Université Toulouse 1 Capitole - IRIT

Argumentation Reasoning

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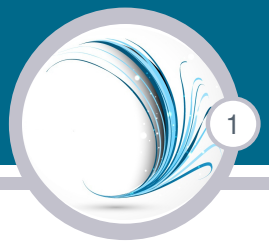
Based on a tutorial given at EASSS'17 Summer School
with Jean-Guy Mailly (Univ. Paris 5 Descartes - LIPADE)

Content



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- **John**: "Moreover, the other restaurants in the streets are closed."

Formalizing Arguments

Formally, an argument is made of a support which allows to deduce a given claim

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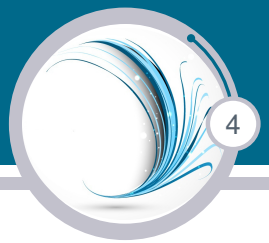
I'm hungry, let's go to this restaurant.

Conflicts between Arguments



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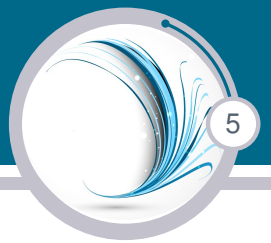
- claim vs claim (rebuttal): "I'm hungry, let's go to this restaurant." vs "Its grades on Tripadvisor are bad, let's go somewhere else."

Conflicts between Arguments

The support (or the claim) of an argument can be incompatible with the support (or the claim) of another argument: **attack**

- claim vs claim (rebuttal): "I'm hungry, let's go to this restaurant." vs "Its grades on Tripadvisor are bad, let's go somewhere else."
- claim vs support (undercut): "The Tripadvisor grades are old and there is a new chef, so it should be better now." vs "I've seen on Tripadvisor that the food is bad, let's go somewhere else."

Formalisms for arguments and attacks



Several **formalisms** capture formally the nature of **arguments** and **attacks**

- Deductive argumentation [Besnard and Hunter 2008]
- Rule-based argumentation
  [Kakas and Moraitis 2003, Toni 2014, Modgil and Prakken 2014]

Support and claims are represented as logical formulas or rules, then arguments and attacks are built

Argument mining

(a)

CLAIM 1 While those on the far-right think that immigration threatens national identity, as well as cheapening labor and increasing dependence on welfare.

[...]

Proponents of immigration maintain that, according to Article 13 of the Universal Declaration of Human Rights, everyone has the right to leave or enter a country, along with movement within it [...] **EVIDENCE 2**

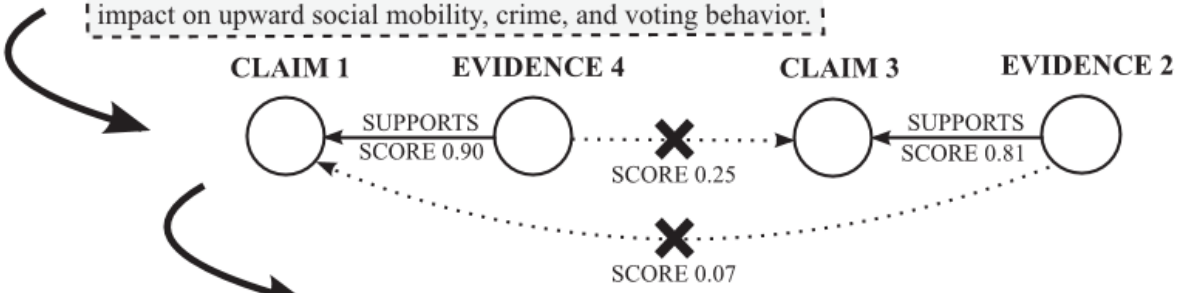
[...]

CLAIM 3 Some argue that the freedom of movement both within and between countries is a basic human right, and that the restrictive immigration policies, typical of nation-states, violate this human right of freedom of movement.

[...]

Immigration has been a major source of population growth and cultural change throughout much of the history of Sweden. The economic, social, and political aspects of immigration have caused controversy regarding ethnicity, economic benefits, jobs for non-immigrants, settlement patterns, impact on upward social mobility, crime, and voting behavior. **EVIDENCE 4**

(b)

