

Towards Negotiating Agents with Realistic Emotional Relationships in Intelligent Learning Environments

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Abstract. Social agents within Intelligent Learning Environments can enhance their own abilities by interacting to reach agreements and carrying them out. The typical reasoning process that directs agents to rejection or acceptance of these agreements is negotiation. In broad terms, an agreement is a series of conditions and commitments accepted by the parties involved that may refer to a future action plan, an exchange of articles, or assignment of tasks and roles. This article is aimed at proposing a negotiating agent that manifests realistic reactions resulting from forming emotional relationships that reflect in their interactions the characteristics of their personality and their emotional state. To this end, the use of negotiations in the development of social activities, some approaches for the implementation of negotiations between agents and software for the implementation of these agents are addressed. To conclude, the proposal of an agent that includes personality and emotions in the negotiation process to contribute to the realistic behavior of interactions in social agents is presented.

Keywords: intelligent learning environments, social agents, negotiating agents, decision making, personality and emotions.

1 Introduction

Negotiation is a central activity in human society, although it is common to think that the negotiation process is only carried out to achieve purchase agreements, labor agreements or agreements in politics, we also use it in daily situations without paying much attention. These situations can be as frequent and ordinary as an outing with friends. Continuing with this example, the group must first agree on the date for the meeting; they can also decide whether to take a walk in the park or go to the cinema.

If you pay attention, we find a second negotiation situation in the location, where surely to make a decision the films available on the billboard and their schedule will be

reviewed. Towards the end of the afternoon they may be hungry generating a new negotiating situation. Will they go to a restaurant or to the house of one of their friends to order food at home? Will they order pizza, chicken, Chinese food ...?

As you can see in the example, negotiation allows a group of individuals with different interests to find realistic and satisfactory solutions.

Negotiation is a process that seeks to reach an agreement and this may be the solution to situations in which it is necessary to reach business dealings, resolve conflicts or to form alliances [1].

In the real world, the relationship between emotions and personality causes changes in human interactions and therefore in negotiations. A contribution to realistic behavior can focus on modeling behavior using personality to create patterns of behavior and emotions to adapt behavior to particular situations. In this work we use these ideas to create an adaptable negotiating agent.

Within the Intelligent Learning Environments, negotiating agents can participate in simulations as actors or tutors. To provide them with the negotiating capacity we must go to the field of automatic negotiation, this field is dedicated to the investigation and study of the mechanics and strategies of negotiation, resulting in computable procedures used to obtain agreements.

2 Collective of Negotiating Agents

The agreements reached through negotiation allow resolutions for situations of assignment of tasks, allocation of resources and resolution of conflicts between agents. Social agents generally have mechanisms that allow beneficial interactions for the individual purposes of each agent [2, 3], such as:

- a. *Communication* that considers communication protocols and levels of communication, can deal from simple isolated data to an integral representation of the communicating agent;
- b. *Negotiation*, which is the process of reaching agreements in matters of common interest, consists of negotiation domain, protocol, strategy and rule of agreement;
- c. *Cooperation acts* understood as the temporary joint operation that allows beneficial treatment for the agent's purposes;
- d. Attitudes of *competition* that are appropriate in limited media environments, negotiation and cooperation come into play.

2.1 Overview of Negotiation between Agents

For the implementation of the processes involved in the negotiations we must first understand what the interactions are like. An interaction is a reciprocal action or influence between two or more entities, we can consider that the interaction requires a capacity and an opportunity to occur since a situation of opportunity that does not have the capacity to perform actions does not produce interaction, in the same way that a capacity without the opportunity to exercise does not produce an interaction either.

In the interactions, the entities involved maintain communication, but how are they to communicate? What is going to communicate?. The **how** is resolved by the negotiation protocol and the **what** by the agent's decision-making model.

