Apply Intelligent Negotiation Agents for B2C E-commerce

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Abstract

B2C e-commerce is becoming more widespread as more people come to recognize its convenience. However, many electronic marketplaces, especially in the business-to-consumer, are in essence some kind of search engine and usually such e-marketplaces do not use agent technology. In addition, in current situation, price is the only criterion and easy to measure and automate. However, criteria for advanced transactions need to be more elaborating, e.g. giveback, dividend. In this paper, we present a multiple-attributes negotiation model for B2C e-commerce, which deploys intelligent agents to facilitate autonomous and automatic online buying and selling by intelligent agents while providing fast response to consumers. These include a 4-phase model, information collecting, searching/offer gathering, negotiating, and evaluating. We also apply fuzzy theory and analytical hierarchy process to develop the system interface to facilitate the user inputs. Finally, an example of notebook buying process is illustrated.

Keywords: Intelligent agents, Multiple-attributes, Negotiation, B2C e-commerce.

1. Introduction

Electronic commerce is a business practice associated with the buying and selling of information, products, and services on Internet. Electronic commerce is increasingly popular in today's businesses [1]. Business-to-Consumer is similar in concept to the traditional method of retailing, the main difference being the medium used to carry out business by the internet. The internet offers consumers greater benefits from increased information and lower transaction costs which are including search costs. At present, B2C e-commerce offers functions which are focus on catalogue browsing, term screening and search. Customers have to spend much time searching and scanning to find products which achieve their demands. In addition, more information does not mean highly efficiency.

Negotiation in B2C commerce is also a time-consuming process because all parties desire to maximize their own payoff while they may have opposing goals. If some of the parties do not concede, it could take forever to reach an agreement [2]. Consequently, considerable amount of work on negotiation is available in literature from different domains, such as operational research, economics, and decision theory [3].

Intelligent agent software is the action of human decision-making behavior in the form of a computer program. The intelligent agent software is that can help user to do some actions which contain search, negotiation, trade off and so on to improve effectively. It also improves the consumer's bargaining position with the opposition by the internet and traditional channels. Morge and Beanue present an agent-based negotiation support system that has the following functionalities: Information sharing among stakeholders, Auto-negotiation between agents, and Modeling of group decision making [4]. However, traditional e-marketplaces do not use agent technology at all although agents could significantly improve the services provided both for the buyers and the sellers. Moreover, prior research is all focus on how to achieve maximum profit. Criteria for advanced transactions need to be more elaborating, e.g. giveback, dividend. Therefore, this paper proposes a multiple-attributes negotiation model for B2C e-commerce.

2. A Solution Approach for Intelligent Agent to Negotiation

2.1 Intelligent agent

Sycara et al. have precise definition that intelligent software agents are programs that act on behalf of their human users to perform laborious information-gathering tasks [5]. Other Scholars consider that agent architecture linking aspects of perception, interpretation of natural language, learning and decision-making is provided [6]. For B2C e-commerce applications, many varieties of choice to the consumers have also introduced the problem of information overloading. Meanwhile, there are so many e-shops and products for the consumers that it has become too time-consuming to find the best deal [7]. For example, when a virtual shopping mall receives product orders from a customer, it is necessary to make the delivery orders automatically without human intervention, generate a request for proposal (RFP) and announce it to multiple delivery companies. Then, the mall and delivery companies will negotiate over the price and quality (e.g., delivery date) of a specific delivery service [8]. Thus, there is a need for IA to assist in negotiation process for B2C E-commerce.

As this adoption spreads, the impetus for employing software agents increases in order to enhance and improve the trading experience [9]. As discuss above, the main purposes of this paper is to develop a multiple-attributes negotiation model for B2C e-commerce and provide more benefit and quickly response.

2.2 Intelligent negotiation agent architecture

In this section, an agent-based architecture called an intelligent negotiation agent (INA) architecture is designed to enhance the existing B2C e-commerce process rather than to modify it. INA architecture which includes buyer agent and seller agent is proposed. Buyer agent can search products, negotiate and access negotiation records. The seller agent negotiates with buyer agent and access products and consumers database.

