Conflicts in Abstract Argumentation*

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Abstract

In abstract argumentation traditionally directed attacks might also be called conflicts if the direction of the attack is not of importance. Recent publications emphasize that argumentation graphs when combined with some semantics feature semantic conflicts that might not coincide with syntactic conflicts defined by attacks. We elaborate on characteristics of various semantics and investigate properties of syntactic and semantic conflicts.

Syntax, Semantics and Conflicts

Formally there is a very clear line to distinguish syntax and semantics. Yet when discussing examples confusion on this difference might occur. With that in mind we first introduce basic concepts, then discuss one particular possibly confusing aspect (i.e. conflicts), and then elaborate on features of this aspect that deem us interesting.

Syntax (for Dung-style argumentation (Dung 1995)) is the underlying structure of arguments and attacks, which might be called *argumentation framework* (AF) or *argumentation graph* (due to its syntactic similarity with graph theory) and is henceforth defined as some pair $F = (A, R)$ where A is a set of *arguments* and $R \subseteq A \times A$ is called the *attack relation*. The importance of this syntactic notion lies in the precondition that all arguments be treated equally.

Semantics (we follow the extension-based approach suggested in (Dung 1995), also see (Baroni, Caminada, and Giacomin 2011)) on the other hand define a notion of *acceptance*. A semantics σ formally is defined as a mapping, such that for each AF $F = (A, R)$ we have $\sigma(F) \subseteq \wp(A)$, i.e. σ tells us for any given AF which sets of arguments are acceptable. A set $S \in \sigma(F)$ is also called an *extension* and accordingly $\mathbb{S} = \sigma(F)$ (or any set of sets of arguments $\mathbb{S}$) is called an *extension set*.

Conflicts are the slightly controversial subject we will be discussing in the remainder of this abstract. Formally for any given AF $F = (A, R)$ a set of arguments $S \subseteq A$ is called *conflict-free* if it does not contain any attack, i.e. there is no $a, b \in S$ such that $(a, b) \in R$. Informally, especially when the direction of an attack does not matter, it is common to refer to an attack (a, b) as a conflict, i.e. a and b are in conflict.

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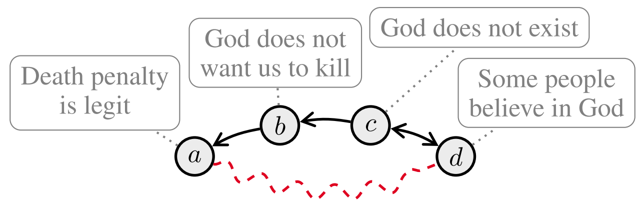

Figure 1: Natural Language Example, Is Death Penalty Legit?

However, as it turns out, all investigated reasonable semantics (i.e. anything but naive semantics) provide another sort of conflict. Formally we will use the following.

Definition 1. Given some AF F an attack is also called a *syntactic conflict*. Given some extension set $\mathbb{S}$ some arguments $a, b \in \bigcup \mathbb{S}$ are in *semantic conflict* if there is no $S \in \mathbb{S}$ such that $a, b \in S$. Naturally given some AF F and some semantics σ arguments a, b are semantically in conflict if they are in semantic conflict in $\sigma(F)$.

Example 1. Consider a dialogue between two people as syntactically depicted in Figure 1. We assume the arguments a, b, c and d to be stated in this very chronological order.

Given that for a debate between people we normally assume the statements declared by a single person to be consistent among themselves in this case we might consider the sets $\{a, c\}$ and $\{b, d\}$ (and only those sets) as acceptable collections of arguments. It even appears that both sets have attacks to each of the arguments from the other set and that there are no attacks between arguments from the same set.[1]

Now observe that a and d do not occur together in any of these two extensions, despites none of them attacking the other. Hence a and d are in semantic but not in syntactic conflict. In this case on the abstract argumentation semantics level we are able to resolve this conflict by explicitly adding an attack (d, a), which does not alter the stable extensions. However, observe that the legal status of death penalty surely should not depend on some random people's belief. Some gods might even support death penalty.

[1] In this abstract we mainly discuss *stable* semantics, where a set S is called a stable extension ($S \in stb(F)$) if it is conflict-free and attacks all other arguments, i.e. its range is total $S^* = S \cup \{a \mid \exists s \in S : (s, a) \in R\} = A$.

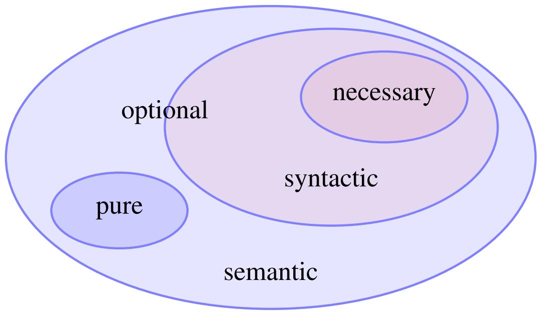

Figure 2: Different levels of conflict in a Venn-diagram.

