

LOGIC

Logic (from the Greek "logos", which has a variety of meanings including word, thought, idea, argument, account, reason or principle) is the study of reasoning, or the study of the principles and criteria of valid inference and demonstration. It attempts to distinguish good reasoning from bad reasoning.

Definition

Logic as "new and necessary reasoning", "new" because it allows us to learn what we do not know, and "necessary" because its conclusions are inescapable.

(Aristotle)

It asks questions like "What is correct reasoning?", "What distinguishes a good argument from a bad one?", "How can we detect a fallacy in reasoning?"

Logic investigates and classifies the structure of statements and arguments, both through the study of formal systems of inference and through the study of arguments in natural language. It deals only with propositions that are capable of being true and false. It is not concerned with the psychological processes connected with thought, or with emotions, images and the like. It covers core topics such as the study of fallacies and paradoxes, as well as specialized analysis of reasoning using probability and arguments involving causality and argumentation theory.

Logical systems should have three things:

1. Consistency (which means that none of the theorems of the system contradict one another);
2. Soundness (which means that the system's rules of proof will never allow a false inference from a true premise)
3. Completeness (which means that there are no true sentences in the system that cannot, at least in principle, be proved in the system).

History of Logic

Logic descends mainly from the Ancient Greek tradition. Both Plato and Aristotle conceived of logic as the study of argument and from a concern with the correctness of argumentation. Aristotle produced six works on logic, known collectively as the "Organon", the first of these, the "Prior Analytics", being the first explicit work in formal logic.

Aristotle espoused two principles of great importance in logic, the Law of Excluded Middle (that every statement is either true or false) and the Law of Non-Contradiction (confusingly, also known as the Law of Contradiction, that no statement is both true and false). He is perhaps most famous for introducing the syllogism (or term logic). His followers, known as the Peripatetics, further refined his work on logic.

In medieval times, Aristotelian logic (or dialectics) was studied, along with grammar and rhetoric, as one of the three main strands of the trivium, the foundation of a medieval liberal arts education.

Logic in Islamic philosophy also contributed to the development of modern logic, especially the development of Avicennian logic (which was responsible for the introduction of the hypothetical syllogism, temporal logic, modal logic and inductive logic) as an alternative to Aristotelian logic.

In the 18th Century, Immanuel Kant argued that logic should be conceived as the science of judgment, so that the valid inferences of logic follow from the structural features of judgments, although he still maintained that Aristotle had essentially said everything there was to say about logic as a discipline.

In the 20th Century, however, the work of Gottlob Frege, Alfred North Whitehead and Bertrand Russell on Symbolic Logic, turned Kant's assertion on its head. This new logic, expounded in their joint work "Principia Mathematica", is much broader in scope than Aristotelian logic, and even contains classical logic within it, albeit as a minor part. It resembles a mathematical calculus and deals with the relations of symbols to each other.

Types of Logic

Logic in general can be divided into Formal Logic, Informal Logic and Symbolic Logic and Mathematical Logic:

Formal Logic:

Formal Logic is what we think of as traditional logic or philosophical logic, namely the study of inference with purely formal and explicit content (i.e. it can be expressed as a particular application of a wholly abstract rule), such as the rules of formal logic that have come down to us from Aristotle. (See the section on Deductive Logic below).

Formalism is the philosophical theory that formal statements (logical or mathematical) have no intrinsic meaning but that its symbols (which are regarded as physical entities) exhibit a form that has useful applications.

Informal Logic:

Informal Logic is a recent discipline which studies natural language arguments, and attempts to develop a logic to assess, analyze and improve ordinary language (or "everyday") reasoning. Natural language here means a language that is spoken, written or signed by

humans for general-purpose communication, as distinguished from formal languages (such as computer-programming languages) or constructed languages (such as Esperanto).

It focuses on the reasoning and argument one finds in personal exchange, advertising, political debate, legal argument, and the social commentary that characterizes newspapers, television, the Internet and other forms of mass media.

Symbolic Logic:

Symbolic Logic is the study of symbolic abstractions that capture the formal features of logical inference. It deals with the relations of symbols to each other, often using complex mathematical calculus, in an attempt to solve intractable problems traditional formal logic is not able to address.

It is often divided into two sub-branches:

Predicate Logic: a system in which formulae contain quantifiable variables. (See the section on Predicate Logic below).

Propositional Logic (or Sentential Logic): a system in which formulae representing propositions can be formed by combining atomic propositions using logical connectives, and a system of formal proof rules allows certain formulae to be established as theorems. (See the section on Propositional Logic below).

Mathematical Logic:

Both the application of the techniques of formal logic to mathematics and mathematical reasoning, and, conversely, the application of mathematical techniques to the representation and analysis of formal logic.

Deductive Logic

Deductive reasoning concerns what follows necessarily from given premises (i.e. from a general premise to a particular one). An inference is deductively valid if (and only if) there is no possible situation in which all the premises are true and the conclusion false. However, it should be remembered that a false premise can possibly lead to a false conclusion.

Deductive reasoning was developed by Aristotle, Thales, Pythagoras and other Greek philosophers of the Classical Period. At the core of deductive reasoning is the syllogism (also known as term logic), usually attributed to Aristotle, where one proposition (the conclusion) is inferred from two others (the premises), each of which has one term in common with the conclusion. For example:

- Major premise: All humans are mortal.
- Minor premise: Socrates is human.
- Conclusion: Socrates is mortal.
- An example of deduction is:
- All apples are fruit.

- All fruits grow on trees.
- Therefore all apples grow on trees.

One might deny the initial premises, and therefore deny the conclusion. But anyone who accepts the premises must accept the conclusion. Today, some academics claim that Aristotle's system has little more than historical value, being made obsolete by the advent of Predicate Logic and Propositional Logic (see the sections below).

Inductive Logic

Inductive reasoning is the process of deriving a reliable generalization from observations (i.e. from the particular to the general), so that the premises of an argument are believed to support the conclusion, but do not necessarily ensure it. Inductive logic is not concerned with validity or conclusiveness, but with the soundness of those inferences for which the evidence is not conclusive.

Many philosophers, including David Hume, Karl Popper and David Miller, have disputed or denied the logical admissibility of inductive reasoning. In particular, **Hume** argued that it requires inductive reasoning to arrive at the premises for the principle of inductive reasoning, and therefore the justification for inductive reasoning is a circular argument.

An example of strong induction (an argument in which the truth of the premise would make the truth of the conclusion probable but not definite) is:

All observed crows are black.

Therefore:

All crows are black.