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# Bidding Agents in Online Auctions: What are they doing for the principal?

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## ABSTRACT

Online auctions were the most notable survivors of the ‘Internet Bubble Burst’ phenomenon that hit e-commerce related businesses at the turn of the millennium. With most online auctions lasting between 1 and 9 days, not all bidders have the time to monitor the progress of an auction for such long periods. In addition, many bidders in online auctions are new to the bidding game, leaving them at a disadvantage in the bidding process. Bidding agents that can place bids in the absence of a bidder can ameliorate the deficiencies of this mercantile process. In this paper we review the various bidding agents presently used by various auction houses and classify them based on their characteristics. We critique the bid composition process of bidding agents and the incentives for bidders to use them. We also contrast the functionality of existing online bidding agents and proposed theoretical models.

## Keywords

Bidding agents, online auctions, sniping, e-commerce, third party agents

## INTRODUCTION

As an effort to add value to the online auction mercantile process, online auction companies provide access to automatic bidding agents and auction management software for participating clients’. Initially, the development of automated bidding agents was aimed at providing bidders in online auctions with participation options that would potentially reduce the opportunity cost of participating in online auctions. This was appealing because the online auctions tended to take longer than their traditional counterparts, and thus, the opportunity cost of participating in online auctions was high. However, as the size and popularity of the online auction market grew, the complexity of participating in online auctions increased. For example, simultaneous auctions with substitutable items are commonplace, and bidders have an incentive to leverage the performance of one auction to another in their favor. Intelligent bidding agents that are capable of maximizing bidders’ participation utility in such complex market environments have become a virtue.

In this paper, we take stock of bidding agents that are currently being used on various online auction sites. We study the services they provide as well as their design. We provide a classification of bidding agents for online auctions. The classification identifies three distinct classes of bidding agents: Auction Site Bidding Agents (ASBA); Third Party Hosted Agents (TPBA), and Desktop Bidding Agents (DTBA). We list examples of agents currently found in each of these categories and provide a summary of the services that each agent provides. Finally, we analyze the different bidding agents and make proposals for their improvement. Our classification and analysis of the bidding agents is based on economic theory of incentive alignment (Ba, Stallaert, Whinston, 2001; Ito, Hattori, Shintani, 2003).

In the rest of the paper we review pertinent literature, identify the various features and the services offered by the bidding agents, classify them based on the service providers and provide insights and critique in to their working.

## LITERATURE REVIEW

Bidding agents for online auctions were initially developed to replace fairly procedural bidding functions. With the increased use of online auctions as a mercantile process, the need for more sophisticated bidding agents that mimic real bidders has become apparent (Gregg and Walczak, 2003). In an experimental game that tested the performance of different bidding agents (Greenwald and Stone, 2001) the best scoring agents had aggressive bidding strategies and risk in their portfolio management. This experiment indicates that bidding agents will need to incorporate information processing capabilities that build up a knowledge base enabling bidders to intelligently deviate from a price takers strategy, where the markets sets a price for the product and the bidder is not in a position to influence it.

A competitive bidding agent that uses private information in bidding, a price modeling agent that uses the price histories in determining its bidding strategies, and a bidder modeling agent that uses the bidding histories of other bidders in determining its own bidding strategies have been modeled (Hu, Reeves, Wong, 1999). Their findings on the performance of these bidding agents show that good agents will have to utilize multiple strategies that require different sources of data.

There are numerous examples in the literature of bidding agents that are able to learn from the auction environment (Viet and Czernohous, 2003; Dumas, Aldred, Governatori, Hofstede and Russell, 2002; Jalali-Sohi and Malkewitz, 2001). These studies utilize Bayesian networks to represent the auction information and provide different applications of the acquired knowledge in the creation of bidding rules and strategies for automated bidding agents. We find a big gap between the current practice in the implementation of bidding agents and the proposed theoretical models.

Most of the literature on bidding agents has focused on agents that participate in single auctions. However, online auctions have been observed to occur simultaneously. That is, it has become common place to identify more than one auction for a similar or substitutable product running at the same time. One common bidding strategy in such situations is to hedge the participation in one auction to the performance of another auction (Plott and Salmon, 2004; Anthony, 1999).

Finally, we would like to highlight the importance of human agent inter-play in the bidding environment. While most of the studies that model bidding agents assume that bidding agents will be competing against other bidding agents, typical online auctions entertain participation from both bidding agents and human bidders. This interplay of agents and human beings infuses additional complexities to the auction agent design (Garcia, Lopes, Bentes, 2001).

