Negotiation Game for Improving Decision Making in Self-managing Teams

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Abstract. This paper presents a game intended to train teams that have both individual and teams goals to negotiate collaboratively in order to reach the team goal in the best way possible. We consider self-managing teams, i.e., teams that do not have a hierarchical structure. The importance of the team goal in comparison to their individual goals is touched upon, as are various conflicts that can occur during such a negotiation. The game, which is implemented in the Blocks World 4 Teams environment, gives a team a specific scenario and allows them to negotiate a plan of action. This plan of action is then performed by agents, after which the team members will be debriefed on their performance.

1 Introduction

In many situations groups of people need to make a joint decision to reach a common goal, while at the same time all participants also try to achieve their individual goals. Examples are friends going on a holiday or planning an evening downtown, teams of researchers negotiating about what proposal to submit and how to divide the budget, incident management teams, design teams of complex systems such as airplanes, collaborating adventure companies that organize a week programme for their clientele.

Our own motivation originated in our research into group decision making for incident management, in which the fire department, police, ambulances, and others have to work together to handle the incident as well as possible. The expectation was that incidents are managed by teams having a clear leader. However, an evaluation of crises has shown that the crisis management decision making process should be seen as a multi-party multi-issue negotiation, as each of the parties in one of the decision-making teams has their own interests and preferences [7] and the nominal leader cannot change that. What motivated us to develop a training game is that in such cases all participants are people dedicated to handle the incident for the good of society, and still they tend to forget this common goal, as they are focusing on the interests associated with their own specialty. When talking to experts involved in airplane design, the issue came up as well: each discipline expert tends to focus on his own problems, and tends to forget to some extent about the airplane they want to create as a team. Once seeing such a pattern, it can be seen in many aspects of life; at work, at home, with friends.

Common in these situations is that in order to make a decision each party has to make some compromises, and the final decision is based on the attitude, negotiation strategy and negotiation skills of each party. Importantly, the authors pose that the team

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will perform better if each team member takes the preferences of other team members into account. When the group decision is not that good, typically, at the start of the process team members do not have this knowledge, nor try to gain this knowledge during the process. Instead they negotiate competitively, meaning that they will focus on and prioritize their own preferences.

Our working hypothesis is that teams in which the team members have individual goals next to the team goal can be trained to adopt a collaborative instead of a competitive mind-set. In this paper we present the design of an agent-based game to train precisely this.

Our game is played by a team that has one group goal to achieve, with each team member also having his own goal to achieve. A negotiation phase is used to create the plan of action, after which software agents play the game based on the negotiation outcome. This allows the players to see the effect that their negotiation result has on the performance. At the end of such a round a debriefing is given to summarize the results to the team and let the team reflect on their performance.

The paper is structured as follows: Section 2 describes related work and Section 3 details the overall design of the game. Section 4 concludes this paper.

2 Related Work

Negotiation is one of the main procedures for dealing with opposing preferences [2]. Such a negotiation can take several forms, either a bilateral negotiation (between two parties only) or a multi-party negotiation (between more than 2 parties) [3]. The topic of negotiation can usually be divided into issues, where each issue has a set of possible values for that issue. Each actor in the negotiation has a preferred outcome, depending on their personal preferences, which will most often not be shared by the other actor(s) as they have differing interests.

Various games have been created that incorporate teamwork and/or negotiation to some extent. In this section we will highlight the two that come closest to our setting.

The SimParc project [1] focuses on participatory park management. The goal of the game is to make players understand conflicts and make them able to negotiate about them. The game takes place in a park council, which consists of various stakeholders like the community or the tourism operator. The topic of discussion is the zoning of the park which entails the desired level of conservation for each part of the park. Each stakeholder has a different preference concerning the zoning for each part of the park, which quickly leads to conflicts of interest. The park manager role acts as an arbiter and makes the final decision based on the final input from the other players. The players can freely negotiate with one or more others. At the end all players can adjust their proposal before the park manager makes a final decision. Players receive information about their performance and can ask the park manager to explain his final decision. The SimParc game comes close to the types of situation we would like to address as it contains a group goal (zoning the park), and individual goals. However, the park manager makes a final decision. In situations we want to address there is no team leader, instead every team member has equal say.

