

## A Model of B2B Negotiation using Knowledge

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### Abstract

*Knowledge incorporation is one challenge in e-Commerce automated negotiation. In this paper, we describe a model of B2B negotiation using knowledge. We classify the types of knowledge namely general knowledge and negotiation knowledge, in the negotiation process. A methodology that uses Knowledge Base (KB) and meta-KB as knowledge representation that would be suitable for the design of automated negotiation systems is discussed. An experimental prototype demonstrates that by incorporating knowledge into automated negotiation yields improved results.*

Keywords: B2B Negotiation, Agents, Knowledge

### 1. Introduction

A huge amount of data generated from B2B transactions include not limit to products, orders, shipping info, custom info, particulars of buyers, sellers and relating parties, but possibly dialogues of negotiations. It is a matter of what and how these data could be reused as some form of knowledge in subsequent dealings. Previous research attempted fusing knowledge into agent communication languages and negotiation functions. They mostly based on rule-based and/or logic-based approaches. However, these techniques show their advantages in individual applications, and they still do have little support in knowledge management. Knowledge management is important in many scenarios where agent negotiation is performed based on knowledge instead of rules and logics alone, e.g. common ontology is necessary for agents sharing knowledge using diverse ontologies. Furthermore those agents do not have self-learning ability since they cannot interpret knowledge.

Therefore, we opt for a model which can capture

the key concepts and elements involved in multi-bilateral multi-attribute e-Procurement negotiation traces. Especially, these include the relationships among multiple negotiation parties, negotiation strategies for trade-off on multiple procurement attributes, and decision-action rules that drive an automated negotiation system [1]. Realized that the business negotiation is not an once-off activity, it should be viewed as a continuous, iterative process. The negotiation outcomes of the current and past negotiations can and should leverage the future choice of negotiation policies and strategies, and, thus the behavior of an automated negotiation system.

A comprehensive negotiation model is needed to clearly define the different phases of a negotiation process and to show: 1) what information and knowledge should be specified or defined at different phases; 2) how they can be used by an automated negotiation system to conduct its negotiations with other automated negotiation systems, and 3) how the results of negotiations provide useful feedback to other phases of a negotiation process.

### 2. Proposed negotiation model

#### 2.1. The Elements and the Lifecycle

We define the model of B2B negotiation using knowledge as a 5-tuple  $\langle C, A, NP, KERM, KACM \rangle$ .

**C** stands for clients. Clients in automated negotiation are people who represent the interests of different business enterprises that participate in negotiations. These people may play different roles and serve different functions in negotiations. For example, the role of the Buyer defines the procurement requirement, preferences scoring, and aggregation methods. The role of the Supplier provides the specifications of products and services. The role of the Negotiation Expert provides the domain knowledge and negotiation expertise needed to conduct a satisfactory automated negotiation.

**A** stands for agents. Three kinds of agents are

defined for performing tasks on behalf of their clients: information agents, knowledge agents, and negotiation agents.

**NP** stands for negotiation protocol.

**KERM** stands for knowledge empowered evaluation and ranking model. This model is used for the buyer to short-list some suppliers which are the best candidates to negotiate with. The knowledge used to assist in the decision making process includes buyer's preferences and suppliers' profiles. During an automated negotiation process, evaluation of quotes or proposals is also needed to form the counter-proposal.

**KACM** stands for knowledge empowered automated concession model. This model is used to compute the concrete concession amount in constructing a counter-proposal during each negotiation round. It is an extended version of Jonker's model [3] that allows the setting of automated negotiation parameters rely on history records. Hence the past experience can be utilized in the current negotiation and better result can be achieved.

The operation is based on a four-phased multi-bilateral multi-attribute negotiation life cycle. Readers are referred to [6] for the full details of KERM and KACM.

## 2.2. Agents in Negotiation Model

Illustrated in Figure 1, an information agent is responsible for manipulating data about the negotiation context stored in a data repository. It works locally on a client's machine, process on the elementary information provided by the client, and provides data and information to both knowledge agent and negotiation agent whenever necessary. The role of buyer through the information agent includes specifying procurement requirement, preference scoring, and aggregation methods.

A knowledge agent is equipped with knowledge management capabilities. The workspace of a knowledge agent consists of a knowledge repository that keeps the general knowledge, and a rule base. It formulates the negotiation knowledge from domain knowledge and expertise provided by the negotiation expert. A knowledge agent serves a negotiation agent as a back-end assistant in providing the knowledge which is needed in a negotiation scenario.

Given a negotiation context with all the information specified and knowledge formulated, a negotiation agent is responsible for the following steps: (1) Receive a preliminary set of quotes from suppliers; (2) Perform assessment on collected quotes and screen for a qualified set of quotes according to buyer's procurement requirement; (3) Rank the qualified

quotes into a ranked list decreasing order of the satisfaction level perceived by the buyer; (4) Select a list of quotes of high rank. For each supplier on the short-list, start a bilateral negotiation with the supplier's agent in an automated way. Coordinate the multiple bilateral negotiation; (5) Determine the final deal from the multiple bilateral negotiation results.

