Managing e-Market Auction through Negotiable Attitudes

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Abstract

The online auctions are one of the most effective ways of negotiation of salable goods over the internet. To be successful in open multiagent environments, agents must be capable of adapting different strategies and tactics to their prevailing circumstances. This paper presents a software test-bed for studying autonomous bidding strategies in simulated auctions for procuring goods. It shows that agents' bidding strategy explore the attitudes and behaviors that help agents to manage dynamic assessment of alternative prices of goods given the different scenario conditions.

1 Introduction

The emergence of electronic market places has dramatically increased the opportunities for the online auctions (e.g. eBay, Amazon etc.). The agents can use different auction mechanisms (e.g. English, Dutch, Vickery etc.) for procurement of goods or reaching agreement between agents. The agent makes decisions on behalf of consumer and endeavours to guarantee the delivery of item according to the buyer's preferences. In these auctions buyers are faced with difficult task of deciding amount to bid in order to get the desired item matching their preferences. Intelligent agent technology provides a powerful mechanism to address complex problems such as dynamic pricing or negotiation. To this end, a number of researchers [5][6][7] have reported different frameworks that help an autonomous agent to tackle the problem of bidding in auctions.

Electronic market is means for agents to communicate and compromise to reach mutually beneficial agreements. In such markets, the agents have a common interest in cooperating, but have conflicting interests over exactly how to cooperate. The agents can mutually benefit from reaching agreement on an outcome from a set of possible outcomes, but have conflicting interests over the outcome that they prefer. This paper reports on my work in developing a bidding agent that has range of strategies that it can employ depending on the user's aim and the environment. In this paper, I present a method of executing behaviors in a multiagent dynamic world based on the concept of *attitude*. Attitude is a mental construct similar to that of commitment and intention. However, the notion of commitments as used in AI is too weak for agents solving problems in dynamic worlds. I propose that when agents are solving problems they must be guided by appropriate attitudes towards world objects and their activities. Thus, in my formulation, agents will adopt a definite attitude towards the bidding activity while performing that activity, even if the activity may not succeed in a dynamic world. The adopted attitude will guide the agent in responding to various different situations. Thus, ideally, agents in dynamic worlds like online auctions must adopt suitable attitudes while engaging in online activity. For this reason, we propose that agents inhabiting in such complex multiagent dynamic worlds, while solving problems must be holding appropriate attitudes towards their physical and mental activities.

2 Bidding Strategy

The bidding process has been long modelled using the tools of game theory, and these are now being used extensively in the development of software agents for automated negotiation. In such encounters, each agents has to make decisions about generating offers and counter offers in such a way that its own utility from the final agreement is maximised. An essential input to his decision making process is information; here defined as the knowledge about all factors which affect the ability of an individual to make choices in given situation. The bidder agent operates effectively in the marketplace, only if it possesses a strategy, which ensures that it can obtain the item within the given time in a manner consistent with the consumer's preferences. An agent's bidding strategy is the specification of the offers the agent plans to make during the auction. Before describing the decision-making strategy, it necessary to report briefly about my assumptions about the environment. My bidding agent is given a *deadline* by when it must obtain the desired item. It is also aware of the *start* and *end* time of the auction. Secondly it is also told the consumer's *private valuation* for a particular

item and it also has the consumer's *attitudes* towards the item.

In this paper, agents' attitudes are the ultimate component of the bidding strategy that decides about placing or accepting offers, making counter offers or withdrawing from auction. We say that, when agents are participating in an auction, they have appropriate *attitudes* towards main negotiable attribute that is price. Thus when an agent participates in an auction, an attitude prescribes how to perform precisely till the item is acquired or and the auction is finished. The agent's decision-making model that works behind the bidding strategy is summarized in the Figure 1. The bidder agent registers itself in a particular auction that sells the product, which it wants to buy. It then gathers relevant information about the auction i.e. the start time of auction, end time of auction and current bid values in that auction. It then calculates the *maximum bid* it is willing to make at a particular time in that auction. To determine the current maximum bid, the agent considers several bidding constraints including the remaining time left, the user's desire for bargain and user's level for desperateness. For each bidding constraint, there is a corresponding attitude that suggests the value to the bid based on the constraint at that time.

