Basic beliefs and argument-based beliefs in awareness epistemic logic with structured arguments[a]

UNIVERSIDAD DE MÁLAGA

Alfredo Burrieza and Antonio Yuste-Ginel[b]

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Motivation

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  Believed sentences should be the conclusions of arguments considered somehow "good" by the agent.
- P2 Argument evaluation is conditioned by belief formation.
  Premisses that are believed should be preferred by the agent to premisses that are not believed.

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- P2 in **formal argumentation**: ordering premisses according to their reliability (Beirlaen et al., 2018).
- P2 in **epistemic justification logic**: acceptance of a complex piece of evidence (Baltag et al., 2012)= belief of its basic parts (premisses).

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$\mathcal{L}_{BA}$ and its semantics

Basic Beliefs and AB-Beliefs

Ongoing and future work

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$$\mid \mathsf{undercuts}(\alpha, \beta) \mid \mathsf{conc}(\alpha) = \varphi \mid \mathsf{strict}(\alpha) \qquad \alpha, \beta \in \mathsf{Ar}, p \in \mathbb{P}$$

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$$\alpha ::= \langle\varphi\rangle \mid \langle\alpha_1, ..., \alpha_n \twoheadrightarrow \varphi\rangle \mid \langle\alpha_1, ..., \alpha_n \Rightarrow \varphi\rangle \qquad \varphi \in \mathcal{L}_{\mathsf{BA}}$$

Single negation

$$\sim\varphi := \begin{cases} \psi & \text{if } \varphi \text{ is of the form } \neg\psi; \\ \neg\varphi & \text{otherwise.} \end{cases}$$

Argument Structure (Modgil and Prakken, 2014)

- $\mathsf{Prem}(\alpha)$ returns the *premisses* of α **Example:** $\mathsf{Prem}(\langle\langle\langle\langle p\rangle, \langle q\rangle \Rightarrow r\rangle \Rightarrow s\rangle \twoheadrightarrow s \vee t\rangle) = \{p, q\}$.
- $\mathsf{Conc}(\alpha)$ returns the *conclusion* of α **Example:** $\mathsf{Conc}(\langle\langle\langle\langle p\rangle, \langle q\rangle \Rightarrow r\rangle \Rightarrow s\rangle \twoheadrightarrow s \vee t\rangle) = s \vee t$.
- $\mathsf{sub}_{\mathsf{A}}(\alpha)$ returns the *subarguments* of α.
- $\mathsf{TopRule}(\alpha)$ returns the *top rule* of α **Example:** $\mathsf{TopRule}(\langle\langle\langle\langle p\rangle, \langle q\rangle \Rightarrow r\rangle \Rightarrow s\rangle \twoheadrightarrow s \vee t\rangle) = (s, s \vee t)$.
- $\mathsf{DefRule}(\alpha)$ returns the set of *defeasible rules* of α **Example:** $\mathsf{DefRule}(\langle\langle\langle\langle p\rangle, \langle q\rangle \Rightarrow r\rangle \Rightarrow s\rangle \twoheadrightarrow s \vee t\rangle) = \{((p, q), r), ((r), s)\}$.

$\mathcal{L}_{\mathsf{BA}}$-models and Truth i

A model for $\mathcal{L}_{\mathsf{BA}}$ is a tuple $M = (W, \mathcal{B}, \mathcal{O}, \mathcal{D}, \mathfrak{n}, ||\cdot||)$ where:

- $W \neq \emptyset$ (*possible worlds*)
- $\mathcal{B} \subseteq W$ and $\mathcal{B} \neq \emptyset$ (*doxastically indistinguishably worlds*)
  - $M, w \vDash \Box\varphi$ iff $w' \in \mathcal{B}$ implies $M, w' \vDash \varphi$
- $\mathcal{O} \subseteq_{\mathsf{fin}} \mathsf{Ar}$ (*awareness set of the agent*)
  - $M, w \vDash \mathsf{aware}(\alpha)$ iff $\alpha \in \mathcal{O}$
- $\mathcal{D} \subseteq_{\mathsf{fin}} \mathcal{L}^n_{\mathsf{BA}} \times \mathcal{L}_{\mathsf{BA}}$ (with $n \in \mathbb{N}$) (*accepted defeasible rules*).
  - $M, w \vDash \mathsf{wellshap}(\langle\varphi\rangle)$
  - $M, w \vDash \mathsf{wellshap}(\langle\alpha_1, ..., \alpha_n \twoheadrightarrow \varphi\rangle)$ iff $M, w \vDash \mathsf{wellshap}(\alpha_i)$ for every $1 \leq i \leq n$ and $\{\mathsf{Conc}(\alpha_1), ..., \mathsf{Conc}(\alpha_n)\} \vdash_0 \varphi$

