An Intelligent Negotiation Model based on Individual Mental Factor in E-commerce

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Abstract: Negotiation is the highlight of e-commerce and artificial intelligence. This paper applies the idea of individual mental factor to BDI models and therefore attempts to present new negotiation architecture and to illustrate the protocol. Through the experiments this paper analyses and proves that the individual mental factor (temperament) exerts great influence on concession rates in negotiation, and therefore affects the choices of negotiation strategy.

I. Introduction

Software agent plays various roles in BtoB Business to Business or BtoC(Business to Customer) commercial activity. Recently, people tend to use CBB model or BBT model to describe individual phases of e-commerce. In the two models mentioned, negotiation is an important link to which many researchers apply the advanced agent technology.

The negotiation in the e-commerce can be defined as the process of the transaction carried on by a group of agents to achieve a mutually acceptable agreement about the properties of some merchandizes. During the transacting, both sides wish that the negotiation can be made to their own greatest profit, which, however, is difficult to be realized. But, if the premise is changed from "to their own greatest profit" to a more realistic one as "to achieve as great profit as possible", then the chances of achieving a successful transaction could be greatly increased. A rational agent hopes to arrive at such agreements through negotiation, but, as the strategies he is to adopt in the negotiation can not be determined in advance, its process become a dynamic one.

There also exists another definition in a stricter sense, that is, the process of deciding and reasoning supported by the artificial intelligence technology and mathematic technology (including logic, case based reasoning, belief correction optimization and game theory) and at the same time based on the agent's own inference of the belief, desire and intention. This demonstrates the importance of the psychological state to both sides of the negotiation during the process. Among the studies of the analysis and modeling of the agent's behavior, the BDI model (Belief, Desire and Intention) is one of the most representative ones. Belief and Desire represent the informational and evaluative state of the agent. While Intention represents the past decision of the agent, which is the key to the ideal performance under the limitation of given condition. A great deal of research work has been done on the form of the BDI model, focusing on describing its nature and behavior. The recognition of the agent's behavior is based on reasoning and goal driving (such as the intentional behavior). While the determining of the goal, the choosing and deciding of the parameter, the semantic and behavior are all based on his beliefs. Therefore the construction of the BDI model plays a very important role in the constructing negotiation models. However, it is regret that many models that had been recently constructed failed to relate the individual psychological factor to them. The present paper is attempting to explore the BDI model from this point.

The unfolding of the following paper goes from a demonstration of the BDI model combined with individual psychological factor in the second section, to negotiation architecture and protocol in the third section, followed by an analysis of the influence of some individual psychological factor on concession rate during the negotiation process and related experiment data and analysis in the fourth section. And finally a presentation of the future development is presented in the fifth section.

II. BDI model based on individual mental factor

The psychological process during the negotiation between the purchaser and the bargainer is the amalgamation and consolidation of the three processes of cognition, emotion, and consciousness, which are derived from the transformation of the properties of the goods into the currency. The psychological phenomenon of the behaviors between the purchaser and the bargainer is the psychological manifestation of an individual in a group as a "person", which is inevitably controlled by the individual psychological characteristics. In commercial activities a person can have various psychological activities — such as perception, apperception, memory, association, attention, imagination, thinking, will and so on, which exhibit the common rules of human psychological activities. As an individual, the person in commercial activities always acts as both purchaser and bargainer, no matter what might be the content in every specific negotiation. And he will keep those steady and essential psychological qualities in a unique combination.

This is called consumer individuality. In the negotiation process this individual mental factor displays the disparity in the aspects of ability, character, temperament, interest and so on. Thus the difference in the behaviors of the negotiation process comes into being.

In commercial activities, the basis of the psychological process between the purchaser and bargainer includes the common process of psychological activities, consumers' individual psychology, consumption needs, and purchasing motives and so on. In the commercial activities of BtoB which are carried on the basis of a fixed relationship and in an atmosphere of friendliness, the need, certainly, is the precondition for the negotiation between the purchaser and bargainer; and therefore, their motivation are naturally favorable. Therefore, we hold that under such circumstance, individual mental factors play a crucial role in the negotiation process.