REPEAT

1. Get current bid value from server
2. Determine the bidder's attitude at that time.
3. Calculate the maximum bid it is willing to make based on bidding constraints
4. Submit bid to server

UNTIL auction finish

Figure 1: Overview of Bidding Agent's Decision Making Model

2.1 Definition of Attitude

Attitude is a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object [4]. But we define attitude as a predisposition to respond consistently in favourable or unfavourable manner with respect to a given object. In other words, the attitude is a preparation in advance of the actual response, constitutes an important determinant of the ensuing behaviour. However this definition seems too abstract for computational purposes. In AI, the fundamental notions to generate the desirable behaviors of the agents often include goals, beliefs, intentions, and commitments. Goal is a subset of states, and belief is a proposition that is held as true by an agent. Bratman [1] addresses the problem of defining the nature of intentions. Crucial to his argument is the subtle distinction between doing something intentionally and intending to do something. The former case might be phrased as deliberately doing an action, while intending to do something means one may not be performing the action in order to achieve it. Cohen and Levesque [3], on the other hand, developed a logic in which intention is defined. They define the notion of individual commitment as persistent goal, and an intention is defined to be a commitment to act in a certain mental state of *believing throughout* what he is doing. Thus to provide a definition of attitude that is concrete enough for computational purposes, we model attitude using goals, beliefs, intentions and commitments. From the Fishbein's [4] definition it is clear that when an attitude is adopted, an agent has to exhibit an appropriate behaviour (predisposition means *behave in a particular way*). The exhibited behaviour is based on a number of factors. The most important factor is goal or several goals associated with the object. During problem solving, an agent in order to exhibit behaviour may have to select from one or several goals depending on the nature of the dynamic world.

In a dynamic multiagent world, the behaviour is also based on appropriate commitment of the agent to all unexpected situations in the world including state changes, failures, and other agents' mental and physical behaviours. An agent intending to achieve a goal must first commit itself to the goal by assigning the necessary resources, and then carry out the commitment when the appropriate opportune comes. Second, if the agent is committed to executing its action, it needs to know how weak or strong the commitment is. If the commitment is week, the agent may not want to expend too much of its resources in achieving the execution. The agent thus needs to know the degree of its commitment towards the action. This degree of commitment quantifies the agent's *attitude* towards the action execution. For example, if the agent considers the action execution to be *higher importance* (an attitude towards the action), then it may choose to execute the action with greater degree of commitment; otherwise, the agent may drop the action even when it had failed at the first time. Thus, in our formulation, an agent when it performs an activity,

since the activity is more likely that it will not succeed in a dynamic world, agents will adopt a definite attitude towards every activity while performing that activity. The adopted attitude will *guide* the agent in responding to failure situations.

Also the behaviour must be consistent over the period of time during which the agent is holding the attitude. Thus attitudes, once adopted, must persist for a reasonable period of time so that other agents can use it to predict the behaviour of the agent under consideration. An agent cannot thus afford to change its attitude towards a given object too often, because if it does, its behaviour will become somewhat like a reactive agent, and its attitude may not be useful to other agents. Once an agent chose to adopt an attitude, it strives to maintain this attitude, until it reaches a situation where the agent may choose to drop its current attitude towards the object and adopt a new attitude towards the same object. I thus, define attitude as follows: *An agent's attitude towards an object refers its persistent degree of commitment towards achieving one or several goals associated with the object, which give rise to an overall favourable or unfavourable behaviour with regard to that object.*

2.2 Properties of Attitudes

We denote the attitude by **K,** thus $\mathbf{K}_A(x)$ denotes that an agent A has an attitude **K** towards the object x, where x can be either an agent or an object (physical or mental). The attitudes adopted by agents must exhibit three important properties: explicitness, evaluational consistency and persistence.

