Deliberation About Preferences and Group Decisions (Doctoral Consortium)

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ABSTRACT

Our research consists of an approach to Group Decision Making in multiagent systems that is inspired by human interaction. The main goal of the thesis is to evaluate how engaging in deliberation can help a group of agents to improve their decisions. In order to achieve that, we proposed a model of preferences that allows arguing about them and a protocol of deliberation which is inherently collaborative, but where preferences play a role to render agents individual and collective opinions. Our next step is to find metrics to quantify the satisfaction of an agent towards a decision, so we can compare the decisions in our method against those provided by social choice methods.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent systems

General Terms

Theory

Keywords

Reasoning (single and multiagent); Preference Handling; Decision Making (single and multiagent)

1. INTRODUCTION

Agents recur to Group Decision Making (GDM) (alternatively known as Collaborative Decision Making or Collective Decision Making), when the preferences of various agents are important to a particular decision. Examples involve the election of a leader, whether or not to accept an offer in negotiation with another group or agreeing on a plan for the group to execute together, just to name a few. Traditional approaches to this kind of decision are based on combining individual preferences mathematically. The first attempt to do so was Social Choice Theory [1]. Social choice is based on preference ordering relations and voting rules that can lead to a series of known inconsistencies. For instance, suppose three friends (agents) are trying to decide where to go for a vacation, while the possible destinations are Australia (A), Brazil (B), and China (C). Furthermore, suppose their preferences over the destinations are as follows:

$$\begin{array}{ll} \text{Agent 1:} & A \succ B \succ C \\ \text{Agent 2:} & B \succ C \succ A \\ \text{Agent 3:} & C \succ A \succ B \end{array}$$

In this situation, the common voting rule, majority, would render a tie. Now, independently of how we take their preferences into account, if we consider that all three friends have the same influence in the outcome, a bigger problem arises when we try to pick a winner: Suppose, for instance, we would elect option A. In that case, we would have $2/3$ of the agents unhappy about the outcome, since they would prefer option C over A. The same goes for options B and C, so any outcome would lead to a majority of the agents displeased about it's election. This is probably the best known example of the Condorcet's Paradox, which suggests that, in some situations, it is impossible to to have most of the voters satisfied.

Our research consists of a deliberation based approach to GDM inspired by human interaction in group decision situations. We believe that decisions reached through deliberation can yield better decisions than social choice, as agents are likely to be more satisfied about outcomes because they get a chance to review their beliefs and, consequently, their preferences. This expectancy suggests preferences should come from beliefs and these concepts should be somehow integrated, a view that is also defended in [3]. If a formalism integrates beliefs and preferences are integrated, agents get enabled to argue about available options and their preferences and deliberation becomes an important aspect of good group decision. This is especially true in case of ties (such as the above example), since arguments that promote or demote an option could influence the opinions of other agents, therefore affecting the result of a vote. Our work aims to study how deliberation focused on the quality of available options can improve group decisions. To evaluate this proposition, we intend to employ metrics able to quantify the satisfaction of agents.

2. COLLECTIVE DECISIONS AS GROUP REASONING

A decision problem is one in which a set of agents $A = \{a_1, \ldots, a_n\}$, $n \geq 1$, tries to reach a common choice out of

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a set of options (outcomes) $O = \{o_1, \ldots, o_m\}$, with $m \geq 2$. We say it consists of a collective decision problem whenever $n \geq 2$. In a decision problem, each agent has their own preferences over the options. When two or more agents agree on a particular decision, i.e., they are all in favor of electing the same outcome, it is said that they reached consensus.

In a collective decision context, the agents involved are supposed to seek the best outcome for *the group*, however maximizing the utility attributed to an option by all agents may be difficult or somehow infeasible. In a deliberation dialogue, the exchange of opinions (arguments) can work in a way to combine the knowledge of agents (such as in Sá and Alcântara [6]) and the conclusions can change the minds of some agents. Usually, a dialogue starts with a proposition and agents assume positions towards it: the proponent defends the proposition while the opponent attacks it. In a discussion about an option being good/neutral/bad for the group, our proposal of model of preferences allows agents to pick a side (proponent if they believe the option is good, opponent if bad) or even be impartial and play both roles (if the option is neutral). This behavior allows agents to play their preferences and combine individual opinions to build collective qualitative opinions about each option available. The group decision consists of picking any option amongst the best rated ones in the collective opinion. Alternatively, agents can just provide their individual opinions on each subject and aggregation is done by employing approval voting [2], where each agent gives a vote to each option they consider good and a tie is broken by randomly picking one of the most voted option.

3. RESULTS AND EVALUATION

In order to accomplish that, we have, as part of out research, developed (*i*) an approach to handle the preferences of agents [7] such that beliefs and utility are integrated and (*ii*) a deliberation protocol [6] in which agents can discuss available options in attempts to find collective opinions about each such option.

We made a step towards integrating beliefs and preferences in [7], where we proposed a way to model preferences so agents base their decisions on beliefs and can reason about such preferences. The approach consists of a definition of preference profile based on predicates in the language of the agent, so preferences are built on top of beliefs. These profiles are equipped with upper and lower *qualitative thresholds*, so the agent attributes utility to each available option, but is also able to describe such options as good (at least as good as the upper threshold), poor (worse than lower threshold) or neutral. Such description is used to build a general theory of what good, poor and neutral options are, so the agent can reason about preferences, build arguments and argue with others about the quality of options. Classifying options as good or poor is also considered in approval voting [2], so the connection of our approach to model preferences and approval voting is natural.

Our proposal is evaluated by means of mathematical proof of properties of the model. Amongst other features, we can show our proposal in [7] allows agents to (*i*) work with different perspectives of preferences, as multiple preference profiles are allowed; (*ii*) build arguments to explain decisions, given the built in general theories of preferences; (*iii*) deal with decision making under uncertainty by evaluating possibilities (multiple models of a theory); and (*iv*) automatically update preferences if they perform belief revision.

In [7], we show our approach to handle preferences successfully connects logical reasoning and rationality, as (i) our proposal to handle preferences satisfies two axioms proposed in [3] which should govern the relationship between an agent's beliefs and their preferences in different profiles, and (ii) the application of decision criteria from game theory such *minimax* [5] applied to the theory of the agent satisfies the criteria of bivariate monotonicity [4], which is proposed as criteria to decision making based on comparison of positive and negative features of available options.

In [6], we show how agents can combine their knowledge and build arguments no single agent is capable of conceiving. When we combine the general theories of preferences from [7] and conditional arguments from [6], the agents are able to evaluate options as they try to build a collective opinion about the quality of such option. The agents can learn from each other in the process, reviewing their own knowledge and, consequently, their preferences. We believe this process renders more satisfying decisions to agents, so the final step of the thesis consists of defining metrics of satisfaction towards a decision to tell how satisfied agents get about the outcomes of each method. With such metrics at hand, we would be able to compare deliberation and voting based methods to evaluate the main hypothesis: deliberation provides better decisions than social choice.

4. CONCLUSIONS

In this paper we described the research of a currently ongoing PhD thesis. The goal of the thesis is to show how a qualitative approach to model preferences can improve collective decisions, as deliberation about preferences are employed to build collective opinions about available options. In order to evaluate whether this approach improves group decisions, the next step is to find metrics to quantify how satisfied agents get about the outcome of a decision. We will then be able to run experiments to compare the agents satisfaction about the outcomes elected by each method in different situations.

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