A. The psychological characteristics between the negotiating two sides

During the whole process of negotiation, for both purchaser and bargainer, the three processes of cognition, emotion and consciousness play important roles. The period during which the customers form the cognition of a commodity refers to the process in which they acquire various information and properties by using all kinds of sense organs. This usually includes the two psychological processes of perception and apperception.

Generally speaking, consumers' psychological processes are divided into four periods: liking, passion, evaluation and choosing. In the negotiation the will process has two characteristics: one is the psychological activities concerning goals; and another is the psychological activities associated with his will of conquering difficulties. Consumers' conscious quality is the steady characteristics manifested during the will actions, which can be observed in the actual consumption activities. The purchasing behaviors of consumers bear prominent features. During the purchasing, some consumers are decisive, prompt, composed, calm and independent. However, others are hesitant, oscillating, impulsive, cursory and dependent. These different kinds of manifestation are decided by the differences both in their individuality mental factor and their consciousness quality.

Psychologically speaking, individuality refers to the integration of the psychological feature which is constantly and steadily manifested in an individual. The so-called psychological feature is the relatively fixed features of an individual formed by a certain enginery characteristic or structure. It is formed and developed through human social activities on the basis of certain physiology under specific social and historical conditions. Therefore, it embodies the distinctive style, typical activity and unique behavior of an individual.

B. The BDI Model based on individual mental factor

The following is an observation of the situations of the BDI Model after the individual mental factors are added to it. In the process of negotiation, the belief, desire and intention in it are always influenced by cognition, emotion and consciousness. And if we add the common individual mental factors to the BDI Model (BDI-IMF), we can get the following graph(figure 1).

The following is a demonstration of the value-taking of the individual mental factors mentioned above from the angle of the psychology.

1. Ability (A): the sequent functions between [0...1] are used to grade the ability. 0 stands for weak, while 1 stands for competent.
2. Temperament (T): it was divided into four types: biliousness, sanguineous, viscous and depression.
3. Character(C): it was divided into introverted and extroverted.
4. Need (N): it was in accord with the theory of Maslow
5. Motivation (M): Like ability, 0 stands for a weak motivation, while 1 stands for a strong one.
6. Values (V): the value in e-commerce includes four aspects, that is, the comparison of the function and price, the quality, the service and the credit.
7. knowledge system(K): the knowledge about negotiation and rival. As follow, we will give out the definition of BDI-IMF.

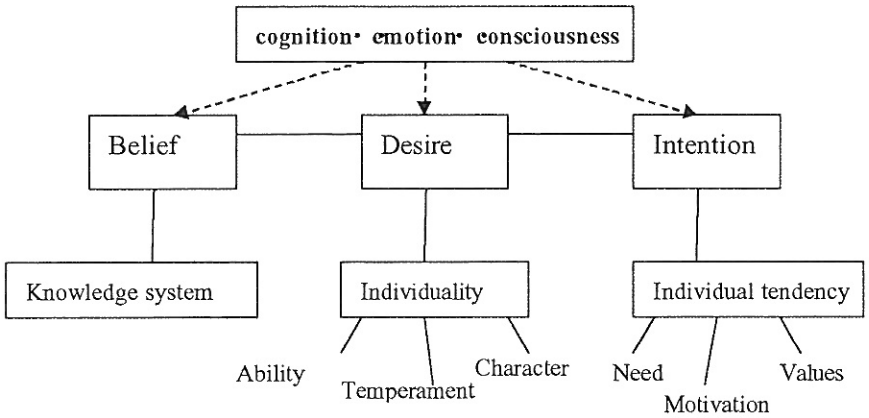


Figure 1: BDI mode based on Individual Mental Factor (BDI-IMF)

Definition 1: (BDI-IMF)
For Agent i , Agent i_BDI-IMF is set
Agent i_BDI-IMF= {Agent i_Believes, Agent i_Desire, Agent i_Intention }
Agent i_ Believes (Agent_name, time interval, K)
Agent i_Desire (Agent name, time , A, T, C, Measure Function)
Agent i_Intention(Agent name, time, N, M, V, Measure Function)

III. Intelligent negotiation model

In this chapter, negotiation architecture and protocol are presented.

