On the benefits of structured argumentation in deliberation dialogues

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Argumentation

- Argumentation logics
  (semantics, structure, values/preferences, . . .)
- Argumentation dialogues
  (persuasion, negotiation, deliberation, . . .)

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Why argue?

Agents that argue are supposed to be

- more efficient
- more effective

But are they, in practise?

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Experimental validation

- Dialogue model *Kok et al. 2010, based on Prakken 2005*
- Generating scenarios *Kok et al. 2011*
- Running agents
- Measure the dialogues
- Analyse

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Deliberation

- Reach decision on a course of action

  Mutual goal *enjoyDinner*
- Propose various options

  $o_1, o_2, \ldots$
- Question, argue, ...

  why-propose(o)

  argue$(A \mid\sim p)$
- Evaluate utterances to select outcome

agent	utterance
a	I suggest we go to the pizzeria.
b	Why should we go there?
a	If we went go to the pizzeria, we could drink wine and that means we will enjoy our food.

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Deliberation (cont.)

- Multiple agents
- Shared and personal goals
- Information dispersion
- Epistemic and practical reasoning

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Communication language

speech act	attacking reply
$propose(o)$	$why\text{-}propose(o)$
	$reject(o)$
$why\text{-}propose(o)$	$argue(A \vdash p)$ where $o \in A$
$reject(o)$	
$argue(A \vdash p)$	$argue(B \vdash p')$ where $B \vdash p'$ defeats $A \vdash p$
	$why(p')$ where $p' \in A$ and $p \notin L_o$
$why(p)$	$argue(A \vdash p)$
$skip$	

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Example dialogue

agent	statement	logical form
a	I suggest we go to the pizzeria.	$propose(o_1)$
b	Why should we go there?	$why\text{-}propose(o_1)$
a	If we would go to the pizzeria, we could drink wine and that means we will enjoy our food.	$argue(o_1, o_1 \overset{\varrho 1}{\Longrightarrow} p_1, p_1 \overset{\varrho 2}{\Longrightarrow} g_d \mathrel{\sim\!\!\vdash} g_d)$
a	There is also a bistro.	$propose(o_2)$
b	I don't want to go there.	$reject(o_2)$
b	The pizzeria does serve tasty pizza's and having those means we will enjoy the food.	$argue(o_1, o_1 \overset{\varrho 3}{\Longrightarrow} p_2, p_2 \overset{\varrho 4}{\Longrightarrow} g_d \mathrel{\sim\!\!\vdash} g_d)$
b	We can not drink wine, though.	$argue(\neg p_1 \mathrel{\sim\!\!\vdash} \neg p_1)$
b	And drinking wine does not mean we will enjoy the food.	$argue(\neg \varrho_2 \mathrel{\sim\!\!\vdash} \neg \varrho_2)$
a		$skip$
b		$skip$
a		$skip$

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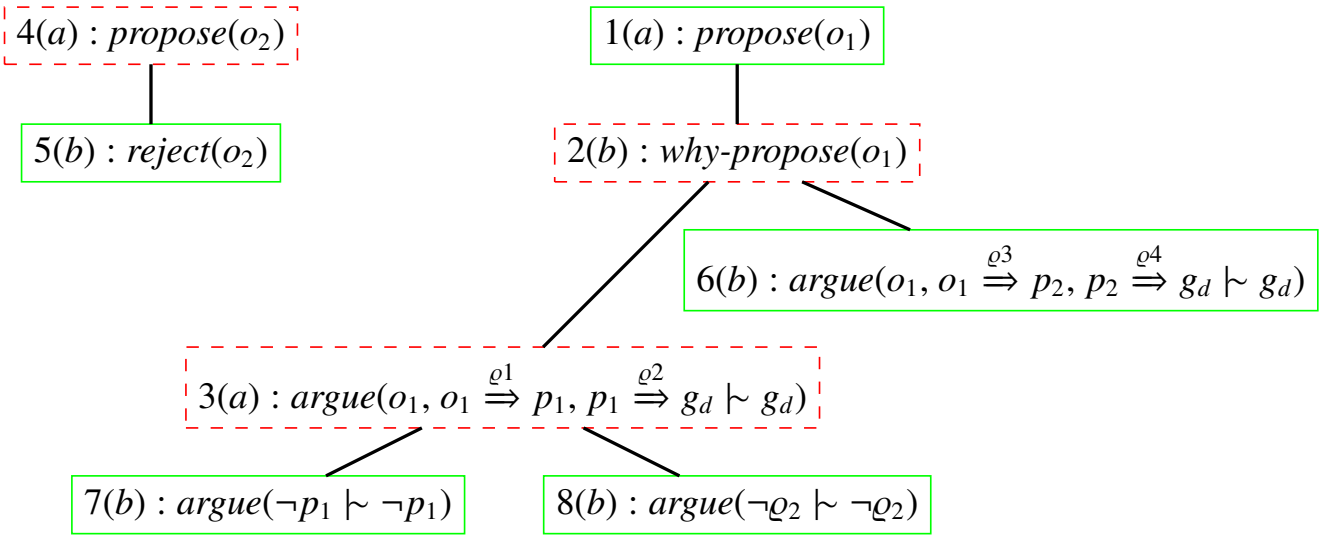
Dialogical structure

