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

(Extended Abstract)

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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.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Multi-agent systems*

General Terms

Experimentation, Design

Keywords

Argumentation, Multi-agent dialogues, Experimental evaluation

1. INTRODUCTION

To improve communication and shared decision making in multi-agent systems it is often proposed to allow for argumentation in inter-agent dialogues. Throughout the years many frameworks and protocols have been developed and the theoretical reachability of ideal and intuitive outcomes has often been proved formally. However, since not all properties can be studied formally at least three works have experimentally explored the benefits of argumentation in dialogues. [2, 5, 1] On the other hand, none of these studies have captured the expressivity of formal models of argument based inference. They particularly lack a language in which arguments with internal structure can be used to cover realistic argumentation dialogues.

2. DELIBERATION MODEL

This paper tests the benefits of argumentation in multi-agent deliberation dialogues. Agents aim to reach agreement on a course of action, while considering a mutual goal. This type of dialogue is of particular interest because of the mix of competitive and cooperative elements. A slightly simplified version of the framework for deliberation dialogues of Kok et al. [3] is used, which models dialogues as a series of moves in which proposals can be made and questioned and where arguments can be stated, constructed using options, goals and beliefs. Figure 1 shows an example of a proposal tree. By making proposals and replying to these the agents influence the dialogical status of the moves and ultimately of the dialogue outcome.

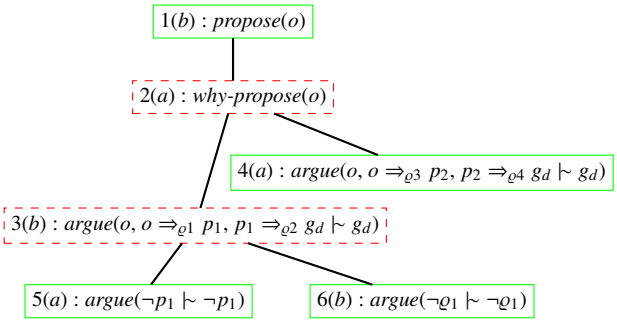

Figure 1: Example of a proposal tree for an option o

Arguments are formed using a simple instantiation of the abstract ASPIC framework for argumentation with structured arguments [6], which is an instance of the Dung abstract argumentation model. An argument can be attacked by rebutting a conclusion of a defeasible inference, by undermining one of its premises or by undercutting one of its defeasible inferences.

3. SCENARIO GENERATION

In the experiment of this paper, agents engage in a dialogue according to a scenario, which represents the underlying deliberation problem. It describes the mutual goal and the beliefs, goals and options known to the agents. Consequently, the structure of a scenario heavily influences the dialogue and the outcome. It is therefore important that scenarios reflect the characteristics of real deliberation problems.

The process to generate these scenarios is explained in detail in [4]. The idea is that agents are assigned beliefs, goals and options in a systematic way through three steps. First, roles are specified from which most of an agent's goals and known options originate. Second, chains of inference rules are generated between an agent's goals and known options. One chain ensures that an agent can potentially form arguments for its options so it can propose and de-

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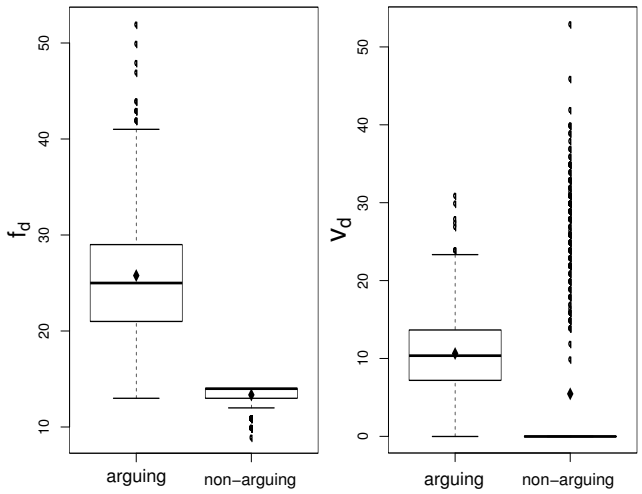

Figure 2: Efficiency f_d and effectiveness v_d of the arguing and non-arguing strategies, with averages ◆

fend them in the dialogue. Third, a set of potential conflicts is generated for every rule chain. These are negated facts that allow agents to undercut, undermine or rebut arguments. Finally, a subset of these generated options, goals and beliefs is assigned to the agent, along with some personal additional goals and beliefs. The resulting scenarios provide a structure that results in interesting dialogues with potential for arguments and counter-arguments.

4. EXPERIMENTAL EVALUATION

To test the benefits of argumentation in dialogues an experiment was conducted in which arguing and non-arguing strategies are tested. In both strategies the agents evaluate their known options based on the utility of defensible goals, but the non-arguing strategy will solely propose options and not play arguments or counter arguments. Since scenarios are generated in a structural fashion, the arguing strategy is likely to be able to form arguments for and against dialogue proposals.

Dialogical effects are tested in terms of dialogue *efficiency* by counting the played number of moves, and dialogue *effectiveness* by measuring the shared utility of the dialogue outcome. Arguing and non-arguing agents engage in a dialogue given a generated scenario and the effectiveness and efficiency is tested at termination. In the final experiment the average efficiency and effectiveness of both strategies were compared over 1000 scenarios.

In Figure 2 the average efficiency f_d, the number of dialogue moves, of the arguing and non-arguing strategies is shown on the left. Clearly the average number of moves when arguing ($f_d \approx 26$) is much higher than when the agents do not argue ($f_d \approx 14$). This is simply because all the non-arguing agents do is propose or reject options, while the arguing agents actually discuss claims. While argumentation may possibly prevent unnecessary moves, improving efficiency, this is clearly not true for this model of this paper.

In Figure 2 the effectiveness v_d, the total utility the agents have for the dialogue outcome, is shown on the right. Clearly, the average effectiveness is much higher ($v_d \approx 10$) for the arguing strategy than for the non-arguing strategy ($v_d \approx 5$). In many dialogues the non-arguing agents reject all proposals, leaving no dialogue outcome and hence a utility of 0. Because the arguing agents can move arguments giving a motivation, they can defend proposals, making them available to select as dialogue outcome again.

Finally, a comparison was made between the arguing strategy and a baseline strategy that never evaluates and rejects options, but proposes all the options known to the agent. Since there is then no selection over preferred outcomes, the strategy was expected to result in a lower effectiveness, that is, a lower shared utility. However, it was found that the average effectiveness betweent he baseline and arguing strategies was very similar. It might seem then that arguing in deliberation dialogues might not be beneficial after all, but there is still a difference in the way the results came to be. The arguing strategy empowers rational and self-interested agents and the dialogues they produce contain useful information like which proposals were clearly not the right choice. Further research is needed to investigate how this additional information can best be utilized.

5. CONCLUSIONS

Existing work on the experimental evaluation of the benefits of argumentation in agent dialogues makes use of very simple models of argumentation, in which arguments have no or very little structure. This paper has improved the state-of-the art by carrying out an experimental evaluation of deliberation with arguments that have considerably more structure and can be attacked by undercutters, underminers or rebuttals. Our work partly confirms findings of earlier work [2, 5, 1] that the use of argumentation in inter-agent dialogues may be beneficial to the agents.

A second contribution of our paper is a methodology for carrying out evaluation experiments using inter-agent dialogues with structured arguments. Since this kind of research is still rare, a new method needed to be developed, based on the generation process for realistic scenarios (presented in further detail in [4]) and a strategy model for goal-directed agents, with the aim to support future experimental research.

6. ACKNOWLEDGMENTS

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