Multi Agent based Hybrid E-negotiation System in E-commerce

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Abstract

E-business negotiation is a decision-making process that seeks to find an electronic agreement, which will satisfy the requirements of two or more parties in presence of limited information, and conflicting preferences. Therefore, we need to use hybrid systems that are able to have an appropriate performance in real conditions of different types of automated negotiations. This paper presents a multi agent based hybrid system that is using multi criteria decision-making and electronic negotiation.

Keywords: E-negotiation, Decision Making, Multi-agent

1. Introduction

Electronic commerce has changed the view of traditional business trading behavior. To automate most of commerce time-consuming stages of the buying process, software agent's technologies have been proposed and employed in different transaction stages of e-commerce. The agents in e-negotiation dialogs based on their owner requirements until reaching agreement on one or multi issues of the negotiation [1]. In addition, in many real conditions negotiation, negotiation agents have only limited information about their opponents and bounded rationality. Therefore, using heuristic algorithm to develop negotiation agents’ decision-making mechanism is useful. For this propose, we proposed multi agent based interactive recommendation and automated negotiation system (IRANS), so we expect that the negotiation time and transaction cost are reduced [4]. Also by the system allow negotiators to negotiate simultaneously in multi negotiation [8]. Since negotiations are often done in the intangible and complex negotiation space [15], negotiation deadline is limited and information is imperfect [26], therefore real negotiation models related to this space should be designed and implemented in corresponding to negotiation goals and constraints. Also, this design should be able to (a) be integrated with other technologies like data mining, information researching and information retrieval [12] (b) carry out of goal driven multi negotiations with multiple issues at the same time [11] (c) create user profiles [10] (d) support vital negotiation mechanism [17] (e) create a hybrid negotiation system (human, system and agent) [12]. Our proposed system is a new design proportionate to above discussion while simple price comparison discarded. Moreover with this design while there is not perfect information of proposal space, negotiation space and goal space, agents can negotiate to each other according to their appropriate requirements and constraints (goals). This paper is structured as follows. In next section, we present related works. Section 3 explains new process model according to the design and roles of multi agents in the design also provides multi agent based architecture of buyer and seller. In section 4, we explain architecture of multi agents IRANS. Section 5 illustrates multi criteria decision-making to find best opponent negotiators. Final section gives conclusions and highlights open issues that need to be addressed in future.

2. Related works

Various e-market places like KASBAH, eBay, Michigan and each electronic markets employed e-negotiation based on agent technology. Unfortunately, the market agents trade only by price [2]. While in real world, negotiations are not only by price but they often involve multiple issues (e.g., Price, Quantity and Quality Product) [14]. In Ref [27] a fuzzy similarity based trade-off mechanism is proposed to search for near optimal negotiation solutions based on realistic assumptions. The solution based on a bilateral negotiation, whereas negotiation in e-commerce often involves multiple parties. Our proposed model solved this problem. Ref [25] and [26] has developed a sequential negotiation
model that allows agents to revise their beliefs about the negotiation environment and the preference of opponents. The multi agent learning mechanism is based on probabilistic framework and employed Bayesian representation and learning. It was assumed that domain knowledge an offering price given the opponents reservation price was available to the system. The proposed model is limited to learning single negotiation issue (e.g., price), also this idea conflict to keep preference information private. Our proposed model does not assume the availability of the opponent preference information. In Ref [5], notwithstanding is used analytic hierarchical process (AHP) for C2B multi issues negotiation but interdependency between criteria is ignored. Also the transaction cost is high. In Ref [13] same to Ref [5] is used fuzzy AHP decision-making method for B2C negotiation. Therefore these solutions are not really business conditions. The hybrid negotiation system in this paper is able to solve this subject. Moreover, our automated negotiation is based on the multi agent system approach where can make autonomous negotiation decisions.

