

b. Exactly 95 percent of Tuesday's total output of resistors work OK.

c. Over 90 percent of Tuesday's total output of resistors work OK.

d. 94 to 96 percent of Tuesday's total output of resistors work OK.

13. If some members of the target population did not have an equal chance to be selected into the sample, then the sample must be nonrandom.

a. true b. false

14. Create an original example of an induction from the general to the specific.

15. Suppose you were interested in whether the customers who buy heavy metal music from your store would like you to carry wall posters of the musicians. You can't ask all the customers, but you can ask a few by taking a poll. You happen to know that about 60 percent of your customers who buy heavy metal music are male. You know that about 50 percent of the people in the world are female. If you were going to stratify your sample on sex, how should you do the stratification?

■ 16. After examining the birth records of as many black persons as she could fine who were born between 1850 and 1950 in a Gulf Coast state, Dr. Gale Carswell discovered that 55 percent of those children were female. She then reported the remarkable result that there were significantly more female than male black children born in the Gulf Coast states during that period. In her study, the population was

a. as many black persons as she could find who were born between 1850 and 1950 in a Gulf Coast state.

b. black persons who were born between 1850 and 1950 in a Gulf Coast state.

c. people living in states along the Gulf Coast between 1850 and 1950.

d. 55 percent of the black persons born in a Gulf Coast state between 1850 and 1950.[327]

17. Logical reasoners should not commit the fallacy of covering up counterevidence. In each of the following passages the reasoner is guilty of committing this fallacy, though you aren’t told why. What would you guess is the negative evidence that is being suppressed either intentionally or unintentionally?

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327 Answer (b).

a. Every day of my life the night has been followed by the sun's coming up. It is reasonable, therefore, to suppose that the sun will always come up in the future.
b. I’ve tried lungfish at three different restaurants over the last few years. Every time it has tasted awful to me. So, if I order the lungfish on this menu tonight, I won't like it.
c. The creation of the world happened long before anyone was around to witness it, so there can be no support for the theory of evolution from individual testimony. The only real evidence for evolution is in the bones embedded in rocks, but there are so many questions in this area of paleontology that even the paleontologists don’t agree. Besides, all the evidence is easily accounted for by the Noah’s flood that is mentioned in the Bible. Therefore if you base your belief in evolution on geology or paleontology you are really being unscientific.

■ 18. If you obtained new theoretical knowledge that the population of objects you are about to study by statistical sampling is not very diverse, then you can make good use of this knowledge by

a. increasing your sample size.
b. decreasing your sample size.
c. assuming that similar effects are likely to have dissimilar causes.
d. avoiding a representative sample.[328]

Other Types of Inductive Arguments

■ 1. Suppose someone offers the following argument: Amassing a fortune is like winning an election because it takes hard work, new ideas, and charisma. Well, behind every great fortune there is a great crime. So, you know what that means for elections. Explain the analogy by identifying the argument's conclusion and the A, B, and C that appear in the standard form of any argument by analogy.[329]

■ 2. Create a short, serious argument by analogy for the following conclusion even if you don’t agree with it:

Abortion clinics deserve to be bombed.[330]

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328 Answer (b).

329 Conclusion: Winning an election depends on a great crime. A = amassing a fortune; B = winning an election; C = depends on a great crime.

330 An abortion clinic is like a nest of wasps in that both harm innocent persons. A nest of wasps deserves to be bombed (with pesticides). So, abortion clinics deserve to be bombed, too.

3. Which one of the following three passages argues in a way that relies on an anecdote?

    a. Uncle Antonio told me, "Don't bother checking," but I didn't listen to him. Somehow I just didn't believe Sandra when she said Sacajawea was some president's wife. I really wanted to find out more about Sacajawea, so I asked the librarian. She said to check the encyclopedia. It said that Sacajawea was an Indian woman who guided Lewis and Clark's expedition in 1804. She didn't marry any president. But think about that expedition. Knowing what you know now about U.S. history since 1804, do you think things would have turned out better if Sacajawea would have refused to be the guide for Lewis and Clark?

    b. Mercy Otis Warren was a black activist who wrote political pamphlets during the American Revolution. I can still remember my grandmother saying to me, "When you grow up, you should read about that revolution. But don't read about it from your high school textbook. Read other books from big libraries." That's why I'm here. I want to know if you have any history books about Mercy Otis Warren. There is no listing for his name in the computerized catalog.

    c. Paula Abdul and Wynton Marsalis are better singers than Lady Gaga. I went to the same concert that you are talking about, but I was closer to the stage than you were. Trust me; Lady Gaga didn't sing those songs; she just moved her lips to make it look that way. Once, when she tripped while dancing across the stage, she closed her mouth for a second, but the song kept right on going.

4. Identify the analogy that is used or mentioned in the following passage:

    Hardly anybody likes to kill people. War is a messy, dirty, godforsaken business. Who wouldn't rather be home eating popcorn on the couch? But let's face it. You can't make an omelet without breaking eggs.

5. Create an original argument about some aspect of warfare. Your argument must be reasonable and nontrivial, and it must rely on an appeal to an analogy.

