

A Survey on Various Negotiation Techniques for Agent-Mediated Negotiation in e-Commerce

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ABSTRACT

In this survey paper, we describe the different negotiation techniques used for implementing agent mediated negotiation system for e-commerce platform. The various techniques for automation of the negotiation process that we have reviewed include Game Theory, Multi-Attribute Utility Theory and Fuzzy Driven Multi-Issue Agent Negotiation. These techniques have been evaluated on the ability to deal with several dimensions and the similarity to outcomes of human negotiations. The results are promising for integrating such techniques into Chatbots in Ecommerce systems.

Index Terms — agent negotiation, fuzzy logic, game theory, artificial intelligence

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I. INTRODUCTION

Negotiation is a discussion that solves transaction conflicts and make deals between trading entities in the commerce market. Negotiation covers many aspects of our lives and has led to extensive research in the area of automated negotiations [9] in e-commerce. Automated negotiation is a computer-based negotiation system. With the rapid growth of e-commerce, there has been a significant interest in building Automated Negotiation Systems (ANS) [14] that can be replaced with human business decision-makers.

The negotiation process involves exchanging of offer and counter-offer between the buyer and the customer so as to make a deal that satisfies both parties. The offer and the counter-offer are generated by using various strategies/techniques which is often kept hidden from the opponent.

In order to design automated negotiation agents first, the negotiation protocol and negotiation strategy need to be decided. The negotiation protocol is a set of predefined rules of engagement that the negotiators need to follow when they negotiate [10]. The negotiation strategy describes how the negotiation will be systematically conducted between participants and how the participant

will achieve their goal [13]. The negotiation strategy involves the analysis of the opponent's offer and generation of a counter-offer. But the main problem here as [13] suggests is that, if the opponent knows the agent's strategy then it could take its advantage. Therefore, the negotiation strategy must be decided taking this problem into account.

Another important constraint for deciding the best strategy for automated negotiation is its similarity or closeness to human negotiation behavior. YuyuXu in [15], analyzed how people negotiate against how an agent negotiates. The results are promising for developing agent negotiators that are able to adopt human negotiation behavior.

Furthermore, Mihai in [6] highlights that negotiation in the real world involves taking into account multiple dimensions such as quantity, warranty, delivery etc. This is an important constraint in deciding the negotiation strategy.

This paper is a survey-based timeline view that reviews the different techniques/strategies for the construction of automated negotiation system for e-commerce by examining their assumptions, goals, advantages and limitations.

II. Techniques for automated negotiations

In this section, we have given an overview and analysis of some approaches for automated negotiation such as Game Theory, Multi-Attribute Utility Theory and Fuzzy Driven Multi-Issue Agent Negotiation.

A. Game Theory for Negotiation

Traditionally, a subfield of economics known as game theory by Nash [8] was being used for automated negotiations. Game theory negotiation works as follows:

Both the customer and supplier involved in this situation are referred as to Players and the negotiation is named as the Game. All the prior information that is accessible to both the parties at the beginning of the negotiation is understood as Information set and the plan of action that a player will take under different scenarios is understood as Strategy. The payout a player receives at the top of the game is known to be the Pay Off and therefore the point at which both the parties reach an agreement is known to be an Equilibrium.

One way to explain the game is by listing the players (or customers) participating in the game, and for every player, listing the alternative choices (actions or strategies) that can be made by the player. In the case of a two-player game, the actions of the first player form the rows, and the actions of the second player form the columns of a matrix. The entries in the matrix are the utility scores or payoff to the first and second player respectively. A play consists of choosing certain strategies by the players; an outcome of the play is a pair of numbers representing the utilities of the players [8].

[2] The outcome of the game is decided using a significant equilibrium concept such as Nash equilibrium and dominant strategies. Dominant strategy can be used by any player independent of the strategy the opponent is using. Nash equilibrium is when unilaterally changing the strategies does not benefit the player. All problems do not always show the best outcome using these strategies. Game theory supplies negotiation strategies, when mathematically analyzed proves that it cannot be always applied to practical problems.

Game-theoretic models have provided great insights into competitive decision-making however, they fall short of informing the specific design of computer models in particular machine learning models of negotiation [5].

The model provides some hints towards the outcomes of a negotiation in particular situations, but there still seem to exist different aspects and objections, such as Common knowledge, Multiple equilibrium and single object, in game theoretic model that forbids us from understanding the specifics of the design to build a computer model based on a learning negotiation model.

B. Multi Attribute Utility Theory

Multi-attribute utility theory (MAUT) takes into account multiple attributes and analyzes preferences. In the aspect of negotiating behavior, according to researchers of J.Y. Kangs in 1998, they generalized the requirements of negotiating behaviors in commercial activities: (1) to provide the negotiating model of Multi-Attribute, such as price, deliver time quality etc. (2) to dynamically adjust negotiating strategy while negotiation or bargain. (3) To consider users' favor. In products of multi-attribute negotiation, M. Barbuceanu group stated a Multi-Attribute Utility Theory to achieve negotiation of products.

Multi-attribute utility theory (MAUT) can help consumers make complex buying decisions taking into account multiple factors including merchants' unique added value (e.g., extended warranty options, delivery options, etc.) [11].