3. IRANS process model and role of multi agent in proposed model

For design of an e-negotiation system, one important activity is determining negotiation process model because the process model describes phases and assigns different activities to them [2]. Another important factor in design of the system is protocol [1]. The protocol is a structure model, involves set of rules, which dictate negotiation system processing and communication tasks, and constrains on activities [2]. In addition, process model and protocol provide plausible method for negotiation systems and remove additional activities of the system [1]. The model with activities related to every phase presented in “Fig.1”. Negotiation process model is formed by goal driven negotiation and requirements assigned to agents. Constraints and requirements are under title of negotiation issues then break down to main goals and due to clear relation between main goals, each main goal, and then break down to sub goals based on the relations exist between sub goals such as support, interference, and independence. Then implantable goals are selected from sub goals based on some rules. According to topology structures of goals, we can define goal driven negotiation process model. Based on such topology, agents are able to improve their behaviors over time. In that way, they may get better with experiences at selecting and achieving goals by taking correct actions. So agents can take proactive and reactive negotiation actions.
Now a day's, because in e-market there are infinite participants[18], exponentially growing amount of information available[13], information transparency, information overloading, different negotiation mechanisms[12] price wars between buyers and between sellers[10]and complexity of modern business trade [16], therefore multi agent based automated negotiation systems are hopeful technologies that play an important role[5]. Multi agents systems can adopt various mechanisms (e.g. bidding, auction, bargaining, and arbitration), information discovery and collection, negotiator selection, proposal generation and evaluation, play of advisor and provide effective suggestion, fully understand of owner requirements and preferences, coordinate interdependent relationships between various negotiations, build comprehensive user models and finally the systems can make trust between both users [9]. In addition, multi agents allow negotiator to play both roles of buyer and seller at the same time [17]. Our proposed design has considered the notations and results of this research show that proposed multi
agent architecture would reduce negotiation time and provide rapid response for their owners. Next step, we explain the particular design of multi agent’s architecture. In order to explain the architecture, first we have to illustrate types of agents employed in the architecture and then we show buyer and seller agent architecture.

In IRANS purposed model, Owner profile agent is to present owner goals, and aid the negotiator deciding on goals and strategies [5]. In addition, agents of this type would be able to adapt to the changes based on owner behavior in the process of negotiations [2, 9]. Searcher Agent is an agent that searches potential buyers or sellers that are in other distributed environments and performs the role of managing, querying, or collating information from many distributed sources [13]. A simple rule matching mechanism is developed to extract relevant negotiator information from the search results.

Figure 2. Buyer and seller agent architecture based on multi agent

This agent also performs post processing for the retrieved items and gives a list of qualified buyers or sellers with the offer. Information mediator agent would envelope in actively searching, fetching, filtering, and delivering information relevant to the issues from market knowledge base. Also this agent type is able to identify the objectives, preferences and strategies of the opponent [2, 10]. Recommender agent is able to generate a set of likely offers to be considered for submission to the opponent [10]. The proposed of advisor agent is to evaluate the offers received from the opponent and provide a feedback on the defect and, possibly benefits of these offers [5, 13]. Negotiator agent is responsible for negotiating with potential buyers or sellers, with respect to the preferences that have been collected from a group of participants [10]. Here, the goal is to bargaining with candidate sellers or buyers for the best offer that satisfies the most demands and preferences of group members. In addition, this agent may be capable of conducting negotiations by itself in a semi-autonomous or fully autonomous mode [13]. Applicability of full automation depends on the degree of certainty in objectives, preferences, and tactics of the negotiator therefore the agent is an agent that optimizes the buyer or seller utility based upon the requirements from owners’ requirements and constraints [2].Buyer or seller mediator agent is an agent that delivers the status messages of active services between negotiators agents, and between peer agents. In addition, this agent can play a role of an expert agent and in a sense; the agent is an intelligent administrator agent [10].

4. IRANS architecture

For illustrate of the propose design, primarily we describe some assumption and then base on negotiation protocol (e.g. one-to-one, one-to-many and many-to-many) in this section we presents multi issue multi agent-based architecture. First assumption is that, the agents have incomplete and limited information and knowledge of requirements (e.g. preferences, issues and constraints) and
negotiation strategies of the other agents that is means all the information about the negotiation objects and domain is assumed unavailable. They make decisions in relation to available information about private issues and individual negotiation strategies. The agents exchange information in the form of offers [22,25]. An offer is a complete solution that 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 issue according to negotiation space that changes dynamically. Each negotiation agent has an iterative process of evaluating the offers, updating the available believes and making the counter offers, according to the individual negotiation [4,7]. These heuristic approaches make use of offer based information which is exchanged between agents to infer useful information which lead to better agreements [26]. Also in this paper, second assumption is that we follow the intuition that is agents may exchange explicit meta-information to improve the way they negotiate. Argumentative messages relevant to the agents’ positions are exchanged that can reveal any unknown, non-shared, incomplete, imprecise information about their underlying mental attitudes [1]. Goal driven negotiation is a particular type of argument-based negotiation, which can also be seen as a special case of heuristic approaches. In addition, this approach assumes that parties are much more likely to come to a mutually satisfactory outcome when the object of negotiation is not considered as central as the agents’ underlying goals [24].