What does a negotiation protocol do? A negotiation protocol determines the general order of the actions that occur during a negotiation session, it is understood as the set of rules that govern the way in which the negotiation is carried out [1]. The protocols describe whether the negotiation has ended, what is the agreement, what actions can be done in the next round. In each particular negotiating state, the number of participants and the valid actions of the participants are taken into account, for example: what messages can be sent by whom, to whom they can send them and at what stage. They can also provide some timeline to agents and notify that a limit of rounds has been reached. In the literature [4] some protocols can be found such as 1) Stacked Alternating Offers, 2) Alternating Multiple Offers, 3) Alternating Majority Consensus, 4) Simple Mediator Based and 5) Mediator Feedback Based.

What should a decision making model consider? During the negotiation, the agent exchanges proposals with the other participants to reach an acceptable agreement, which is a contract that all negotiating parties accept [1]. The set of all possible negotiation results is called negotiation domain. Preferences on the negotiation domain that each agent has define a particular negotiation scenario. So making decisions is navigating the negotiation domain proposing, accepting or rejecting possible solutions.

In the development of a negotiation session it is common for agents to make a proposal and at some point one will be accepted for which the agent must be able to perform the following two tasks: 1) *Formulate offers*, which implies some knowledge of the negotiation issues and their possible values. 2) *Choose appropriate actions*, which implies a design capable of operating with the actions defined in the negotiation protocol, it is generally sought to use them in the most convenient way to their objectives.

2.2 Approaches to Negotiation Techniques between Agents

Observing the techniques of automatic negotiation in the paradigm of agents, Huhns and Stephens in [2] have identified two aspects described below:

Environment-centered techniques: they seek to solve the question: How can the rules of the environment be designed so that the agents in it, regardless of their origin, capabilities or intentions, interact in a productive and equitable way? For this, the negotiation mechanism produced should have the following five characteristics: 1) Efficiency: the environment must not allow agents to waste resources to reach an agreement; 2) Simplicity: the negotiation mechanism should impose low computing demands and bandwidth on agents; 3) Stability: no agent should have an incentive to deviate from the agreed strategies; 4) Distribution: the negotiation mechanism should not require a central decision maker; and 5) Symmetry: the mechanism should not be biased against any agent for arbitrary or inappropriate reasons.

Agent-centered techniques: focus on finding the best strategy for the agent to follow a given environment. Most of these negotiation strategies have been developed for specific problems, so few general negotiation principles have emerged. However, there are two approaches, each based on an assumption about the particular type of agents

involved: In the first approach it seeks to formalize the negotiation protocols and their components, through speech acts together with a possible common semantics. This clarifies the conditions of satisfaction for different types of messages. The second approach is based on small sets of agents, which must have a common language and abstraction of the problem to reach a group solution. In the development of the negotiation the agents discuss a set of all the offers that have a positive utility for each agent. These agents follow a pre-established protocol to create a deal, that is, a joint plan between the agents that would satisfy all their objectives.

3 Automated Negotiating Agents

Research on negotiating agents have different methodological and software tools to support planning, documentation, implementation and experimentation. For example, on the side of the methodological tools are AUML [5], ANML [6] and on the software side we find GENIUS [7] and IAGO [8]. These last two tools provide facilities in the development and testing of negotiating agents. Both have been used in the Automated Negotiating Agents Competition (ANAC) tournaments [9, 10, 11].

GENIUS [7] was created as a tool for research in the area of bilateral negotiation of multiple topics that facilitates the creation of negotiating agents and information gathering. Its name comes from the acronym of Generic Environment for Negotiation with Intelligent multi-purpose Usage Simulation. GENIUS allows you to simulate individual negotiation sessions, as well as tournaments between negotiation agents in various negotiation scenarios. It can also be used in experiments with human negotiators who negotiate against automatic agents or other human beings.

On the other hand, the Interactive Arbitration Guide Online (IAGO) platform [8] was specifically developed as a test bench for negotiation between agents and humans. It is a web-based servlet hosting system that provides services for data collection and recording, providing an HTML5 GUI for use by humans and an API to design agents with corporeality and dialogues. Built with web technologies, IAGO supports a variety of functions for realistic communication between human agents such as partial offers, preference statements, natural language argumentation phrases (customizable) and expressive humanoid virtual agent.

