Propositional Logic Encyclopedia Article

Propositional Logic

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Propositional Logic

Propositional logic explains how to work with the most basic elements of logic, propositions. A proposition is any statement that is either true or false but not both. Declarative sentences such as "The sky is blue," "I have one arm," and "1 + 1 = 3" are all propositions. **Commands** ("Close the door!"), interrogatives ("What are you doing?"), and sentences that include variables ("Someone is watching me.") are not propositions.

The truth or falsity of a proposition might change depending on the speaker and the time it is uttered. The proposition "I have one arm" is true only when spoken by a person with one arm and false when spoken by those with two or no arms. A proposition that is always true, for example, "Either it is raining or it is not raining," is called a tautology; a proposition that is always false, as with "1 + 1 = 3," is called a contradiction. The truth **value** of a proposition is T if it is true and F if it is false.

Compound propositions can be created through the use of logical operators. For example, if *p* is any proposition, the negation of *p* can be written, "It is not the case that *p*." Other logical operators include "and," "or," "if, then," and "if and only if." The truth or falsity of a compound proposition is determined by examining the truth or falsity of each of its component propositions. The truth of the compound proposition "*p* and *q*," for example, is true only when both *p* is true and *q* is true.

A statement that contains a **variable**, such as "*x* is divisible by 6," can be turned into a proposition through the use of a quantifier and a universe of discourse. The quantifiers come in two forms: universal ("For all *x*, ...") and existential ("There exists an *x* such that..."). The universe of discourse tells us what values *x* can possibly be. Through quantifiers the statement above can become the (false) proposition, "For all *x* such that *x* is a whole number, *x* is divisible by 6." Using the existential quantifier on the above statement produces a true proposition since there does exist at least one whole number that is divisible by six, six itself being one example.