# Contract Negotiation in E-Marketplaces



**Larbi Esmahi**
*Athabasca University, Canada*

**Elarbi Badidi**
*United Arab Emirates University, UAE*

## INTRODUCTION

The advancement in distributed and intelligent computing has facilitated the use of software agents for implementing e-services; most electronic market places offer their customers virtual agents that can do their bidding (i.e., eBay, onSale). E-transactions via shopping agents constitute a promising opportunity in the e-markets (Chen, Vahidov, & Kersten, 2004). It becomes relevant what kind of information and what kinds of bargain policies are used both by agents and by the market place. There are several steps for building e-business: (1) attracting the customer, (2) knowing how they buy, (3) making transactions, (4) perfecting orders, (5) giving effective customer service, (6) offering customers recourse for problems such as breakage or returns, and (7) providing a rapid conclusion such as electronic payment. In the distributed e-market paradigm, these functions are abstracted via agents representing both contractual parts. In recent years, many researchers in intelligent agents' domain have focused on the design of market architectures for electronic commerce (Fikes, Engelmore, Farquhar, & Pratt, 1995; Schoop & Quix, 2001; Zwass, 1999), and on protocols governing the interaction of rational agents engaged in such transactions (Hogg & Jennings, 1997; Kersten & Lai, 2005). While providing support for direct agent interaction, existing architectures for multiagent virtual markets usually lack explicit facilities for handling negotiation protocols, since they do not provide such protocols as an integrated part of the framework.

In this article we will discuss the problem of contract negotiation in e-marketplaces. In the next section, we will present related models commonly used to implement negotiation in e-markets, game theory models, auction models, and contract-net protocols. Then the following section continues with the presentation of a negotiation protocol based on dependency relations. We then present a negotiation strategy based on risk evaluation. The conclusion summarizes the article and paves the further way concerning the truth in the negotiation strategy and the use of temporal aspects on commitments and executions of contracts.

## NEGOTIATION PROTOCOLS FOR E-MARKET

The interaction between agents inside the marketplace is managed by a negotiation protocol. In fact, the negotiation protocol defines a set of public rules that allow agents to set up transaction contracts or cooperation agreements. Previous work and significant achievements are reported on various related fields of research and concrete solutions. Most of the Internet-based market places use auction protocols, especially the English auction.

Hereafter, we present and evaluate some negotiation models either developed in some research works or implemented in some practical systems: game theory, auction models, and contract-net protocols.

### Game Theory Models

Game theory models address many aspects of the agents' interaction: contract elaboration, profit repartition, and conflict resolution. Many negotiation models have been proposed in this topic (Ephrati & Rosenschein, 1992; Genesereth, Ginsberg, & Rosenschein, 1986; Khedro & Genesereth, 1994; Kraus, Wilkenfeld, & Zlotkin, 1995; Rosenschein & Genesereth, 1985; Zlotkin & Rosenschein, 1991). These models have some desirable properties, such as insuring the negotiation convergence, the Nash-equilibrium, and the pareto-optimality. The main representative works in this domain are those presented by Zlotkin and Rosenschein (Rosenschein & Genesereth, 1985; Rosenschein & Zlotkin, 1994; Zlotkin & Rosenschein, 1991). The authors propose a

formal model that allows agents to select the pareto-optimal solution that maximizes their utilities. The agents communicate their desires explicitly by exchanging messages and may accept concessions that allow them to elaborate contracts that satisfy their goals. A contract may concern task repartition (task-oriented domains), utility value repartition (worth-oriented domains), or decision making on the next state of the environment (state-oriented domains). Different types of contracts have been studied: pure contracts where the agent's role in the joint plan is fixed, and mixed contracts where the agent's role depends on a probability.

If we consider a negotiation between two agents A1 and A2, the authors propose a protocol that can be summarized as follow:

1. At each step $t \geq 0$, both agents propose their deals $\delta 1(t)$ and $\delta 2(t)$ such that those deals satisfy two conditions: (1) the deals must be individually rational to their respective agents ($\forall Ai\ \delta i$, the utility $Ui(\delta i) \geq 0$), and (2) for each $Ai \in \{A1, A2\}$, $t > 0$ we have $Ui(\delta i(t)) \leq Ui(\delta i(t-1))$.
2. The negotiation finishes at a step t when one of the two situations happens:
   - The agents agree on a deal. $\exists i \neq j \in \{A1, A2\}$, such that $Uj(\delta i(t)) \geq Uj(\delta j(t))$.
   - The agents run on a conflict. $\forall Ai \in \{A1, A2\}$, $Ui(\delta i(t)) = Ui(\delta i(t-1))$ (i.e., no more concession is possible for both agents).

The advantage of the proposed protocols in game theory consists of their suitability for rational cooperating agents that work for maximizing their profits. However, the main drawbacks of those models consist of (1) their inability to take into consideration the history of the negotiation process and (2) the fact that each step is processed as a stand-alone step. Furthermore, the agents are supposed to have complete information on their partners, especially by knowing all their matrix of profits. The agents are also supposed of being self-sufficient, while the complementarity and dependency between agents is ignored.

## Auction Models

Auction theory analyzes the protocols and strategies used by agents during an auction sale. Many protocols have been proposed in auction theory (Rasmusen, 2001):

- **English Auction:** In the English auction, the bidding process is public, so each bidder has complete information about the auction. At any time, each agent is free to raise his bid. When no bidder is willing to raise anymore, the auction ends, and the highest bidder wins the item at the price of his bid. The agent's strategy consists of a series of bids, where the bidding value is a function of his or her private value, his or her prior estimates of other bidders' valuations, and the past bids of others. An agent's dominant strategy is to always bid a small amount greater than the current highest bid, and stop when his or her maximum value is reached.
- **Sealed Bid Auction:** In the sealed bid auction, each bidder submits one bid without knowing the others' bids. The highest bidder wins the item and pays the amount of his bid. The agent's strategy consists of determining his or her bid as a function of his or her private value and prior beliefs of others' valuations. In general there is no dominant strategy for acting in this auction.
- **Dutch Auction:** In the Dutch auction, the seller or the auction manager continuously lowers the price until one of the bidders takes the item at the current price. The Dutch auction is strategically equivalent to the sealed bid auction, because in both games, an agent's bid matters only if it is the highest and no relevant information is revealed during the auction process.
- **Vickrey Auction:** The Vickrey auction is similar to the sealed bid auction with some detail exceptions. In fact, each bidder submits one bid without knowing the others' bids, and the highest bidder wins, but it pays only the price of the second highest bid. The agent's strategy consists of determining his or her bid as a function of his or her private value and prior beliefs of others' valuations. The dominant strategy in Vickrey auctions is to bid one's true valuation. If an agent bids more than that and the increment hits the difference between winning or not, the agent will end up with a loss if he or she wins. If the agent bids less, there is a smaller chance of winning, but the winning price is unaffected. The dominant strategy result of Vickrey auctions means that an agent is better off bidding truthfully no matter what the other bidders are like—what are their capabilities, operating environments, bidding plans, and so