Abduction (Logic)

Definition: abduction from The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide

In philosophy and logic, a form of probable inference, reaching a probable conclusion on the basis of available evidence. Aristotle uses the term to refer to a weak syllogism that fails to carry certainty. For US philosopher Charles Peirce, it is the process of generating hypotheses.

Summary Article: Abduction from The Pragmatics Encyclopedia

Widely understood as inference to the best explanation, abduction may be conceived of even more generously as a form of backwards-chaining reasoning, with or without explanatory force as the case may be. Adumbrated in remarks of Aristotle (Prior Analytics 2, 69a 20-36), today's notion of abduction is more commonly associated with the American pragmatist, Charles Sanders Peirce (1839-1914), who schematized it as follows:

The surprising fact C is observed. But if A were true, C would be a matter of course. Hence there is reason to suspect that A is true.

(Peirce 1931-58: 5.189)

In some contexts, it is clear that 'C would be a matter of course' can be interpreted as 'C would be explained'. From the fact that, if true, A would explain C, it is conjectured that A might be true. In this form, successful abduction is understood as 'inference to an explanation', but it is more faithful to Peirce's schema to say 'inference from an explanation'. Where there is more than one explanation, abduction opts for the best, that is, the most explanatory of them. Some commentators are of the view that 'C would be a matter of course' also admits of non-explanationist interpretation. Consider, for example, Newton's celestial mechanics, in which gravitational force acts instantaneously over arbitrary distances. Newton regarded this as a conceptual impossibility, but he tied his acceptance of it to the extraordinary accuracy of the relevant equations. 'Hypothesis non fingo', as he famously said. By this Newton meant that he regarded the action-at-a-distance claim as inexplicable. Abductions such as these may be thought of as having instrumental rather than explanatory value. More recent examples of instrumental abduction are Planck's conjecture of quanta and Gell-Mason's conjecture of quarks.

Peirce himself was careful to emphasize the highly conjectural nature of abduction. He holds that abduction is a form of guessing (Peirce 1931-58: 5.172); that a successful abduction lacks probative value, that is, it provides no grounds for believing the abduced proposition to be true (Peirce 1992a: 178); that, rather than believing them, the proper thing to do with abduced hypotheses is to submit them to experimental trial (1931-58: 5. 599, 6. 469-6. 473, 7. 202-19); that the connection between an abduced hypothesis and the observed fact is subjunctive (1931-58: 5. 189); that the inference licensed by abduction is not to the proposition A, but rather to the proposition that A's truth might plausibly be conjectured; and that the inference itself is defeasible (1931-58: 5. 189). As with many of his better ideas, Peirce has nothing like a fully developed account of abduction. But these remarks are telling all the same. It is interesting to speculate on what Peirce's rather bare-bones schema would look like had these six observations been incorporated into it.

It is possible to construe Peirce's notion of surprise not as a psychological shock, but as the kind of

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cognitive irritation that attends one’s failure to hit an epistemic target with resources presently at hand. There are two standard responses to this kind of ignorance problem. One is to acquire some new knowledge. The other is to abandon or suspend the epistemic target in question. The first way, one overcomes one’s ignorance. The second way, one’s ignorance overcomes one. Sometimes there is a third response. This is the abductive response, intermediate between the other two. Like the first, abduction furnishes the basis for new action (albeit defeasibly). Like the second, it fails to remove the ignorance that occasioned the irritation to which it is a response. It is, in other words, an action-enabling but ignorance-preserving form of inference. For generality, let \( T \) be an agent's epistemic target at a time, and \( K \) the agent's knowledge base at that time. Let \( R \) be an attainment relation for \( T \) and \( R^{\text{subj}} \) a subjunctive attainment relation for it. Let \( H \) be a hypothesis. Then \( K(H) \) is the revision of \( K \) upon the addition of \( H \). \( C(H) \) denotes the conjecture of \( H \), and \( H^c \) denotes its activation. With these parameters at hand, the expanded Peircean schema would look something like this (Gabbay and Woods 2005):

1. Target \( T \) is set by an agent.
2. \( K \) does not attain \( T \). [fact]
3. \( H \) is a proposition not in \( K \). [fact]
4. \( K(H) \) does not attain \( T \).
5. But \( K(H) \) does subjunctively attain \( T \). [fact] (‘If \( H \) were true then \( K(H) \) would attain \( T \).’)
6. So, \( C(H) \). [sub-conclusion]
7. So, \( H^c \).

