Rationalisation of Profiles of Abstract Argumentation Frameworks

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Motivation

Central question in MAS research is how to aggregate diverse "views" of several agents. Also relevant: what diversity is actually possible?

We consider this second, less commonly asked question:

- we model "views" as abstract argumentation frameworks
- individual view is mix of "facts" and "preferences"
- can we *rationalise* diverse observations by disentangling them?

Talk Outline

- Background: *value-based* variant of *abstract argumentation*
- Concept: formal definition of the *rationalisability problem*
- Results: *single-agent case* and *multiagent case*

Value-Based Argumentation

An *argumentation framework* $AF = \langle Arg, \rightharpoonup \rangle$ consists of a finite set of *arguments* Arg and a binary *attack-relation* $\rightharpoonup$.

An *audience-specific value-based AF* $\langle Arg, \rightharpoonup, Val, val, \succcurlyeq \rangle$ consists of an AF $\langle Arg, \rightharpoonup \rangle$, a *labelling* $val : Arg \rightarrow Val$ of arguments with *values*, and a (reflexive and transitive) *preference order* $\succcurlyeq$ on Val.

Argument A *defeats* B ($A \rightleftharpoons B$) if $A \rightharpoonup B$ but $val(B) \not\succ val(A)$. Note that $\langle Arg, \rightleftharpoons \rangle$ is itself just another AF.

P.M. Dung. On the Acceptability of Arguments and its Fundamental Role in NMR, LP and n-Person Games. *Artificial Intelligence*, 77(2):321–358, 1995.

T.J.M. Bench-Capon. Persuasion in Practical Argument Using Value-Based Argumentation Frameworks. *Journal of Logic and Computation*, 13(3):429–448, 2003.

The Rationalisability Problem

Given n *agents* and a *profile* of AF's $(\langle Arg_1, \rightharpoonup_1\rangle, \ldots, \langle Arg_n, \rightharpoonup_n\rangle)$ the *rationalisability problem* asks whether there exist:

- a master attack-relation $\rightharpoonup$ on $Arg = Arg_1 \cup \cdots \cup Arg_n$
- a set of values Val and a value-labelling $val : Arg \rightarrow Val$
- a profile of preference orders $(\succcurlyeq_1, \ldots, \succcurlyeq_n)$

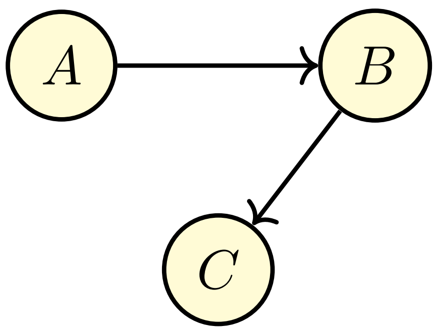
such that $A \rightharpoonup_i B$ <u>iff</u> $A \rightharpoonup B$ but $val(B) \not\succ_i val(A)$ [for all i, A, B].

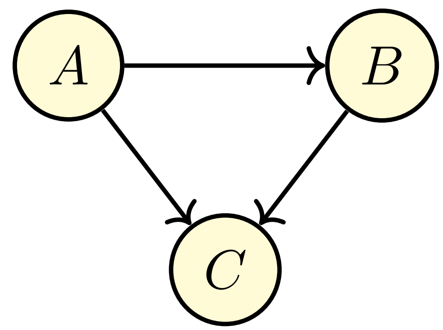
We may also wish to impose certain *constraints* on allowed solutions.

Example: Single-Agent Case

Let $Arg = \{A, B, C\}$. Suppose the master attack-relation $\rightharpoonup$ is fixed.

observed defeat-relation $\rightleftharpoons$ fixed master attack-relation $\rightharpoonup$





Can you rationalise $\rightleftharpoons$ in terms of $\rightharpoonup$ using . . .

- up to *two* values?
- up to *three* values?
- up to *three* values and a *complete* preference order?

Results

Single-Agent Case

- alway rationalisable if *no constraints*
- easy-to-check characterisation if master *attack*-relation $\rightharpoonup$ given
- polynomial algorithm if $|Val| \leqslant k$ and *complete* $\succcurlyeq$ required [but complexity is open problem for possibly *incomplete* $\succcurlyeq$]

Multiagent Case

- identified certain conditions for *decomposability* ($\Rightarrow$ polynomial)
- rationalisability is *NP-complete* if $|Val| \leqslant k$ required [for $k \geqslant 3$]
  - restriction to *complete* $\succcurlyeq_i$'s makes no difference
  - open problem in case we require $Arg_1 = \cdots = Arg_n$
  - *polynomial* for $k \leqslant 2$ [not in paper] and $|Arg| - k$ *constant*

Last Slide

We have introduced the *rationalisability problem* for a given profile of argumentation frameworks, one for each agent in a multiagent system:

- identified various cases that admit *polynomial algorithms*
- but multiagent case with bound on values is *NP-complete*
- several *open problems* regarding complexity

Definition of the rationalisability problem in terms of Bench-Capon's *value-based* argumentation frameworks, but basic idea is general.

Possible *application* scenarios:

- to determine relevant profiles for research on aggregating AF's
- if rationalisable, we can use preference aggregation instead
- to spot inconsistencies on online debating platforms