Semantic Change and Extension Enforcement in Abstract Argumentation

Sylvie Doutre[1] Jean-Guy Mailly[2]

1: IRIT – doutre@irit.fr
2: LIPADE – jean-guy.mailly@parisdescartes.fr

11th International Conference on Scalable Uncertainty Management (SUM'17)
Granada, Spain, October 4-6, 2017

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Plan

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Plan

Dung's Framework [Dung 1995]

- **AF** are digraphs $F = (A, R)$, with A the arguments and $R \subseteq A \times A$ the attacks
- **Extension-based semantics** : determining sets of jointly acceptable arguments

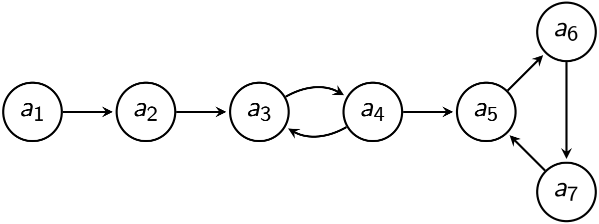
Dung's Framework [Dung 1995]

- **AF** are digraphs $F = (A, R)$, with A the arguments and $R \subseteq A \times A$ the attacks
- **Extension-based semantics** : determining sets of jointly acceptable arguments

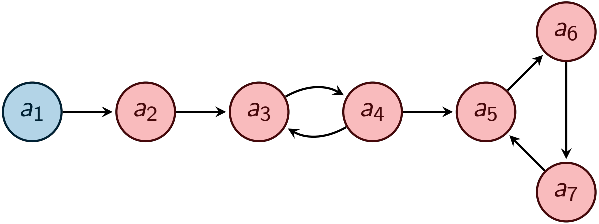
Many semantics. A set $E \subseteq A$ is

- **cf** w.r.t. F if $\nexists a_i, a_j \in S$ s.t. $(a_i, a_j) \in R$;
- **ad** w.r.t. F if S is cf and S defends each $a_i \in S$;
- **na** w.r.t. F if S is a maximal cf set (w.r.t. $\subseteq$) ;
- **co** w.r.t. F if S is ad and S contains all the arguments that it defends ;
- **pr** w.r.t. F if S is a maximal co extension (w.r.t. $\subseteq$) ;
- **st** w.r.t. F if S is cf and $S_R^+ = A$;
- **gr** w.r.t. F if S is a minimal co extension (w.r.t. $\subseteq$) ;

Example

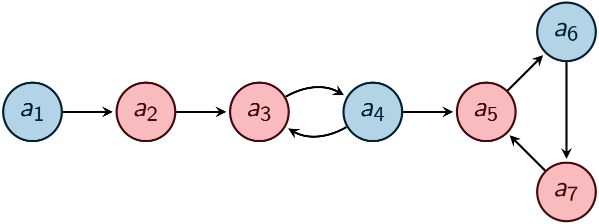


Example



$Ext_{gr}(F) = \{\{a_1\}\}$

Example

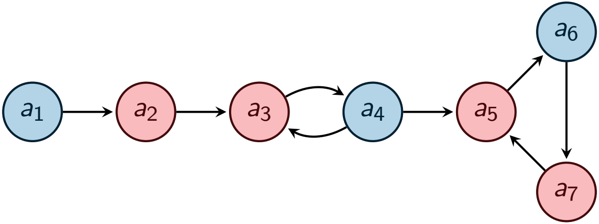


$$Ext_{st}(F) = \{\{a_1, a_4, a_6\}\}$$

LIPADE
Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

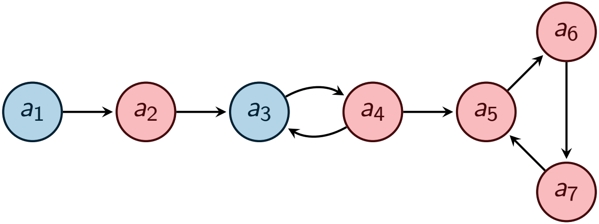
Example



$$Ext_{pr}(F) = \{\{a_1, a_4, a_6\}, \{a_1, a_3\}\}$$

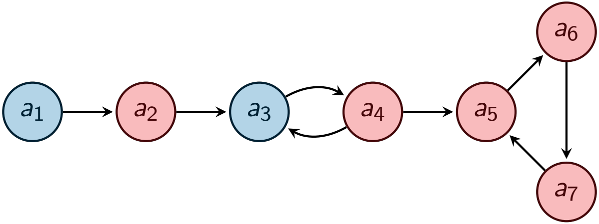
Laboratoire d'Informatique PAris DEscartes