4 Towards Individually Adaptable Agents

During the negotiations an agent may face the situation in which a second agent generates interactions of little or no value. This assessment made by the first agent about the second can be produced by an interpretation of the agent's actions, regarding the objectives of the first agent. The evaluated agent would now have associated a status that the first agent (evaluator) should consider in his reasoning.

The evaluating agent must resolve how to meet its objectives considering that there are agents that may not contribute to them or even be contrary to them.

In the following sections we discuss two proposals of the literature in negotiating agents focused on the aspects of pursuit of objectives and management of cooperative behavior. The first proposal uses a reasoning system based on beliefs, desires and

intentions (BDI - beliefs, desires and intentions) in a multi-agent negotiation system; the second uses the concept of personality to model cooperative behavior in dependency relationships. To conclude, the conceptual proposal of a negotiating agent adaptable to individual treatment with other agents is presented. The behavior of this agent is the result of the influence of his personality profile and an emotional state on the BDI scheme.

4.1 Agents with Beliefs, Desires and Intentions

The BDI reasoning scheme represents a decision-making mechanism applicable to automatic negotiation. This reasoning allows the individual objectives (desires) to be met in an environment that produces new data to be interpreted by forming beliefs. Decision making (intentions) is affected by these interpretations of the environment. A representative example is the work of Kiam Tian Seow and Khee Yin How in [12] where they present a multi-agent collaboration algorithm that uses the concepts of the BDI scheme. In this work the negotiation is collaborative since it involves the reasoning and interaction of the agents in an attempt to achieve their own objectives. In general terms, each collaborating agent has local knowledge only and the individual intentions of exchanging resources are arbitrated by an agent dedicated to this role. This arbitrating agent coordinates the negotiations and the collaborating agent communicates his intentions awaiting a response. The authors consider that collaborative negotiations allow us to propose a parallel treatment to the problem, which is why they extend centralized algorithms to a parallel-distributed approach.

4.2 Negotiating Agents with Personality

To establish cooperative relationships, agents must be willing to participate in useful behavior and maintain their commitments to other agents. Talman and collaborators in [13] use a model in which an agent chooses actions based on the degree of utility of other agents, given a dependency relationship between them. Agents perform their assigned task by design and choose a collaborator whose behavior is observed, which is interpreted as their personality. The collaborators attend the requests with certain frequency and give results of different reliability, these variations in their behavior are valued by the other agents. In this model, the utility of the agents is characterized in terms of cooperation and reliability. Their experimentation was carried out in a negotiation game in which participants need to exchange resources to achieve their objectives, without information about the resources of others. Talman and collaborators report demonstrating that agents that vary cooperation and trustworthiness regarding who they interact with can outperform agents that do not perform adaptation. They estimate that identifying individuals and adapting behavior to them allows them to punish non-useful behaviors against those that are, which improves the performance of all agents in the system, including non-useful agents.

4.3 Towards a Negotiating Agent with Personality and Emotions

This section presents the currently working on the project of creating an agent with a behavioral model that includes personality and emotions to make it individually

adaptive in the development of negotiations. By implementing the behavioral model, the agent would be affected by his reasoning and gain the ability to individually evaluate another agent, form a judgment about it and integrate this judgment into the landscape of a global problem. In this way, it will be able to form emotional relationships with other agents and present reactions to the particular situation since the other agents have different objectives and behaviors. The implementation of this agent was called *Affective Negotiating Agent (ANA)* and the behavior model was given the name of *Architecture for the Integration of Personality and Emotions in Negotiation (AIPEN)*. The works described in sections 4.1 and 4.2 use objective-based systems, generate trends in their decision-making and create valuations of other agents. Unlike these works where the main focus is optimization, the ANA design focuses on the behavioral differences that are exhibited in different situations. The differences in negotiation behavior occur in how different types of personalities experience an emotional state in the context of an affective relationship between agents. This will generate changes in the way of dealing with each agent and will cause the evolution of their relationships varying their degree of cooperation.