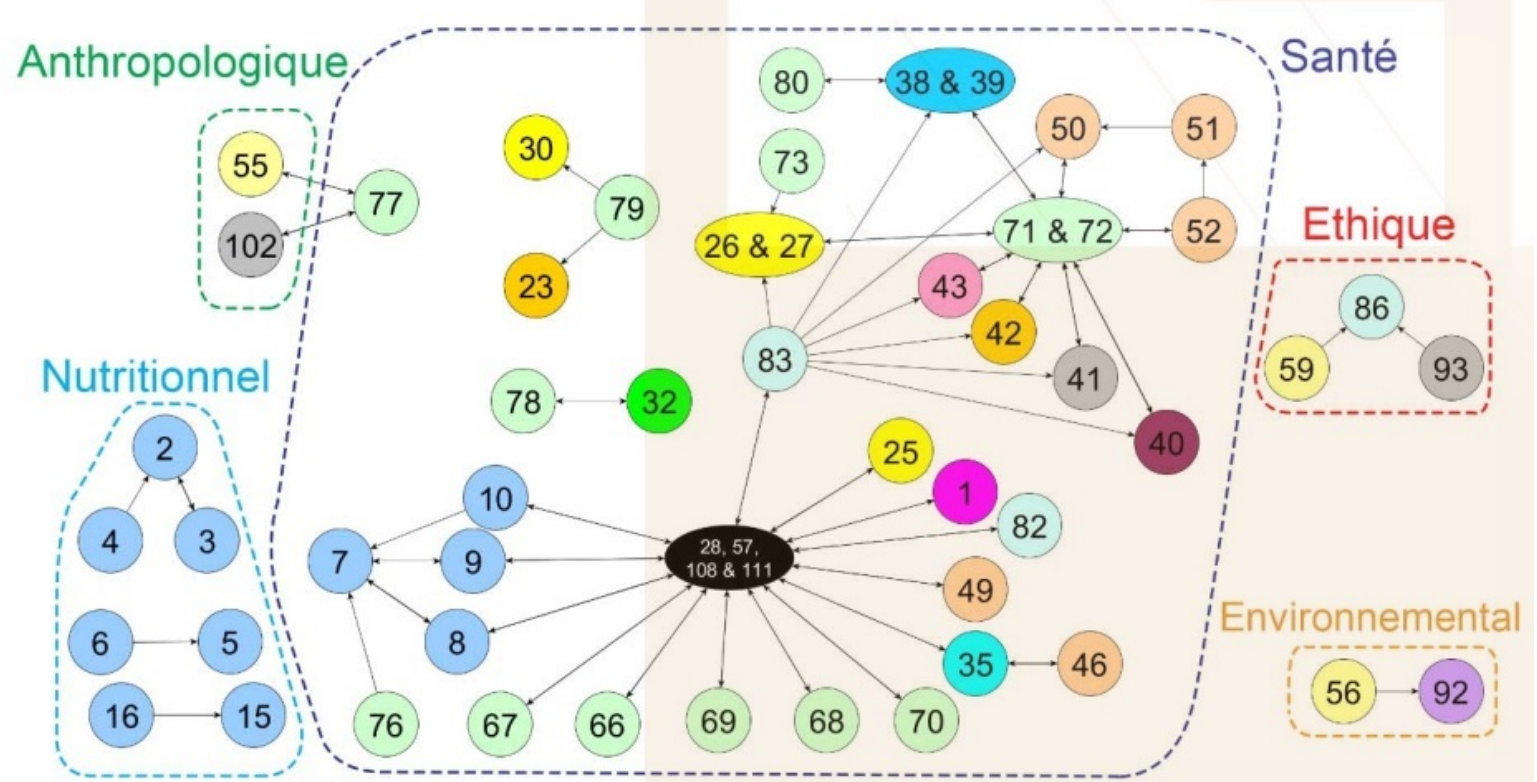


(c)

[Lippi and Torroni 2016]

Example
Debate about reduced meat consumption

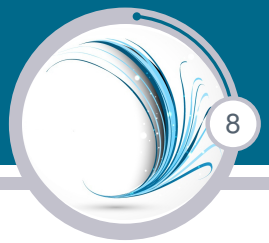
Figure 3 : Représentation graphique des arguments et des attaques au sujet de la réduction de consommation de produits animaux



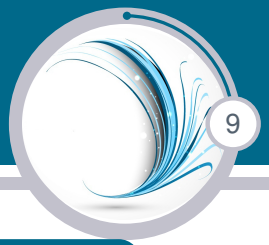
Chaque numéro correspond à un argument exprimé par une source. Chaque source est représentée par un nœud de couleur excepté pour des arguments similaires qui ont été regroupés. Les arguments ont été groupés par catégorie.

[Salliou and Thomopoulos 2018]

Content



Abstracting arguments and relationships



Dung's Argumentation Framework [Dung 1995]

Argumentation Framework (**AF** for short): $F = (A, R)$ where

- A is a set of arguments
- $R \subseteq A \times A$ represents attacks between arguments

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Dung's Argumentation Framework [Dung 1995]

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- A is a set of arguments
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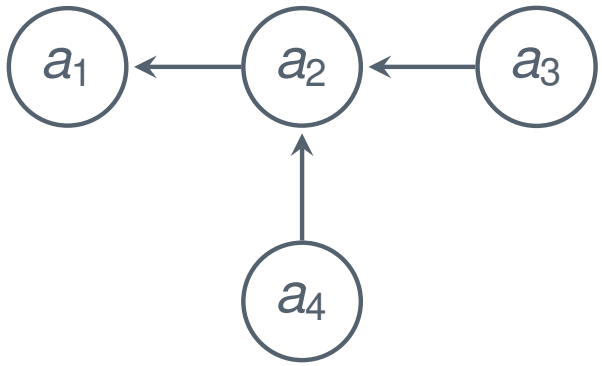
- Example:
  - a_1: (John) "I'm hungry, let's go to this restaurant."
  - a_2: (Yoko) "I've seen on Tripadvisor that the food is bad, let's go somewhere else."
  - a_3: (John) "The Tripadvisor grades are old and there is a new chef, so it should be better now."
  - a_4: (John) "Moreover, the other restaurants in the streets are closed."

$F = (A, R)$ with
$A = \{a_1, a_2, a_3, a_4\}$,
$R =$
$\{(a_2, a_1), (a_3, a_2), (a_4, a_2)\}$



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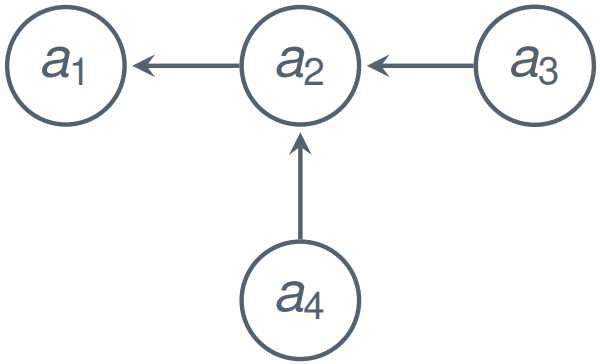

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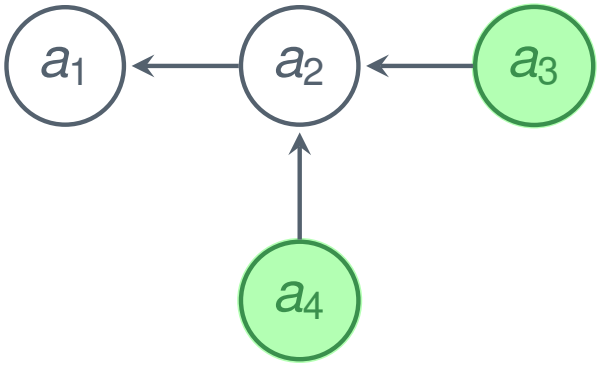

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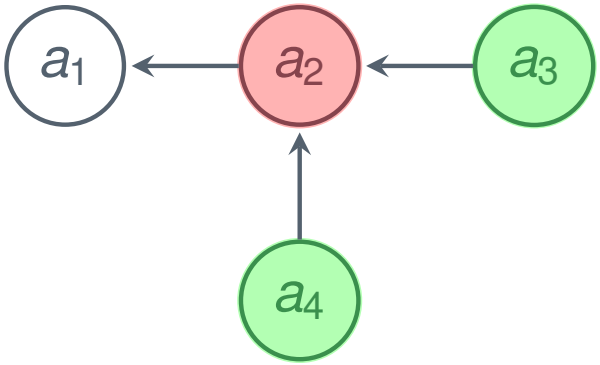

