Dynamic Argumentation in Abstract Dialogue Frameworks*

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Abstract. In this work we present a formal model for collaborative argumentation based dialogues by combining an abstract dialogue framework with a formalism for dynamic argumentation. The proposed model allows any number of agents to interchange and jointly build arguments in order to decide the justification status of a given claim. The model is customizable in several aspects: the argument attack relation and acceptability semantics, the notion of relevance of contributions, and also the degree of collaboration are selectable. Important properties are ensured such as dialogue progress step by step, completeness of the sequence of steps, and termination. Under the higher degree of collaboration, the dialogue constitutes a sound and complete distributed argumentation process.

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1 Introduction and Motivation

Multi-agent systems (MAS) provide solutions to problems in terms of autonomous interactive components (agents). A *dialogue* is a kind of interaction in which a sequence of messages, over the same topic, is exchanged among a group of agents, with the purpose of jointly drawing some sort of conclusion. There is a subset of dialogues, which we call *collaborative*, in which the agents are willing to share any relevant knowledge to the topic at issue, having no other ambition than achieving the right conclusion on the basis of all the information they have.

Argumentation-based dialogues usually consist of interchanging arguments for and against certain claim. Mostly in the literature, these dialogues are held between two agents, one of them putting the arguments 'for' and the other putting the arguments

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'against'. In order to achieve collaborative (in the sense described above) behavior, all the participants should contribute with both kinds of arguments, and also they should be able to jointly build new arguments. Even as part of non-collaborative dialogues (*e.g.* persuasion) it may be useful to build arguments in conjunction.

Classical *abstract argumentation* [3] assumes a static set of already built arguments, resulting insufficient for modeling collaborative dialogues. The set of arguments involved in a dialogue is, in contrast, dynamic: new arguments jointly constructed by the agents may arise, and also arguments may be invalidated (note this is not the same as defeated) at the light of new information. The argument construction step cannot be performed separately from the dialogue.

Recently, a *dynamic abstract argumentation framework (DAF)* has been proposed by Rotstein *et al.* [13], which extends the work done on acceptability of arguments, by taking into consideration their construction and their validity with respect to a varying set of evidence. This approach results, hence, very suitable for the modeling of collaborative dialogues. The main elements of the DAF are summarized in Sect. 2.

In [6] we have defined an *abstract dialogue framework ($\mathfrak{DF}$)* together with a set of *collaborative semantics* which characterize different levels of collaboration in dialogues, in terms of a given reasoning model and a given notion for the relevance of contributions. Under certain natural conditions, the proposed semantics ensure important properties of collaborative dialogues, such as termination and outcome-determinism.

The aim of this work is to show how the abstract dialogue framework and semantics [6] can be applied to dynamic argumentation [13]. As will be seen, the agents will interchange both arguments (in Rotstein's sense) and evidence, achieving the joint construction of arguments in the usual sense. A particular framework for argumentation-based dialogues will be obtained, which inherits the semantics and properties defined for the abstract framework. In sections 4 through 6, we will reintroduce the abstract concepts that constitute the $\mathfrak{DF}$ showing how they can be instantiated in terms of the DAF.

2 Background

Next we summarize an abstract argumentation framework capable of dealing with dynamics through the consideration of a varying set of evidence [13]. Depending on a particular situation (given by the content of the set of evidence), an instance of the framework will be determined, in which some arguments hold and others do not.

The formalization is coherent with classical abstractions [3], however arguments play a smaller role: they are aggregated in structures. These argumental structures can be thought as if they were arguments (in the usual sense), but they will not always guarantee their actual achievement of the claim.

A language $\mathbf{L}$ will be assumed for the representation of evidence, premisses, and claims. An *argument* $\mathcal{A}$ is a pair $\langle \{s_1 \dots s_n\}, \delta \rangle$ consisting of a consistent set of *premisses*, noted $\mathtt{supp}(\mathcal{A})$, and a *claim*, noted $\mathtt{cl}(\mathcal{A})$. These basic premisses are considered the argument *support*. A *supporting argument* is one that claims for the premise of another argument. The language of all the possible arguments built from $\mathbf{L}$ will be noted $\mathbf{L}_{\mathrm{A}}$. Consider for instance the argument $\mathcal{A}_1 = \langle \{th, ps\}, dr \rangle$ which assumes a route to be dangerous because there are known thieves in that area and the security there is poor.