2.2.1 Explicitness

In a multiagent dynamic world, an attitude **K** that an agent A holds towards an object x, that is $\mathbf{K}_A(x)$, must be explicit. We define explicitness as follows:*An attitude **K** held by an agent A is said to be explicit if the agent A has the capability to inform other agents that it believes that it is (indeed) holding the attitude **K** towards x whenever it is holding that attitude.*Thus, according to this definition it is sufficient that agent A exhibits the above minimum communicative behaviour. If the attitude is implicit, then there is no way of finding out whether any such attitude exists at all, since the agent may not even have a name to refer to that attitude. Since the mental states are entirely local, the attitudes of one agent may not be entirely visible to another agent or *implicit*. An observer can at most observe the behaviors of the agent, infer a certain attitude, name it, and describe it to the other agents. In a multiagent world, a given agent A_1 will have to be constantly interacting with other agents, say A_2. This is the case not only in cooperative situations, but also in other noncoopertive situations as well (for example, competing, indifferent, etc.). In some simple cases, it may be possible for an observing agent A_2 to infer partial information about the mental states of A_1 (called mental state recognition).

2.2.2 Attitudes and Behavior

The attitude is typically viewed as a latent or underlying variable that is assumed to guide or influence behavior. The tie-up between attitudes and behavior can be noticed if one considers real life situations. For example, an individual agent with an attitude toward the victim in the fire world will help the victim on one occasion and pass without offering help on another occasion. Thus the totality of agent's attitude ultimately determines its overall behavior or the knowledge of an agent's attitude, therefore, permits prediction of one or more specific behaviors. The change in behavior is also linked with attitudes. The behavior of an agent changes if there is a change in attitude towards that behavior.

2.2.3 Attitudes and Persistence

The attitudes, once adopted by an agent A, must persist for a reasonable period of time so that other agents can use it to predict the behavior of the agent A. An agent cannot thus afford to change its attitude towards a given object every time it senses a change in the world, because if it does, its behavior will become somewhat like a reactive agent, and recognize that this attitude may not be useful to other agents in complex worlds. Thus, perhaps the most important requirement of an attitude is that it should be persistent for a reasonable period of time. This means, the agents' mental and physical behavior should be such that any other distractions that an agent is likely to face should be postponed holding on to the current attitude. For example, when the agent holds the attitude $\boldsymbol{important}_A(t)$, it has to engage itself in a behavior that conveys the meaning of this attitude. This is done by forming a set of intentions resulting in a set of commitments. Note that the set of intentions and commitments should necessarily include the persistence requirements of the attitude as well. Thus, if the attitude $\boldsymbol{important}_A(t)$ implies that a particular plan p has to be executed, then the agent will execute this plan overcoming the hurdles if any that the agent may face during the execution. To what extent the agent will venture to face the hurdles to achieve

the persistence is essentially included in the behavioral requirements of the attitude $important_A(t)$. Thus inherent in the attitude specification are the requirements for the persistence of the attitude as well. Once an agent chooses and adopts an attitude, it strives to maintain this attitude, until it reaches a situation where the agent may choose to drop its current attitude towards the object and adopt a new attitude towards the same object. Complex agents, before changing to new attitudes, may sometimes choose to vary the degree of attitude as deemed fit for the current environmental condition before entirely dropping it and adopting a new one.

2.3 Computational Model of Attitude

As discussed above, we understand that ultimately attitudes need to be translated into appropriate behaviors. We present a computational model in which we define that every attitude **K** towards an object x exhibits a behavior **beh** consisting of physical, communicative and mental actions. We represent the attitude **K** (x) using the following attributes:

Name of Attitude: This attribute describes the name of the attitude e.g. like, hate, cautious etc.

Description of Object: The description of the object contains the name of the object and a description of the internal organization in terms of the components of the object.

Basic agent behavior towards x: This attribute specifies the behavior that will be performed by the agent with respect to the object x.

Evaluation: This attribute specifies whether the attitude is favorable or not. If the beliefs of an agent are with favorable attributes, the attitude tends to be positive. Conversely, a negative attitude will result if the beliefs have primarily unfavorable attributes.

Concurrent attitudes: This attribute specifies any other attitudes that can coexist with this attitude.

Persistence of Attitude: This attribute specifies how long the attitude will persist under various situations. For example, it may specify how the attitude itself will change over time; that is, when to drop it and change it to another attitude, when to pick it up and how long to maintain it.

Type of Attitude: This attribute specifies whether the attitude is individual or collective.

