SURVEY OF E-CONTRAT NEGOTIATIONS ISSUES

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Abstract

Contract negotiation is a costly process. By the use of Internet, it is possible to reduce the costs related with face-to-face meeting and to shorten the whole process. Internet can be used to develop new negotiation models that improve current negotiation capabilities. In this paper, the state of the art in the contract negotiation area is presented. First, negotiation process models for electronic market design are introduced. Next, agent-based negotiation models are discussed. Then, an overview of computer supported negotiations is given.

INTRODUCTION

Contracting is one of the foundation of economy. The fundamental act in every business transaction is the establishment of a contract. A contract is the agreement of two or more parties on various provisions. In classical economy, contracts are often negotiated. A contractor (parties) establish a first contract version, which is then modified by others contractors to reach an agreement. When the agreement is reached, the contract is signed by all contractors to seal the agreement.

The negotiation phase is usually costly in terms of time and money. Face-to-face meetings between contractors are usually needed to precise some provisions of the contract and to sign it. The costs related to trips and hotel accommodation are high. Meeting scheduling is a difficult task, because of the incompatibilities between contractors' schedule.

Internet can reduce partially the costs of the contract negotiation process. Contractors' various geographical locations disappear with Internet. The costs related to face-to-face meetings are reduced by the use of asynchronous, such as email exchange, and/or synchronous communications, such as teleconferences. Asynchronous communications, which are the base of the more widely used applications of Internet, removes also problems related to schedule

incompatibilities. Using email exchange, someone in Tokyo can easily negotiate a contract with someone in New York City, even if when one works, the second sleeps.

Internet can, however, be used to build new contract negotiation models that would allow to improve the negotiation process adding new functionalities and lower costs. In this paper, we present the state of the art in the area of contract negotiation. In Section 2, negotiation models for electronic market design are presented. In Section 3, agent-based negotiation models are discussed. In Section 4, computer supported negotiation are presented. Section 5 concludes this paper.

NEGOTIATION MODELS FOR ELECTRONIC MARKET DESIGN

The design of electronic markets is a challenging research direction. With the growth of the electronic commerce, many works have been done to understand what are the mechanisms involved in negotiation. As a result, many negotiation process models have been developed that are based on the game theory [1].

In game-theoretic models [2][3], negotiation process is seen as a decision making process under uncertainty. Using the utility theory [4], the result of the negotiation is predicted on the basis of each contractor's preferences and of the rules of the game, given by the negotiation type (English, Dutch, first-price sealed-bid auctions, etc.) [5].

The most researched auction model is the *symmetrical independent private values (SIPV)* model. In the SIPV model, it is assumed that all the contractors are equals (*symmetrical*). Each contractor has her/his *private value* for the good being negotiated. Contractors are considered *risk neutral*. The more interesting characteristic of the SIPV model is that the payoff is the same if the negotiation type is English, Dutch, Vickrey of first-price sealed-bid auctions.

Another interesting model is the *common value* model, in which it is assumed that contractors have their own private values and one or more external information, such as the market price for the good or other contractors' opinions. Under these conditions, the winner frequently bids more than the good's true value. This phenomenon is referred as the *winner's curse*. The common value model demonstrates also that contractors should shade their bids as the winner is always the one who provides the most optimistic estimate of the good's value.

Although these models are quite elegant and based on strong mathematical foundations, they are not suitable for contract negotiation. First, most of these

models are dealing with single attribute auctions, i.e. the price of a stock option, but and cannot be applied to multi-attribute contracts. Such attributes are for instance the good's price, the delivery date, or legal provisions.

Another important limitation is that, according to various experiments [5][7], the existing models provide a poor representation of real negotiation cases. According to several empirical studies conducted by Balakrishnan [8], it seems that fundamental concepts in game theory are not valid for real-world environments.

AGENT-BASED NEGOTIATION MODELS

In order to reduce the costs of the negotiation process, human interventions can be reduced. Agent-based techniques propose solutions to minimize human intervention. In agent-based negotiations models [9][10], software agents act on behalf of contractors in order to reduce the costs related with the time-expensive process of risks evaluation. The main challenging issues are the establishment of ontologies for agent communications [11] and the adaptation of the agent behavior to changing marketplace rules [12].