Example



$$Ext_{pr}(F) = \{\{a_1, a_4, a_6\}, \{a_1, a_3\}\}$$

Example



$Ext_{co}(F) = \{\{a_1, a_4, a_6\}, \{a_1, a_3\}, \{a_1\}\}$

Distance between Semantics [Doutre and Mailly 2016]

$Inc(\Sigma)$ with $\Sigma = \{cf, ad, na, st, pr, co, gr\}$.

$$\begin{array}{ccccccc} pr & \longrightarrow & co & \longrightarrow & ad & \longrightarrow & cf \\ \uparrow & & \uparrow & & & & \uparrow \\ st & & gr & & & & na \end{array}$$

Σ-Inclusion Difference Measure

$\delta_{Inc,\Sigma}(\sigma_i, \sigma_j)$ is the length of the **shortest non-oriented path** between σ_i and σ_j in $Inc(\Sigma)$

- e.g. $\delta_{Inc,\Sigma}(st, ad) = 3$, $\delta_{Inc,\Sigma}(pr, gr) = 2$, and $\delta_{Inc,\Sigma}(co, pr) = 1$

Extension Enforcement [Baumann and Brewka 2010]

Strict (resp. Non-Strinct) Enforcement

$$\left.\begin{array}{c} F = \langle A, R \rangle \\ E \subseteq A \end{array}\right\} \implies F' = \langle A', R' \rangle$$

such that E is an extension (resp. included in an extension) of F'

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Expansions of AFs [Baumann and Brewka 2010]

Given $F = \langle A, R \rangle, F' = \langle A', R' \rangle$,

- F' is a **normal expansion** of F iff $A \subset A'$ and $R' \cap (A \times A) = R$
- F' is a **weak expansion** of F iff F' is a normal expansion of F s.t. $\forall (a_i, a_j) \in R' \backslash R,\ a_j \notin A$
- F' is a **strong expansion** of F iff F' is a normal expansion of F s.t. $\forall (a_i, a_j) \in R' \backslash R,\ a_i \in A' \backslash A$

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Enforcement Based on Expansions [Baumann and Brewka 2010]

Strict (resp. Non-Strinct) Normal (resp. Weak, Strong) Enforcement

$$\left.\begin{array}{c} F = \langle A, R\rangle \\ E \subseteq A \end{array}\right\} \implies F' = \langle A', R'\rangle$$

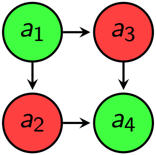
such that E is an extension (resp. included in an extension) of F' and F' is a normal (resp. weak, strong) expansion of F

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

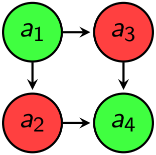
Example of Strong Enforcement

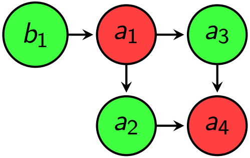
- Using $\sigma = st$, how to enforce $E = \{a_2, a_3\}$ in F ?



Example of Strong Enforcement

- Using $\sigma = st$, how to enforce $E = \{a_2, a_3\}$ in F?





Laboratoire d'Informatique PAris DEscartes

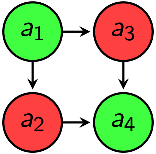
UNIVERSITÉ PARIS DESCARTES

Argument-Fixed and General Enforcement [Coste-Marquis et al 2015]

- **Argument-fixed enforcement** : perform a strict or non-strict enforcement without modifying the set of arguments (modifying attacks is possible)
- **General enforcement** : perform a strict or non-strict enforcement by any possible means (adding arguments, modifying attacks)

Example of Argument-Fixed (General) Enforcement

- Using $\sigma = st$, how to enforce $E = \{a_2, a_3\}$ in F ?

