Persuasive Argumentation and Epistemic Attitudes

Carlo Proietti and Antonio Yuste-Ginel

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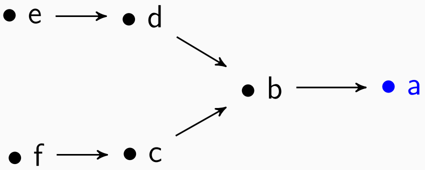
A bloody crime

Interrogation room. 1 is the main suspect. 2 is the detective.
These are the only relevant pieces of information:



a: "1 is innocent"

b: "1 was seen close to the crime scene"

c: "1 has a twin brother living in the city"

d: "1 works in a butcher's nearby"

e: "1 was fired from the butcher's a week ago"

f: "1's twin brother was in Venice last night"

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- What are the appropriate tools for capturing the epistemic component of persuasion?

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- Previous work (e.g.(Rahwan and Larson, 2009; Sakama, 2012)) have ignored this fact
- What are the appropriate tools for capturing the epistemic component of persuasion? **Proposal**: abstract argumentation + awareness DEL

Outline

AFs and Justification Status

Persuasiveness and Epistemic Persuasiveness

New Advances and Future Work

AFs and Justification Status

Definition (Dung (1995))

An argumentation framework (AF) is a pair $(A, \rightsquigarrow)$ where:

- $A \neq \emptyset$ and finite (*arguments*)
- $\rightsquigarrow \subseteq A \times A$ (*attack relation*)

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Including agents: a **TAF** is a tuple $(A, \rightsquigarrow, A_1, A_2)$ where $A_i \subseteq A$ and $i's$ **subgraph is defined** as $(A_i, \rightsquigarrow_i)$ with $\rightsquigarrow_i = \rightsquigarrow \cap (A_i \times A_i)$ for every $i \in \{1, 2\}$.

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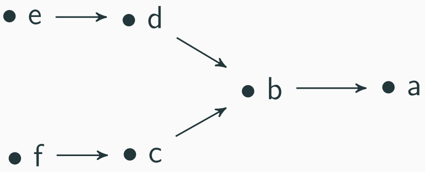
Pointed TAFs $(A, \rightsquigarrow, A_1, A_2, a)$ where $a \in A_1 \cap A_2$ are used to represent debate scenarios about a.

Example of TAF



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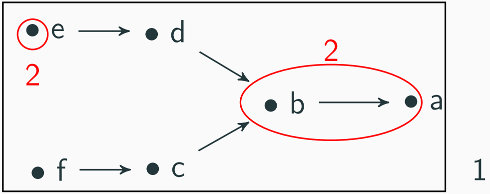

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Justification Status

Definition (based on Wu et al. (2010))

The **justification status of a for i** is the outcome yielded by the function $\mathcal{JS}_i : A \to \wp(\{\text{in}, \text{out}, \text{undec}\})$ defined as:

$$\mathcal{JS}_i(a) := \{\mathcal{L}_i(a) \mid \mathcal{L} \quad \text{is a complete labelling of} \quad (A_i, \rightsquigarrow_i)\}$$

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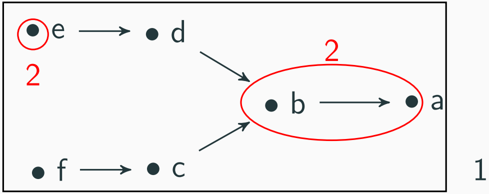
JS^* is the set of possible outcomes of $\mathcal{JS}$, which naturally defines an acceptance hierarchy:

$$\text{strong acceptance } \{\text{in}\} > \{\text{in}, \text{undec}\} > \{\text{undec}\} = \{\text{in}, \text{out}, \text{undec}\} > \{\text{out}, \text{undec}\} > \{\text{out}\} \text{strong rejection}$$

Examples



$$\mathcal{JS}_1(a) = \mathcal{JS}_2(a) = \{\text{out}\}$$
$$\mathcal{JS}_1(b) = \mathcal{JS}_2(b) = \{\text{in}\}$$

