Control Argumentation Frameworks

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Plan

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Background: Dung's Framework

Control Argumentation Framework

Conclusion

Dung's Framework [Dung 1995]

- **AFs** $F = (A, R)$, A: arguments and $R \subseteq A \times A$: attacks
- **Extension**: set of jointly acceptable arguments
- **Credulous/Skeptical acceptance**: an argument is accepted if it belongs to at least one/each extension

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Dung's Framework [Dung 1995]

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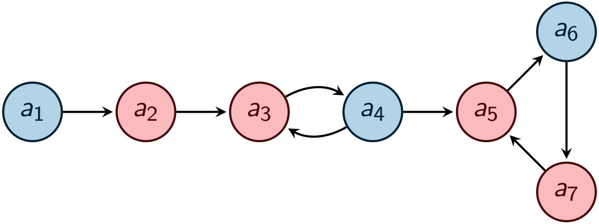
Many semantics. Here we exemplify with stable semantics:

- A set $S \subseteq A$ is **cf** w.r.t. F if $\nexists a_i, a_j \in S$ s.t. $(a_i, a_j) \in R$;
- A set $S \in cf(F)$ is **st** w.r.t. F if $\forall a_j \in A \backslash S$, S attacks a_j.

Example



$st(F) = \{\{a_1, a_4, a_6\}\}$

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Intuition

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- This evolution can be a threat for some goal (e.g. an argument supporting a decision to be accepted)
- Can the agent deal with the effects of these threats?

Classical Argumentation Dynamics vs CAFs

- "Classical" Argumentation Dynamics:

$$\left.\begin{array}{c} F = \langle A, R \rangle \\ \text{Constraint} \end{array}\right\} \implies F' = \langle A', R' \rangle \text{ which satisfy the constraint}$$

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Classical Argumentation Dynamics vs CAFs

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- CAF: anticipating possible changes, to protect some goal from the threats represented by the changes

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What is a CAF?

A CAF is an argumentation framework where arguments are divided in three parts: *fixed*, *uncertain* and *control*.

- **fixed** background knowledge about a static environment
- **uncertain** changes that may occur in the environment
- **control** possible actions of the agent

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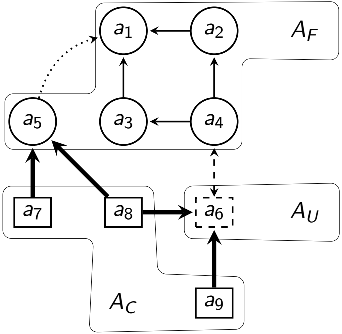
CAF by Example



- Fixed part: circle arguments + "normal" arrows
- Uncertain part:
  - dashed arguments
  - dotted arrows
  - two-heads dashed arrows
- Control part: square arguments + bold arrows

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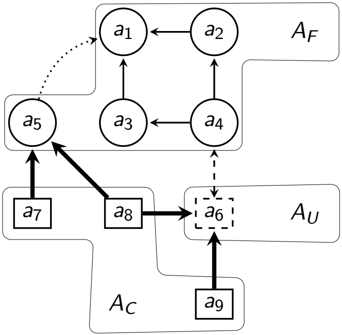
CAF by Example



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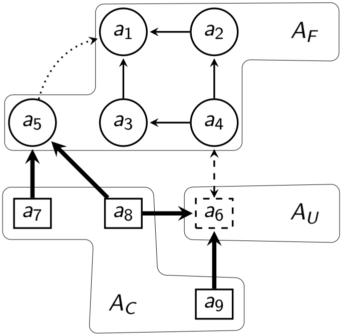
- certain knowledge: always exist

CAF by Example



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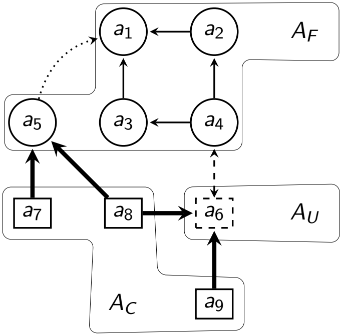
- the argument could exist, or not

CAF by Example



- the attack could exist, or not

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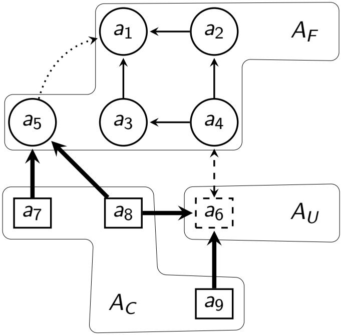
CAF by Example