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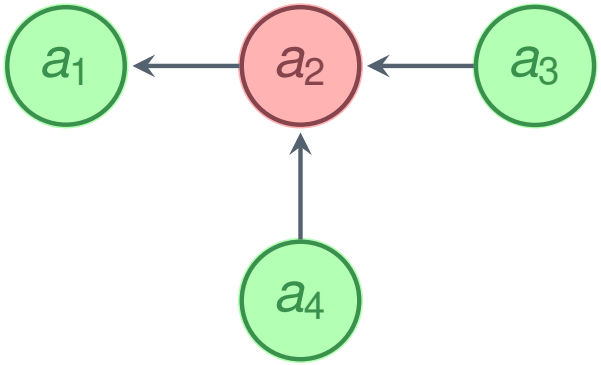
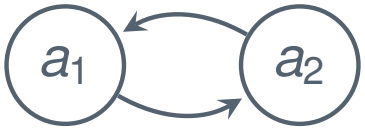


Cycles: Dilemmas

- a_1: "I like this restaurant, let's eat here." (John)
- a_2: "I don't like this restaurant, let's go somewhere else." (Yoko)



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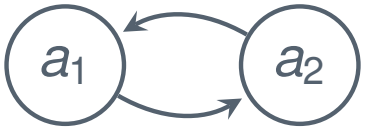

What can we accept?

Cycles: Paradoxes

- a_1: "John says that Paul is a liar."
- a_2: "Paul says that George is a liar."
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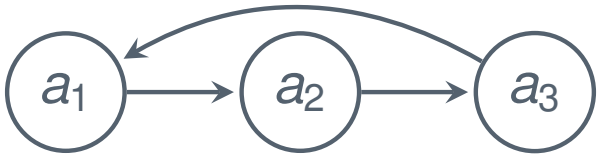

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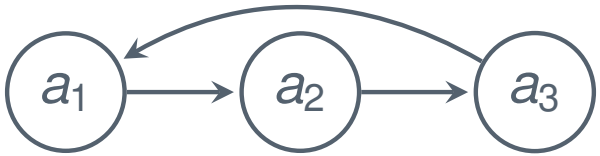


What can we accept?

Content

Extension-based Semantics [Dung 1995]

- **Extension**: set of jointly acceptable arguments
  - "solution" of the debate
  - "point of view" about the situation
- A set of arguments has to satisfy some properties to be an extension: *e.g.* we don't accept arguments a_1 and a_2 together if there is an attack between them
- **Semantics**: Function σ which maps an AF F to a set of extensions $\sigma(F)$

Dung's Semantics

Basic semantics

A set $S \subseteq A$ is

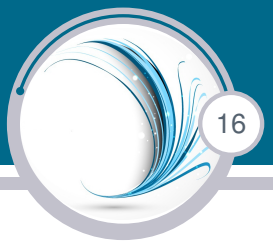
- conflict-free (**cf**) w.r.t. F if $\nexists a_i, a_j \in S$ s.t. $(a_i, a_j) \in R$
- admissible (**ad**) w.r.t. F if S is cf and S defends each $a_i \in S$ (*i.e.* $\forall a_i \in S, \forall a_j$ s.t. $(a_j, a_i) \in R, \exists a_k \in S$ s.t. $(a_k, a_j) \in R$)

Classical semantics

A set $S \subseteq A$ is

- complete (**co**) w.r.t. F if S is ad and S contains all the arguments that it defends
- preferred (**pr**) w.r.t. F if S is a maximal co extension (w.r.t. $\subseteq$)
- stable (**st**) w.r.t. F if S is cf and S attacks every $a_j \in A \setminus E$
- grounded (**gr**) w.r.t. F if S is a minimal co extension (w.r.t. $\subseteq$)

Arguments' Acceptance



Skeptical Acceptance

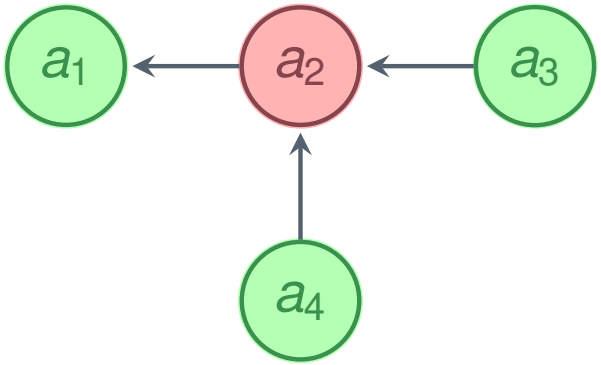
Given $F = \langle A, R \rangle$ and σ, $skep_\sigma(F) = \bigcap_{S \in \sigma(F)} S$ is the set of skeptically accepted arguments

Credulous Acceptance

Given $F = \langle A, R \rangle$ and σ, $cred_\sigma(F) = \bigcup_{S \in \sigma(F)} S$ is the set of credulously accepted arguments

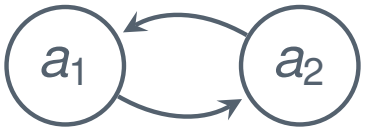
Dung's Semantics

Example:



- $\{a_1, a_3, a_4\}$ is the unique complete (resp. preferred, stable, grounded) **extension**.
- This set is then also the set of **skeptically** and of **credulously** accepted arguments under these semantics.

How Semantics Deal with Dilemmas



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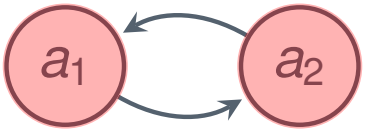

Semantics σ	σ-extensions	$cred_\sigma$	$skep_\sigma$
grounded	$\{\emptyset\}$	$\emptyset$	$\emptyset$

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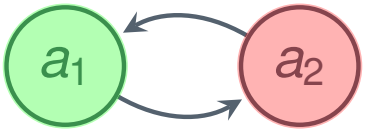

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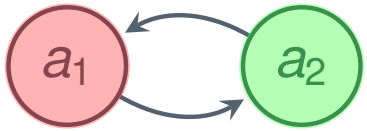

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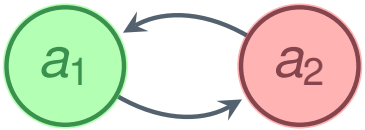

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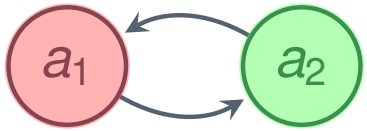

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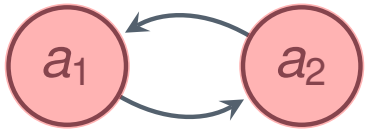

