FeNAs: A Fuzzy e-Negotiation Agents System

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Extended Summary

As e-commerce becomes common a large number of Internet-based systems has been developed to assist users in different aspects of electronic trading. In particular systems that use software agent technologies are proving to be effective in supporting and automating various stages of the trading process (e.g. product finding, supplier finding, product ordering, delivery monitoring etc). More recently software agents have successfully been introduced to support and/or automate negotiation in e-commerce (e-negotiation). Examples of such systems are Kasbah, AuctionBot and Tete-a-Tete. The purpose of such systems is to find a mutual agreement on the terms of transactions that satisfies all parties' constraints, preferences and objectives. Most of agent systems can negotiate on behalf of users based on auctions and other forms of competitive negotiation according to the users' instructions. Some systems can handle aspects of uncertainty associated with incomplete information about other parties. However they typically assume that all information available is precisely defined. For example they usually require the users to provide exact and precise information about their private preferences, constraints and objectives (e.g. price \(<$99\), delivery time \(=1\) day, etc). Because most real-world negotiation problems can also involve preferences and constraints that may be imprecisely defined (eg. low price, high quality, short delivery time etc) negotiation agents that can also consider imprecise information may be needed.

This paper overviews an experimental fuzzy e-negotiation agents system FeNAs that can support automated negotiation in the presence of imprecise information. The system uses the principles of fuzzy constraint-based reasoning involving fuzzy constraint modeling, satisfaction and propagation. It is demonstrated with a prototype for the used car-trading problem. The system supports multi-issue negotiations where offers consist of a number of issues that can include the price of the car and other value-added services such as warranty and the value of the trade-in car. The agents exchange offers on the basis of the information available and negotiation strategies used by each party. Information available to both the buyer and the seller can include the make, model, color, transmission, age and mileage of the car. Each agent has also some private information including preferences, priorities and financial constraints that are not available to other agents. This information can be imprecise where constraints, preferences and priorities are defined as fuzzy constraints describing the level of satisfaction of an agent (and its user) with different potential solutions. The overall objective of an agent is to find a solution that maximizes the agent's utility at the highest possible level of constraint satisfaction subject to its acceptability by other agents. During negotiation the agents follow a common protocol of negotiation and individual negotiation strategies. The protocol prescribes the common rules of negotiation (e.g. agents are expected to accept own offers, negotiation is successful if the final offer satisfies all parties, issues of negotiation can include the price, warranty and trade-in). The negotiation strategies specify how the agents evaluate and generate offers in order to reach a consensus according to their constraints and objectives. In general the received offers are evaluated and counter-offers are generated with the support of fuzzy constraint-based reasoning. A number of negotiation strategies have been implemented in FeNAS including a shopping strategy, fixed value strategy, simple step strategy, consensus strategy and their better deal versions.
The environment can consist of many autonomous e-negotiation agents representing buyers and sellers. Each pair of the selling and buying agents can negotiate with each other at a time. An agent consists of user interfaces, a communication interface and a negotiation engine. The main user interfaces of the buying and selling agents are shown in figure 1. They display public information about the subject of negotiation, allow the users to define and select the negotiation issues, preferences, constraints and negotiation strategy for an agent, and display the progress and results of each negotiation session. The users can define fuzzy variables and fuzzy constraints on the issues of negotiation within an editor as shown in figure 2.
A communication interface is responsible for setting up and maintaining the communication between the agents. A negotiation engine provides the main decision making functionality of an agent during negotiation.
negotiation, i.e. evaluation of the received offers and generation of the counter-offers according to the constraints, preferences and negotiation strategies. The negotiation engine uses the principles of fuzzy constraint satisfaction and propagation that allow the agents to keep tracks of changing options during negotiation including the ranges of issue values in possible offers together with the level of constraint satisfaction. An example of the fuzzy constraint propagation during negotiation is presented in figure 3.

The FeNAs system has been implemented in Java and uses a Java based constraint programming library JFSolver to handle and propagate fuzzy constraints. JFSolver is an extension JSolver developed to provide fuzzy constraint-based reasoning capabilities in FeNAs. The system has been tested with several trading scenarios and is publicly available at http://www.cmis.csiro.au/aai/ITA.htm.

The results of the initial experiments indicate that the FeNAs system can successfully handle a variety of e-negotiation problems with imprecise preferences and constraints. Although the overall results are encouraging a number of research issues need further investigation. For example, flexibility, adaptability and learning of the negotiation strategies are the subject of our current research.

References