Expressing agent-opinions

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   • A modal hybrid framework for opinions
   • Some relations between opinions

3 Opinions, Beliefs and Preferences on Agents
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An opinion

Opinion
A belief or judgment that rests on insufficient grounds.

- Opinions about facts.
- Opinions about agents.

Main concern: How these opinions relate with each other?
Suppose you (Y) are sitting in an office without windows. Next to you is a colleague (C), inside the same office. Simultaneously, you are talking on the phone with a friend (F), who is sitting in a street café.

F: "Everything your colleague says is false; the sun is shining!"
C: "Everything your friend says is false; it is raining!"

- How to represent such opinions?
- Which is a suitable logical language to talk about such representation?
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PROP a **finite** set of atomic propositions, NOM a set of world-names (nominals), AG a **finite** set of agent-names.

**Opinion model**

A graph-like structure $M = \langle W, A, R^+, R^-, O^+, O^-, V, N \rangle$ where

- nodes are given by $W \cup A$ (**world-nodes** and **agent-nodes**),
- $R^+ \subseteq (A \times W)$, $R^- \subseteq (A \times W)$ (agent’s **opinions** about **facts**),
- $O^+ \subseteq (A \times A)$, $O^- \subseteq (A \times A)$ (agent’s **opinions** about **agents**),
- $V : (\text{PROP} \cup \text{NOM}) \rightarrow \wp(W)$ a **valuation** with $|V(i)| = 1$ for $i \in \text{NOM}$,
- $N : \text{AG} \rightarrow A$ an injection **naming** agent-nodes.

Some restrictions apply when we look for completeness results.
An opinion model

\[
\text{PROP} := \{s\} \quad \text{AG} := \{y, f, c\}
\]

\[
W := \{w_1, w_2\} \quad A := \{a_1, a_2, a_3\}
\]

\[
R^+ := \{(a_2, w_1)\} \quad R^- := \{(a_3, w_2)\}
\]

\[
O^+ := \{(a_1, a_2)\}
\]

\[
O^- := \{(a_1, a_3), (a_2, a_3), (a_3, a_2)\}
\]
An opinion model

\[
\begin{align*}
\text{PROP} & := \{s\} & \text{AG} & := \{y,f,c\} \\
W & := \{w_1,w_2\} & A & := \{a_1,a_2,a_3\} \\
R^+ & := \{(a_2,w_1)\} & R^- & := \{(a_3,w_2)\} \\
O^+ & := \{(a_1,a_2)\} \\
O^- & := \{(a_1,a_3),(a_2,a_3),(a_3,a_2)\}
\end{align*}
\]
Main differences w.r.t. Kripke models

- Two kinds of nodes (and hence, two “valuations”).
- Agents are nodes!
- Two kinds of relations: opinions about facts and opinions about agents.
- Two relations for each kind of opinions.
- Opinions are global notions!
The language

\[ \varphi ::= p \mid i \mid \neg \varphi \mid \varphi \lor \psi \mid \Box_a \varphi \mid \Box_a \varphi \mid \Theta_{a:b} \mid \Theta_{a:b} \mid \Theta_i \varphi \]

with \( p \in \text{PROP} \), \( i \in \text{NOM} \) and \( a, b \in \text{AG} \)

- \( \Box_a \varphi \): Agent \( a \) has a \textbf{positive} opinion about \( \varphi \).
- \( \Box_a \varphi \): Agent \( a \) has a \textbf{negative} opinion about \( \varphi \).

- \( \Theta_{a:b} \): Agent \( a \) has a \textbf{positive} opinion about agent \( b \).
- \( \Theta_{a:b} \): Agent \( a \) has a \textbf{negative} opinion about agent \( b \).
For $p \in \text{PROP}$, $\neg$, $\lor$ is a usual. For the rest,

$(M, w) \models i$ iff $\{w\} = V(i)$

$(M, w) \models \boxplus_a \varphi$ iff for all $u \in W$, $R^+ N(a) u$ implies $(M, u) \models \varphi$

$(M, w) \models \boxdot_a \varphi$ iff for all $u \in W$, $R^- N(a) u$ implies $(M, u) \models \neg \varphi$

$(M, w) \models \oplus_{a:b}$ iff $O^+ N(a) N(b)$

$(M, w) \models \ominus_{a:b}$ iff $O^- N(a) N(b)$

$(M, w) \models \ominus \varphi$ iff $(M, u) \models \varphi$, where $V(i) = \{u\}$
So

\[\begin{align*}
\text{\(a\)} & \quad + \quad \text{\(p\)} \quad \Rightarrow \quad a \text{ has positive opinion about } p. \\
\text{\(a\)} & \quad - \quad \text{\(p\)} \quad \Rightarrow \quad a \text{ has negative opinion about } p. \\
\text{\(a\)} & \quad + \quad \text{\(\neg p\)} \quad \Rightarrow \quad a \text{ has positive opinion about } \neg p. \\
\text{\(a\)} & \quad - \quad \text{\(p\)} \quad \Rightarrow \quad a \text{ has negative opinion about } \neg p.
\end{align*}\]
Our previous model

\[ y \vdash f \wedge c : \text{Agent } f \text{ has a positive opinion about } s \text{ and agent } c \text{ has a negative opinion about } s. \]

\[ f : c \wedge f : c : \text{f and c have both a negative opinion about each other.} \]

\[ y : f \wedge y : c : \text{You have a positive opinion about } f \text{ and a negative one about } c. \]
But it may be stronger

\[ \Box_a p \land \Box_a \neg p: \text{ Positive opinion about } p \text{ and negative opinion about } \neg p. \]
Also