All the attributes described above play an important part in the proper understanding of the agents' behaviors in a multiagent dynamic world. Without the knowledge of these attributes, the agent will not be able to respond appropriately to the various situations of the dynamic world.

2.4 Attitude Based Bidding Strategy

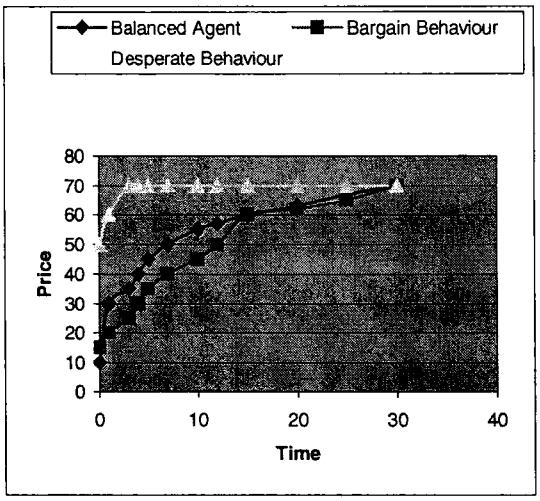

Figure 2: Different Bidding Behaviors

The agent's attitude can workout various strategies that are useful in different environments. Broadly the agent's decision making is dependent on its private valuation of the product, the remaining time left and the agent's behavior. The agent private valuation can be categorized by its value: low, medium and high. The agent's behavior can be categorized as *desperate*, looking for *bargain* and *balance* of both. At any given time, the agent may consider any of these bidding constraints individually or combine them depending on the situation. Figure 2 illustrates how these bidding constraints combine to produce to produce a bid value at a given time. The figure suggests how the agent should bid when a particular behavior is considered. For example, if the agent considers desire for a bargain as the only bidding constraint, it should start bidding at low value and slowly move towards its private valuation. On the other hand, balanced agent would start bidding at a reasonably high value and slowly reach its private value. The desperate agent would start bidding at a very high value and reach its private valuation very quickly.

To get comparative, as well as quantitative bidding value, three distinctive types of *attitudes* are considered (i) *high* attitude (A_{high}) (ii) *medium*

attitude (A_{medium}) (iii) *low* attitude (A_{low}). In case of *high* attitude, the degree of commitment of an agent towards a particular attribute or behavior is more than 80%. In case of medium attitude, the degree of commitment is between 60% to 80%. For the *low* attitude, the degree of commitment is very less (<60%). I have applied attitudes to various bidding constraints to lead to a strategy for current maximum bid at a particular time. To determine the current maximum bid I have considered four constraints: private valuation of item, remaining time left, the agent's desire for bargain, the agent's level of desperateness. For each bidding constraint, there is a corresponding attitude that suggests the value to bid on the constraint at that time. It is seen that by varying attitudes on bidding constraints, different bidding patterns can be generated.

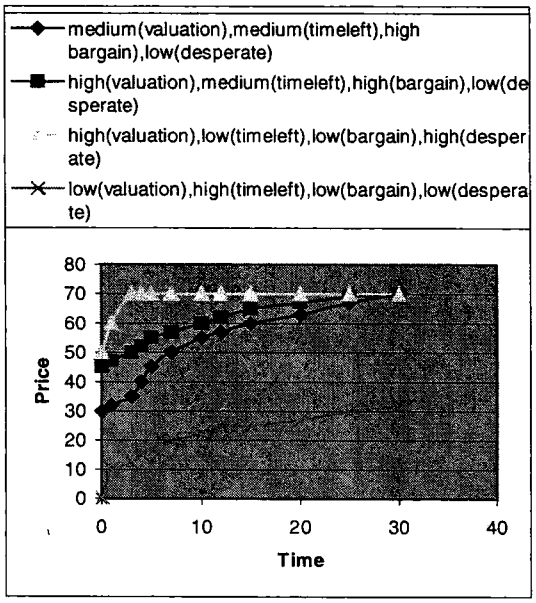

Figure 3: Various Combinations of Bidding Constraints

3 Experimental Evaluation

To evaluate the performance of my agent, I undertook an empirical evaluation to show that my bidding strategy performs effectively in a wide range of bidding contexts. In order to assess the robustness of our bidding agent, the experiments have concentrated on evaluating the performance of attitude-based agents in case of unexpected events. When a problem occurs, the attitude model stipulates a new set of behaviors for the agents. The agents with attitude respond to changes in the world by adopting a set of attitudes towards these changes.

