Negotiation Teams in Multiagent Systems

(Extended Abstract)

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ABSTRACT

In this paper, I present my ongoing research on agent-based negotiation teams. An agent-based negotiation team is a group of two or more agents with their own and possibly conflicting goals that join together as a single negotiation party because they share a common goal that is related to the negotiation. Our research goal is to provide agent-based solutions for problems which may need negotiation teams.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Multiagent systems, Intelligent agents*

General Terms

Theory

Keywords

Negotiation Teams, Agreement Technologies

1. INTRODUCTION

Most of the research in negotiation has focused on processes where parties are formed by individuals. However, most real world negotiation processes usually involve parties which are formed by more than a single individual. For instance, imagine a simple and everyday example where a married couple negotiates house rental conditions with a landlord who has several apartments for rent. Another possible example is a negotiation process carried out between human organizations. These parties are known in the social science literature as *negotiation teams* [2, 7]. Thompson, et al., define a negotiation team as a group of two or more interdependent people who join together as a single negotiation party because of their similar interests and objectives related to the negotiation and who are all present at the bargaining table [2]. The reasons to send a negotiation team to the bargaining table are mainly twofold:

- Negotiation teams are sent to processes where the negotiation domain is inherently complex and requires the expertise and skills of members from different knowledge areas [1, 4].
- The party is formed by different stakeholders whose possibly conflicting interests are relevant to the negotiation (e.g., different departments from a human organization, the married couple) [3]. Thus, they should be taken into account in decision-making processes.

Similarly to the human case, these kinds of situations which require negotiation teams may also be found in agent-based systems. For instance, imagine an e-commerce system where a group of friends decides to go on a trip together and has to negotiate this trip package with travel agencies. In this case, the agents representing the friends have a common goal which is going on a travel together (shared goal); although they may have different preferences regarding the trip conditions (individual goals). These agents have to act accordingly to get a satisfactory deal from the travel agencies while managing their internal conflicts. Another possibility involves two agent organizations which are going to merge in order to deal with the increasing demand of service. The different agent organizations may be formed by different stakeholders and, thus, their interests have to be represented in the negotiation process. On top of that, the domain may be inherently complex due to the uncertainty about benefits of the different deal options and may need from different agents with complementary knowledge and abilities.

The problem of negotiation teams has only been partially analyzed by social sciences [1, 2, 3, 4, 7]. As far as we know, there are not studies which have addressed the problem of negotiation teams from the point of view of software agents. My main thesis goal is providing computable models for agent-based negotiation teams in software agent societies. More specifically, I am interested in negotiation models for intra-team dynamics, which I have termed as intra-team organizations. An intra-team organization defines how agents distribute their roles during the negotiation process, which intra-team strategy is used (which decisions are taken by the team and how and when these decisions are taken), and how agents decide their initial strategy to carry out with the opponent. These models may allow agents to solve negotiations such as the ones mentioned above as optimally as possible while being computable. Additionally, since negotiation teams have not been thoroughly studied by social sciences due to the complexity of team dynamics, some of the results provided by my thesis may also prove useful for social sciences.

2. INTRA-TEAM ORGANIZATIONS

In the first place, we started studying social sciences' literature. From this study, I was able to propose a general workflow of tasks for agents that participate in a negotia-

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tion team [5]. My thesis work has been focused on intra-team organizations, which covers part of the general workflow. Basically, an intra-team organization governs how the team behaves and how it is structured during the negotiation process (i.e., team dynamics). I decided to focus on this problem because it is possibly one of the issues which affects team performance the most. The aspects that I consider in an intra-team organization are:

- Roles: It refers to the responsibilities that the teammates assume. For instance, we may find a flat structure where all of the teammates have the same duties or more complex organizations where there is a certain distribution of tasks according to agent capabilities.

- Intra-team strategy: This aspect defines which decisions are taken by the negotiation team (e.g., offers to send, offer acceptance, leave negotiation), and how (e.g., voting) and when these decisions are taken (e.g., before/during the negotiation process).

In my thesis, we focus on studying intra-team organizations for negotiation teams which have members with possibly conflicting preferences. Thus, despite the fact that they share some common goals, they may have different preferences regarding the different negotiation attributes options. Therefore, the problem has a dual nature since teammates need of the other teammates to complete the negotiation, but they also want to optimize their preferences as much as possible. Of course, they do not only have to manage their inner conflicts, but they also have to handle the conflicts with the opponent preferences. Even though it seems reasonable to assume that teammates may have different preferences even in the simplest example (e.g., married couple), very little research has been done in social sciences [3]. Thus, results obtained from proposed computational models focusing on intra-team strategies may provide useful results for both software agents and human processes. Nevertheless, my main goal is providing results for software agents.

One of my work's hypotheses is that environmental conditions affect how the different negotiation strategies perform. This is my current research work. For instance, some strategies may work better in long negotiation processes whereas other may prove more adequate in environments with short deadlines. Ideally, a team of agents should select their intra-team strategy according to what they believe it is the best given what they know about the current environmental conditions. The adequateness of an intra-team strategy is studied from the point of view of utilitarian (e.g., average team utility, minimum team utility, etc.) and computational results (e.g., number of rounds). In addition, the negotiation environment conditions which are taken into account right now are the team preference diversity, the length of the negotiation process (short/long deadline), and the concession strategy of the opponent (boulware or conceder). As of today, we have focused on studying four different intra-team strategies for a team of agents (flat structure) which negotiates with an opponent following an alternating bilateral protocol in different negotiation environments [6]. These strategies differ in the level of consensus they are able to obtain (representative, majority, semi-unanimity, unanimity).

Some initial results suggest that there is not a universally better strategy for all of the negotiation environments and proposed metrics. Thus, it is necessary to thoroughly study how the different intra-team strategies are affected by the different environmental conditions.

3. FUTURE WORK

My current work focuses on identifying which of the proposed intra-team strategies work better given certain environmental conditions. However, my work still needs some mechanisms to apply the useful knowledge provided by simulations. More specifically, I plan on working in the following aspects: (i) further study more environmental conditions such as competition and other opponent concession strategies; (ii) provide mechanisms that allow agents to identify environmental conditions as closely as possible; (iii) provide mechanisms that allow agents to re-organize themselves during the negotiation process due to changing environmental conditions

As stated above, the amount of works related to negotiation teams in social sciences is limited. Thus, some of my research work may be of interest to this research field. In this line, we are working in collaboration with Prof. Katia Sycara to provide computational models for human negotiation teams which come from different cultures.

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