■ 6. Discuss the strength of the following argument by analogy:

    Mercury is like water in that they are both liquids. Water seeks its own level, so the mercury in that thermometer will, too, if you break it open.[331]

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331 That argument is weak. Here is a much better argument:

    All liquids seek their own level when not confined. Mercury is a liquid.
    So, Mercury will seek its own level, too, when not confined.

The first premise here follows from a scientific theory of liquids. The reason that the original argument is weak as it stands is that it is quite similar to the following inductively weak argument:

7. Discuss the quality of the reasoning in this argument. Is it valid, sound, fair, etc.?

    You have to be a lesbian to be a feminist, but the film “Still Killing Us Softly” doesn't promote lesbianism, so the film is antifeminist.

8. Which of the following passages contain arguments that are inductions by appeal to a typical example?

    a. This piece of copper is a typical example of copper. All copper conducts electricity. Therefore, this piece of copper does, too.

    b. Let me make this appeal one more time, but it's the last time. If you want to keep your roof from leaking next winter, you’ve got to buy our Number One roof treatment. It has worked for all our customers, so it will work for you, too.

    c. Woody Allen's “Annie Hall” was a comedy, so his films are probably all comedies, don't you think?

    d. Our polling indicates that very few black Canadians can name one famous black American who lived in the nineteenth century. Their best guess for an example of a black American was Huey Newton. Newton was black, but he was a Black Panther organizer in Oakland, California in the 1970s, not in the nineteenth century.

9. Do some independent research and then write a short essay explaining to what extent the flow of electricity in a wire is analogous to the flow of water in a pipe.

10. Write a short essay explaining to what extent the operation of a family is and isn’t analogous to the workings of a country.

11. After receiving another student's answer to the previous question, write a short essay evaluating the student's answer.

12. State the implicit analogy used in the following argument:

    You wouldn’t think it’s right to attack your neighbor across the street, so it is immoral for any country to attack its neighbor.

■ 13. State the implicit analogy used in the following argument:

    There's no challenge in defeating Princeton in baseball. Would you take candy from a baby for the challenge of it?[332]

Mercury is like water in that they are both liquids. Water is a thirst-quenching liquid, so the mercury in that thermometer is, too.

Mercury is actually poisonous, as are all metals.

332 Defeating Princeton in baseball would be like taking candy from a baby.

■ 14. Choose the letter of the ranking that goes from strongest argument to weakest:

(1) Pele scored 10, 9, and 11 goals respectively in his last three games, so he will score 10 goals next game.

(2) Pele scored 10, 9, and 11 goals respectively in his last three games, so he will score 9 to 11 goals next game.

(3) Pele scored 10, 9, and 11 goals respectively in his last three games, so he scored an average of 10 goals in his last three games.

a. 123
b. 321
c. 213
d. 312
e. 231[333]

15. During this year's soccer season, our team has lost all three of its games against Princeton University. It's a good bet that tomorrow's game against them will also be one big tragedy.

Consider the following changes to the above argument. Would each change (separately) be likely to strengthen, weaken, or not affect the argument?

a. Meredith, who is Princeton's best player, played in all three of the previous games, but she won't be playing tomorrow.

b. Helan, who is our team's best player, played in all three of the previous games, but she won't be playing tomorrow.

c. The last three games against Princeton were played on our field, and the next one will be, too.

d. The last three games against Princeton were played in different places: on our field, Princeton's, and the local community college's.

e. One of the games was played during a high wind, and the other two were played during a cold drizzle, but the weather prediction for tomorrow is warm, sunny, and calm.

f. During the past three games you have bet on the results and won, but this time you are not going to bet.

333 Answer (b). Argument 3 is deductively valid, unlike the other two arguments.

■ 16. Lady Theresa claims to be a psychic and to have perceptive abilities beyond those of most other people. She was tested in a laboratory once for her ability to guess which queen is missing from an ordinary deck of fifty-two playing cards, each containing four different queens. A friend of Lady Theresa was surprised to learn that she correctly identified the missing card only 50 percent of the time; she expected her to have a 100 percent success rate.

a. If in future card tests the experimenter were to have a professional magician specializing in card tricks observe Lady Theresa and help detect any cheating, should this make a 50% success rate more believable or less believable?

b. If not 50 percent, then what score should you expect the average, nonpsychic person to get on the card tests?

c. The experimenter says that Lady Theresa's 50 percent is not statistically significant. Why do you suppose it isn't significant, and what do you recommend doing to determine whether her ability on these card tests is significantly better than the average person's ability?[334]

17. Is mathematical induction a particular kind of inductive argument?

18. Comment on the strength of these inductive arguments:

a. Our lunar module landed on Saturn's closest moon and found the surface everywhere to be powdery down to two inches. Therefore, the surface of Saturn itself is covered everywhere with two inches of powder.

b. The chemical 3,4,5-trimethoxylate benzaldehyde killed David and his son when they drank it, so it will kill anybody.

19. Create your own multiple-choice question, with answer, about induction by appeal to a typical example. Make the question realistic, unambiguous, and the appropriate level of difficulty for students in your own class.