In the INA system, each INA is able to perform one or more services (Figure 1). The activities of the INA agents involve:

- Selecting products to satisfy the requirements of customers
- Evaluating and Negotiation the products into an integrated service
- Coordinating and scheduling the processes intelligently.

All INAs have the same basic architecture. This involves an agent body that is responsible for managing the agent's activities and interacting with peers and an agency that represents the solution resources for the problems of product negotiation processes. The body has a number of functional components responsible for each of it's main activities – e.g. In buyer agent, interfacing with users, searching desired products, negotiating with sellers and managing the tasks; In seller agent, interfacing with users, negotiating with buyers and managing the tasks.

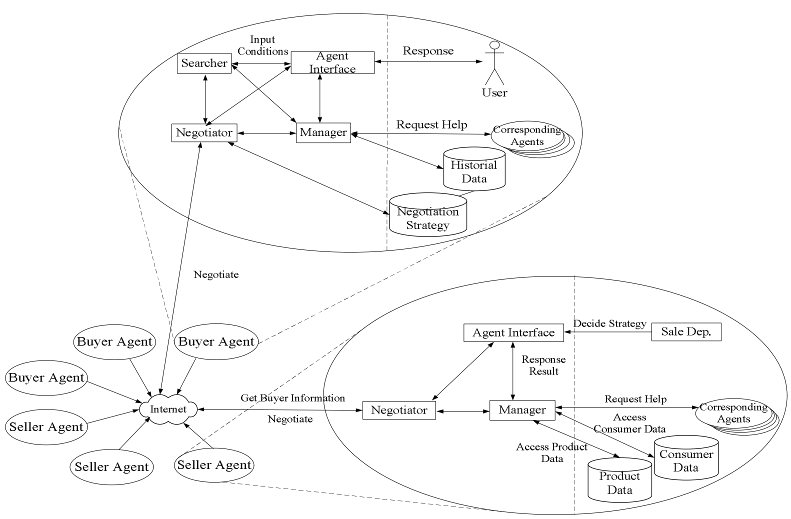

Figure 1. Intelligent negotiation agent (INA) architecture

2.3 Agent negotiation workflow

The INA plays four roles in the design processes:

1. A *Negotiator* is an agent that optimizes the product utility based upon the requirements from customers' requirements and constraints.
2. A *Manager* is an agent that delivers the status messages of active services between *Negotiator* and the clients, between an agent and its agency, and between peer agents

3. A *Searcher* is an agent that searches the products that are located in other distributed databases and performs the role of managing, querying or collating product information from many distributed sources.
4. *Agent Interface* is an agent that communicates between the customer and agents.

Agent negotiation is a method which present object and exchange each other to get benefit. In negotiation processes, buyer want to buy lower price, contrarily, seller want to sell product as expensive as possible. Therefore, in the negotiation process, agents not only consider with price, but also consider the after service, preference, present and so on. The detailed operations will be explained in later section.

3. Negotiation Model

According to the negotiation structure and flow as discuss above, we develop the following negotiation model. The negotiation model includes negotiation decision function, fuzzy theory and Analytical Hierarchy Process to get the product utility. After that, applies the product utility to negotiate for the following purposes. First, decrease the time of filter product information. Secondly, decrease the negotiation time. Third, to meet buyer's preference and maximum the user's utility.

3.1 Utility function

Faratin et al. presented the Negotiation Decision Function (NDF) which was the negotiation criterion [10]. The NDF allows agents negotiate with multi-attributes such as price and quantity. The NDF function is shown as follow.

$$U = \frac{\sum w_i \times V^i}{\sum w_i} \quad ; \quad 0 \le U \le 1; \quad , \quad 0 \le V^i \le 1; \quad , \quad 0 \le w_i \le 1 \qquad (1)$$

U means the utility and V^i means the utility of issue i. W_i is the weight of issue i.

