On the Revision of Argumentation Systems: Minimal Change of Arguments Statuses

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AMANDE - WP3
Protocols for Multiparty Argumentation
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Plan

Introduction

Abstract Argumentation [Dung 1995]

- An 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 : Complete, Stable, Preferred, Grounded, etc.
- The aim is to know whether an argument is accepted or refused (w.r.t. the chosen semantics σ).
  - An argument $\alpha \in \mathcal{A}$ is (skeptically) accepted iff it belongs to every extension of the argumentation framework for the chosen semantics σ :

$$AF \mid\!\sim_{\sigma} \alpha$$

Belief Revision

- A formula α can have three different epistemic statuses in the belief base B of an agent :
  - $B \vdash \alpha$: the agent accepts the information α
  - $B \vdash \neg\alpha$: the agent refuses the information α
  - $B \nvdash \alpha$ and $B \nvdash \neg\alpha$: the agent neither accepts nor refuses the information α

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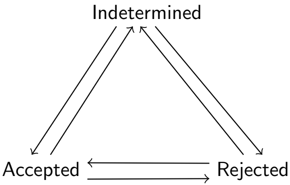
- Belief change operators = transitions between statuses



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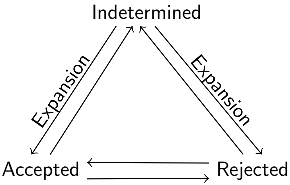

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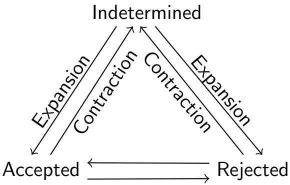

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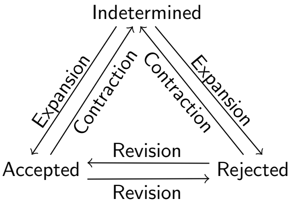

AGM Framework for Belief Change

- Principles of belief change :

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  - Primacy of update

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  [Alchourrón, Gärdenfors and Makinson 1985]

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- Set of postulates proposed for the three operations : to characterize an operator which has a “good” behavior
  [Alchourrón, Gärdenfors and Makinson 1985]
- Representation theorem : “An operator satisfies the postulates iff it is an instance of a given class.”

Dynamics of Abstract Argumentation

- Two components of an argument framework :

  Arguments   Attacks

- Question : What are the fundamental pieces of information for argumentation ?
  - What are the revision inputs ?

    Arguments   Attacks

  - What change do we minimize ?

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    - Enforcement [Baumann, Brewka 2010]

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- A two-step process :

$$AF \rightarrow \text{extensions} \rightarrow AFs$$

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Plan

Definition of the Revision of Argumentation Systems

Revision Formulae

- Formulae on the Arguments

$$\Phi ::= \alpha | \neg\Phi | \Phi \wedge \Phi | \Phi \vee \Phi$$

- Candidate Extension
  A *candidate* or *candidate extension* (CE) is a set of arguments.
- Satisfaction of a Formula by a CE
  - $\varepsilon \mid\!\sim \alpha$ iff $\alpha \in \varepsilon$
  - $\varepsilon \mid\!\sim \neg\varphi$ iff $\varepsilon \not\mid\!\sim \varphi$
  - $\varepsilon \mid\!\sim \varphi \wedge \psi$ iff $\varepsilon \mid\!\sim \varphi$ and $\varepsilon \mid\!\sim \psi$
  - $\varepsilon \mid\!\sim \varphi \vee \psi$ iff $\varepsilon \mid\!\sim \varphi$ or $\varepsilon \mid\!\sim \psi$
- Satisfaction of a Formula by an Argumentation Framework

$$AF \mid\!\sim_\sigma \varphi \text{ iff } \forall \varepsilon \in Ext_\sigma(AF), \varepsilon \mid\!\sim \varphi$$

Postulates Expressed with the Extensions

Notation

A^{σ}_{φ} denotes the set of the CE which satisfy φ and which are representable w.r.t. σ.