The given linguistic objection aside, on a purely abstract level, however, the question occurs whether semantic conflicts can always be expressed as attacks through modification of the attack relation without altering the given extension sets. Another question that pops up is whether some semantic conflicts actually are necessary syntactic as well.

In the following we will make use of realizability. Given semantics σ an extension set $\mathbb{S}$ is called σ-realizable if there is some AF F with $\sigma(F) = \mathbb{S}$.

Definition 2. Given some semantics σ, some σ-realizable extension set $\mathbb{S}$ and some semantic conflict $\{a, b\}$ of $\mathbb{S}$. The conflict $\{a, b\}$ is called

- *pure semantic* if there is no realizing AF F such that $\{a, b\}$ is a syntactic conflict of F;
- *necessary syntactic* if for all realizing AFs F we have that $\{a, b\}$ is a syntactic conflict of F;
- *optional* otherwise.

Now observe that as far as conflicts are concerned we have presented notions of different level. Semantic conflicts are defined for extension sets, and thus also for AFs when bundled with some semantics. Syntactic conflicts are defined for AFs, namely on a syntax level. Pure and necessary conflicts are defined only for extension sets in combination with some semantics. To ease some confusion regarding this definitions we refer to Figure 2 as a Venn-Diagram for the relation of possible membership of conflicts.

We first give an insight (which is non-trivial) on the justification of above conflict definitions. Observe that to this end we make use of a weaker form of purity, A-purity. Given extension set $\mathbb{S}$ and argument set $A \supseteq \bigcup \mathbb{S}$ a conflict $\{a, b\}$ of $\mathbb{S}$ is called *A-pure semantic* if there is no realizing AF $F = (A, R)$ with syntactic conflict $\{a, b\}$. Specifically for $A = \bigcup \mathbb{S}$ we refer to (Dunne et al. 2015) for a conjecture and (Linsbichler, Spanring, and Woltran 2015) for a matching counter example.

Theorem 1. *Necessary syntactic, optional and A-pure semantic conflicts may occur for arbitrary AFs.*

Figure 3 presents an example where most semantics show an A-pure semantic conflict. The basic idea is that the syntactic conflict $\{x_2, y_2\}$ transfers to the semantic conflict $\{a_0, b_0\}$. However the directionalities of attacks between arguments a_i and b_j are necessary and hence for instance a_0 may not defend a_1 against b_0. One aim of this line of research is to elaborate on how these pure conflicts can happen.

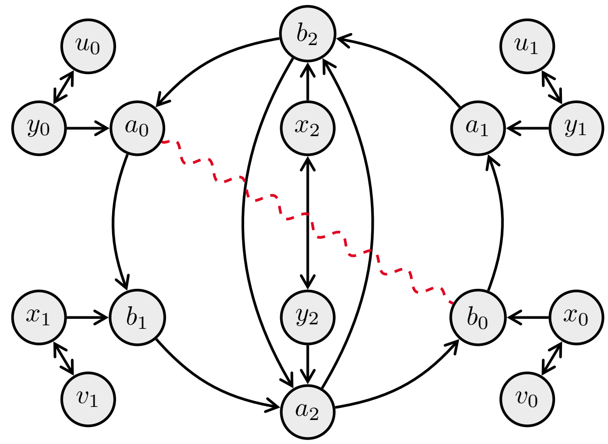

Figure 3: Bipartite planar AF with A-pure semantic conflict $\{a_0, b_0\}$.

Another aim, and indeed necessary work for showing the former, is under what circumstances conflicts (or attacks) are necessary syntactic.

We now present a result on necessity of syntactic conflicts. Here we make use of *compatibility* of arguments x, y where given extension set $\mathbb{S}$ there is $T \in \mathbb{S}$ with $\{x, y\} \subseteq T$.

Theorem 2. *Given some stable-realizable extension set $\mathbb{S}$, semantic conflicts of the kind $\{a, b\}$, such that there is $S \in \mathbb{S}$ with $a \in S$ and each $c \in S$ with $c \neq a$ is compatible to b, are necessary syntactic. All other conflicts are optional.*

There is a fair amount of examples featuring A-pure conflicts, facilitating various properties of various semantics (preferred, semi-stable, stable, stage, cf2 and derivations). For simplicity these examples feature a high density of necessary attacks. However, let it be noted that for the given definition of necessary attacks these could be replaced by optional conflicts. Characterizations of necessary attacks for other semantics than stable are possible, but more sophisticated. The main open questions now are whether A-pure (or A-necessary) conflicts allow for a nice characterization as well, and whether syntactic analysis of AFs allows conclusions on the nature of involved attacks/conflicts.

References

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