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A Framework for Developing Experience Based e-Negotiation System

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Abstract: In this study we propose multi-agent distributed electronic negotiation system, where the learning process is facilitated by using the CBR approach in combination with case database and addition of ability to roam through a network allows considering outside options using mobile agent technology. CBR is an AI methodology which combines re-use of the past experiences with case base. Cases similar to the current case at hand are retrieved from case base, revised and used to develop new offers and counter-offers.

Key words: Outside options, mobile agent, CBR, multi-agent

INTRODUCTION

While e-commerce provides tremendous new opportunities for businesses, it requires new business models in order to realize its potentials and to be cost-effective. E-commerce transactions are mostly un-, or partially- automated, involving human decisions in most stages, thus adding to transaction costs. New electronic markets are represented by selling agents (both human and/or artificial) displaying goods and services[1] and buying agents which can scan markets for information gathering, negotiation and purchasing. In such new models most time consuming tasks, such as decision making and human involvement are minimized.

Automation of a negotiation process will most certainly benefit e-business community, because a negotiation is a composite part of a large number of e-commerce processes, such as contracting, auctions, legal disputes settlement, scheduling, etc. Negotiation is a form of interaction between parties which wish to cooperate in order to reach an agreement, but have conflicting goals. For example, a seller wants to sell his product or service at a higher price to maximize his profits, while a buyer tries to buy the same product or service for as little as possible. Most of the commercial negotiations are bilateral processes[2] with only two parties involved, either human or artificial, where the parties involved try to resolve such a conflict, reach an agreement that will benefit both negotiating sides. It also can be used to resolve a dispute when a third party is not trustable, or simply not available. Real-life negotiation is a lengthy and complicated process, involving a lot of issues.

A number of theoretical models for negotiation have been developed in economics, such as perfect equilibrium, Ramsey equilibrium, alternative-offers bargaining, models with incomplete information, etc. All these models have been built under certain static assumptions specific for the given model and quite often contradicting assumptions used for other models. This made it very difficult or sometimes impossible to integrate them which is necessary in order to facilitate e-negotiations. Even so in the new generation of e-negotiation systems this problem has been dealt with to some degree, negotiation strategies are still mostly static. New opportunities or threats are very likely to arise after an agent has been created. An agent should be able to see these opportunities or threats in order to reach a better agreement. And yet other facts can add pressure on a negotiator – bounds on time to reach an agreement or restrictions on the resources being negotiated. Because strategies are set up in the pre-negotiation phase, the dynamics of the negotiation process have not been taken into a consideration.

Creation of a dynamic e-negotiation system which will be able to react on changes in an environment and re-adjust values of attributes preset by a principal is a task that needs to be look at.

All theoretical negotiation models developed in the past were built on centralized decision making approach. It was assumed that complete information has been available about negotiating parties and issues being negotiated and that computational resources are unlimited. Due to the simple facts that business partners can be located far away, information about counterparts is very likely to be incomplete and computational capabilities usually are limited, such models cannot be used in the real-life e-commerce. New ways of conducting business requires new models which will be able to perform efficiently in the distributed environment.

In order to design an effective e-negotiation strategy, we should also consider existing outside options. A negotiating party may have more than one source to choose from. Existence of outside options can either positively or negatively affect the outcome of negotiations and certainly has its impact on the negotiation strategy. A negotiator with more than one choice can use this fact to his advantage by employing

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more aggressive strategy. At the same time certain risks are involved. If a negotiator cannot be sure about a utility, he could option for a tradeoff between probability of loosing one chance and expectation of a future deal.

This study presents an alternative approach of e-negotiation model based upon an AI methodology using Case Based Reasoning (CBR) combined with multi-agent technology. The proposed model will tackle the above mentioned problems. The CBR approach makes use of previous experience to solve newly encountered problems. Case based reasoning approach is based on re-use of the past experience that is organized in the form of cases. The purpose of CBR is to help its user to find and retrieve cases similar to the current problem and adapt them so they can be used to solve this new problem. After the final result has been reached, it can be stored in the case base as another case thus expanding our knowledge base.