A. Negotiation architecture

Based on the BDI-IMF model, we can construct negotiation agents adapt multi-agent structure. Concretely description you can find in figure 2. In order to render in simpler style, only describe the seller side.

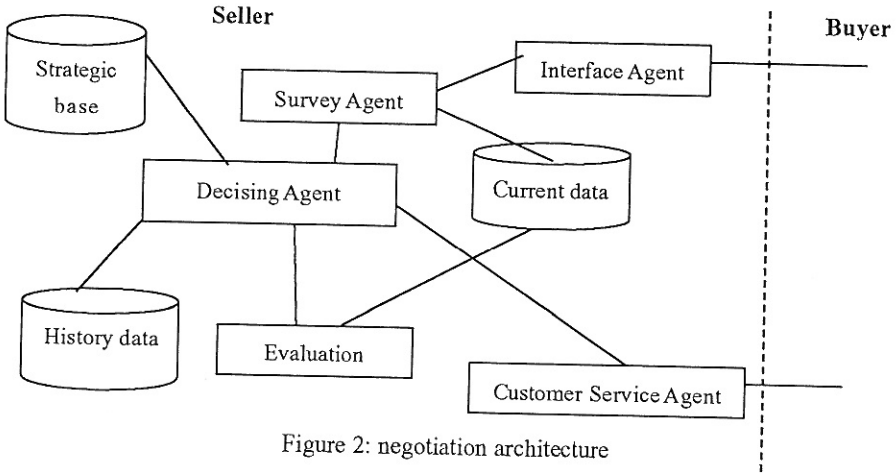


Figure 2: negotiation architecture

B. Negotiation protocol

In general, negotiation protocol in one-one negotiation is used to coordinate the activity of agents in order to satisfy their goals. To this end, figure 3 give out a bilateral negotiation protocol.
The negotiation process as follow:
1: Agent A give a request for negotiation beginning.
2. Agent B agreed and entry into negotiation
3. Agent A give out initial offer, and beginning negotiation
4. Agent B received offer and enter decision-making
5. Agent B give out counter-offer (reject, accept, tradeoff)
6. Agent A present another offer, turn to 4
7. If anyone present accept or reject, or time out , the negotiation be ended.

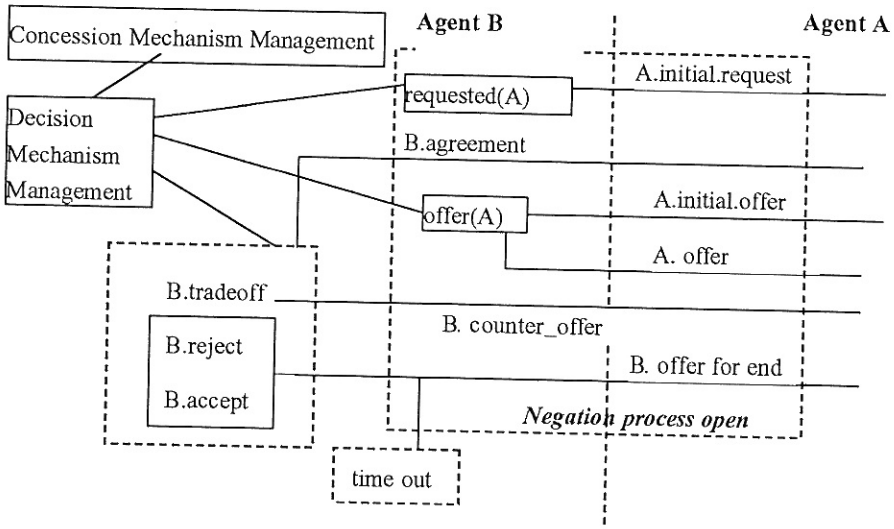


Figure 3: A Bilateral Negotiation Protocol

IV. Experiment evaluation

A. Preferences

Because of the limitation of the experimental condition and the number of the individual psychological factors gathered, the experiment did not validate more factors. The followings are suppositions given for the 7 factors.

