An Introduction to Logic

by Kevin Winters

Introduction

The following is an introduction and elucidation of general logic. It will include an explanation of logical forms, fallacies, and general principles of logic, along with examples and possible applications. It is hoped that those who are already familiar with logic will gain a better understanding of its uses and applications while those who are unfamiliar with it will gain a functional understanding capable of common use in evaluating everyday arguments. What follows is a brief introduction to logical terms following which an introduction to Aristotle's Syllogistic Logic will be explicated. After that I will elucidate Stoic Truth-Functional Logic and Quantificational Logic. Following this will be a closer look at inductive fallacies. Interspersed throughout will be examples and exercises to help in general application and awareness of when certain fallacies are being used.

What is Logic?

Logic is essentially the study of arguments and inference. An **argument** is any series of statements used to support a given proposition; the former are termed **premises** while the latter is termed a **conclusion**. **Inference** is the process by which one can deduce from a series of statements a given conclusion, or in moving from a set of given statements to a new synthetic statement that is related to and depends on the prior premises. Consider the following:

(I) It is commonly said that money does not grow on trees. It is also said that time is money. Therefore, it can be concluded that time does not grow on trees.

The above has two premises, ‘money does not grow on trees’ and ‘time is money,’ from which the conclusion, ‘time does not grow on trees,’ is deduced.

The particular things that are talked about in an argument are called the statement’s **terms**. The above example has three terms: ‘money,’ ‘trees,’ and ‘time.’ As will be seen below (see **Undistributed Middle**), an argument’s success will partly depend on the utilization and proper ordering of given terms both in the premises and in the conclusion. In **Syllogistic** and **Truth-Functional Logic**, the given terms in an argument are symbolized by letters, such as *a*, *b*, *c*, and *d*. Example (I) above could be symbolized as follows:

1. $m \rightarrow \sim t$
2. $c \rightarrow m$

$\therefore$ $c \rightarrow \sim t$

In the above, the terms are as follows: m = money; t = grows on trees (and ~t = does not grow on trees); and c = time. The other symbols will become clear in time, but it should be obvious how arguments may be abstractly symbolized. As an issue in history, it has been argued (and that effectively) that the three primary types of logical symbolization (i.e. **Syllogistic**, **Truth-Functional**, and **Quantificational Logic**) are each limited in their use. While Quantificational Logic is superior to Syllogistic and Truth-Functional Logic, it also has some weaknesses, particularly as it relates to probabilities (for which **Fuzzy Logic** has been developed). Likewise, Syllogistic and Truth-Functional Logic are weak in that they are not capable of illustrating relationships between entities, though they still have uses. Thus, in what follows, don’t feel discouraged if you can’t reduce all arguments to some sort of logical form.

When discussing any particular argument, there are generally two ways we can characterize an argument: as **valid** or **sound**. When an argument is valid, it follows a particular logical form (say **Modus Ponens**), but the truth or falsity of the premises is inconsequential (i.e. an argument can be valid but still be false).[1] When an argument is sound, it follows a particular logical form but the premises are true. Thus, an argument can be valid but still be false while a sound argument must be both valid and true. As the truth or falsity of many premises and/or conclusions cannot always be easily proven, most describe logic as a 'negative condition' for an argument's truth, meaning that an argument cannot be true without being valid and, if it is true, it must be valid. Harold H. Joachim put it thus:

> The form [i.e. validity] under which the infinitely various materials are ordered, is the universal form of all thinking…. This arrangement under the form of thinking cannot *of itself* guarantee the truth of the result. For false materials, as well as true, may be painted with the royal colour. But the result cannot be true *without* this arrangement, which is thus a *sine qua non* or a 'negative condition' of truth.[2]

This points to an interesting fact that the conclusion of a valid argument may be true or false, even with false premises. Consider the following chart:

[1] This demonstrates the fact that one's argument can be valid (i.e. the conclusion follows from the premises), but the premises may be argued. Thus, one can admit that another presents a good argument, but such does not necessarily mean one has to accept their premises or conclusion.

[2] "The Nature of Truth," in Simon Blackburn and Keith Simmons, ed., *Truth* (New York: Oxford University Press, 2000 (1999)), 48-49. Of course, this only applies to the truth or falsity of propositions; if there is truth that escapes being quantized in propositional content (as many postmodern theories posit), they may be described as *non*-logical truths, not *il*-logical truths (which, according to the above, is a contradiction in terms).