## CURRENT STATE OF BIDDING AGENTS

We turn our attention to the current state of bidding agents for online auctions and discuss their features and services. The bidding agents list was compiled through online search and message board browsing on auction houses<sup>1</sup> and sites that provide downloads of freeware, shareware and trial software for auctions<sup>2</sup>. We identified the various features and services that these agents provide to the bidders and classified them in to three groups based on the service provider.

### Features and Services of Bidding Agents

All bidding agents require some start-up steps to be undertaken by the bidder. The most important step is to choose the maximum bid value. The maximum bid serves as a reservation bound on a bidder's willingness to pay. Bidding agents continuously submit a bid on behalf of the bidder, whenever the bidder is outbid and the winning bid is below the reservation price. This iterative process continues until the participating bidder has either won the auction or the bid is above his reservation price.

This basic service of incremental bidding provided by the bidding agents is supplemented by a variety of additional services at different levels in different bidding agents. In this section we describe the services provided by different agents, and later provide a classification of bidding agents.

1. **Continuous Automatic Bidding:** When the bidder chooses the bidding agent as a proxy, the agent takes over the bidding responsibilities by continuously ensuring that the bidder is winning the auction at the lowest possible winning bid. All the identified participants participate by submitting the minimum required bid below the reservation price.

<sup>1</sup> [www.ebay.com](http://www.ebay.com); [amazon.com](http://amazon.com); [auctions.yahoo.com](http://auctions.yahoo.com); [ubid.com](http://ubid.com);

<sup>2</sup> [www.ebaysoftwarereview.com](http://www.ebaysoftwarereview.com)

2. **Max-Price Retraction:** Max-Price retraction is defined as the feature of an auction agent, which would either allow or restrict the users from changing their maximum price limit (the reservation price or the maximum willingness to pay). Since the length of online auctions varies between a few hours to up to ten days, the bidder's ability to modify his reservation price over time is significant. All the auction agents allow a user to modify the max-price limit anytime during the auction as long as the new revised reservation price is above the current bid.
3. **Sniping:** Sniping is a bidding strategy where bidders wait until the final moments of the auction to place their bid. When the auction duration is fixed, this strategy maximizes the bidder surplus since counter bids from competing bidders will be time barred by the auctioneer.
4. **Automatic Feedback:** This is feature of convenience provided by third party bidding agents that allow a bidder to track winning auctions and consequently leave feedback for the seller. The agents prompt the user to leave feedback whenever they are used thus reducing the chances of the user overlooking feedback submissions, which has led to the other party in the transaction leaving negative or neutral feedback for the user being a poor communicator.
5. **Automatic notification of Winning or losing bid:** Automatic notification is a feature of bidding agents that communicates the results of an auction with the bidder, using alternative modes of communication like e-mail. Two messages commonly communicated; (i) when the bidder is losing and the auction price exceeded the bidder's reservation price; and (ii) when the auction closes, the agent sends a message informing the bidder of the auction outcome.
6. **Feedback Filter:** Many sellers on auction houses like eBay and Yahoo have feedbacks running into thousands, which makes it difficult for bidders to go through each page searching for the negative and neutral feedbacks. Many third party automatic bidding agents help the bidder overcome this problem by gathering and displaying the neutral and negative feedbacks about the seller, thus giving the bidder insight into particular problems that others had with that seller.
7. **Multiple Auction Monitoring:** The agent could be configured to monitor multiple auctions for a substitutable item and participate in one auction at a time. It would stop its monitoring as well as participation in the other auctions when the bidder has won one of the auctions below his reservation price.
8. **Usage cost:** Agents provided by the auctioneers are free and the users are encouraged to use bidding agents for participating in auctions. Third party agents charge a fee as monthly subscription (Powersnipe.com, Auctionsniper.com) or commission or percentage of the winning bid (eSnipe.com) or one time software licensing fee as is the case of most desktop bidding agents (Cricket Jr., Auction Sentry etc...).
9. **Shill-Bid Activity Detection:** Shill bidding is the process where the auctioneer's proxy participates in the auction to drive the price up. Some of the third parties bidding agents provide options to bidders to search all the previous and current available auctions of a seller, looking for suspicious activity like a single bidder bidding in many of the sellers' auctions indicating possible shill-bid activity.

