

# ANTE: Agreement Negotiation in Normative and Trust-enabled Environments

Henrique Lopes Cardoso, Joana Urbano, Pedro Brandão, Ana Paula Rocha, Eugénio Oliveira

## 1 Introduction

Research on negotiation and task allocation has been in the multi-agent systems realm since its inception as a research field. More recently, social aspects of agenthood have received increasing attention, namely developing on the fields of normative and trust systems. The integration of these different research contributions will allow to build robust applications for electronic agreement negotiation, aiming at their acceptability and application in industry.

The ANTE<sup>1</sup> framework is the corollary of an ongoing long-term research project that encompasses three main agreement technologies: negotiation [3], normative environments [1], and computational trust [5]. Although ANTE has been targeting the domain of B2B electronic contracting, it was conceived as a more general framework having in mind a wider range of applications.

This paper describes a demonstration showing the application of the ANTE framework to an agent-based automatic electronic contracting domain.

## 2 Main purpose

ANTE addresses the issue of multi-agent collective work in a comprehensive way, covering both negotiation as a mechanism for finding mutually acceptable agreements, and the enactment of such agreements. It also includes the evaluation of the enactment phase, with the aim of improving future negotiations. This demonstration shows an application scenario where three research areas – negotiation, normative

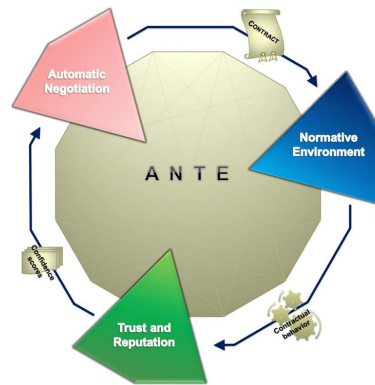
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Henrique Lopes Cardoso, Joana Urbano, Pedro Brandão, Ana Paula Rocha and Eugénio Oliveira  
LIACC / DEI, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465  
Porto, Portugal, e-mail: {hlc, joana.urbano, pedro.brandao, arocha, eco}@fe.up.pt

<sup>1</sup> Agreement Negotiation in Normative and Trust-enabled Environments

environments and computational trust – seamlessly glue together in order to be exploited by software agents that, while working as delegates of different stakeholders, interact in order to establish successful agreements.

With a strong automation perspective, the scenario envisages the use of software agents negotiating on behalf of their principals, which are buyers or suppliers in a B2B network. Negotiation is therefore used to select, among a group of potential suppliers, the best ones to fit a particular business opportunity. Contracts resulting from successful negotiations are validated, registered and digitally signed, before being handed to the normative environment for monitoring and enforcement purposes. Finally, the way agents enact their contracts provides important information for trust building. A repository of trust and reputation information may then complete the circle by providing relevant inputs for future negotiations. The integration of all these stages is depicted in Figure 1.



**Fig. 1** The ANTE framework.

Important synergies are obtained from the integration of the three main research domains identified in Figure 1. Negotiation is informed by trustworthiness assessments of negotiation participants, in one of three possible ways: using trust for preselecting the partners with whom to negotiate; evaluating negotiation proposals taking into account the trustworthiness of proposal issuers; or exploiting trust information when drafting a contract with a selected supplier, e.g. by proposing a (more or less severe) sanction in case the supplier breaches the contract, thus trying to reduce the risk associated with doing business with less trustworthy agents.

Connecting the monitoring facility of the normative environment with a computational trust engine means that we can use contractual evidences regarding the behavior of agents when enacting their contracts to build trust assessments. Our approach to model contractual obligations [2] allows for a rich set of possible contract enactment outcomes (fulfillments, delays, breaches, and so on), which in turn enables a trust engine to weight differently the possible sub-optimal states that might be obtained [4, 5].