Colored Trails [6] is game that is also close to what we want. It was developed for testing the decision-making procedures in task-oriented settings; it is used for examining agent and human behavior. It focuses on the interaction between the individual goal

and the group goal. The game can be played by more than 2 players and consists of a rectangular board containing colored squares. The players get a starting position on this board, a goal position and an initial set of chips. The objective for the players is to reach the goal square. Players can only move to a square which is adjacent to the one they currently occupy. A move has to be paid for with a chip having the same color as the square the player wants to move to. Players negotiate bilaterally to exchange chips. After the game is over, the results are calculated using a scoring function which uses the number of chips the player has left, the distance to the goal position, the number of moves made by the player and whether or not the player has reached the goal state. Group goals can be modeled by adding a scoring component that can only be maximized when all players reach their goal and are therefore composed of multiple individual goals. However the negotiation protocol of Colored Trails is limited to bilateral negotiations, while we want to support situations that require multi-party negotiations.

3 Game Design

In this section, we outline the design of the game that we want to use for training multi-party negotiation.

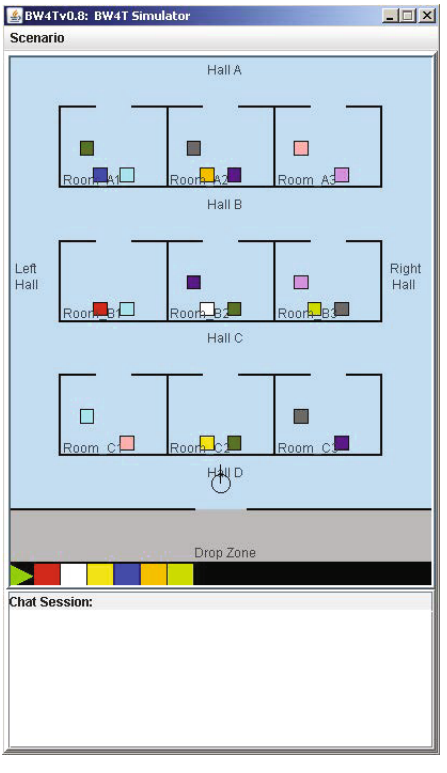

Fig. 1. BW4T Environment

For our game we use the Blocks World For Teams (BW4T) environment as a basis [5]. This environment was originally created to study human-agent teamwork. Our initial reasons for choosing this environment were that it is simple and that it is not directly related to crisis management. The latter is based on the assumption that virtual crisis management environments may not be realistic enough for incident management experts, which might hamper their immersion in the game and reduce the training effect. Furthermore, the game should be effective for any situation in which teams without a clear hierarchy have to make decisions to reach a team goal, while all team members also try to satisfy their individual preferences. An abstract environment, therefore, seems appropriate.

The BW4T environment, shown in Figure 1, consists of 9 rooms in which colored blocks are hidden. One or more simulated robots, which can be controlled by humans or software agents, can traverse these rooms in order to find these blocks.

The goal of the game is to collect certain colors in a preordained order, depicted below the grey area called Drop Zone. Players can pick up one block at a time and can bring it back to and drop it in the Drop Zone. Players can send messages to other players, for example telling them what blocks they have found in a room. None of the players can see the other players.

