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A study of Traditional Negotiation and Electronic Negotiation

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Abstract
This paper presents an experiment that contributes to the comparison of traditional negotiation and electronic negotiation. The experiment is part of an ongoing attempt of improving the quality of electronic negotiation. The validity of the experiments was tested using Statistical techniques on data produced from experiments. The results indeed reveal a number of strengths and weaknesses of the traditional negotiation and electronic negotiation. For example, the number of rounds in negotiation in traditional negotiation is more as compare to electronic negotiation.

1. Introduction

Negotiation is a decentralized decision-making process used to search for and arrive at an agreement that satisfies the requirements of two or more parties in the presence of limited common knowledge and conflicting preferences. As per [1], Software agents carrying out negotiation activities on behalf of users are known as negotiation software agents (NSAs). These artificial negotiators are expected to be able to negotiate against other artificial- and against human negotiators. However, negotiation will never be delegated to artificial negotiators (also called agents), if their performance is not at least as good as that of human negotiators.

The need to establish the quality of negotiators implies a need for evaluation tools and experimental setups in which negotiators can be tested against each other. Note that in this formulation, negotiators can be either human or artificial. The GENIUS 3.0 [3] system developed by TUDelft [3] is a software environment that allows negotiators to play against other negotiators and that contains tools to evaluate the negotiation traces against a library of dynamic properties.

This paper takes a step towards the proposed benchmark by providing the setup of an experiment and showing their appropriateness by performing statistical test on results. In the experiment negotiations are to be performed traditionally as well as electronically through software agents and GENIUS Negotiator.

2. Attributes of Negotiation Process

To analyse the differences between traditional negotiation and electronic negotiation, attributes of negotiation process are investigated. To measure the performance of the different parties in the negotiation, a number of different properties from the literature (e.g., [8], [9]) are included in the library. In this paper we analyse only two properties:

(i) *Negotiator Final Utility*: a number between 0 and 1, indicating the negotiator's utility for the final bid in the negotiation (i.e., the bid that both parties agreed upon). The higher the utility, the higher the satisfaction of the negotiator. A high (but < 1) number does not mean that the negotiator could not have performed better. Furthermore, the utility of the one does not give any information about the utility of the other.

(ii) *Number of rounds*: a natural number, indicating the number of rounds the negotiation process took. One round consists of a bid made by the seller, followed by a bid made by the buyer. The smaller this number, the quicker an agreement was reached.

3. GENIUS - Negotiation Environment for Heterogeneous Agents

TUDelft Negotiations have developed a negotiation environment that implements an open architecture for heterogeneous negotiating agents. It provides the basis for an implementation of a testbed for negotiating agents that includes a set of negotiation problems for benchmarking agents, a library of negotiation strategies, and analytical tools to evaluate an agent's performance.

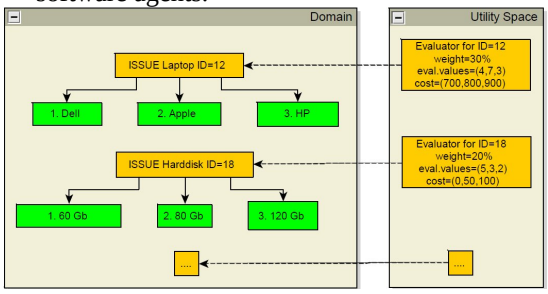
The software has been developed using widely-accepted standards such as *design patterns* to integrate various components of the architecture. The software supports the development of new negotiating agents as well as integration of existing agent implementations through a simple API (e.g., in [2] we demonstrated how an existing agent can be integrated into the system using the *Adaptor* design pattern). This approach minimizes programming effort required to (re-)integrate and maintain code of

a negotiation agent. The *XML* file format [4] is used system-wide to specify the negotiation domain, preference profiles, and export results of simulations for detailed analysis. The use of XML simplifies the task of maintaining the persistent information in the system, allows extending the original information structures of the system with new concepts with no impact on the existing code, and integration with other systems.

As per [5], The software environment consists of two main modules:

(i) Scenario Editor, a GUI-based editor that allows to create, store, and modify a negotiation domain and preferences of the negotiating parties;

(ii) Simulator, a tool used to simulate and analyze negotiation between the software agents and allows humans to negotiate with others or with software agents.



Overview of the data structures and relations

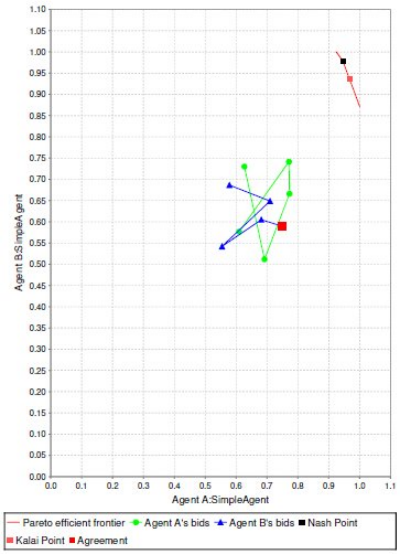
3.1 Utility of a Bid

A bid is a set of chosen values *v*1K*vN* for each of the *N* issues. Each of these values has been assigned an evaluation value eval(*vi*) in the utility space, and also there are fixed costs cost(*vi*) associated with each value. The utility is the weighted sum of the normalized evaluation values, under the assumption that the cost is below the maximum cost of 1200. If the maximum cost is exceeded, the utility is zero (e.g., [5]).

$$Utility(v_1 \ldots v_N) = \begin{cases} U(v_1 \ldots v_N), if\ CostSum(v_1 \ldots v_N) \le 1200 \\ 0, if\ CostSum(v_1 \ldots v_N) > 1200 \end{cases}$$

$$U(v_1 \ldots v_N) = \sum_{i=1}^{N} w_i \frac{eval(v_i)}{\max(eval(v_k))}$$

$$CostSum(v_1 \ldots v_N) = \sum_{i=1}^{N} \text{cost}(v_i)$$



Utility Plot indicates for both agents of a particular bid.

