Deduction and Induction

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Glossary

argument Sets of statements that support a conclusion. An argument is designed to persuade.
inference The evidentiary relationship maintained between premises and conclusions.
logic A normative discipline that studies the forms of reasoning; seeks the criteria by which to differentiate good from bad arguments.
soundness A quality of an argument if and only if it contains all true premises.
validity If the premises of an argument are taken as true and the conclusion drawn is compelling, the argument is considered valid. A valid argument is sound if and only if all the premises are in fact true. Invalid arguments cannot be sound.

Deduction and induction are two different forms of argument. In a deductive argument, the conclusion necessarily follows from premises. In an inductive argument, the premises support a conclusion to varying degrees. Part of the challenge of the inductive argument is to establish criteria by which to determine which conclusion is best supported. In this article, deductive and inductive inferences are examined with the aim of showing how to establish the criteria by which to differentiate between good and bad arguments.

Logic and Validity

William and Martha Kneale begin their book, *Development of Logic*, with the claim that "logic is concerned with the principles of valid inference." Their contention is that logic is not simply valid argument but involves "reflection upon the principles of validity." In other words, we are concerned with determining the criteria by which we decide whether an argument is good or bad. It is also by way of such reflection that we can properly identify the basic differences between induction and deduction.

Logic studies forms of thought, and this distinguishes it from other disciplines. For example, sociologists study human society and physicists study the physical universe. Both the sociologist and the physicist are concerned with formulating good arguments and somehow distinguishing, in light of their specific interests and research, between good arguments and bad ones. Hence, we can understand logic as being, at its core, a normative discipline that is concerned with providing the proper criteria for differentiating good arguments from bad ones. In calling logic normative, we are contrasting it with the descriptive or the empirical. Whereas we might subject our descriptive claims to logical analysis, our aim in logic is to ask what it is that makes a good argument "good." Indeed, we might also ask what it is about a compelling argument that makes rejecting it very difficult, or perhaps impossible. Understanding, even in a general way, what arguments are and how to distinguish between good and bad forms are essential to understanding the differences between deduction and induction. These two central categories of logic designate forms of arguments that are basic to understanding the nature of the claim or claims being made in a given argument. Examination of some distinctions will help to understand what this means.

Stating that "the car will not start," for example, would not be making an argument; rather, it would be stating a fact. On the other hand, stating that "you ought to take a course with Professor Keenan because he is a good professor" would be trying to persuade someone to do something. An indispensable part of argumentation is persuasion. Suggesting that someone should act in a certain way for a specific reason is making a claim that aspires to persuade, resulting in belief and action. This is also making an argument.

Typically, when a claim of the sort suggested is made, an interlocutor will ask for qualification ("why do you think that I should take a course with Professor Keenan?"). In asking this question, the interlocutor is asking for the set of sentences that bring the original speaker to maintain the claim that has been made. We can say of arguments, again in a rough and ready sense, that they are sets of sentences that are designed to persuade a reader, a listener, indeed any interlocutor, to believe some conclusion. So, to say of the city that it is beautiful is not to make an argument; the intent is not to persuade or to change someone's mind. In contrast, claiming that "Professor Keenan is a good professor and you ought to take a course with him" is arguing and not merely stating a fact.

Take the example of the following argument:

1. All coffee at the neighborhood coffeehouse is either dark or light roast.
2. Andy has a cup of coffee from the neighborhood coffeehouse.
3. Therefore, Andy's coffee is either dark or light roast.

The conclusion (the claim) is that Andy's coffee is either dark or light roast. If the supporting sentences are true, if we accept that (1) and (2) are true, can the argument (3) be anything but valid? No. If the supporting sentences are true, then the argument is valid. In the case of this argument, we are compelled to believe that Andy's coffee is either dark or light roast. Take the example of another argument:

1. Kevin is an archaeology student.
2. Some archaeology students love underwater archaeology.
3. Therefore, Kevin loves underwater archaeology.

