Teaching Heuristic Reasoning with Logic: A Proposal for a Philosophy of Science Course
(Extended Abstract)

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Abstract

In this talk I shall present a proposal for the use of logic to teach heuristic reasoning in the Philosophy of Science master program at UNAM in Mexico. In particular, I make use of an extension of the semantic tableaux framework (Aliseda 1997, 1998) to introduce students to the notions of confirmation and falsification, as well as for presenting the processes for empirical progress in science, as found in Kuipers (forthcoming).

Logic is taught in a variety of academic programs including philosophy, mathematics and computer science, both at an undergraduate and a graduate level. While in the first two areas classical logic is still the main subject of study, at least as far as obligatory courses go, in the latter field we find courses on computational logic, which stress the procedural potential of a subset of classical logic (clausular logic) as well as courses on non-monotonic logics, which aim to model common sense, rather than mathematical reasoning.

The case of the teaching of logic in philosophy of science programs is rather peculiar, I think. On the one hand, normally students get the same logic courses as those for philosophy, thus learning classical logic. In addition they get some probability to understand issues in statistical inference and of bayesian approaches. But soon they learn that classical logic is of little use. In fact, a whole generation headed by Stegmuller and Kuhn, showed that logical positivism was a failed attempt (not just for their logic, though), so why bother with logic?

On the other hand, interdisciplinary programs related to cognitive science (Carnegie Mellon in the USA, Toronto in Canada, Groningen in the Netherlands, soon UNAM in Mexico) are offering courses on a rather new field, “Computational Philosophy of Science”, which uses programs based on heuristic search from artificial intelligence as well as models from cognitive psychology to model processes such as theory generation and explanation in the philosophy of science.

Therefore, the situation of the teaching of logic in philosophy of science programs, as I see it, is that while there are some novel courses applying issues from cognitive psychology and artificial intelligence, new uses of logic is simply out of the picture. Part of the reason lies in that not much research has taken up this route. Some exceptions make connections between non-monotonic logics and issues of explanation, such as Tan’s treatment of Hempel’s inductive statistical inference in Reiter’s default logic (Tan 1992) or an application of abductive reasoning as a model for scientific explanation (Aliseda 97).

Thus, we aim at using our abductive model, based on an extension of the semantic tableaux framework, to show students that logic can be used not just for testing scientific theories in regard to evidence, that is, to answer the “truth-question” by testing whether a theory H entails evidence E given some initial conditions, which is what classical methods can offer, but to actually answer the “success” and the “improvement” questions by computing those appropriate initial conditions which make evidence successful, by dictating how a theory may be improved to account for its lacuane (those evidence which neither confirm nor falsify a theory) or by stating how a theory may be revised to account for its failures as cases of successes.

Our proposal is based on Kuipers account of empirical progress in science, which goes beyond the Popperian dictum that scientific theories are useless after they are falsified, by proposing a further evaluation of theories with respect to its successes, failures and lacunae. It also provides principles for theory improvement, giving a precise measure for comparison amongst (conmesurable) theories, thus making it possible to single out the theory which is “more successful” or which is “closer to the truth”. And we apply our abductive semantic tableaux framework for modeling these notions.
Our original proposal (Aliseda 1997) provides a way to compute those additional formulae (abductive explanations) to make an surprising observation a predictable one, and when this is not possible, it offers the needed operations to revise a theory (possibly retracting some formulae from it) into another one which accounts for the required observed fact. These procedures form the basis to model empirical progress in science.

A feature of our model is that rather than proposing a new logic to account for confirmation, falsification and theory improvement, we propose to use classical logic (in fact propositional logic to start with) and just extend the potentials of an existing logical method, that of semantic tableaux, to account for some of the processes of scientific theory building and change in philosophy of science. We hope this approach will help to get a refreshed look of classical logic back into the picture of philosophy of science, at least in so far students can appreciate the potentials of formalization in science.

The details of our proposal as well as some examples, will be given in the talk.

References:

Aliseda, A. Seeking explanations: abduction in logic, philosophy of science and artificial intelligence, Dissertation Stanford University and ILLC Dissertations Series (1997-04), Amsterdam. 1997.

Aliseda, A.. “Computing Abduction in Semantic Tableaux”, Computación y Sistemas: Revista Iberoamericana de Computación, Volumen II, Número 1. July-September 1998. pp. 5-13. Centro de Investigación en Computación (CIC), Instituto Politécnico Nacional, México. D.F.

Kuipers, T. “Abduction aiming at empirical progress or even at truth approximation”, Foundations of Science 4: 307-323. 1999. Kluwer Academic Publishers.

Kuipers, T. “From Instrumentalism to Constructive Realism: On Some Relations Between Confirmation, Empirical Progress, and Truth Approximation. Synthese Library, Kluwer AP. 2000.

T. Kuipers (Forthcoming) “Structures in Science: Heuristic Patterns Based on Cognitive Structures (An Advanced Textbook in Neo-classical Philosophy of Science”. Synthese Library, Kluwer Academic Publishers.

Tan, Y.H. Non-Monotonic Reasoning: Logical Arquitecture and Philosophical Applications. PhD Thesis, University of Amsterdam. 1992.

Thagard, P. Computational Philosophy of Science. Cambridge, MIT Press. Bradford Books. 1988.