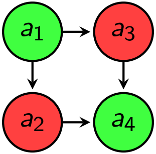


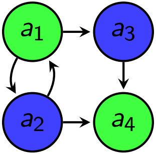
Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Example of Argument-Fixed (General) Enforcement

- Using $\sigma = st$, how to enforce $E = \{a_2, a_3\}$ in F?





LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Minimal Change Extension Enforcement [Baumann 2012]

- **Minimal enforcement** : F' must be as close as possible from F, closeness is measured with Hamming distance

$$d_H(F, F') = |(R \backslash R') \cup (R' \backslash R)|$$

- Characteristics : given an enforcement operator Op, a semantics σ, and AF $F = \langle A, R \rangle$ and $E \subseteq A$, $\mathbf{V}^{\mathbf{F}}_{\sigma,\mathbf{Op}}(\mathbf{E})$ is the function which computes the minimal change to enforcement E in F w.r.t. σ

Plan

LIPADE
Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Fixed Semantics Enforcement vs Semantic Change

- Existing enforcement methods consider that
  - either the semantics doesn't change
  - or the new semantics is given as a parameter of the operator no justification of *why* it changes nor *how* the new one is chosen

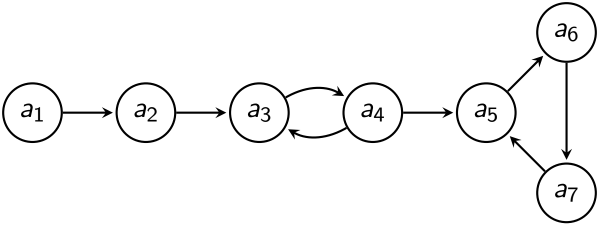
Idea of Semantic Change for Enforcement

- Define enforcement operators equipped with a set of possible semantics
- Choose the best new semantics in this set to obtain minimal change enforcement

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Example



- Current semantics : $\sigma = st$, $Ext_{st}(F) = \{\{a_1, a_4, a_6\}\}$
- Goal : enforcing $E = \{a_1, a_3\}$
- Without semantic change : the graph has to be modified
- With semantic change : switch semantics from *st* to *pr*, since $E \in Ext_{pr}(F) = \{\{a_1, a_3\}, \{a_1, a_4, a_6\}\}$. **No change of the graph at all**

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

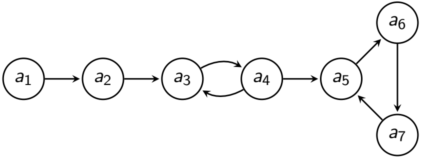
Enforcement With Semantic Change

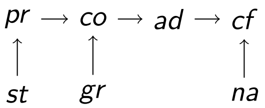
$$\left.\begin{array}{c} F = \langle A, R \rangle \\ \sigma \\ \Sigma = \{\sigma'_1, \ldots, \sigma'_k\} \\ E \subseteq A \end{array}\right\} \implies \left\{\begin{array}{c} F' = \langle A', R' \rangle \\ \sigma' \in \Sigma \end{array}\right.$$

such that

- E is a σ'-extension (resp. included in an extension) of F'
- F' is as close as possible from F
- σ' is as close as possible from σ

Example





- $\sigma = st$, $Ext_{st}(F) = \{\{a_1, a_4, a_6\}\}$, $E = \{a_1, a_3\}$
- $F = F'$, so $d_H(F, F') = 0$ is minimal
- $\delta_{Inc,\Sigma}(st, pr) = 1 < \delta_{Inc,\Sigma}(st, co) = 2 < \delta_{Inc,\Sigma}(st, ad) = 3 < \delta_{Inc,\Sigma}(st, cf) = 4$

Success of Semantic Change

Question : When is it useful/successful to use semantic change ?

- Useful when it guarantees that enforcement with σ_j can be realized with strictly less changes of the graph than with σ_i
  - A threshold can be considered : useful when the change with σ_j is at least τ% "easier" than with σ_i

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Success of Semantic Change

Question : When is it useful/successful to use semantic change ?

- Useful when it guarantees that enforcement with σ_j can be realized with strictly less changes of the graph than with σ_i
  - A threshold can be considered : useful when the change with σ_j is at least τ% "easier" than with σ_i
- Guarantee : our method can't give a worse result than "classical" enforcement

Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Success of Semantic Change

Question : When is it useful/successful to use semantic change ?

