

On Enforcing a Constraint in Argumentation

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Abstract. This paper addresses the issue of enforcing a constraint in an argumentation system. The system consists in (1) an argumentation framework, the structure of which is made up of a set of arguments and of an attack relationship, (2) an acceptability semantics, and (3) acceptable sets of arguments, computed from (1) and (2). An agent may want another agent to consider a new attack, or to have a given argument in at least one extension, or even to relax the definition of the semantics. A constraint on any of the three components is thus defined, and it has to be enforced in the system. The enforcement may result in changes on components of the system. The paper surveys existing approaches for the dynamic enforcement of a constraint and its consequences, in the light of the three components, and reveals enforcement cases that remain to be investigated.

1 Constraints and changes

Argumentation is an active research topic, that finds natural applications in the context of multi-agent systems [13]. This paper addresses the issue of enforcing a constraint in an argumentation system. An argumentation system is defined here as a set of three components: (1) an *argumentation framework* AF , the structure of which, according to Dung [10], consists in a set of abstract *arguments* A and in an *attack* relationship among them $R \subseteq A \times A$; (2) a *semantics* that gives a definition of collectively acceptable sets of arguments; (3) a set of *extensions*, which are the acceptable sets of arguments of the argumentation framework (1) under the given semantics (2). Many semantics have been defined; evaluation principles that underlie most of them have been identified [1].

Quite recently, the community has started to study the question of the dynamics of the structure of an argumentation framework in an argumentation system: the addition and the removal of arguments, of attacks, and their impact on the acceptable sets of arguments ([7] notably). Such work directly applies to argumentation in a multi-agent setting, where, for instance, agents dialogue and add arguments and attacks to a debate, or possibly withdraw arguments or attacks, the acceptable sets of arguments evolving as the debate proceeds.

The dynamics in such approaches originates in a change in the structure of the argumentation framework that has to be taken into account (which we call a *structural constraint*); the enforcement of this constraint indeed results in a change of the structure of the argumentation framework (a *structural change*),

and it may imply changes on the acceptable sets of arguments under the given semantics (an *acceptability change*).

The dynamics in the system may also originate in a need for a change of the acceptable sets of arguments. For instance, it may be the case that an agent may want another agent to have in at least one extension (or in all the extensions) some arguments that are currently in none (or not in all), possibly under some conditions. It is, what we call, an *acceptability constraint* that has to be taken into account by the agent. The enforcement of such a constraint changes the acceptable sets of arguments (acceptability change) and it may be done by modifying:

- the structure of the argumentation framework (structural change): arguments, attacks, may be added or removed so that the extensions of the new argumentation framework satisfy the acceptability constraint [2,9,12];
- the definition of the semantics (*semantic change*): the semantics may be modified so that the extensions of the argumentation framework under the new semantics satisfy the constraint.

The *quality* of the changes may be assessed, for example in terms of minimality. [2,12] study the minimal number of structural modifications needed to enforce an acceptability constraint (in [12], the changes are restricted to the addition/removal of arguments). [9] focuses on a minimal acceptability change (the new extensions have to be as close as possible of the original ones, closeness being defined by notions of distances).

The enforcement of an acceptability constraint by a semantic change has not been addressed very often. Up to our knowledge, only [3] addresses this issue (they name it liberal enforcement), and not on its own, but in combination with a structural change. The constraint consists in a set of arguments that has to become an extension and the only allowed structural changes are the addition of attacks and arguments. Depending on principles that the original semantics and the new semantics satisfy, the results highlight cases where the enforcement is not possible.

The enforcement of an acceptability constraint by a semantic change deserves to be studied on its own. In fact, changing the structure of the argumentation framework may turn out to be not possible. For example, two agents engaged in a dialogue may have jointly built an argumentation framework, which is such that a given argument a does not belong to any extension under the considered semantics. If one agent wants a to belong to at least one extension, if she cannot find any new argument nor any new attack, and if removing an argument or an attack from the argumentation framework would not be relevant neither to her nor to the other agent, the only remaining possibility she has to enforce the constraint is to try to change the way extensions are defined.

In order to do so, an option is to identify the reasons why the constraint cannot be enforced, that is, to look at the rationales underlying the impossibility; more precisely, what are the principles the original semantics satisfies that make the constraint impossible to enforce. Another option is to look at the principles

the semantics should satisfy for the constraint to be enforced. Neither option may be an easy task. However, it may lead to interesting results; the set of principles needed to enforce the constraint may lead for example to original semantics that have not yet been studied.

Whereas a semantic change is a mean to enforce an acceptability constraint, it may be the case that an agent wants a semantics to change, wholly, or on some of its principles, for instance because it relies upon some maximality principle that cannot be taken into account any longer because too costly to compute. The dynamics hence comes from a *semantic constraint* that needs to be enforced. This enforcement results in a semantic change, and it may imply an acceptability change (the extensions may be different under the new semantics).

A first approach to the enforcement of a semantic constraint, in combination to other constraints, appears in [11]. Given an argumentation framework, an original semantics and a new semantics (the semantic constraint), [11] studies the structural changes needed for the extensions of the changed argumentation framework under the new semantics to be in certain correspondence (the same or close) to the ones of the original framework under the original semantics.

More generally, the three kinds of constraints (structural, semantic, acceptability) may be combined. For example, an agent may want another agent to take into account a new argument a along with some attacks to a or from a (structural constraint), and she may want at the same time that a be in at least one extension under the semantics (acceptability constraint). The frameworks of [4,5], among others, allows enforcing structural and acceptability constraints. [11] may be seen as the enforcement of a semantic constraint, along with an acceptability constraint: the extensions under the new semantics should be in correspondence with the ones under the original one. Other combinations of constraints, in particular, ones that involve semantic constraints, remain to be studied.

Beside the enforcement of a constraint done dynamically, with changes, it is worth noticing that variants of Dung's argumentation framework allow constraints to be expressed directly in the framework. For example, [6] expresses acceptability constraints at the level of the arguments, and [8] considers a global acceptability constraint along with Dung's argumentation framework.

2 Conclusion

This paper takes a global view on the dynamic enforcement of a constraint in an argumentation system.

Given that an argumentation system is composed of (1) an argumentation framework, (2) a semantics and (3) extensions, three kinds of constraints (resp. changes), one on each component, may need to be enforced (resp. applied): structural constraints (resp. changes) on (1), semantic constraints (resp. changes) on (2), and acceptability constraints (resp. changes) on (3).

The following table summarizes the changes involved in enforcements:

		<i>Change</i>		
		structural	semantic	acceptability
<i>Constraint</i>	structural	needed	–	implied
	semantic	–	needed	implied
	acceptability	implied	–	needed
		–	implied	needed
		implied	implied	needed

Whereas the enforcement of structural constraints and acceptability constraints have already been studied, the enforcement of semantic constraints on their own has not yet been addressed. The enforcement of an acceptability constraint only by a semantic change has not yet been studied either.

A combination of different kinds of constraints may have to be enforced. Whereas some combinations may be captured by recent frameworks, others remain to be studied, in particular those that would involve semantic changes.

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