

Critical Thinking

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Lecture 8

MGM115
Critical Thinking



جامعة الجميع الذكية
EVERYONE'S SMART UNIVERSITY

Inductive Reasoning

Mostly from Critical Thinking, Bassham and others

Inductive Reasoning

This lecture includes:

- **Evaluating Inductive Generalizations**
- **Opinion Polls and Inductive Generalizations**
- **Statistical arguments**
- **Reference Class**
- **Induction and Analogy**
- **Causal Arguments**

INTRODUCTION TO INDUCTION

An inductive argument is one in which the premises are intended to provide support, but not conclusive evidence, for the conclusion. Because inductive arguments do not guarantee that their conclusions are true, we evaluate them according to the strength of the support they provide for their conclusions. An inductive argument is strong when its premises provide evidence that its conclusion is more likely true than false. An inductive argument is weak when its premises do not provide evidence that its conclusion is more likely true than false. As we shall see, arguments have varying degrees of strength and weakness.

INTRODUCTION TO INDUCTION

- If the argument's conclusion does not follow with strict logical necessity from its premises, the argument should normally be treated as inductive.
- Among the important indicator words and phrases for inductive arguments are likely, probably, it's plausible to suppose that, it's reasonable to believe that, one would expect that, it's a good bet that, chances are that, and odds are that.
- Another way to identify inductive arguments is to look for their common patterns. Four of these are inductive generalizations, statistical arguments, arguments from analogy, and causal arguments

INDUCTIVE GENERALIZATIONS

A generalization is a statement made about all or most members of a group. Inductive generalization is one of the most important kinds of inductive arguments. An inductive generalization is an argument that relies on characteristics of a sample population to make a claim about the population as a whole. In other words, it is an argument that uses evidence about a limited number of people or things of a certain type, the sample population, to make a claim about a larger group of people or things of that type, the population as a whole.

Evaluating Inductive Generalizations

Although there are standard tests for determining whether a deductive argument is valid or invalid, there is no standard test for determining whether an inductive argument is strong or weak. Still, we are not totally lost when it comes to evaluating inductive generalizations. There are three questions we must ask of each inductive generalization we examine:

- **Are the premises true?**
- **Is the sample large enough?**
- **Is the sample representative?**

Evaluating Inductive Generalizations

Are the Premises True?

One thing that inductive arguments have in common with deductive arguments is the need for true premises. The premises of an inductive generalization can provide strong support for its conclusion, but if the premises are not all true, it is not a cogent inductive argument. A cogent argument has all true premises and supplies strong support for its conclusion.

One or more false premises makes an inductive argument uncogent.

Evaluating Inductive Generalizations

Are the Premises True?

Consider this example:

Most CEOs of Fortune 500 companies are women.

So, the CEOs of most big businesses are probably women.

The premise in this argument provides strong support for the conclusion. After all, if most of the CEOs of the most financially successful big businesses are women, it would seem likely that the CEOs of most big businesses are women. The premise is false, however (most CEOs are men), so it cannot legitimately be used to support the conclusion. The argument is not cogent.



Evaluating Inductive Generalizations

Is the Sample Large Enough?

Common sense prompts us to ask that obvious question about an inductive generalization. The size of the sample population must be sufficient to justify the conclusion about the population as a whole. A sample is “large enough” when it is clear that we have not rushed to judgment, that we have not formed a hasty generalization. Admittedly, this business of specifying what we mean by “enough” is not easy. For the moment, we shall rely on common sense to determine whether the sample is large enough. In the next section of this chapter, we’ll take a look at the mathematical determination of sample size.

Evaluating Inductive Generalizations

Is the Sample Large Enough?

Let's take this example:

None of the thousands of rabbits Alan has come across has tried to attack him. So, most rabbits are not inclined to attack human beings.

Thousands of encounters with rabbits seems like a large enough sample size to support the modest conclusion that most rabbits are not inclined to attack human beings. No inductive argument can guarantee the truth of its conclusion, but you don't have to be an expert in statistics to see that this one is a pretty good bet.