1. Knowledge system: Suppose both sides have competent recognition of it.
2. Ability: As for the ability of negotiation, suppose they have an average value 0.5, and it is a fixed one.
3. Temperament: This factor will be considered in the negotiation. But suppose it has been examined before hand, and it has 4 values.
4. Character: it is divided in two types. And it will affect the concession rate
5. Need: Because it is in experiment, so the rate f need is quite high, so this factor will be ignored temporarily
6. Motivation: like the 5th factor, it will be ignored temporarily.
7. Values: the order and the priority of the four aspects are the main focus for this factor. In order to simplify the problem, suppose they are fixed too.

From the above analysis, it can be seen that there are only two direct factors which need validating, temperament and character. We will discuss them in next.

B. Preconditions

1). Content for negotiation

The content for negotiation includes service quality, price of product and delivery time of product. The evaluation method is below. (B denotes Buyer, S denotes Seller).

$B_{service(x)}$ = {high, medium, low}

$B_{price(y)}$ = [18000, 35000]•

$B_{delivery(z)}$ = [0 weeks, 16 weeks]•

$S_{service(x)}$ = {high, medium, low}

$S_{price(y)}$ = [20000, 40000]•

$S_{delivery(z)}$ = [0 weeks, 30 weeks]

2). Utility function

The method for measuring utility is from N.R.Jennings [4][7][8]. The utility function is together with all attribution in negotiation content. As follow:

$U_b = V_b service + V_b price + V_b delivery$

$U_s = V_s service + V_s price + V_s delivery$

$V_b service(x)$ = {(high, 0.8), (medium, 0.5), (low, 0.2)}

• $V_b price(y) = \frac{price - 18000}{35000 - 18000}$ •

$V_b delivery(z)$ = delivery / 16 •

$V_s service(x)$ = {(high, 0.3), (medium, 0.4), (low, 0.7)}

• $V_s price(y) = 1 - \frac{price - 20000}{40000 - 20000}$ •

$V_s delivery(z)$ = 1- delivery /30

We specialize the weight of each factor is decided by seller or buyer. For example: buyer can regulate price weight is 0.6, service for 0.2 and delivery for 0.2, otherwise seller give weight as (0.5,0.3, 0.2). so you say, the utility function as follow:

$U_b = V_b service(x)*0.6 + V_b price(y)*0.2 + V_b delivery(z)*0.2$

$U_s = V_s service(x)*0.5 + V_s price(y)*0.3 + V_s delivery(z)*0.2$

where, 18000• X• 3500,

y= low, medium, high, 0• z• 16.•

C. concession rate based on temperament

In this part, we will present different concession rate based on different temperament

1). Human temperament

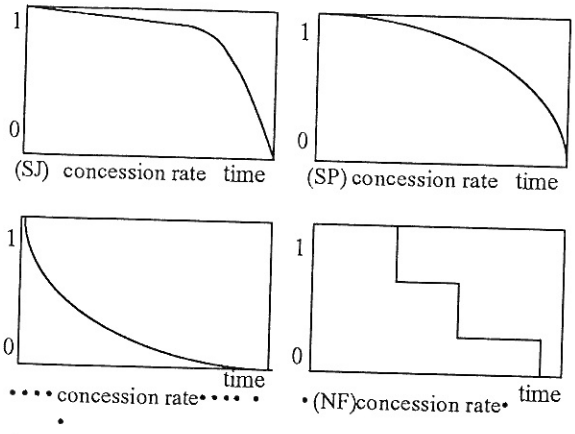
In this chapter, temperament factor will be added in experiments. Temperament as defined here refers to individual in behavioral style. Carl Jung [1] asserted that people are fundamentally different and can be classified into "psychological types" based on their particular preferences. The four pairs of opposite preferences are Extraverting (E) and Introverting (I), Sensing (S) and intuiting (N), Thinking (T) and Feeling (F), and Judging (J) and Perceiving (P). Within each pair of opposite preferences, a person leans toward one or the other in most cases. Later, Katherine Briggs and Isabel Myers [2] adopted Jung's theory and designed the Myers-Briggs Type Indicator (MBTI), a questionnaire for helping people to identify their innate personality types. David Keirsey [3] correlated his theory into the MBTI system and classified the sixteen personality types into four temperaments as SJ, SP, NT, and NF. Each related MBTI type has the two temperament letter codes in it. A statistic report on the percentage distributions of the temperaments in the United States showed that most people are SJs (46.7%), sensing and judging (Table 1). From the temperament point of view, an information space in the real world can be specified as having a temperament-segmented structure by identifying the interdependent feature of human temperaments and preferences.