A multi-agent system is a group of intelligent agents working towards finding an acceptable solution to a problem at hand. Such e-negotiation system will accept user's preferences, pass them to the CBR system where the best matching case or cases are retrieved from a case base. After an offer has been created based, multiple copies of negotiation agent will be dispatched into the Internet to search for acceptable counterparts. Agents may not be individually capable of finding the best deal. Each agent may retrieve the best local counter-offer, which, when compared with others, may not result in the best overall case in terms of global measures. But cooperation among agents may lead to achievement of the final goals of finding the most satisfactory agreement.

The research on negotiations has been conducted in two fields of economics and artificial intelligence (AI): Research in the economics field concentrated on the outcome of a negotiation that satisfy the balance equation between negotiating sides under some particular assumptions, while AI focuses on the development of intelligent agents which will be able to negotiate on behalf of their users in an intelligent way. AI models are used in more complex situations where equilibrium (or balance equation) is not applicable, or its implementation is too complicated. In such cases good results can be achieved by using heuristic methods, or by creating agents who will be able to learn from and adapt to the surrounding environment, flexible and self-optimizing. Several approaches have been used for modeling of the electronic negotiation systems: game theory based[3], Bayesian networks[4,5], evolutionary computation[6] and distributed artificial intelligence models[7].

Two approaches have been deployed in development of automated negotiation systems: Negotiation Support Systems and software agent technology. Both approaches have been the subject of extensive research over the last few years.

Negotiation Support Systems (NSS) have been designed to help negotiators achieve optimal solutions. Usually these systems consist of two or more networked Decision Support Systems (DSS) and provide three levels of support for the negotiation process: process support, decision support and decision automation[8]. NSSs with process support use the electronic media to facilitate a negotiation process, while NSSs with decision support uses the electronic media to suggest optional solutions in an attempt to improve the outcome of the negotiation. The last relatively new level of negotiation support, agent-based NSSs, attempts to automate negotiation through the use of software agents over the electronic media.

Negotiation Support Systems have been extensively studied and developed by researchers[9-12]; but this research had little influence in the real-life commerce in the past. Some of the reasons were that most traditional NSSs require specific software installation, often implemented in an electronic meeting room setting in LAN environment and must be accompanied with face-to-face meeting[13]. Such requirements significantly limited the potential use of computer-based negotiation support systems in business because of the redundancy and extra expenses involved.

Advances in the development of new technologies gave a new prospective to NSSs. Several systems have been developed to facilitate the various phases of the negotiation process such as understanding the negotiation case, assigning preference ratings for negotiable issues and options and setting the reservation level before the negotiation begins. The tools for support are varied and they include decision science methods (decision tables, decision trees, multi-attribute utility theory), statistical methods (forecasting, regression, what-if analysis) and game theory[14].

Most of the earlier systems were developed by universities to study and teach negotiations[15-18] and are LAN based. Due to this fact they cannot be applied to real-life negotiations. New generation of NSSs are so called web NSSs. Examples of such web-based e-negotiation support systems are Inspire[15], WebNS[9,16,19], SimpleNS[9,17], etc.

Each of the above mentioned systems has its limitations. Inspire does not provide consistency verification mechanism, has a fixed set of alternatives, limited use of visualization, a narrow communication channel bandwidth and predefined negotiation phases, which have to be followed. WebNS does not provide analytical or solution-driven support. SimpleNS facilitates storage, retrieval, organization and display of information only with no analytical tools what so ever.

Software agent technology has become another popular approach in electronic negotiations, because use of software agents on behalf of negotiating parties

could significantly reduce efforts and time needed to conduct and finalize negotiations. Agents can be personalized to reflect their principal's preferences. They are also capable of learning from past experiences and adapting to changing network and e-negotiation system conditions.

Earliest agents, even so they were classified as automated negotiation tools in many reviews, have been mostly used to automate various stages of the Consumer Buying Behavior (CBB) model: need identification, product brokering, merchant brokering, negotiation, purchase and delivery, product service and evaluation[1], in particular product and merchant brokering. BargainFinder provides merchant brokering, Jango is the first comparison-shopping agent, PersonaLogic and Firefly are capable of product brokering and so on. Despite the claims made by the NSA developers, the use of negotiation methodologies is often oversimplified and the systems engage in bidding or simple single-issue negotiations with predefined behavior, strategy and tactics.

MarketMaker, AuctionBot and Tete-a-tete are examples of agent-based systems that seek mutual agreements on the terms of transactions that satisfy the parties' predefined constraints, preferences and objectives. These agents engage in the information exchange activities that are typical to auctions rather than negotiations and are not capable of engaging in context rich and complex negotiations.