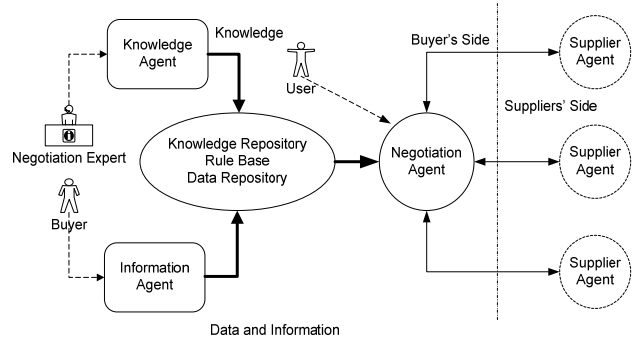


Figure 1. Agents in negotiation model.

In the multi-bilateral multi-attribute negotiation life cycle, there is plenty of data which can be collected, manipulated and utilized. Besides, domain knowledge and negotiation expertise are crucial for defining negotiation strategies, plans of actions, and preference scoring and aggregation methods. Both negotiating parties are responsible for collectively maintaining their own data repository, rule base and knowledge repository.

## 2.3. Knowledge Taxonomy

The goal of a corporate taxonomy is to provide a list of authorized terms in knowledge management and information seeking, as well as the mapping between concepts to connect negotiation parties with the right knowledge at the right time. Mainly two categories of knowledge are addressed in the proposed framework: (1) general knowledge and negotiation knowledge. General knowledge provides the specification of different categories of objects in the e-Commerce domain, which are the fundamental knowledge. An object can be a RFQ, a trader, a deal, or any object that associated with manipulation methods. (2) Negotiation knowledge, or negotiation expertise comprises knowledge of, or skill in observation of experience gained through negotiation in e-Procurement process. The concept of experience generally refers to know-how or procedural knowledge, which is the knowledge of how to perform certain tasks. Procedural knowledge is different from other kinds of knowledge in that it can be directly applied to a task. It includes the specification of different forms of relation existed among attributes represented as some form of general

knowledge, which is necessary to carry out a specific task.

## 2.4. Knowledge Representation

Knowledge Bead (KB) as an object-oriented knowledge representation scheme was defined in [4], as an encapsulation of definition, behavior, and data:  $KB = \text{Definition} + \text{Behavior} + \text{Data}$ . A KB can be a composite object, or a simple, atomic part object in most cases; each has their own methods and data. **Definition** means a static unique description; this can be a UPC (Universal Product Code) or a unique index implemented at the ontology databases for referencing this KB. **Behavior** is described by a set of possible methods and rules manipulating KB's and their attributes. Some typical ones include KB formation, duplication, attribute alteration, pruning and linking to other KB's. They are analogous to class functions in object-oriented programming, and can be inherited from base classes. **Data** consists of a group of attributes defined for the KB. Associated with each attribute, a weight is given as a relative priority indicating how important this attribute is in the current KB. Every general knowledge item can be represented in a certain template. The main categories of domain correspond to the types of general knowledge items including RFQs, quotes, proposals, agreements, profiles, and traces.

## 3. Using knowledge in negotiation

Most multi-agent systems which have applied ontology design focus on the use of domain ontology. In contrast with domain ontology which characterizes the domain knowledge where the task is performed [5], task ontology characterizes the computational architecture of a knowledge-based system which performs a task. To establish the task ontology based on KB's framework, we propose the methodology of KB's for automated negotiation. Here the methodology is defined as a set of procedures employed by a discipline that is used in the negotiation life cycle. The discipline is determined on the use of the knowledge, i.e. the function making use of the knowledge.

### 3.1. Manipulating KB's

One elementary method used in knowledge management is classification and clustering. The purpose of doing classification and clustering of KB's is for automating the negotiation process. Its use aims at transmitting appropriate knowledge to negotiation agents and making it easy for them to access the knowledge they need during the process execution.

Primary classification of KB's is done when a KB's is instantiated from the KB template in the specific domain. The KB's identity is used to locate the KB when it is looked up in any circumstance. KB's clustering is vital in knowledge management when general knowledge must be manipulated first before they can be used to formulate the negotiation knowledge.