Persuasiveness and Epistemic Persuasiveness

Definition (Persuasiveness of a set of arguments)

Let $\mathcal{G} = (A, \rightsquigarrow, A_1, A_2, a)$ and $B \subseteq A_1$ the *resulting pointed TAF* is $\mathcal{G}^B := (A, \rightsquigarrow, A_1, A_2^B, a)$ where $A_2^B = A_2 \cup B$. Let goal $\in$ JS*, B is said to be **persuasive** iff $\mathcal{JS}_2(a) =$ goal w.r.t. $\mathcal{G}^B$

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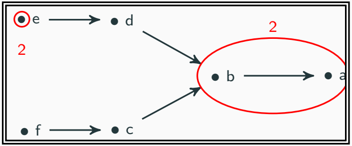
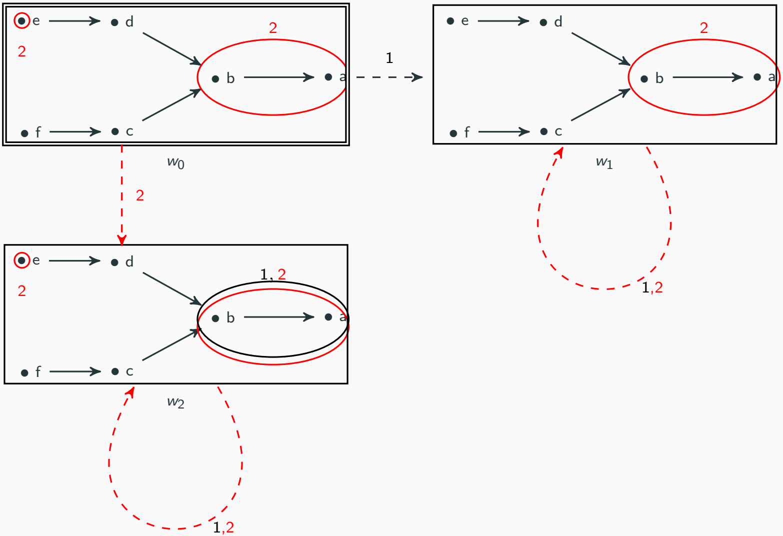
Persuasion is understood as a change in the hearer's justification status that matches the speaker's intentions.


e
d
2
2
b
a
f
c


e
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d
2
1, 2
b
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f
c
w_2
1,2

Epistemic argumentative models

Definition (Schwarzentruber et al. (2012))

An pointed model for $(A, \rightsquigarrow, A_1, A_2)$ is $(M, w) = ((W, \mathcal{R}, \mathcal{D}), w)$ where:

- $W \neq \emptyset$ (*possible worlds*) with $w \in W$
- $\mathcal{R} : \mathrm{Ag} \rightarrow \wp(W \times W)$ (*accessibility relations*)
- $\mathcal{D} : (\mathrm{Ag} \times W) \rightarrow \wp(A)$ (*awareness function*) s.t. $\mathcal{D}_1(w) = A_1$ and $\mathcal{D}_2(w) = A_2$.

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1. If $w\mathcal{R}_i u$, then $\mathcal{D}_i(w) \subseteq \mathcal{D}_i(u)$ (Positive Introspection)
2. If $w\mathcal{R}_i u$, then $\mathcal{D}_{\mathbf{j}}(u) \subseteq \mathcal{D}_i(w)$ (General Negative Introspection)

Definition (Communication Model)

A *communication pointed model* $(M, w)^{+b} := ((W, \mathcal{R}, \mathcal{D}^{+b}), w)$ where $\mathcal{D}^{+b} : (\text{Ag} \times W) \to \wp(A)$ is defined by cases for each $i \in \text{Ag}$ and each $v \in W$ as follows:

$$\begin{array}{ll} \mathcal{D}_i(v) \cup \{b\} & \text{if } b \in \mathcal{D}_1(w) \\ \mathcal{D}_i(v) & \text{otherwise} \end{array}$$