Evaluating Inductive Generalizations

Is the Sample Large Enough?

On the other hand, consider this example:

Brooke taught three students with purple hair last semester, and all of them were A students.

So, all students with purple hair must be A students.

Considering the thousands of students with purple hair, three students is clearly not a large enough sample on which to base this conclusion. The conclusion may or may not be true; but given the small sample, the premise is not strong enough support for it.



Evaluating Inductive Generalizations

Is the Sample Representative?

An inductive generalization is weak if the sample population it draws on is not enough like the population as a whole about which it makes its claims. In technical terms, we want the sample population to be representative. A representative sample is like the population as a whole in all relevant ways. It should be a miniversion of the population as a whole.

Evaluating Inductive Generalizations

Is the Sample Representative?

Example: All the bass Hank has caught in the Susquehanna River have weighed less than one pound. So, most of the bass in the Susquehanna River weigh less than one pound. Let's assume for the sake of argument that Hank has caught hundreds of bass in the Susquehanna River and that they all weighed less than one pound. That would seem to be a large enough sample, but the argument could still be weak. How? It could be that the hundreds of bass Hank caught were not truly representative of the population of bass in the Susquehanna River as a whole. Why? There are many possible reasons. Perhaps Hank has fished only a short stretch of the river, and there are actually much larger bass 20 miles north. Perhaps Hank has fished only with artificial lures, but if he used live bait he could catch three-pound bass right under the Market Street Bridge, where he usually fishes. Can you think of other reasons?

Opinion Polls and Inductive Generalizations

Opinion polls are an excellent source of inductive generalizations. In recent years polling has become an increasingly large part of the political process. Gallup and Harris polls are often very accurate in predicting the outcomes of national elections, for example. The aim of a poll is to determine what a large population thinks or believes about a certain issue. To make that determination, it is not necessary to ask every member of that population. Rather, the preferred method is to ask a question of a sample of the population that is both large enough and representative of the population as a whole.

No sample, no matter how large, will ever guarantee that poll results will be accurate. Still, we can use polls to arrive at a level of 95 % certainty that a sample population will mirror the population as a whole within a small margin of error. The margin of error is usually indicated by a combination of the $\pm$ signs, . This means that the results will be within a range of plus or minus the amount indicated. For example, let's say that the latest poll shows Alen leading Sami by a margin of 60 to 40 with a margin of error of ± 3 . This suggests that there is a 95 percent chance that if the population as a whole voted, the result would be somewhere between 63 and 37 percent and between 57 and 43 percent in favor of Alen. Not bad. So how large does the sample have to be to yield these kinds of results? The following table gives the breakdown.



As you can see, it doesn't take a huge sample to yield a reasonable margin of error. With a sample of just 1,500, the margin of error is ± 3 . We can add 2,500 more people to the sample, and the margin of error decreases only slightly to ± 2 . So, we can produce a fairly accurate poll on a presidential election with millions of voters with a sample population of only 1,500 voters, but there's a catch: The sample must be representative too. The millions of voters represent a great diversity of people, and somehow the sample must be representative of this larger group.

<i>Number Polled</i>	<i>Margin of Error</i>
4,000	± 2
1,500	± 3
1,000	± 4
750	± 4
600	± 5
400	± 6
200	± 8
100	± 11



Opinion Polls and Inductive Generalizations

A well-respected periodical, the Literary Digest, conducted a telephone poll to predict the winner of the 1936 presidential election. The pollsters for the magazine understood that the sample had to be large enough. In fact, they went overboard, gathering more than two million responses. They also understood that the sample had to be representative, so they randomly picked names from phone books all over the country. Having gathered and tabulated all the responses, the Literary Digest predicted a landslide victory for Alf Landon over Franklin Delano Roosevelt. As it turned out, Roosevelt won by an even greater landslide. Although the sample was more than large enough, it was not representative, despite the effort to select the sample population randomly. Why was the sample not representative? Because in 1936 many people did not have, and could not afford, a telephone in their home, and the people without telephones were mostly members of the lower and middle classes, who voted in droves for Roosevelt