We have tried to find the probability of success in case (i) agents having attitude- $A_{with\text{-}attitude}$ (ii) agents having no attitude $-A_{without\text{-}attitude}$ The performance of two types of agents is measured in terms of the rate of change of world and time taken to complete the task. Figure 4 shows the performance of agents in terms of their success rate. The success rate is defined as the number of times, as a percentage, the agent is successful in obtaining the item. The x-axis of the graph shows success rate in percentage, while the y-axis represents the time taken by bidder to acquire an item.

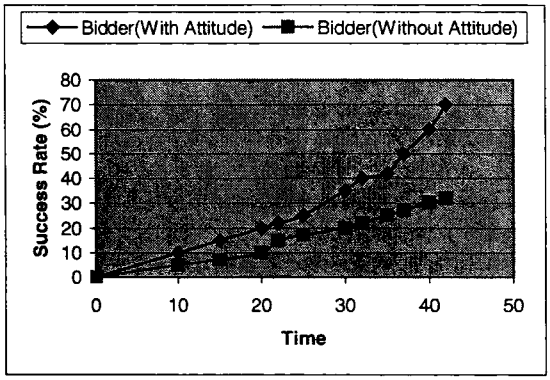

Figure 4: Success Rate Comparisons for agents with or without Attitude

We also found that success rate in case of attitude-based agents are more, while in case of non-attitude based agents is less. The attitude-based agents performs better than the non-attitude based agents, because attitude based agents can easily adapt themselves to newer situations and have better tools to calculate bid prices appropriately.

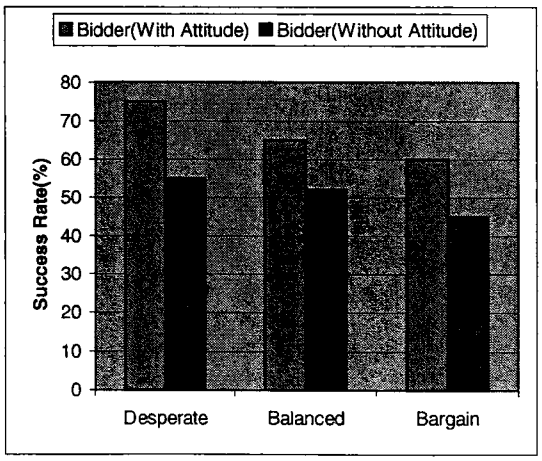

Figure 5: Success rates of Desperate, Balanced and Bargain agents

Figure 5 show the success rate for the three agent behaviours i.e. desperate, bargain and balance. It can be seen that agent's with attitude achieve high success rate as compared to the agents without attitude. This shows that bidders with attitude have

strategies to choose from as compared to agents without attitude.

4 Related Work

Recent work in the field of artificial intelligence has introduced the possibility of creating autonomous bidding agents to participate in auctions. In particular, the first trading agent competition (TAC) was held in Boston in July 2000 [8]. TAC agents acted as simulated travel agents and had to procure goods for their clients in different types of auctions, bidding against autonomous agents. Priest et al. [7] proposed an algorithm design for agents that participate in multiple simultaneous English auctions. The algorithm proposes a coordination mechanism to be used in environment where all the auctions terminate simultaneously, and a learning method to tackle auctions that terminate at different times. Byde et al. [2] presented another decision theoretic framework that an autonomous agent can use to bid effectively across multiple auctions with various protocols. The framework uses an approximation function that provides an estimate of the expected utility of participating in the set of future auctions and it can be employed to purchase single or multiple items.

5 Conclusions

In this paper, the effectiveness of attitude-based agent bidding behaviours are discussed. It was noticed that attitude based agents outperform the agents without attitude. Agents which adopt attitudes behave more flexibly and efficiency than agents without attitude and adapt more easily to dynamic situations. I would further like to explore the development of strategies for multiple auctions. I would also like to compare my method with other decision theoretic approaches to determine the relative strengths and weaknesses of the these methods.

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