Table1.The Percentage Distributions of the temperament in the United States.

Emperament(%)	MBT1(%)			
SJ	ESTJ	ESFJ	ISTJ	ISFJ
46.7	9.9	9.6	15.6	11.5
SP	ESTP	ESFP	ISTP	ISFP
21.4	4.8	5.7	6.4	4.5
NT	ENTJ	ENTP	INTJ	INTP
16.1	2.8	4.7	3.5	5.2
NF	ENFJ	ENFP	INFJ	INFP
15.8	2.5	6.3	2.6	4.3

2). concession rate base on temperament

According to temperament theory which above mentioned, we present four type of concession rate function as follows.



3). Tactic of negotiation

this tactic determines the recommended price based on the amount of time remaining and concession rate related time for the agent. . Assume that the agent is biding at time 0 The agent bids from P_{max} as beginning price ,when t=0, and at $t=t_{max}$ the agent can't get reasonable price, negotiation is failed.

To calculate the bid value at time t, the following expressing is used:

$$p(t) = F_{\sigma}(t) \times p_{\max}$$

When $F_{cr}(t)$ is a polynomial function of he form:

$$F_{\sigma}(t) = 1 - K_{\sigma}(t/t_{\max})CR_i(t)$$

K_{cr} is a constant that determined the value of the end bid of the agent in negotiation. CRi(t) is function relation to temperament. {SJ,SP,NT,NF} By varying the value of $F_{cr}(t)$, a wide range of time dependant function can be defined from those that start biding near p max, to those that only bid near Pmax(1-Kcr), to all possibilities between. The only condition is that

$$0 \le F_{\sigma}(t) \le 1, F_{\sigma}(0) = 1, F_{\sigma}(t_{\max}) = 1 - K_{rt}, and 0 \le k_{rt} \le 1$$

D. Result of experiment

To evaluate the performance of our agent using the method described above, 112 persons attend this negotiation experiment. Before negotiation, we have evaluated their temperament, thereinto SJ is 48, and SP have 25, NT have 26 and NF have 13. the people who attend our experiment will progress two different negotiation system. One is old system which strategy for negotiation adopt approximate linear function, the another negotiation model is based on temperament. Figure 4 shows the performance of two systems in term of their success rate. The success rate is defined as the number of times, as a percentage, the agent is successful in acceptable price. Figure5 shows the max, min average time taken by the agents to negotiation. Figure6 relates closely to the success rate performance of all the agents in the experiment. It shows the agents' finalprice.

