The Dynamics of Reasoning in the Sciences: Illustrations of and Challenges for the Adaptive Logics Programme

Joke Meheus*
Centre for Logic and Philosophy of Science
Ghent University
Belgium
Joke.Meheus@rug.ac.be

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Today, most historians and philosophers of science recognize that scientific reasoning, like everyday reasoning, proceeds in a dynamical way: conclusions drawn at a certain moment in time may later be withdrawn. This dynamics may be external (when the withdrawal is caused by the addition of new information) or internal (when it is caused by the further analysis of the available information). Partly in view of this recognition, a whole range of non-standard logics has been designed that can capture various forms of dynamical reasoning patterns. One of the most fruitful approaches in this respect concerns so-called adaptive logics.[1]

At this moment, adaptive logics have mainly been tested against toy examples and not against examples of real cases of scientific reasoning. One of the reasons for this is that the logics are designed to explicate the dynamics of individual inferences (rather than, for instance, broad-scale changes of paradigms), and that especially these forms of dynamics leave very few traces in the historical sources.[2] The aim of this presentation is to provide some examples of small-scale dynamics from the history of the sciences and to use these as test cases for adaptive logics.

I shall proceed as follows. Based on Larry Holmes' excellent case study of the work of Lavoisier (see [2]), I shall first present some of the nicest examples of dynamical reasoning patterns that have ever been discovered in notebooks and manuscripts. What is especially interesting about these examples is that one can actually *see* how and why Lavoisier changed his opinion about certain previously derived conclusions. Next, I shall show that some of these examples

*Postdoctoral Fellow of the Fund for Scientific Research – Flanders (Belgium).

[1]See, for example, [1] for an introduction to adaptive logics.

[2]An early exception to this can be found in [3] and [4]. There, adaptive logics are used to explain why Rudolf Clausius, in his attempt to resolve the inconsistencies that plagued early thermodynamics, withdrew certain conclusions arrived at by means of *Reductio ad Absurdum* while accepting others. The explanation, however, is an indirect one: it is not based on an actual record of the dynamics involved, but on some comments Clausius made about fifteen years later.

can adequately be explicated by adaptive logics already available, but that others reveal forms of dynamics that have not yet been tackled within the adaptive logics programme. More specifically, I shall show that some of the most interesting forms of dynamics do not lead to the *withdrawal* of previously derived conclusions, but merely to *changes in the degree of confidence* one has in these conclusions. I shall moreover show that the changes in degree of confidence are not based on an external decision of the reasoner, but on a logical analysis, and that, because of this, even prioritized adaptive logics are inadequate to explicate this particular type of dynamics.[3] Finally, I shall discuss some philosophical implications related to the logical explication of reasoning *processes* (instead of their result)—for instance, with respect to the notion of rationality, the notion of a 'proof', and the distinction between the context of discovery and the context of justification. I shall also address the question why the explication of actual cases of reasoning processes is important.

References

[1] D. Batens. A general characterization of adaptive logics. To appear.

[2] F. L. Holmes. *Lavoiser and the Chemistry of Life. An Exploration of Scientific Creativity.* University of Wisconsin Press, 1985.

[3] J. Meheus. Adaptive logic in scientific discovery: the case of Clausius. *Logique et Analyse*, 143–144:359–389, 1993 (appeared in 1996).

[4] J. Meheus. Inconsistencies in scientific discovery. Clausius's remarkable derivation of Carnot's theorem. In G. Helge Krach, Vanpaemel and P. Marage, editors, *History of Modern Physics*, pages 143–154. Brepols, Turnhout, 2002.

[3]Prioritized adaptive logics can handle sets of premises over which some preference ranking is defined, but cannot handle changes in these preferences (unless they are made by the reasoner).