Imperial College London

ABA$^+$: Assumption-Based Argumentation with Preferences

Cardiff Argumentation Forum

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Argumentation with Preferences

Ways to account for preferences:

- Encode within existing components
- Discard attacks
- Compare extensions

1. Encode preferences within existing components

- Preferences as assumptions [Kowalski and Toni, 1996]
- (Sets of) sentences into assumptions and rules [Thang and Luong, 2014]

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Issues:

- concision
- modularity
- generalizability

2. Discard attacks

Given $(Args, \rightsquigarrow, \leqslant)$: if $A \rightsquigarrow B$ and $A < B$, then $A \not\rightsquigarrow B$.

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- Abstract Argumentation
  [Amgoud and Cayrol, 2002, Bench-Capon, 2003, Kaci and van der Torre, 2008]
- Structured argumentation
  [Prakken and Sartor, 1999, Besnard and Hunter, 2014, García and Simari, 2014, Modgil and Prakken, 2014]

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Issues:

- conflict-freeness
- restrictions

3. Compare extensions

Lift preferences to the extension level from:

- the argument level [Amgoud and Vesic, 2011] (AA);
- the object level [Wakaki, 2014] (ABA).

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Issues:

- absence of extensions
- 'wrong' extensions
- preference aggregation

Omissions

- *Encode within/discard attacks [Modgil, 2009, Baroni et al., 2011, Brewka and Woltran, 2010]
- Bipolar Argumentation Frameworks [Amgoud et al., 2004]
- [Villata et al., 2012]: AA with prioritized support
- [Dunne et al., 2011]: weighted attacks, inconsistency budget
- [Booth et al., 2013]: arguments with properties, motivational states, weighting relation

Attack Reversal in Abstract Argumentation

Proposed for AA: *(Rich) PAFs* [Amgoud and Vesic, 2014].

Given $(Args, \rightsquigarrow, \leqslant)$: if $A \rightsquigarrow B$ and $A < B$,
then $A \not\rightarrow B$ and $B \hookrightarrow A$.

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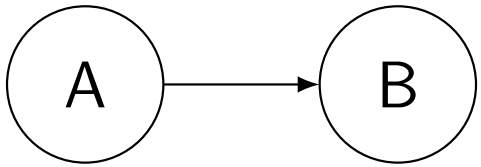
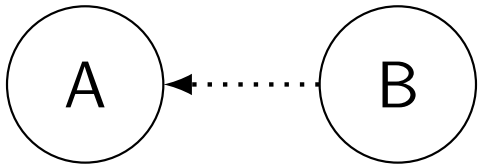
Example

$Args = \{A, B\}$, $A < B$:

$(Args, \rightsquigarrow, \leqslant)$



$(Args, \hookrightarrow)$



Attack Reversal in Structured Argumentation

- Assumption-Based Argumentation (ABA)
  [Bondarenko et al., 1997, Dung et al., 2009, Toni, 2014]

- ABA$^+$ [Čyras and Toni, 2016a, Čyras and Toni, 2016b]:
  ABA with preferences over assumptions

ABA

- ABA framework $(\mathcal{L}, \mathcal{R}, \mathcal{A}, \overline{\ })$:
  - deductive system $(\mathcal{L}, \mathcal{R})$;
  - assumptions $\mathcal{A} \subseteq \mathcal{L}$;
  - contrary mapping $\overline{\ } : \mathcal{A} \to \mathcal{L}$.
- Tree-like deductions $S \vdash^R \varphi$
- Attacks as deductions for contraries
- Semantics: extensions as sets of assumptions

ABA$^+$

- ABA$^+$ framework $(\mathcal{L}, \mathcal{R}, \mathcal{A}, \overline{\ }, \leqslant)$:
  - ABA framework $(\mathcal{L}, \mathcal{R}, \mathcal{A}, \overline{\ })$;
  - transitive binary $\leqslant$ on $\mathcal{A}$.

ABA$^+$

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  - ABA framework $(\mathcal{L}, \mathcal{R}, \mathcal{A}, \overline{\ })$;
  - transitive binary $\leqslant$ on $\mathcal{A}$.
- New attack relation $\rightsquigarrow_<$:
  - if A $\rightsquigarrow$ B ('on $\beta \in$ B') and no $\alpha \in$ A with $\alpha < \beta$, then A $\rightsquigarrow_<$ B;
  - if A $\rightsquigarrow$ B ('on $\beta \in$ B') and some $\alpha \in$ A has $\alpha < \beta$, then B $\rightsquigarrow_<$ A.