- Useful when it guarantees that enforcement with σ_j can be realized with strictly less changes of the graph than with σ_i
  - A threshold can be considered : useful when the change with σ_j is at least τ% "easier" than with σ_i
- Guarantee : our method can't give a worse result than "classical" enforcement
- How to determine when it gives a better result ?

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Experimental Protocol

General Idea

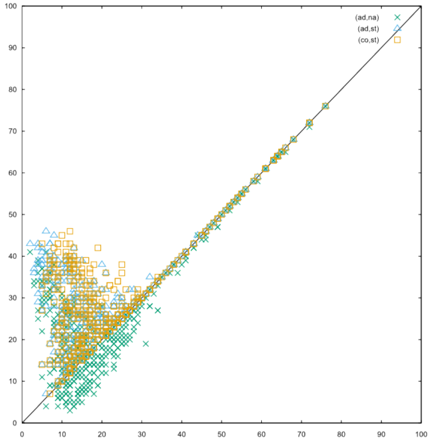
- For a large set of F and E, enforce E in F for $\sigma \in \Sigma$
- For each instance, compute $V^F_{\sigma,Op}(E)$ for all $\sigma \in \Sigma$
- For each pair of semantics (σ_i, σ_j), it is useful to change the semantics when $V^F_{\sigma_j,Op}(E) \leqslant 0.9 \times V^F_{\sigma_i,Op}(E)$

Details

- The instances come from [Wallner et al, AAAI 2016] : 400 instances for each $|A| \in \{50, 100, 150, 200, 250, 300\}$
- Enforcement operator : strict argument-fixed operator, $\{ad, st, co\}$ come from [Wallner et al], home-made implementation for *na*

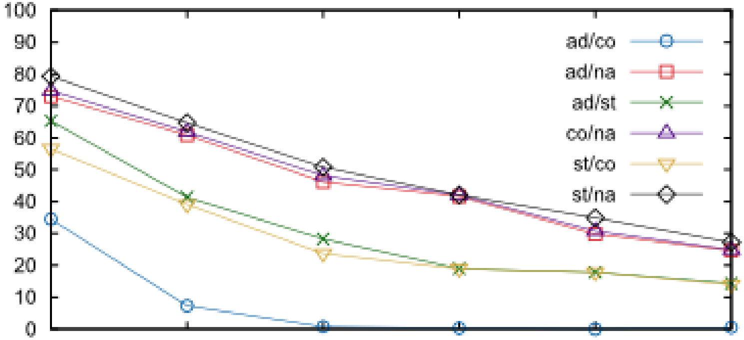
LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES



- $|A| = 50$
- Similar results for (st, na) and (na, co), only (ad, co) gives a lot of instances close to the diagonal
- Similar results for other $|A|$

Influence of $|A|$



- Percentage of success depending on $|A|$

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Plan

Summary

- Generalizing enforcement operators to benefit from semantic change
  - Experimental evaluation shows that semantic change brings better results in a lot of situations
- Not in the talk : we have extended Baumann's study of characteristics

Future work (1/2)

About characteristics

- Some characteristics are still unknown for several semantics and enforcement operators

About the experimental evaluation

- Conduct similar studies with other semantics and operators
- Success rate with other values than 0.9

About implementations

- Generalize the software systems : compute the characteristics for different semantics and operators before performing enforcement, to be able to choose the best one (w.r.t. change of the graph)

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES

Future work (2/2)

Deeper questions on extension enforcement

- The success rate seems to decrease when $|A|$ increases. Does it decrease to 0 or is there a minimal ?
- Our evaluation of success is only experimental. Are there properties related to success ?
  - Some graphs structures, pattern, etc which would guarantee that semantic change is/isn't successful

Semantic change for other operations

- Revision of AFs [Coste-Marquis et al, KR'14] returns a set of AFs, with two notions of minimality (difference of the graph and cardinality of the result)
- Can we use semantic change to improve the minimality w.r.t. one (or both) of these notions ?

LIPADE Laboratoire d'Informatique PAris DEscartes

UNIVERSITÉ PARIS DESCARTES