- Proposal trees through move targets
- A move is either *in* or *out*
- Dialogue outcome

  A proposal that is *in*



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Generate scenarios

- Experimentation requires scenarios
- Reflect typical deliberation issues
  - Multiple agents
  - Shared and personal goals
  - Information dispersion
  - Epistemic and practical reasoning
- Generate them in a structured fashion

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Rule chains

Given some length l, an option o, a goal g and set of beliefs $\{p_1, \ldots, p_n\}$

$$C_{g,o} = \{o \overset{\varrho 1}{\Longrightarrow} p_1, \ \ldots, \ p_i \overset{\varrho i}{\Rightarrow} p_j, \ \ldots, \ p_n \overset{\varrho n}{\Longrightarrow} g\}$$

Restricted, but sufficiently complex...

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Conflict generation

A set of possible conflicts $\bar{C}_{g,o}$ contains for every rule $p \overset{\varrho}{\Rightarrow} q \in C_{g,o}$

- a fact $\neg\varrho$ (an undercutter)
- a fact $\neg p$ (an underminer)
- a fact $\neg q$ (a rebuttal)

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Rule chains

For example, rule chain

$$C_{g_2,o_1} = \{o_1 \overset{\varrho 1}{\Longrightarrow} p_5, p_5 \overset{\varrho 2}{\Longrightarrow} p_2, p_2 \overset{\varrho 3}{\Longrightarrow} g_2\}$$

is associated with possible conflicts

$$\bar{C}_{g_2,o_1} = \{\neg\varrho_1, \neg p_5, \neg\varrho_2, \neg p_2, \neg\varrho_3\}$$

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Knowledge allocation

- Assign sets of goals and options
- Assign role beliefs
  - Rule chains or conflicts for the various options
- Assign personal beliefs
  - Non-role goals and appropriate rules chains
- Some beliefs are omitted

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Generated example scenario

O_{a_1}	o_1, o_2	G_{a_1}	g_d, g_1, g_2, g_4
O_{a_2}	o_1, o_2	G_{a_2}	g_d, g_1, g_2, g_3
O_{a_3}	o_2, o_3	G_{a_3}	g_d, g_3, g_4, g_2

