퍼지 및 지능시스템학회 논문지 2004, Vol. 14, No. 3, pp. 342-348

A Cognitive Map Approach to B2B Negotiation to Integrate Unstructured and Structured Negotiation Term

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Abstract

As the advent of the Internet, B2B negotiation process on the Internet has been given attention from both researchers and practitioners. However, literature still shows that only structured conditions have been explicitly considered, despite the fact that unstructured conditions should be rendered as well. In this sense, this paper proposes a new negotiation support mechanism to incorporate causal relationships between structured and unstructured conditions in the process of B2B negotiation. Fuzzy cognitive map was used as a main source of causal knowledge as well causal inference engine. A prototype named CAKES-NEGO was developed to perform experiments with an illustrative example. Results revealed the robustness of our proposed negotiation support mechanism.

Key words : B2B, B2C, Causal knowledge, Fuzzy cognitive map (FCM), Negotiation

1. Introduction

As the advent of the Internet, most companies get the opportunity to engage in B2B electronic commerce (Bakos, 1998). In comparison with B2C, B2B gains more momentum among companies due to its properties such as a huge amount of trade volume and amount in money and quantity, long-term trust and necessity of negotiation between trading partners (Dai & Kauffman, 2002; Park & Park, 2003; Subramaniam & Shaw, 2002). Especially, B2B requires negotiation to some degree before striking a deal between trading partners. However, B2B negotiation on the Internet without seeing face-to-face needs intelligent decision support from negotiation support system. To induce high quality negotiation results, the paper examines the role of causal knowledge in the process of B2B negotiation. Causal knowledge is based on a fuzzy cognitive map representing causal relationships among factors that are comprised of a certain B2B negotiation.

Those factors relating to the B2B negotiation are organized into two groups such as "structured" and "unstructured". Structured factors are always target of B2B negotiation because they encompass price, quantity, quality, payment conditions, etc. Meanwhile, there exist unstructured factors that have causal relationships with structured conditions-i.e., resource availability, preference about vendors, labor-management relationships, etc. In literature, structured factors have been analyzed in the process of B2B negotiation (Kersten and Noronha, 1999; Kersten et al., 2003), while ignoring the causal relationships among structured and unstructured factors. In fact, negotiators should not only consider structured conditions, but also unstructured conditions that have profound impact on the quality of structured conditions although not explicitly discussed in the process of negotiation. Therefore, it is essential to incorporate causal relationships among structured and unstructured conditions into the negotiation process objectively and systematically if the B2B negotiation

접수일자 : 2004 년 2 월 16 일
완료일자 : 2004 년 5 월 24 일
감사의 글 : This work was supported by Korea Research Foundation Grant (KRF-2001-041-C00339).

Table 1. Inference process by FCM

Stage	Factors (Concept Nodes)															
	CR	SP	BR	IC	AC	CF	MP	WA	TD	IR	CA	BE	SS	NE	LD	OS
1	0	0	-1	0	0	0	1	0	0	0	0	0	1	0	0	0
2	1	1	0	1	0	1	0	0	1	0	0	-1	0	0	0	0
3	1	1	0	1	0	1	0	0	-1	0	0	0	0	0	0	-1
4	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
5	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0

results may be beneficial mutually to B2B negotiation partners. However, without resorting to the negotiation support system, it is very hard for decision makers to perform B2B negotiation effectively because number of factors to be considered is great, and causal relationships among them are very complicated to understand beforehand.

In this sense, the objective of this paper is to propose a causal knowledge-based expert system for B2B negotiation named CAKES-NEGO in which both structured and unstructured factors are evenly considered with the aid of a fuzzy cognitive map. Causal knowledge among factors relating to B2B negotiation is first organized by a fuzzy cognitive map or FCM, being incorporated into knowledge base of CAKES-NEGO. Besides, the inference mechanism by FCM, which will be described in section 2, provides a basis for inference engine of CAKES-NEGO. Then it is applied to induce best set of conditions for B2B negotiation.

2. Fuzzy Cognitive Map

A fuzzy cognitive map (FCM) has originally been used for representing knowledge in political and social sciences under the name of cognitive map, representing the cause-effect relationships which are perceived to exist among the factors of a given environment. The concern of FCM is to see whether the state of one factor is perceived to have an influence on the state of the other. For instance, in Figure 1, if market position of a firm improves, then the stock price would increase. In turn, this increase of stock price would consecutively result in the improvement of credit. From these descriptions about interpreting the FCM operation, it can be easily observed that positive causality denoted as "+" in Figure 1 should be regarded as excitatory relationships while negative causality "–" as inhibitory relationships between the corresponding two factors (Zhang et al., 1989). Therefore, FCM can represent experts' beliefs and cognition about ill-structured social relationships (Huff, 1990).