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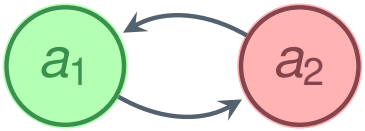

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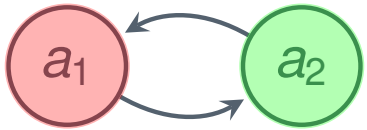

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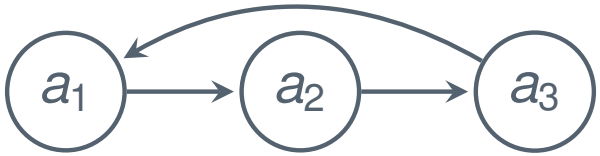

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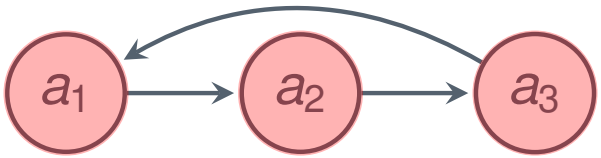

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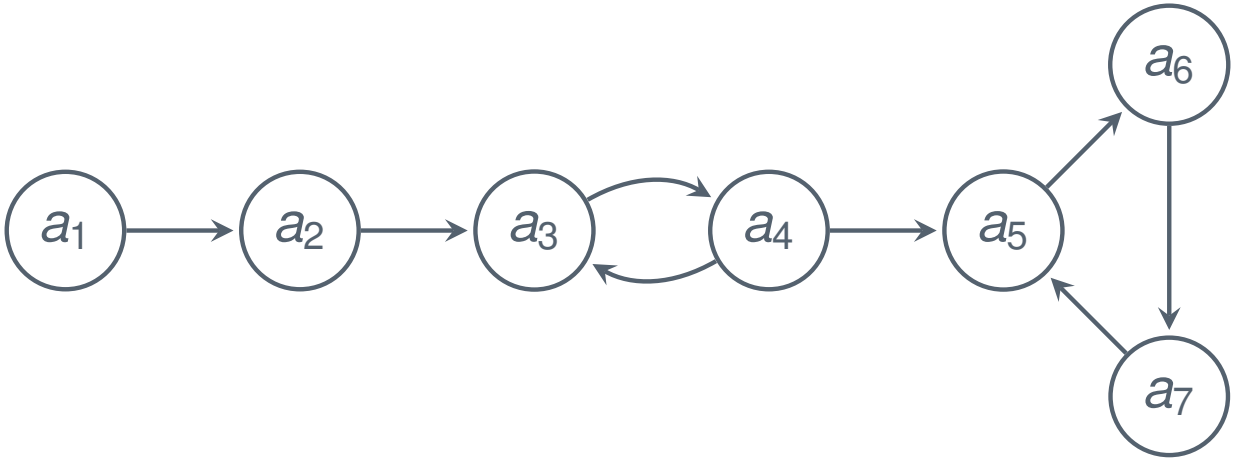
Exercise



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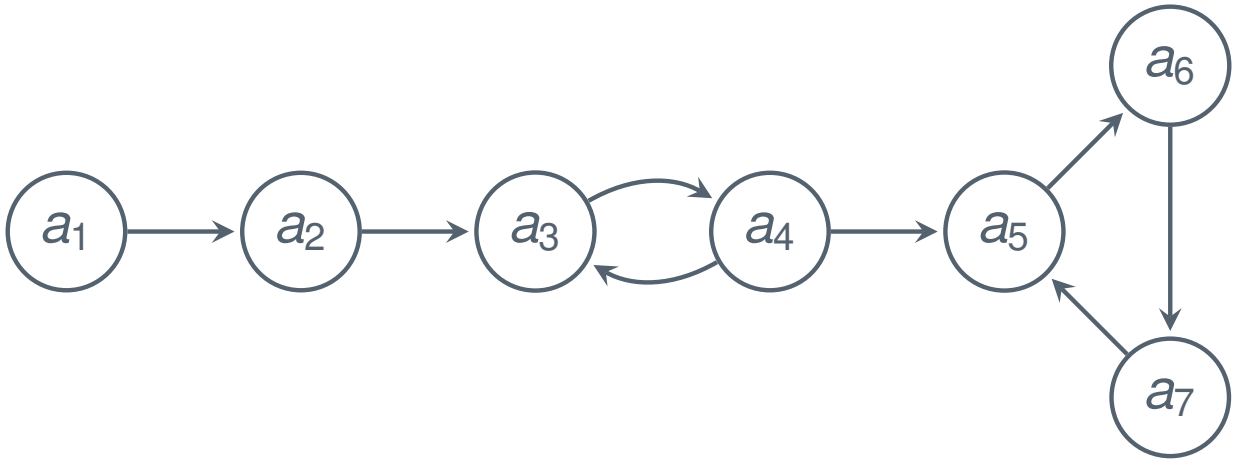


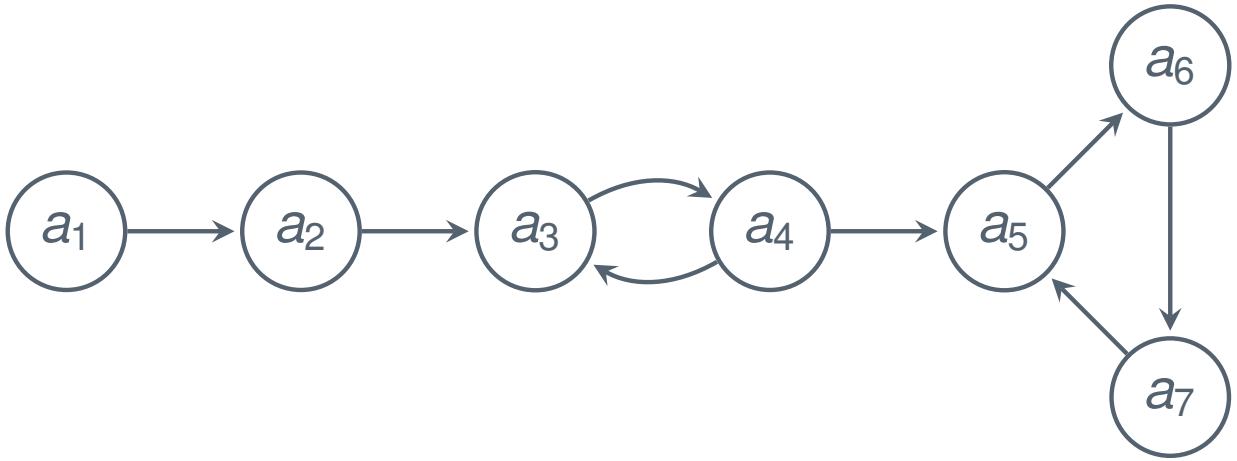
Questions:

- What are the **extensions** under the various semantics (grounded, stable, preferred, complete)?
- Under each semantics, which arguments are **credulously** accepted? Which ones are **skeptically** accepted?