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- $M, w \vDash \mathsf{wellshap}(\langle \alpha_1, ..., \alpha_n \Rightarrow \varphi \rangle)$ iff $M, w \vDash \mathsf{wellshap}(\alpha_i)$ for every $1 \leq i \leq n$ and $((\mathsf{Conc}(\alpha_1), ..., \mathsf{Conc}(\alpha_n)), \varphi) \in \mathcal{D}$
- $\mathfrak{n} : \mathcal{D} \to \mathbb{P}$ ((possibly partial) *naming function*), where $\mathfrak{n}(R)$ means "the defeasible rule R is applicable".
  - $M, w \vDash \mathsf{undercuts}(\alpha, \beta)$ iff $\mathsf{Conc}(\alpha) = \sim r$ and $\mathfrak{n}(\mathsf{TopRule}(\beta)) = r$
  - $M, w \vDash \mathsf{conc}(\alpha) = \varphi$ iff $\mathsf{Conc}(\alpha) = \varphi$
  - $M, w \vDash \mathsf{strict}(\alpha)$ iff $\mathsf{DefRule}(\alpha) = \emptyset$

Basic Beliefs and AB-Beliefs

Basic beliefs

(basic implicit belief) $\Box\varphi$

(basic explicit belief) $\Box^{\mathsf{e}}\varphi := \Box\varphi \wedge \mathsf{aware}(\langle\varphi\rangle)$

- "Positive" informal reading (reasonable assumptions, sound observations,...)
- "Negative" informal reading (biases,prejudices,...).

Attacks

- (undermining: attacking ordinary premisses)

$$\text{undermines}(\alpha, \beta) := \bigvee_{\varphi \in \mathsf{Prem}(\beta)} \text{conc}(\alpha) = \sim \varphi$$

- (rebuttal: attacking the conclusion)

$$\text{rebuts}(\alpha, \beta) := \bigvee_{\langle \beta_1, \ldots, \beta_n \hookrightarrow \varphi \rangle \in \mathsf{sub}_{\mathsf{A}}(\beta)} \text{conc}(\alpha) = \sim \varphi$$

where $\hookrightarrow \in \{\twoheadrightarrow, \Rightarrow\}$

- (undercutting: attacking the inference link)

undercuts is a primitive operator in $\mathcal{L}_{\mathsf{BA}}$:

$$M, w \vDash \text{undercuts}(\alpha, \beta) \text{ iff } \text{Conc}(\alpha) = \sim r \text{ and } \mathfrak{n}(\text{TopRule}(\beta)) = r$$

Attacks

- (undercutting*: attacking a defeasible inference link of some subargument)

$$\text{undercuts}^*(\alpha, \beta) = \bigvee_{\beta' \in \text{sub}_{\text{A}}(\beta)} \text{undercuts}(\alpha, \beta')$$

We are finally able to express what does it mean for an argument to attack another:

$$\text{attacks}(\alpha, \beta) := \text{undermines}(\alpha, \beta) \vee \text{rebuts}(\alpha, \beta) \vee \text{undercuts}^*(\alpha, \beta)$$

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- Use of preference

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Defeat and Associated AF

Defeat=successful attack, similar to ASPIC$^+$, except for:

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Given (M, w), where $M = (W, \mathcal{B}, \mathcal{O}, \mathcal{D}, \mathfrak{n}, ||\cdot||)$. The **AF associated to** (M, w) is $AF^M = (\mathcal{O}^{\mathsf{ws}}, \rightsquigarrow)$ where $\mathcal{O}^{\mathsf{ws}} := \{\alpha \in \mathcal{O} \mid M, w \vDash \mathsf{wellshap}(\alpha)\}$ and $\rightsquigarrow \subseteq \mathcal{O}^{\mathsf{ws}} \times \mathcal{O}^{\mathsf{ws}}$ is defined as $\alpha \rightsquigarrow \beta$ iff $M, w \vDash \mathsf{defeat}(\alpha, \beta)$

AB-Beliefs

A sentence φ **is argument-based believed in** (M, w), denoted as $M, w \models \mathsf{B}^{\mathsf{AB}}\varphi$, iff there is a $\alpha \in GE(AF^M)$ s.t. $\mathsf{Conc}(\alpha) = \varphi$.