Postulates

- **(AE1)** $Ext(AF \star \varphi) \subseteq A^{\sigma}_{\varphi}$
- **(AE2)** If $Ext(AF) \cap A^{\sigma}_{\varphi} \neq \emptyset$ then $Ext(AF \star \varphi) = Ext(AF) \cap A^{\sigma}_{\varphi}$
- **(AE3)** If φ is σ-consistent, then $Ext(AF \star \varphi) \neq \emptyset$
- **(AE4)** If $\varphi \equiv_{\sigma} \psi$, then $Ext_{\sigma}(AF \star \varphi) = Ext_{\sigma}(AF \star \psi)$
- **(AE5)** $Ext(AF \star \varphi) \cap A^{\sigma}_{\psi} \subseteq Ext(AF \star \varphi \wedge \psi)$
- **(AE6)** If $Ext(AF \star \varphi) \cap A^{\sigma}_{\psi} \neq \emptyset$ then $Ext(AF \star \varphi \wedge \psi) \subseteq Ext(AF \star \varphi) \cap A^{\sigma}_{\psi}$

Representation Theorem

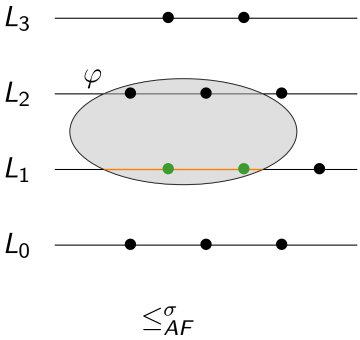
A faithful assignment is a mapping from an argumentation framework $AF = \langle A, R \rangle$ (given a semantics σ) to a total pre-order $\leq^{\sigma}_{AF}$ on the set of CE s.t. :

- if $\varepsilon_1 \in Ext_\sigma(AF)$ and $\varepsilon_2 \in Ext_\sigma(AF)$, then $\varepsilon_1 \simeq^{\sigma}_{AF} \varepsilon_2$
- if $\varepsilon_1 \in Ext_\sigma(AF)$ and $\varepsilon_2 \notin Ext_\sigma(AF)$, then $\varepsilon_1 <^{\sigma}_{AF} \varepsilon_2$

Theorem

Given a semantics σ, a revision operator $\star$ satisfies the rationality postulates **(AE1)**-**(AE6)** iff there exists a faithful assignment which maps every argumentation framework $AF = \langle A, R \rangle$ to a total pre-order $\leq^{\sigma}_{AF}$ s.t. :

$$Ext_\sigma(AF \star \varphi) = \min(A^{\sigma}_{\varphi}, \leq^{\sigma}_{AF})$$



- Every point represent a CE
- Level $L_0 = \sigma$-extensions of AF
- Other levels $=$ other CEs sorted by "distance"

Plan

A Two-step Process

Distance-based Revision Operators

- Pre-order between CE
  Let AF be an argumentation framework and σ be a semantics. Given d a pseudo-distance between CE, one defines $\leq_{AF}^{\sigma,d}$ by

$$\varepsilon \leq_{AF}^{\sigma,d} \varepsilon' \text{ iff } d(\varepsilon, Ext_\sigma(AF)) \leq d(\varepsilon', Ext_\sigma(AF))$$

- Hamming Distance
  - $d_H(\varepsilon, \varepsilon') = |(\varepsilon \backslash \varepsilon') \cup (\varepsilon' \backslash \varepsilon)|$
  - $d_H(\varepsilon, \{\varepsilon'_1, \ldots, \varepsilon'_n\}) = \min_{1 \leq i \leq n} d_H(\varepsilon, \varepsilon'_i)$
- Distance-based Revision Operator
  Let σ be a semantics, and d be a pseudo-distance between CE.
  The distance-based operator $\star^d$ is defined as

$$Ext_\sigma(AF \star^d \varphi) = \min(A_\varphi^\sigma, \leq_{AF}^{\sigma,d})$$

- Every distance-based operator satisfies the postulates **(AE1)**-**(AE6)**.

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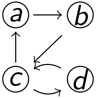
Example

- Framework to revise

  $AF =$ 

  $\varphi = b$

- Its extensions
  - for the preferred and stable semantics : $\{\{a, d\}\}$
  - for the grounded semantics : $\{\emptyset\}$
- Revised extensions
  - $Ext_{pr}(AF \star b) = Ext_{st}(AF \star b) = \{\{a, b, d\}\}$
  - $Ext_{gr}(AF \star b) = \{\{b\}\}$

Generation of Corresponding Argumentation Frameworks

- **Remember.** A two-step process :

AF → extensions → AFs

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Generation of Corresponding Argumentation Frameworks

- Generation Operator
  A generation operator $\mathcal{AF}_\sigma$ is a mapping from a set of CE $\mathcal{C}$ to a set of argumentation frameworks s.t. $Ext_\sigma(\mathcal{AF}_\sigma(\mathcal{C})) = \mathcal{C}$.
- Revision Operator
  Given a semantics σ, a faithful assignment which maps every argumentation framework to a pre-order $\leq^\sigma_{AF}$ and a generation operator $\mathcal{AF}_\sigma$, the corresponding revision operator $\star$ is defined by

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- Proposition
  Every revision operator as define above satisfies the postulates **(AE1)**-**(AE6)**.

