Abduction at the interface of logic and philosophy of science

van Benthem, J.

Published in:
Theoria

DOI:
10.1387/theoria.447

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Abduction at the interface of Logic and Philosophy of Science

Johan van Benthem, Amsterdam & Stanford, http://staff.science.uva.nl/~johan/

May 2007

It is a pleasure to say, and write a few words in connection with Atocha Aliseda’s recent book *Abductive Reasoning: Logical Investigations into Discovery and Explanation* – which is based on her doctoral dissertation which I supervised during her years at Stanford as a first-wave student in the pioneering Symbolic Systems Program.

As is clear from the title, the book brings together two fields of research whose relations through history have varied. Clearly, great philosophers like Bolzano, Mill, Peirce, and Carnap were masters of both logic and methodology of science, and so was my predecessor Beth on the general logic chair in Amsterdam. Indeed, when Beth and Tarski realized their planetary ambitions after much plotting and scheming (Van Ulsen 2000), they created the “International Division of Logic, Methodology and Philosophy of Science” around 1960. But soon after, the fields went largely their own way – partly under the influence of the Suppes–Sneed view that set-theoretic structures alone are the privileged representation of scientific theories. This leaves little room for the logical languages needed to start up the model-theoretic machinery of logicians. And as we all know, frictions lead to partner change. History and sociology started wooing the philosophy of science, while logicians made new friends in linguistics and computer science. For these and other reasons, our two fields are largely disjoint today, with their own journals, jargon, and intellectual attitudes.

But now, looking at many other signs around us, it seems that a new spring is in the air. Can old love be re–kindled, after many decades of separation? Well, one reason why the two fields meet today is a shared modern environment, namely, developments in computer science and artificial intelligence. In particular, since the 1980s, AI has developed accounts of ‘common sense reasoning’ doing justice to a variety of inferential tasks far beyond standard logical deduction, and closer to the rich repertoire of activities of confirmation,
explanation, and prediction found in the philosophy of science. But computer science uses language and logic essentially, and hence one is together again. Indeed, there are interesting parallels between common sense reasoning and the variety of reasoning styles studied by Bolzano (van Benthem 2006), who advocated a wide-ranging awareness of different logical properties of different styles. And the same liberal conception is found, of course, in the innovative work of Peirce on deduction, induction, and abduction. Such studies can be undertaken in at least two ways, both of them represented in Atocha’s book. One is ‘top-down’, in terms of structural properties such as Monotonicity (persistence of conclusions when new premises are added), or the lack of it. This is in line with many other themes in logic since the 1980s, culminating in the research area of ‘substructural logics’. But there is also a ‘bottom-up’ approach looking at specific computational mechanisms for performing different styles of reasoning. There are many of these, but it is a pleasure to note that Atocha’s book uses Beth’s semantic tableaux, born and bred in Amsterdam.

Of course, this is just the beginning of a field of study. In particular, attractive and liberal as it sounds, the ‘pluralist’ methodology raises some issues. If humans have all these reasoning abilities, presumably these meet and combine in fruitful manners, as we integrate information from various sources. But then, we should definitely describe mixtures of styles, including classical deduction, abduction, and what have you. And this is not at all a simple matter of throwing everything into one combined system. In various areas of modal logic, it has been discovered that natural combined systems with decidable components can even become undecidable – sometimes by making some apparently harmless assumptions about agents’ abilities, such as their having perfect memory. So, how harmless are combined abductive–deductive systems for perfect reasoners? I guess we do not know.

Moreover, let us also put the above developments, encouraging as they are, in a broader perspective. Should the current meeting of logic and philosophy of science be cast in terms of consequence relations like abduction? I myself would prefer a much broader view of cognitive actions that are involved in intelligent tasks. E.g., I have argued that maybe the main phenomenon in non-monotonic common sense reasoning is not consequence, but acts of belief revision (van Benthem 2007). Sticking to mathematical proof is hard in some
ways, but it is still an easy form of cumulation. But in real life, we are proved wrong all the
time, and our intelligence shows in how we deal with that. I myself think that it might be
very fruitful to critically compare, and perhaps merge currently disjoint work on abduction,
circumscription, belief revision, and dynamic logics. And once on this road of actions of
information-processing and self-correction, the longer-term perspective would be one of
forming and modifying hypotheses over time, as in formal learning theory (Kelly 1996).
These matters are of joint interest to logicians and philosophers of science, and they can be
studied in dynamic and temporal logics of information flow (van Benthem 2006).

But let me go one step further than individual action. When Kuhnian influences entered the
philosophy of science, a shudder could be felt, as real people started walking in the Platonic
Museum of abstract scientific theories, with their shouts and steps reverberating on the
immaculate tiles. But nowadays, multi-agent interaction is coming to be seen as crucial to
intelligent behaviour (ESF 2007). Logicians think of proofs as strategies for successful
interaction, computer science is all about distributed systems and interacting ‘agents’,
linguists cast meanings as equilibria in coordinate games between speakers and hearers,
and many philosophers find the test of ‘true knowledge’ in being able to survive the
grindstones of controversy. In line with this, logic, computer science, economic game
theory, and formal sociology are rapidly developing new interfaces today, including studies
of strategies, belief change, and preference merge. I think the same would be wise for the
methodology of science. Kuhn and even the social critics of traditional neo-positivism had
a serious point, and indeed much of what they said makes sense in this new formal setting.

Finally, the realities. For testing their theories, formal philosophers of science and logicians
often appeal to intuitions and carefully stream-lined historical facts. But nowadays,
empirical cognitive science is knocking on the door of such theoretical research. If there are
all these inference mechanisms like deduction and abduction, surely, we should find some
trace of them in the workings of the human brain? The last few years have seen some
exciting discoveries on this score, e.g., proofs by various authors that neural nets may be
viewed as computing conclusions in non-monotonic default logics (Leitgeb, to appear).
Thus, stale polemics between paradigms in cognitive science come to a fitting end. Indeed,
some young logicians and philosophers of science at this interface see all this as leading to
a possibly new life for the Vienna Circle Program, but now in a new guise, informed by
new logics and new access to empirical facts. I find this broad-band revivalist program very
appealing, and it would reflect my own view of logic today: not as an absolute guardian of
truth and consistency, but as a way of dealing with the continuous surprises that intellectual
life has in store for us, delivered either by Nature or by our interactions with other people.
If you wish (and I do…): logic is the immune system of the mind!

References
J. van Benthem, 1990, ‘Artificial Intelligence, a Continuation of Philosophy by
Other Means’, Algemeen Nederlands Tijdschrift voor Wijsbegeerte 82, 83-100.
J. van Benthem, 2000, ‘Reasoning in Reverse’, Preface to Abduction and Induction,
Handbook of the Philosophy of Logic, Elsevier, Amsterdam.
J. van Benthem, 2007, ‘Modal Logic Meets Situation Calculus’,
submitted to special issue of Artificial Intelligence.
European Science Foundation, 2007, LogiCCC. Modeling Intelligent Interaction:
Logic in the Humanities, Social and Computational Sciences,
Eurocores Program Document, Strassbourg.
P. van Ulsen, 2000, Evert Willem Beth als Logicus, Dissertation, Institute for Logic,
Language and Computation, University of Amsterdam.