ABA vs. ABA$^+$

Formally

- $A \subseteq \mathcal{A}$ **attacks** $B \subseteq \mathcal{A}$ just in case:
  $A' \vdash^R \overline{\beta}$, for some $\beta \in B$ and $A' \subseteq A$,

ABA vs. ABA$^+$

Formally

- $A \subseteq \mathcal{A}$ $<$-**attacks** $B \subseteq \mathcal{A}$ just in case:
  - either $A' \vdash^R \overline{\beta}$, for some $\beta \in B$ and $A' \subseteq A$,
    and $\forall \alpha' \in A'$ we have $\alpha' \not< \beta$;

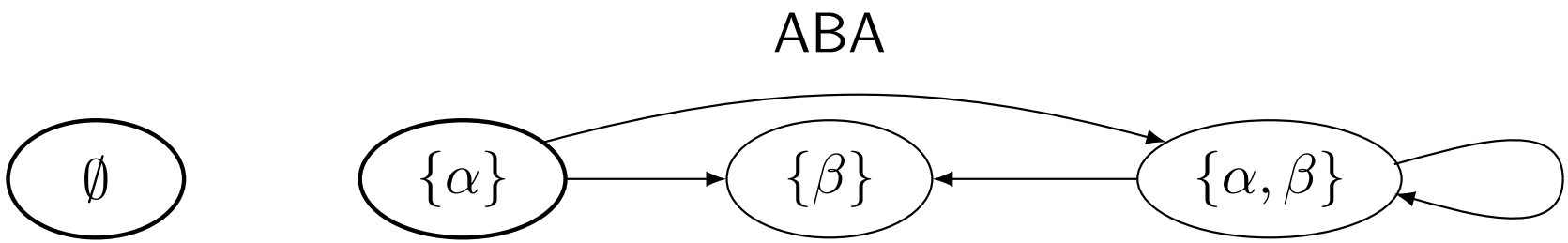
ABA vs. ABA$^+$

Formally

- $A \subseteq \mathcal{A}$ **$<$-attacks** $B \subseteq \mathcal{A}$ just in case:
  - either $A' \vdash^R \overline{\beta}$, for some $\beta \in B$ and $A' \subseteq A$, and $\forall \alpha' \in A'$ we have $\alpha' \not< \beta$;
  - or $B' \vdash^{R'} \overline{\alpha}$, for some $\alpha \in A$ and $B' \subseteq B$, and $\exists \beta' \in B'$ with $\beta' < \alpha$.

Simple Example

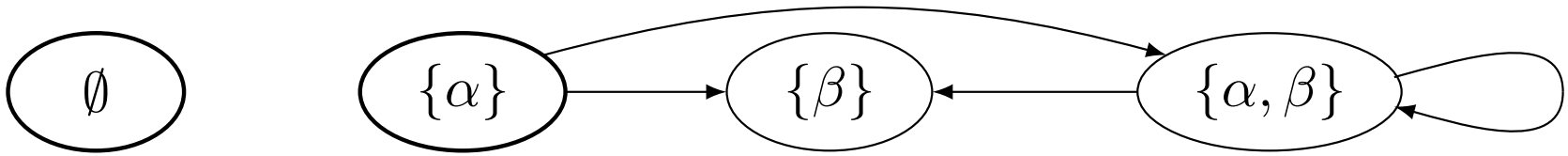
$$\mathcal{L} = \{\alpha, \beta, \overline{\alpha}, \overline{\beta}\},\ \mathcal{R} = \{\overline{\beta} \leftarrow \alpha\},\ \mathcal{A} = \{\alpha, \beta\}$$



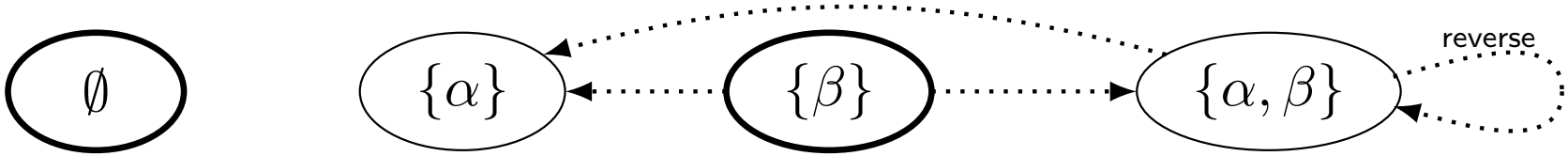
Simple Example

$\mathcal{L} = \{\alpha, \beta, \overline{\alpha}, \overline{\beta}\}$, $\mathcal{R} = \{\overline{\beta} \leftarrow \alpha\}$, $\mathcal{A} = \{\alpha, \beta\}$, $\alpha < \beta$.

