On testing the use of argumentation in deliberation dialogues

Eric M. Kok John-Jules Ch. Meyer Henry Prakken
Gerard A. W. Vreeswijk

Utrecht University

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Introduction

The deliberation dialogue

Efficiency and effectiveness

Deliberation framework

Dialogue model

Agent model

Experimental setup

Experiments

Preliminary observations

Future work

Argumentation

- Argumentation logics

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Argumentation

- Argumentation logics
- Argumentation-based dialogues

Argumentation

- Argumentation logics
- Argumentation-based dialogues
  - Persuasion
  - Negotiation
  - Deliberation
  - ...

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Argumentation

- Argumentation logics
- Argumentation-based dialogues
  - Persuasion
  - Negotiation
  - Deliberation
    - Decision making
    - Multi-agent
    - Partially cooperative
  - ...

An example dialogue

- *a*: We should go to the local pizzeria.

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- *a*: We should go to the local pizzeria.
- *b*: Why should we go there? I propose to the nearby bistro instead.

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- *b*: Why should we go there? I propose to the nearby bistro instead.
- *a*: Well, the pizzeria serves tasty pizza's. And we can drink wine as well. Why go to the bistro?

An example dialogue

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- *b*: Why should we go there? I propose to the nearby bistro instead.
- *a*: Well, the pizzeria serves tasty pizza's. And we can drink wine as well. Why go to the bistro?
- *b*: The toppings at the pizzeria are very dull, while the bistro has the best steaks in town.

An example dialogue

- *a*: We should go to the local pizzeria.
- *b*: Why should we go there? I propose to the nearby bistro instead.
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Arguments decide, right?

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- Assumptions...
- Based on:
  - Improved internal reasoning
  - Improved dialogues

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- Argumentation helps to:
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  - Improve effectiveness
- Assumptions...
- Based on:
  - Improved internal reasoning
  - Improved dialogues
- What metrics to use?

Existing work

- Rahwan et al. (2007)
  - Negotiation with explicit asking for goals
  - Reach wider variety of goals
  - No (counter-)arguments

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  - Negotiation with explicit asking for goals
  - Reach wider variety of goals
  - No (counter-)arguments
- Karunatillake et al. (2009)
  - Negotiation in agent society
  - Providing reasons increases efficiency
  - Concealing information lowers effectiveness
  - No (counter-)arguments

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Dialogue model

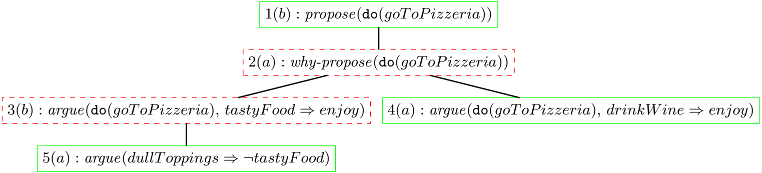
- Set of agents $\mathcal{A}$
- Topic language L_t
  - Action-options $L_o \subseteq L_t$
  - Beliefs $L_b \subseteq L_t$
  - Goals $L_g \subseteq L_t$
- Communication language L_c
- A dialogue d
  - A mutual goal $g_d \in L_g$
  - A protocol $\mathcal{P}$
  - Dialogue proposals $Q_d = \{q \in L_o | propose(q)) \in d\}$
  - Dialogue outcome $\mathcal{O}(d) = \texttt{random}(\{o | o \in Q_d \text{ where } o \text{ is } in\})$

Communication language

speech act	attacks	surrenders
propose($\mathtt{do}(q)$)	*why-propose*($\mathtt{do}(q)$)	
why-propose($\mathtt{do}(q)$)	*argue*($A \Rightarrow g_d$) where $\mathtt{do}(q) \in A$	
skip		
inform($A \Rightarrow p$)		
argue($A \Rightarrow p$)	*argue*($B \Rightarrow p'$) where $B \Rightarrow p'$ defeats $A \Rightarrow p$	*concede*(p)
	why(p') where $p' \in A$	*concede*(p') where $p' \in A$
why(p)	*argue*($A \Rightarrow p$)	*retract*(p)
concede(p)		
retract(p)		

Dialogue example

$\mathcal{A} = \{a, b, c, d\}$ with dialogue goal *enjoy*



Goal-based agents

- A set of belief $B_{d,a}$

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- A set of goals $G_{d,a}$
- Strategy in a dialogue d:
  - Move evaluation
  - Option analysis
  - Move generation