4. Experiment

An experiment based on mobile domain was performed to analyse the difference between two negotiation processes: a traditional face-to-face negotiation and an electronic negotiation using software agent.

Participants. Gather a group of students belongs to MBA course. The selection should contain enough students to possibly gain statistically significant results. The size of the group depends on the number of variables in the domain. In this experiment total sixteen students were participated. The group consisted of 11 males and 5 females. The age of students participated, varying between 19 and 27 years.

Preparation. Before starting the experiment, the participants are to be provided enough background information to be able to perform the negotiation and use the software environment used to register the negotiations. The participants should be motivated to do their best during the negotiation. In the case study the participants were motivated by the challenge to obtain a high

utility, and to perform better than the electronic negotiation they were also allowed to perform. The participants formed 8 groups of two persons, and each group was assigned to a computer.

Method. In the traditional negotiation process, one person is assigned the role of the buyer, and the other one is assigned the role of the seller. The buyer negotiates with the seller (both using their own profile). In the electronic negotiation process, a computer buyer negotiates with a computer seller

(both using the profile of the corresponding negotiator in traditional negotiation). By keeping the negotiation profile stable over the two processes, it is guaranteed that the utility spaces remains the same, and that the resulting traces are thus comparable.

5. Results

Using GENIUS system the negotiation attributes have been collected through traces that resulted from the experiments. Paired t-test have been performed, of which the results collected from experiments using the software STATGRAPHICS® Centurion XV [6]. Table 1 shows the rounds and final utilities of all 8 traditional negotiations.

Round (traditional)	Utility A (Buyer) (traditional)	Utility B (Seller) (traditional)
10	0.77	0.61
8	0.77	0.78
6	0.80	0.69
9	0.76	0.76
8	0.70	0.73
6	0.75	0.78
8	0.78	0.69
8	0.72	0.72

Table 1: Rounds and Final utilities of Traditional Negotiations

Table 2 shows the rounds and final utilities of all 8 electronic negotiations.

Round (eNegotiation)	Utility A (Buyer) (eNegotiation)	Utility B (Seller) (eNegotiation)
8	0.75	0.59
6	0.75	0.76
3	0.78	0.67
4	0.73	0.74
2	0.68	0.70
5	0.72	0.65
4	0.70	0.72
7	0.76	0.69

Table 2: Rounds and Final utilities of Traditional Negotiations

Hypothesis Tests for Round (traditional) - Round (eNegotiation)
Sample mean = 3.0
Sample median = 2.5
Sample standard deviation = 1.85164
t-test
Null hypothesis: mean = 0.0
Alternative: not equal
Computed t statistic = 4.58258
P-Value = 0.002536
Reject the null hypothesis for alpha = 0.05.

The t-test tests the null hypothesis that the mean Round (traditional) - Round (eNegotiation) equals 0.0 versus the alternative hypothesis that the mean Round (traditional) - Round (eNegotiation) is not equal to 0.0. Since the P-value for this test is less than 0.05, we can reject the null hypothesis at the 95.0% confidence level (e.g., [7]). This proves that the number of rounds was significantly more in traditional negotiation as compare to electronic negotiation.

Hypothesis Tests for Utility A (traditional) - Utility A (eNegotiation)
Sample mean = -0.0325
Sample median = -0.025
Sample standard deviation = 0.0205287
t-test
Null hypothesis: mean = 0.0
Alternative: not equal
Computed t statistic = -4.47782
P-Value = 0.00287381
Reject the null hypothesis for alpha = 0.05.

The t-test tests the null hypothesis that the mean Utility A (traditional) - Utility A (eNegotiation) equals 0.0 versus the alternative hypothesis that the mean Utility A (traditional) - Utility A (eNegotiation) is not equal to 0.0. Since the P-value for this test is less than 0.05, we can reject the null hypothesis at the 95.0% confidence level. This proves that the Utility of Buyer was significantly higher in traditional negotiation as compare to electronic negotiation.

Hypothesis Tests for Utility B (traditional) - Utility B (eNegotiation)
Sample mean = 0.03
Sample median = 0.02
Sample standard deviation = 0.0447214
t-test
Null hypothesis: mean = 0.0
Alternative: not equal
Computed t statistic = 1.89737
P-Value = 0.0995912
Do not reject the null hypothesis for alpha = 0.05.

The t-test tests the null hypothesis that the mean Utility B (traditional) - Utility B (eNegotiation) equals 0.0 versus the alternative hypothesis that the mean Utility B (traditional) - Utility B (eNegotiation) is not equal to 0.0. Since the P-value for this test is

greater than or equal to 0.05, we cannot reject the null hypothesis at the 95.0% confidence level. This proves that in case of Utility of Seller, there was no significant difference between the traditional negotiation and electronic negotiation.

6. Conclusion

This paper describes study of electronic negotiation by studying the comparison of traditional face-to face negotiation and electronic negotiation through software agent. Also focus on the attributes of negotiation, which can be used for comparing two different negotiations. The current research aims to enhance the knowledge of using electronic negotiation via computer. Some of the issues that we plane to focus on in the future include, making it easier to define and implement electronic negotiation and negotiation software agents.

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