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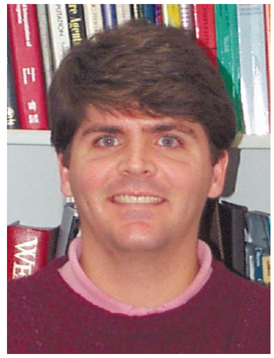

ONLINE AUCTIONS

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"Going once…going twice…[*bang*]. Sold to the agent on LAN124.56."

Our agent just bought the suit of medieval armor we had been searching for and paid for it with the proceeds from the sale of our antique radio. The agent had been monitoring several online auctions and began bidding when the armor became available. Our agent's winning bid quickly brought to a close an intense bidding war among 42 agents scattered across the country. All it has left to do is contact a shipping agent to have the armor delivered.

Auctions can involve not only consumers, but also businesses. An auction might be an ideal way for a business to sell excess inventory. Auctions can form dynamically and enable the exchange of goods much as stock exchanges manage the buying and selling of securities. But because auctions have a wide scope and a short lifetime, the opportunistic behavior needed for successful interaction requires agents to both participate in and manage auctions.

Types of Auctions

Over the years many types of auctions have been developed to satisfy different requirements. The most familiar is the first-price, open-cry auction, also known as the English auction. The auctioneer asks for progressively higher bids and closes when no one is willing to exceed the current bid. The winning buyer (highest bidder) then pays the amount bid to the seller in return for the item. Typically, the auctioneer receives a small percentage of the sell price.

Other types of auctions include the first-price, sealed-bid auction, where each buyer submits only one bid in a sealed envelope; the second-price, sealed-bid (Vickrey) auction, where the buyer pays the second-highest bid price; and the Dutch auction, where the price descends from a sufficiently high number until someone states a desire to buy at the current price.

First-price, open-cry auctions are often preferred because sellers are not required to reveal their true valuations. Buyers, however, are encouraged to speculate about each other's reservation price. Dutch auctions can conclude more quickly by lowering the price at a faster rate, but they also encourage speculation. In a second-price, sealed-bid auction, the buyers' best strategy is to bid (and thereby reveal) their true valuation. They must also trust the auctioneer to reveal the correct second price.

Each auction type has advantages, depending on the values placed on buyer/seller privacy, time to closing, avoidance of speculation, fairness of the final sale price, and so on. Most current Internet auctions, such as eBay and OnSale, use the English auction, since their primary goal is entertainment, delivered in the form of buyer speculation.

A Bid for Position

Users employing search engines to locate relevant Web sites don't always realize that those appearing at the top of the resulting list may have purchased this prominent position. At GoTo.com, content providers bid to be listed earlier (first) on search lists. If one bids 6 cents a hit to be listed first, it stays in that position until another bids 7 cents a hit. Providers pay their bid amount each time someone uses their link.

AltaVista is also arranging for providers to bid for placement on the search results that it returns. If you're a consultant on the Y2K problem and you'd like to be listed first when a user searches on the keyword "Y2K," then you would try to be the highest bidder for this keyword. At AltaVista the minimum bid is 25 cents, and you would pay this every time a search result listed you near the top.

Right now, list preference auctions are held just once, and no software agents are involved. This makes it difficult for new businesses to get listed in favorable positions. In the future, however, the bidding might occur much more frequently, with providers essentially bidding for top position on each user's search request. Such an arrangement would require agents to both manage the bidding and represent each of the bidders.

User Agents at the Ready

Because online auctions can occur at any time, our agents must be alert to the appearance of items that we might wish to buy. They need to know not only our interests, but also the value we attach to items and how much we would be willing to pay or what we would be willing to trade.

The Tete-a-Tete (T@T) system implements shopping agents that embody a user's preferences over a number of attributes such as price, warranty, color, and so on. These agents then negotiate transactions with seller agents on the user's behalf. A deal closes when both agents are satisfied.

While T@T implements complex value trade-offs, other, simpler agent-like interfaces exist for the popular online auctions. For example, OnSale

System of the Bimonth

An interesting agent-based online auction is the AuctionBot at http://auction.eecs.umich.edu. AuctionBot is a multipurpose Internet auction server developed at the University of Michigan. Use the AuctionBot to create automated Internet auctions according to your specifications, or bid in existing AuctionBot auctions. Check it out!

Web addresses for other online auction sites discussed in this column can be found at:

eBay • www.ebay.com
eCo • www.commerce.net/projects/currentprojects/eco/
Moai Technologies • www.moai.com
OnSale Inc. • www.OnSale.com
Tete-a-Tete • ecommerce.media.mit.edu/tete-a-tete/
UMDL • www.si.umich.edu/UMDL/

Web addresses concerning bidding for search-list position are

AltaVista • www.doubleclick.net/advertisers/altavista/why.htm
GoTo.com • www.goto.com/d/about/advertisers/

has a proxy agent called BidWatcher that automatically bids on the user's behalf. The user tells it the maximum price he or she is willing to pay, and BidWatcher bids the minimum price possible to win the auction without exceeding the user's maximum. Similar interfaces exist for other online auctions.