### Classification of Bidding Agents

Intelligent E-Commerce Agents as described by Wagner and Turban (2002), present a broad variety of agents that have been classified or organized based on the functions they perform like search, buy, sell, and negotiate. Wang (1999) broadly classifies the functions that need to be supported in E-Commerce in to eight distinct categories, which in turn are accomplished, by an individual or a group of Intelligent Agents. They have also been organized in to three distinct groups by Maes et al. (1999) depending on the functions they perform in the CBB (Consumer Buyer Behavior), with each group corresponding to one of the stages in CBB (Product Brokering, Merchant Brokering and Negotiation). Hendler (1999) also attempts a general classification of the agents by function in to Problem-solving agents, User-Centric agents, Control agents and Transaction agents. In this paper we look at the bidding agents and attempt to classify the existing bidding agents based on their functionality and service provider, which are critical for buyers surplus maximization and auctioneer revenue maximization. Even though each bidding agent has a distinct advantage in comparison with the other group, we will try to analyze each type based on whose advantages outweigh the others.

The current online auction market place is being serviced by bidding agents that fall in three distinct categories. The first category is made up of agents that are owned and operated by the auctioneers. We refer to these as Auction Site Bidding Agents (ASBA's). These agents require bidders to indicate the maximum price that they are willing to bid in an auction. Some online auctions call it the bidder's reservation price. If a bidder's reservation price for an item is higher than the current winning bid, the auction site provides the bidder with the services of a bidding agent that continuously bids on user's behalf. Each time that a bidder is outbid, the bidding agent submits bids that conform to the auctioneers minimum required bid. This process repeats until the auction closes or the bid value is higher than the bidder's indicated reservation price.

Agent Name (Web Site)	Features/Services Provided by Agents (1– 9)								
	1	2	3	4	5	6	7	8	9
Ebay								Free	
Yahoo								Free	
Ubid								Free	
Amazon								Free	

**Figure 1: Services Provided by Auction Site Bidding Agents<sup>1</sup>**

Based on the services described under Features and Service of Bidding *Agents*, ASBA's provide bidders with continuous bidding (1), automatic notification of change in auction status (5), and capability to monitor multiple auctions (7). Even though these agents are free to use, they restrict the bidder's ability to lower his/her reservation price once submitted, even if it is above the current winning bid.

The second class of bidding agents is the Third Party Bidding Agents (TPBA). These are independent dedicated web servers that run or parse the software agents that bid on behalf of the auction participant. They function independent of the auction houses and have no affiliation with them. All except one among the TPBA's, service bidders participating on eBay.com alone. Perplexed by this lack of third party bidding agents for other auction sites, we contacted a service provider (www.sniperight.com), who explained that only ebay.com has enough bidder volume for the development of a bidding agent to make economic sense. The exception was eSnipe that provides services for bidders on both eBay and Yahoo based on custom requests. Figure 2 below, summarizes the services provided by the different agents that we found in this class.

From the table below we can see that all the TPBA's provide services for Continuous Automatic Bidding (1), Maximum price retraction (2) and Sniping (3)<sup>3</sup>. Automatic Notification of winning or losing bid (5) and Multiple Auction Monitoring (7) are provided by all the TPBA's except eSnipe, which we found out to be a basic sniping service for eBay and Yahoo with out any other features that other TPBA's provide. Among the TPBA's, Bidnapper and PhantomBidder provide the most comprehensive set of features and services that that includes Automatic Feedback (4) and Feedback Filter (6). All the TPBA's charge a fee from the user based on the final auction winning price or monthly subscription for the usage of their services. It is also important to mention that the commission that these agents charged the user for winning the auction was not significant and generally was capped between \$5 and \$10.

The last class of bidding agents is the Desktop Bidding Agents (DTBA). These agents reside on the bidder's computer and retrieve auction information from the auction site. The current DTBA's use what is popularly called scraping approach (requiring a separate script for retrieving information from each auction house) to communicate with the auction house. We observed that the service providers have generally been reliable in providing software upgrades based on changes made by the auction house to its standards.

The DTBA's provide most of the features and services that other bidding agents provide. One of the often cited drawbacks of the DTBA's by their competitors is that the bidder has to leave the computer turned on and connected to the internet the whole auction time. Some of the DTBA's try to overcome this drawback by designing their agents to be able to connect to the internet a few minutes before the auction ends and start bidding on the item. Even though this counters part of the argument of the competitors, it still does not overcome the problem of the bidder remembering to turn on the computer before the auction. The DTBA providers charge users a one time licensing fee or a yearly fee for their use. All the DTBA's observed here provide most of the services listed with the exception being Bidslayer.

<sup>3</sup> Even though all of the TPBA's give the option of retracting the maximum bid limit, they restrict this option to a few minutes before the auction.

