Integrating Argumentation and Social Choice: Three Ideas

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Argumentation and Social Choice Theory

SCT is the study of mechanisms of collective decision making, such as voting rules, fair division protocols, judgment aggregation rules, . . .

Three ideas for integrating *argumentation* and *SCT:*

[⇒] (logic-based) argumentation applied to SCT:

- arguing about voting rules

[⇐] SCT applied to (abstract) argumentation:

- aggregating argumentation frameworks
- rationalisability of profiles of argumentation frameworks

Three slides per idea: the *idea*, an *example*, some early *results*.

Idea 1: Arguing about Voting Rules

Maybe we can use tools from argumentation theory to enable a computer-supported debate about voting rules:

- to support a group choosing a suitable voting rule for themselves
- to justify or explain an election outcome to someone

This is joint work with Olivier Cailloux (Paris).

O. Cailloux and U. Endriss. Arguing about Voting Rules. Proc. AAMAS-2016.

Example

Voter 1:	$A \succ B \succ C$
Voter 2:	$A \succ B \succ C$
Voter 3:	$C \succ B \succ A$

A wins under *Borda*, but B wins under *Veto*. Suppose we want our system to provide a justification for A winning this election.

System: Take the *red subprofile*. Here, *A should win*, right? [unanimity]

User: Obviously!

System: Now consider the *green subprofile*. For symmetry reasons, there should be a *three-way tie*, right? [cancellation]

User: Sounds reasonable.

System: So, as there was a three-way tie for the green part, the red part should decide the overall winner, right? [reinforcement]

User: Yes.

System: To summarise, you agree that A should win.

Results

We have defined a general *logic-based language* $\mathcal{L}$ for speaking about the (desired) behaviour of a voting rule (for m alternatives) .

It's simply classical propositional logic with atoms of this form:

"if the profile is $\boldsymbol{R}$, then elect an alternative from the set S"

In principle, you can express anything about a voting rule in $\mathcal{L}$ and you can prove anything that's true using, say, natural deduction.

In practice, you cannot. But:

> We can, for any profile, automatically generate a *proof* that the *Borda winner* is the only reasonable winner given basic assumptions such as *reinforcement* and *cancellation*.

Idea 2: Aggregating Argumentation Frameworks

Suppose n *agents* each provide us with their own *attack-relation* $\rightharpoonup_i$ over a common set of *arguments* Arg.

To get a collective view, we want to *aggregate* using some *rule* F.
Our Focus: what *semantic properties* are *preserved* under aggregation?

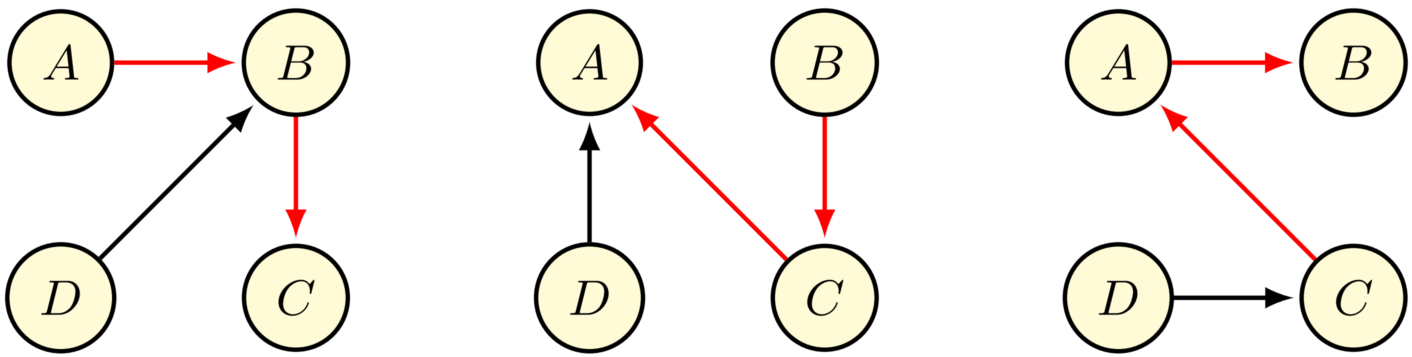
Joint work with Weiwei Chen (Guangzhou & Amsterdam), building on prior work with Umberto Grandi (Toulouse) on graph aggregation.