Examples

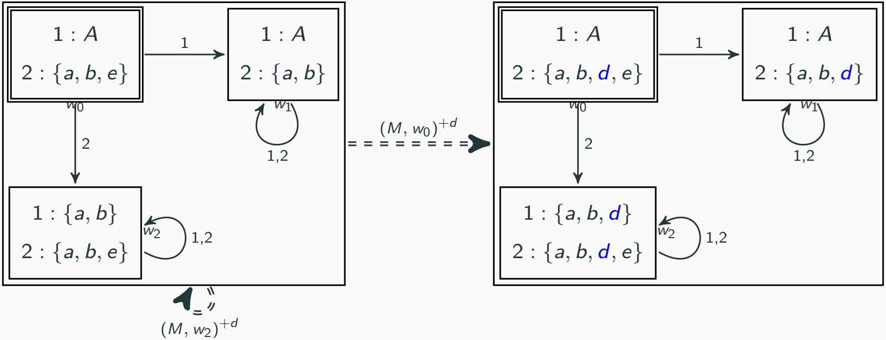

Figure 1: Communication Model

Epistemic Persuasiveness

Definition (Epistemic-based persuasive arguments)

Let (M, w) be a pointed model for $(A, \rightsquigarrow, \mathcal{D}_1(w), \mathcal{D}_2(w), a)$, let goal $\in$ JS*, we say that $\mathbf{B} \subseteq \mathcal{D}_1(w)$ is **persuasive from 1's perspective** iff $\mathcal{JS}_2(a) =$ goal w.r.t. $(\mathcal{D}_2^{+B}(w'), \rightsquigarrow\restriction \mathcal{D}_2^{+B}(w'))$ for all $w' \in W$ s.t. $w\mathcal{R}_1 w'$.

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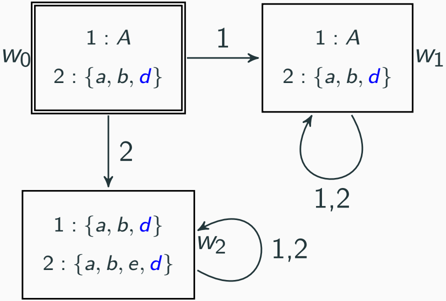
A set of arguments is epistemically persuasive iff it is thought to be persuasive by the speaker.

Plain Persuasion and Epistemic Persuasion



Assume goal $= \{\text{in}\}$

Figure 2: $(M, w_0)^{+d}$

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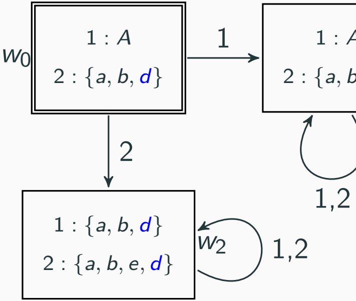

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- $\{d\}$ is persuasive from 1's perspective in (M, w_0)

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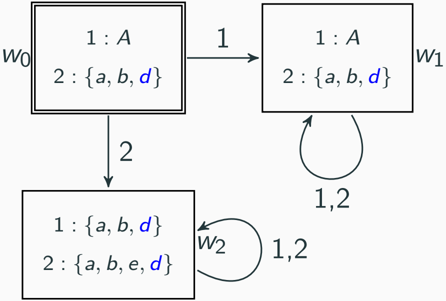

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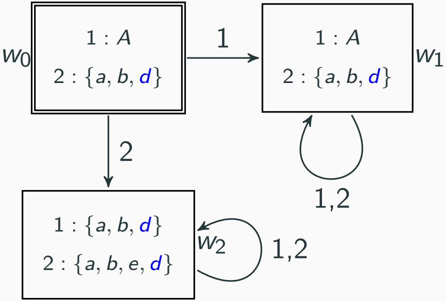

Assume goal = {in}

Figure 2: $(M, w_0)^{+d}$

- $\{d\}$ is persuasive from 1's perspective in (M, w_0)
- $\{d\}$ is not actually persuasive
- goal = {in} is not achievable in $(A, \mathcal{D}_1^{+d}(w_0), \mathcal{D}_2^{+d}(w_0), \rightsquigarrow)$,

