Argumentation Meets Computational Social Choice

PART I: Preservation of Semantic Properties

Verifying Semantics in Incomplete AFs

PART II: Gradual Acceptance in Argumentation

PART III: Rationalization

Discussion and Outlook

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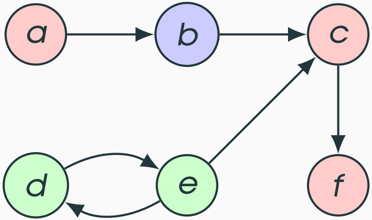
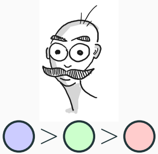
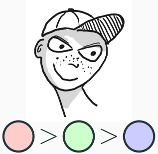
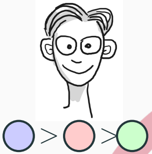
Value-based Argumentation Framework

Audience-specific value-based argumentation framework (AVAF)





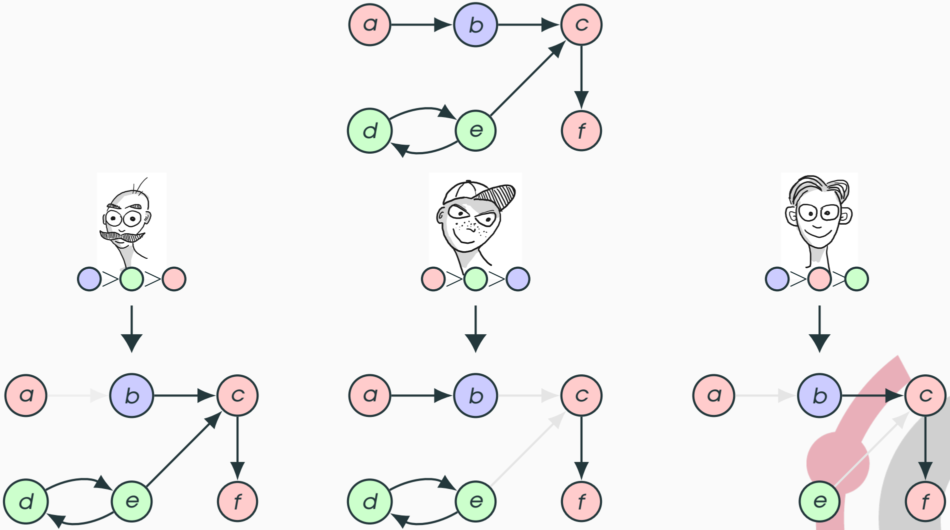




a defeats $b \Leftrightarrow (a, b) \in \mathcal{R}$ and $val(b) \not> val(a)$

T. Bench-Capon. “Persuasion in practical argument using value-based argumentation frameworks”. In: *Journal of Logic and Computation* 13.3 (2003), pp. 429–448.

AVAF - Individual Views



Audience-specific value-based argumentation framework (AVAF)

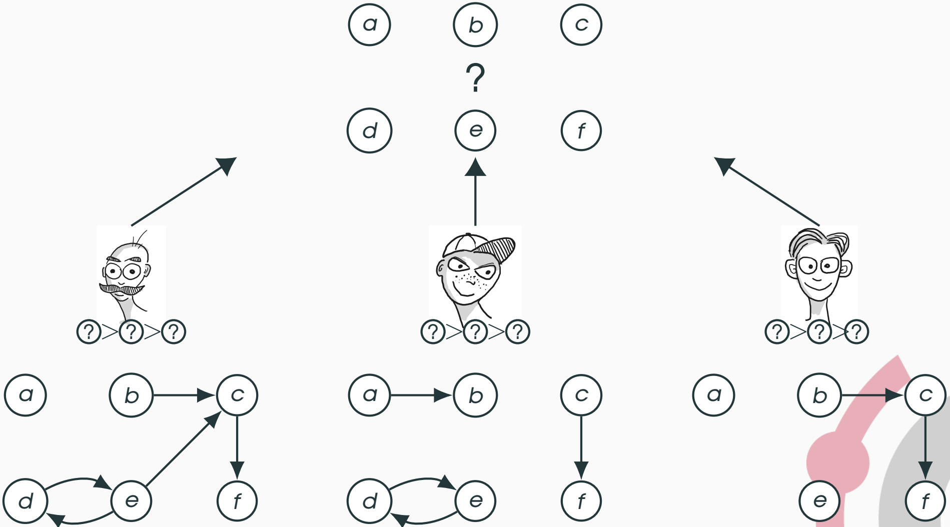
AVAF:

- $AF = \langle A, R \rangle$ with:
  - A: arguments
  - $R \subseteq A \times A$: attack relation
- Val: finite set of values
- $val : A \rightarrow Val$, assigns a label to each argument
- $(>_1, \ldots, >_n)$: preference orders of the agents on Val.