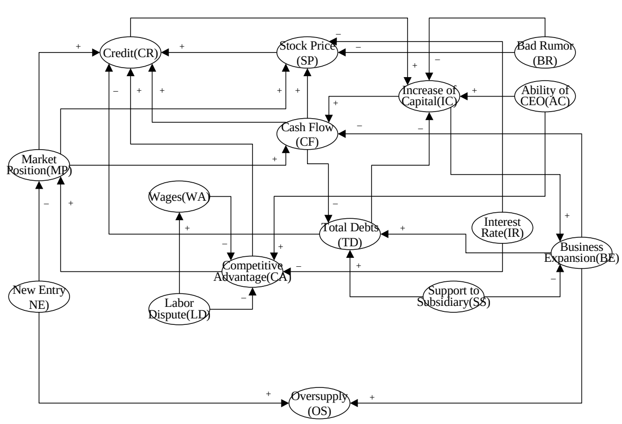


Fig. 1. FCM for analyzing firm's credit

The causality value of FCM can be fuzzified into a real value between 1 and 1 (Kosko, 1986; Lee et al., 1992). FCM enables causality value to be fuzzified into [-1, 1] (Liu, 2000; Liu & Satur, 1999; Satur & Liu, 1999). In this sense, FCM is an useful vehicle of modeling the world as a collection of factors (or concepts) and causal relations between factors with a fuzzified causality (Kosko, 1986; Klein & Cooper,1982; Diffenbach, 1982; Ramaprasad & Poon, 1985; Noh et al., 2000).

In usual, a factor is depicted as a node in FCM as shown in Figure 1, and a causal relationship between two factors is represented as an edge (or path). Positive causality on an edge from a factor c_i to c_j indicates that increase of c_i causes increase of c_j. Negative causality from c_i to c_j indicates vice versa- increase of c_i causes decrease of c_j.

To show the forward evolving inference by FCM, an initial information of new problem is assumed to be collected as followings: no bad rumor (BR), higher market position (MP), more support to subsidiary (SS). In accordance with this information, the inference procedure starts by setting BR to –1, MP and SS to 1, respectively and all other nodes to zeros. According to the inference mechanism used in Lee & Kim (1997), the resulting inference history is shown in Table 1.

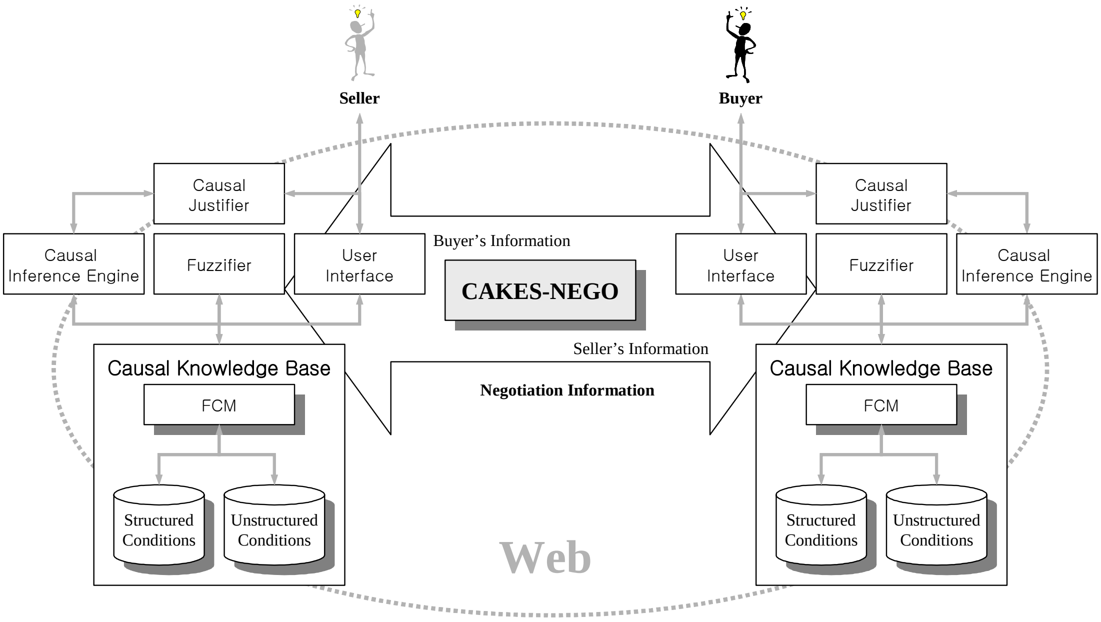


Fig. 2. Architecture of CAKES-NEGO

From the above result, it is provided the following information:

1) While total debts (TD) increases temporarily because of support to subsidiary (SS), higher market position (MP) leads to increase of cash flow (CF), rise of stock price (SP), and increase of capital (IC) (stage 2).
2) As stock price (SP) rises and cash flow (CF) increases, total debt (TD) decreases and credit (CR) become rising (stage 3).
3) According to continuously rising of stock price (SP), cash flow (CF), and capital (IC), credit (CR) maintains high (stage 4).

Based on this inference analysis by FCM, the loan request of the analyzed company may be accepted because of high credit.

As another example of applying inference capability of FCM, Lee & Kim (1997) suggested bi-directional inference mechanism based on FCM in the field of stock market analysis. In contrast, this paper is aimed at proposing a FCM-based negotiation support system in B2B domain, where both unstructured and structured negotiation conditions can be weighed equally, and their causal relationships, which are too complicated for negotiators to fully understand without intelligent support from negotiation support system, can be analyzed. In this sense, a prototype system named CAKES-NEGO which is based on causal knowledge is designed and applied to an illustrative example of B2B negotiation.

3. Design of CAKES-NEGO

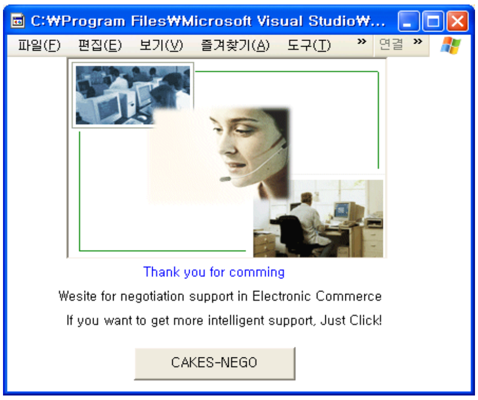
CAKES-NEGO is a FCM-based expert systems allowing the B2B negotiation to be performed seamlessly between buyer and seller. CAKES- NEGO consists of causal knowledge base, causal inference engine, and causal justifier. Figure 2 shows the main components of CAKES-NEGO.

As mentioned in section 2, CAKES-NEGO depends itself on FCM for inference engine mechanism and causal knowledge base. First of all, causal knowledge has the formal form as follows:

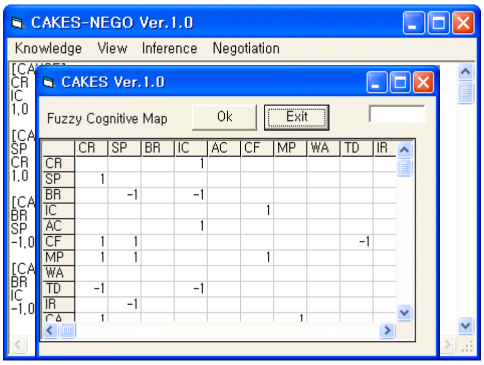
[CAUSE] <*Cause node, Effect node, causality value*>

[CAUSE] is a reserved word for representing causal relationship between "Cause" node and "Effect" node. For example, consider the following example-[CAUSE] <MP, CF, +1>. This causal knowledge means that MP causes CF with causality "+1". With this formalism, causal knowledge is extracted from a FCM relating to a target domain, being organized into a causal knowledge base.

Inference engine of CAKES-NEGO operates like conventional expert system-prompting users to answer essential questions before making an appropriate inference. Figure 3 depicts a snapshot of inference process by CAKES-NEGO. As shown in Table 1, CAKES-NEGO inference engine generates detailed information how a certain target node (or factor) changes according to changes in some input nodes.



