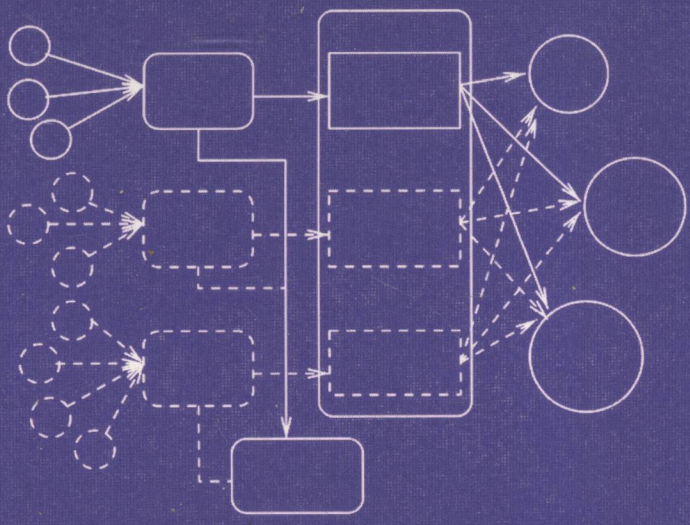
Frank Dignum
Ulises Cortés (Eds.)

LNAI 2003

Agent-Mediated Electronic Commerce III

Current Issues in Agent-Based Electronic Commerce Systems



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Current Issues in Agent-Based Electronic Commerce Systems

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Preface

In this book we present a collection of papers around the topic of Agent-Mediated Electronic Commerce. Most of the papers originate from the third workshop on Agent–Mediated Electronic Commerce held in conjunction with the Autonomous Agents conference in June 2000. After two previous workshops, one during the Autonomous Agents conference in 1998 in Minneapolis and the second one in conjunction with the International Joint Conference On Artificial Intelligence in 1999, this workshop continued the tradition of the previous ones by setting the scene for the assessment of the challenges that Agent-Mediated Electronic Commerce faces as well as the opportunities it creates. By focusing on agent-mediated interactions, specialists from different disciplines were brought together who contribute theoretical and application perspectives in the narrowly focused topic that nevertheless involves wide ranging concerns such as: agent architectures, institutionalization, economic theory, modeling, legal frameworks and policy guidelines. The main topics for the workshop were:

- Electronic negotiation models for agents
- Formal issues for agents that operate in electronic market places
- Virtual trading institutions and platforms
- Trading strategies for interrelated transactions (respectively auctions)

The workshop received 12 submissions of which 7 were selected for publication in this volume. Although the number of submissions was less then expected for an important area like agent-mediated electronic commerce there is no reason to worry that this area does not get enough attention from the agent community. In fact, we noticed that many papers on agent-mediated electronic commerce found their way to the main conference. We decided therefore to invite a number of authors to revise and extend their papers from this conference and combine them with the workshop papers. Finally, we decided to include a paper that discusses the results of the Fishmarket tournament that was held during the workshop. The result is that this volume contains 12 high quality papers that really can be called representative of the field at this moment.

We have arranged the papers in the book according to the topics indicated above. The first section containing three papers is focused on negotiation models. This section starts with a more theoretical paper on a bilateral negotiation model for agent-mediated electronic commerce from *G. de Paula, F. Ramos and G. Ramalho.* In this paper they describe a model for bilateral negotiation, which offers support for, e.g., alternative product suggestion and ultimatum generation. It is therefore a generalization of the models used in current e-commerce systems such as Kasbah and MAGMA.

The second paper in this section (from *M. Barbuceanu and W. Lo*) discusses simultaneous negotiation over several attributes of a product. It uses constraint optimization as a model to concurrently satisfy several objectives as well as possible.

The same type of techniques are used in the paper of *R. Kowalczyk and V. Bui*, which uses constraint-based reasoning to support the negotiation process of agents in a car-trading system.