- Agents can express preferences over arguments
- Each agent has an individual view on the given AF
- Attack relation is not the only possible truth
- Agents can declare forbidden values

Rationalization

Rationalization



Rationalization

Given the individual AFs of the agents, can they be derived from some master AF?

Possible choices:

- Values and assignment to arguments
- Individual preferences over the values
- Master attack relation

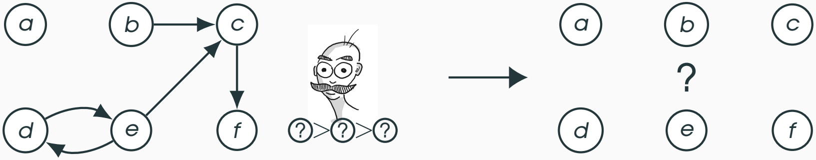
Motivation:

- Agents become aware of a subset of the arguments
- They choose the attacks from the master AF that do not contradict with their preferences
- Rationalizability is a justification to aggregate the underlying preferences and then infer the aggregated defeats from the master attack relation.

S. Airiau et al. "Rationalisation of Profiles of Abstract Argumentation Frameworks: Characterisation and Complexity". In: *Journal of Artificial Intelligence Research* 60 (2017), pp. 149–177.

Single Agent

Without constraints rationalization is always possible.



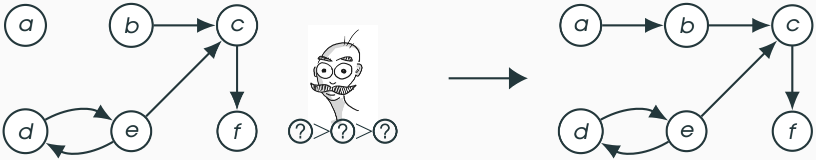
- Master AF equals individual AF
- Values can be chosen arbitrarily
- Preference is indifferent between any two values.

Constraints involving only *Val* or *val* are also trivial.

$\Rightarrow$ Non-trivial instances: constraints on the master attack relation.

Rationalizability with a **fixed master attack-relation** can be decided in polynomial time.

⇒ Compatibility of a given AF with some ground truth



Possible choices:

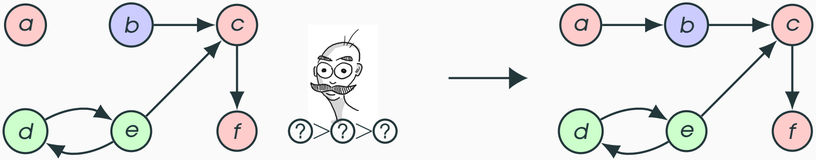
- Values and assignment to arguments
- Individual preferences over the values

Single AF is rationalizable if and only if

- there are no new edges in the individual AF,
- the preference order has to delete all edges not contained in the individual AF, and
- the preference order does not delete edges that should stay.

Single Agent - Constraints II

Rationalizability with a **fixed master attack-relation** and **fixed value-labeling** can be decided in polynomial time.



Possible choices:

- Individual preferences over the values

Single AF is rationalizable if and only if

- there are no new edges in the individual AF,
- the preference order has to delete all edges not contained in the individual AF, but attacks between arguments with the same label cannot be removed, and
- the preference order does not delete edges that should stay.

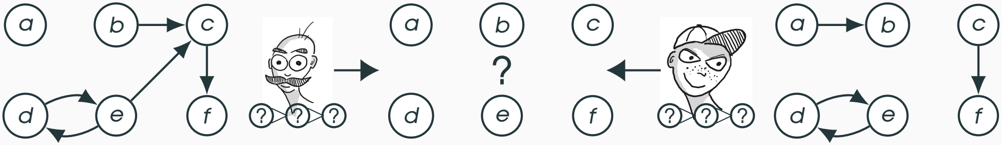
Rationalizability can be decided in polynomial time in the following case:

- single agent,
- fixed master attack-relation,
- upper bound on the number of values, and
- complete preference order.

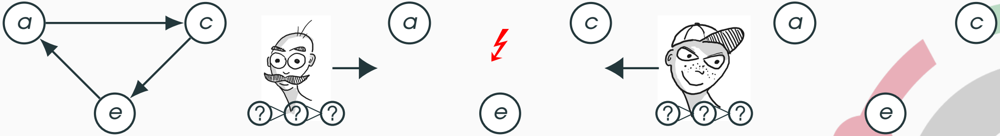
Proof by an integer program with at most two variables per inequality.

Open question: incomplete preferences

Multiagent



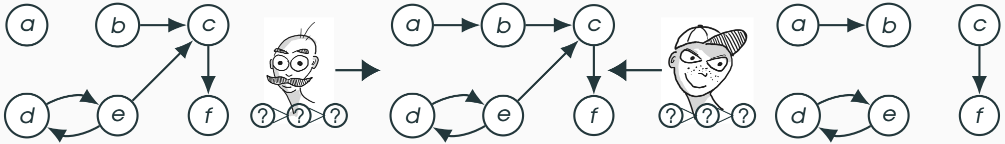
Can the positive results from the single agent case be transferred to the multiagent case?