Simple move evaluation

Simple move evaluation:

Simple move evaluation

Simple move evaluation:

- $B_{d',a} = B_{d,a}$
- $O_{d',a} = O_{d,a} \cup B^m$ if m is a propose move
- $G_{d',a} = G_{d,a}$

Option analysis

From goal to action-option utility:

Assign an option attitude ($\{\texttt{build}, \texttt{destroy}, \texttt{indifferent}\}$):

Similar to Amgoud and Maudet (2002)

Option analysis

From goal to action-option utility:

- Every $g \in G_{d,a}$ has a utility $\mathcal{V}^g_{d,a}$
- Promoted goals $F^o_{d,a}$ for each $o \in O_{d,a}$ that has a defensible argument in $B_{d,a} \cup \{o\}$
- Option utility $\mathcal{U}^o_{d,a} = \sum_{g \in F^o_{d,a}} \mathcal{V}^g_{d,a}$

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Assign an option attitude ($\{\texttt{build}, \texttt{destroy}, \texttt{indifferent}\}$):

Similar to Amgoud and Maudet (2002)

- $H^o_{d,a} = \texttt{build}$ if $o = \arg\max_{o \in O_{d,a}} \mathcal{U}^o_{d,a}$ where $\mathcal{U}^o_{d,a} > 0$
- $H^o_{d,a} = \texttt{destroy}$ otherwise

Move generation

Input: dialogue d, agent a

for all $o \in O_{d,a}$ **do**
  if $o \notin Q_d$ **and** $H^q_{d,a} = build$ **then**
    return $propose(q)$
  else if $o \in Q_d$ **and** $H^q_{d,a} = build$ **or** $H^q_{d,a} = \texttt{destroy}$ **then**
    {Loop through all moves that are 'actively attacking' the proposal}
    for all $m \in getActiveAttackers(\emptyset, propose(q), \top, d)$ **do**
      if $m = propose(o)$, m is *in* **and** $why\text{-}propose(o) \notin d$ **then**
        return $why\text{-}propose(o)$
        {For argue moves, first try to give a counter-argument before questioning}
      else if $m = argue(A \Rightarrow p)$, B-defensible argue move $B \Rightarrow p'$ defeats $A \Rightarrow p$ **and** $argue(B \Rightarrow p') \notin d$ **then**
        return $argue(B \Rightarrow p')$
      else if $m = argue(A \Rightarrow p)$, $p' \in A$ **and** $why(p') \notin d$ **then**
        return $why(p')$
      else if $m = why\text{-}propose(o)$ **and** B-defensible argue move $argue(A \Rightarrow g_d) \notin d$ where $\texttt{do}(o) \in A$ **then**
        return $argue(A \Rightarrow g_d)$
      else if $m = why(p)$ **and** B-defensible argue move $argue(A \Rightarrow p) \notin d$ **then**
        return $argue(A \Rightarrow p)$
      end if
    end for
  end if
end for

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Move generation

Input: attackers set *att*, move *m*, if parent is attacker *par*, dialogue *d*

if $m = propose(q)$ or m is an attacking move **then**
    if m is *in* **then**
        {Include moves that are *in*}
        $att = att \cup \{m\}$
        for all $m' \in d$ where $\texttt{target}(m') = m$ **do**
            $getActiveAttackers(att, m', \top, d)$
        end for
    end if
else if *par* **then**
    {If this move's target was *in*, also look though its attackers}
    for all $m' \in d$ where $\texttt{target}(m') = m$ **do**
        $getActiveAttackers(att, m', \bot, d)$
    end for
end if
return *att*

Scenario generation

Knowledge pool I:

Scenario for empty dialogue $d = \emptyset$:

Scenario generation

Knowledge pool I:

- Set of n_O action-options O_I
- Set of n_G goals G_I ($g_d \in G_I$)
- Set of n_C facts C_I (n_N % negated beliefs)
- Set of n_{CR} fact rules CR_I of the form $f_i \rightarrow f_j$
- Set of n_{GR} goal rules GR_I of the form $f_i \rightarrow g_j$
- Set of n_{OR} option rules OR_I of the form $o_i \rightarrow f_j$

Scenario for empty dialogue $d = \emptyset$:

Scenario generation

Knowledge pool I:

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- Set of n_G goals G_I ($g_d \in G_I$)
- Set of n_C facts C_I (n_N % negated beliefs)
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- Set of n_{OR} option rules OR_I of the form $o_i \rightarrow f_j$

Scenario for empty dialogue $d = \emptyset$:

- Mutual goal g_d
- Each agent $a \in \mathcal{A}$ is randomly assigned:
  - A set of m_C facts, m_{CR} fact rules, m_{GR} goal rules and m_{OR} option rules $B_{d,a}$
  - A set of m_O options $O_{d,a}$
  - A set of m_G goals $G_{d,a}$, each with utility $\mathcal{V}^g_{d,a}$

Example scenario

Knowledge pool I

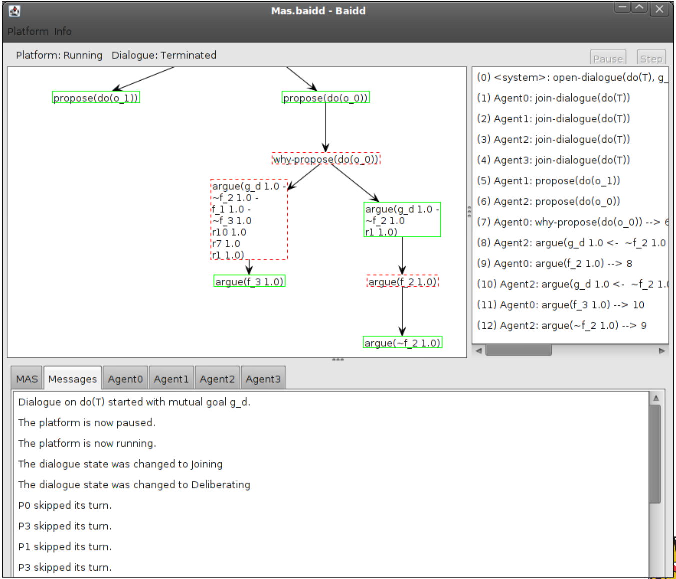
$$
\begin{aligned}
B_I = \{ & f_0,\ f_1,\ f_2,\ f_3,\ f_4,\ \neg f_0,\ \neg f_1,\ \neg f_2,\ \neg f_3,\ \neg f_4, \\
& f_4 \leftarrow \neg f_3,\ f_1 \leftarrow f_2,\ f_1 \leftarrow f_2,\ f_1 \leftarrow f_2,\ f_0 \leftarrow \neg f_3,\ \neg f_2 \leftarrow f_1,\ \ldots, \\
& f_0 \leftarrow do(o_1),\ f_0 \leftarrow do(o_2),\ \ldots, \\
& g_1 \leftarrow \neg f_2,\ g_2 \leftarrow \neg f_4,\ \ldots, \\
O_I = & \{\mathtt{do}(o_0), \mathtt{do}(o_1), \mathtt{do}(o_2)\} \\
G_I = & \{g_d, g_0, g_1\}
\end{aligned}
$$

Example scenario

Agent *a*'s internal model

$$B_{\emptyset,a} = \{f_1,\ f_2,\ f_3,\ f_4,\ \neg f_2,$$
$$f_0 \leftarrow \neg f_3,\ f_1 \leftarrow f_2,\ \neg f_2 \leftarrow f_1,\ f_0 \leftarrow \neg f_3,\ f_4 \leftarrow \neg f_3,$$
$$g_1 \leftarrow \neg f_2,\ g_d \leftarrow \neg f_4,$$
$$f_0 \leftarrow do(o_1),\ \neg f_4 \leftarrow do(o_1),\ \neg f_4 \leftarrow do(o_2),$$
$$O_{\emptyset,a} = \{\mathtt{do}(o_0), \mathtt{do}(o_1)\}$$
$$G_{\emptyset,a} = \{g_d, g_0\}$$
$$\mathcal{V}^{g_d}_{\emptyset,a} = 5 \text{ and } \mathcal{V}^{g_0}_{\emptyset,a} = 5$$