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- the attack exists (if both arguments exist), but we are not sure of the direction

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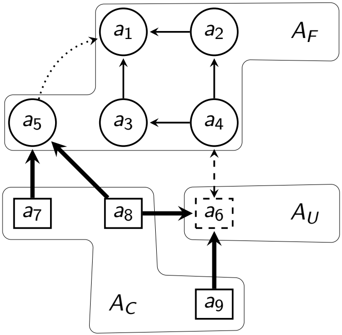
CAF by Example



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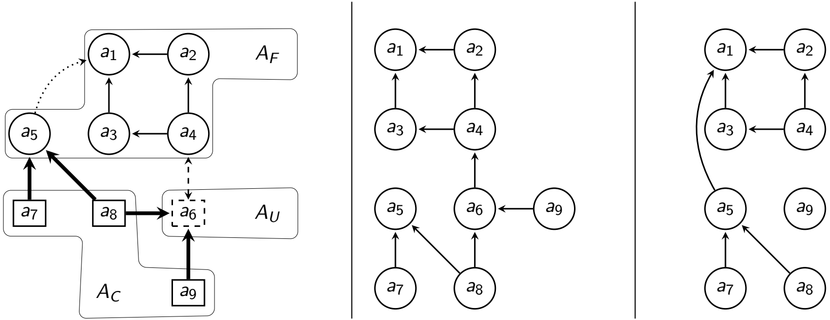
  - exist only if the agent selects the arguments

Completions

A completion is a classical AF which is “compatible” with the CAF



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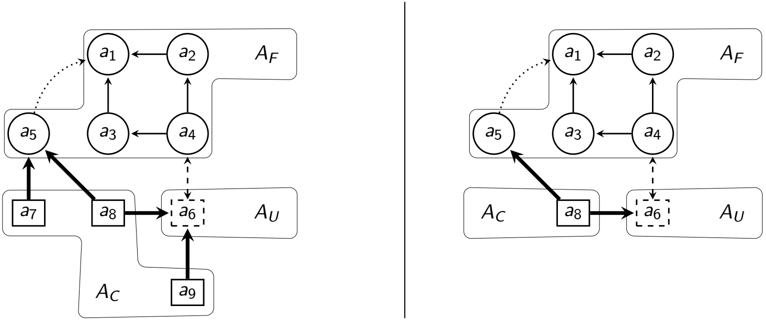
Control Configuration

- A control configuration is a subset $A_{conf} \subseteq A_C$
- A configured CAF: remove from the initial CAF the arguments $A_C \backslash A_{conf}$ (and their attacks)



Example: In the CAF configured by $A_{conf} = \{a_8\}$, $T = \{a_1\}$ is accepted whatever the completion

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Formal Definition of Controllability

Given

- a target $T \subseteq A_F$
- a semantics σ

$\mathcal{CAF}$ is skeptically (resp. credulously) *controllable* w.r.t. T and σ if $\exists A_{conf} \subseteq A_C$ s.t.

- $\mathcal{CAF}'$ is the result of configuring $\mathcal{CAF}$ by A_{conf}
- T is included in every (resp. at least one) σ-extension of every completion of $\mathcal{CAF}'$

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We say that T is a skeptical (resp. credulous) conclusion of $\mathcal{CAF}$

First Results on Complexity

Simplified Control Argumentation Framework

We call Simplified Control Argumentation Framework (SCAF) a CAF with an empty uncertain part.

Skeptical (resp. Credulous) Conclusion Problem

- Input: $\mathcal{CAF}$, $q \in A_F$
- Decision: Is $\{q\}$ a skeptical (resp. credulous) conclusion of $\mathcal{CAF}$?

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	Skeptical Conclusion	Credulous Conclusion
CAFs	$\in \Sigma_2^{\mathrm{P}}$	Σ_2^{P}-hard, $\in \Sigma_3^{\mathrm{P}}$
SCAFs	NP-hard	NP-complete

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Summary

- New framework to tackle argumentation dynamics under uncertainty
  - Generalizes existing work on argumentation dynamics
  - Generalizes existing work on uncertainty in argumentation
- Preliminary complexity results
- Not in the talk: QBF-based method to decide controllability (and compute the control configuration, if it exists)

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Future work

Short term

- More detailled results about complexity (completeness, other semantics)
- Implementation (work in progress)

Mid term

- Application to concrete scenario (negotiation, risk management, design of self-adaptive systems,...)
- Optimization version: what to do when the CAF is not controllable?

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- More complex models of uncertainty (probabilities?)
- Structured CAFs

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Thank you for your attention!