Agent Name	Features/Services Provided by Agents (3.1.1 – 3.1.9)									Target Site
	1	2	3	4	5	6	7	8	9	
Auction Sniper								% Winning Bid		eBay
eSnipe								% Winning Bid		eBay, yahoo
Bidnapper								Subscription Option		eBay
Phantom Bidder								Fixed Price/ Winning bid		eBay
Powersnipe								Subscription Option		eBay
Bidslammer								% Winning Bid		eBay

Figure 2: Services Provided by Third Party Hosted Bidding Agents

Agent Name	Features/Services Provided by Agents (3.1.1 – 3.1.9)									Target Site
	1	2	3	4	5	6	7	8	9	
Cricket Jr.								Fixed		eBay
Auction Sentry								Fixed		eBay
Bidslayer								Fixed		eBay
Sniperight								/Year		eBay

Figure 3: Services Provided by Desktop Bidding Agents

## INSIGHTS AND CRITIQUE

Bidding agents will continue to play a central role in the online auction business. Although their model has evolved in tandem with technological developments of the internet infrastructure, our research on existing auction bidding agents shows that developments in this budding industry still lag behind the theoretical proposals of bidding agents that have been advanced. In this section, we provide insights into some of these differences, their causes, and propose remedial measures to overcome this difference. We discuss these insights under (i) auctioneer incentives to support bidding agents; (ii) diversification of bidding strategies; and (iii) intermediation incentives.

### Auctioneer Incentives to Support Bidding Agents

The dominant players in the online auction market have a significant impact in the success of supporting innovations, such as bidding agents. We have seen that the ASBA's have flourished, mainly because they have the blessings of their parent auction sites. However TPBA's and DTBA's, where we believe the future lies, are struggling to interact with auction sites. The development of integration standards and protocols for third party agents is a crucial cooperative initiative that is required of online auctioneers in order to create an enabling environment for the development of online auction bidding

agents. Although such standards and protocols are required, they will open up both challenges and opportunities we discuss here. Our analysis indicates that the incentives for supporting online bidding agents, especially third part bidding agents, are not apparent to the auctioneers.

Third party agents pose a significant business challenge to the online auction business. These third party agent sites can easily transform into aggregator sites that would use automatic search agents to sift through various auction offers, collect information and display it on their websites. Ebay.com successfully sued an aggregator site in 2000 citing various reasons, which it claimed were harmful for its business. Among the reasons advanced by EBAY were that these sites displayed outdated information which lowered auction users purchasing experience, and at the same time overloaded EBAY's own servers through frequent use of their search agents (Wagner and Turban, 2002).

The second challenge that third party agents pose to the auction house is that, by intermediating consumer access to the auction website, they could potentially affect advertising revenue which is a significant portion of the revenues in the online auction industry (ebay.com reported 7% (\$54.9 Million) of net revenues from online advertising in 2002).

On the positive side, establishment of standards and protocols for cooperative bidding agent interaction will see the development of third party auction bidding agents, in an environment that is devoid of incentive conflicts between bidders and auctioneers that plague the ASBA's, giving bidder an incentive to disclose their true willingness to pay and set higher reservation prices.

Standardization will also provide a potential for the creation of agents that can participate in multiple auctions. This would expose the auction to a larger audience and increase participation in the auction. Although there is the concern that the bidders could hedge their reservation price to the lowest price in all the auctions they are participating in, the exposure to a larger audience in itself is good for ascending price auctions (Klemperer 2003).

Bidding agents will inevitably reduce the number of personal visits that bidders make to the auction sites, perhaps to a maximum of two visits. During first visit the bidder will identify and evaluate the item on offer. Using this information, other private and secondary information, the bidder will proceed to configure the bidding agent. The bidder may make a second personal visit to collect post auction information, which the bidding agent did not communicate. We do not preclude the possibility of other visits, especially depending on the features of the bidding agent, but this typical bidder-agent-auction interaction serves to underscore the effect of reduced click through rates that auctioneers fear might affect their online advertising revenues. It is worthy to note that this trend will be witnessed for all agent supported bidding activity including that of ASBA's that are supported by the auction site. In supporting standardized agent protocols, the shift of agent bidding activity will be from ASBA's to TPBA's and DTBA's, which are more aligned with bidder's incentives and will not have any net effect on the expected click through rates and hence advertising revenue.

In an environment where flexible standards and protocols for agent-auction interaction exist, auction sites that are fearful of the uncontrolled practices of autonomous third parties bidding agents, can establish sister companies that handle the bidding agent work. With an appropriate business model, these entities can maximize their revenues, while serving the bidders' as their principal.