4.1. Bilateral negotiation in IRANS

There are two key points in the field of E-Negotiation systems, protocol, and strategy. The protocol determines the flow of messages between the negotiating agents; it is necessarily public and open. The strategy, on the other hand, is the way in which an agent acts within the protocol in an effort to get the best outcome of the negotiation [3]. In this section, we describe the process of negotiation between the seller agent, the buyer agent and mediator agents. This type of negotiation is restricted to two negotiation partners’ one buyer and one seller. The mediator agents will behave differently in our negotiation protocol depending on the types of negotiation. At the beginning, the seller agent evaluates the profit and chooses an optimal offer to the buyer agent. After receiving the offer from the seller agent, the buyer agent updates recent belief according to opponent offer, and then estimates the offer to judge whether accepts it or not [10]. If the buyer agent does not accept the offer, then the buyer agent will adjust its own strategy, proposes a new offer, and sends the offer to the seller agent. For evaluation of the offer and counter offer, we can use multi-issue utility theory and fuzzy decision process [20]. The belief is having a preview about the opponent private information and recent environment state. The agent belief model updates the negotiation according to received offer. Through offering and counter-offering, the agent would gradually know opponent offer strategy, and then it can propose a favorable offer by itself. The owner agent will check the restrictions according to the corresponding issues and restrictions in the database of user’s restrictions, after the negotiation agent received the offer. If the restriction is disobeyed, the agent should broaden restriction or adjust restriction artificially, adjust negotiation strategy according to negotiation environment and the received offer, and then propose a new offer. In the bilateral IRANS as you see in “Fig. 3”, there are three important views: (a) the mediator agent is expert agent and manages communication between IRANS entities (e.g. buyers, sellers, buyer agents, seller agents). Also the agent performs negotiation process, and filters the offers from buyers/seller agents on behalf of owners. (b) The seller and buyer agents, which are negotiating with a large number of agents. They can refuse to negotiate by setting a timeout. This timeout allows the agents to avoid interacting with overloaded agents. (c) These buyer /seller agents involve multi agents like “Figure.2.”
4.2. Multilateral negotiation in IRANS

The conventional approaches often used to model and analyze negotiation, like auction theory, are hardly useful for modeling of multilateral negotiation about many issues and with vague preferences and uncertain information on either negotiating side. There are two types of multilateral negotiation, One-sided multilateral negotiations that are characterized by one seller and many buyers or by many sellers and one buyer [3,16]. This type of negotiation is deemed the standard form of auctions. 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 [10]. Another multilateral negotiation is double-side multilateral negotiation. Many buyers and many sellers [3] characterize double-sided multilateral negotiations. This section presents multilateral negotiation that: (1) Buyer/Seller agent can use different negotiation strategies to negotiate with different agents; (2) Buyer agent negotiate with seller agents through mediator agents by creating a number of one-to-one negotiations between each of seller agents. Also Seller agents negotiate with buyer agents through mediator agents by creating a number of one-to-one negotiations between each of buyer agents “Fig. 2”. Fig. 4 shows how a one-to-many negotiation could be implemented by coordinating a number of parallel one-to-one negotiations. In the complex business world, many negotiators participate in the negotiation. Each of users is responsible for representing only his/her own goals and interests in the negotiation. Therefore, to prevent price war between users, we needs to coalition agents. In “Fig. 5” coalition process illustrated clearly.
4.3. Integrated architecture of IRANS

According to the above discussions, in the “Figure6” we present integrated IRANS architecture. Viewpoint of the architecture is that agents interacts and communicates each other. By this architecture while there is not complete information and there are multi issue, e-marketplace users negotiate with each other in real business world.
5. Multi criteria decision-making in IRANS

The seller or buyer selection problem is a strategic issue in e-marketplace. On the other hand, selecting the optimal seller for buyer and buyer for seller among many alternatives is a decision-making [2]. This paper develops an evaluation model based on Analytical Network Process (ANP) and the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS), to help the sellers or buyers in e-marketplaces for the selection of optimal alternatives in fuzzy environments. The fuzzy environment deals with the uncertainty and imprecision related with information concerning several parameters [21]. The vagueness is handled with linguistic values parameterized by triangular fuzzy numbers. The fuzzy ANP (FANP) is used to capture the fuzziness in evaluation of criteria and sub criteria [23]. FANP has some additional advantages according to the conventional ANP method. After we obtain criteria weight by FANP, to avoid a large number of pairwise comparisons in ANP method in this proposed model, we use fuzzy TOPSIS method to obtain the final ranking results [19, 21].

In a negotiation environment, if there are \((m)\) criteria and \((n)\) alternatives, we need to \((k)\) pairwise comparisons to run a full FANP solution [19].

\[
k = \left( \frac{m \times n \left( n - 1 \right)}{2} \right)
\]

6. Conclusion

In this paper we present a new design that can work in real business world. The proposed architecture increase probability of reaching to agreement while there isn’t any opponent information and negotiators face to almost imperfect information. Also through using architecture, a negotiator can negotiate with several participants, different strategies and multi issues at the same time. To improve the design, in future we are going to implement proposed design and log result of the implementation.

7. References