Example scenario



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Metrics

Efficiency

- $\epsilon_{\texttt{move}}(d) = |d|$

Relevance

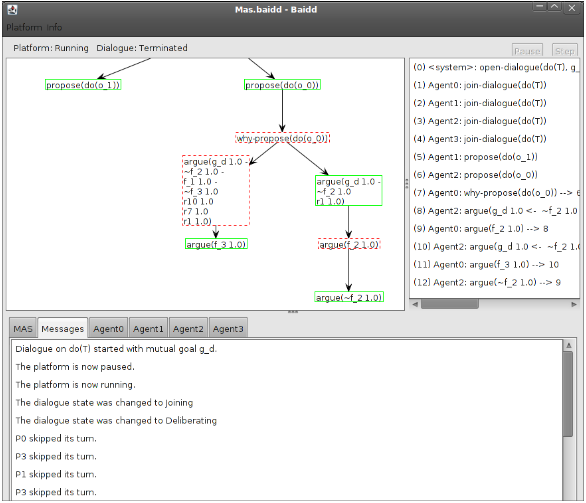
- $\epsilon_{\texttt{relevance}}(d) = \frac{|\{m|m \in d \text{ where } m \text{ was relevant }\}|}{|d|}$

Information concealment

Effectiveness

- $\epsilon_{\texttt{total}}(d, q) = \sum_{a \in A} \mathcal{U}^{q}_{d,a}$

Metrics example



$$\epsilon_{\texttt{move}}(d) = 8 \quad \epsilon_{\texttt{relevance}}(d) = 1 \quad \epsilon_{\texttt{total}}(d, \mathrm{do}(o_0)) = 10$$

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Running experiments

- Generating and playing many scenarios

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- Applying metrics

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Running experiments

- Generating and playing many scenarios
- Applying metrics
- Comparing results (ANOVA)

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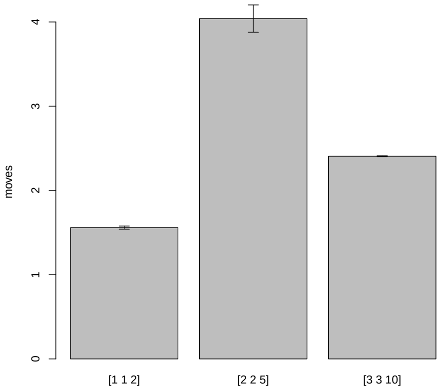
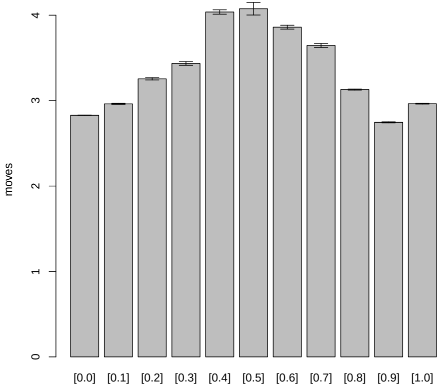
Partial versus complete knowledge



e_{move} comparison

Percentage negated facts



e_{move} comparison

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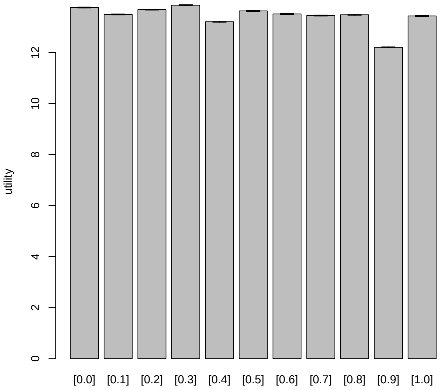

e_{total} comparison

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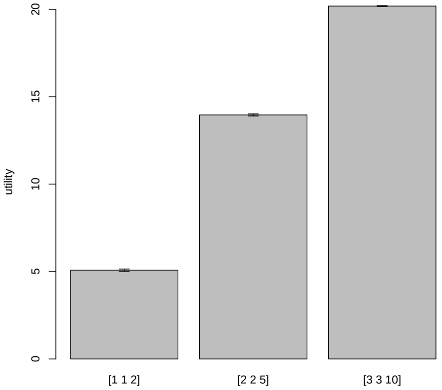
Partial versus complete knowledge



e_{total} comparison

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Future experiments

- Varying protocol rules
  - Outcome selection function

Future experiments

- Varying protocol rules
  - Outcome selection function
- Varying strategies
  - Belief revision
  - Move generation
  - Arguing versus non-arguing

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- Web: http://people.cs.uu.nl/erickok/
- E-mail: erickok@cs.uu.nl