An Implementation of Basic Argumentation Components (Demonstration)

Mikolaj Podlaszewski
Université du Luxembourg
6, rue Richard
Coudenhove-Kalergi
L-1359 Luxembourg
mikolaj.podlaszewski@gmail.com

Martin Caminada
Université du Luxembourg
6, rue Richard
Coudenhove-Kalergi
L-1359 Luxembourg
martin.caminada@uni.lu

Gabriella Pigozzi
Université Paris Dauphine
Place du Marchal de Lattre de
Tassigny
75775 Paris Cedex 16
gabriella.pigozzi@lamsade.dauphine.fr

ABSTRACT

The current implementation provides a demonstration of a number of basic argumentation components that can be applied in the context of multi-agent systems. These components include algorithms for calculating argumentation semantics, as well as for determining the justification status of the arguments and providing explanation in the form of formal discussion games. Furthermore, the current demonstrator also includes the first implementation we know of regarding argument-based judgment aggregation theory.

Categories and Subject Descriptors

I.2.3 [**Artificial Intelligence**]: Deduction and Theorem Proving

General Terms

Algorithms

Keywords

Argumentation, Communication Protocols, Judgment Aggregation and Belief Merging

1. INTRODUCTION

In order for multi-agent systems (MAS) to truly benefit from recent developments in the field of formal argumentation theory, what seems to be needed is a standard library of reusable components that provide basic functionality for various agent-related argumentation tasks. With the current demonstrator (called *ArguLab*) we aim at providing such a library, and illustrate its possible uses.

The functionality of the demonstrator can be divided into four parts: applying argumentation semantics to an abstract argumentation framework, determining the justification status of the various arguments, entering into a structured discussion in which arguments are exchanged and applying argument-based judgment aggregation operators. These four forms of functionality will now be explained in further detail. A video showing the use of the demonstrator is available at http://www.youtube.com/user/ArguLabDemo

2. ARGUMENTATION SEMANTICS

One of the key notions in argumentation theory is that of an *argumentation framework* [7], which is in essence a directed graph in which the nodes represent arguments and the arrows represent the attack relation. For the purpose of logical entailment, the argumentation framework can be constructed from an underlying knowledge base, as is for instance done in [10]. However, once the argumentation framework is constructed, determining which arguments to accept and reject is done purely on the topology of the graph, without looking at the actual structure (the logical content) of the arguments. Various topological criteria have been stated in the literature for determining which sets of arguments to accept and reject. These topological criteria are commonly referred to as *argumentation semantics*. The current demonstrator implements some of the mainstream argumentation semantics that have been stated in the literature. These include grounded, preferred and stable semantics [7], semi-stable semantics [1, 14], stage semantics [14], ideal semantics [8] and eager semantics [2]. These semantics are computed in the form of *argument labellings* [4], which is in essence a function that assigns each argument precisely one label: `in` stating that the argument is accepted, `out` stating that the argument is rejected, and `undec` stating that one does not have an explicit opinion on whether the argument is accepted or rejected. In essence, a labelling provides a (subjective) position on which arguments to accept, which to reject and which to abstain from having an explicit opinion about. It has been shown in [4] that labellings coincide with extensions. That is, the set of `in`-labelled arguments of a preferred labelling is a preferred extension, the set of `in`-labelled arguments of the grounded labelling is the grounded extension, etc.

For each of the above mentioned argumentation semantics, the demonstrator is able to compute the associated labellings, given an argumentation framework. The procedure is first to construct an argumentation framework (or to select one from the library) and then to click on one of the buttons for computing the various semantics. The resulting labellings will then be listed below, and clicking on them will display them graphically.

It should be mentioned that the current input method for argumentation frameworks is for demonstration purposes only. In the context of a MAS, the arguments are likely to come from multiple agents, in a distributed way, as is for instance the case in [12, 13]. The aim of the current demonstrator is to provide open source software components

that would be useful in such a setting.

3. JUSTIFICATION STATUS

When applying a particular semantics results in more than one labelling being applicable to the argumentation framework under consideration, the question then becomes what is the overall status of a particular argument, given the multiplicity of possible labellings. In order to deal with this issue, the notion of *justification status* has been defined [16]. In essence, the justification status of an argument consists of the possible labels it can have, given a particular semantics. For instance, the justification status {in} (*strong accept*) means that the argument is accepted in every reasonable position (as specified by the argumentation semantics). Another example would be the justification status {in, undec} (*weak accept*) which specifies that the argument *can* be accepted, does not *have to be* accepted, but at least *cannot* be rejected. The current demonstrator is able to determine the justification status of the arguments in a given argumentation framework with respect to complete semantics, using the procedure specified in [16].