A Logic for Argument Disclosure

Let $A \neq \emptyset$ and finite and define $\mathcal{L}^{+!}(A)$

$$\varphi ::= \mathsf{owns}_i(a) \mid \neg\varphi \mid \varphi \wedge \varphi \mid \Box_i\varphi \mid [+a]\varphi \mid [a!]\varphi$$

$$a \in A \quad i \in \{1, 2\}$$

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$$\begin{array}{lll}
(M, w) \vDash \mathsf{owns}_i(a) & \text{iff} & a \in \mathcal{D}_i(w) \\
(M, w) \vDash \Box_i\varphi & \text{iff} & (M, w') \vDash \varphi \quad \forall w' \text{ s.t. } w\mathcal{R}_i w' \\
(M, w) \vDash [a!]\varphi & \text{iff} & (M, w)^{a!} \vDash \varphi \\
(M, w) \vDash [+a]\varphi & \text{iff} & (M, w)^{+a} \vDash \varphi
\end{array}$$

where $(M, w)^{a!} = ((W, \mathcal{R}, \mathcal{D}^{a!}), w)$ and $\mathcal{D}_i^{a!}(v) = \mathcal{D}_i(v) \cup \{a\}$ for all $v \in W$

Axioms	
All propositional tautologies	(Taut)
$\vdash \Box_i(\varphi \rightarrow \psi) \rightarrow (\Box_i\varphi \rightarrow \Box_i\psi)$	(K)
$\vdash \mathsf{owns}_i(a) \rightarrow \Box_i \mathsf{owns}_i(a)$	(PI)
$\vdash \neg\mathsf{owns}_i(a) \rightarrow \Box_i \neg\mathsf{owns}_j(a)$	(GNI)
Rules	
From $\varphi \rightarrow \psi$ and φ, infer ψ	MP
From φ infer $\Box_i\varphi$	NEC

Table 1: Axioms for the static fragments

Reduction Axioms

$\vdash [+a]\varphi \leftrightarrow (\text{owns}_1(a) \rightarrow [a!]\varphi) \wedge (\neg\text{owns}_1(a) \rightarrow \varphi)$	(Def+)
$\vdash [a!]\text{owns}_i(a) \leftrightarrow \top$	(Atoms$^{=}$)
$\vdash [a!]\text{owns}_i(b) \leftrightarrow \text{owns}_i(b)$ where $a \neq b$	(Atoms$^{\neq}$)
$\vdash [a!]\neg\varphi \leftrightarrow \neg[a!]\varphi$	(Negation)
$\vdash [a!](\varphi \wedge \psi) \leftrightarrow ([a!]\varphi \wedge [a!]\psi)$	(Conjunction)
$\vdash [a!]\Box_i\varphi \leftrightarrow \Box_i[a!]\varphi$	(Box)
From $\varphi \leftrightarrow \psi$, infer $\delta \leftrightarrow \delta[\varphi/\psi]$	SE

Table 2: Reduction Axioms for $\mathcal{L}^{+!}(A)$

Plain Persuasiveness and Epistemic Persuasiveness

Proposition

Given a pointed model (M, w) *for* $(A, \rightsquigarrow, A_1, A_2, a)$*, let* $B \subseteq A$ *be persuasive from the speaker's perspective. Let*
$A_i := \{a_i \in A \mid M, w \models \mathsf{owns}_2(a_i) \wedge \neg\Box_1 \mathsf{owns}_2(a_i)\}$.

If $A_i \not\rightsquigarrow (\mathcal{D}_2^{+B}(w) \setminus A_i)$ *then* B *is persuasive.*

New Advances and Future Work

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1. Capturing persuasive sets and *EB*-persuasive sets in the object language:
    - Including new kind of variables in the propositional fragment to talk about the attack relation (following (Doutre et al., 2014, 2017))and the belonging of each argument to certain subsets
2. Dropping the assumption of credulous agents
    - Studying new forms of update where the hearer behaves more sceptically (for instance by privately learning an attacker of the communicated argument)

Thanks for your attention!

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