In this paper, we extend NDF function and join the concept of threshold value of utility to calculate satisfaction. If total utility of a product is lower than the threshold value, eliminate it from the list of negotiation objects. This method will decrease negotiation time and the number of negotiating objects. The extension NDF function is as follows.

$$U = \frac{\sum w_i \times V^i}{\sum w_i} \quad ; \quad 0 \le U \le 1; \quad , \quad 0 \le V^i \le 1; \quad , \quad 0 \le w_i \le 1$$
$$U \ge \overline{u_i} \qquad (2)$$

$\overline{u}_i$ means the average utility of success negotiation records.

3.2 Analytic hierarchy process

The Analytic Hierarchy Process (AHP) is a mathematical decision making technique that allows consideration of both qualitative and quantitative aspects of decisions. The AHP method uses the human ability to compare single properties of alternatives. It not only helps decision makers choose the best alternative, but also provides a clear rationale for the choice. The process was developed in the 1980 by Saaty [11].

This paper adopts AHP to calculate products weight for initializing product's attributes. In the initial step, user makes comparisons between each possible pair in each matrix to calculate their attention degree. After getting the weight of products attributes, calculate the total utility of product with utility function.

3.3 Fuzzy theory

Fuzzy logic is a superset of conventional logic that has been extended to handle the concept of partial truth values between "completely true" and "completely false". It was introduced by Zadeh in the 1965 as a means to model the uncertainty of natural language [12]. It contains extensive range, including fuzzy sets, fuzzy relation, fuzzy logic, fuzzy control, fuzzy measure, and so on.

This paper applies the concept of fuzzy sets to calculate the utilities of each attribute. In the initial negotiation step, agent will ask user to set up membership function of each products attribute. In addition, we adopts triangular membership function in this paper because its algorithm is easier, its computing time is faster, and it suits with agent more. Next, agent normalizes these different products attribute according to the membership function. After educing margin utility with membership function, agent computes utility of products attribute and finally calculates total utility with utility function combining with weight.

3.4 Negotiation strategy

In this paper, both buyer agent and seller agent own their negotiation strategy. We will discuss as follow. Buyer strategy means the offer method of buyer agent and the stop conditions. The New offer is calculated according to total utility of products and the offering function [7]. The new offering function is defined as follow:

$$Offer_{new} = utility \times 100 * u + Offer_{old} \qquad (3)$$

Which $Offer_{new}$ means new price, utility is product utility, u is the unit increase value, $Offer_{old}$ is the last offer.

Seller strategy decides the seller agent current offer and the stop condition. This paper calculate next offer as follow [13].

$$x[i]_{new} = x[i]_{old} + (-1)^{w} F \mid RV_{i} - x[i]_{old} \mid \qquad (4)$$

$x[i]_{new}$ is the new offer and $x[i]_{old}$ is the last offer. F is the factor which between 0 to 1, w is factor to control increase or decrease. RV means the max or min limit value, setting value or buyer offer. For seller agent, the condition to stop negotiate is when the price buyer offices is located at seller's acceptable price.

3.5 Negotiation process

The negotiation process can divide four stages which include information collecting, searching/offer gathering, negotiating, and evaluating. Figure 2 shows the negotiation processes workflow. The first stage includes insert product search and negotiation conditions, setting product attribute membership function, compare product attribute and apply AHP to calculate attribute weights. Second stage is according to search conditions that user inserts. And then agent will search products from internet and get sellers' information response to user. Thirdly, agents will start negotiate by the search result and calculate product utility and determine whether receive product or not. Finally, negotiation evaluate state is the finally state of negotiation which buyer agent and seller agent will determine when to finish.

4. Example Illustration

In this paper, an example of instance notebook sales is illustrated. The sellers will provide the information of the products on e-commerce platform through the seller agent. The buyer also will filtrate, search and negotiate with the seller through the buyer agent. The four negotiation stages which presented above will be described and show below.

4.1 Information colleting stage

4.1.1 Input preference. Before negotiating, buyer agent will ask user to login the system and input preference, related settings which include price ratio, price range, product specifications, giveaway and preference (Table 1).