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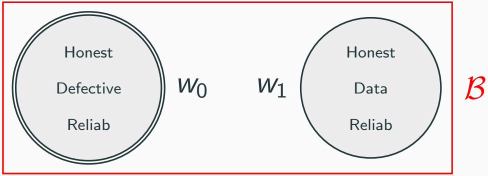
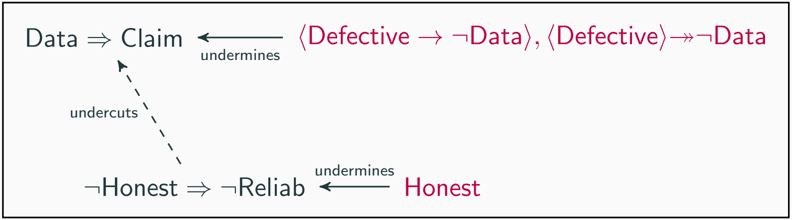
- B^{AB} cannot be captured in $\mathcal{L}_{\mathsf{BA}}$, therefore we need to enrich $\mathcal{L}_{\mathsf{BA}}$ with B^{AB}.

An example



AF^M



$GE(AF^M)$

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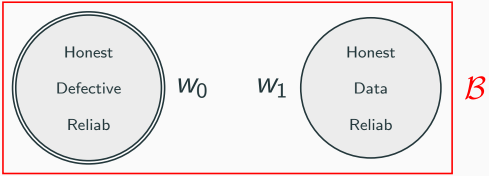

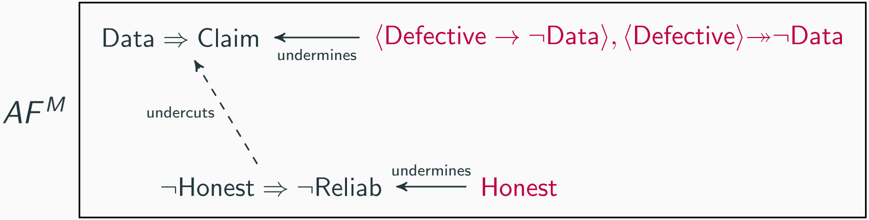

$GE(AF^M)$ $\quad$ $M, w \models \Box^e \text{Honest}$

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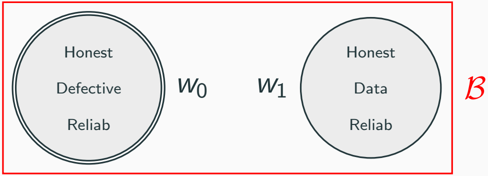

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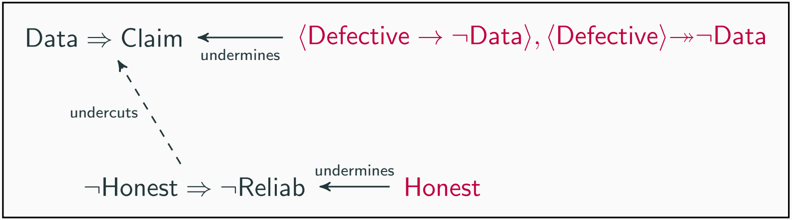

$GE(AF^M)$ $\qquad$ $M, w \vDash \neg \mathsf{B}^{AB}\mathsf{Claim}$

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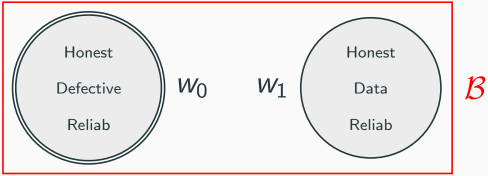

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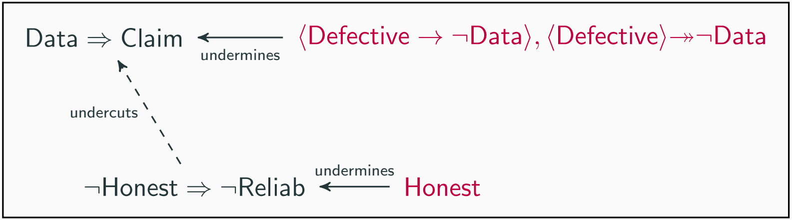

$GE(AF^M)$ $\quad$ $M, w \models \neg \mathrm{B}^{AB} \neg \mathrm{Claim}$

Ongoing and future work

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Thank you!

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