

On the structure of multi-agent deliberation dialogues

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- The deliberation dialogue
- Existing work

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- Formal system
- Status of moves
- Protocol
- Dialogue outcome

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Argumentation dialogues

► Persuasion

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Argumentation dialogues

- ▶ Persuasion
- ▶ Negotiation

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Argumentation dialogues

- ▶ Persuasion
- ▶ Negotiation
- ▶ Deliberation

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Argumentation dialogues

- ▶ Persuasion
- ▶ Negotiation
- ▶ Deliberation
- ▶ ...

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An example dialogue

- ▶ a_1 : We should go to the local pizzeria.

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An example dialogue

- ▶ a_1 : We should go to the local pizzeria.
- ▶ a_2 : Why should we go there? I propose we go to the nearby bistro instead.

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An example dialogue

- ▶ a_1 : We should go to the local pizzeria.
- ▶ a_2 : Why should we go there? I propose we go to the nearby bistro instead.
- ▶ a_1 : Well, the pizzeria serves tasty pizza's. Why should we go to the bistro?

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An example dialogue

- ▶ a_1 : We should go to the local pizzeria.
- ▶ a_2 : Why should we go there? I propose we go to the nearby bistro instead.
- ▶ a_1 : Well, the pizzeria serves tasty pizza's. Why should we go to the bistro?
- ▶ a_2 : The toppings at the pizzeria are very dull, while the bistro has the best steaks in town.

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An example dialogue

- ▶ a_1 : We should go to the local pizzeria.
- ▶ a_2 : Why should we go there? I propose we go to the nearby bistro instead.
- ▶ a_1 : Well, the pizzeria serves tasty pizza's. Why should we go to the bistro?
- ▶ a_2 : The toppings at the pizzeria are very dull, while the bistro has the best steaks in town.
- ▶ ...

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Deliberation characteristics

▶ Multi-agent

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Deliberation characteristics

- ▶ Multi-agent
- ▶ Multiple proposals
 - Single dialogue topic
 - Proposals for action

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Deliberation characteristics

- ▶ Multi-agent
- ▶ Multiple proposals
 - Single dialogue topic
 - Proposals for action
- ▶ Cooperative and competitive
 - Mutual goal
 - Conflicts on beliefs and preferences

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- ▶ Framework for deliberation

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- ▶ Framework for deliberation
- ▶ Fixed communication language

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- ▶ Framework for deliberation
- ▶ Fixed communication language
- ▶ Very liberal protocol

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- ▶ Framework for deliberation
- ▶ Fixed communication language
- ▶ Very liberal protocol
- ▶ No explicit proposal status

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- ▶ Framework for persuasion

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- ▶ Framework for persuasion
- ▶ Dialogue game with explicit reply structure

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- ▶ Framework for persuasion
- ▶ Dialogue game with explicit reply structure
- ▶ Coherence based on move status

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Deliberation system

- ▶ Topic language L_t

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Deliberation system

- ▶ Topic language L_t
- ▶ Argumentation logic \mathcal{L}

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Deliberation system

- ▶ Topic language L_t
- ▶ Argumentation logic \mathcal{L}
- ▶ Communication language L_c

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Deliberation system

- ▶ Topic language L_t
- ▶ Argumentation logic \mathcal{L}
- ▶ Communication language L_c
- ▶ Set of agents \mathcal{A}

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Deliberation system

- ▶ Topic language L_t
- ▶ Argumentation logic \mathcal{L}
- ▶ Communication language L_c
- ▶ Set of agents \mathcal{A}
- ▶ Set of moves M , with each $m \in M$
 - identifier $\text{id}(m)$
 - agent $\text{player}(m)$
 - speech act $\text{content}(m)$
 - targeted move $\text{target}(m)$

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Deliberation system

- ▶ Topic language L_t
- ▶ Argumentation logic \mathcal{L}
- ▶ Communication language L_c
- ▶ Set of agents \mathcal{A}
- ▶ Set of moves M , with each $m \in M$
 - identifier $\text{id}(m)$
 - agent $\text{player}(m)$
 - speech act $\text{content}(m)$
 - targeted move $\text{target}(m)$
- ▶ Set of dialogues $M^{\leq \infty}$, where
 - $d \in M^{\leq \infty}$ is a single legal finite dialogue
 - $D \subseteq M^{\leq \infty}$ is a non-empty subset of all legal finite dialogue