The supporting sentences (1) and (2) in this argument are true, but are we compelled to accept the conclusion (3)? No. Why not? Whereas in the former argument, the conclusion followed from the supporting sentences, in this argument, it is clear that Kevin may not love underwater archaeology and that claming he does is not secured by the supporting sentences (1) and (2).

Given what has been said so far, it is possible to discriminate between two parts of any argument. The first part provides the claim or the conclusion of the argument. This is what we would like our interlocutor to believe. The second part concerns the reasons why we should believe the conclusion. These are the argument's premises, or supporting sentences. If we take the premises to be true, then the conclusion should follow; the deduction is valid. Logic, then, in its broadest sense, involves establishing criteria by which to judge good arguments. Deductive arguments and inductive arguments typically separate two fundamentally distinct forms of argument. How we go about establishing the criteria for judging whether a given argument is good or bad also depends on the kind of argument we are scrutinizing.

Deduction

Consider the following argument (a traditional example of a deductive argument):

1. All humans are mortal.
2. Socrates is human.
3. Therefore, Socrates is mortal.

The conclusion (3) in this argument is established by the premises (1) and (2). It is a valid argument; (1) and (2) have to be true, but apart from whether this is a good or bad argument, we can recognize this argument as expressing the standard form of a deduction, i.e., it is a deductive argument.

Deductive arguments are unique in that the claims of such arguments are conclusive. When, as in the preceding argument, the conclusion follows from the premises, we have validity. If the conclusion did not follow, we would say of this argument that it is invalid. For deductive arguments, when it is not possible for the premises to be true at the same time that the conclusion is false, we say that the conclusion follows from the premises. Note well that the premises need not actually be true. The requirements of deductive validity require only that it is not possible for the conclusion to be false while at the same time the premises are true. The conclusion of a valid deductive inference is never false.

Oftentimes it is suggested that deductive arguments move from the general to the particular, as in the claim that Socrates is mortal. In this case, talk of the particular simply refers to the conclusion having to do with "Socrates" as a single object of the deduction's focus. Irving Copi and Keith Burgess-Jackson suggest that this way of thinking of deduction and deductive arguments is more than slightly misleading. "The difficulty lies," they write, "in the fact that a valid deductive argument may have universal propositions for its conclusion as well as for its premises." For example, consider the argument that Copi and Burgess-Jackson provide to substantiate their claim:

1. All animals are mortal.
2. All humans are animals.
3. Therefore, all humans are mortal.

This argument is valid; (3) follows from (1) and (2). But the conclusion (3) is not about a particular object; the conclusion (3) quantifies over all objects that fall into the class of mortals (2). Copi and Burgess-Jackson add that "a valid deductive argument may have particular propositions for its premises as well as for its conclusion." They consider

the following example as exemplifying this type of contrasting argument:

1. If Socrates is human, then Socrates is mortal.
2. Socrates is human.
3. Therefore, Socrates is mortal.

What can be said, then, of deductive arguments (or of deductive inference) is that conclusions of this sort follow from their premises, and so long as we take the premises to be true, the conclusions cannot be false. The conclusion is a necessary consequence of the true premises.

Truth and Soundness

Suppose that the following argument is made:

1. All trucks have seven wheels.
2. Anna's vehicle is a truck.
3. Therefore, Anna's truck has seven wheels.

If we accept the premises as true in this deductive argument, are we also compelled to accept the conclusion? If yes, then we have to accept that this argument is valid. So it can be said that the premises are taken as true in a valid argument; they establish the conclusion and the validity of the argument. The problem is that validity guarantees the truth of the conclusion only on the grounds that the premises are in fact true. Validity is only the first step in evaluating deductive arguments. Once we have determined if an argument is valid, we then wish to know if it is sound—that is, if the premises of the valid argument are in fact true. A sound deductive argument is an argument in which the truth of the conclusion is guaranteed. Validity is not enough to secure truth. We require further criteria to establish truth and we require a further distinction.