B_{a_1}	$o_1 \Rightarrow_{\varrho 1} p_5, p_5 \Rightarrow_{\varrho 2} p_2, p_2 \Rightarrow_{\varrho 3} g_2,$
	$o_1 \Rightarrow_{\varrho 4} p_6, p_4 \Rightarrow_{\varrho 6} g_d,$
	$o_2 \Rightarrow_{\varrho 7} p_5, p_5 \Rightarrow_{\varrho 2} p_2, p_2 \Rightarrow_{\varrho 8} g_1,$
	$o_2 \Rightarrow_{\varrho 9} p_9, p_9 \Rightarrow_{\varrho 10} p_1, p_1 \Rightarrow_{\varrho 11} g_d,$
	$\neg\varrho_{17}, \neg p_3,$
	$o_1 \Rightarrow_{\varrho 23} p_2, p_3 \Rightarrow_{\varrho 19} g_4$
B_{a_2}	$p_5 \Rightarrow_{\varrho 2} p_2, p_2 \Rightarrow_{\varrho 3} g_2,$
	$o_1 \Rightarrow_{\varrho 4} p_6, p_6 \Rightarrow_{\varrho 5} p_4, p_4 \Rightarrow_{\varrho 6} g_d,$
	$o_2 \Rightarrow_{\varrho 7} p_5, p_5 \Rightarrow_{\varrho 2} p_2, p_2 \Rightarrow_{\varrho 8} g_1,$
	$o_2 \Rightarrow_{\varrho 9} p_9, p_9 \Rightarrow_{\varrho 10} p_1, p_1 \Rightarrow_{\varrho 11} g_d,$
	$\neg\varrho_{17}, \neg p_7,$
	$o_2 \Rightarrow_{\varrho 25} p_2, o_1 \Rightarrow_{\varrho 25} p_5$
B_{a_3}	$\neg\varrho_4,$
	$o_2 \Rightarrow_{\varrho 9} p_9, p_9 \Rightarrow_{\varrho 12} p_8, p_8 \Rightarrow_{\varrho 13} g_4,$
	$o_2 \Rightarrow_{\varrho 14} p_1, p_1 \Rightarrow_{\varrho 15} p_9, p_9 \Rightarrow_{\varrho 16} g_d,$
	$o_3 \Rightarrow_{\varrho 17} p_7, p_7 \Rightarrow_{\varrho 18} p_3, p_3 \Rightarrow_{\varrho 19} g_4,$
	$o_3 \Rightarrow_{\varrho 17} p_7, p_7 \Rightarrow_{\varrho 21} p_8, p_8 \Rightarrow_{\varrho 22} g_d,$
	$p_8 \Rightarrow_{\varrho 26} p_7, p_2 \Rightarrow_{\varrho 3} g_2$

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Deliberation strategies

Strategy to make moves in a dialogue

- Evaluate known options
- Propose?
- Reject?
- Argue?

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Internal reasoning

- Every goal has a utility U_a^g
- For an option, sum the utilities of goals it promotes
  - Possible to construct an argument $A \vdash g$ for o such that $o \in A$?
- Option heuristic $H_{d,a}^o$
  - `build` iff the sum of utilities > 0
  - `destroy` otherwise

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Arguing strategy

Not yet proposed

- Propose if `build`

Existing proposals

- `build` and currently *out*?
- `destroy` and currently *in*

  Find argument to play or question a move

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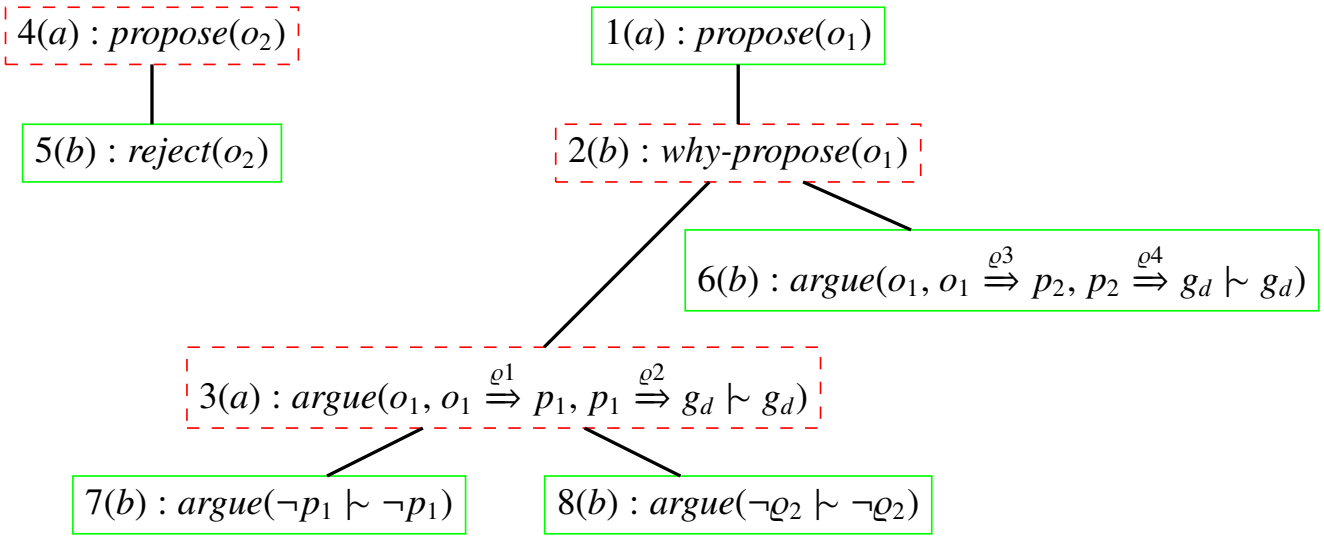
Example dialogue (cont.)