As online auctions gain popularity and transition from purely recreational pursuits to more mission-critical functions, we should expect to see smarter, more complex user agents.

A "Fair and Secure" Site

Online auctions must be both fair and secure. They should not let users or agents manipulate the auction to their own or anyone else's advantage. They should preserve the participants' confidentiality and ensure that all transactions are private and completed successfully. Also, they should enable low overhead by limiting both added cost per transaction and additional procedural complexity.

Businesses can set up their own auctions using software such as Moai's LiveExchange Auction Server, which manages auctions among designated bidders. LiveExchange 2.2 can implement most of the major auction formats, such as English and Dutch, and augments these with features such as close-time bidding (to allow last-minute bidding) and reserve pricing. CyberCash is used for credit card validation and SSL (Secure Sockets Layer) for secure connections.

Emergent Standards

For agents to participate in online auctions, relevant protocols should be well defined, probably based on speech acts, and should be supported by agent communication languages such as KQML and FIPA's ACL. Adopting a language with precise semantics will make it easier for agents to communicate without misunderstandings. A communication standard will also foster expansion of agent-based commerce.

Currently, there is a lot of interest in the XML standard. While XML does not provide electronic commerce tags or other semantics, several companies and industrial consortiums, such as eCo, have proposed competing XML-based commerce protocols.

It is not yet clear which protocols will become accepted standards. Agent communication languages have strong semantics and will likely lead to more robust agent systems. However, timing and market forces may make a simpler, XML-based electronic commerce protocol the de facto standard.

Open Market on Information

Auctions can be used not only for goods and services but also for information. Consider, for example, a system developed as part of the University of Michigan's Digital Library effort.[1] The UMDL implements an open market in which information providers, such as publishers, can sell their goods to individual consumers. The system is composed of collection interface agents (CIAs), user interface agents (UIAs), mediators, and facilitators. CIAs provide an interface between the publishers' databases and the UMDL. UIAs provide an interface between a user, or a user's browser, and the UMDL. Mediators match buyers with sellers, while facilitators handle the economic infrastructure.

Almost all UMDL transactions have an associated dollar value and are facilitated by auction agents. For example, when a user issues a query, his UIA first finds an auction agent that is advertising the correct type of mediator agents—those that can answer the query. The UIA bids in this auction for mediator service. Once the auction clears, the query is sent to the winning mediator for processing. The mediator in turn might also use an auction to find the services it needs. Once suitable documents are identified in particular collections, the CIAs responsible for them are paid, using some third-party payment mechanism, and the documents are sent to the UIA, which forwards them to the user.

The UMDL implements, in its own microcosm, a working model of the envisioned worldwide electronic commerce infrastructure. It showcases both the power and the drawbacks of using automated auctions. Research results[1] show that these auctions serve as effective load balancers. For example, when one agent crashes or bogs down from a heavy load, the flow of

queries is automatically directed toward underemployed agents, because they can offer lower prices. On the other hand, the use of auctions adds an extra layer of overhead to the system, which sometimes increases response time.

The "Invisible Hand" in an Agent Economy

If we are going to have online auctions with agents buying and selling items automatically, we should first stop and think about such a system's dynamics. In a market system populated by rational humans, Adam Smith's "Invisible Hand" tells us that the price of goods will approach their marginal costs.[2] However, the Invisible Hand refers only to traditional markets as defined by economists. In such markets, each product of a given type is indistinguishable from others of the same type, there is a sufficient number of parties involved, and the parties act to maximize profit.

In an economy of agents, some of the necessary conditions for a competitive market may not be met, and prices will not reach the equilibrium point. For example, a buyer agent may be unable to reliably assess the quality of a purchased service, as Vidal and Durfee indicated in relation to the UMDL.[3] Sellers take advantage of this scenario by providing lower quality services. More complex buyers might then retaliate by modeling the sellers' behaviors. Sellers might in turn build models of the buyers' models of the sellers' models, and so on. This situation leads to an escalation of modeling levels and to price dynamics not seen in human auctions.

Another possibility is building agents with myopic decision functions that maximize only the agents' immediate payoff. Kephart et al.[4] studied such a scenario and found that these systems could lead to continual price wars. Rather than settling on an equilibrium price, the agents would underbid each other until the price became too low, at which point they would start the price war again but at a higher price.

These examples warn us that the price dynamics of market systems composed of software agents will not always be the same as those of market systems composed of human agents. We must be careful when choosing the auction types, protocols, and agents that will populate the future online auction landscape. ■

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