An argument is thought to be sound if and only if it is valid and it contains all true premises. Take the following argument (it is valid but not sound):

1. Lou is a secretary.
2. All secretaries are female.
3. Lou is female.

Although the premises (1) and (2) in this argument are true, we are compelled to question its conclusion (3). Valid arguments do not secure true conclusions (even if we later find out that "Lou" is short-form for "Louise." In contrast, consider the following argument (it is sound, which implies that it is already valid):

1. All medical students are in the Faculty of Medicine.
2. Nafisa is a medical student.
3. Therefore, Nafisa belongs to the Faculty of Medicine.

Not only does (3) follow from the true premises (1) and (2), we are compelled to believe that (3) is true and so the argument is sound.

So far, we have been considering arguments that are deductive; the contents of the conclusions lie entirely within the domain of the contents of the premises. In such arguments, it seems relatively straightforward to think about the differences between validity, truth, and soundness. Matters get more complicated when these principles of logic are applied to induction, or to inductive arguments.

Induction

Take the example of the following argument from Copi and Burgess-Jackson:

1. Most corporation lawyers are conservatives.
2. Barbara Shane is a corporation lawyer.
3. Therefore, Barbara Shane is probably a conservative.

This kind of argument is different from the kinds we have considered. In this inductive argument, the conclusion lies at least partially outside the content of the premises, though we can say of this argument that premises (1) and (2) are true and that its conclusion (3) is more than likely to also be true. Interestingly, we can strengthen or weaken this argument by adding premises. We might add the premise that Barbara Shane is an officer of the American Civil Liberties Union (ACLU). We might also add that most officers of the ACLU are not conservatives. These additions would no doubt cast some level of suspicion about the likelihood of the conclusion (3) being true. Our inference (our having moved from the premises to the conclusion) is in this case nondemonstrative insofar as the conclusion does not necessarily follow from the premises. As noted of deductive arguments, the conclusions do necessarily follow from their premises and so the conclusions are guaranteed. What is especially noteworthy of inductive arguments is that the evidence is compatible with several hypotheses. We depend on better reasons to accept one conclusion over another. How we go about deciding on good reasons is part of the riddle of induction.

There are generally thought to be two kinds of inductive inference, namely, enumerative and hypothetical. The former is often attributed to David Hume (1711–1776). In his famous *An Enquiry Concerning Human Understanding*, Hume questions the commonplace understanding of causation. He first makes an important distinction between relations of ideas and matters of fact. Hume thinks that geometry, algebra, and arithmetic are species of the former; he notes that "every affirmation" involved in these "sciences" is "either intuitively or

demonstratively certain." In short, Hume understands relations of ideas as being species of deductive inference. On the other hand, Hume thinks that matters of fact present especially difficult challenges to certainty:

> *Matters of fact, which are the second objects of human reason, are not ascertained in the same manner; nor is our evidence of their truth, however great, of a like nature with the forgoing. The contrary of every matter of fact is still possible; because it can never imply a contradiction, and is conceived by the mind with the same facility and distinctness, as if ever so conformable to reality. That the sun will not rise to-morrow is no less intelligible a proposition, and implies no more contradiction, than the affirmation, that it will rise. We should in vain, therefore, attempt to demonstrate its falsehood. Were it demonstratively false, it would imply a contradiction, and could never be distinctly conceived by the mind.* [Steinberg, 1977, pp. 15–16]

Hume is saying that the inference that the sun will rise tomorrow is nondemonstrative; the conclusion does not follow necessarily from the evidence. Hume is further claiming that there is no noncircular justification to a general or particular knowledge of things that have not been observed. We are inclined to accept inductive arguments on the grounds of past experience, but this in itself is an inductive argument; hence the circularity.

