A UNIFIED FRAMEWORK FOR E-COMMERCE NEGOTIATION AGENTS

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Abstract

One of the challenges of designing a negotiation agent, is to provide a unified framework. This allows heterogeneous agents to interact, despite their underlying architecture differences. In this paper, we presented a unified framework for e-commerce negotiation agent. The unified framework supports not only one-to-one and one-to-many negotiation, but also many-to-many negotiation. In supporting many-to-many negotiation, the proposed framework supports both competitive and coalition negotiations.

1. Introduction

In recent years, autonomous software agents, which can be viewed as delegates of human being in the cyber space, have drawn much attention because of their potential capacity to radically change traditional e-commerce technologies. But several challenges, including both technical and social aspects, must be addressed before the wide application of multi-agent systems in real-world e-commerce [1]. One of these challenges is to determine how these heterogeneous, self-interested agents should interact and negotiate with each other, given that there is no global control on the Internet. A common approach to this problem is to construct a negotiation model that guides the agents’ negotiation activities. Many researchers have developed the negotiation protocols to guide agents. However, these protocols are designed to support only one type of negotiation, namely one-to-many distributive negotiation. In this paper, we propose a unified framework for e-commerce negotiation, which supports multi-type negotiation models. The paper is organized as follows: section 2 discusses current approaches in negotiation agents. We present the unified framework for e-commerce agents in section 3. It describes how our unified framework supports different types of negotiations. We conclude our paper in section 4.

2. Negotiation Agents

Many research groups such as MIT Media Lab, have proposed agent-based e-commerce in order to solve e-commerce related problems [2]. Agents, which act autonomously and intelligently on behalf of their users, make e-commerce more effective. To reduce a user’s burden of negotiating directly with a seller, and make the best deal for them, automated negotiation agents are required. With the agent-based e-commerce system, BargainFinder, we could find product information sorted by price. This comparison-shopping may be bad for several suppliers because of no comparison in other attributes except price [3]. There is no navigation or negotiation based on a user’s interest or preference. However, there are some other agents with automated negotiation process for instance Kasbah, Sardine, Tete-@-Tete, MAGNET and UNICAMP. Kasbah, Sardine, and Tete-@-Tete were developed by MIT Media Lab. These agents were developed as a web-based multi-agent classification as system where users create buying agents and selling agents to help transact products. These agents use a distributive negotiation strategy. After buying agents and selling agents are matched, the only valid action in the negotiation protocol is for buying agents to offer a bid to
selling agents with no restrictions on time or price. However, some agents for example Tete-@-tete negotiate across multiple terms of transaction e.g. warranties, delivery time, etc [4].

In order to conduct automated negotiation in e-commerce, it is important to formalize communication and decision making processes. Much research has been done on the automated negotiation agent as discussed earlier. However, most of the current agents support only the distributive negotiation in business-to-customer (B2C). Distributive negotiation auctions focus the consumers’ attention solely on product’s price-comparison shopping agents. It hides important merchant added value from consumer consideration [5]. The negotiation should involve sharing of information among the participants. The outcome of the negotiation should be perceived to bring benefits to all the participants. This type of negotiation is known as integrative negotiation. This type of negotiation is different from the common model adopted by auctions [6].

3. Negotiation Protocols

In this paper, we propose the unified framework for e-commerce negotiation agents. The framework is a general architecture, which supports both distributive and integrative negotiations. In terms of the parties involved, a negotiation protocol can be one-to-one, one-to-many, or many-to-many. In terms of negotiation attributes, a negotiation can involve a single attribute or multiple attributes. Figure 1 illustrates the unified negotiation framework.

In our approach, the agents have limited information and knowledge of preferences, attributes and negotiation strategies of the other agents. They make decisions in relation to available information about private preference attributes and individual negotiation strategies. The agents exchange information in the form of offers. An offer is a complete solution which is currently preferred by an agent given its preferences, attributes and the negotiation history of offers and counter offers. An agreement takes place when another party accepts a particular offer. During the negotiation process, the offers change by modifying the value of each attribute according to the current information available. Each negotiation agent has an iterative process of evaluating the offers, updating the available options and making the counter offers, according to the individual negotiation strategies.