	Valid	Invalid	Sound
True Premises/ True Conclusion	Tula is a cat. All cats lick themselves. Therefore, Tula licks herself.	All dogs lick themselves. All cats lick themselves. Therefore, no cats are dogs.	Fido is a dog. All dogs like meat. Therefore, Fido likes meat.
True Premises/ False Conclusion	[Empty]	Earl is an axe murderer. All axe murderers are guilty. Therefore, Earl is a nice guy.	[Empty]
False Premises/ True Conclusion	All fish have fur. All furry things can swim. Therefore, all fish can swim.	The moon is cheese. All cheese preserves well. Therefore, water is wet.	[Empty]
False Premises/ False Conclusion	All men are rational. All rational beings are smart. Therefore, all men are smart.	All whales are skinny. Red hot tamales are mild. Therefore, this makes sense.	[Empty]

From the above one can deduce the following:

1) If an argument is valid, we know nothing about the truth of the premises or the conclusion.
2) If an argument is sound, we know that the premises and the conclusion are true.
3) If an argument is invalid, anything goes, with or without continuity between the premises and the conclusion.

Given the above, logic deals primarily with whether an argument is valid; it generally cares very little about whether an argument is true (that is left to the differing specialists in their various fields). Still, this does not make logic useless for the truth-seeker; to be able to see faulty inferences in any given argument is a powerful skill. In fact, someone versed in logic can often give useful (though not complete) criticisms of arguments in any given field; as long as arguments are given, the logician can usually say something (even if they ignore the truth or falsity of the premises of the argument).[3]

[3] As some personal advice: it is *not* suggested that the person who reads this take it upon herself to go about critiquing everything in a negative manner; to merely demonstrate how an argument is wrong without (where possible) providing corrections or ways to strengthen a given argument is intellectually inappropriate. When possible, always seek to help others improve their logic, not simply demonstrating how the argument does not follow. In this case, follow the old Boy Scouts adage: ‘Always leave the place (in this case a person and their arguments) in better condition than when you got there.’

Some Basic Terminology

Before we get to the meat, here are some general terms that may be useful when discussing logic. When one reads arguments in just about any format, it is not always clear which statements are the premises and which are the conclusion; they are not always laid out as neatly as much of what follows. For example, consider the following:

(II) Pollution rates have risen in Nevada over the last 5 years by over 20%. Something has got to be done if we are going to lower it to a safe level. Because of the increase in pollution, asthma patients have nearly doubled their hospital visits within any given month.

It may not be entirely clear which statements are the premises and which are the conclusions. But if I rewrote it as follows, it would be clearer:

(II') Pollution rates have risen in Nevada over the last 5 years by over 20%. Because of the increase in pollution, asthma patients have had nearly doubled their hospital visits within any given month. As such, something has got to be done if we are going to lower it to a safe level.

With the inclusion of two new words, "as such," including resituating the sentences, it is easier to see which statement is the conclusion of (II'). Terms like "as such" are called **illatives**, or *conclusion-indicators*.[4] With the above argument, the "because" indicates a causal connection between premise 2 and premise 1; "because" of premise 1, the state of affairs in premise 2 has occurred.

If all that we had were premises 1 and 2, premise 2 would not be the conclusion as one cannot draw a useful inference from a single premise. In such a case, we have two options: first, we can make a **tautology**, or simply restate the same sentence with slightly different wording, which adds nothing to our knowledge; second, we can declare the statement an **enthymeme**, or an argument with implied or hidden premises (i.e. they are

[4] Here is a list of some common illatives:

therefore	hence	thus	accordingly
in consequence	which demonstrates	which entails	which indicates
from which we can infer	we can conclude	it follows	for this reason

not stated, only presupposed). With the above, we could say that the proposition, 'Increases in pollution always results in increased medical problems with asthma patients,' would be a hidden premise that would complete the argument. Still, it should be clear that the final sentence is the conclusion of the argument; the two previous premises support the call to action.

Furthermore, not all arguments are **syllogisms**, or arguments that contain two premises and one conclusion. There is no intrinsic limit on how many premises a given argument may have; they can be as few as two to as many as you can fit into a 1,000-page tome (and even then some).[5] As such, large arguments will often be chopped into a series of smaller arguments and then tie them together; thus, one can deal with fewer conclusions than original premises in comprehending the larger argument. When a conclusion of a previous argument is used as a premise in a new argument, it is called a **sorites**.

