Comparison Criteria for Argumentation Semantics

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

[1]IRIT, Université Toulouse 1 Capitole, France

[2]LIPADE, Université Paris Descartes, France

EUMAS 2017
14-15 December 2017

Argumentation System

Argumentation system

(1) Argumentation framework F	$+$	(2) Semantics σ	$\Longrightarrow$	(3) Evaluation of arguments acceptance $\sigma(F)$

Example:

$c \longrightarrow b \longrightarrow a \quad + \quad$ Stable semantics $\quad \Longrightarrow \quad \{\{c, a\}\}$

Argumentation System

Given a Dung's argumentation framework $F = \langle A, R \rangle$, $S \subseteq A$ is

- conflict-free w.r.t. F if $\nexists a_i, a_j \in S$ s.t. $(a_i, a_j) \in R$
- admissible w.r.t. F if S is conflict-free and S defends each of its arguments against all of their attackers
- a naive extension of F if S is a maximal conflict-free set (w.r.t. $\subseteq$)
- a stable extension of F if S is conflict-free and S attacks each argument in $A \setminus S$

Argumentation System

Examples:

$c \longrightarrow b \longrightarrow a$ + Stable semantics $\Longrightarrow$ $\{\{c, a\}\}$

$c \longrightarrow b \longrightarrow a$ + Naive semantics $\Longrightarrow$ $\{\{c, a\}, \{b\}\}$

$c \longrightarrow b \longrightarrow a$ + Admissible semantics $\Longrightarrow$ $\{\{c, a\}, \{c\}, \emptyset\}$

Argumentation System
Motivation for Comparison Criteria

Argumentation system

(1)		(2)		(3)
Argumentation framework F	$+$	Semantics σ	$\Longrightarrow$	Acceptable sets of arguments $Ext_\sigma(F)$

In the context of the dynamics of argumentation systems, σ may have to be changed to a σ'

Possibly, σ' should be not too different from σ

Example

Argumentation system and acceptability requirement:

(1)		(2)		(3)
$c \longrightarrow b \longrightarrow a$	$+$	Stable semantics	$\Longrightarrow$	$\{\{a, c\}\}$

$\uparrow$

b in an acceptable set

Enforcement:

(1')		(2)		(3')
$d \longrightarrow c \longrightarrow b \longrightarrow a$	$+$	Stable semantics	$\Longrightarrow$	$\{\{d, b\}\}$

Example

Argumentation system and acceptability requirement:

(1)	(2)		(3)
$c \longrightarrow b \longrightarrow a$ +	Stable semantics	$\Longrightarrow$	$\{\{a, c\}\}$

$\uparrow$

b in an acceptable set

Enforcement:

(1)	(2')		(3')
$c \longrightarrow b \longrightarrow a$ +	Naive semantics	$\Longrightarrow$	$\{\{a, c\}, \{b\}\}$

Towards Semantic Change

Question

How to measure how different two semantics σ and σ' are?

Four types of comparison criteria:

$\Longrightarrow$ Property-based

$\Longrightarrow$ Relation-based

$\Longrightarrow$ Acceptance-based

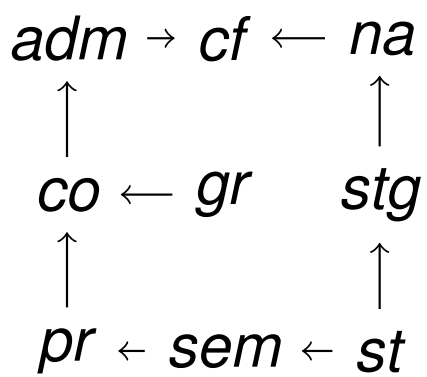
$\Longrightarrow$ Complexity-based

Property-based Difference Measures

- Rely on the principles the semantics are defined on. E.g.:
  - admissible semantics: relies on conflict-freeness and admissibility
  - naive semantics: relies on inclusion-maximality for conflict-freeness
- A weight can be assigned to each principle.
- Measure the difference between the principles the semantics are based on, and their possible weights.

Relation-based Difference Measures

- A certain relation between semantics is considered. E.g.:
  - the inclusion relation between extensions under the semantics
- This relation is represented as a graph. E.g.:



- The length of the shortest path between σ and σ' in this graph is measured.