In later works negotiation agent Atin was developed to provide assistance to a negotiator; it does not actually conduct negotiations. It offers its owner context-dependent support in the use of the system and an advice regarding the negotiation process and the user's and his opponent's tactics and strategies. It might ask for some additional information from the user such as negotiation strategy, willingness to make concession, etc. These inputs from the user will help the agent to filter out irrelevant information and display the most appropriate advice upon user's request.

Software agents can be used in conjunction with NSSs with the purpose of providing help in the system use and understanding of its requirements; advice regarding the strategy, tactic and the formulation of offers, concessions and arguments; and interpreting the counterpart's moves. An example is Aspire, which is an integration of Inspire, e-negotiation support system and Atin, a negotiation support agent[20]. Atin continuously monitors the negotiation process independently of the user activities, provides advice regarding the negotiation process and parties' tactics and strategies and warns the user about actions that may have negative impact on his situation.

Several of agent-based e-commerce applications have been implemented as e-marketplaces. Generic auction server AuctionBot allows users to auction products by employing agents. Agents are created by users using the interfaces offered conduct negotiation with customized bidding strategies. MIT Media Lab's Kasbah[1] is an online marketplace where buyer and seller agents can interact. Users can create buyer or seller agents, provide them with a set of criteria and dispatch them into the marketplace. Buyer agents filter the available offers according to users' criteria and then proceed to negotiate a deal. ICOMA[21] is an open infrastructure to simulate intelligent agent-based e-commerce, mainly dealing with product searching and filtering.

However, agents in all these applications operate at a single server site and they cannot roam from server to server. Users cannot easily embed individual preferences in their agents and are given few or no options to customize agents. One of the major objectives of this research is to design an e- negotiation system solving the above problems.

CBR and multi-agent system in e-Negotiation: Practical e-negotiation system should not be built on the centralized decision making approach. In this work the possibility of combination of centralized and decentralized decision making is explored.

By nature, there are usually previous negotiation cases. A lot of negotiations are conducted repeatedly on the same or similar resources with similar issues, so identical tasks are performed over and over again. In general, a negotiation agent knows its principal's preferences, but not the preferences of the opponent. It has to be able to make reasonable decision based on incomplete information. One possible solution is to use Case-Based Reasoning (CBR) approach, which allows an agent to learn from previous experiences. Since an agent exists in dynamic environment, it should be able to adapt to any changes that happens after the agent has been created, such as new opportunities or treats. In this approach cases similar for the current one are looked up and used to resolve the current problem. The CBR technique[22] comprised of four processes: retrieval of previous case or cases related to the current problem; reuse the retrieved data; revision of the solution based on reused case(s) and addition of the revised solution to existing case database (Fig 1). Some of the advantages of the CBR are better prediction accuracy by comparison with other methods, capability to handle both qualitative and quantitative data, using analytical techniques, adaptation of the existing solutions to the current situation, fast implementation, taking advantage of the previous experience, etc. The database is updated by adding a new solution to it. CBR approach has been used successfully in many areas. In addition to above listed advantages of case-based reasoning method another beneficial feature needs to be mentioned which is the ability to identify potentially high risk situations, thus allowing to avoid conditions that could lead to failure of negotiation or to an unfavorable outcome.

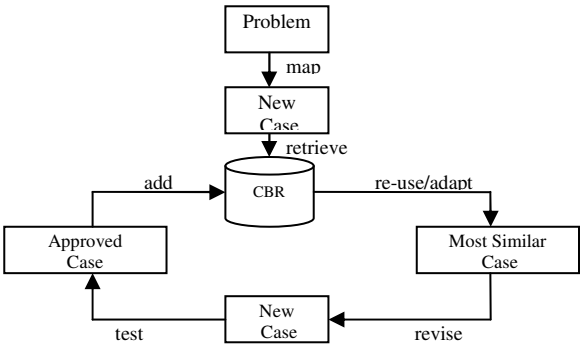

Fig. 1: Case-based reasoning cycle

The software agent technology is well suited for e-negotiation applications because its implementation could reduce efforts required to conduct e-negotiations. Agents can be personalized at the time of creation to represent their principals' preferences; they are autonomous and capable of learning from their environment and past experiences. Addition of mobility to e-negotiation agents amplifies their potential even more. Such an agent could autonomously act and negotiate on behalf of its principal in distributed environment. Mobility also allows achieving better network utilization, providing support to mobile users that can become disconnected so their agents can move around network and reducing connection costs[19]. In the Internet environment mobility allows to conduct negotiation locally in the particular e-marketplace, without maintaining connection with remote host, or using valuable network bandwidth.

