TACtic- A Multi Behavioral Agent for Trading Agent Competition

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Abstract. Software agents are increasingly being used to represent humans in online auctions. Such agents have the advantages of being able to systematically monitor a wide variety of auctions and then make rapid decisions about what bids to place in what auctions. They can do this continuously and repetitively without losing concentration. To provide a means of evaluating and comparing (benchmarking) research methods in this area the trading agent competition (TAC) was established. This paper describes the design, of TACtic. Our agent uses multi behavioral techniques at the heart of its decision making to make bidding decisions in the face of uncertainty, to make predictions about the likely outcomes of auctions, and to alter the agent's bidding strategy in response to the prevailing market conditions.

Keywords: Game Theory, Multi behavior, intelligent agents, online auctions, trading agent competition (TAC).

1 Introduction

AGENT-MEDIATED electronic commerce involves software agents acting on behalf of some or all the parties in e-commerce transactions [4], [6]. Here, a software agent is viewed as an encapsulated computer system, situated in some environment that is capable of flexible autonomous action in that environment in order to meet its design objectives [7]. The rationale for introducing such agents in e-commerce scenarios is to offer faster, cheaper, more convenient and more agile ways for both customers and suppliers to trade. As the agents represent distinct stakeholders and organizations, the *de facto* way in which they interact is through some form of *negotiation*. In human negotiations, two or more parties typically bargain with one another to determine the price or other transaction terms [2].

Given the potential and the importance of using agents in online auction settings, there has been considerable research endeavor in developing bidding strategies for different types of agents in different types of auctions (see Section V for more

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details). Therefore, in order to develop a means of comparing and evaluating this work, it was decided to establish an International Trading Agent Competition (TAC) (similar in spirit to other initiatives such as RoboCup,[3] RoboCupRescue[4] and the Planning Competition[5]). In this competition, software agents compete against one another in 28 simultaneous auctions in order to procure travel packages (flights, hotels and entertainment) for a number of customers (see Section II for more details of the roles).

2 Introducing Trading Agent Competition

In each TAC trading game, there are eight software agents that compete against each other in a variety of auctions to assemble travel packages for their individual customers according to their preferences for the trip. A valid travel package for an individual customer consists of: i) a round trip flight during a five-day period (between TAC-town and Tampa), and ii) a stay at the same hotel for every night between their arrival and departure dates. Moreover, arranging appropriate entertainment events during the trip increases the utility for the customers. The objective of each agent is to maximize the total satisfaction of its eight customers (i.e., the sum of the customers' utilities).

3 TACtic

Our design is quite different from other agents. TACtic has inherited its characteristics from 3 successful agents. RoxyBot, Attac-2000 and SouthamtonTAC are the agents that we have used. These agents are advantageous on different situations. TACtic uses a Probabilistic learning automaton with 4 different behaviors to achieve the best outcome. These behaviors are as follows and will be discussed in more details later on. In our implementation we use riskful, economical, computational, and prudent behavior.

TACtic uses Attac-2000's rules on risk averse agents and SouthamtonTAC's rules on airplane ticket division to split the competition into 5 different environments as shown. Table1 shows these environments.

Table 1. Different environments of tac that tactic uses

Plane Types / Number of Risk agents	Cat0	Cat1	Cat2	Cat3
1,2	4	3	2	1
3,4	5	4	3	2
5,6,7	6	5	4	3

TACtic uses the 6 mentioned environments with the automaton to learn which behavior is most suitable for different environments. The extended version of the paper fully discuses the states of the automaton.

This automaton tries learning what behavior works better for what environment. It increases and decreases the probabilities to converge to the right values. We believe

that the competition's environment is very dissimilar and it needs different behaviors to maximize its utility at different places. We will try to explain these behaviors separately.

Riskful behavior: The riskful behavior is actually pretty common in TAC. For buying airplane tickets in this behavior, we ask the allocator about our needs at the beginning of the game. Most of the plane tickets needed are bought without considering their price. After receiving the requirements from the allocator, the agents bids high enough to get the plane tickets.