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Communication language

Table: The speech acts of L_c

speech act	attacks	surrenders
<i>propose</i> (P)	<i>why-propose</i> (P) <i>reject</i> (P)	
<i>reject</i> (P)	<i>why-reject</i> (P)	
<i>why-propose</i> (P)	<i>argue</i> ($A \Rightarrow p$)	<i>drop-propose</i> (P)
<i>why-reject</i> (P)	<i>argue</i> ($A \Rightarrow \neg p$)	<i>drop-reject</i> (P)
<i>drop-propose</i> (P)		
<i>drop-reject</i> (P)		
<i>prefer</i> (P, Q)		
<i>prefer-equal</i> (P, Q)		
<i>skip</i>		
<i>argue</i> ($A \Rightarrow p$)	<i>argue</i> ($B \Rightarrow q$) where $B \Rightarrow q$ defeats $A \Rightarrow p$ <i>why</i> (q) where $q \in A$	<i>concede</i> (p) <i>concede</i> (q) where $q \in A$
<i>why</i> (p)	<i>argue</i> ($A \Rightarrow p$)	<i>retract</i> (p)
<i>concede</i> (p)		
<i>retract</i> (p)		

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Deliberation system (cont.)

- ▶ Dialogue purpose to reach a decision on a course of action
 $P \in L_t$

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Deliberation system (cont.)

- ▶ Dialogue purpose to reach a decision on a course of action
 $P \in L_t$
- ▶ Mutual goal $g_d \in L_t$ as deliberation context

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Deliberation system (cont.)

- ▶ Dialogue purpose to reach a decision on a course of action
 $P \in L_t$
- ▶ Mutual goal $g_d \in L_t$ as deliberation context
- ▶ Protocol $\mathcal{P} : D \times L_t \longrightarrow Pow(M)$

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Deliberation system (cont.)

- ▶ Dialogue purpose to reach a decision on a course of action
 $P \in L_t$
- ▶ Mutual goal $g_d \in L_t$ as deliberation context
- ▶ Protocol $\mathcal{P} : D \times L_t \rightarrow Pow(M)$
- ▶ A turntaking function $\mathcal{T} : D \rightarrow \mathcal{A}$

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Deliberation system (cont.)

- ▶ Dialogue purpose to reach a decision on a course of action $P \in L_t$
- ▶ Mutual goal $g_d \in L_t$ as deliberation context
- ▶ Protocol $\mathcal{P} : D \times L_t \rightarrow Pow(M)$
- ▶ A turntaking function $\mathcal{T} : D \rightarrow \mathcal{A}$
- ▶ A deliberation outcome function $\mathcal{O} : D \times L_t \rightarrow L_t$

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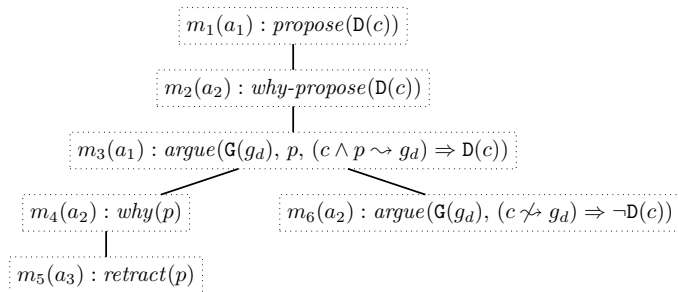
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An example

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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Dialogical status of a move

A move m is *in* iff:

1. m is surrendered in d by every agent $a \in \mathcal{A}$; or else,
2. m has no attacking replies that are *in*.

Otherwise it is *out*.

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Dialogical status of a move

A move m is *in* iff:

1. m is surrendered in d by every agent $a \in \mathcal{A}$; or else,
2. m has no attacking replies that are *in*.

Otherwise it is *out*.

A move m is *surrendered* by some agent a iff:

1. m is an argue move $A \Rightarrow p$ and a has made a reply m' to m that has $\text{content}(m') = \text{concede}(p)$; or else
2. a has made a surrendering reply to m .

Otherwise it is *out*.