Opinion Polls and Inductive Generalizations

Some polls do not even attempt to utilize a truly random sample. Instead, they use self-selecting samples. Television talk shows and news broadcasts that invite you to call a certain phone number to cast your vote and register your opinion are prime examples of self-selecting samples. The question of the day might be, for example, “Should flag burning be protected under the First Amendment?” Although this is a controversial issue, it would not be surprising to find a large majority of votes against the protection and legality of flag burning. Why? There could be many reasons. Perhaps the show during which this issue was raised has an overwhelming and nonrepresentative percentage of conservative viewers. Perhaps those against flag burning are just more vocal and outspoken about their position and so are more inclined to call in to register their opinion.



Such call-in polls face another problem: they have a significant percentage of nonresponses. The nonresponses leave us with the problem of a sample population that is not likely to be representative of the population as a whole. The bias introduced by nonresponses will be even greater if the polling is done using an Internet Web site for people to register their votes. Those who respond to an Internet poll will likely be, on average, younger, better educated, and wealthier than the population as a whole. In fact, most people realize that such call-in polls and Internet surveys are not reliable. The shows responsible for them usually make clear that the results are not the product of a “scientific poll.” In other words, aside from the entertainment aspect, they have little value at all.

Opinion Polls and Inductive Generalizations

What might seem random often isn't. Choosing names out of a phone book will not necessarily produce a representative sample, but what about approaching people on the street? This could work, but there are potential pitfalls here too. The pollster, the person taking the poll, might introduce bias into the sample because of a tendency to approach certain kinds of people and not others. Perhaps the pollster is not even aware that he is doing it. For example, he might have a tendency to approach only people who look "friendly." This may mean that he is more inclined to approach a well-dressed businesswoman and much less inclined to approach a disheveled man. This may introduce a gender bias and a socioeconomic bias into the sample population, automatically eliminating a significant portion of the population, namely, lower-class males. Perhaps the problem could be solved by randomly selecting the people on the street to be approached.

Opinion Polls and Inductive Generalizations

Still another factor that may affect the reliability of polls is dishonesty. We all like to give the “right answer” to a question, even when the question does not have a right answer but is simply a matter of opinion or an attempt to collect information. The result is that some people lie in response to anonymous polls. For example, in response to the question, “Do you consider yourself racially prejudiced?” we can expect more people to respond no than is actually the case. People think that the “right answer” is no, so some will answer no even if they do indeed consider themselves racially prejudiced. Polling agencies often take advantage of this tendency of people to try to give the right answer by asking slanted questions. For example, depending on the answer that a polling agency wants respondents to consider the right answer, they might ask two very different questions. On the subject of whether the United States should decrease the size of its nuclear arsenal, a polling agency might ask, “Are you in favor of peaceful multilateral nuclear disarmament?” Or, alternatively, “Are you against the weakening of the ability of the United States of America to offer a sufficient nuclear deterrent against foreign attack?” There is not much need to wonder what the right answer is in each case

Another potential pitfall of objective polling is the person who is doing the poll. Even without intending to, he or she may provide a clue as to what the right answer is, or respondents may answer differently depending on the pollster. A white male is much less likely to admit that he considers himself racially prejudiced if he is polled in person by a black male. A woman is much less likely to admit that she has had a venereal disease when polled by a man rather than by a woman. What is the solution? Polling should be double-blind; that is, the person taking the poll and the person responding should have no information about each other, or at least as little as possible. And neither the pollster nor the respondent should have any indication of the “right answer.”

Statistical arguments

Like other inductive arguments, statistical arguments are evaluated along a continuum of strong to weak. A statistical argument is strong when it provides evidence that its conclusion is more likely true than false—that is, when the chances that the conclusion is true are greater than 50 percent. A statistical argument is weak when it provides evidence that its conclusion is more likely false than true—that is, when the chances that the conclusion is true are less than 50 percent.

Statistical arguments

Let's look at the example:

Only 3 percent of Wexford College students are against building the new gymnasium.
Johnny Z is a Wexford College student.