Communications between agents are complex and cannot be modeled easily. The main problem in agent communication is the lack of established ontology and tools to manipulate them. Ontologies define relations between semantically related terms. An Internet ontology may define the relation between an IP address, a DNS computer name. Agents need ontologies to be able to communicate about the objects being negotiated.

The RDF framework [13], defining a format to describe relations between resources, is a step toward ontologies establishment. However, the RDF framework defines only a possible ontology format, the contents defining ontologies are to be defined. Ontology manipulation tools are also needed to allow agents to operate on various ontologies concerning semantically related ontologies. If an agent has to compare various insurance offers from various companies, and each company uses a different ontology, the agent needs to have some ontology tools that can map semantically equivalent terms. Currently, no ontology manipulation tool exists.

Another issue concerning agent-based contract negotiation results from the continuously changing nature of markets. Agent behavior is generally defined by its programmer and it is static. In markets, agents need to behave dynamically to provide the maximum benefits to contractors.

Learning agents may theoretically change their behavior in response to the experience they gain from interactions with their environment. However, currently, learning agents are only studied in a few research labs. The development of such agents is a very time-consuming task and, by nature, results are difficult to measure.

Another solution to the problem of dynamically behaving agents is base on modular agent model. In modular agent model, agent behavior is modularized in various parts. The agent responsibility is to retrieve appropriated behaviors to a given situation and to act as a mediator between the market and the retrieved behavior. However, the development of modular agents is a complex task, because the number of behaviors to be defined is unlimited.

Finally, an important issue of automated negotiations is the problem of multi-attribute negotiations, where the search space is typically complex and large. Classical agent-based models are not able to deal with such negotiations. Genetic algorithms [14] may be used to solve complex optimization computations needed to maximize all contractors' satisfaction for all attributes in two ways, either to generate negotiation strategies [15] or counter-offers [16]. Genetic algorithms can be applied to measurable issues only, such as prices or delivery dates. For issues that cannot be measured, genetic algorithms are of no use.

COMPUTER SUPPORT FOR NEGOTIATION

Via Internet, it is possible to connect hundreds of users. Negotiations involving hundreds of contractors are thus possible, on the contrary to the real world. The main issue of such negotiations is the great amount of data contractors have to deal with. Papers presented below provide computer support for negotiation, to help human beings to be more efficient when the amount of data in the negotiation process is great.

In [17], Schoop and Quix present a model that systematize the meta-data about the negotiation process. Meta-data are information exchanged during the negotiation about the negotiation process itself. Meta-data can be a remark about some contract part, a refusal of some clause, pure informational message, etc. Meta-data are an essential part of negotiation and thus must be integrated with document management systems that are classically used to provide contract persistence.

The speech act theory is the fundament of the model proposed in [17]. The speech act theory was published by John Searle in 1969 [18]. According to the speech act theory, the minimal unit of an utterance is a speech act. A speech act

consists of the prepositional contents – such as “pay two weeks after delivery”- and of the illocutionary force, which describe the way the contents were uttered – a promise in the former case. Searle classifies speech acts in five classes, regarding to the illocutionary force. An utterance that represents a fact of the real world, such as. technical characteristics of a car or financial reports, is an *assertive*. An utterance that represent the speaker’s intention to perform an action, e.g. promises, is a *commissive*. An utterance that represent the speaker’s attempt to get the hearer to perform an action, e.g. requests, is a *directive*. An utterance that represent the speaker’s feeling or psychological attitudes, e.g. apologies, is an *expressive*. Utterances that change the world by their utterance, such as prisoner sentencing, are *declaratives*.

The utterance classification can be use to introduce semantics in meta-data (message) exchange during the negotiation process. In [17], a message consists of contents, type (illocutionary force) and timestamp. A message always has a reference to a contract version A message can also be the answer to a previous message. In Figure 1, the message structure is illustrated. This model allows monitoring of contractual obligations and traceability of both contracts and messages and their interrelations.