W. Chen and U. Endriss. Preservation of Semantic Properties during the Aggregation of Abstract Argumentation Frameworks. Working Paper, 2017.

U. Endriss and U. Grandi. Graph Aggregation. *Artif. Intell.*, 245:86–114, 2017.

Example

Three agents disagree on the attacks between four arguments:



What would be a good compromise? We could try the *majority rule*.

What *semantic properties* are *preserved* under aggregation?

- *acceptability of D* under the grounded semantics is preserved ✓
- *nonemptiness* of the grounded extension is preserved ✓
- no agreement on the *grounded extension* in the profile already (✓)
- *acyclicity* (avoiding semantic ambiguity) is lost ✗

Results

We have focussed on "simple" aggregation rules (e.g., quota rules).

Examples for results regarding the preservation of semantic properties:

- Every *grounded* aggregation rule preserves *conflict-freeness*.
- The only *quota rule* preserving *admissibility* is the *nomination rule*.
- Every *neutral* and *independent* aggregation rule that preserves *acyclicity* must give at least one agent the right to *veto* attacks.
- Every *unanimous*, *grounded*, *neutral*, and *independent* rule that preserves *grounded extensions* must be a *dictatorship*.

Disclaimer: Some results only true under certain conditions on $|Arg|$.

Idea 3: Rationalisability

For work such as ours, what profiles do you need to be able handle? For which profiles can we *rationalise* the diversity of views observed?

We make these assumptions:

- all agents agree on some factual *master attack-relation*
- all agents agree on what *social value* each argument relates to
- every agent has her own *preference relation* over such values

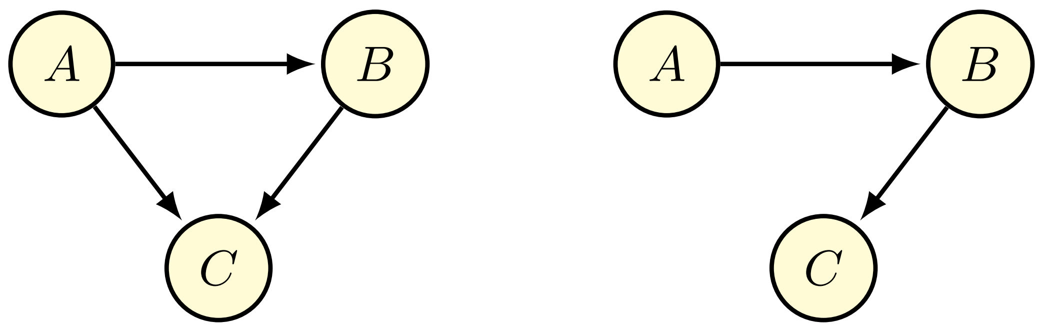
We say that a given profile is *rationalisable* if such components can be found so that every agent obtains her own attack-relation when she cancels the master attacks in conflict with her preferences.

This is joint work with Stéphane Airiau, Elise Bonzon, Nicolas Maudet, and Julien Rossit (all Paris).

S. Airiau, E. Bonzon, U. Endriss, N. Maudet, and J. Rossit. Rationalisation of Profiles of Abstract Argumentation Frameworks. Proc. AAMAS-2016.

Example

Two agents disagree on the attacks between three arguments:



Any suitable *master attack-relation* must include all three attacks.
So the *righthand agent* must have preferences $\succ_2$ that cancel $A \rightharpoonup C$:

$$val(C) \succ_2 val(A)$$

Thus, rationalisation is *impossible* in either one of these two cases:

- when preference relations must be complete
- when we may assume the existence of at most two distinct values

Results

Can we check efficiently whether a given profile can be rationalised?

Examples for complexity results for the rationalisability problem:

- *polynomial* if master attack-relation and value-labelling are given
- *NP-complete* if at most k values can be used (for $k \geqslant 3$)

Last Slide

Integrating argumentation and social choice is a promising undertaking. The transfer of knowledge can go in either direction.

We have discussed three ideas of this kind:

- arguing about voting rules (such as justifying election outcomes)
- aggregating argumentation frameworks (preservation of properties)
- checking rationalisability of profiles of argumentation frameworks