

# A Proposal for Consensual Decision Making using Argumentation

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## Abstract

We propose an approach where a consensual decision making in multiagent systems can be reached using argumentation, with dialogues inspired in the interaction among humans in presencial meetings. The goal of the study is to identify the main features needed to reach consensus, like speech acts that are necessary in a dialogue using argumentation and ways in which agents can accept or reject formulas of the presented arguments and update their belief bases with those formulas. Every argument needs a strength based on the acceptability of each formula. Our next step is to calculate the best decision among all the alternatives using the dialogues and the strength of the arguments, and be able to compare our results to other proposals that do not focus on consensus.

## 1 Introduction

In presencial meetings, where there are a number of people discussing about an issue, the group needs to reach an agreement on a single alternative among other available options. By means of argument exchange, each individual dialogue participant presents his opinion or points of view about the issue under discussion. The decision making process consists of evaluating every information presented by the group during the dialogue, endorsing or rejecting the entire arguments or piece of the information in the arguments.

The most popular argumentation frameworks applied in decision making are usually abstract (traditional, bipolar, question-and-answer, value-based) [Carstens *et al.*, 2015], others use an argumentation system with logical language [Muller and Hunter, 2012; Toni, 2014; Amgoud and Prade, 2009; García and Simari, 2004], or use social argumentation to represent votes in arguments or attack relations [Egílmez *et al.*, 2013]. These frameworks are about argumentation and decision making, but every one has a different mechanism to achieve the best result. Neither of them deals specifically with situations where consensus is required. To have consensus, we need to consider each formula (information) in an argument with the expertise (trust) of each issuer. The set of formulas with their relations of acceptance or rejection and

the expertise of the issuer about the subject in discussion can indicate the strength of the argument

This paper aims to propose an approach for decision making using argumentation applied to multiagent systems where agents dialogue with others by presenting their arguments in favor or against about every decision alternative. The proposal contains three stages: (1) dialogue stage: a specific dialogue protocol is proposed to rule the sequence of moves and the speech acts. During the dialogue, all agents have a trust function that determines whether an agent must update or not his knowledge base; (2) argumentation stage: a mechanism is proposed to calculate the strength of the arguments based on the trust degree of the agents and the relation of acceptance/rejection of each formula in the argument; and (3) decision stage: the definition of a strategy to calculate the preference relation about each decision alternative based on the strength of the arguments and the attack relations.

This work is organized as follows: Section 2 presents the dialogue stage that has a framework for dialogue among agents looking for consensus in each formula of the argument, rules for dialogue moves, and the trust function used to updating beliefs with consensual information. Section 3 shows the need to calculate the strength of the arguments after the dialogue in the argumentation stage. Finally, Section 4 concludes the work.

## 2 Dialogue Stage

Let  $A$  be a set of agents  $\{a_1, \dots, a_n\}$  with  $n > 1$  that take part in a dialogue, every agent  $a_i$  uses a common propositional language  $L$  to represent their knowledge about the world. To deal with dialogue among agents, we propose a protocol that consists of:

- Arguments [Amgoud *et al.*, 2002], and attack relations of two types: undercut and rebuttal [Parsons and McBurney, 2003];
- Structure of agents with knowledge base  $\Sigma = K_i \cup G_i \cup KO_j^i$  ( $K_i =$  knowledge about the environment,  $G_i =$  desirable features in a decision, and  $KO_j^i =$  with  $i \neq j$  consensual information from agent  $j$ ) and a set of dialogues tables, one table for each decision alternative;
- Framework for consensual decision making that contains all elements necessary to execute the argumenta-

tion (agents, trust score of all agents, decision alternatives, attributes considered with higher impact in the decision, waiting time, and a pre-order of the decision alternatives representing the result of the framework;

- Artifact composed by a set of operations and set of observable properties [Ricci *et al.*, 2009]. This artifact contains a list that represents the queue with the sequence of moves. An agent can: (1) register in the list that represents the speech sequence; (2) query the list; and (3) remove its registry in the list;
- Speech acts (Propose(Arg, Attack), Accept( $\gamma$ ,  $\Phi$ ), Refuse( $\gamma$ ,  $\Phi$ ), Challenge( $\gamma$ , Ag, h), Ask-if(Ag,  $\Phi$ ), Query-if(Ag,  $\mu$ ,  $\Phi$ ), Inform( $\gamma$ , Ag,  $\Psi$ ));
- Trust function to analyse each formula in an argument indicating whether an agent must update his beliefs with that information (acceptance and rejection relations).

The dialogue process is presented in Figure 1:

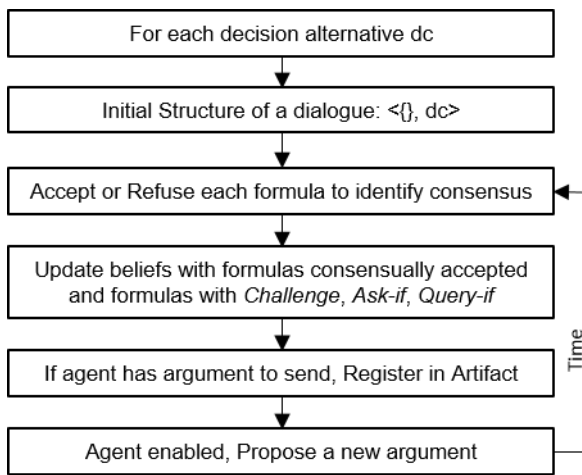


Figure 1: Sequence of steps in a dialogue

### 3 Argumentation Stage

To reach consensus, the agents must have compatible knowledge with each other. In the dialogue protocol, whenever an agent sends an argument, the other agents communicate their acceptance or refusal on each formula. Thus, agents having some formulas in  $\Sigma$  contradicting or endorsing formulas of the presented argument communicate such refusal/acceptance to the others using the speech acts Accept or Refuse.

Assuming that an argument  $\langle \{a, a \rightarrow b\}, b \rangle$  is proposed by agent  $ag_1$ , we represent the formulas accepted (or rejected) in this argument as  $a[ag_2, ag_3]$  or  $a \rightarrow b[ag_2]$ . According to the trust level of agent  $ag_1$  and what extent the formulas accepted (or rejected) by the group, the strength of the argument can be calculated with a weighted sum.

This strength will be used to create a graph based on an abstract argumentation with weighted arguments. After mapping each dialogue table to a graph, we may use some semantic to obtain the preferred arguments for every decision alternative, and create a mechanism to compare all the results to compute the preferred alternative among all agents.

### 4 Conclusions

In this work we presented the current research of an ongoing PhD thesis. The main goal is to investigate how a consensus can be reached among agents when they have to make decisions using argumentation, where all arguments in a dialogue have to be considered. We may detect to what extent each formula in the argument is believed by the group (consensual information) and this relation to the strength of the argument. We observed that when a formula of an argument is not rejected, it may be reviewed by the agents and considered as acceptable, leading to a consensual information.

We will continue with the analysis of the consensus on every formula and improve the calculus of strength regarding the trust level of the agents and the relations of acceptances and rejections. Finally, we intend to create a mechanism to map the dialogue tables to an argumentation framework and apply some semantics to investigate the results, comparing to the existing approaches.

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