Inductive and Deductive/Refutation and Proof

Within logic, there are generally two types of argumentation: **inductive** and **deductive**. An inductive argument is one that provides partial/non-conclusive support for the conclusion; thus, an inductive argument generally has to deal with probabilities of truthfulness depending on the strength of the argument. A deductive argument, on the other hand, is one that provides complete support for the conclusion; thus, a true deductive argument is not open for **proof**. As a general rule, most arguments you will

[5] Of course, the more premises one has to deal with, the harder it often becomes to follow the argument; one can easily become lost in a sea of premises and then completely miss the conclusion.

come upon will be inductive as it is very difficult to create a deductive argument in real-life situations.[6]

As with the two general forms of logical argumentation, there are (generally speaking) two ways one can disprove an argument: **refutation** and **proof**. One demonstrates the falsity of an argument by *refutation* when they argue that, even assuming that the premises are true, one can deduce a different conclusion from the same premises. One demonstrates the invalidity of an argument by *proof* when they demonstrate that the argument does not follow the rules of inference. From these definitions, it is easily recognized that only inductive (and invalid) arguments can be refuted and only deductive (and valid) arguments can be proven (or disproved).[7] Put more explicitly, since a deductive argument purports to provide complete support for the conclusion, its falsity can only be demonstrated by showing that the premises do not follow from the accepted laws of inference to reach the conclusion. Likewise with inductive arguments: since they inherently purport to give only partial support for their conclusion, demonstrating how one may come to a different conclusion from the same premises (refutation) will have more strength than saying that it is not valid (something it does not necessarily purport in the first place).

As an illustration, take the following argument with two different concluding claims:

(IIIa) Within world history, there have been multitudes of people who have reported experiences with the divine. Even more surprisingly, despite

[6] There are various theories on how/why this is the case, ranging from realizing the ambiguities of language to just plain ignorance on the given matter. Throughout this text, I will take the time to discuss each, but will not give any full conclusions.
[7] Another way to state refutation is: if an argument can be refuted, it is not valid; which lends itself to the description that only invalid arguments can be refuted. This also means that one can refute an *alleged* valid/deductive argument.

various differences in content, these individuals appear to be couching their explanations of these experiences in a similar form. Therefore, one simply must conclude that a divinity of some form exists.

(IIIb) Within world history, there have been multitudes of people who have reported experiences with the divine. Even more surprisingly, despite various differences in content, these individuals appear to be couching their explanations of these experiences in a similar form. Therefore, one may safely conclude that a divinity of some form exists.

The above arguments (simplified versions of the 'Argument from Religious Experience') come to two different conclusions: (IIIa) purports to be a deductive argument—"one simply *must*" accept the conclusion, given the evidence; (IIIb) purports to be an inductive argument—"one may *safely* conclude" that the conclusion is true, given the evidence. Put another way, (IIIa) claims that it has *conclusively* proven that "a deity of some form exists" while (IIIb) claims that it has demonstrated a good probability that "a deity of some form exists."

Given the qualifications (or lack thereof) present in each conclusion, each will have to be handled in a different way: for (IIIa), the opponent might argue that A's argument does not follow logically as it rests on implied premises (an enthymeme), but that the implied premises are suspect. Given A's claim to giving conclusive evidence for his conclusion, such is the best way to prove its lack in demonstrative power; after it has been proven wrong, one may then move on to inductive arguments (as the argument's deductivity is now suspect). If someone were to claim, per refutation, that given the premises one may come to a different conclusion, the person making the argument may deny that such is the case, hence the necessity of demonstrating its invalidity before one can move on.[8]

[8] For one interesting illustration of this point, look into the history of the 'Ontological Argument' for God's existence (started by Anselm and currently championed, in a slightly different form, by Alvin Plantinga).

For (IIIb), the opponent might argue that such experiences are merely neural malfunctioning in the brain of the person; that such things are malfunctioning biological equipment in the individual that draws on the prominent mythological paradigms of the time for its religious content (hence the discontinuity in the descriptions). In this way, the opponent admits that B's premises (i.e. that people *have* had such experiences throughout history and they *do* have many similarities) may be true, but she provides an alternate conclusion. As neither conclusion necessarily claims to be conclusive, which conclusion one will take will depend on what one finds persuasive in the inductive arguments for each (or perhaps one may reject the argument as ineffective but provide another in its stead) according to its *logical force* (i.e. the persuasiveness with which the argument strikes the person). Two ways one may refute an argument is by 'analogous reasoning'—by providing a similar argument that follows the same form as the one given but provides a false inference—and/or by 'counterexample'—by providing an alternative conclusion based upon the same premises.

While Anselm thought that the argument was deductive, Plantinga's reformed ontological argument only claims to provide for the (inductive) possibility of the existence of (the classical Christian) God. See Anselm's *Prosologion* and Platinga's *The Nature of Necessity*, respectively, for the specific arguments.