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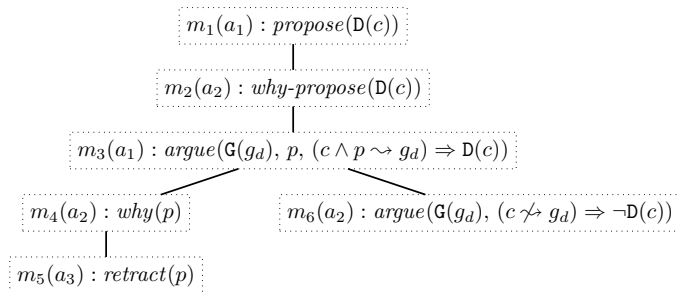
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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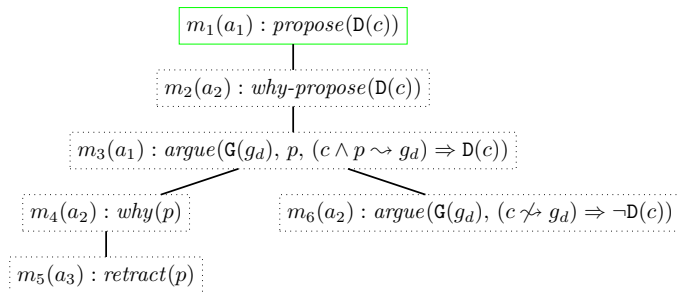
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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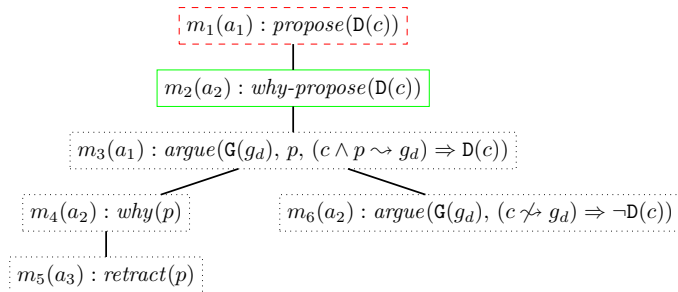
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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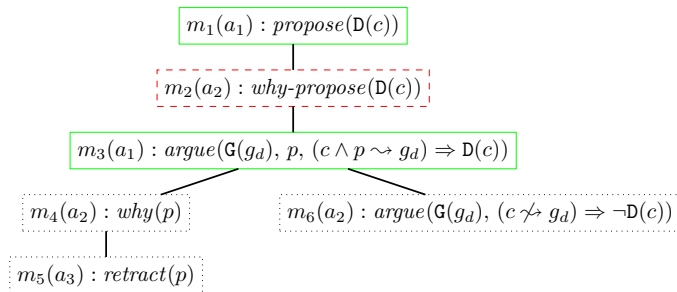
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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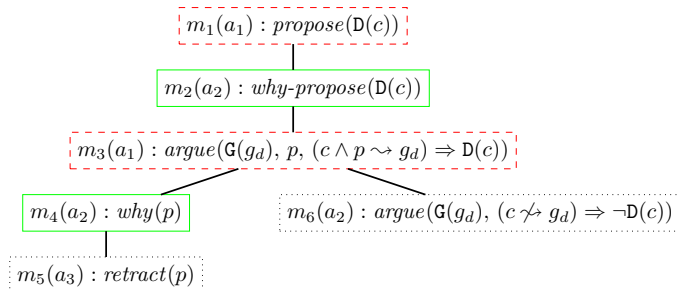
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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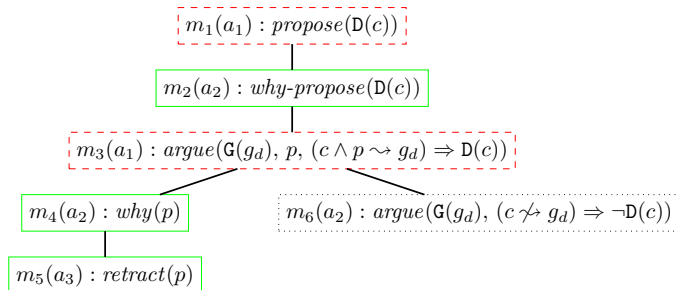
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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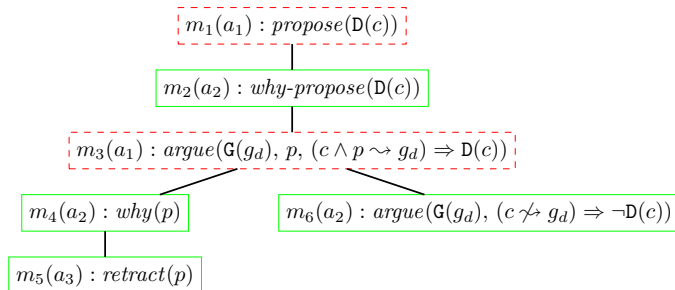
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An example (cont.)