So, Johnny Z is not against building the new gymnasium.

This is a strong argument, offering evidence that there is a 97 percent chance that the conclusion is true. The argument could be made even stronger by softening the conclusion so that the argument would say instead:

Only 3 percent of Wexford College students are against building the new gymnasium.
Johnny Z is a Wexford College student.

So, Johnny Z is **probably** not against building the new gymnasium.

The word probably safeguards this conclusion by claiming less than the conclusion in the original formulation did.

Reference Class

The reference class is the group to which statistics apply. As a rule, the more specific the reference class is, the better the argument is. Adding new information to an inductive argument can change its strength. In this case, changing reference classes called for a different conclusion.

Example:

Ninety-five percent of college students are in favor of not having a cumulative final exam in their critical thinking class.

Vera Peterson is a college student.

So, Vera Peterson is in favor of not having a cumulative final exam in her critical thinking class.

Suppose we discovered that 85 percent of students who like writing essays want a cumulative final because there will be an essay on the cumulative final—and that Vera is a student who likes writing essays.

That would change things. Now our argument is as follows:

Eighty-five percent of college students who **like writing essays** want the cumulative final because it will have an essay.

Vera Peterson is a college student **who likes writing essays**.

So, Vera Peterson probably wants the cumulative final.

Now we have a strong argument that contradicts the conclusion of the original version of the argument. With the added information, we have changed the reference class. As a rule, the more specific the reference class is, the better the argument is. In changing the reference class from “college students” to “college students who like writing essays,” we found that the conclusion about Vera changed. Adding new information to an inductive argument can change its strength. In this case, changing reference classes called for a different conclusion.

Induction and Analogy

An analogy is a comparison of things based on similarities those things share. Analogies, then, depend on what is similar or the same in two or more cases. Analogies are everywhere: on exams, in arguments, in newspapers, in poems, and in songs. In literature in general, and poetry in particular, analogies are common.

How can we argue by analogy?

An argument from analogy depends on an analogy or a similarity between two or more things. Analogies compare two or more things; arguments from analogy go one step further. They often claim that another similarity exists, given the similarities already recognized. Whereas an analogy simply points out a similarity, an argument from analogy claims that certain similarities are evidence that there is another similarity (or other similarities).

example:

The Post Office is a government agency.

The Department of Motor Vehicles is a government agency.

The Post Office is closed for The National Day.

So, the Department of Motor Vehicles must be closed for The National Day.

Evaluating arguments from analogy

Consider these things in evaluating the strength of an argument from analogy:

- the truth of the premises
- the relevance of the similarities
- the number of relevant similarities
- the relevance of dissimilarities
- the number of relevant dissimilarities
- the diversity of the sample, especially with increased sample size
- the specificity of the conclusion relative to the premises

Induction and Causal Arguments

We should note that not all causal arguments contain the word cause. Other causal terms include produces, is responsible for, affects, makes, changes, and contributes to. Such arguments come in two broad types: (1) arguments about the cause of a single instance and (2) arguments about a general relationship.

Here's an example of an argument about a single instance:

Megan's car wouldn't start this morning, and she hasn't replaced the battery since she bought the car six years ago.

So, it is probably a dead battery that caused the car not to start.

Here's an example of an argument about a general relationship:

The Surgeon General has found that there is a strong link between smoking cigarettes and getting lung cancer.

So, smoking cigarettes causes lung cancer.

Induction and Causal Arguments

In each case, it should be clear that the argument is inductive. The premises provide evidence (strong evidence) for the conclusion. The conclusion does not follow with strict necessity from the premises. It is always at least possible that the premises are true and the conclusion is false. Given what the argument says, it is at least possible that the car's alternator is shot and the battery is fine. Of course, there would be ways to investigate the matter further, but the argument, as it stands, does not do so. Given only what the second argument says, there is no guarantee that smoking is the cause of lung cancer.