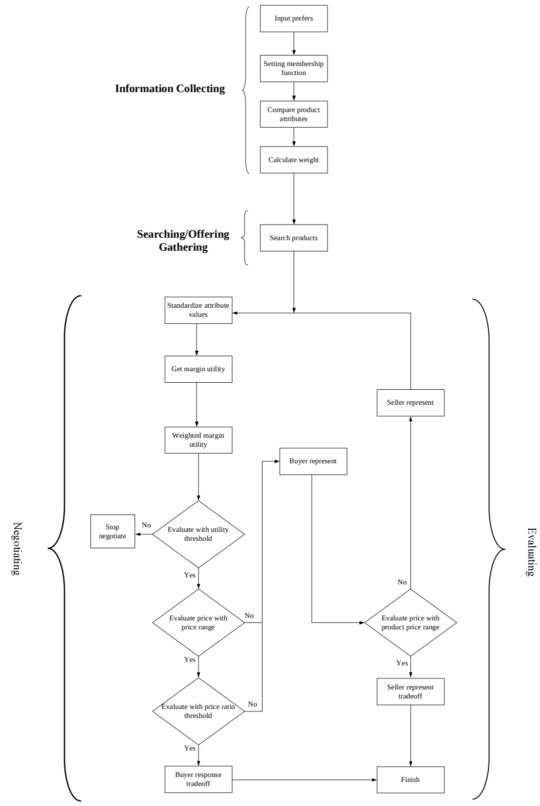

Figure 2. Negotiation Processes

Table 1. User Demand Reference

Preference	Details
Product	Notebook
Price Range	Lower bound: 15,000 Upper bound: 25,000
Spec.	CPU: 1.5G above HD: 80G above Memory: 512 MB above ROM：DVD+-R(W)
Dividend	Yes
Giveback	Yes
Increase Unit	20
Threshold	0.95

4.1.2 Setting membership function. The membership function of the products setting is let user to set all products attribute in order to carry on the follow-up negotiation by the agent. The membership function of the price set by the user is shown in Figure 3. After setting the membership function of the products, we can obtain margin utility value which includes left value, middle value and right value.

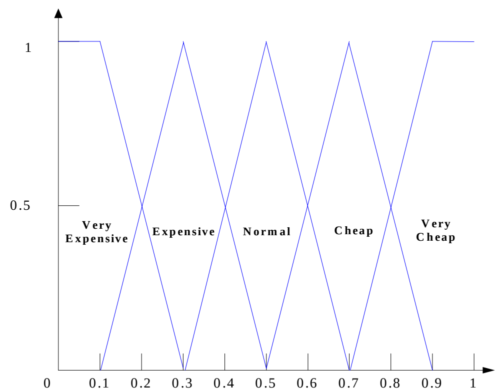

Figure 3. Membership Function (Price)

4.1.3 Compare product attributes. The purpose of the establishment of a pair-wise comparison matrix is to derive the degree of relative importance among the elements. In this step, user will compare the attribute pair-wise and get the comparison matrix.

4.1.4 Calculate Weight. Continuing with the AHP analysis, the pair-wise comparison procedure is used to determine the priorities for each of the elements. The eigenvector is then derived to indicate the degree of relative importance among the alternatives. Then, by multiplying the eigenvector of relative importance among the alternatives and transposing of the eigenvector of relative importance among the elements, the overall weights can be obtained. In this stage, consistency index (CI) is used to judge the degree of consistency. If the consistency index (CI) <= 0.1, it means that the consistency level is satisfactory. In this case, CI is obtained as follows:

$$CI = \frac{4.116 - 4}{4 - 1} = 0.039$$

Since the consistency index (CI) <= 0.1, it indicates that the consistency level is satisfactory.

4.2 Searching/offer gathering stage

After buyer input the search conditions and define membership functions, agent will go to next stage and search products from e-commerce platform.

4.3 Negotiating stage

In the step, according to search result, buyer agent will calculate product utility. We divide this state into two steps. First, buyer agent will calculate attribute utility. Secondly, apply utility function and attribute weight to get product utility.

4.3.1 Standardize Attribute Values. Before calculating product utility of each attribute, we have to normalize attribute. The dividend is normalized based on market price and the giveback is normalized according to the discount of market price and favorable price. Particularly, the item of product specification includes other sub-items (Table 2). Therefore, we normalize sub-items first. After calculating, the sub-item utility of each product is in turn A=0.358, B=0.358, C=0.358, D=0.592, and E=0.583.