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Non-arguing strategy

Not yet proposed

- Propose if `build`

Existing proposals

- Reject if `destroy`

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Metrics

Test the performance of arguing and non-arguing strategies

- Efficiency (number of moves)

$$f_d = |d|$$

- Effectiveness (combined utility for the outcome)

$$v_d = \sum_{a \in A} \sum_{g \in G_a} U_a^g \text{ if } O_d \text{ is a justified option for } a$$

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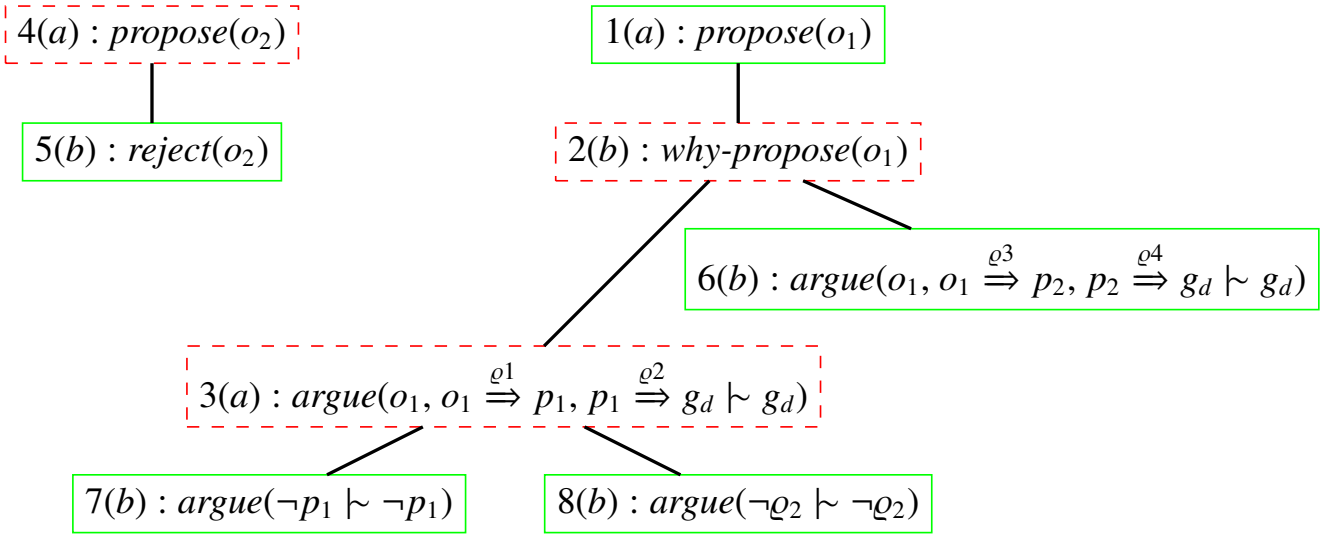
Example dialogue (cont.)

Given $U_a^{o_1} = 10$ $U_b^{o_1} = 0$
$U_a^{o_2} = 0$ $U_b^{o_2} = 10$



$f_d = 8$
$v_d = 10$

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Software simulation

- Java implementation of
  - Dialogue model
  - Scenario generation
  - Agent strategies
  - Metrics
- Play many dialogues. . .
- Data is analysed using R

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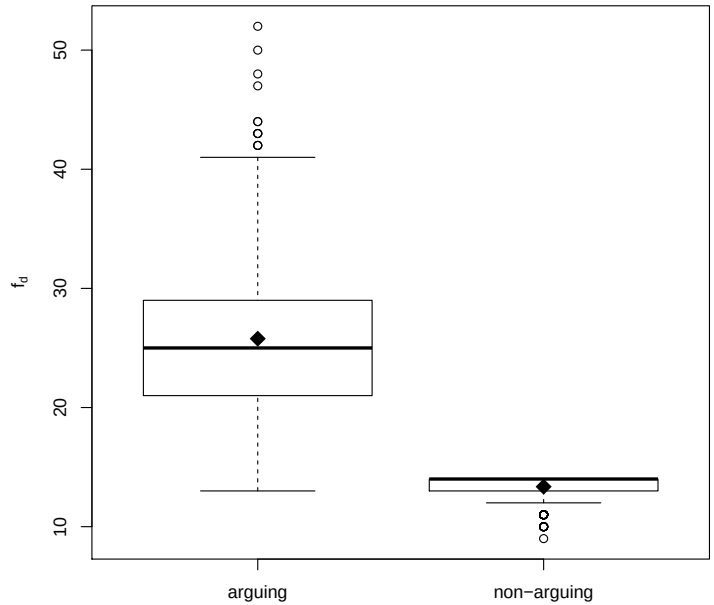
Dialogue efficiency