Need **help**?

⇒ [ConArg] (Web interface, to be used with the example in Appendix)

Example: Semantics Comparison



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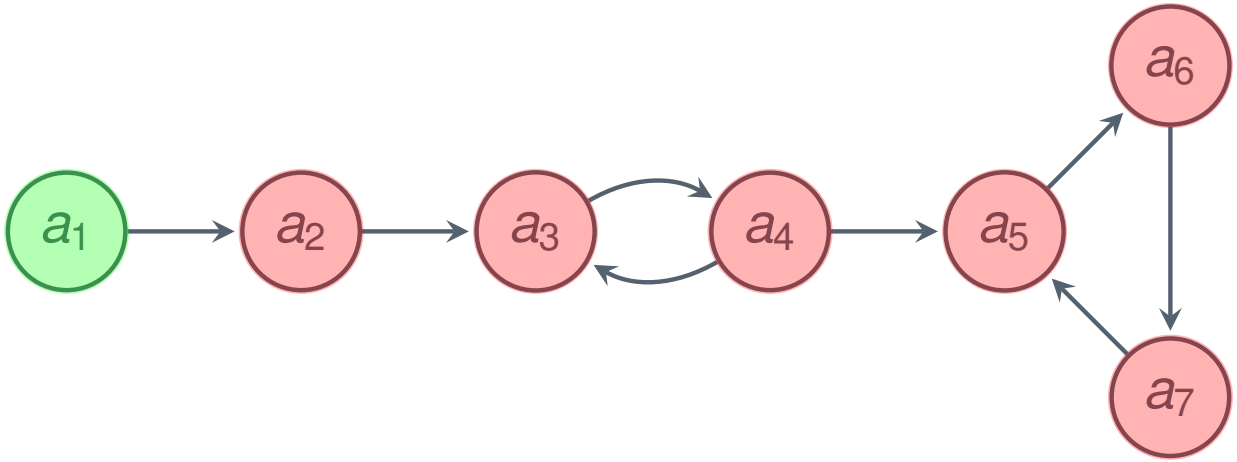

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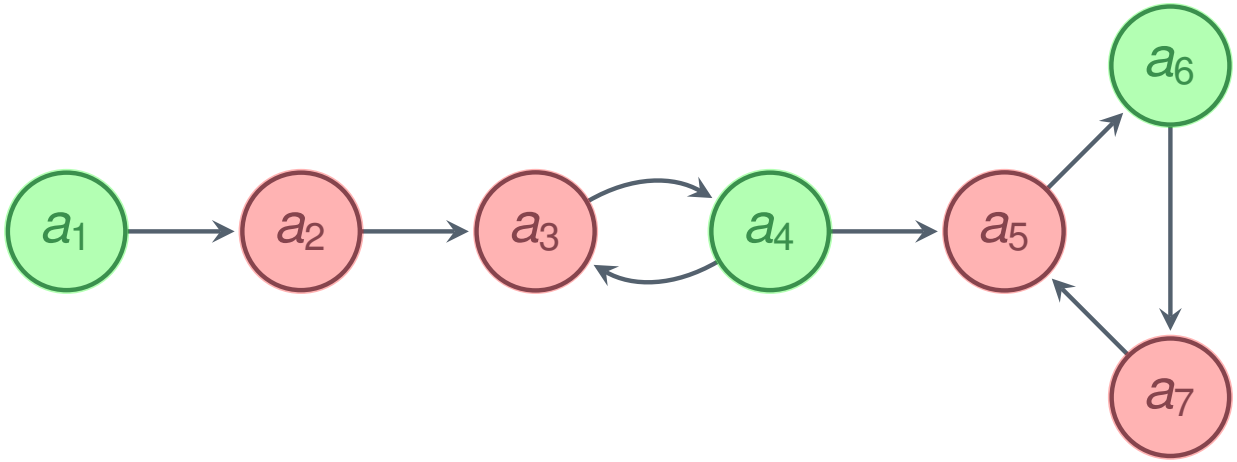

Semantics σ	σ-extensions	$cred_\sigma$	$skep_\sigma$
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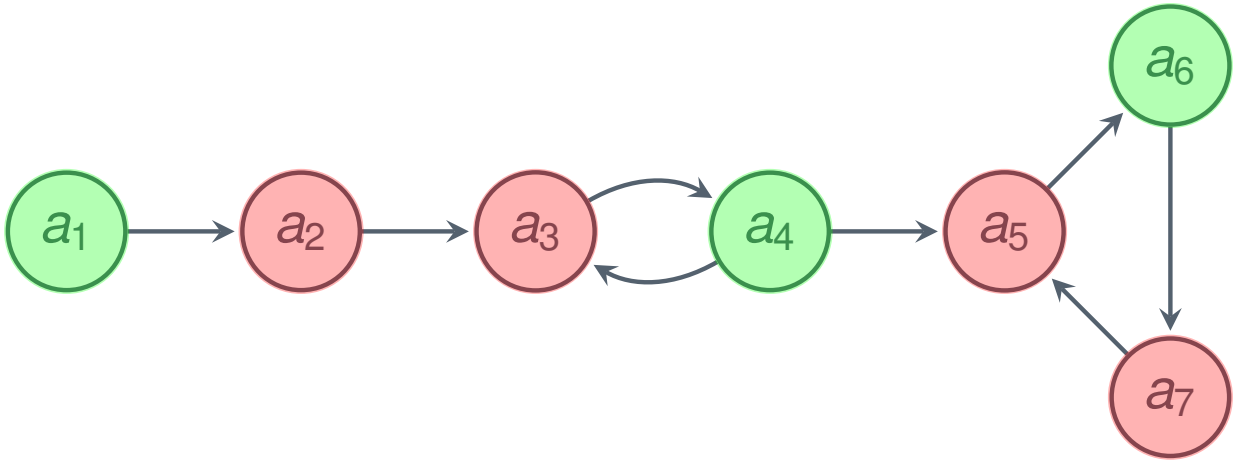