(a) CAKES-NEGO on the Web



(b) FCM matrix of buyer (seller) on the Web

(c) FCM inference with the input values of buyer (seller)

Fig. 3. Inference process of CAKES-NEGO

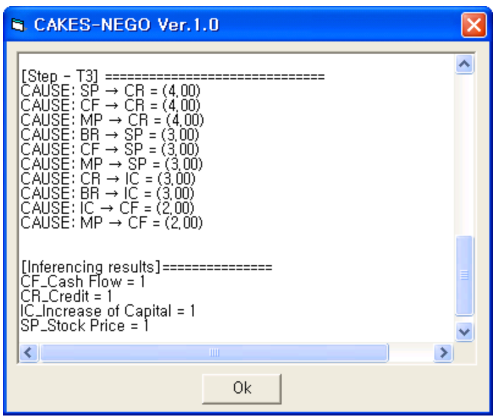


Fig. 4. Justification by CAKES-NEGO

As pointed by Giarratano and Riley (1998), an explanation or justification function is an integral part of expert systems. Since CAKES-NEGO operates based on causal knowledge, its justification is made up of a series of causal knowledge fired with respect to a given problem. Figure 4 depicts a scene of justification showing a series of causal knowledge fired for the credit problem in Figure 1.

4. Experiments with CAKES-NEGO

Experiments with CAKES-NEGO are basically performed with an illustrative B2B negotiation problem with conditions listed in Table 2, where buyer company has 8 structured conditions and 4 unstructured conditions, while supplier company 7 structured conditions and 7 unstructured conditions.

Table 2. Negotiation conditions

Buyer		
Node Name	Descriptions	Type
Price	Purchasing price	Structured
Quantity	Purchasing quantities	"
Discount	Discount rate	"
Refund	Term of refund	"
Return	Conditions for returning goods	"
Quality	Product quality	"
Delivery	Delivery time	"
Payment	Satisfaction for payment condition	"
Trust	Trust for contract	Unstructured
Budget	Budget available	"
Intention	Intention to purchase	"
Contract	Satisfaction for contracts	"

Seller		
Node Name	Descriptions	Type
Price	Selling price	Structured
Quantity	Selling quantities	"
Discount	Discount rate	"
Refund	Term of refund	"
Return	Conditions for returning goods	"
Delivery	Delivery time	"
Payment	Delivery time	"
Resource	Resource availability	Unstructured
Supplier	Suppliers' preference	"
Labor	Labor availability	"

Transport	Transport mechanism	"
Trust	Trust for contract	"
Intention	Intention to sell	"
Contract	Satisfaction for contract	"

Causal knowledge is described in the form of causal relationships between the conditions. Table 3 summarizes causal knowledge with corresponding causality value and causal relationships that have been confirmed through five rounds of consultations with three experts from KTNet (http://homepage.ktnet.co.kr/ktnet), a professional company for providing e-trade and e-negotiations service to companies seeking B2B electronic commerce.

Table 3. Causal knowledge

Buyer			
Cause	Effect	Causal relationship	Causality Value
A. Price	C. Discount	+	0.8
	E. Return	+	0.5
	J. Budget	-	-0.8
	L. Intention	-	-0.9
B. Quantity	C. Discount	+	0.9
	D. Refund	+	0.6
	E. Return	+	0.5
	L. Intention	+	0.8
G. Delivery	C. Discount	+	0.7
	D. Refund	+	0.4
	L. Intention	-	-0.7
H. Payment	I. Trust	+	0.8
	J. Budget	+	0.8
	L. Intention	+	0.7
C. Discount	I. Trust	-	-0.8
	H. Payment	+	0.7
	J. Budget	+	0.6
	L. Intention	+	0.8
D. Refund	I. Trust	+	0.5
	L. Intention	+	0.7
E. Return	L. Intention	+	0.6
F. Quality	I. Trust	+	0.8
	L. Intention	+	0.8
K. Security	I. Trust	+	0.7
I. Trust	M. Contract	+	0.8
J. Budget	M. Contract	+	0.6
L. Intention	M. Contract	+	1.0

Seller			
Cause	Effect	Causal Relationship	Causality Value
A. Price	C. Discount	+	0.7
	E. Return	+	0.7
	M. Intention	+	0.9
B. Quantity	C. Discount	+	0.6
	D. Refund	+	0.8
	E. Return	+	0.6
	M. Intention	+	0.8
F. Delivery	I. Supplier	+	0.9
	J. Labor	+	0.8
	M. Intention	+	0.8
G. Payment	M. Intention	+	0.7
C. Discount	E. Return	-	-0.6
	G. Payment	-	-0.6
	M. Intention	-	-0.9
D. Refund	C. Discount	-	-0.5
	G. Payment	-	-0.5
	M. Intention	-	-0.7
E. Return	M. Intention	-	-0.7
H. Resource	M. Intention	+	0.8
I. Supplier	H. Resource	+	0.9
J. Labor	M. Intention	+	0.8
K. Transport	N. Contract	+	0.8
L. Trust	C. Discount	+	0.9
	N. Contract	+	0.7
M. Intention	N. Contract	+	1.0