20. Create your own essay question, with answer, about induction by appeal to a typical example. Make the question realistic, unambiguous, and the appropriate level of difficulty for students in your own class.

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334 Answer (a). This will make it more believable because it will make it more difficult for her to cheat or to get lucky. In short, you will have a better-designed experiment. (b) The answer is 25 percent, which is one queen out of four. (c) It probably wasn't significant, because so few tests were run. Maybe she guessed twice and was correct one of the two times. Do more tests.

21. For the problem of deciding whether a vaccine manufactured from chicken eggs will be effective against the common cold, would you say that a healthy sixty-two-year-old female designer of anti-tank weapons for the Boeing Corporation in Seattle, Washington would be a sufficiently typical member of the target population such that if the vaccine works on her it would work on anybody? Why? Mention any relevant background knowledge you have about diversity.

■ 22. State the conclusion of the following inductive argument, and then describe the argument's structure:

> David was caught cheating on his history homework when he was in high school, and now you want to hire him to work the cash register in our office? Get serious. A leopard doesn't change its spots.[335]

335 Conclusion: David will continue to cheat if he is hired to work the cash register in our office. It's an argument from the past to the future passed on the idea that the past pattern of cheating will be likely to continue in the future. The comment about leopards is a common expression used to make the point that old patterns will continue to hold in the future. This passage could be analyzed as containing two arguments. First comes the argument mentioned in the preceding paragraph. The second argument has more implicit elements: its conclusion is that we shouldn't hire David. The argument contains implicit premises about it being unwise to hire people who cheat, especially if the job is to work a cash register. It is unclear, however, whether the second argument actually occurs; perhaps it doesn't and we are just guessing that the second argument is likely to be created or accepted by the arguer.

23. Which of the following is the only one argument that relies on an induction from the past to the future? State the conclusions of all the arguments.

    a. Joey's leopard had spots in the past and it will have spots in the future. So, a leopard doesn't change its spots.

    b. Yesterday there was a full jar of jelly beans on that shelf. This morning there is a half-empty jar. Somebody took some last night, right?

    c. When you bought that goldfish, who ended up taking care of it, me or you? Now you want to buy a guinea pig, and you expect me to believe that you will take care of it. No thanks.

    d. You've got to buy either the goldfish or the guinea pig. My older sister told us that the goldfish is cheaper to buy and to feed, although it is also a little less fun to play with. So, let's buy the guinea pig, not the goldfish.

24. The following passage describes a scientific experiment. It then makes an induction from the past to the future.

    We showed the person who claimed to be a psychic a deck of regular playing cards in which one card had been removed. The psychic was shown the backs of the cards but was not allowed to touch the cards. During the twenty times we tested the psychic, he correctly guessed which card was missing from the deck over 50 percent of the time. Therefore, he will get it right more than half of the time on the next twenty times we perform the test. Would the above argument be improved, weakened, or unaffected if

    a. The phrase *twenty times we tested* is changed to *twenty-four times we tested*.

    b. The phrases *missing from* and *half* are replaced by *not in* and *50 percent*, respectively.

    c. The word *half* is changed to *three-quarters*.

    d. The psychic was quite comfortable in the past tests but will be made uncomfortable in the future tests.

    e. In the previous tests a magician trained in card tricks was present to observe the psychic and to help the experimenter discover cheating that would invalidate the experiment, but in future tests the magician will not be present.

    f. In the past tests the experimenter knew which card was missing, but in the future even the experimenter won't know the answer at the time the question is asked of the psychic.

    g. The past tests and results were duplicated by an independent and trustworthy research organization.

h. Instead of all past twenty tests having been performed on a single day in a single lab, they were spread across fourteen days in seven different labs.

■ 25. John is a part-time cotton farmer in Alabama who has tried for four years to get a decent crop on his small plot. Every year he's had so much damage from pests that he hasn't made a decent profit. He concludes that next year's results will be just as bad. Would the strength of his argument be improved, weakened, or unaffected if he next year John will be adding alfalfa clippings as a fertilizer to his crop? Why?[336]

26. Consider the character of this passage:

> Medieval war is like a chess game because there are knights battling on horseback, kings at the center of attention, powerful queens, bishops who support the king, and so forth.

In the passage, there is an argument

a. by disanalogy
b. by appeal to a typical example.
c. by analogy that is not an appeal to a typical example.
d. whose conclusion is an analogy.

27. Criticize the following argument by analogy by using the technique of pointing out disanalogies:

> Government budgets are like personal budgets in so many ways. Since you can't last long when your own budget is in the red, you shouldn't permit deficit spending by your government.

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336 The argument probably will be weaker, because there is now less similarity between the past and the future in regard to a causally relevant characteristic. In particular, the fertilizer might make the crop more hardy and thus more resistant to the pest. Only if you knew that adding this fertilizer would tend to hurt the crop — say, by promoting pest growth — could you safely say that the argument would be strengthened. If you didn't know whether adding the fertilizer would help or hurt the crop, then just the fact that you know that adding it would be likely to affect the crop is reason enough to say the argument is weaker.