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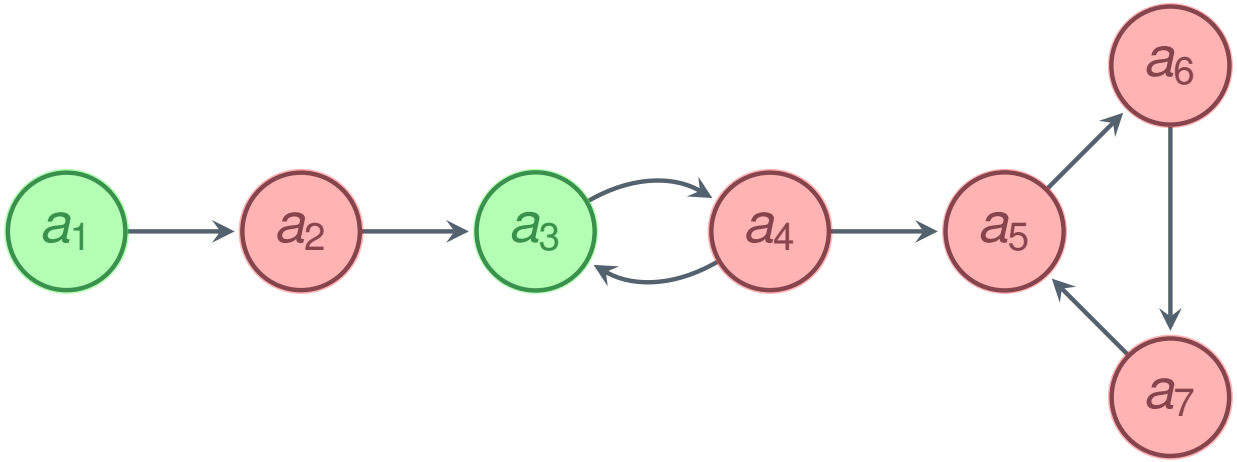

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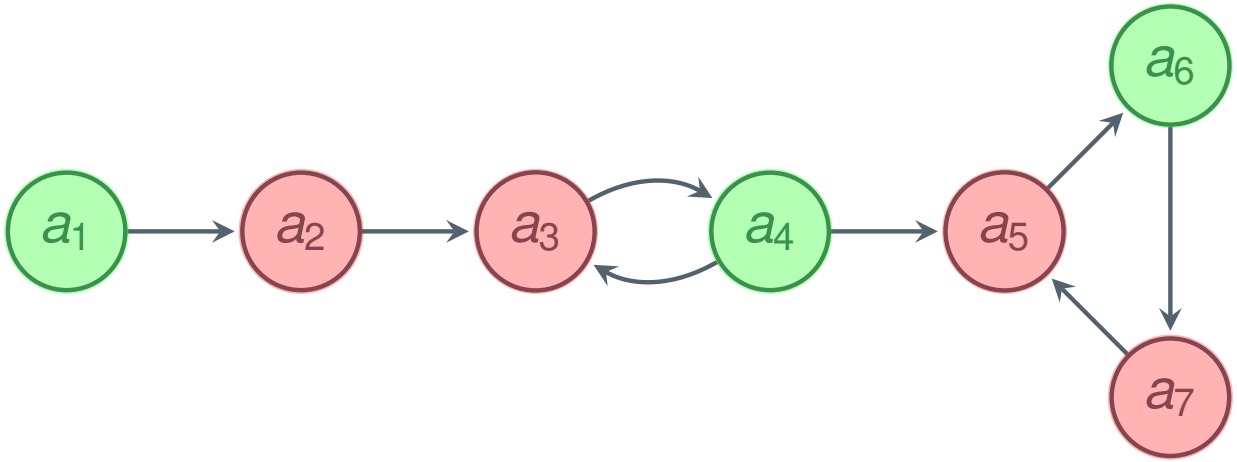

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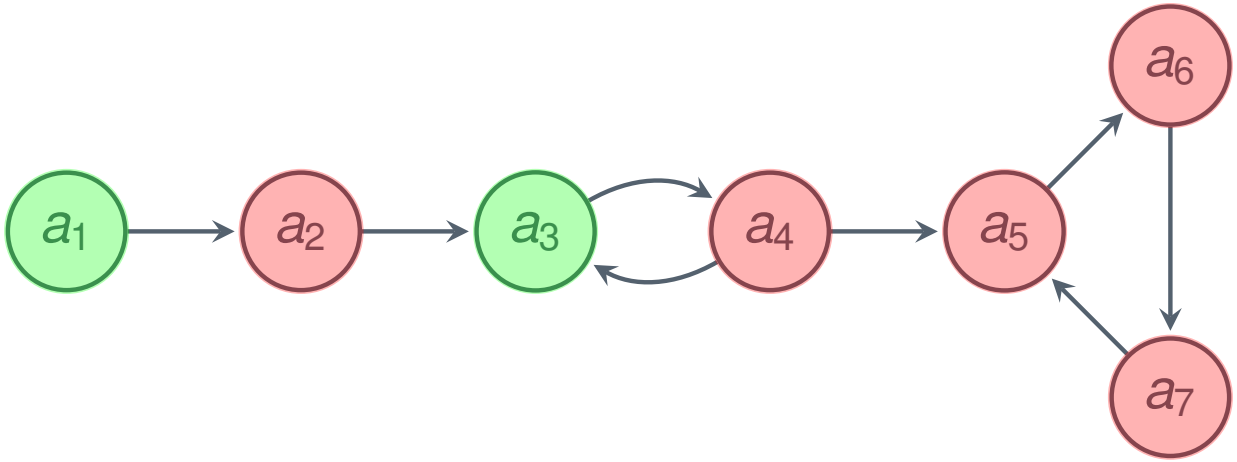

