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Logical form

In philosophy and mathematics, a **logical form** of a syntactic expression is a precisely-specified semantic version of that expression in a formal system. Informally, the logical form attempts to formalize a possibly ambiguous statement into a statement with a precise, unambiguous logical interpretation with respect to a formal system. In an ideal formal language, the meaning of a logical form can be determined unambiguously from syntax alone. Logical forms are semantic, not syntactic constructs; therefore, there may be more than one string that represents the same logical form in a given language.[1]

The logical form of an argument is called the **argument form** or *test form* of the argument.
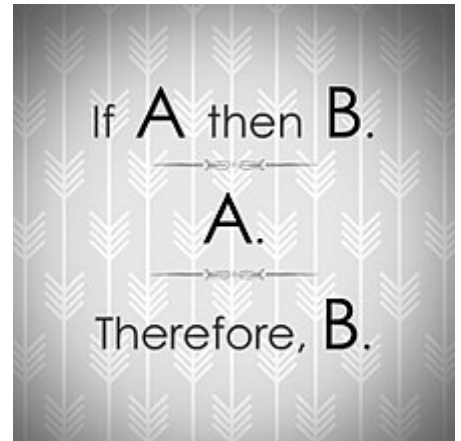
This logical argument utilizing modus ponens makes use of three statements in logical form expressed in simplified English.

Contents

History

The importance of the concept of form to logic was already recognized in ancient times. Aristotle, in the Prior Analytics, was probably the first to employ variable letters to represent valid inferences. Therefore, Łukasiewicz claims that the introduction of variables was 'one of Aristotle's greatest inventions'.

According to the followers of Aristotle like Ammonius, only the logical principles stated in schematic terms belong to logic, and not those given in concrete terms. The concrete terms *man*, *mortal*, etc., are analogous to the substitution values of the schematic placeholders 'A', 'B', 'C', which were called the 'matter' (Greek *hyle*, Latin *materia*) of the argument.

The term "logical form" itself was introduced by Bertrand Russell in 1914, in the context of his program to formalize natural language and reasoning, which he called philosophical logic. Russell wrote: "Some kind of knowledge of logical forms, though with most people it is not explicit, is involved in all understanding of discourse. It is the business of philosophical logic to extract this knowledge from its concrete integuments, and to render it explicit and pure."[2][3]

Example of argument form

To demonstrate the important notion of the *form* of an argument, substitute letters for similar items throughout the sentences in the original argument.

Original argument

All humans are mortal.
Socrates is human.
Therefore, Socrates is mortal.
Argument form
All *H* are *M*.
S is *H*.
Therefore, *S* is *M*.

All we have done in the *Argument form* is to put 'H' for 'human' and 'humans', 'M' for 'mortal', and 'S' for 'Socrates'; what results is the *form* of the original argument. Moreover, each individual sentence of the *Argument form* is the *sentence form* of its respective sentence in the original argument.[4]

Importance of argument form

Attention is given to argument and sentence form, because *form is what makes an argument valid or cogent.* All logical form arguments are either inductive or deductive. Inductive logical forms include inductive generalization, statistical arguments, causal argument, and arguments from analogy. Common deductive argument forms are hypothetical syllogism, categorical syllogism, argument by definition, argument based on mathematics, argument from definition. The most reliable forms of logic are modus ponens, modus tollens, and chain arguments because if the premises of the argument are true, then the conclusion necessarily follows.[5] Two invalid argument forms are affirming the consequent and denying the antecedent

Affirming the consequent
All dogs are animals.
Coco is an animal.
Therefore, Coco is a dog.

Denying the antecedent
All cats are animals.
Missy is not a cat.
Therefore, Missy is not an animal.

A logical argument, seen as an ordered set of sentences, has a logical form that derives from the form of its constituent sentences; the logical form of an argument is sometimes called argument form.[6] Some authors only define logical form with respect to whole arguments, as the schemata or inferential structure of the argument.[7] In argumentation theory or informal logic, an argument form is sometimes seen as a broader notion than the logical form.[8]

It consists of stripping out all spurious grammatical features from the sentence (such as gender, and passive forms), and replacing all the expressions specific to *the subject matter* of the argument by schematic variables. Thus, for example, the expression 'all A's are B's' shows the logical form which is common to the sentences 'all men are mortals', 'all cats are carnivores', 'all Greeks are philosophers' and so on.

Logical form in modern logic

The fundamental difference between modern formal logic and traditional, or Aristotelian logic, lies in their differing analysis of the logical form of the sentences they treat:

- On the traditional view, the form of the sentence consists of (1) a subject (e.g., "man") plus a sign of quantity ("all" or "some" or "no"); (2) the copula, which is of the form "is" or "is not"; (3) a predicate (e.g., "mortal"). Thus: 'all men are mortal'. The logical constants such as "all", "no" and so on, plus sentential connectives such as "and" and "or" were called syncategorematic terms (from the Greek *kategorei* – to predicate, and *syn* – together with). This is a fixed scheme, where each judgment has a specific quantity and copula, determining the logical form of the sentence.
- The modern view is more complex, since a single judgement of Aristotle's system involves two or more logical connectives. For example, the sentence "All men are mortal" involves, in term logic, two non-logical terms "is a man" (here *M*) and "is mortal" (here *D*): the sentence is given by the judgement *A(M,D)*. In predicate logic, the sentence involves the same two non-logical concepts, here analyzed as $m(x)$ and $d(x)$, and the sentence is given by $\forall x. (m(x) \rightarrow d(x))$, involving the logical connectives for universal quantification and implication.

The more complex modern view comes with more power. On the modern view, the fundamental form of a simple sentence is given by a recursive schema, like natural language and involving logical connectives, which are joined by juxtaposition to other sentences, which in turn may have logical structure. Medieval logicians recognized the problem of multiple generality, where Aristotelian logic is unable to satisfactorily render such sentences as "Some guys have all the luck", because both quantities "all" and "some" may be relevant in an inference, but the fixed scheme that Aristotle used allows only one to govern the inference. Just as linguists recognize recursive structure in natural languages, it appears that logic needs recursive structure.

See also

- Argument map
- Fallacy

    - Logical fallacy
    - Informal fallacy

- Categorial grammar
- Sense and reference
- Analytic–synthetic distinction
- List of valid argument forms

References

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Further reading

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External links

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- Pietroski, Paul. "Logical Form". In Zalta, Edward N. Stanford Encyclopedia of Philosophy
- Logical form at the Indiana Philosophy Ontology Project
- Beaney, Michael, "Analysis", The Stanford Encyclopedia of Philosophy (Summer 2009 Edition), Edward N. Zalta (ed.)

- IEP, Validity and Soundness