The second section of the book contains three papers with a more formal, logical flavor. The first two papers both discuss issues related to the communication between agents in an e-commerce setting. The first paper of *A. Artikis, F. Guerin and J. Pitt* shows how conversations between more than two parties can be formally modeled and given a clear semantics. The theory is used to model some frequently occurring auction protocols.

The second paper (*M. Wooldridge and S. Parsons*) discusses some issues for the design of negotiation protocols for agent communication languages that are based on logic. It indicates that a seemingly simple question as to whether agreement between the parties has been reached is difficult to answer formally (based on the protocol and the messages exchanged). It sets forth to indicate a number of progressively more complex negotiation languages and considers the complexity of these languages.

The last paper of this section, from *M. Pradella and M. Colombetti*, gives a formal description of a practical agent for e-commerce. The formal model makes it possible to prove certain properties of the agent, which would otherwise be hard to discover.

The third section of this book is devoted to platforms and institutions for agent-mediated electronic commerce. *H. Cardoso and E. Oliveira* describe a platform that can be used for e-commerce between agents and which supports adaptive agents, i.e., agents that learn from past experiences. The platform also supports multi-lateral and multi-issue negotiation.

In the paper of *M. Schröder, J. McMann and D. Haynes* it is argued that in trading a universal ontology is often assumed for matching offers and demands. This ontology is often a bottleneck for the scalability of the system. The paper describes a system which circumvents the necessity of such a universal ontology by making the clients a bit more flexible, while the traders specify their products a bit less precisely.

The last paper in this session is from *M. Tsvetovat, K. Sycara, Y. Chen and J. Ying* and discusses the formation of customer coalitions on electronic markets. It discusses the possible formation processes with their advantages and risks and indicates which model is most likely to succeed.

The last section of the book contains four papers related to agent strategies for agents that operate on markets where multiple interrelated auctions are running. The first paper of *C. Preist, C. Bartolini and I. Phillips* discusses the design of an algorithm for an agent that participates in multiple simultaneous auctions. The algorithm is designed to divide the wanted number of products over the auctions in an optimal way.

The other paper of this section is from *J. Béjar and Cortés* and discusses strategies for agents that participate in the Fishmarket games using the Dutch Bidding Protocol. In these games the agent has to participate in a number of successive auctions, trying to buy an optimal amount of fish. The last paper by

J. Béjar and J. Rodríguez-Aguilar describes the exhibition tournament held for this workshop. It also discusses the reasons for the success or failure of some strategies and lessons that can be learned from the tournament.

We want to conclude this preface by extending our thanks to the members of the program committee of the AMEC workshop who were willing to review the papers in a very short time span and also of course to the authors who were willing to submit their papers to our workshop and the authors that revised their papers for this book.

December 2000

Frank Dignum
Ulises Cortés

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Bilateral Negotiation Model for Agent-Mediated Electronic Commerce

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Abstract. One of the main issues in electronic commerce is the inclusion of the negotiation facilities commonly available in human client-vendor interaction in real world commerce. E-commerce negotiation processes have usually been modeled as self-interested multi-agent systems. In these systems buyers and sellers are represented by agents that have opposite demands and decide what to do on the flight, based on the available information. However, currently e-commerce systems, such as Kasbah and Magma [21], provide a small number of bilateral negotiation facilities. Fortunately, some general negotiation models could be at first applied to e-commerce domain. This is typically the case of Faratin's model, which can be seen as an extension of Kasbah's. In this paper, we propose an original bilateral agent negotiation model, which extends Faratin's one. We introduce various facilities, such as alternative product suggestion, ultimatum generation, local contract agreements, etc. These facilities intend to grant users with a more flexible e-commerce environment. We present our model formalization, including the knowledge base that determines agent behavior. Some empirical validation is also presented to the case of computer purchase.