$\mathcal{A} = \{a_1, a_2, a_3\}$ with dialogue goal g_d



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Protocol rules

- ▶ Agents can only reply to moves of others

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant
- ▶ A turn can contain at most one proposal move

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant
- ▶ A turn can contain at most one proposal move
- ▶ A proposal must be unique in the dialogue

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant
- ▶ A turn can contain at most one proposal move
- ▶ A proposal must be unique in the dialogue
- ▶ Prefer moves must maintain an agent's transitivity and antisymmetry in the option ordering

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant
- ▶ A turn can contain at most one proposal move
- ▶ A proposal must be unique in the dialogue
- ▶ Prefer moves must maintain an agent's transitivity and antisymmetry in the option ordering
- ▶ Every argue replying to a *why-propose*($D(P)$) contains an argument for $D(P)$ with premise g_d

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Protocol rules

- ▶ Agents can only reply to moves of others
- ▶ Every attacking or surrendering move must be relevant
- ▶ A turn can contain at most one proposal move
- ▶ A proposal must be unique in the dialogue
- ▶ Prefer moves must maintain an agent's transitivity and antisymmetry in the option ordering
- ▶ Every argue replying to a *why-propose*($D(P)$) contains an argument for $D(P)$ with premise g_d
- ▶ Every argue replying to a *why-reject*($D(P)$) contains an argument for $\neg D(P)$ with premise $\neg g_d$

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Options

Dialogue options are defined by

- ▶ Options function $O : D \longrightarrow Pow(L_t)$

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Options

Dialogue options are defined by

- ▶ Options function $O : D \longrightarrow Pow(L_t)$
- ▶ Where $O(d) = \{o \mid o = \text{content}(m) \text{ for each proposal move } m \in d\}$
 - $\text{move}(o) \in O(d)$ refers to m

An option $o \in O(d)$ for any dialogue d is:

- ▶ *justifiable* iff $\text{move}(o)$ is in
- ▶ *invalid* iff $\text{player}(\text{move}(o))$ played a move m such that $\text{target}(m) = \text{move}(o)$ and $\text{content}(m) = \text{drop-propose}(o)$,
- ▶ otherwise it is *defensible*.

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Preference ordering

An option preference relation \preceq is a partial order of O , giving $o_i \prec o_j$ (strictly preferred) and $o_i \approx o_j$ (equally preferred)

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Preference ordering

An option preference relation \preceq is a partial order of O , giving $o_i \prec o_j$ (strictly preferred) and $o_i \approx o_j$ (equally preferred)

This can be use to create

- ▶ A single total preliminary ordering \preceq_p over O
- ▶ For every agent a partial agent ordering \preceq_a over O

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Preference ordering

An option preference relation \preceq is a partial order of O , giving $o_i \prec o_j$ (strictly preferred) and $o_i \approx o_j$ (equally preferred)

This can be use to create

- ▶ A single total preliminary ordering \preceq_p over O
- ▶ For every agent a partial agent ordering \preceq_a over O

To be aggregated to select a final dialogue outcome

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Conclusions

- ▶ Extended Prakken 2005's framework
 - Multiple proposals
 - Dialogical status for deliberation relevance

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- ▶ Extended Prakken 2005's framework
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- ▶ Formalises McBurney et al. 2007's framework
 - Explicit reply structure
 - Classification on proposed options

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- ▶ Extended Prakken 2005's framework
 - Multiple proposals
 - Dialogical status for deliberation relevance
- ▶ Formalises McBurney et al. 2007's framework
 - Explicit reply structure
 - Classification on proposed options
- ▶ McBurney et al. 2002's desiderata for argumentation protocols

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- ▶ Formal properties

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Future work

- ▶ Formal properties
- ▶ Preference-based argumentation

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- ▶ Formal properties
- ▶ Preference-based argumentation
- ▶ Value-based argumentation

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Future work

- ▶ Formal properties
- ▶ Preference-based argumentation
- ▶ Value-based argumentation
- ▶ Deliberation strategies

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- ▶ Formal properties
- ▶ Preference-based argumentation
- ▶ Value-based argumentation
- ▶ Deliberation strategies
- ▶ Testing argumentation dialogues

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