Table 2. Sub-items Margin Utility

NB	Product Spec.		Margin Utility		
	Item	Standardization	Left Value	Middle Value	Right Value
A	Pentium D-805/2.66G	0	0	0.1	0.3
	SATAII 160G	0.33	0.2	0.4	0.6
	DDRII 667 1G	1	0.7	0.9	1
	DVD burner	0.09	0	0.1	0.3
B	Intel Pentium-D 915 (2.8GHz)	0.4	0.2	0.4	0.6
	SATAII 250G	0.62	0.4	0.6	0.8
	DDRII667 1G	0.62	0.4	0.6	0.8
	DVD burner	0	0	0.1	0.3
C	Intel Pentium-D 915 (2.8GHz)	0.4	0.2	0.4	0.6
	SATAII 250G	1	0.7	0.9	1
	DDRII 667 512MB	0	0	0.1	0.3
	DVD burner	0.03	0	0.1	0.3
D	P4-935 3.2G	1	0.7	0.9	1
	SATAII 160G	0.14	0.05	0.2	0.4
	DDRII667 1G	1	0.7	0.9	1
	External DVD burner	0.09	0	0.1	0.3
E	Core 2 Duo E4300/1.8G	0.6	0.4	0.6	0.8
	80G IDE	0	0	0.1	0.3
	DDRII 667 1G	1	0.7	0.9	1
	DVD 16X burner	1	0.7	0.9	1

4.3.2 Get margin utility. After calculating normalizations of each attribute, we check membership function region of each attribute to educe margin utility.

4.3.3 Weighted Margin Utility.

Margin utility multiplied by weight

Taking advantage of margin utility and weight which was calculated previously, we multiply margin utility by weight.

Averaged of left value, middle value and right value

Finally, average left value, middle value and right value and the result is product A' total utility. Therefore, A=0.45, B=0.43, C=0.81, D=0.17, and E=0.19. We assume that the threshold value would be 0.4. In this negotiation, product A's, B's, and

C's utility threshold are all greater than threshold value so buyer agent offers and negotiates only with product A, B and C.

4.4 Evaluating stage

4.4.1 Iteration 1 (Buyer side). When buyer agent receives offer from seller agent, buyer agent will evaluate product's utility threshold first. After calculating, only product A, B and C are greater than threshold. Then, buyer agent evaluates price ratio threshold. In this range, the price ratio threshold buyer sets is 0.95. And the ratio of product A=15000/20410=0.735, product B=0.73, and product C=0.81. The ratios are all smaller than the threshold so buyer agent will not accept seller's offer. Therefore, buyer agent calculates new prices and presents to seller agent according to formula 3. The next offer of product A=0.45×100×20+15000=15880, product B=15820, and product C=16620.

4.4.2 Iteration 1 (Seller side). After receiving buyer agent prices, seller agent checks whether the prices are larger than the lower limit of price range first. In this negotiation, no product meets the threshold. Therefore, seller agent offers again. The new offer of product A=19051, product B=19076, and product C=17967.

4.4.3 Iteration 2 (Buyer side). After receiving seller agent's new offer, buyer agent calculate utility threshold first — product A=0.24, product B=0.27, and product C=0.83. We eliminate product A and B from the negotiation objects because their utility is too low. Then, buyer agent evaluates product C's price ratio threshold — 16620/17967=0.93. Although product C's price ratio doesn't meet the threshold, buyer again offers again owing to its high utility. In this case, buyer agent's offer is product C=18220 which is greater than seller agent's last offer (17967). In order to ensure buyer's profit, agent accepts seller agent's last offer (18220/17967>0.95). So buyer agent replies to accept product C. The negotiation ends.

5. Conclusion

This paper we present negotiation model which include utility function, fuzzy theory and AHP in B2C e-commerce environment. Agents support both buyers and sellers to negotiate each other and then present benefit and response quickly. In future work, we can validate the model and develop the negotiation system. After that, analysis the feasibility on actually world and then modify the model to more fit the B2C e-commerce environment.

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