4. ARGUMENT-BASED DISCUSSION

A particular feature of the current demonstrator is that it is not only able to calculate the justification status of the arguments, it can also explain the correctness of its answer by entering into a structured discussion with whichever agent or human user to whom this correctness is not immediately clear. Two types of structured discussion games have been implemented for this: the *grounded game* [11, 9] and the *preferred game* [15, 3]. It has been shown in [16] that these two games are sufficient to determine the correctness of a particular justification status with respect to complete semantics.

5. JUDGEMENT AGGREGATION

Even when all agents agree on the structure of the argumentation framework, as well as on the semantics to be applied, they can still have private reasons for preferring one labelling above the other. For instance, a lawyer might not be able to change the facts of a case, but he can still prefer an interpretation that is as favourable as possible to his client. Given the fact that agents can have different positions (labellings) based on the same information (argumentation framework), a relevant question is how these positions can be aggregated, so that a group of agents comes to a common position. This is the topic of the work of [5] where three different labelling-based aggregation operators have been specified: the *sceptical*, *credulous* and *super credulous* operator. The properties of these operators have been studied in [6]. The current demonstrator provides an implementation of each of them, as well as of the concepts of *down-admissible* (DA) and *up-complete* (UC) labellings [5].

6. REFERENCES

[1] M. Caminada. Semi-stable semantics. In P. Dunne and T. Bench-Capon, editors, *Computational Models of Argument; Proceedings of COMMA 2006*, pages 121–130. IOS Press, 2006.

[2] M. Caminada. Comparing two unique extension semantics for formal argumentation: ideal and eager. In M. M. Dastani and E. de Jong, editors, *Proceedings of the 19th Belgian-Dutch Conference on Artificial Intelligence (BNAIC 2007)*, pages 81–87, 2007.

[3] M. Caminada. Preferred semantics as socratic discussion. In A. E. Gerevini and A. Saetti, editors, *Proceedings of the eleventh AI*IA symposium on artificial intelligence*, pages 209–216, 2010.

[4] M. Caminada and D. Gabbay. A logical account of formal argumentation. *Studia Logica*, 93(2-3):109–145, 2009. Special issue: new ideas in argumentation theory.

[5] M. Caminada and G. Pigozzi. On judgment aggregation in abstract argumentation. *Autonomous Agents and Multi-Agent Systems*, 22(1):64–102, 2011.

[6] M. Caminada, G. Pigozzi, and M. Podlaszewski. Manipulation in group argument evaluation. In *Proceedings of Tenth International Conference on Autonomous Agents and Multiagent Systems*, 2011. in print.

[7] P. Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence*, 77:321–357, 1995.

[8] P. M. Dung, P. Mancarella, and F. Toni. Computing ideal sceptical argumentation. *Artificial Intelligence*, 171(10-15):642–674, 2007.

[9] S. Modgil and M. Caminada. Proof theories and algorithms for abstract argumentation frameworks. In I. Rahwan and G. Simari, editors, *Argumentation in Artificial Intelligence*, pages 105–129. Springer, 2009.

[10] H. Prakken. An abstract framework for argumentation with structured arguments. *Argument and Computation*, 1(2):93–124, 2010.

[11] H. Prakken and G. Sartor. Argument-based extended logic programming with defeasible priorities. *Journal of Applied Non-Classical Logics*, 7:25–75, 1997.

[12] I. Rahwan, K. Larson, and F. Tohmé. A characterisation of strategy-proofness for grounded argumentation semantics. In *Proceedings of the 21st International Joint Conference on Artificial Intelligence (IJCAI)*, 2009.

[13] K. L. S. Pan and I. Rahwan. Argumentation mechanism design for preferred semantics. In *Proceedings of the 3rd International Conference on Computational Models of Argument (COMMA)*, pages 403–414, 2010.

[14] B. Verheij. Two approaches to dialectical argumentation: admissible sets and argumentation stages. In J.-J. Meyer and L. van der Gaag, editors, *Proceedings of the Eighth Dutch Conference on Artificial Intelligence (NAIC'96)*, pages 357–368, Utrecht, 1996. Utrecht University.

[15] G. Vreeswijk and H. Prakken. Credulous and sceptical argument games for preferred semantics. In *Proceedings of the 7th European Workshop on Logic for Artificial Intelligence (JELIA-00)*, number 1919 in Springer Lecture Notes in AI, pages 239–253, Berlin, 2000. Springer Verlag.

[16] Y. Wu and M. Caminada. A labelling-based justification status of arguments. *Studies in Logic*, 3(4):12–29, 2010.