Multi attribute utility theory considers consumer's vague preferences to decide what product to buy and from whom to buy the product from. In this case, the multi-attribute theory is used to rank the crisp proposals coming from the merchants according to the consumer's vague preferences. [12]. this theory takes into account that different negotiators have different preferences for buying a product and these preferences are of different importance to each one of them. These issues can be calculated using a relation function between scoring function and normalization depending on the situation. Though this theory gives you a many to many negotiation base, it does not give any general idea about constructing the negotiation strategies.

C. Fuzzy Driven Multi-Issue Agent Negotiation

[1] Shows an implemented a fuzzy evaluation system which is capable of determining which of all available offers has closest attributes to preferences defined by the user. The fuzzy inference module takes the current offer, utility score and negotiation remaining time as an input and generates a counter offer. The experiments show that the proposed intelligent agent raises its counteroffer slightly at the beginning of the negotiation and raises more when the negotiation moves towards its ending. However, by how much an agent raises its counter offer depends on the utility score of the item being negotiated and the current seller's offer. An agent concedes more for an item that has higher utility score (i.e. matches client's preferences better) and concedes less for an item with lower utility score. This model performs better compared to fixed concession rate in the perspective of the buyer, i.e. the buyer pays less for the same item.

The fuzzy agent is developed to make its offers according to the utility scores of a particular product. The agent is said to perform better than the fixed concession rate model in the perspective of the buyer.

From [16] the roles and benefits of the fuzzy constraint based approach can be summarized as follows:

- Fuzzy constraints are a natural means of modelling the buyer’s requirements over products’ single issues and the combination of the products’ multiple issues. They are also appropriate for modelling trade-offs between different issues of a product.

- During negotiation it is often the case that a seller’s offer only partially satisfies or violates the buyer’s constraints. In other words, it is often unavoidable that the buyer has to relax its constraints. The computational framework of fuzzy constraints is ideally suited for capturing this process.

Representation of User Preferences using Fuzzy Logic

Fuzzy sets and linguistic variables are best suited in approximating the buyer’s linguistically defined terms. For example, a product features such as ‘price is low’ or ‘speed is high’ can be represented using appropriate triangular fuzzy numbers. A triangular fuzzy number is a particular case of fuzzy sets. It has a triangle-shaped membership function, which can be viewed as possibility distribution [1].

[4] Proposes a multi-demand negotiation model based on fuzzy logic that takes the effect of human users’ psychological characteristics into consideration. Each negotiating agent's preference over its demands can be changed according to human users’ attitudes to risk, patience and regret, during the course of a negotiation. And the change of preference structures is determined by fuzzy logic rules, which are elicited through the psychological experiments.

III. Comparison of the techniques

CRITERIA	GAME THEORY	MULTI ATTRIBUTE UTILITY THEORY	FUZZY DRIVEN MULTI ISSUE AGENT
Applications	Game theory provides a useful set of tools for the design of multi-agent architectures	Multi-attribute utility theory is normally used to rank the crisp proposals coming from the merchants according to the consumer's vague preferences.	Fuzzy Driven Multi-issue Agent Negotiation is used to develop an intelligent negotiation model based on fuzzy constraints

			for bilateral multi-issue negotiation in business environments.
Advantage	Provides a classification of negotiation In many situations, complete mathematical analysis is possible Bargaining with uncertain and vague information can be modeled.	Many-to-many multilateral negotiations For linear scoring functions, optimal value of the ‘best deal’ can be found Bargaining with uncertain and vague information can be modeled	The fuzzy function is used to negotiate the optimal price and quality. The buyer agent will generate the next offering price considering those issues. The buyer agent and the seller agent of this negotiation model are capable of operating in real time.
Limitation	Game theory cannot always be applied to practical problems. Frequently simplifying assumptions limit the practical applicability of game-theoretic results Game theory is concerned	Scoring functions are problem- and user-dependent For non-linear scoring functions, the mathematical analysis is very difficult No general recommendations on how to	Difficult to implement

	with what constitutes an optimal decision given a game description.	construct the negotiation strategies	
Attributes	Deals with single attribute.	Deals with multiple attributes	Deals with multiple attributes

IV. FUTURE RESEARCH CHALLENGES

Development of enhanced automated negotiation strategies that can overcome the limitations of the above mentioned techniques for automated negotiation.

V. CONCLUSION

Game theory works well for single attribute negotiation. Though Game Theory provides many benefits, it cannot be applied in all situations. For example here are instances where mutual benefit might not be the most ideal outcome. During situations like this, one has to make the decision of whether or not to use Game Theory to settle issues.

Multi-attribute utility theory (MAUT) can help consumers make complex buying decisions taking into account multiple factors including merchants unique added value (e.g., extended warranty options, delivery options, etc.). But there are no general recommendations on how to construct the negotiation strategies.

Fuzzy constraints are a natural means of modelling the buyer’s requirements over products’ single issues and the combination of the products’ multiple issues. They are also appropriate for modelling trade-offs between different issues of a product. This can be used to develop intelligent negotiation agents.

This paper provides a snapshot of different techniques which are very helpful for other researchers to enhance the existing techniques in order to develop advanced automated negotiation agents.

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