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# Abduction and Creative Inferences in Science

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The symposium aims to explore abduction (inference to explanatory hypotheses), an important but neglected topic in scientific reasoning. The aim is to integrate philosophical, cognitive, and computational issues. The main thesis is that abduction is a significant kind of scientific reasoning, helpful in delineating the first principles of a new theory of science. The status of abduction is very controversial. When dealing with abductive reasoning misinterpretations and equivocations are common. What are the differences between abduction and induction? What are the differences between abduction and the well-known hypothetico-deductive method? What did Peirce mean when he considered abduction a kind of inference? Does abduction involve only the generation of hypotheses or their evaluation too? Are the criteria for the best explanation in abductive reasoning epistemic, or pragmatic, or both? How many kinds of abduction are there? The symposium aims to increase knowledge about creative and expert inferences. The study of these high-level methods of abductive reasoning is situated at the crossroads of philosophy, epistemology, artificial intelligence, cognitive psychology, and logic; that is at the heart of cognitive science.

More than a hundred years ago, the great American philosopher Charles Sanders Peirce coined the term "abduction" to refer to inference that involves the generation and evaluation of explanatory hypotheses. The study of abductive inference was slow to develop, as logicians concentrated on deductive logic and on inductive logic based on formal calculi such as probability theory. In recent decades, however, there has been renewed interest in abductive inference from two primary sources. Philosophers of science have recognized the importance of abduction in the discovery and evaluation of scientific theories, and researchers in artificial intelligence have realized that abduction is a key part of medical diagnosis and other tasks that require finding explanations. Psychologists have been slow to adopt the terms "abduction" and "abductive inference" but have been showing increasing interest in causal and explanatory reasoning.

Thus abduction is now a key topic of research in philosophy of science. First, this symposium ties together the concerns of philosophers of science and logicians, showing, for example, the connections between formal models and abduction (Meheus, Woods and Gabbay). Second, it lays out a useful general framework for discussion of various kinds of abduction (Magnani), such as model-based and manipulative abductions. Third, it develops important ideas about aspects of abductive reasoning that have been relatively neglected in philosophy of science, including the role of testing in abductive inference (Aliseda), and the interrogative model of inquiry and the role of different kinds of why-questions and strategic principles employed in attempts to find and construct answers also at the computational level (Sintonen and Paavola, Addis and Gooding). The clarification of these topics aims to increase knowledge about some aspects of explanatory reasoning and hypothesis formation very relevant in many epistemic tasks.

1. If we stress the concept of *model-based and manipulative abduction* (Magnani), creative inferences in science can be seen as formed by the application of heuristic (strategic) procedures that involve all kinds of good and bad inferential actions and both internal and external representations, and not only the mechanical application of rules.

2. Recent *logical models* can illustrate in a rigorous way how these (strategic) abductive steps are combined with deductive steps (Meheus, Woods and Gabbay).

3. Common to all abduction problems is a cognitive target that cannot be hit on the basis of what the abducer presently knows. Abductive hypotheses do not enhance a reasoner's knowledge. Abduction, accordingly, is ignorance-preserving inference. These abductive processes are dynamical (Woods and Gabbay).

4. The "abductive steps" are also analyzable in terms of responses to surprising singular or general facts, showing a connection to *explanation-seeking why-questions* (Sintonen and Paavola).

5. The importance of *experimental verification for hypotheses evaluation* in science is stressed by the relationship between abduction and pragmatism in Peirce (Aliseda).

6. Abduction cannot be thought of in isolation from the two other type of inference (deduction and induction/validation) identified by Peirce. Computer models of scientific behaviour and music conversation suggest that in simulation of abduction requires the use of mixed strategies using random actions as suggested by game theory (Addis and Gooding).