Step (6) says that conjecturing \( H \) is justified by the foregoing facts, and (7) denotes the permissibility of acting on \( H \) in a certain way, namely by making it a ‘working’ hypothesis. This is done by releasing it for provisional premissory work in the domain of discourse that gave rise to the agent's ignorance problem.

The Peircean element of surprise is represented here as the cognitive irritation inherent in an ignorance problem. Since abduction is ignorance-preserving, the ‘so’ of the schema is meant defeasibly. The schema is also expressly subjunctive about the attainment relation between \( K(H) \) and \( T \). So the further elements of non-probativity and conjecture-only are clearly present. Step (7) of the schema takes abduction further than Peirce himself wanted to go. For him, the only thing to do with an abduced hypothesis is to submit it to experimental test. On the face of it, Peirce’s caution is sensible. Given that abduction is a kind of guessing, it would seem imprudent to place any cognitively serious weight on it. Against this, (7) proposes a suitably constrained relaxation of Peirce’s diffidence. This it does by generalizing the notion of test in a way that recognizes that there are classes of apparently reasonable abductions for which experimental testing is not presently (or ever) available. Accordingly, (7) allows for the indirect testing of an \( H \) by dint of its contribution to a successful practice or theory. A well-known example is Bertrand Russell’s embrace of the ‘axiom’ of infinity, whose postulation he sought to justify by its contribution to a type-theoretic treatment of classes. Russell’s employment of the postulate is precisely the kind of action mandated by step (7).

If the present schema deviates from the Peircean paradigm by ‘over-playing’ step (7), other approaches deviate by ‘under-playing’ this and other Peircean elements. The following is a format for the ‘stripped-down’ schema (Josephson and Josephson 1994; Magnani 2001; Aliseda 2006). In it \( E \) is a sentence

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reporting some event, $K$ is a knowledge base, $H$ a hypothesis and $\rightarrow$ an implication relation:

1. $E$ [fact]
2. It is not the case that $K \rightarrow E$ [fact]
3. It is not the case that $H \rightarrow E$ [fact]
4. It is the case that $K(H) \rightarrow E$ [fact]
5. So, $H$. [conclusion]

Peircean elements are not to be found here. The standard schema imposes no requirement that $E$ be surprising, or that successful abduction be non-probative, or that the sentence ‘$K(H) \rightarrow E$’ be in the subjunctive mood, or that $H$ be merely conjectured, or that the ‘so’ of line (5) marks the inference as defeasible. It is possible, of course, that some proponents of the present schema take it that some or all of these features are ‘understood’.

Both schemata are somewhat over-simplified. Neither makes express provision for the requirement that if more than one hypothesis is available for a given abduction problem, a hypothesis-selection procedure is activated. Various criteria for bestness have been proposed. Among them are that $H$ be consistent, minimal, simplest, most coherent with $K$, most relevant, and most plausible. It is a matter of contention as to whether all these are necessary for bestness, still less sufficient.

A further point of contention is the claim that abduction is inherently ignorance-preserving. There is no space to give this full consideration here. But two observations can be made briefly. One is that among philosophers of science there is some disagreement as to whether explanation is probative. If it is, explanatory abduction will not rest easily with the Peircean insistence that the successful abduction of $H$ is no reason to believe that it is true, with obviously negative consequences for the ignorance-preservation claim. A second point is that ignorance preservation does not preclude there being some antecedent reason to believe an abductively successful $H$. But it does preclude that its abductive success provides additional reason to believe it. Accordingly, a winning $H$ may enjoy a degree of evidential support, provided that the evidence in question is not sufficiently strong or abundant to reach the epistemic bar embedded in the target with respect to which the abduction-creating ignorance-problem arose in the first place.

**See also:** Inference; Peirce, C.S.; reasoning

**Suggestions for further reading**


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