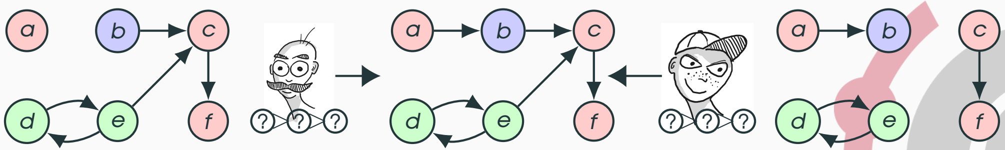
Multiagent - Decomposition

Is it possible to decompose the problem into single-agent rationalizability problems?

Only the **master attack-relation** is fixed ⇒ solve problems independently, verify global solution



Only the **master attack-relation** and the **value-labeling** are fixed ⇒ solve problems independently, verify global solution



Multiagent - Constraints I

Deciding rationalizability is NP-complete for the following case:

- fixed master attack-relation
- upper bound on the number of values (≥ 3)

Proof by a reduction from Graph Coloring.

The proof constructs complete preferences.

Open question: upper bound of 2 on the number of values

(Graph Coloring with 2 colors is in P)

Open question: all agents are aware of the same arguments

(In the above proof different agents may be aware of different sets of arguments)

BUT: Deciding rationalizability is in P for the following case:

- fixed master attack-relation
- upper bound on the number of values (≤ 2)
- there is a common set of arguments

Rationalizability under Expansion Semantics

Standard semantics:

1. agents consider a subset of all arguments
2. attack relation: inferred from master attack-relation with individual preferences

Expansion semantics:

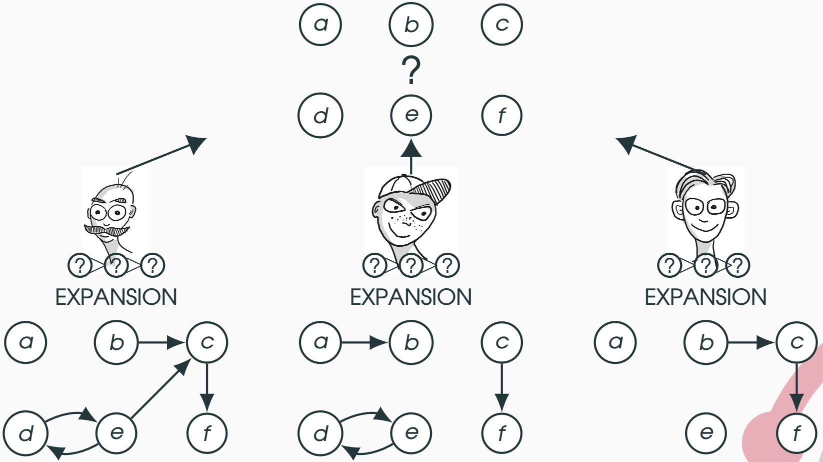
1. reduce master-attack relation according to individual preferences
2. choose a subset of the arguments

For the same set of arguments both definitions coincide.

Rationalizability under expansion semantics:

- expansion of each individual AF that contains all arguments
- rationalize set of expansions under standard semantics

Rationalizability under Expansion Semantics



Expansion

If there are no constraints on the expansion it holds:

rationalization is possible under standard semantics

$\Leftrightarrow$

rationalization is possible under expansion semantics.

Types of expansion:

- **Maximal expansion**: accept **all** attacks from the master attack-relation involving unreported arguments
- **Minimal expansion**: accept **no** attacks from the master attack-relation involving unreported arguments

For the case of maximal expansions and complete preferences standard semantics and expansion semantics may differ.

For a **fixed master attack-relation** and **maximal expansions** it holds again:

rationalization is possible under standard semantics $\Leftrightarrow$ rationalization is possible under expansion semantics.

Discussion and Outlook

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Argumentation theory can benefit from COMSOC methods:

- by preserving semantic properties when aggregating argumentation frameworks
- by verifying semantics in *incomplete* argumentation frameworks
- by applying social welfare functions to rankings obtained through ranking semantics
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Results include:

- **Characterization results:** Which aggregation rule satisfies which combination of semantic properties? Under which conditions is rationalization possible?
- **Impossibility results:** Only dictatorships can preserve the most demanding semantic properties
- **Complexity results:** Completeness of natural problems in the lower levels of the polynomial hierarchy

Discussion and Outlook II

Open questions:

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- *Connection between AF aggregators* and social welfare functions for given ranking semantics
- *Decide rationalizability*
  - for a single agent with a fixed master attack-relation, an upper bound on the number of values and incomplete preferences
  - in the multiagent case with a fixed master attack-relation and a maximum of two values
  - in the multiagent case with a fixed master attack-relation and a common set of arguments for all