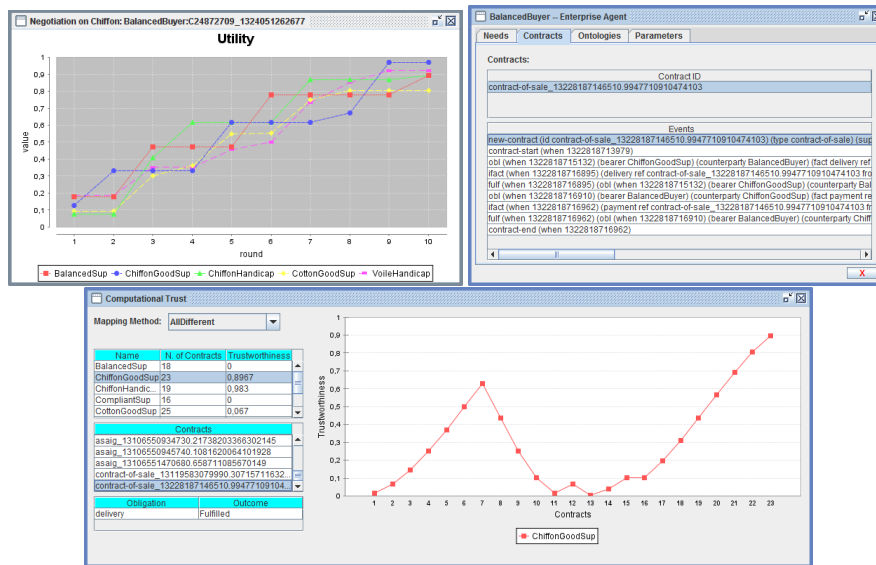
### 3 Demonstration

ANTE has been realized as a JADE-based platform, including a set of agents that provide contracting services, namely negotiator, computational trust, ontology mapping, notary and normative environment. User agents comprise buyers and suppliers.

Using an appropriate graphical user interface (GUI), a buyer can specify its needs and start a multi-attribute negotiation using the negotiator service. The buyer specifies how trust is to be used in each negotiation step, and indicates the contract type to be created; norms governing specific contract types are predefined in the normative environment, thus making it easier to establish a contract.

The supplier’s GUI displays the negotiations in which a supplier has participated, together with the messages exchanged during those negotiations.

The negotiator service’s GUI (Figure 2, *top left*) shows the evolution of the proposals received from a number of suppliers during a multi-round negotiation protocol, in terms of the utility of such proposals for the buyer.



**Fig. 2** Negotiator (*top left*): proposals’ utility evolution in a multi-round negotiation. Normative environment (*top right*): reported contract enactment events. Computational trust (*bottom*): computing trustworthiness assessments from contractual evidences.

Both buyers and suppliers include in their GUI a list of the contracts they have already established and a set of events related to their enactment. These events (such as obligations, delays, fulfillments or violations) are automatically reported by the normative environment in the contract monitoring phase (Figure 2, *top right*).

The GUI for the computational trust service (Figure 2, *bottom*) allows us to inspect how trustworthiness assessments are computed, including the contractual evi-

dences used as input for each agent. It also allows us to choose the mapping method to be used when weighting each of the possible contract enactment outcomes.

## 4 Conclusions

Real world applications of agreement technologies are better addressed taking an integrative approach. The ANTE framework seeks to provide an environment where the interdependencies between different research domains – namely negotiation, norms and trust – can be experimented. Although not addressed in this paper, other areas of agreement technologies, such as semantics (ontologies) and argumentation, are also being addressed within the same research environment.

We have run several experiments with the aim of trying to figure out the best ways of integrating negotiation, norms and trust (see [7, 5, 6]). Furthermore, the modular architecture of the framework allows its easy extension in two respects. At a macro level, different negotiation protocols, trust aggregation engines or norm monitoring approaches may be developed that integrate with the other pieces of the puzzle (see Figure 1). Also, agents using different negotiation strategies, trust usage policies or contractual behaviors can be deployed, making the overall environment quite heterogeneous in terms of participating agents.

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