On the Justification Status of Arguments [1]

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1 Introduction

In the current paper we propose justification statuses of arguments based on the notion of complete labellings. One of the main advantages of our proposal is that it allows for a more fine-grained notion of a justification status than is provided by the traditional extensions-based approaches. In particular, it allows for six distinct justification statuses (strong accept, weak accept, strong reject, weak reject, undetermined border line and determined border line) which correspond with different levels of acceptance and rejection. Furthermore, our proposal is fully compatible with Dung's approach [2] in the sense that it works on standard argumentation frameworks and can be implemented using existing argumentation-based proof procedures.

2 Complete Labellings

The concept of complete semantics in abstract argumentation was originally stated in terms of sets of arguments. It is equally well possible, however, to express this concept in terms of *argument labellings*. In the current paper, we follow the approach of [1] where a labelling assigns to each argument exactly one label, which can either be `in`, `out` or `undec`. The label `in` indicates that the argument is accepted, the label `out` indicates that the argument is rejected, and the label `undec` indicates that the status of the argument is undecided, meaning that one abstains from an explicit judgment whether the argument is `in` or `out`. The idea of a complete labelling is that one accepts an argument iff one rejects each of its attackers, and one rejects an argument iff one accepts at least one of its attackers. Hence each complete labelling can be seen as a reasonable position one can take in the presence of the conflicting information of the argumentation framework.

Definition 1 ([1]). *Let* $\mathcal{L}ab$ *be a labelling of argumentation framework* (Ar, att) *and* $\mathcal{L}ab : Ar \to \{\texttt{in}, \texttt{out}, \texttt{undec}\}$ *be a total function. We say that* $\mathcal{L}ab$ *is a* complete labelling *iff it satisfies the following:*

1. $\forall A \in Ar : (\mathcal{L}ab(A) = \texttt{out}$ *iff* $\exists B \in Ar : (B\ att\ A \wedge \mathcal{L}ab(B) = \texttt{in}))$*. and*

2. $\forall A \in Ar : (\mathcal{L}ab(A) = \texttt{in}$ *iff* $\forall B \in Ar : (B\ att\ A \supset \mathcal{L}ab(B) = \texttt{out}))$*.*

In [3], it is stated that complete extensions and complete labellings are one-to-one related. In essence, the set of `in`-labelled arguments of a complete labelling is a complete extension (and vice versa).

3 Justification Statuses of Arguments

Our proposed justification status of an argument consists of the set of labels that could be assigned to the argument. Hence the justification status answers the question "can the argument be accepted (`in`), can the argument be rejected (`out`) and is it possible to abstain from having a explicit opinion (`undec`)".

Definition 2. *Let* $AF = (Ar, att)$ *be an argumentation framework and* $A \in Ar$*. The justification status of* A *is the outcome yielded by the function* $\mathcal{JS} : Ar \to 2^{\{\texttt{in},\texttt{out},\texttt{undec}\}}$ *such that* $\mathcal{JS}(A) = \{\mathcal{L}ab(A) \mid \mathcal{L}ab$ *is a complete labelling of* $AF\}$*.*

[1] The full version of this paper is published in the proceedings of NMR2010 [3]

Given the above definition, one would expect there to be eight (2^3) possible justification statuses, one for each subset of $\{\texttt{in}, \texttt{out}, \texttt{undec}\}$. However two of these subsets turn out not to be possible. First of all, it is not possible for a justification status to be $\emptyset$, because there always exists at least one complete labelling (the grounded labelling [1]). Furthermore, it is also impossible for a justification status to be $\{\texttt{in}, \texttt{out}\}$, because when `in` and `out` are both included in the justification status, then `undec` should also be included, as is proved in the full paper [3].

We will refer to the justification status $\{\texttt{in}\}$ as *strong accept*, to $\{\texttt{in}, \texttt{undec}\}$ as *weak accept*, to $\{\texttt{in}, \texttt{out}, \texttt{undec}\}$ as *undetermined borderline*, to $\{\texttt{undec}\}$ as *determined borderline*, to $\{\texttt{out}, \texttt{undec}\}$ as *weak reject* and to $\{\texttt{out}\}$ as *strong reject*. Hence strong accept means that the argument has to be accepted in each reasonable position, weak accept means that the argument can be accepted, does not necessarily have to be accepted but at least cannot be explicitly rejected, etc. An overview of the justification statuses is provided in Figure 1.

As an example of how our notion of justification status can be applied, consider Figure 2. Here, D is the strongest argument (weak accept), C is the weakest argument (weak reject) and A and B are in between (undetermined borderline). Hence, our approach is able to make more fine-grained distinctions than for instance grounded or ideal semantics (which treats A, B, C and D the same), credulous preferred (which treats A, B and D the same) and sceptical preferred semantics (which treats A, B and C the same). Some connections between our approach and other approaches are given by proposition 1 which is shown below.

Membership of an admissible set [2] and membership of the grounded extension, of the argument itself and of its attackers, is sufficient to determine the argument's justification status. The overall procedure of doing so (of which the correctness is provided in the full paper [3]) is shown in Figure 3. Hence, our notion of justification status can be computed using standard algorithms for grounded semantics and admissible semantics.

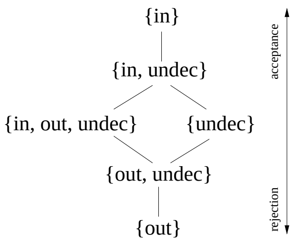

Figure 1: The hierarchy of justification statuses

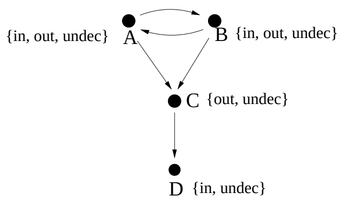

Figure 2: An example

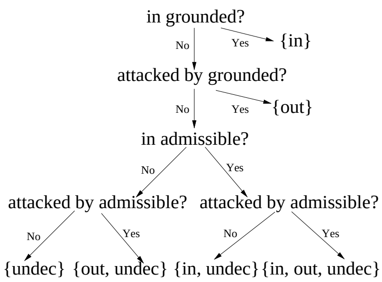

Figure 3: determining the justification status of an argument

We now specify the connection between our notion of justification status and the existing approach of grounded semantics, credulous preferred semantics, sceptical preferred semantics, semi-stable semantics and ideal semantics.

Proposition 1. *Let (Ar, att) be an argumentation framework and $A \in Ar$. It holds that (1) A is in the grounded extension iff it is strongly accepted, (2) A is in at least one preferred extension iff A is strongly accepted, weakly accepted, or undetermined borderline, (3) if A is in every preferred extension then A is strongly or weakly accepted, (4) if A is strongly accepted then A is in every semi-stable extension; if A is weakly accepted then A is in at least one semi-stable extension, and (5) A is in an ideal set iff A is member of an admissible set consisting only of strongly or weakly accepted arguments.*

References

[1] Martin Caminada and Dov Gabbay. A logical account of formal argumentation. *Studia Logica*, pages 347–374, 2009.

[2] P. M. 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.

[3] Yining Wu, Martin Caminada, and Mikolaj Podlaszewski. A labelling based justification status of arguments. In *13th international workshop on Non-Monotonic Reasoning*, 2010.