Consider another example of an enumerative induction (this one comes from the American philosopher, Gilbert Harman):

1. All peaches have pits.
2. *X* is a peach.
3. *X* has a pit.

Suppose that we have a basket of 100 peaches. We have now examined 99 peaches; the evidence of the peaches in the basket does not guarantee that the next peach will also have a pit. The conclusion (3) does not provide a guarantee as it would in a deductive inference. Still, there does seem to be something reliable in thinking that the last peach in the basket will have a pit. Why? It seems that we might be adding on a hidden premise, the uniformity premise. This premise suggests that the unobserved will resemble the observed. Take the following example, which looks a great deal like the argument we have just considered:

1. All observed *X*s are *Y*s.
2. Therefore, all *X*s are *Y*s.

Now reconstruct this argument with the uniformity principle:

1. All *X*s are *Y*s.
2. The unobserved resembles the observed (the uniformity principle).
3. Therefore, all *X*s are *Y*s.

The problem is still whether we are entitled to believe the uniformity principle. It seems that our experience of the world tells us that the uniformity principle obtains, but in accepting the principle, we are making an inductive inference. The crux of Hume's problem with induction is that any attempt to justify an inductive inference is circular. Even the uniformity principle is unhelpful. But why, in spite of Hume's logical attack on induction, should we worry about circularity? The problem arises, in part, because we are taking the uniformity principle for granted, without justification. Using empirical evidence to justify recourse to the principle is doing what Hume is warning against. Calling forth "deeper reasons," cashing out the laws of physics or chemistry that seem to "guarantee" uniformity of nature, is recoiling into a former induction to justify the present one.

One way to cope with the problem of induction is to agree with the skeptic that the future never exactly resembles the past. But the future is, on balance, something that more likely than not resembles the past. Consider the following argument:

1. Previously observed *X*s are *Y*.
2. Therefore, future and other unobserved *X*s are probably *Y*.

Any observed evidence is only a sample; we have not seen every crow to determine whether all crows are black. But in the second kind of inductive inference, the hypothetical induction, a hypothesis is inferred as the best explanation for the given evidence. Imagine hearing a knock at the window. You are likely to think that there is someone there, but on moving the curtains, you realize that a branch is banging at the window. Your original inference is nondemonstrative. You might have settled on "someone being at the window" or on "the branch is banging at the window." You did settle for what you took to be the best explanation.

Matthew Ginsberg has suggested that we think of induction in its widest sense, such that it constitutes our default assumptions about our experience. For instance, imagine that you are asked if you need a lift from campus to your hotel when you are attending a conference. You simply assume that the person asking you can drive. This is a default assumption, because it could be the case that your colleague cannot drive, but it is unlikely. In cases of nondemonstrative inductive inferences, the given evidence is compatible with many hypotheses; the aim is to determine which hypothesis best explains the phenomena in question. Harman, as recounted in Dancy and Sosa's *A Companion to Epistemology*, reminds us that this is workable for induction, but we should proceed with caution: "Consider Sam's evidence that several peaches have been found not to have pits.

That evidence is compatible with Sam's hypothesis that all peaches have pits and also with the hypothesis that only some peaches have pits but Albert has been removing all the peaches without pits before Sam sees them."

See Also the Following Articles

Causal Inference • Falsification in Social Science Method and Theory

Further Reading

Copi, I. M., and Burgess-Jackson, K. (1996). *Informal Logic.* Prentice Hall, Upper Saddle River, New Jersey.

Dancy, J., and Sosa, E. (1992). *A Companion to Epistemology.* Blackwell Reference, Oxford, United Kingdom and Cambridge, Massachusetts.

Ginsberg, M. L. (1987). *Readings in Nonmonotonic Reasoning.* M. Kaufmann Publ., Los Altos, California.

Kneale, W. C., and Kneale, M. (1962). *The Development of Logic.* Clarendon Press, Oxford.

Steinberg, E. (ed.) (1977). *Hume, David. 1777. An Enquiry Concerning Human Understanding and A Letter from a Gentleman to His Friend in Edinburgh*. Hackett Publ. Co., Indianapolis.