The dilemma of outside options can be resolved by applying the mobile agent approach, where copies of an e-negotiation agent are working in parallel trying to get a better deal for his principal.

In this work we propose multi-agent distributed electronic negotiation system, where the learning process is facilitated by using the CBR approach in combination with case database and addition ability to roam through a network allows considering outside options.

The proposed approach: The complementary properties of CBR and multi-agent technology can be advantageously combined to build an efficient e-negotiation model to which only one technique fails to provide a satisfactory solution. The mobile agent can be effective in addressing the problem of negotiation in dynamic environments by considering existence of outside options and be able to react on changes. Case Based Reasoning approach is used to allow for learning from past experiences. Case base contains previously negotiated cases. System will calculate the similarity coefficient, using attribute values provided by user and search its case base for cases similar to the current case. Similar cases are retrieved, used to suggest a new solution, tested and adapted if the attribute values of retrieved case differ from that of the current case. And at last the current case with derived solution is stored as a new case in the case base thus expanding our knowledge base. Each previously negotiated case is stored in the case base contains a description of the negotiating problem, a solution and/or the outcome.

The overall framework of the proposed system is presented in Fig. 2. It consists of a number of agents. Each agent is designed to represent a specific functional unit. This requires three different agent types, one mobile and two static (negotiator mobile agent, interface agent and task agent).

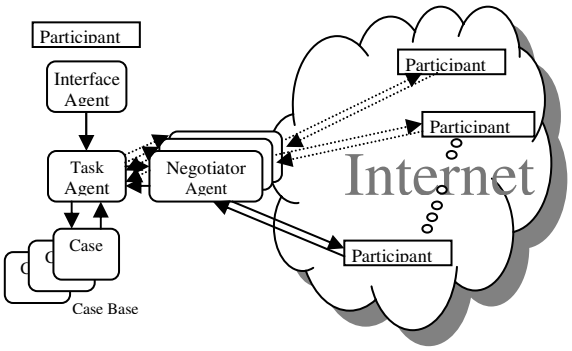

Fig. 2: Automated e-Negotiation system

An interface agent interacts with the negotiating party directly. Its main task is assisting a user in using e-negotiation software, search for information and available services. After a client specifies his preferences with an interface agent, the agent continues the job on his own. It is, in a manner of speaking, a communication point between a user and an automated e-negotiation system and its tasks are relatively simple. In addition to its task of assisting users it also should be able to accept the user preferences, pass them on to a task agent, observe user, adapt to his needs and return results in the form acceptable to a user.

A task agent resides within a domain. It should be capable to comprise an offer on behalf of the user according to his preferences. To achieve this task agent will communicate with a case base. To accomplish its job task agent should be capable to:

* Communicate with an interface agent to get preferences specified by a user.
* Pass information about user's preferences to the CBR system.
* Comprise an offer based on the user's information and case, similar to the current one returned by CBR.
* Create a mobile e-negotiation agent, containing an offer and launch it to search for potential counterpart. Normally there should multi-agents working in parallel.
* Filter information returned by mobile agents in order to find acceptable counter-offers, process

them, create a new offer and so on, until a negotiation will be finalized.

* Organize result in a format suitable for a user.

A negotiator agent should contain an offer, developed by task agent in cooperation with the CBR system. Several copies of the same agent migrate through Internet looking for potential counterparts. A negotiation agent should be capable of searching, based on an offer it contains and conducting preliminary bilateral negotiations independently. If some kind of preliminary agreement has been reached, the agent returns result to the task agent.

CONCLUSION

In this study, a new e-negotiation model which integrates case-based reasoning and multi-agent technology has been presented. The study described the application of cased-based reasoning in development of an effective automated e-negotiation system in combination with multi-agent technology. This model can be applied to a wide range of negotiation situations. Its modularity allows for development of a domain independent e-negotiation system. By generalization of negotiation strategies a system that can manage both the offers/counter-offers and the information may be developed.

Future work primarily will emphasize on how to guarantee the proposed system trust, honesty and security.

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