1 Introduction

As the e-commerce usage has been growing, the involved companies have been trying to offer buy-and-sell facilities to their clients that are as close as possible to the real world ones. These facilities rely essentially on the client-salesman interaction. In fact, clients usually do not know precisely which product to buy or how much to pay for it. The salesman can then (i) help the client to choose the product that best fits his or her needs; (ii) suggest alternative products; and (iii) negotiate shopping prices and conditions. These facilities are desirable because they provide user with a more flexible environment to do their shopping, and this will probably help him to get better purchase conditions.

Agent's metaphor and technologies [9, 22] can be used to model the behavior, the desires and the goals of both salesman and client, providing the typical facilities of client-salesman interaction, which are not yet present in e-commerce. Under this agent mediated e-commerce (AMEC) perspective, one of the main issues is to model and implement negotiation, which involves the specification of the negotiable attributes, agent possible moves, and agent decision making strategies.

F. Dignum and U. Cortés (Eds.): AMEC 2000, LNAI 2003, pp. 1-14, 2001.

MIT Kasbah market place [2, 3] is the most significant example of e-commerce negotiation system. This market place simulates an environment where an user can create an autonomous agent to buy or sell a product, negotiating product price on his/her behalf. The agent configuration includes some behavior rules, such as the maximum time to reach a deal, the desired price interval and the price suggestion function. Kasbah provides a small number of facilities to the user's negotiation process.

Fortunately, since negotiation is a central component of many self-interested multi-agent systems [2, 3, 7, 8, 13, 14], some of them could be adapted to e-commerce domain. This is typically the case of Faratin's negotiation model [5], which can be seen as an extension of Kasbah's. In fact, Faratin's model includes new features, such as multiple attributes negotiation, and imitative and resource dependent proposal generation.

In this paper, we detail an agent bilateral negotiation model, which is an extension of Faratin's one applied to e-commerce domain. The main extensions encompass the incorporation of negotiation cost in decision function; the possibility of negotiating over a set of products and multiple attributes; the ultimatum generation; and the suggestion of alternative products.This paper is organized as it follows. In the next section, we present our view of the negotiation problem and processes. In Section 3, we analyze Kasbah and Faratin's model, highlighting their limitations. In Section 4, we present our model, pointing at some solutions to overcome these limitations. We present the negotiable products representation, the agent possible moves (which defines agent complexity), and the agent behavior rules. Some empirical validation to the case of computer purchase are also presented in Section 5. Conclusions and future work are given in the last Section.E-commerce Negotiation.

2 E-Commerce Negotiation

In this Section, we discuss some problems and processes underlying e-commerce negotiation, stressing the difficulties of modeling real world features.

2.1 Real World Negotiation Features

The virtual negotiations, which take place in the Internet, are far away from a real world one, because several features are not considered. Human behavior in real world commerce negotiation involves difficult points, such as:

- *Multiple attributes negotiation*: negotiation usually involves several attributes, such as price, delivery time, taxes, etc.;
- *Similar product suggestion*: clients usually do not know precisely which product to buy. They have only an idea of the desired product class. In this case, the negotiation can regard similar alternative products;
- *Correlated product suggestion*: when a client buys a television, a salesman can offer a discount in the case that the client also buys a video cassette;
- *Ultimatum*: when a negotiator wants to leave the negotiation process, he/she gives an ultimatum to the opponent indicating that this is his/her last offer. This

ultimatum is used to indicate the desire to leave the negotiation process if the last offer is not accepted.
- *Negotiation cost*: a client can buy the product at hand only to avoid the cost (locomotion, parking, etc.) of trying to find a cheaper one somewhere else;
- *Learning*: the experience of previous negotiations is usually taken into account in the future;

As far as we know, only the first of the above features has been incorporated by the e-commerce systems developed so far.

2.2 Principles of Bilateral Agents Negotiation

In automatic bilateral negotiation, two agents (seller and buyer) that have contradictory demands must exchange proposals in order to reach a deal.

Each agent has a private *border proposal*, which is a maximum (or minimum) limit that must be respected in reaching a deal (see Figure 1). The intersection between agents' border proposals defines what we call the *deal range*. If the deal range will be empty, the deal is impossible. A formal definition of these concepts is available in [4].