Acceptance-based Difference Measures

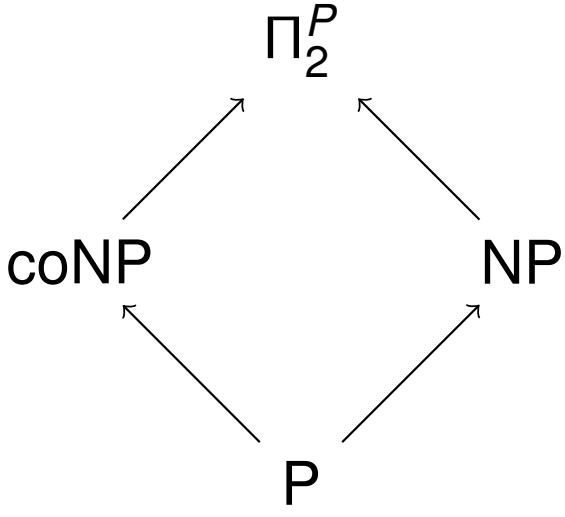
- Unlike the two previous types of measures, these ones are relative to a given argumentation framework F.
- The sets of extensions $\sigma(F)$ and $\sigma'(F)$ are considered.
- The difference between these two sets (e.g. using the Hamming distance) is measured.

Complexity-based Difference Measures

- Depends on a (set of) reasoning task(s) (skeptical acceptance, credulous acceptance,. . .)
- Build a graph representing inclusion of the complexity classes for these tasks and semantics
- The distance is the length of the path

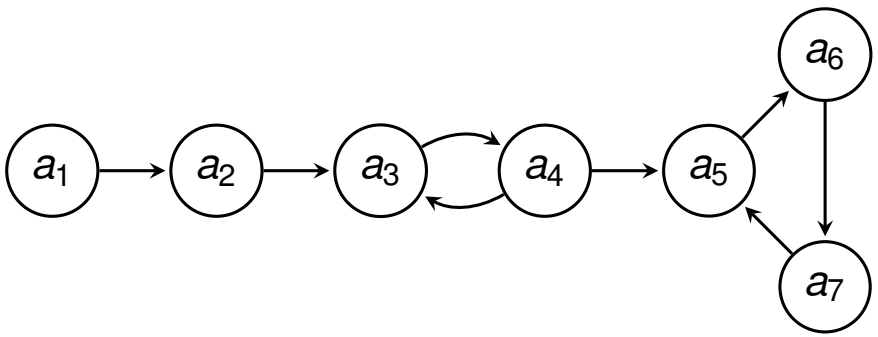
Example:

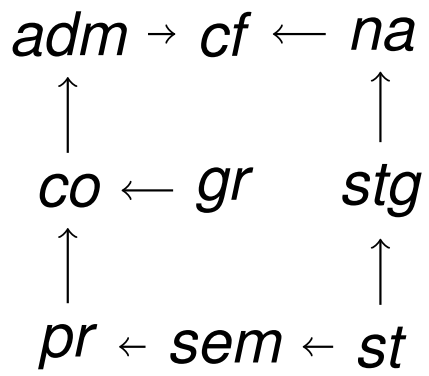
- $\mathcal{S} = \{co, pr, st, gr\}$
- $T = \{Cred_\sigma, Skept_\sigma, Exist_\sigma\}$
- $\mathcal{C} = \{\mathrm{P}, \mathrm{NP}, \mathrm{coNP}, \Pi_2^P\}$
- $\delta_T^{\mathcal{S}}(Cred_{gr}, Cred_{co}) = 1$
  ($Cred_{gr} \in \mathrm{P}$ and $Cred_{co}$ is NP-c)



Applying our Distances

Semantic Change in Extension Enforcement [Doutre and Mailly, SUM'17]





- $\sigma = st$, $st(F) = \{\{a_1, a_4, a_6\}\}$, $E = \{a_1, a_3\}$
- $E \in \sigma'(F)$ for $\sigma' \in \{pr, co, adm, cf\}$
- No change of the graph at all
- $\delta_{Inc,\Sigma}(st, pr) = 2 < \delta_{Inc,\Sigma}(st, co) = \delta_{Inc,\Sigma}(st, cf) = 3 < \delta_{Inc,\Sigma}(st, ad) = 4$
- The new semantics must be *pr*

Conclusion and future work

- Toward semantic change:
  - 4 kinds of difference measures for semantics
  - These measures can be combined
  - A semantics σ may be "closer" to a σ' than a σ'' according to one measure, but not according to another measure
  - Application of our measures: extension enforcement [Doutre and Mailly, SUM'17]
- Future work:
  - Application of these measures in the context of the revision of argumentation systems
  - In this context, study of the combination of these measures with measures for changes on argumentation frameworks
  - Difference between ranking-based semantics