A Taxonomy for Argumentative Frameworks based on Labelled Deduction

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1. Introduction and motivations

Artificial Intelligence has long dealt with the issue of finding a suitable formalization for reasoning with incomplete and potentially inconsistent information. *Defeasible argumentation* [SL92,CML00,PraVre99] has proven to be a successful approach in many respects, since it naturally resembles many aspects of commonsense reasoning (see [CML00,PraVre99] for details). Besides, recent work [PraVre99,BDKT97] has shown that defeasible argumentation constitutes a confluence point for characterizing many different approaches to non-monotonic reasoning.

Nevertheless, the evolution of different, alternative formalisms for modeling argumentation has resulted in a number of models that share some common features (the notion of argument, attack between arguments, defeat, dialectical analysis, etc.). This constitutes a motivation for the definition of a unified ontology, under which these different features can be analyzed and inter-related. As a by-product from such an ontology, a classification (or taxonomy) of argumentation frameworks in terms of knowledge encoding capabilities, expressive power, etc. would be possible.

In [Che01] a logical framework for defeasible argumentation called SDE_{AR} was developed. The SDE_{AR} framework is based on *labelled deductive systems* [Gab96]. Labelled Deductive Systems offer an attractive approach to formalizing complex logical systems, since they allow to characterize the different components involved by using different sorts of labels. One of the motivations for developing this framework was namely the definition of a single, unified ontology to capture the main issues involved in defeasible argumentation by specifying a suitable underlying logical language and its associated inference rules.

In this presentation we focus on a particular research line which emerged from the above formalization, namely the classification of different defeasible argumentation frameworks based on features that can be 'abstracted away' in the SDE_{AR} framework. The presentation is structured as follows: first, in section 2, we will briefly sketch how the SDE_{AR} framework works. Then, in section 3 we will describe how different argumentation frameworks can be interrelated through SDE_{AR}. Finally, section 4 concludes.

2. The SDE_{AR} framework. Fundamentals

Traditionally, a logical system $(\Gamma, |\sim)$ allows the inference of new wffs from those available in Γ using the rules of inference that characterize the notion of logical consequence $|\sim$. In order to formalize defeasible argumentation within a logical system (which involves the well-known

problems associated with non-monotonic reasoning), we will make use of the LDS methodology [Gab96]. In LDS, the usual notion of formula is replaced by the notion of *labelled formula* expressed as *Label*: α, where *Label* represents a label associated with the wff α. Inference rules that characterize the notion of consequence in an LDS will be augmented in order to include labels.

In our approach, the agent's knowledge base Γ will contain incomplete, potentially inconsistent information. Hence we will provide our intelligent agent with a *defeasible* LDS $(\Gamma,|\sim_{arg})$ which will allow him to arrive to tentative conclusions. Those conclusions will correspond to labelled formulas *label*:wff, where *label* will be associated with the notion of argument (as defined originally in [SL92]). The possibility of building arguments supporting conclusions leads to a comparative, recursive analysis in which a given argument should be compared with all those *counter-arguments* which may defeat it.

To model this process, our approach will consist in extending the consequence relationship $|\sim_{arg}$, in order to obtain a new consequence relationship $|\sim_{tree}$,. Those wffs derivable from Γ via $|\sim_{tree}$ will correspond to *dialectical trees* for a given argument. These new labelled wffs will have the form *dialectical tree: conclusion.* The resulting labelled deductive system $(\Gamma , |\sim_{tree})$ has been called SDE_{AR} . Figure 1 shows the main elements involved in the ontology of the framework.

3. Relating Argumentation Frameworks through SDE_{AR}

Since SDE_{AR} is a logical framework, its knowledge-encoding capabilities are determined by the underlying logical language, whereas the inference power is characterized by its natural deduction rules. Adopting a different KR language or modifying the existing inference rules will lead to different *variants* of SDE_{AR}. Thus, for instance, adopting a full first-order language will lead to a logical system with a behavior similar to the SL framework [SL92]. On the other hand, restricting the KR language to Horn clauses will result in a formulation closer to normal logic programming (NLP). Figure 1 summarizes some of these variants, and shows how they can be related to some existing argumentation frameworks.