3.1 One-to-one Negotiation Protocol

First scenario, we view a simple negotiation between two parties. Figure 2 illustrates the scenario for one-to-one negotiation between buyer agent 1 (B1) and seller agent 1 (S1) through buyer administrator agent (BAd) and seller administrator agent (SAd). The BAd and SAd will behave differently in our negotiation protocol depending on the types of negotiation. In this protocol, BAd and Sad act as a messenger who passes the messages between the buyer agent and the seller agent.
For this example, we use the scenario in distributive negotiation between buyer and seller. At the beginning, the buyer 1 gives the information about the required items include attributes of item, value of each attribute, and weight of each attribute to the buyer agent \((B_1)\). \(B_1\) sends out the propose message \((P)\) through the buyer administrator agent \((BAd)\). \(BAd\) then pass the message to the seller administrator agent \((SAd)\) to broadcasts the requested to seller agent 1 \((S_1)\) in market place. Then \(S_1\) replies with an offer message \((O)\) or a rejection message \((R)\). The rejection is used by seller agent to refuse the negotiation if this agent could not offer any feasible proposal to \(B_1\). The seller agent can also refuse to negotiate, if it is already interacting with a large number of buying agents. However, the buying agent is also able to set a timeout, which can be used to set the maximum time for the seller agent to answer the requesting proposal. This timeout allows the buying agent to avoid interacting with an overloaded seller agent. After \(SAd\) receives the proposal message from \(S_i\), then it sends the offer message \((O)\) back through \(BAd\). \(BAd\) passes the offer message \((O)\) back to \(B_1\).

The negotiation process involves several rounds, and ends when both buyer and seller agents evaluate the current offer as acceptable. For any offer message \((O)\) received by \(B_1\) to be considered, it has to satisfy all constraints. That is, the proposal value of each attribute must belong to its preferences as specified by \(B_1\). The evaluation of the offer and counter offer used multi-attribute utility theory. The utility function is used for comparing and ordering alternative acceptable solutions [7].

### 3.2 One-to-many Negotiation Protocol

The second scenario is one-to-many negotiation. The negotiation protocol, found in these automated agents, is based on traditional auctions such as English or Dutch auctions [3]. These negotiation agents are efficient and simple to implement in current e-commerce application, fundamentally due to their simplicity. They follow a bidding style, which considers competitive offers between bidders flowing in one direction. However there is a significant limitation of auction-based negotiation. They do not allow for exchanging offers and counter offers, and exploiting the flow of information in both directions [7]. Moreover, exercising different negotiation strategies with different parties cannot be implemented in auctions. We now present our approach for one-to-many negotiation between buyer agent 1 \((B_1)\) and seller agents \(\{S_1, S_2, S_3\}\). With our approach, the agent \(B_1\) can use different negotiation strategies to negotiate with different seller agents. In this protocol, we assume that \(B_1\) gives the knowledge of the weight of each attribute of the item to the administrator agent \((BAd)\) through the propose message. \(BAd\) performs negotiation process, and filters the offers from seller agents on behalf of \(B_1\). \(BAd\) negotiate with seller agents through \(SAd\) by creating a number of one-to-one negotiations between \(BAd\) and each of seller agents as illustrated in Figure 3b.

![Figure 3 One-to-many negotiations](image)

Figure 3a shows the buyer agent 1 \((B_1)\) giving the information about the required items in the propose message \((P)\) via the buyer administrator agent \((BAd)\). \(BAd\) then sends the propose message to the seller administrator agent \((SAd)\) which broadcasts the request to all participating seller agents in market place. After broadcast the propose message through \(SAd\), the selling agents can answer
with an offer message (O), or a rejection message (R). Then \( BAd \) conducts a one-to-one negotiation with different seller agents, illustrated in Figure 3b. \( BAd \) summarizes and filters the offers from all participating seller agents to decide the best possible proposal to meet the request from \( B1 \). In order to select the seller agents, \( BAd \) uses the information about the weight of each attribute to evaluate the offer and counter offer, by using multi-attribute utility theory and constraint-based reasoning [7]. Finally \( BAd \) sends the best offer (\( O_1 \)) back to agent \( B1 \) which either accepts or modifies the proposal.