Two Approaches for ensuring Minimality

- Minimal change on the graph :

$$AF_{\sigma}^{dg,AF}(\mathcal{C}) = \bigcup\{AFs \in sets | card(AFs) \text{ is minimal}\}$$

with

$$sets = \{AFs \quad | \quad Ext_{\sigma}(AFs) = \mathcal{C} \text{ and } \sum_{AF_i \in AFs} dg(AF, AF_i) \text{ is minimal}\}.$$

- Minimal cardinality : $AF_{\sigma}^{card,AF}(\mathcal{C}) = \bigcup\{AFs \in sets | \sum_{AF_i \in AFs} dg(AF, AF_i) \text{ is minimal}\}$

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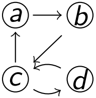
$AF =$ 

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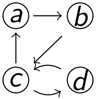
$AF =$ 

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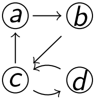
$AF =$  $\varphi = b$

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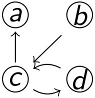

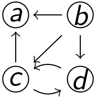

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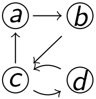
$AF =$ 

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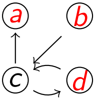

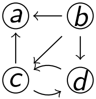

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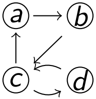
$AF =$ 

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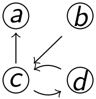

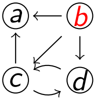

Example (3)

$AF =$ (a) (b) (c)

$\varphi = (a \vee b) \wedge (\neg a \vee \neg b)$

- $Ext_{st}(AF) = \{\{a, b, c\}\}$
- $Ext_{st}(AF \star \varphi) = \{\{a, c\}, \{b, c\}\}$

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Minimal Distance : 

AF_1^d

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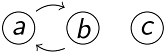
Minimal Cardinality : 

AF_{card}

Use Labellings to Define Other Distances

One can use reinstatement labellings to define other distances :

- difference between *undec* and *out*
- to build systems from a different set of labellings allow the creation of different attack relations

Plan

Discussion

Discussion

- The result is a set of AFs (not a single AF)
- Meaning of changing/removing/adding an attack between arguments

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The result is a set of AFs

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AF → extensions → *AFs*

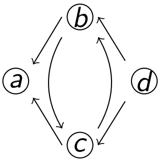
- Usual in Belief Revision !
  - Partial meet contraction functions : $K - \alpha = \bigcap \delta(K \perp \alpha)$
  - Flocks [Fagin,Ullman,Vardi 1983]

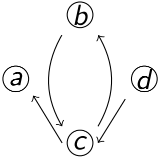
The result is a set of AFs : Avoid Arbitrary Choices

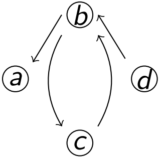
- $\sigma =$ preferred, $Ext(AF) = \{\{a, d\}\}$
- $\varphi = b \vee c$
- b and c play symmetric roles

- Two CEs are at a distance equal to 1 from the extensions of AF : $\{a, b, d\}$ and $\{a, c, d\}$

- 2 solutions :

$AF =$ 





Meaning of changing/removing/adding an attack

- Preferential Argumentation Framework (PAF)
  - Change in the attacks can be performed by changing the preference relation
- Enthymemes
- In some situations, it is more conceivable to change the attacks than to “create” a new argument

Changing Attacks vs Adding Arguments

Social Issues : Taxation

Every possible argument about taxation has been stated :

- pro :
  - The state needs it
  - Allows to protect weakest people
  - . . .
- cons :
  - Personal freedom / responsability
  - Rich people prefer leaving the country rather than paying high taxes
  - . . .

► In this kind of situations, it is more conceivable to change the attacks than to "create" a new argument

Application Example

Gabbriellini et Torroni 2013 MS Dialogues : Persuading and getting persuaded, A model of social network debates that reconciles arguments and trust

- Two agents A and B debate on a social network, each has his own "internal" argumentation system
- A uses an argument a which is not accepted by B, but B considers that A is trustworthy : B must revise her argumentation system to incorporate a in the accepted arguments wrt her internal system
- This process can be extended to formulae

Plan

Conclusion and Future Work

Conclusion

- Definition of a language to express complex informations from an argumentation system
- Formal definition of the revision of argumentation systems via an adaptation of the AGM framework
  - Definition of rationality postulates
  - Representation theorem
  - Definition of revision operators which satisfy the postulates

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- This work can be adapted to the case of reinstatement labellings

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Thank you for your attention