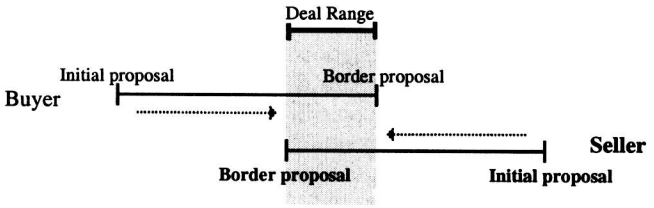

Fig. 1. Bilateral negotiation process. Seller is in bold and buyer is in normal. The dashed area is the deal range.

Each agent's border proposal values are normally kept hidden from its opponents. Some approaches, such as *vickrey* mechanism, multi-unit *vickrey* [6], have been developed to force the opponent agent to reveal its border values. However, it has been shown that this approach has several limitations when applied to bounded rationality applications like the one considered here [19].

2.3 Problems of Bilateral Agent Negotiation

In order to model an environment where agents can negotiate on behalf of human beings taking into account real world features, it is necessary to answer the following questions:
- How to model the proposals?
- How proposals are evaluated?
- Which are the agent possible moves in negotiation?
- How do agents decide which move to take in each of negotiation round?

The first question regards the content and the representation of the proposals exchanged during negotiation. The answers depend on what should be considered in

negotiation. A proposal may contain more than one *deal attribute*, such as price, delivery time, delivery tax, guaranties, etc. *Product attributes* can also be considered in a proposal. For instance, in the purchase of a computer, these attributes could be the computer brand, the processor speed, the memory size, etc.

The answer to the second question depends on the answer to the first one and defines an *evaluation function*. If the proposals consider more than one deal attribute, for instance, it would be necessary to combine theses attributes to obtain a single value. If product attributes are considered, then they should also be included in the evaluation function.

The answer to the third question depends on the desired negotiation complexity. A basic negotiation usually embodies three moves: accept an offer; quit negotiation; and generate a counterproposal. The agent can *accepts* a proposal when it is between its initial and border proposals range and the agent cannot generate a better counterproposal. Normally agent *quits* negotiation when the opponent current proposal is not good enough and a given maximum negotiation time is reached. Otherwise, the agent could generates a counterproposal. A sophisticated negotiation could encompass additional moves, such as alternative or correlated products suggestion; and ultimatum offer (See Section 2.1).

The fourth question addresses the decision making problem. If only the basic moves are adopted, a simple function can be defined to classify the moves importance, based on the proposal evaluation (see second question). The closer is the model to real world negotiation, the greater is its complexity, since further moves are considered and the definition of the classification function becomes harder. In the case of choosing counterproposal generation, it is also necessary to determine its value. This can be made according to some tactics [5], such as: time-dependent tactics, where proposals depend only on the elapsed time in a constant rate; behavior-dependent tactics (tit-for-tat) where proposals depend only on the opponent behavior; resource-dependent tactics where proposals depends on the amount of some resource in the negotiation environment (e.g., number of available sellers).

3 State of the Art

We discuss now how two negotiation systems, Kasbah [2, 3] and Faratin's [5], address the four questions raised in the previous section. As stated in the introduction, Kasbah is the most significant e-commerce system devoted to the simulation of real world negotiation conditions. Although Faratin's model has been applied to a business process management domain, it can be seen as a direct extension of Kasbah's model. We believe that Faratin's model can be easily applied to e-commerce and, besides that, be extended to include new features.

In Kasbah, the proposals consist only of a single item: the product price (the product attributed are not considered). The proposals evaluation in then the simplest as possible consisting of the suggested price. The moves implemented are the basic ones: quit, accept and generate counterproposal (see Section 2.3). All counterproposal generation functions are time-dependent, with variation rates being linear, quadratic or cubic. Negotiation cost is not considered in decision process.

Faratin's model extends Kasbah's in three aspects: proposal representation, proposal evaluation and counterproposal generation tactics. In fact, a Faratin's