For instance, the history contracts dealt with the same group of suppliers can be clustered so that the past contract item, e.g. latest delivery day, can be retrieved easily. If the current negotiation succeeds in producing a contract in the end, the newly committed contract will be added to the same contract cluster for future reference. Based on the manipulated contract cluster, the negotiation expertise specified by the rule can then be formed and executed in an efficient way. If the supplier presents any similar preference to that of some old suppliers, then the behavior of the new supplier would be considered predictable by the buyer relying on the history records. For another instance, the buyer clusters all the past contracts perceived as good bargains with some discount on the price. Suppliers who had ever offered discount form a favorite supplier list for the buyer. The list would be used as an additional factor affecting the quotes evaluation and ranking process when there are multiple suppliers that are qualified to negotiate with the buyer.

As general knowledge items are represented by KB's and negotiation knowledge are specified as constraints and rules that defined on attributes in KB's, the classification and clustering of KB's helps to manipulate and present the knowledge whenever it is needed by the system. Negotiation knowledge and general knowledge are used respectively for assisting the user to create a RFQ, and for the automated negotiation process. At the end of the process, log files are generated and added to the general knowledge database.

### 3.2. Meta-KB

To make use of the knowledge contained in KB's, the negotiator first identifies the function that he need to do in the negotiation process. Then it's the knowledge agent who provides a concrete plan of utilizing the appropriate knowledge in the specific function. The proposed model also provides the negotiator the flexibility to adjust the weight of the knowledge factors which affect the function result. To our knowledge, most current automated negotiation systems lack the ability of specifying the explicit use of knowledge in a systematic way, thus lack an efficient knowledge assisted automatic negotiation process. For this purpose, we define **meta-KB** as a meta-object for

describing the procedural knowledge necessary to perform a certain task in the e-Procurement context. It contains the meta-knowledge about KB's, which is knowledge about knowledge. The function which makes use of the meta-KB determines its discipline. Like an ordinary KB, a meta-KB contains attributes forming the knowledge. The attributes are either inherited from an existing KB or defined especially for the specific function, depending on the meta-KB's discipline. For each attribute, the meta-KB specifies how the attribute value is obtained.

Several typical functions are executed many times in different phases or in parallel during the multi-bilateral negotiations, including supplier credit evaluation, quote evaluation, and negotiation result assessment. For instance, illustrated in Table 1, the meta-KB for negotiation result assessment is used to measure how satisfactory a successful negotiation is, and the efficiency of the negotiation strategy used in negotiation. It is also served as an experience reference in KACM. Full details can be found in [6].

Table 1. Meta-KB for negotiation result assessment.

Meta-KB	
Use: Negotiation Result Assessment	
Inherited From: Negotiation Trace	
Attribute	Derived From
Agreement Utility	$U^{\text{Agreement}}(\text{Negotiation Trace})$
Negotiation Rounds	$s(\text{Negotiation Trace})$
Concessions	$t(\text{Negotiation Trace})$

## 4. Experiments

Mainly two experiments are done on the prototype system. One is to compare the negotiation results with different assumptions in the quotes evaluation and ranking phase. The objective of negotiations for a buyer is to achieve a most satisfactory final deal, among all the potential deals. One important performance index is the average overall utility of negotiation agreement, which measures how much the agreement satisfies the buyer's request in general. The proposed model evaluates all the qualified quotes from the suppliers and gives the buyer a ranked list of potential suppliers by the suitability of their quotes. The buyer then only negotiates with a shortlist of the best suppliers. To test this merit, three different scenarios are assumed in the quotes evaluation and ranking phase: (1) No explicit evaluation and ranking is performed; (2) Quotes evaluation and ranking is performed without KERM; (3) KERM is used in evaluation and ranking. The comparison result is shown in Figure 2. The other experiment is to compare the negotiation results with and without history

knowledge when automated concession is computed. More result details can be found in [2].

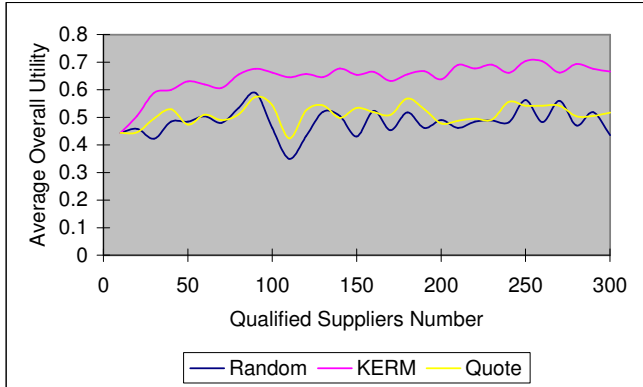


Figure 2. Utility values in different scenarios.

## 5. Conclusion

We discussed a B2B negotiation model using knowledge, applying a methodology that is based on Knowledge Bead (KB). With the proposed model, quote specification and bargaining process can be streamlined, and data resulted from negotiation can be reused as knowledge in future negotiation. This provides a foundation for the knowledge management life cycle designed for coexisting with the negotiation life cycle. Experimental results illustrate the advantages of the proposed model.

## 6. References

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