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Deductive Logic

Deductive logic is a category of reasoning that is fundamental to the sciences and technology and, therefore, especially important for science communicators and others concerned with understanding science. In fact, deductive logic is important anywhere computers are used. Deductive logic forms the basis of all computer code and is often taught in computer science curricula, not just in philosophy departments.

Logic itself is commonly understood as the relationships and principles of reasoning. The phrase "the process of reasoning" generally refers to the way in which one or several sentences give reason to believe some conclusion, which is itself another statement. For instance, when Jack is taller than Tom and when Tom is taller than Allen, someone can know from these two premises that Jack must be taller than Allen. This example is an instance of deductive logic.

Deductive logic is generally contrasted with inductive logic. Inductive logic is the kind of reasoning that is founded upon premises that support a conclusion with a degree of likelihood or probability, not with necessity. For example, when Jill sees clouds outside, she reasons that it will rain. She does not know this with certainty, but this is not her fault. Until a sign appears that implies there will necessarily be rain, something that is not yet the case, Jill cannot know for sure what the weather will do. By contrast, consider that when there is fire, there must be oxygen present. This is true because fire itself is a process that requires oxygen. So wherever there is fire, there is at least some oxygen.

Arguments that involve necessity, such as the kind involving fire and oxygen, are different in kind from inductive arguments. It is important not to assume that in all deductive arguments the conclusion necessarily does follow from the premises, however. That is because the argument can simply be a bad one, called invalid. Take the following as an example: Jack is a bachelor; therefore, Jack is married. This is an example of a deductive argument, but it is one in which the necessary characteristics of bachelorhood are mistakenly related to being married. In fact, to be a bachelor implies that one is not married. This argument would be called deductive, but invalid. The valid version looks like this: Jack is a bachelor; therefore, Jack is not married.

There are several different kinds of deductive argumentation. The simplest kind is an *argument from definition.* The example of bachelorhood is one of these. How terms are defined bears important consequences, however, since the definitions used imply consequences than can be better or worse for particular purposes. Controversies can arise over the proper way to define terms. Some controversial examples have included terms such as *planet*, *marriage*, or *enemy combatant.*

Another kind of deduction is called *natural deduction.* Natural deduction generally refers to the forms that arguments take. There are certain shapes that our arguments frequently form. When someone substitutes other terms and categories into well-designed deductive arguments, some forms never lead to false conclusions. Those are the arguments that are called valid. For example, one argument form, called modus ponens, is especially common and important to the study of logic. In modus ponens, the arguer says that if some condition P is true, then condition Q is also true. He or she then claims that P is true. Therefore, according to these reasons, it must be that Q is also true. This form of argument has been shown time and time again to be irrefutable. There could be mistakes made in filling in the details, but the form itself cannot lead someone from true premises to a false conclusion. When an argument has proper form but has premises that are not true, the argument is called valid but unsound. In fact, all deductive arguments that are either invalid or that have one or more false premises are considered unsound. Therefore, a sound argument, technically speaking, is a valid, deductive argument in which the premises are true.

A further sort of deductive argument is called *propositional logic* and is associated with Venn diagrams and categories. Certain categories of

things bear necessary consequences. For instance, all human beings are mortal. Based on this categorical statement, it is also true that no human beings are immortal. If someone knows that some fruits are apples, they also know that it is false that no fruits are apples. While statements like these can sound obviously true in these examples, the examples are chosen because of how simply they demonstrate these principles. In technical matters, it is very important to check one's reasoning to avoid mistakes.

In deductive arguments, the purpose is not looking for conclusions that are likely to be true. The test for the quality of a deductive argument is whether the conclusion must be true. If the argument's conclusion could be false with true premises, then the argument is deemed invalid. The test of the quality of a deductive argument is called the counterexample method. Instead of testing to see whether a conclusion could be true with some premises, the real test for a deductive argument is whether or not there could be even one example in which the same form could be used with different terms to yield a true set of premises and a false conclusion.

This is important because if the answer is yes, someone cannot say with certainty that true premises in such an argument necessarily support the conclusion. As the standard for deductive arguments is truth-preserving necessity, to find a counterexample to someone's argument is to show that his or her reasoning is flawed.

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See also Inductive Logic; Scientific Method

Further Readings

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Deficit Model

Every so often, at least in the Western world, there seems to be a bit of a panic: politicians, media professionals, and ordinary citizens do not know enough science to value, appreciate, and rationally discuss it and the issues it poses. It happened in Britain in the late 1820s, and the upshot was the foundation of the British Association for the Advancement of Science. U.S. scientists and politicians were shocked in the 1950s to discover that the Russians had successfully launched the first artificial satellite, *Sputnik*; surveys showed that the average American knew very little science. The result was an intense drive for scientific literacy in the education system. Crises in funding for scientific research in the mid-1980s coupled with concerns that the "Asian tiger" economies, led by Japan, were outstripping Europe gave rise to the latest phase of actions to promote the public understanding of science across the European Union. And despite the change in rhetoric to include *dialogue* and *debate*, behind much of what passes for engaging the public is still aimed at redressing some perceived deficiency among ordinary citizens. Where science is concerned, there is a public deficit, and it is the job of the scientific community to address it—that, in a nutshell, is what the deficit model entails.

In 1985, the Royal Society—Britain's premier scientific society—produced the report "The Public Understanding of Science" that urged the media to carry more science and told scientists that they had a duty, no less, to communicate with the public about the work that they did, changing the ethos of several decades during which researchers who did make their work accessible to their fellow citizens had been shunned as self-serving attention seekers, who were not very good scientists anyway. Instead, thousands of scientists, from the humble PhD student to the superannuated Fellow of the Royal Society, were encouraged—and sometimes funded—to give public lectures, take part in science fairs, and be friendly to the media—all aimed at increasing the public understanding of science and scientific literacy. Analyzing the motives for this activity in 1987, Oxford scholars Geoffrey Thomas and John Durant found that these ranged from macroeconomics and national prestige, to enabling citizens to be involved in informed democratic debate and to lead fulfilled lives, to enhancing moral behavior.

Thomas and Durant later surveyed levels of scientific literacy—defined by knowing a dozen or