Since the agent has bought most of the plane tickets required, it doesn't have much flexibility on hotel reservation. The agent bids high knowing that it needs to get a hold of these rooms. In this behavior the agent works out the maximum price in which the hotel is worth getting and uses that price to bid in the auctions. On entertainment goods, the agent knows exactly when each of its customers are arriving and leaving. This will make it much easier to decide on what to buy. The agent works like Attac-2000 on goods that he has but doesn't need them.

Economical behavior: This behavior is completely new in TAC. As far as our research goes, we haven't seen any agents that use this method. For buying airplane tickets, The agent starts looking through the airplane auctions. In this behavior buying is not done through a list, but everything that seems to have reasonable price is bought. Here the agent doesn't consider the problem of allocating the good, but fully concentrates on the prices in the auctions. Any plane ticket cheaper than $320 is bough immediately. After the fourth minute the agent uses the allocator before bidding in auctions.

For bidding in hotel auctions the agent needs to be active. The agent tries bidding on the 15 cheapest rooms which are atleast from 4 different auctions. For doing so the agent should have a sorted array of all of the auction prices at all times which is a simple algorithm but require a lot of time. In entertainment goods the same algorithm is used. The agent tries bidding on the cheapest goods of the market and sells its most expensive tickets. This procedure is carried out for 4 minutes. After that the agent uses the allocator to decide on its biddings.

Computational behavior: This behavior is based on prediction mostly. For bidding in plane auctions, the agent uses SouthamtonTAC's method which is actually very efficient [9]. For hotel auctions, Roxybots method of allocation [5] is used. For finding the maximum benefit that the room can have, we calculate our utility using Roxybot's allocation method once with and once without the room. The difference between these two numbers will give us the maximum benefit that the reservation of the room has for us.

In entertainment auctions, first each of the 12 tickets that we have, are valued the same way as hotel rooms values were found. Since 24 allocations should be done Roxybot's algorithm takes too long to use. We use the 100 arrangements [15] prepared by Attac-2000 which is reasonably fast. The same algorithm is used for buying goods. We calculate our utility with and without the ticket which will give us the value of the ticket.

Prudent behavior: This behavior is based on not committing to any plans for the future. The agent in this behavior buys a few airplane tickets at the beginning of

the game. These tickets will be bought from the two most popular auctions for the agent. Since the agent wants many tickets from these auctions, buying half of them at the beginning doesn't really bring much commitment.For hotel auctions, since the agent doesn't have any commitment towards any plan, it can choose from cheaper hotel rooms. Actually the agent starts making commitment by reserving low-priced hotel rooms.

At the beginning of the game the agent only buys goods for nights which it thinks more than 5 customers are on holiday. This way it doesn't face great risks in committing. The rest of the tickets are bought as game goes by and plans are made. Attac-2000 method for finding the right price is used.

The agent also has architecture and a way of allocating goods which due to space limitations will not be discussed here and will be given a longer version of the paper.

5 Conclusion and Future Works

This paper presents a successful application of multi behavioral acts in agent-mediated electronic commerce. It details the design of TACtic an agent that employs a range of techniques at its core. Specifically, it uses the advantages of different other successful agents to determine the type of environment it is situated in and then uses an adaptive bidding strategy to change its strategy depending on this assessment. TACtic has been shown to be successful across a wide range of TAC environments. Naturally the strategies that have been employed are tailored to the specific auction context of the competition. Nevertheless, we believe that the TAC domain exhibits a number of characteristics that are common to many real-world online trading environments. These attributes include a time constrained environment, network latency, unpredictable opponents, multiple heterogeneous auction types, and the need to purchase inter-related goods. Given this, we believe that a number of technologies and insights from our work are applicable in a broader agent-mediated e-commerce context and our future work aims to exploit these.

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