ABA



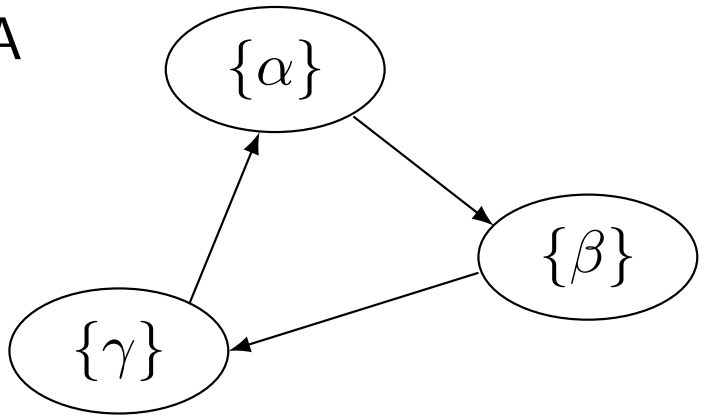
ABA$^+$



Cycle

$$\mathcal{R} = \{\overline{\beta} \leftarrow \alpha;\ \overline{\gamma} \leftarrow \beta;\ \overline{\alpha} \leftarrow \gamma\},\ \mathcal{A} = \{\alpha, \beta, \gamma\},$$

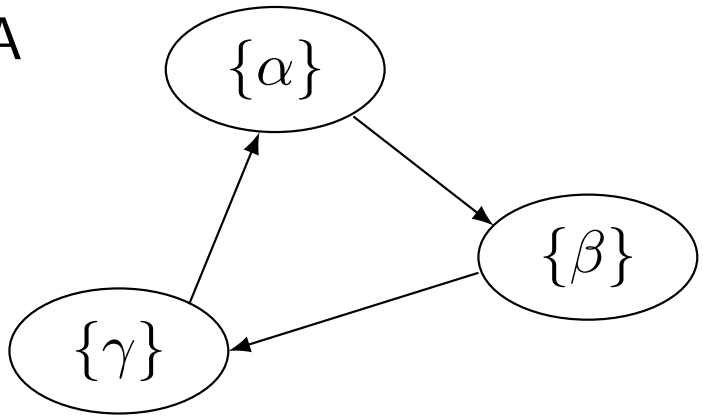
ABA



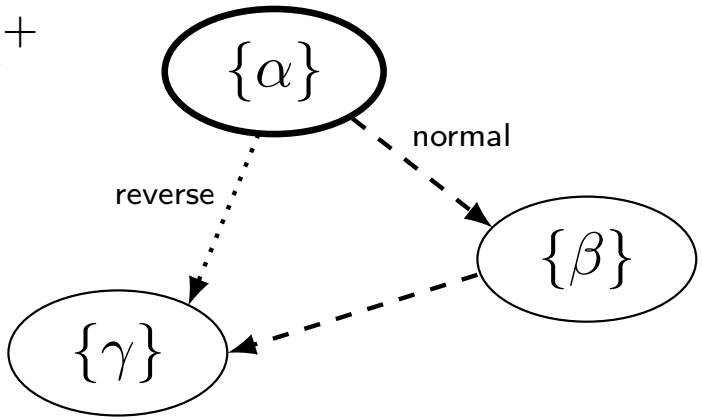
Cycle

$\mathcal{R} = \{\overline{\beta} \leftarrow \alpha;\ \overline{\gamma} \leftarrow \beta;\ \overline{\alpha} \leftarrow \gamma\}$, $\mathcal{A} = \{\alpha, \beta, \gamma\}$, $\gamma < \beta < \alpha$.

ABA



ABA$^+$



Comparison

- ABA$^+$ generalizes PAFs [Amgoud and Vesic, 2014]

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- p_ABA [Wakaki, 2014] does not generate new extensions
- ASPIC$^+$ [Modgil and Prakken, 2014]:
  - contraries vs. contradictories, c-classicality, contraposition
  - different if no contraposition
  - . . . in between . . .
  - conjecture: instance if flat, contraposition, with elitist

ABA$^+$ So Far

ABA with $\preccurlyeq$ over assumptions:
reverses attacks by incorporating $<$ directly into $\rightsquigarrow$.

- conservative extension of ABA
- conflict preservation
- preference handling properties
- rationality postulates [Caminada and Amgoud, 2007]
- Fundamental Lemma holds with a weaker form of contraposition

Ongoing Work

- Relaxing contraposition
- Further comparison
  - contraposition: flat ABA$^+$ as an instance of ASPIC$^+$ with the elitist comparison ?
  - likewise for Deductive Argumentation [Besnard and Hunter, 2014] ?
  - map to PAFs with arguments as sets of assumptions

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