An Overview of Labelling-Based Justification Status

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Abstract

The current paper provides an overview of the definitions, properties and proof procedures regarding labelling-based justification status. It is argued that labelling-based definitions of justification status provide a more fine-grained account than the traditional extension-based concepts of sceptical and credulous acceptance.

Introduction

In Dung's argumentation theory, the possible existence of multiple extensions can pose a challenge if one is interested primarily in the overall justification status of a particular argument. The traditional approach is to call an argument *sceptically accepted* iff it is in each extension, and *credulously accepted* iff it is in some, but not in each extension. In the current paper, we review a more refined but little known alternative approach to defining the justification status of an argument, one that is based not on extensions but on labellings instead.

Throughout the paper, we assume familiarity with the concepts of an argumentation framework (which we write as (Ar, att)) an argument labelling (which we write as $\mathcal{L}ab : Ar \to \{\texttt{in}, \texttt{out}, \texttt{undec}\}$) and labelling-based semantics. We refer to (Baroni, Caminada, and Giacomin 2011) for details. For now, we briefly recall that a complete labelling is a labelling such that each `in`-labelled argument has all its attackers labelled `out`, each `out`-labelled argument has an attacker that is labelled `in`, and each `undec`-labelled argument has not all its attackers labelled `out` and has no attacker that is labelled `in`.

Justification Status of Arguments

The idea of a labelling-based justification status (Wu and Caminada 2010) is that the justification status of an argument consists of the labels that can be assigned to the argument. Hence the justification status answers the question "is it possible to accept the argument (label it `in`), is it possible to reject the argument (label it `out`) and is it possible to abstain from having an explicit opinion (label it `undec`)?"

Definition 1 ((Wu and Caminada 2010))**.** *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 $AF\}$.*

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 (Baroni, Caminada, and Giacomin 2011)). 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 (Wu and Caminada 2010).

In (Wu and Caminada 2010) the justification status $\{\texttt{in}\}$ is referred to as *strong accept*, $\{\texttt{in}, \texttt{undec}\}$ as *weak accept*, $\{\texttt{in}, \texttt{out}, \texttt{undec}\}$ as *undetermined borderline*, $\{\texttt{undec}\}$ as *determined borderline*, $\{\texttt{out}, \texttt{undec}\}$ as *weak reject* and $\{\texttt{out}\}$ 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.

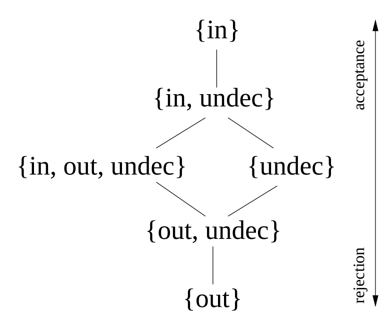

Figure 1: The hierarchy of justification statuses

As an example of how the notion of labelling-based 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, one 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).

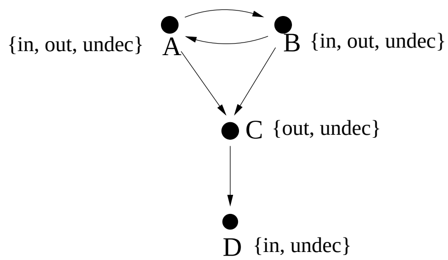

Figure 2: An example of justification statuses

Membership of an admissible set 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 proved in (Wu and Caminada 2010)) is shown in Figure 3. Hence, the notion of labelling-based justification status can be computed using standard algorithms for grounded semantics and admissible sets.

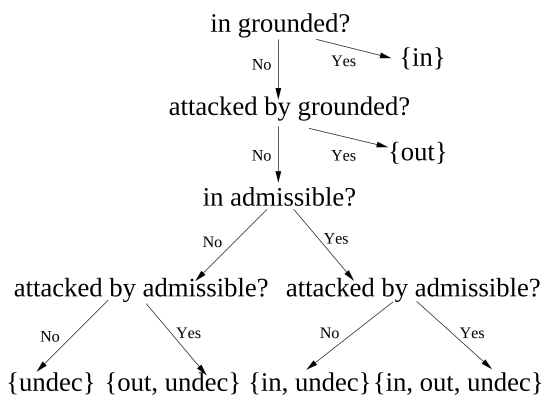

Figure 3: Determining the justification status of an argument

There exists a connection between the notion of labelling-based justification status and the more traditional notions of sceptical and credulous acceptence under various extension-based semantics, as stated in the following proposition.