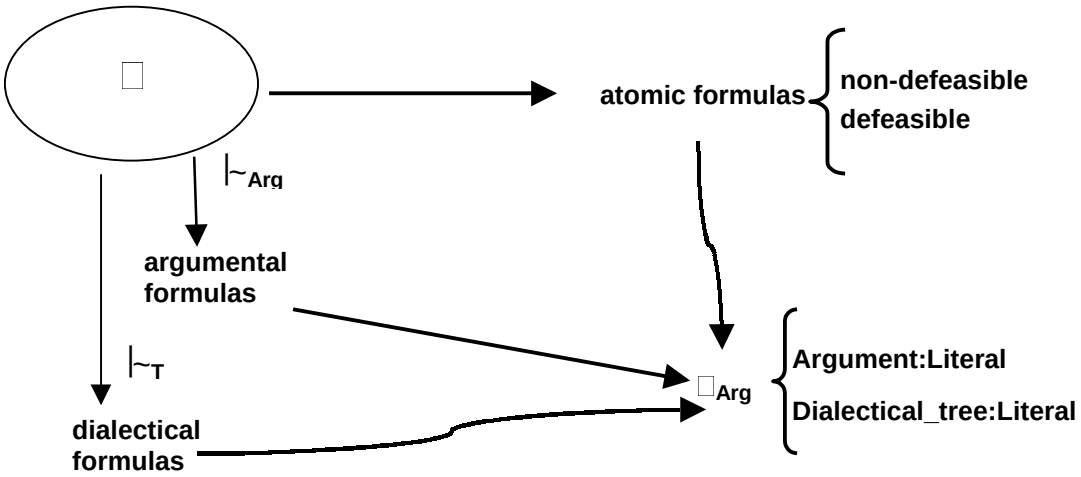

Figure 1: SDE_{AR} : main elements

4. Conclusions

As we have shown in this presentation, Labelled Deductive Systems offer a powerful tool for formalizing different aspects of defeasible argumentation. On the one hand, the notion of label allows

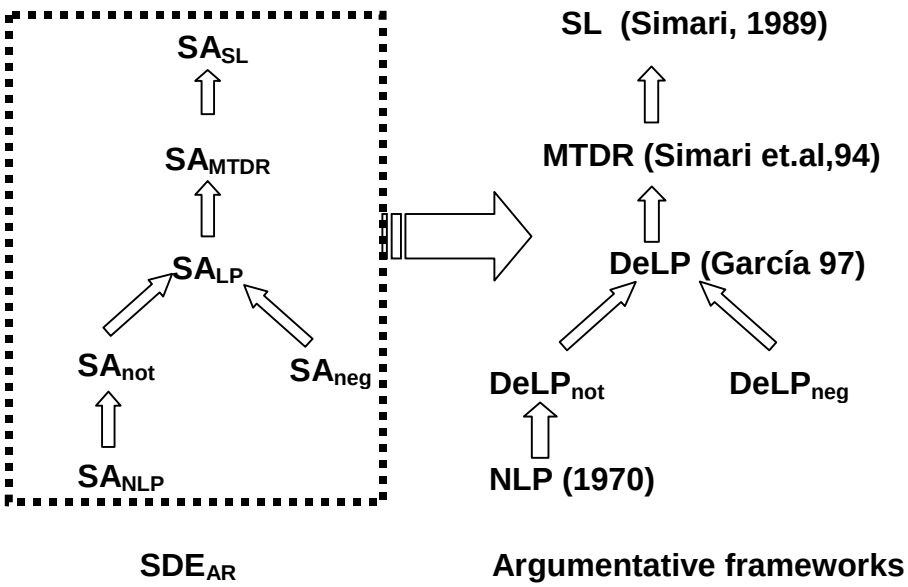

Figure 2: Relating argumentation frameworks through SDE_{AR}

to capture the concept of argument as a set of wffs supporting a given proposition. On the other hand, the concept of dialectical tree can be also captured by a complex label, defined in terms of more simple ones. The SDE_{AR} framework has been defined based upon these notions.

During the last decade, a 'clash of intuitions' has appeared within the argumentation community, where different, alternative approaches have been intended. As we have briefly sketched in this presentation, having a logical system such as SDE_{AR} makes it easier to analyze, compare and relate different features associated with existing argumentative frameworks, providing at the same time a test-bed for studying other related issues (such as argumentation protocols, resource-bounded reasoning, etc.). Research in this direction is currently being pursued.

Bibliography

[BDKT97] BONDARENKO, A.; DUNG, P.; KOWALSKI, R.; TONI, F - *An abstract, argumentation-theoretic approach to default reasoning*. *Artificial Intelligence*, 93(1-2):63-101, 1997.

[Che01] CHESÑEVAR, Carlos - *Formalizing Argumentation Processes as Labelled Deductive Systems* – PhD Thesis (in Spanish). Universidad Nacional del Sur, March 2001.

[CML00] CHESÑEVAR, Carlos, MAGUITMAN, Ana and LOUI, Ronald - *Logical Models of Argument* - ACM Computing Surveys, Vol. 2, Number 2, Dec. 2000.

[Gab96] GABBAY, Dov - *Labelling Deductive Systems* (vol.1) Clarendon Press, Oxford, 1996.

[Gar00] GARCIA, Alejandro - *Programación en Lógica Rebatible: Lenguaje, Semántica Operacional y Paralelismo.* PhD Thesis, Dep. de Cs. de la Computación, Universidad Nacional del Sur, Dec. 2000.

[PraVre99] PRAKKEN, Henry and VREESWIJK, Gerhard – *Logics for Defeasible Argumentation*. In *Handbook of Philosophical Logic*, Editor D.Gabbay, Ed. Kluwer Academic Publisher, 1999.

[SL92] SIMARI, Guillermo and LOUI, Ronald - *A Mathematical Treatment of Defeasible Reasoning and its Implementation*. Artificial Intelligence 53 (1992), 125-157.

[Vre93] VREESWIJK, Gerhard – *Studies on Defeasible Argumentation* – PhD Thesis – Vrije University, Holland, 1993.