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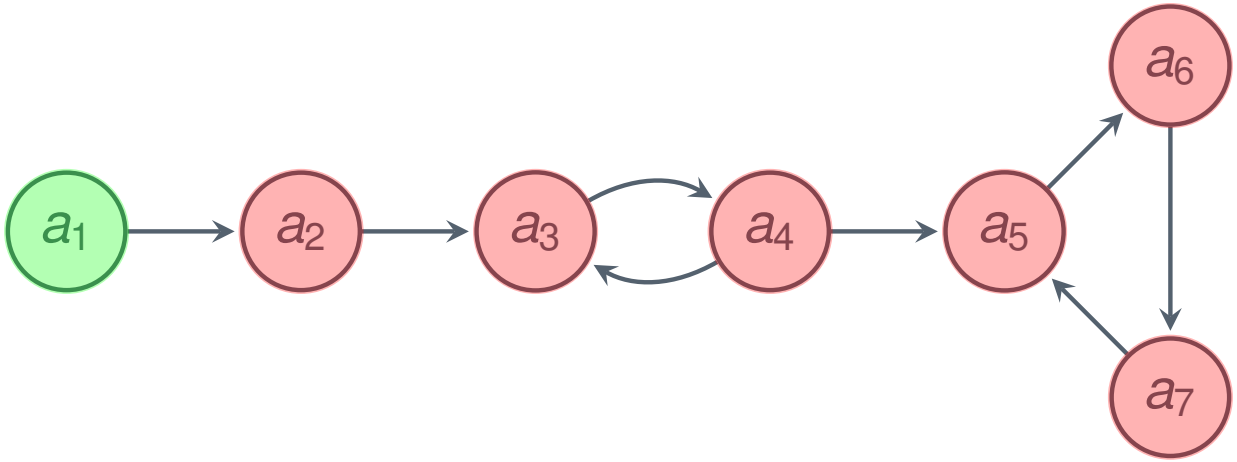

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To sum up...

- An argumentation system is made of:

(1) Argumentation framework F	$+$	(2) Acceptability Semantics σ	$\Longrightarrow$	(3) Argument evaluation $\sigma(F)$

More Semantics

Other **extension-based** semantics:

- naive
- ideal
- stage
- semi-stable
- eager
- . . .

See [Baroni, Caminada, Giacomin 2011]

More Semantics

Other types of semantics:

- **Labelling-based** semantics
  - Every argument is assigned a label: **in**, **out** or **undec**.
  - a is labelled **in** iff $\forall b$ s.t. $(b, a) \in R$, b is labelled out
  - a is labelled **out** iff $\exists b$ s.t. $(b, a) \in R$ and b is labelled in
  - a is labelled **undec** iff a is neither labelled in nor out
  - Several possible labellings can result.
  - Correspondence shown between labellings and extensions

  $\Rightarrow$ [ArgTeach] to learn how to label (to be used with the example in Appendix)

More Semantics

Other types of semantics:

- **Ranking-based** semantics
  - A **pre-order** on arguments is defined, instead of sets of collectively acceptable arguments.
  - The pre-order compares the acceptability of arguments.
  - The comparison may be based on the number of attacking and defending arguments, for example.

$\Rightarrow$ See [Bonzon, Delobelle, Konieczny, Maudet 2016] for a comparative study of ranking-based semantics

Content

Generalization of Dung's Framework

There are many ways to **extend** the expressiveness of abstract argumentation, *e.g.*:

- Preferences
- Support relation
- Abstract dialectical frameworks

Preference-based Argumentation
[Amgoud and Cayrol 2002]

- besides conflicts between arguments, the agent has some **preferences** between arguments
- if a_1 is preferred to a_2, then no attack from a_2 to a_1 can succeed

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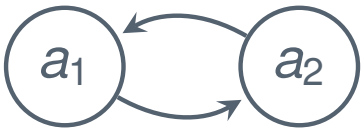

$PrF = \langle A, R, \leq \rangle$ with

- $A = \{a_1, a_2\}$
- $R = \{(a_1, a_2), (a_2, a_1)\}$
- $a_2 \leq a_1$ (*i.e.* a_1 is "better than" a_2)

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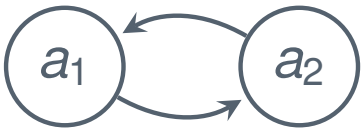

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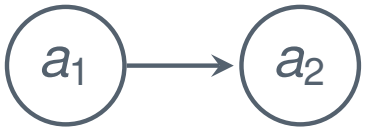

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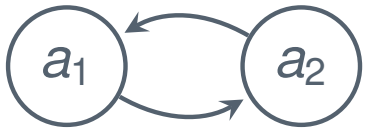

$VAF = \langle A, R, V, val \rangle$ with

- $A = \{a_1, a_2\}$
- $R = \{(a_1, a_2), (a_2, a_1)\}$
- $V = \{\text{env}, \text{eco}\}$
- $val(a_1) = \text{env}$, $val(a_2) = \text{eco}$
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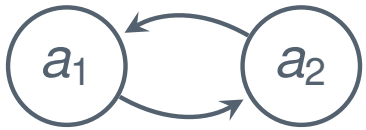

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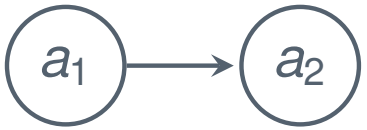

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Bipolar Argumentation
[Amgoud *et al* 2008]

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Bipolar Argumentation
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- pure support graphs also exist (*e.g.* recommendation letter, job application,. . .)

- Concepts like conflict-freeness and admissibility are generalized for this setting, then semantics can also be defined (see [Amgoud *et al* 2008] for technical details)

Abstract Dialectical Frameworks
[Brewka and Woltran 2010]

- Abstract entities are called **statements**
- Statements can be linked together
- Each statement s_i is associated with a propositional formula built on other statements s_j s.t. there is a **link** from s_j to s_i
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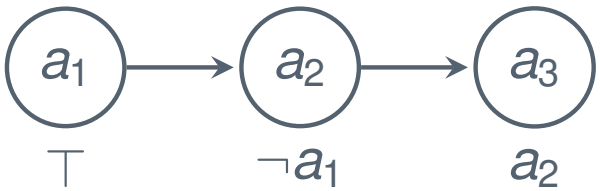

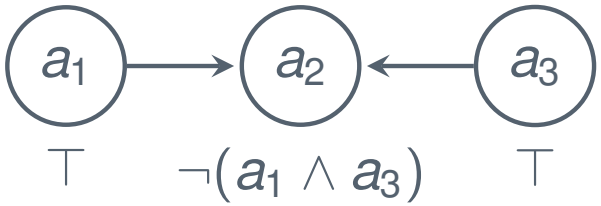

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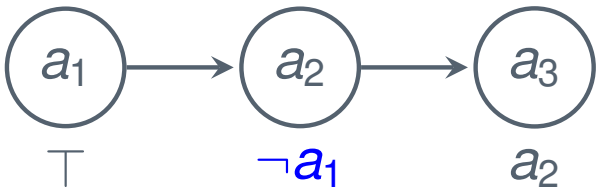