To exemplify the proposal, first imagine a group of agents that must negotiate using the Alternating Multiple Offers Protocol [4], where each has its own personality profile. The personality profile has the function of directing the action plan that the agent will use giving him a behavioral tendency, ranging from an aggressive negotiation plan to a collaborative one; this action plan consists of a negotiation strategy and a type of dialogue. The emotions of the agent are caused by the experiences that are had with another agent that is the source of those emotions (that is, a causal agent), the role of emotions is to adjust the action plan. The agent must follow that plan by making offers and voting for or against offers shared by the rest of the agents. The supply and voting actions would be accompanied by a dialogue that varies according to the personality profile and the emotional state of the agent, this would serve as a means of expression that allows sharing useful information such as the agent's beliefs and preferences. Given the above, we can initiate a negotiation protocol that would request an initial offer to be shared with the other agents in the negotiation, which in turn also share an opening offer.

Once the agent receives the offers and dialogues from the other negotiators, a three-stage process begins: *interpretation*, *strategy* and *action*. It begins with the stage of *interpretation* where the agent will begin an analysis of each of the responses captured, this process would be based on emotional and personality models so that each agent can determine if the actions and dialogues received are pleasant or not, if the causal agent likes it or not and if he considers the negotiations to progress or not. With the results obtained from this analysis, the agent's emotional state, its negotiation strategy and types of dialogue are updated.

After evaluating the actions of the other agents and having a new emotional state, the *strategy* stage is entered. At this stage a variation of the action plan indicated by the personality profile is generated, in which the emotional state of the agent and the quality of the relationship with each agent are taken into account.

To find the new action plan would be considered a mapping (personality, emotion) that is associated with one of several plans, for example *Yield* in the next offer, *Keep it* or *Demand* more; so that each type of personality experiences and reacts differently to each emotion. Now, to integrate the quality of the relationship with each agent in the

negotiation reasoning, we take advantage of the previous evaluation. Since the agent can form an individual image of each member of the group, he can also choose which of these to take into account and to what extent to consider them to formulate the following offer, for example, will give benefits to the agents with whom he has better relations and in the case of electing votes, varying the ease with which one votes in favor of an offer. In addition, it will be possible to select the type of dialogue that will be used with a specific agent, which could be *Friendly*, *Rough*, *Neutral* or *Inexpressive* as a result of a mapping (personality, quality of relationship). Thus, for example, in the case of interacting with an agent with whom you have bad relations, the dialogue can become empty (analogy of withdrawing the word to someone who is not to our liking).

As the next step in the protocol, the votes chosen by each agent with respect to each offer are requested, placing the agent in the stage of *action* in which he performs the necessary calculations to accept or reject an offer. The protocol proceeds by sharing the votes between the agents and the group of agents once again enters the stage of *interpretation* in which they analyze the vote and dialogue. The data generated will serve the agent to continue to form an image of the other agents and have elements to decide the following votes and offers. With regard to the protocol, it will follow its normal order alternating rounds of bidding and voting.

The relationships between the agents would evolve producing some social situations. A situation is expected to have a direct effect on the collaboration: an agent could be friends with another agent and as a consequence grant him benefits in the negotiation; or, on the other hand, antagonize and be progressively more demanding, one end of this behavior can be a total cut of communication. Another possible situation is the adaptation of the individual to the group, consider an agent whose offers are very aggressive for a group of agents that do not tolerate that behavior, with the passage of the interactions the aggressive agent could begin to be rejected by the members of that group which would worsen the aggressive agent's chances of reaching an agreement (considering that as bad as it may be, an agreement is more valuable than not achieving any). Consequently, the aggressive agent would be forced to change his behavior with these agents to some extent.

5 Conclusion and Future Works

Whatever the case, social agents with these behavioral adaptation capabilities would be valuable in different fields where negotiations are applied. Agents endowed with these characteristics can enhance their abilities by forming relationships based on the profit or utility that they perceive from others, responding to these relationships with cooperation if they are positive and evasion if they are negative. The above reinforces realistic behavior since it is typical human behavior to associate with individuals with similar goals and problems.

For example, a simulation to perform sales training exercises against different types of personalities such as training in the role of seller or buyer. Another example may be a serious game in which a game mechanic based on negotiation is used to exchange goods or plan agreements between different virtual agents and the player; then during the development of the game different sides could be generated based on the evolution of relationships.

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