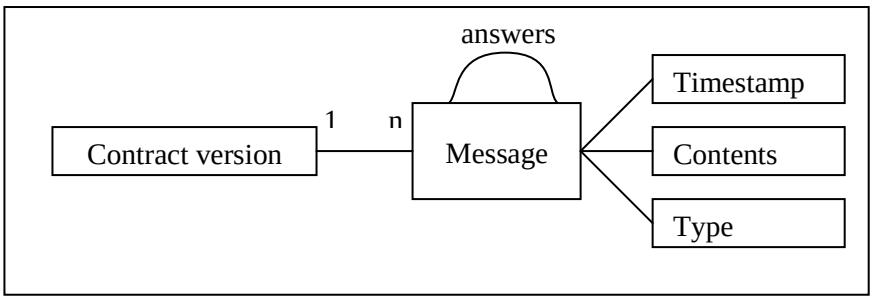

Figure 1. Message structure and relation with contract

Another research area for computer support for negotiation explores tools that provide analyses of the negotiation process. In highly concurrent environments, it is difficult to deal with a great number of contractors and contract versions. Contractors can be easily lost in the great amount of data. Analysis of the negotiation process is fundamental in all negotiation processes, but, in the case of highly concurrent environments, the analysis must be computed. The edition process can be automatically analyzed using ultra-metrics and the automatic classification theory.

In [19], the analysis of the negotiation process is based on the automatic classification theory and the use of ultra-metrics [20][21][22].

The mathematical definition of ultra-metrics is the following:

$$d \text{ is an ultra - metrics on space } D$$

$$\Leftrightarrow$$

$$\begin{cases} d : D^2 \to \Re^+ \\ \forall (x,y) \in D^2, d(x,y) = 0 \Leftrightarrow x = y \\ \forall (x,y) \in D^2, d(x,y) = d(y,x) \\ \forall (x,y,z) \in D^3, d(x,y) \leq \max(d(x,z), d(y,z)) \end{cases}$$

Having such an ultra-metrics, the automatic classification theory guarantees that space *S* can be partitioned into classes. Moreover, this classification is hierarchical, which allows controlling the space clustering granularity.

In [19], ultra-metrics and automatic classification are used to analyze the negotiation process. Negotiation analyses can be used to detect anomalies in the negotiation process. Some ultra-metrics can be used to detect contractors that do not work on the contract or that systematically reintroduce old versions of the contract. Other ultra-metrics can detect contractors having an incoherent behavior, proposing for instance illogical data with huge variations between various contract versions. In the case of supervised negotiations, this data may indicate that some changes are needed, or that a given contractor should leave the negotiation process. In the edition analysis model, it is assumed that many analyses can be computed and do not impose any restriction on the choice of ultra-metrics.

This hierarchical classification can be seen at various detail levels. Having a given threshold *T*, the space to be analyzed can be partitioned into different classes. Changing the threshold, it is possible to have control on the granularity of space partition. In the context of highly concurrent environments, this ability enables contractors to evaluate efficiently the status of the negotiation process. A high threshold gives a high level classification (with a few classes) while a low threshold allows fine-grained classification (with many classes).

The choice of the threshold and the possible use of many ultra-metrics provide a very flexible framework for contract negotiation analyses. The capability to analyze every aspect of the negotiation process combined with the hierarchical classification allows to focus on a given problem and to view the results of the analyses at various detail levels.

CONCLUSIONS

All models presented in this paper aim to reduce the costs related with the negotiation process. Contract negotiation is a brand-new hot topic and none of the presented model provides a complete and satisfying solution. However, the convergence of many research areas, such as artificial intelligence (AI), multi agent systems (MAS), data mining, genetic algorithms or pattern recognition, moves towards two directions: automated negotiation and computer support for negotiation.

On the basis of contract negotiation, many other works are currently done on a global electronic commerce infrastructure. These models focuses on the whole commercial transaction, from client-buyer matching to execution of signed contracts [23][24]. Such models, based on electronic contract negotiation, proposed generic contracting service, which could radically change the fundamental notion of the contract act, providing for instance executable contracts.

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