Argumentative networks: A still missing integration of philosophical approaches to argumentation with AI-models, with an application to mathematical practice.

WWW.VUB.AC.BE/CLWF/

1 Theme(s) of research

In the field of philosophy there is a well-established tradition of research on argumentation, both from an informal and a formal point of view; a research programme which in the latter case is strongly intertwined with the development of non-classical logics. Recently within the field of computer science, a fairly new approach to argumentation has been presented, the so-called argumentative networks, a formal model with applications of a high potential value. The aim of the proposed research is to demonstrate the usefulness of argumentation theory and argumentative networks for the understanding of the functioning of "real" mathematical proofs, i.e., the proofs as they actually appear in mathematical journals and textbooks. The underlying hypothesis is that the most fruitful way to approach such "real" proofs is to understand these as 'pieces' of argumentation, instead of as reconstructed formal proofs, and that doing so truly enhances our insights into the role these proofs play in the mathematician's daily practice. We intend to look at a particular case study, viz., the classification theorem of finite, simple groups.

2 The argumentative background

No one will doubt that argumentation theory has a long and respectful history within philosophy, starting with Aristotle, who, at the same time, initiated the distinction, if not opposition, between the predominantly informal realm of argumentation (to convince an audience) and the more formally oriented field of logic (to establish necessary truths). In the 20th century this situation changed drastically: new developments were initiated that aimed at a formal argumentation theory.

2.1 Formal argumentation theory.

The major contributions are the following:

First of all, dialogue logic, as designed by Paul Lorenzen [LL78] must be mentioned. The core idea is that a logical system, axiomatically and/or deductively presented, can be reformulated in terms of rules for a discussion between two parties, thus showing that the distinction between logic and argumentation is partially fictitious. Similar attempts in terms of game theory were made by Jaakko Hintikka [Hin85] and related models were developed by Else Barth and Erik Krabbe [BK82].

A rather different approach in modern argumentation theory was initiated by the work of Paul Grice [Gri75], who formulated his "maxims" that act as guides for a good discussion, e.g., "be relevant", "speak truthfully", etc.. Usually in the past his work was not linked to formal logic, but, recently, starting from the 90s, interesting attempts have been proposed to formalize these maxims in the so-called neo-Gricean approach. From a different angle, it is worth mentioning that the resulting logics are often non-classical, as, e.g., the rule of addition (to conclude "p or q" from p) is no longer acceptable in the analysis of [VH05].

Related to (b), logicians who have tried to formalize discussions and argumentations, have had a strong interest in how to avoid the infamous "ex falso sequitur quod libet" (to conclude q from p and not-p). Since, in a discussion, different viewpoints, often expressed by p and non-p, are the starting point, we have all reasons to avoid this inference. Many answers have already been proposed: the discursive logic D2 by Jaskowski (see Meheus [Meh06]), the wide variety of paraconsistent logics that in turn provide the basis for the even wider variety of adaptive logics, developed by the logic group at the University of Ghent, headed by Diderik Batens.

Finally, the above-mentioned connection between dialogue logic and the development of non-classical logics has recently started to play a role in the debate between logical monists and pluralists ([BR06]). For instance, the use and defence of non-normal modal logics in a dialogical framework by Rahman and Keiff [RK05, Rah06] is an attempt to formally vindicate the changes in logical standards that might occur throughout a discussion. At the same time, there have been new parallel developments in informal argumentation theory.

2.2 Informal argumentation theory.

Of major importance in this field is the work of Grootendorst and Van Eemeren (the "classic" being Van Eemeren, Grootendorst & Kruiger [EGK78]). The Amsterdam school, the driving force behind the International Society for the Study of Argumentation (ISSA, http://cf.hum.uva.nl/issa/), is mainly interested in specific case studies to determine how participants in a dialogue or discussion deal with arguments and their evaluation. There is a direct connection with the Canadian school, the best known members of which are Douglas Walton, see, e.g., [Wal91] and John Woods [Woo03]. Here too there is a strong focus on concrete situations and, above all, a careful investigation whether fallacies are always to be rejected in a discussion or debate or whether in some particular circumstances they can be acceptable forms of reasoning. For example, classically the argument "ad autoritatem" is considered to be a fallacy, but expertise in a court of law is clearly acceptable.