### **Diversification of Bidding Strategies**

There are two bidding strategies that are currently offered by the bidding agents that we studied: (i) minimum required bid and (ii) Sniping. With the minimum required bid strategy, the bidding agent submits a bid that is equal to the minimum required bid set by the auctioneer. This strategy is optimal if all bidders use the same strategy. However, a typical online auction will have a mix of bidders using agents and some who physically participate in the auction and adopt more complex bidding strategies. In such an environment, using the minimum bid increment may result in sub-optimal results.

Sniping strategies optimize the bidders expected surplus by submitting the minimum required bid close to auction end time. This is a strategy practiced widely in the non-agent online auction environment (Bapna et.al 2001). When a number of agents are configured to snipe on behalf of their bidders, the probability of winning reduces and in an auction format where the closing time is extended based on bidding activity, sniping results in intense bidding activity towards the end of the auction, without any significant advantage to any of the bidding agents. There is also a chance of the sniping strategy causing discontent for the auctioneer and there have been instances of negative feedback left for snipers ([www.sniperight.com](http://www.sniperight.com)). Some of the latest sniping tools try to shield the user from these negative reactions of the auctioneer by sending small probing bids through out the auction without causing a significant change in the auction price. Regardless of these modifications, we do not see any strategic advantages that the current bidding strategies provide to the principals.

There are numerous theoretical proposals for agent biddings strategies based on adaptive bidding strategy and q-learning (Viet and Czernohous, 2003; Greenwald and Stone, 2001). These agents utilized a variety of bidding strategies, some akin to the sniping strategy already discussed, while others employed more sophisticated strategies that utilize artificial intelligence heuristics to determine optimal bidding strategies. Additionally, these agents were developed to participate in combinatorial auctions. A proposal where bidders in simultaneous auctions submit bids driven by two principles: surplus maximization and bid minimization, lend itself easily to agent automation (Plott and Salmon, 2003). Indeed, there are numerous theoretical proposals that serve as a base for the development of bidding agents that utilize diverse bidding strategies. The challenge remains to bring these agent proposals to fruition, by integrating them into bidding agents used in online auctions. Part of the challenge as discussed above has been the need for a co-operative effort to create an enabling environment by setting up standards and protocols for the interaction of bidding agents and the auction sites.

### Intermediation Incentives

One positive development in the bidding agent field has been the creation of third party enterprises that provide bidding agent services. Agents of third party entities such as Auction Sniper, Bidnapper, and PhantomBidder provide users with web interfaces that allow bidders to configure them and agents such as Cricket Jr and Auction Sentry are software that can be downloaded onto bidder's computers and configured to proxy bid. On observing the services that these agents provide, the limitation that we mention in sections 4.1 and 4.2 are evident.

These developments, although in their nascent stage, are significant because the overall business model is sustainable and the incentives are well aligned. Note that effective and efficient bidding agents have bidders as their principal and have to optimize the bidder's objective. The bidder's principal objective is to win an auction at the lowest possible price. When the agent development business is left to the auctioneer, he will provide support and develop features that support the auctioneers' objective, which is to extract the maximum surplus from bidders, and in the process maximize revenue. Thus we can argue that a feasible business framework for the development of bidding agents exists and it is away from the auctioneer.

### CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

From our review of existing bidding agents for online auctions, we conclude that there is significant gap between the 'theoretically proposed and experimentally tested agents' and 'existing online bidding agents'. This observation is especially supported by the fact that online auctions provide only one type of bidding agent that use a static minimum bid increment to compose bids. Recent improvements in internet technologies create an enabling environment for the deployment of more sophisticated third party bidding agents.

Bidding agent service in online auctions have traditionally been provided by the auction houses, creating an obvious conflict of information sharing between the auctioneer and the bidder. In our review, we identified several emerging third party bidding agents that will result in increased bidder confidence, because the agents will be more aligned to the objectives of their principals. The development of third party bidding agents is however limited by the co-operation of auction houses to provide interfaces that can facilitate the integration of third-party bidding agents. Auctioneers can provide Web-Services that support the development of third party bidding agents. Besides addressing the exact specifications of such Web-Service, it has to be clear to the auctioneers that the resultant auction environment will benefit them. We are currently undertaking research in this aspect.

Finally, we observed that companies in the online auction business accrue some revenues from advertising. Naturally, the scope for this business opportunity is inversely related to the extent to which bidding agents are used. By reviewing the financial statements of some of the online auction companies, it was evident that the streams of advertising revenues have recently been declining. From a business opportunity perspective, the exact benefits of enhanced use of bidding agents will have to be evaluated against such losses.

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