Testing the Benfits of Structured Argumentation in Multi-Agent Deliberation Dialogues

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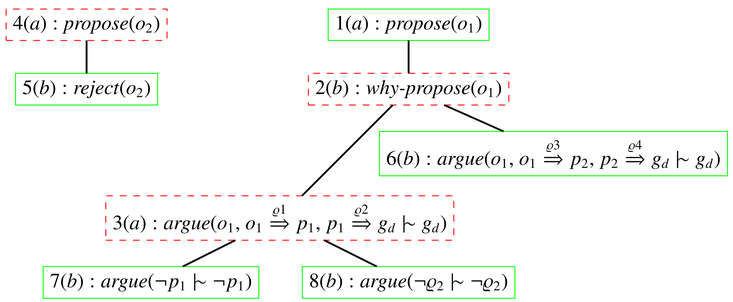
Abstract

Work on argumentation-based dialogue systems often assumes that the adoption of argumentation leads to improved efficiency and effectiveness. Several studies have taken an experimental approach to prove these alleged benefits, but none has so far supported the expressiveness of a logic for structured argumentation. This paper shows how the use of argumentation in deliberation dialogues can be tested while supporting goal-based agents that use the ASPIC framework for structured argumentation.

Example dialogue

agent	utterance	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.	$argue(o_1, o_1 \overset{\varrho 1}{\Rightarrow} p_1, p_1 \overset{\varrho 2}{\Rightarrow} g_d \mid\sim g_d)$
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.	$argue(o_1, o_1 \overset{\varrho 3}{\Rightarrow} p_2, p_2 \overset{\varrho 4}{\Rightarrow} g_d \mid\sim g_d)$
b	We can not drink wine, though.	$argue(\neg p_1 \mid\sim \neg p_1)$
b	And drinking wine does not mean we will enjoy the food.	$argue(\neg \varrho_2 \mid\sim \neg \varrho_2)$
a		*skip*
b		*skip*
a		*skip*

Deliberation model



Uses the ASPIC+ framework for structured argumentation. Moves are *in* if not attacked by a move that is *in*, otherwise it is *out*.

Scenario generation

Rule chains

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

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

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)

Strategies

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 $A \mid\sim g$ for o such that $o \in A$?
- Option heuristic $H_{d,a}^o$
  - `build` iff the sum of utilities > 0
  - `destroy` otherwise

Arguing agent

If not yet proposed, propose if `build`

For existing proposals

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

  Find argument to play or question a move

Non-arguing agent

If not yet proposed, propose if `build`

For existing proposals

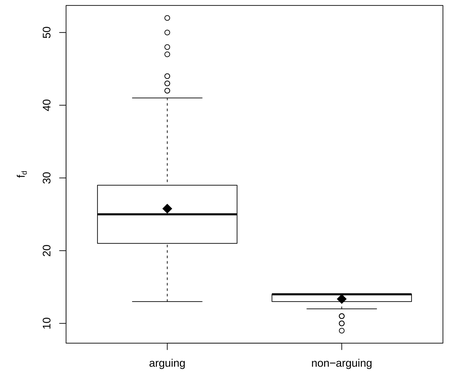
- Reject if `destroy`

Conclusion

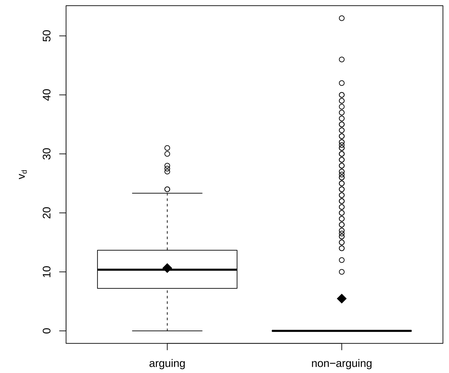
- First experiments with structured argumentation
- Arguing outperforms non-arguing effectiveness
- Partly confirms Karunatillake et al. 2009, Pasquier et al. 2010, Black 2011

Experiment

An Java implementation of the dialogue model, scenario generation model and agent strategies was made. 1000 dialogues were generated and two metrics were applied.



Arguing vs. non-arguing efficiency (number of moves)



Arguing vs. non-arguing effectiveness (combined utility for the outcome)