\( \neg \Box_a p \wedge \neg \square_a p: \) No opinion (neither positive nor negative) about \( p \).
And even

$$\Box_a p \land \Box_a \neg p$$: Both opinions (positive and negative) about $p$. 

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“Inconsistent” opinions

\[ \Box_a p \land \bigoplus_{a:b} \land \Box_b \neg p : \ a \ has \ a \ positive \ opinion \ about \ both \ p \ and \ b, \ but \ b \ has \ a \ negative \ opinion \ about \ p. \]
**Some Postulates**

P1  Opinions about agents to whom we have positive and negative opinions influence *positive* opinions about facts.

P2  Opinions about agents to whom we have positive and negative opinions influence *negative* opinions about facts.

P3  Similar opinions about facts lead to *positive* opinions between agents.

P4  Opposite opinions about facts lead to *negative* opinions between agents.
Their syntactic counterpart

- \( \text{Pos}_{AG}(a) := \{ b \in AG \mid O^+ N(a) N(b) \} \)
- \( \text{Neg}_{AG}(a) := \{ b \in AG \mid O^- N(a) N(b) \} \)
- \( \text{Pos}_{PROP}(a) := \{ p \in PROP \mid R^+ N(a) u \text{ implies } u \in V(p) \} \)
- \( \text{Neg}_{PROP}(a) := \{ p \in PROP \mid R^- N(a) u \text{ implies } u \notin V(p) \} \)

A1 \( \left( \land_{b \in \text{Pos}_{AG}(a)} \boxPLUS b p \land \land_{b \in \text{Neg}_{AG}(a)} \boxPLUS b p \right) \rightarrow \boxPLUS a p \)

A2 \( \left( \land_{b \in \text{Pos}_{AG}(a)} \boxMINUS b p \land \land_{b \in \text{Neg}_{AG}(a)} \boxPLUS b p \right) \rightarrow \boxMINUS a p \)

A3 \( \left( \land_{p \in \text{Pos}_{PROP}(a)} \boxPLUS b p \land \land_{p \in \text{Neg}_{PROP}(a)} \boxPLUS b p \right) \rightarrow \oplus a \cdot b \)

A4 \( \left( \land_{p \in \text{Pos}_{PROP}(a)} \boxMINUS b p \land \land_{p \in \text{Neg}_{PROP}(a)} \boxPLUS b p \right) \rightarrow \ominus a \cdot b \)
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Adding beliefs to the picture

- Conceptual differences between opinions and beliefs.
- Technical differences between them: opinion is global, belief is local.
- Nesting of opinions is meaningless; nesting of beliefs is relevant.
**Extending the Framework**

**Opinion Model**

A graph-like structure

\[ M = \langle W, A, R^+, R^-, O^+, O^-, \{R_a \mid a \in AG\}, \{\leq_a \mid a \in AG\}, V, N \rangle \]

where

- \( R_a \subseteq (W \times W) \) is a **serial, transitive and euclidean** relation for each agent-name \( a \),
- \( \leq_a \subseteq (A \times A) \) is a **reflexive and transitive** relation for each agent-name \( a \).

**Language and Semantic Interpretation**

\[ (M, w) \models B_a \varphi \quad \text{iff} \quad \text{for all } u \in W \text{ s.t. } R_a w u, \text{ we have } (M, u) \models \varphi \]

\[ (M, w) \models a \leq_c b \quad \text{iff} \quad N(a) \leq_c N(b) \]
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**P5** Opinions about agents lead to preferences about agents.

\[(\oplus_{a:b} \land \ominus_{a:c}) \rightarrow c \preceq_{a:b} \]

**P6** Preferences about agents and opinions about facts of those agents can lead to **positive** opinions about facts.

\[(c \preceq_{a:b} \land \boxplus_{b} \varphi \land \Box_{c} \varphi) \rightarrow \boxplus_{a} \varphi \]

**P7** Preferences about agents and opinions about facts of those agents can lead to **negative** opinions about facts.

\[(c \preceq_{a:b} \land \Box_{b} \varphi \land \Box_{c} \varphi) \rightarrow \Box_{a} \varphi \]
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So far

- Language and semantic model for representing opinions about facts and about agents.
- Postulates stating some relations between opinions.
- Extension with beliefs and preferences over agents.
- Postulates for some relations between the different notions.
To do

- Other postulates for relations between the concepts.
- Dynamic look at these “reasonable” properties.
Thanks!