BW4T as proposed by Johnson et al. includes a group goal, but no individual goals for the players. Therefore, we extend BW4T to BW4T-I by assigning individual goals to each player. That way we can create conflicts between the group goal and individual goals of players, and between the individual goals themselves. Creating these conflicts is necessary as they occur in the situations for which we want to train people. We consider a conflict between two goals to exist when the achievement of one goal hinders the achievement of the other. Various kinds of individual goals may be thought of, creating different kinds of conflicts. Whether a conflict with the group goal occurs, depends also on the choice of the group goal. The criteria we propose for selection of individual goals are as follows:

- High severity of conflict, as a higher amount of conflict should improve awareness of these conflicts in players.
- Possibility of an integrated plan, meaning the possibility of creating a plan that achieves all goals with a lower performance impact. This should show players of our game that by negotiating collaboratively these solutions can be found.
- Ideally there is a way to translate the sets of individual goals and the joint goal to particular problems in the incident management domain, for comparison purposes.

A combination of individual goals, group goal and block configuration, is what we define as a scenario for the game. Below we give an example of a scenario that we have been implemented in our game, and that satisfies our criteria. This scenario involves the group goal "Red, Blue, Green, Yellow, Red, Red, Blue, Green, Yellow" and the individual goal (for all team members) to search all rooms.

The block configuration for this scenario was chosen in such a way that each room has to be explored in order to achieve the group goal. The group goal therefore also contains nine colors as there are nine rooms. This is not a problem when only one player plays this scenario and searches all the rooms. However with more players searching all the rooms, this creates a conflict with the group goal as it takes a lot longer to achieve it. An integrated plan can be created to lessen the delay by letting each player explore the rooms in a different order; however the result will still be slower than dropping the individual goals entirely. The amount of conflict is high as achieving the group goal is delayed greatly by all players searching every room. A translation to incident management could be the fire brigade that would try to get best possible access to the scene of the incident, whereas the ambulances would like to use the same resources (roads) to transport the wounded, and the police needs them for evacuating the population. The number of routes in and out of a quarter of city are limited and should be divided in such a way that the individual goals of all partners are respected as much as possible, while providing the best possible way of handling the incident.

Our game starts with a negotiation phase in which the team members make a joint decision on how they are going to play the game, depending on the group and individual goals. They need to reach an outcome in ten minutes, which emulates the time pressure

in the crisis management decision making process. This outcome is given to the agents that play the game using the agreements in the outcome. This allows the team members to see the direct effect of their negotiation outcome, and also prevents team members from changing their plans during the game. After the agents finish the game, a debriefing is given to the team members. The debriefing phase summarizes the results of the negotiation, including how the team members behaved during the negotiation, as well as the resulting performance of the agents.The next round starts after this debriefing. It was necessary to create a fixed negotiation domain for the game, as the agents need to be able to work with the negotiation outcome. In order to create this domain, we conducted experiments with the purpose of determining the issues and values in this domain. In the experiment, participants were allowed to freely negotiate, and in this way relevant issues and values were determined.

As the agents should show the effect of a certain negotiation outcome all of their reasoning uses this outcome. The agents follow a task structure containing three tasks. These tasks are the exploration, delivery and drop off tasks. The exploration task is performed first. This task is used to find the next block that the agent should collect. The delivery task is used to pick up the next block relevant for achieving the team goal. The agent will continue exploring if the next color that the agent should pick up is not the next color in the team goal list. The drop off task is used for dropping a block in the drop zone.

4 Conclusion

This paper presents a training game for training people to negotiate collaboratively in self-managing teams in which there are group goals as well as individual goals in order to create conflicts. Our game design extends the BW4T environment with individual goals. BW4T already has a group goal. Per scenario, team members are allowed 10 minutes to negotiate their joint plan of action. Software agents were implemented to play the game based on the negotiation outcome. The team members are debriefed using the performance of the agents and the results of the negotiation. This should lead to a change in negotiation behavior in the next round.

In the future we intend to perform an experiment in order to test whether our devised game actually changes the perception towards individual and group goals in participants. Moreover, we will investigate the use of automated negotiation agents, using the Genius environment [4], to replace part of the human participants in the first phase of the game. These agents should be endowed with the ability to exhibit different negotiation styles, corresponding with more or less collaborative behavior.

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