2.3 Argumentative networks.

Finally, the third development is within the field of Artificial Intelligence (AI), where there has been an interest for some time now in the modelling of argumentations [Tou58, Vre97, Pol94]. The purpose of this research is to develop applications in decision-guided systems and intelligent agents [Ree98]. Argumentative networks [Dun95] have recently been proposed as a simple but very powerful model that allows one to represent a static structure of "argument" in competition with one another. However the model is rather abstract: arguments are viewed solely in relation to other arguments, where the basic relation is one argument "attacking" another. Several semantics have been proposed for such networks, e.g., [BDKT97, Dun95, JV96, JV99b], which all take as a starting point a declarative and monological approach. In a further stage so-called "dialectical" semantics have been investigated [JV99a, PS96], searching for applications in judicial reasoning [Ver95]. A connection has already been shown between some of these semantics and the "well-founded" and "stable" semantics of logic programs, see [KMD94]. More generally speaking, such argumentative networks can be applied in areas where it is important to have a motivation or argumentation for a result or a decision, e.g., in medicine [ABCM05] or in bioinformatics [JKS+ar]. As far as we are aware, applications to mathematical contexts are more or less absent and, as stated, it is the main purpose of this project to fill in this gap.

3 Aim(s) of the project

Our first aim is based upon the observation that both fields of argumentation theory and the work on argumentative networks are, at the present moment, still acting more or less separately (as can be easily established by comparing references and bibliographies). Nevertheless, they could be mutually quite inspiring. Hence, a comparative study is urgently required. However, in order to avoid "mere" theoretical results, our second and more specific aim is, as mentioned above, to look for applications within the practice of mathematics. Although there exists at the present moment a modest literature concerning proofs seen as arguments, see, e.g., [Abe07], [Ben08a], [Ben08b], much work remains to be done. It is worth noting that in this approach Stephen Toulmin, one of the great defenders of informal argumentation theory, plays a central part. The choice of the case study, viz., the classification theorem of finite, simple groups, is mainly determined by the fact that no single mathematician can comprehend the entire proof, hence, it has to be 'shared' in the community of mathematicians. This invites the use of argumentative frameworks, the core theme of this research proposal.

References

[ABCM05] K. Atkinson, T. Bench-Capon, and P. McBurney. A dialogue game protocol for multi-agent argument over proposals for action. Journal of Autonomous Agents and Multi-Agent Systems, 11(2):153–171, 2005.

[Abe07] A. Aberdein. The informal logic of mathematical proof. In J. P. Van Bendegem & B. Van Kerkhove, editors, Perspectives on mathematical practices: Bringing together philosophy of mathematics, sociology of mathematics, and mathematics education. Springer-Verlag, 2007, pp. 135–51.

ASPIC2 -Argumentation Service Platform with Integrated Components http://www.argumentation.org/.

[BR06] J.C. Beall and G. Restall. Logical Pluralism. Oxford: Oxford University Press, 2006.

[BDKT97] A. Bondarenko, P.M. Dung, R. A. Kowalski, and F. Toni. An abstract, argumentation-theoretic approach to default reasoning. Artificial Intelligence, 93(1–2):63–101, 1997.

[Ben82] J.P. Van Bendegem. Pragmatics and mathematics or how do mathematicians talk? Philosophica, 29:97–118, 1982.

[Ben85a] J.P. Van Bendegem. Dialogue logic and problem-solving. Philosophica, 35:113–134, 1985.

[Ben85b] J.P. Van Bendegem, editor. Recent Developments in Dialogue Logic, volume 35. Special issue of Philosophica, 1985.

[Ben08a] J.P. Van Bendegem and Bart Van Kerkhove. Pi on Earth, or Mathematics in the Real World. Erkenntnis, to appear, 2008.

[Ben08b] J.P. Van Bendegem. Elements for a rhetoric of mathematics: How proofs can be convincing. In Helge RÃijckert et al. (eds), Festschrift at the Occasion of the 60th Birthday of Shahid Rahman, to appear, 2008.

[BK82] E. M. Barth and E. C. W. Krabbe. From Axiom to Dialogue. A Philosophical Study of Logics and Argumentation. Walter de Gruyter, 1982.

[Dun95] Phan Minh Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. Artificial Intelligence, 77(2):321–358, 1995.