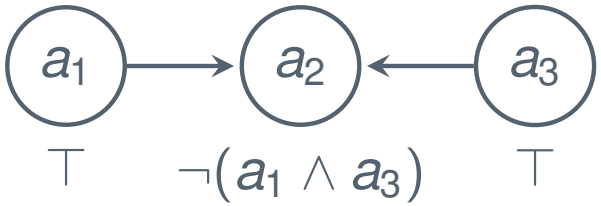

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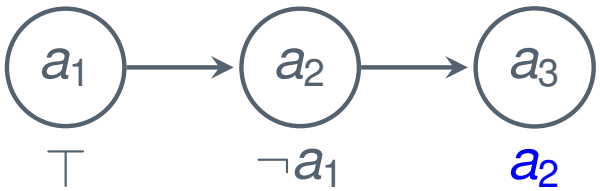

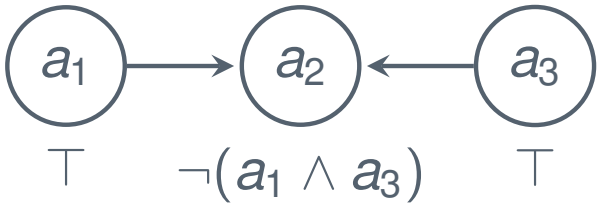

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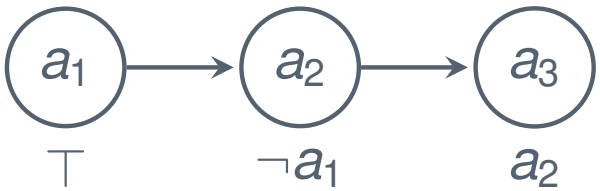

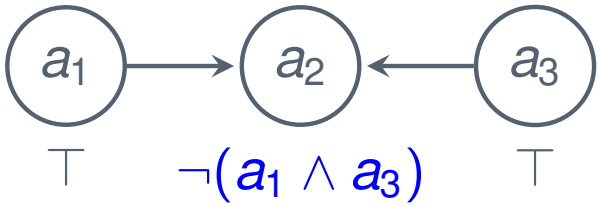

Content

The dynamics

- Given:

  the stable semantics produces as set of extensions: $\{\{a_1, a_3\}\}$

- Consider the following **constraints**:
  1. a new argument a_4 must be added
  2. argument a_1 must be removed
  3. a new attack from a new argument a_4 to argument a_1 must be added
  4. the attack from a_1 to a_2 must be removed
  5. a_2 must be in an acceptable set
  6. there must be several acceptable sets of arguments

- For each of these constraints:
  - What are all the **ways to enforce** it?
  - What are the **changes** implied by each of these enforcements?

Open Questions

Many challenging enforcement problems remain to be explored in **Dung**'s argumentation **framework**:

- **Semantic change**
  - As a result of the enforcement of a semantic constraint
  - Alone, as a means to enforce an acceptability constraint
  - Quality
- **Combination** of constraints, and of requirements on the quality of changes
- **Computational approaches**: quite recent for computing extensions, almost nothing for argumentation dynamics

Open Questions

Enforcement problems to be extended to **other** abstract **frameworks** and **semantics**:

- Adaptation to argumentation frameworks **other than Dung**'s one
- Investigation of constraints and changes in **ranking-based semantics**

Open Questions

Challenging problems have to be explored in **structured** argumentation **frameworks** as well:

- Constraints and changes in structured argumentation frameworks
  - on the **underlying structure of arguments**, with possible impacts at the graph level
  - **at the graph level**, with possible impacts on the underlying structure of arguments

Argumentation and Applications

[Atkinson *et al* 2017] K. Atkinson, P. Baroni, M. Giacomin, A. Hunter, H. Prakken, C. Reed, G. Simari, M. Thimm and S. Villata, *Towards Artificial Argumentation*. AI Magazine. In press.

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[Salliou and Thomopoulos 2018] N. Salliou and R. Thomopoulos, *Je mange moins de viande ! Quels arguments ?*. Revue Viandes Produits Carnés, 2018.

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[ConArg] `http://www.dmi.unipg.it/conarg/`

[ArgTeach] `http://argteach.herokuapp.com/`

[Grafix] `http://www.irit.fr/grafix`

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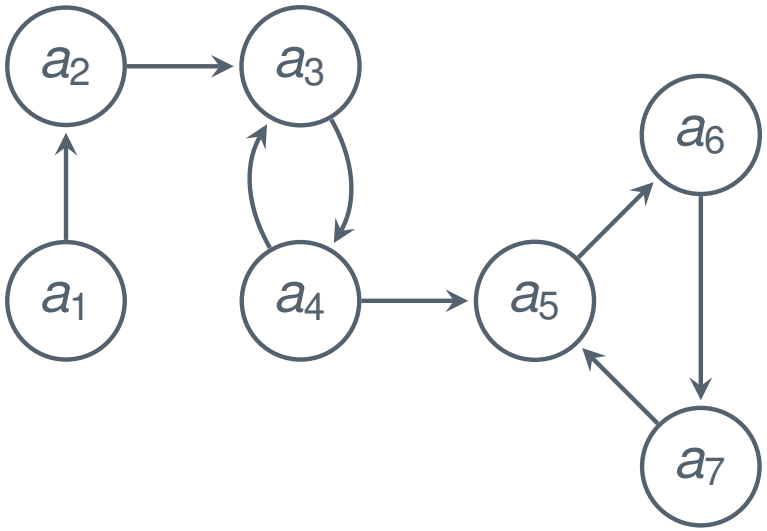
[Doutre and Mailly 2018] S. Doutre and J.-G. Mailly *Constraints and changes: A survey of abstract argumentation dynamics*. Argument and Computation 9(3), 223-248, 2018.

[Doutre *et al* 2014] S. Doutre, A. Herzig and L. Perrussel, *A Dynamic Logic Framework for Abstract Argumentation*. KR'14, 2014.

[Doutre and Mailly 2017] S. Doutre and J.-G. Mailly, *Semantic Change and Extension Enforcement in Abstract Argumentation*. SUM'17, 2017.

Appendix

- Graph example in the Aspartix format:



$\Rightarrow$ Can be used in [ConArg] and [ArgTeach]

```
arg(a1).
arg(a2).
arg(a3).
arg(a4).
arg(a5).
arg(a6).
arg(a7).
att(a1,a2).
att(a2,a3).
att(a3,a4).
att(a4,a3).
att(a4,a5).
att(a5,a6).
att(a6,a7).
att(a7,a5).
```