Agent-based Auctions

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Abstract

This paper discusses the technical challenges, business implications and research issues of agent-based auctions.

1. Introduction

The arrival of the World Wide Web has made the Internet a ubiquitous communication and application medium, over which many electronic markets have emerged, and various electonic market mechanisms and automation technologies have been introduced. Agent technology is becoming the dominant automation enabler due to its promise of personalization, information discovery, and 'intelligent' trading via a combination of learning and negotiation capabilities.

2. Agent-based Auctions

Among the different e-market mechanisms, auctions have attracted the most attention. Partly we can attribute this to the fact that most people are intrigued by the dynamics of real-time price determination, and perhaps also by the satisfying sensation of getting an apparent bargain or outbidding others with a seemingly superior strategy. I would argue, however, the possibility of automating the auction process using technologies such as agents is going to be the main driving force for its future acceptance [6].

Electronic auctions are formalized communication procedures in which the traders' interaction is governed by specific auction rules [2]. Usually, the auctioneer functions as an intermediary or agent for the sellers, but this does not have to be the case. The auction rules vary according to the trade objects and trade rules. Auctions are particularly suitable for those objects whose values are undetermined and cannot be priced directly -auctions offer an efficient mechanism in determining market prices. However, relatively fixed-priced objects can also be traded by simple one-sided auctions. In such a case, an ordinary e-commerce transaction can be seen just as a special case of an auction.

2.1. Challenges

In order to automate auctions with agent technologies, in addition to a thorough theoretical understanding of the dominant strategies (if they exist) under different auction forms and rules and their underlying assumptions [3], there are two major technical challenges:

- A uniform platform supporting various auction format and rules [4], and also the vast variety of (externally and individually designed) auction strategies;

- A mechanism for capturing users' preferences on private valuations, time sensitivity, and risk characteristics; and their strategies including the change of risk characteristics as a function of the signals (e.g. bidding behavior) from others.

The forms and rules of auctions vary considerably. Crucial variables consist of open or sealed, price ascending or descending, one-sided or double (hence mechanisms for setting settlement-price), single or multi-unit (hence simultaneous or sequential), and so on. A generic interactive protocol capable of encapsulating all these varieties that also allows for extension is vital. In auctions the initiating agents have the right to choose and design the forms and rules of the auctions, which do not necessarily belong to any previously known auction formats. Thus, designing a generic platform and protocol capable of supporting a wide class of auction forms is one of the most challenging aspects in agent-based auctions.

As in electronic auctions and e-commerce, agents represent different real world entities such as different companies, self-interest prevails. These agents cannot be assumed to use *centrally* designed strategies, but instead, they will attempt to find a strategy that maximizes their utility. Therefore, the auction platform must allow externally designed agents (or at least their strategies) to participate in the process. Technically, this is much more than simply having an interoperable standard. As most users are probably not interested in designing the agent *per se* but only in their strate-

gic reasoning, the problem so becomes of how to 'open' the agent to incorporate user-defined strategies dynamically.

Moreover, designing optimal strategies *off-line* is difficult enough[1], but realizing and modifying strategies in agents *on-the-fly* as auction proceeds may prove to be cognitively and technically too demanding for average users. To facilitate agent-based auctions, mechanisms to capture users' strategies conceptually and then automatically realize them dynamically in agents are important. This is analogous to finding out all users' moves in an extensive formed game. The key could be how to capture a (small) number of strategic decisions based on users' direct and indirect utilities [1] in the whole auction process, and be able to extrapolate them using general preferences and risk characteristics to every decision point. In other words, we need a mechanism to generate utility function automatically for the users. It will be even more complicated if risk characteristics are a function of signals of other agents, auctions, and markets.

Similarly, strategies themselves can also be a function of signals of other agents, auctions and markets. Complex as it may be, such multi-auction correlation and affiliation in strategies would be crucial in agents if they were to engage in more than one auction simultaneously. This is especially so if these auctions are not independent or agents are subject to budgetary constraints.

2.2. Implications and issues

Such opportunistic behavior could have profound implications on the market prices. As agents are much less expensive to look for opportunities (e.g. mispriced objects) and be more capable to exploit these opportunities through engaging in multiple auctions, the law of one price (i.e. market consensus price) could be more readily enforced by agent-based *arbitrage*. Price differentials in (homogeneous or correlated) objects would be subject to unprecedented imbalance of supply and demand, and eventually converge.

When agents with such capability become a reality, margins to suppliers would be reduced significantly. Inefficient suppliers may not survive, resulting in a market with much fewer suppliers than before. One possible scenario is that monopoly or oligopoly would then arise, driving up prices and hence margins. This begs the question of whether suboptimal strategies should be allowed so that in the long term more competition would remain. This is, however, not stable. Could trading relationships and loyalty offer the stability? Is it plausible that utility depends not only on prices but on previously established relationships too?

Should long-term relationships become a factor, then

auctions are no longer independent with one another but interrelated - and equilibrium strategies in independent auctions may not be optimal in *sequential auctions* [5]. What then are the issues in designing optimal strategies?

Traditionally, all auction transactions are binding. In agent-based auctions, under some circumstances such as more profitable opportunities are discovered or new information updates private valuation, previous auction deals may no longer be optimal. Should agent-based auctions allow the options of re-negotiation or even withdrawal on penalty? How should these options be priced?

3. Conclusion

We have discussed a number of challenges in agent-based auctions and their possible implications. We have also raised certain issues that require further research. As business transactions are increasingly reply on the use of electonic media and softwares with sophisticated features, agent-based e-commerce and auctions are believed to be the logical consequence.

The introduction of strategic behavior in agents would ultimately alter the way that softwares are designed and that companies operate. Firstly, it provides a computational testing-ground for game-theoretic and auction-theoretic tools. Secondly, it requires a fundamentally different software architecture whereby behavioral characteristics can be incorporated dynamically. Furthermore, with agents most companies would be able to conduct transactions in mechanisms most appropriate for their business characteristics, the market would then become more efficient.

Clearly there is incentive for businesses to conduct agent-based e-commerce or auctions, it is only a matter of time for agents to become the mainstream tools for business coordination. And I believe that competition will make their arrival very imminent.

References

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[1]According to auction and game theory, optimal strategies are usually found only in some auction formats and only under certain assumptions such as symmetry, risk characteristics, and existence of independent information. Furthermore, all players are assumed rational.