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.*

So far, we have only examined the concept of labelling-based justification status in the context of complete semantics (following (Wu and Caminada 2010)). However, it is also possible to examine it in the context of other labelling-based semantics, as was subsequently done in (Dvořák 2012). Depending on the semantics, this yields a different set of possible justification statuses. For instance, for grounded and ideal semantics (as well as for any other unique status semantics) the possible justification statuses are $\{\texttt{in}\}$, $\{\texttt{out}\}$ and $\{\texttt{undec}\}$, for stable semantics the possible justification statuses are $\{\texttt{in}\}$, $\{\texttt{out}\}$, $\{\texttt{in}, \texttt{out}\}$ and $\emptyset$, and for preferred and semi-stable semantics the possible justification statuses are $\{\texttt{in}\}$, $\{\texttt{out}\}$, $\{\texttt{undec}\}$, $\{\texttt{in}, \texttt{undec}\}$, $\{\texttt{out}, \texttt{undec}\}$, $\{\texttt{in}, \texttt{out}, \texttt{undec}\}$ and $\{\texttt{in}, \texttt{out}\}$. For details, including an analysis of how the justification status of different semantics is related to each other, and an analysis of computational complexity, we refer to (Dvořák 2012).[1]

Justification Status of Conclusions

If one assumes that each argument A has a conclusion $\texttt{Conc}(A)$, as is the case in several formalisms for instantiated argumentation, it becomes possible to define justification status not just for arguments but also for conclusions. For this, a *conclusion labelling* is defined as a function $\mathcal{C}onc\mathcal{L}ab : \mathcal{L} \rightarrow \{\texttt{in}, \texttt{out}, \texttt{undec}\}$, with $\mathcal{L}$ being the logical language of the instantiated argumentation formalism.

Given a particular argument labelling $\mathcal{A}rg\mathcal{L}ab$ one can then define an associated conclusion labelling $\mathcal{C}onc\mathcal{L}ab$ such that for each $c \in \mathcal{L}$ it holds that $\mathcal{C}onc\mathcal{L}ab(c) = \max(\{\mathcal{A}rg\mathcal{L}ab(A) \mid \texttt{Conc}(A) = c\} \cup \{\texttt{out}\})$.[2] We say that $\mathcal{C}onc\mathcal{L}ab$ is a complete (resp. grounded, preferred or semi-stable) conclusion labelling iff $\mathcal{A}rg\mathcal{L}ab$ is a complete (resp. grounded, preferred or semi-stable) argument labelling. The justification status of conclusion c (witten as $\mathcal{JS}(c)$) is then defined as $\{\mathcal{C}onc\mathcal{L}ab(c) \mid \mathcal{C}onc\mathcal{L}ab$ is a complete conclusion labelling $\}$ (Wu and Caminada 2010).

One particular advantage of conclusion-based justification status is the way it treats floating conclusions, which become *weakly accepted*. It then depends on the particular application whether weak accept passes the treshold to take action. We refer to (Wu and Caminada 2010) for details.

References

Baroni, P.; Caminada, M.; and Giacomin, M. 2011. An introduction to argumentation semantics. *Knowledge Engineering Review* 26(4):365–410.

Dvořák, W. 2012. On the complexity of computing the justification status of an argument. In Modgil, S.; Oren, N.; and Toni, F., eds., *Theory and Applications of Formal Argumentation*, Lecture Notes in Computer Science. Springer. 32–49.

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

[1] As for computational complexity, an interesting observation is that weak acceptance under preferred semantics has a lower complexity than the traditional notion of sceptical preferred.

[2] We assume labels to be ordered s.t. $\texttt{in} > \texttt{undec} > \texttt{out}$.