[EGK78] F.H. Van Eemeren, R. Grootendorst, and T. Kruiger. Argumentatietheorie. Het Spectrum, 1978.

[Gri75] H. P. Grice. Logic and conversation. In D. Davidson and G. Harman, editors, The Logic of Grammar, pages 64–75. Dickenson Encino, 1975.

[Hin85] J. Hintikka. A spectrum of logics of questioning. Philosophica, 35:135– 150, 1985.

[JKS+ar] B. R. Jeffreys, L. A. Kelley, M. J. Sergot, J. Fox, and M. J. E. Sternberg. Capturing expert knowledge with argumentation: a case study in bioinformatics. Bioinformatics, to appear.

[JV96] H. Jakobovits and D. Vermeir. Contradiction in argumentation frameworks. In Proceedings of the IPMU conference, pages 821–826, 1996.

[JV99a] H. Jakobovits and D. Vermeir. Dialectic semantics for argumentation frameworks. In Proceedings of the seventh international conference on artificial intelligence and law, pages 53–62. ACM, june 1999.

[JV99b] H. Jakobovits and D. Vermeir. Robust semantics for argumentation frameworks. Journal of Logic and Computation, 6(2):215–261, 1999.

[KMD94] A. C. Kakas, P. Mancarella, and Phan Minh Dung. The acceptability semantics for logic programs. In P. Van Hentenrijck, editor, Proceedings of the 11th International Conference on Logic Programming, pages 504– 519. MIT Press, 1994.

[LL78] P. Lorenzen and K. Lorenz. Dialogische Logik. Wissenschaftliche Buchgesellschaft, 1978.

[Meh06] J. Meheus. An Adaptive Logic Based on Jaskowski's Approach to Paraconsistency. Journal of Philosophical Logic 35(6): 539-67, 2006.

[Pol94] John Pollock. Justification and defeat. Artificial Intelligence, 67:377–407, 1994.

[PS96] H. Prakken and G. Sartor. A dialectical model of assessing conflicting arguments in legal reasoning. Artificial Intelligence and Law, 4:331–368, 1996.

[RB02] S. Rahman and J. P. Van Bendegem. The dialogical dynamics of adaptive paraconsistency. In W. A. Carnielli, M. E. Coniglio, and I. M. Loffredo DâĂŹOttaviano, editors, Paraconsistency. The Logical Way to the Inconsistent, pages 295–321. Marcel Dekker, 2002.

[Rah06] S. Rahman. "Non-Normal Dialogics for a Wonderful World and More." In The Age of Alternative Logics. Assessing Philosophy of Logic and Mathematics Today, edited by Johan Van Benthem, G. Heinzmann, M. Rebusschi and H. Visser, 311-34. Dordrecht / Boston / London: Kluwer Academic Publishers, 2006.

[RK05] S. Rahman and L.Keiff. "On How to Be a Dialogician." In Logic, Thought and Action, edited by Daniel Vanderveken, 359-408. Dordrecht / Boston / London: Kluwer Academic Publishers, 2005.

[Ree98] C.A. Reed. Dialogue frames in agent communication. In Proceedings of the 3rd International Conference on Multi Agent Systems (ICMAS'98), pages 246–253. Paris, July 1998.

[Ue05] T. Uebel, "Learning Logical Tolerance: Hans Hahn on the Foundationd of Mathematics." History and Philosophy of Logic 26(3): 175-209, 2005.

[Tou58] S. Toulmin. The Uses of Arguments. Cambridge University Press, Cambridge, MA, 1958.

[Ver95] Bart Verheij. Two approaches to dialectical argumentation: admissible sets and argumentation stages. Technical report, University of Limburg, Maastricht, 1995.

[VH05] L. Verhoeven and L. Horsten. On the exclusivity implicature of "or" or on the meaning of eating strawberries. Studia Logica, 81:19–42, 2005.

[Vre97] Gerard A.W. Vreeswijk. Abstract argumentation systems. Artificial Intelligence, 90(1-2):225–279, 1997.

[Wal91] D. N. Walton. Begging the Question. Circular Reasoning as a Tactic of Argumentation. Greenwood PG, 1991.

[Woo03] J. Woods. Paradox and Paraconsistency. Conflict Resolution in the Abstract Sciences. Cambridge University Press, 2003.