Correlation and cause

Sometimes two things or events are clearly associated or linked: Where you find X, you will often find Y. A relationship such as this, in which two things are frequently, or even constantly, found together, is called a correlation. In a correlation two things share a mutual relationship; where one is found, the other is often, or always, found. In contrast, in the relationship of causation, one thing produces or brings about the other. Sometimes a correlation is an indicator of a cause-and-effect relationship. For example, the high rate of lung cancer deaths among smokers led to the investigation and discovery of a causal link between them.

Correlation and cause

We must be careful, though. Most correlations do not indicate a causal relationship between the two things or events correlated. For example, there is a strong correlation between shoe size and average ability in math among children. The larger the shoe size, the greater the average ability in math. For example, on average, children who wear a size 8 shoe score higher on the same exam than those who wear a size 6 shoe. Does this imply that having large feet causes an increase in mathematical ability? Or does it suggest that mathematical ability causes feet to grow? Of course not. There is an underlying explanation for this phenomenon. A child's age is correlated with both shoe size and mathematical ability. As a child grows older, both shoe size and mathematical ability tend to increase, but neither one causes the other.

Correlation and cause

A positive correlation, one that indicates two things are found together more than 50 percent of the time, may indicate a causal connection between one thing and the other. A negative correlation, one that indicates two things are found together less than 50 percent of the time, may indicate that one thing prevents the other. The important question is this: Is the correlation significant? The answer depends, in part, on the size of the sample.

- This lecture focused on forming and critically evaluating inductive arguments — arguments whose premises are intended to provide support, but not conclusive evidence, for the conclusion. In particular, we examined four common types: inductive generalizations, arguments from analogy, causal arguments, and statistical arguments.
- Inductive arguments do not guarantee their conclusions. We evaluate them according to the strength of the support they provide for their conclusions. An inductive argument is strong when its premises provide evidence that its conclusion is more likely true than false. An inductive argument is weak when its premises do not provide evidence that its conclusion is more likely true than false.

- Among the important indicator words and phrases for inductive arguments are likely, probably, it's plausible to suppose that, it's reasonable to believe that, one would expect that, it's a good bet that, chances are that, and odds are that.
- An inductive generalization is an argument that relies on characteristics of a sample population to make a claim about the population as a whole. In other words, it is an argument that uses evidence about a limited number of people or things of a certain type (the sample population) to make a claim about a larger group of people or things of that type (the population as a whole).

Ask these questions in evaluating an inductive generalization:

- **Are the premises true?**
- **Is the sample large enough? (The size of the sample population must be sufficient to justify the conclusion about the population as a whole.)**
- **Is the sample representative? (A representative sample is like the population as a whole in all relevant ways. It should be a mini-version of the population as a whole.)**

- Polling should be double-blind; that is, the person taking the poll and the person responding should have no information about each other, or at least as little as possible. And neither the pollster nor the respondent should have any indication of the “right answer.”
- A statistical argument argues from premises regarding a percentage of a population to a conclusion about an individual member of that population or some part of that population.
- Statistical arguments that approach 50 percent may be strong but are to be considered relatively unreliable.
- The reference class is the group to which statistics apply. As a rule, the more specific the reference class is, the better the argument is.

- **An analogy is a comparison of things based on similarities those things share. Whereas analogies simply point out a similarity, arguments from analogy claim that certain similarities are evidence that there is another similarity (or other similarities).**
- **Things to consider in evaluating the strength of an argument from analogy include the truth of the premises; the relevance of the similarities; the number of relevant similarities; the relevance of dissimilarities; the number of relevant dissimilarities; the diversity of the sample (especially with increased sample size); and the specificity of the conclusion relative to the premises**

- **Not all causal arguments contain the word cause. Other causal terms include produces, is responsible for, and affects. Such arguments come in two broad types: arguments about the cause of a single instance and arguments about a general relationship**
- **Sometimes, two things or events are clearly associated or linked: where you find X, you will often find Y. A relationship such as this, in which two things are frequently found together, is called a correlation. Sometimes a correlation is an indicator of a cause-and-effect relationship.**

Thank you