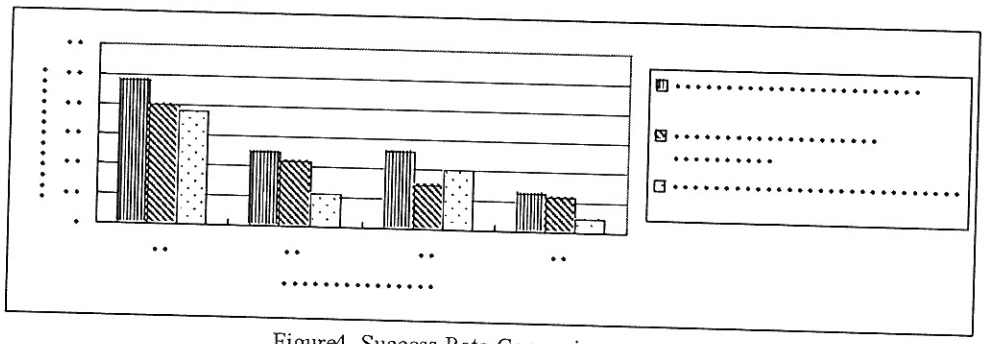


Figure4. Success Rate Comparison

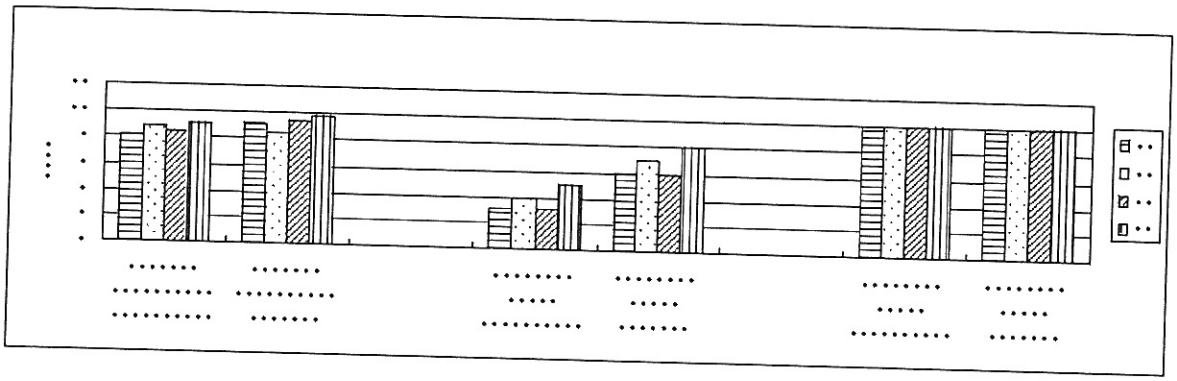


Figure5. Closing Time Comparison

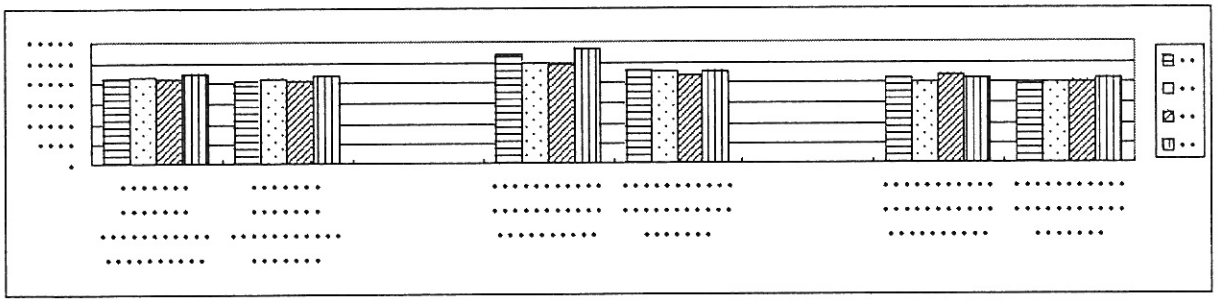


Figure6 Closing Price Comparison

V. Conclusion and Future Work

Psychologists have identified human temperament as predominant factor in the patterns of human behavior. Neuroscience research indicates that temperament is an innate property of the brain. The potential for employing human temperament as an effective negotiation is strong. The mode based on individual mental factor proposed a solution to characterize concession rate in negotiation by taking human factor, particularly human temperament into considerations. In this ongoing research, we are ready to experiment with a prototype system to evaluate the proposed temperament-based negotiation approach in comparison with the ordinary methods, as linear. From research data, we find this new model is effective, also this study to provide a new general approach to incorporating human factors, particularly human temperament, into the negotiation in e-commerce. This method presents an effective framework for analysis of the concession rate in negotiation.

Our main line of work is to further explore the development of strategies for our negotiation agent. Since the process in which the negotiation in e-commerce is running is highly dynamic, we intend to extend this work by using a revolution method to classify the users, and develop various strategies for different temperament people.

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