Arguing vs. non-arguing efficiency

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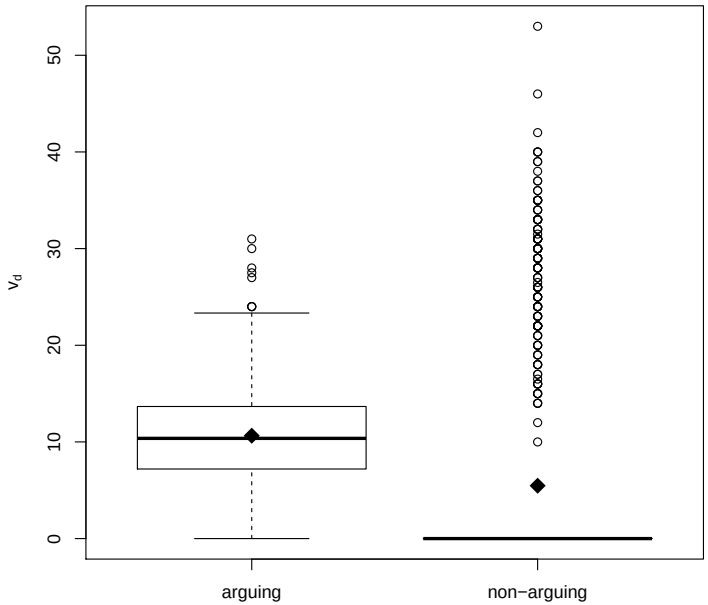
Dialogue effectiveness



Arguing vs. non-arguing effectiveness

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Baseline effectiveness

Never reject? All options are in. . .

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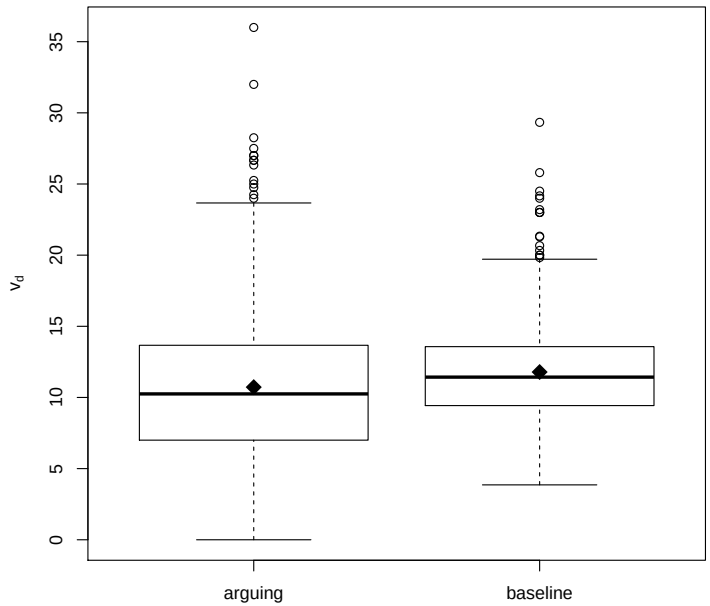
Baseline effectiveness

Never reject? All options are in. . .



Arguing vs. baseline effectiveness

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Conclusion

- Experiments with structured argumentation
- Arguing outperforms non-arguing effectiveness
- Partly confirms Karunatillake et al. 2009, Pasquier et al. 2010, Black 2011

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Work to do

- Improved metrics (belief concealment, relevance)
- Improved strategies (belief revision, hiding information)
- Testbed for argumentation

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Work to do

- Improved metrics (belief concealment, relevance)
- Improved strategies (belief revision, hiding information)
- Testbed for argumentation
- Write my thesis. . .

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