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Designing a multi-issues negotiation support system based on prospect theory

Huan-Jyh Shyur [a,*], Hsu-Shih Shih [b]

[a] Department of Information Management, Tamkang University, Tamsui, New Taipei City 25137, Taiwan, ROC
[b] Department of Management Sciences, Tamkang University, Tamsui, New Taipei City 25137, Taiwan, ROC

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ABSTRACT

Considering a prospect-theory type marginal utility function, the S-shape value function is utilized to encode the preferences of negotiators. This article presents the framework of a purchase negotiation support system. Based on the proposed framework, a prototype system was developed to carry on multi-issue decision problems during the purchase negotiation process. To examine the feasibility of using the value function to represent players' preferences in the negotiation system, we examined the final agreements from 25 simulated negotiation scenarios using two different preference settings.

1. Introduction

In a negotiation process, human actors are often responsible for making the final decision. Multiple issues and numerous possible outcomes can confuse negotiators, causing them to make decisions based on experience and intuition rather than rationality. In particular, when under the stress of an intensive negotiation, negotiators may make logic errors and take short-cuts in the negotiation process. A negotiation support system is a system that helps those involved in a negotiation to reach an agreement [10]. Du and Chen [5] provided a brief review of current negotiation systems. Most of the negotiation systems that have been developed involve support for construction and counter-offer evaluation by means of a rating based on the preference function. They premise the decision maker always looks for the offer corresponding to the maximum of some global measure of a preference value. This process can rely on several mechanisms such as: auctions, game theory, and intelligent agent mechanisms. [24]. It has been mentioned when each negotiator makes their decision, there are costs/benefits and risk associated with it [1]. Without properly assessing the risks, negotiators are often unrealistically confident about obtaining a favorable outcome [22]. This article considers negotiation to be a multi-issue decision making problem. Both buyers and sellers bargain using the same issue to maximize their best interests based on their own weighting of that issue. The weighted interests are then converted into preference values that represent the degree of satisfaction with the negotiation result according to predefined preference functions. The proposed method uses a global measurement of preference value through the application of prospect theory. The theory is based on a description, proved by empirical evidence, of how people effectively make decisions in the face of risk [3].

An agent-based negotiation support system is implemented to evaluate the capability of using prospect theory to analyze the risk associated in the decisions made by a negotiator. The developed system helps both buyers and sellers carry on

* Corresponding author. Tel.: +886 2 26215656x2881.
E-mail addresses: shyur@mail.im.tku.edu.tw (H.-J. Shyur), hshih@mail.tku.edu.tw (H.-S. Shih).

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integrated bargaining under the situation where both players may have some private information about their own situation that is unavailable to the other players. We assume the buyer first ranks the sellers using a group decision support system, and then carries on a one-to-one negotiation with the top ranked seller. The process will continue until a consensus can be reached or the negotiation time is over. The newly developed system looks for more diversified decision tools for modeling and supporting purchase negotiations which can permit the incorporation of multiple issues to conciliate differences between buyers and sellers and to suggest potential offers for a final compromise. Fig. 1 shows the system architecture. The buyer agent and seller agent assist the buyer and seller while they work with multi-criteria decision making and negotiate with other agents. For this, the developed agents need to capture user activities and appropriately react by changing the negotiation strategy. To allow the exchange of offers and counter offers between agents, all agents are registered by a coordinator. The application provides additional functionalities to negotiate a joint representation of the problem and to automatically justify offers based on this joint representation. A simulation tool is developed and provided to analyze the potential outcomes according to their current strategy setting and the possible negotiation strategy setting of the opponent. The results of the simulation can be used to uncover the key issues and potential solutions for negotiation strategy setting. Using optimization technologies, the system can provide an offer of a compromise solution satisfactory to both players involved in the process when players agree to disclose their preference to the coordinator.

The preliminary result shows the performance of adopting prospect theory in a negotiation system is very good. The remainder of this paper is organized as follows. Section 2 of this paper reviews the current negotiation systems. In Section 3, prospect theory is reviewed and the preference function is introduced. Section 4 presents the autonomous purchase negotiation support system and discusses its decision support tools. In Section 5, one experiment is described to illustrate the feasibility of using the function to represent players' preferences in an NSS. In the final section, conclusions are drawn and remarks are made as regards to future study.

2. Related work

NSSs are one type of negotiation system. According to the decision models used, Matwin et al. [19] distinguished NSSs into two categories: analytically-based systems and knowledge-based systems. In analytically-based systems, the decision problems are formulated by specific mathematical models and solved by numerical methods. Knowledge-based systems involve a symbolic representation of the problem which is subject to logical inference processes. Another categorization of NSSs is determined by the degree of completeness of information supplied by the system to the users [19]. The mediator of an NSS has to be provided with complete information about all the parties in the negotiation process. Use of complete information can provide an idea of a compromise solution satisfactory for all parties. On the other hand, the advisor of an NSS supports one of the parties by supplying advice on how to negotiate based on the incomplete information that he/she knows about his/her opponent. NSSs are also classified into solution-driven systems and process-driven systems [14,21,23,30,38]. Solution-driven systems provide alternative solutions and assist negotiators in making their decisions. Process-driven systems support and enhance the complete negotiation process by enriching communication channels and co-operative work but not providing suggested solutions. Kersten and Noronha [14] provided the first web-based process-driven NSS.

From the perspective of the automatic process, automated negotiation systems (ANSs) are another type of negotiation system, which provide information and negotiation strategies to negotiators [5]. ANSs construct automatic negotiation processes and mainly use agents to travel between computers to simplify the negotiation process. Recently, agent-mediated negotiations on electronic marketplaces and human resources application have been introduced in several studies [2,6,7,15,18,20,26,35]. Based on computationally tractable assumptions, Faratin et al. [6] developed a model of negotiation between autonomous agents which defines a range of strategies and tactics that agents can employ to generate initial offers, evaluate offers, and generate counter offers. Kurbel and Loutchko [15] created a model and used it in a prototype of an agent–based system for multi-lateral negotiation with multiple negotiation issues to deal with an electronic job

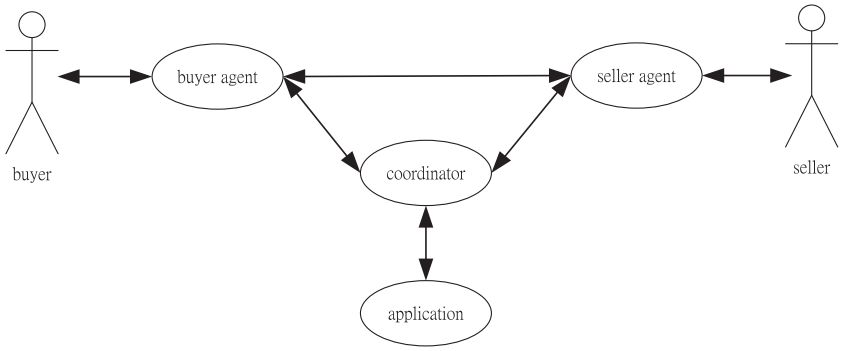

Fig. 1. System architecture.