### 3.4 Coalition Negotiation Protocol.

In social structure terms, the simplest form of negotiation occurs when only two individuals are involved [8]. However, in the real business world, many parties involve in the negotiation. Each of individual parties is responsible for representing only his/her own needs and interests in the negotiation. For example, if two students want to buy a television and they both show up at the seller’s shop at the same time, then the seller must decide whether to deal with them separately or together. The buyers may get into a bidding war with each other or the seller might get greedy because his television seems to be very attractive, raise his price, and then both of the buyers walk away. If this situation was different, for example, the two buyers were roommates who were going to share the television, different negotiating dynamics might occur. When there are more than two negotiators in the event, negotiations instantly become more complex, and the likelihood increases that various subgroups may get together in some form of coalition. Our framework can be supported the complex coalition negotiation. Figure 4 shows an example of a coalition negotiation. We use the scenario in integrative negotiation between two buyers (\( B1 \) and \( B2 \)). They form a coalition agent, which interacts with the seller agents in distributive negotiation.

![Figure 4 Many-to-many coalition negotiations](image)

In this scenario, there are two rounds of negotiation. First round negotiation (as shown in Figure 4a) begins with negotiating between the participating buyer agents who are interested in joining the coalition through the buyer administrator agent (\( BAd \)). The negotiation begins when \( B1 \) sends the propose message (\( P \)) to \( BAd \). Instead \( BAd \) passes the message to \( SAd \), which broadcasts the message to other buyer agents \{\( B2, B3, B4 \}\). We assume that only \( B2 \) is interested in developing the coalition agent. Then it sends the offer message (\( O_2 \)) back to \( BAd \). \( BAd \) conducts the negotiation with \( B2 \) on behalf of \( B1 \). \( BAd \) summarizes and gathers all the item requirements from \( B1 \) and \( B2 \), to generate the coalition message. \( BAd \) then acts on behalf of the coalition agent to begin the second round of negotiation as illustrated in Figure 4b. \( BAd \) sends the message (\( P \)), which is the agreement of the first round negotiation between the buyer agents to \( SAd \). \( SAd \) broadcasts the message to seller agents to begin the second round negotiation. This negotiation process is the same as one-to-many negotiation, which describe earlier. On the other hand, the coalition agent can be established by seller agents as well. For example if the one seller cannot meet the requirements of the item of the buyer. Instead of terminating the negotiation, it can broadcast the purpose message via \( SAd \) to other seller agents to form the coalition agent. \( SAd \) will generate the offer (\( P \)), which is an agreement of the negotiation among seller agents with to the buyer agents.
4. Conclusions and Future Research

This paper proposes the unified framework for e-commerce negotiation agent. From an architectural point of view, our framework provides an effective and practical approach for enabling negotiation agents to interact with each other in many ways. Our framework offers simplicity by allowing us to capture the complexity of negotiation processes in the real world. It supports fully autonomous multi-attribute negotiations in the presence of limited common knowledge. In this paper, we showed how a one-to-many negotiation could be implemented by coordinating a number of parallel one-to-one negotiations. Furthermore we showed how the coalition agent could be formed through our framework. We also identified the roles of the buyer and seller administrator agents, in different negotiation protocols. For instance, the role of the administrator agents is only passing messages between buyer agents and seller agents in one-to-one negotiation. However, in more complex negotiation protocols such as one-to-many, many-to-many and coalition negotiations, the behavior of the administrator agents will involve more than just passing the message. They become the coordinating agents among the buyer agents, and the seller agents, particularly in coalition negotiation.

A unified framework is providing a general concept to construct a complete unified negotiation agent. In the near future, we would like to extend our work by implementing different negotiation strategies in our framework, to fully support integrative and distributive negotiation. The negotiation strategy is expressed in intra-agent behavior that determines how the agents evaluate the offer and counter offer. Furthermore, the communication protocol is required in an agent’s language to use in exchanging information. Finally, if the negotiation process could learn from its previous experience, the performance might improve over time.

References