Extension Enforcement in Abstract Argumentation as an Optimization Problem

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Plan

Abstract Argumentation [Dung 1995]

- An abstract argumentation framework is a pair $\langle \mathcal{A}, \mathcal{R} \rangle$ with $\mathcal{R} \subseteq \mathcal{A} \times \mathcal{A}$:

- An extension is a set of arguments that can be accepted together
  - Different semantics to define the extensions: complete, stable, preferred, grounded, etc.

Extension Enforcement [Baumann and Brewka 2010]

- Given an AF $F = \langle A, R \rangle$, a semantics σ and a set of arguments $E \subseteq A$, is it possible to modifiy F into F' such that E is (included in) a σ-extension of F'?

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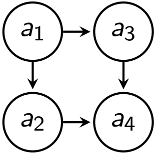
Different Enforcement Methods [Baumann and Brewka 2010]

- normal enforcement: new arguments can attack (and be attacked by) the former ones, but no change of the former attacks
- weak enforcement: normal + new arguments are weak (they cannot attack the former ones)
- strong enforcement: normal + new arguments are strong (they cannot be attacked by the former ones)

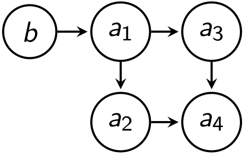
- strict enforcement: if E is expected to be exactly an extension
- non-strict enforcement: if E is expected to be included in an extension

Example of Strong Enforcement

$F_1 =$



$F_2 =$



- $Ext_{st}(F_1) = \{\{a_1, a_4\}\}$

- Enforcement of $E = \{a_2, a_3\}$
- $Ext_{st}(F_2) = \{\{b, a_2, a_3\}\}$

Failure of Normal/Strong/Weak Enforcement

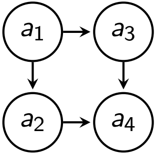
- It is already known that enforcement may be impossible [Baumann and Brewka 2010]
- Some new results about failure of strict enforcement:
  - strict enforcement is impossible wrt the stable semantics,
  - several cases of impossibility with complete and grounded semantics

Argument-fixed Enforcement

- New kind of dynamic scenario: when no new arguments can be added, the only solution is to change the attacks between the existing arguments
- Overcomes the failure of enforcement: this argument-fixed enforcement approach always succeeds to perform strict enforcement

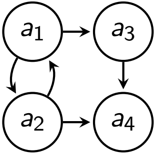
Example of Argument-fixed Enforcement

$F_1 =$



- $Ext_{st}(F_1) = \{\{a_1, a_4\}\}$

$F_3 =$



- Enforcement of $E = \{a_2, a_3\}$
- $Ext_{st}(F_3) = \{\{a_1, a_4\}, \{a_2, a_3\}\}$

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Encoding AFs: Example of Stable Semantics

Based on [Besnard and Doutre 2004]: each model of

$$\bigwedge_{a_i \in A} [a_i \Leftrightarrow (\bigwedge_{(a_j, a_i) \in R} \neg a_j)]$$

is a stable extension of $F = \langle A, R \rangle$. Generalization of the encoding:

- $\forall a_i, a_j \in A$, att_{a_i, a_j} means that a_i attacks a_j

$$\Phi_{st} = \bigwedge_{a_i \in A} [a_i \Leftrightarrow (\bigwedge_{a_j \in A} (att_{a_j, a_i} \Rightarrow \neg a_j))]$$

This new encoding allows to link the attack relation with the statuses of arguments.

Encoding Argument-fixed Enforcement

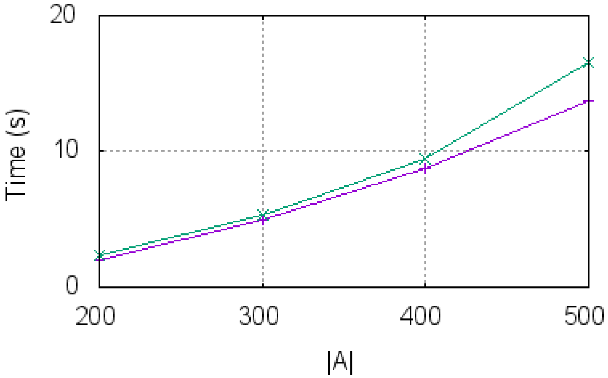
Given $E = \{a_1, \ldots, a_n\}$,

- $\Phi_{st} \wedge \bigwedge_{a_i \in E} a_i$ + SAT solver: enforcement of E
- $\Phi_{st} \wedge \bigwedge_{a_i \in E} a_i$ + optimization software: enforcement of E with minimal change of the attack relation

- Similar encodings are defined for the other enforcement operators and their strict counterpart

Experimental Results
Claim: The Approach Scales Up Well

- Average time depending on *n* for strict argument-fixed (+-curve) and strong enforcement (×-curve)



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Summary of this Work

- Definition of new enforcement approach which tackles new dynamics scenario and overcomes the failure of existing approaches
- Encoding of enforcement as satisfaction and optimization problems (stable and complete semantics)
- Implementation of minimal change enforcement through CPlex optimization software: the methods scales up well on random AFs

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Future Work

- Encoding of other semantics
- Incorporation of integrity constraints in the enforcement process
- Minimal change of arguments statuses

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Thank you for your attention!
I am waiting for you in front of my poster for more details!

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