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A labeled argumentation framework

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ABSTRACT

To increase the expressivity of an argumentation formalism, we propose adding meta-level information to the arguments in the form of labels representing quantifiable data such as reliability degree, strength measure, skill, time availability, or any other feature about arguments. The extra information attached to an argument is then used in the acceptability determination process.
We present a *Labeled Argumentation Framework* (LAF), combining the knowledge representation capabilities provided by the *Argument Interchange Format* (AIF) with an *Algebra of Argumentation Labels*, enabling us to handle the labels associated with the arguments. These labels are propagated through an argumentative graph according to the relations of support, conflict, and aggregation between arguments. Through this process we obtain final labels attached to the arguments that are useful to determine their acceptability.

1. Introduction

The study and implementation of systems that exhibit autonomous intelligence guiding their behavior has been a long term concern of Artificial Intelligence researchers. Argumentation, as an area of Knowledge Representation and Reasoning, specializes in modeling the process of human reasoning to determine which conclusions are acceptable in a context of disagreement. Broadly speaking, argumentation theories deal with the interactions between arguments that are in favor of or against a specific conclusion, such as support or attack, with the final goal of determining when a conclusion is acceptable (see [4,29] for a general account); these theories are extensively used in diverse domains such as legal reasoning, dialogue

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and persuasion, recommender systems, intelligent web search, autonomous agents and multi-agent systems, and many others [27,24,9,29,21].

In certain applications of argumentation, it is necessary to provide further details of the arguments that represent real-world features aiming to obtain more refined results. Moreover, the properties related to the intrinsic logical soundness of an argument are not always the only ones that matter in determining its acceptability; other qualities can be weighted in the decision process of acceptability. For instance, each argument may have associated different characteristics such as its strength [3,7], weight [13], or reliability varying on time [6]. In the domain of agents and multi-agent systems, it is important to associate each argument with the reliability degree of their source and an accuracy measurement associated with the information on which the arguments are based, increasing the information that is used to determine their acceptability.

Based on this intuition, the argumentation process is defined in two steps: the determination of the argument valuations, and the selection of the set of most acceptable arguments. The former can be obtained independently of the interactions with other arguments as [3,14], or those that are dependent on the relations (support and attack) that the argument has with other arguments [17,7]. For the latter, it is possible to analyze this in two ways: the individual acceptability, where the acceptability of an argument depends on its attributes [3,22], and the collective acceptability, where a set of arguments satisfies certain properties [12,8]. Recently, a combination of both points of view was considered, increasing the capability of representing real world applications, and providing more information about argument acceptability [7,13].

We will address here a combination of these proposals, generalizing them and providing a flexible structure which allows different instantiations of its elements to create models tailored for particular goals. Our formalization, called *Labeled Argumentation Framework* (LAF), combines the capabilities of knowledge modeling of the *Argument Interchange Format* (AIF) [10] with an *Algebra of Argumentation Labels* which allows to manipulate and propagate labels through a series of operations defined for that purpose. These labels will be combined and propagated through an argumentation graph according to the manner in which the interactions between arguments are defined: support, conflict, and aggregation. Each one of these has received extensive attention, in particular, aggregation has been studied in the form of argument accrual [28,33,25]; for each of these interactions, an associated operation in the algebra is introduced. Once completed the propagation process which produces the *definitive* argumentation labels associated with the arguments, we continue to establish the arguments' acceptability using the information on the labels to offer, for example, the reliability degree of an acceptability status or an explanation. In addition, using the information provided by the labels we will define an *acceptability threshold* to determine whether an argument satisfies certain conditions to be accepted in a particular query and also to specify when an argument is better to another.

This paper is structured as follows: in Section 2, we introduce a particular abstract algebra for handling the labels associated with the arguments that we call *Algebra of Argumentation Labels*; the core contribution of the paper is presented in Section 3 as the formalism characterizing *Labeled Argumentation Frameworks* (LAF) together with an example of application in the domain of agents and multi-agents systems; finally, in Section 4 we discuss related work, and in Section 5 we conclude and propose future work.

2. An initial example

The aim of our work is to increase the representation capability of argumentation systems through the use of labels that represent real world features of the arguments, bringing the possibility of operating over these labels to compute the corresponding labels of derived arguments. This information will be used to refine the assessment process providing additional details attached to the conclusions offered by the system. Additionally, we will show how our formalism is suitable to be used in different artificial intelligence