In Table 3, C*ausality value* means the causal relationship between *Cause* and *Effect* node, capable of being represented by real value between -1 and +1. For example, *causality value of* +0.8 between *Price* (Cause, A node) and *Discount* (Effect, C node) denotes that *Price* causes *Discount* with causality +0.8. Based on causal knowledge information in Table 3, CAKES-NEGO constructs causal knowledge base, generating corresponding FCMs as depicted in Figure 5 for each seller and buyer.

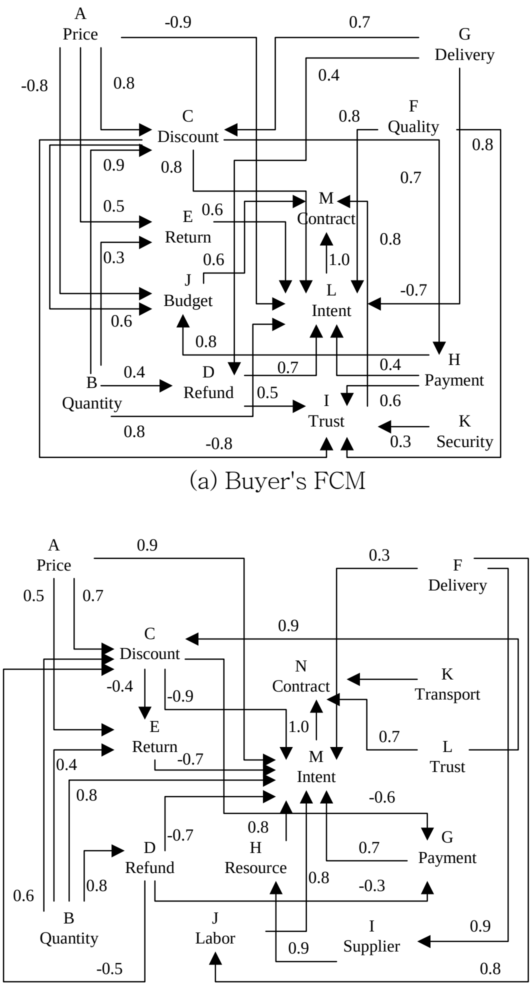
Buyer's offer:

Price = $4,000 (Min. $3,500-Max. $5,000 available)
Quantity = 3,000EA (Min. 1,000 - Max. 4,000)
Delivery (time) = 7 days (Min. 1 - Max. 20)

Then according to the buyer's offer like this, seller asks CAKES-NEGO to compute *satisfaction with contract*. Table 4 shows inference results by CAKES-NEGO, where N (*Contract*) = 0.6 (or 60%)

Table 4. Inference results by CAKES-NEGO

A: Price	B: Quality	C: Discount	D: Refund	E: Return	F: Delivery	G: Payment	H: Resource	I: Supplier	J: Labor	K: Transport	L: Trust	M: Intention	N: Contract
0.3	0.9	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0
0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.4	0.0	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
0.3	0.9	0.6	0.6	0.4	0.8	-0.6	0.5	0.6	0.6	0.0	0.0	0.7	0.6



(a) Buyer's FCM

(b) Seller's FCM

Fig. 5. FCMs created by CAKES-NEGO

Suppose that buyer provides the offer below.

denotes that seller would be satisfied with this value if it accepts the buyer's offer. Alphabet name for each node in Table 3 and 4 indicates identification sign for avoiding confusion. Therefore, if seller stops with this buyer's offer, then CAKES-NEGO will show this inference result as a finalized negotiation deal. Otherwise, CAKES-NEGO will iterate further negotiation support by issuing another inference results with respect to modified offers.

5. Concluding Remarks

This paper showed that causal knowledge extracted from FCM can be used for rendering effective B2B negotiation support. To illustrate our claim, we developed a prototype CAKES-NEGO on the web, operating with a real example acquired from KTNet. Results revealed that CAKES-NEGO with causal inference engine, causal knowledge base, and causal justifier can provide a robust negotiation support to complicated B2B negotiation problem. Especially, another virtue of this paper worthy of being mentioned is that through working with CAKES-NEGO unstructured negotiation conditions are seamlessly combined with structured conditions, resulting in a balanced B2B negotiation deal.

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