Chapter L
An Introduction of Evolutionary Computation in Auctions

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ABSTRACT

The increasing use of auctions as a selling mechanism has led to a growing interest in the subject. Thus both auction theory and experimental examinations of these theories are being developed. A recent method used for carrying out research on auctions has been the design of computational simulations. The aim of this chapter is to give a background about auction theory and to present how evolutionary computation techniques can be applied to auctions. Besides, a complete review to the related literature is also made. Finally, an explained example shows how a genetic algorithm can help automatically find bidders' optimal strategies for a specific dynamic multi-unit auction—the Ausubel auction—with private values, drop-out information, and with several rationing rules implemented. The method provides the bidding strategy (defined as the action to be taken under different auction conditions) that maximizes the bidder's payoff. The algorithm is tested under several experimental environments that differ in the elasticity of their demand curves, number of bidders, and quantity of lots auctioned. The results suggest that the approach leads to strategies that outperform sincere bidding when rationing is needed.

INTRODUCTION

According to the historical archives, the first time auctions were implemented was 500 B.C. Herodotus reports that in Babylon, men had to buy their future wives by bidding in auctions. Nowadays auctions are widely used as selling mechanisms in different markets around the world. The items auctioned range from the wide variety being offered on Internet marketplaces like eBay, the auctions of art, antiques, financial assets, agricultural goods, fish, and so forth. Perhaps at the present time the most important agents using auctions are governments. The authorities usually carry out auctions both for selling and buying. Governments sell by means of auction commodities like emission permits, electromagnetic bands for communication, or the rights for use of natural resources or public companies. On the other hand, when governments are the buyer that is in procurement auctions, bidders compete for the right to sell their products or services and the lowest bid wins the contract. As a result of these activities, auction theory and experimental examinations of these theories are of growing interest.

Experiments done on auctions suggest that frequently bidders make systematic bidding errors, so the final outcome does not fit the theoretical results (Kagel, 1995). In order to understand these divergences, a recent method used for analyzing strategies on auctions is the use of systems of artificial adaptive agents (AAAs). Moreover, these learning models with adaptive agents can be helpful not only where theory and experimental results disagree, but for those situations where the environment is so complicated that a theoretical result has not been modeled yet. In this context, genetic algorithms (GAs) are a good learning method for optimization in complex problem domains. In this way, the use of machine learning systems can help find equilibrium strategies or in the evaluation, from different points of view, of an auction itself with respect to other possible auctions. The analysis of these systems gives us new approaches to understanding the economic and social behavior of auctions.

The remainder of the chapter is organized as follows. The next section gives the reader a minimum background about auction theory. The third section presents how evolutionary computation techniques can be applied to auctions and gives a review of related literature. Then, in the section Analysis of the Ausubel Auctions by Means of Evolutionary Computation, a detailed example of one research project that uses genetic algorithms to develop bidder strategies in Ausubel auctions is given; at this point the experimental framework is shown, along with a description of the bidding strategy encoding with the results obtained. Finally, conclusions are drawn.

THE STANDARD AUCTION TYPES

Although auctions have been used from time immemorial, they did not enter into the economic literature until relatively recently. Most likely the starting point of the auction theory is the work done by Vickrey (1961) on the equivalence in the expected revenue of different auction forms, where he described, for the first time, the sealed-bid second-price auction. Since this research a lot of work has been done on this topic, especially at the end of the 1970s. It is very difficult to list the numerous papers on auctions; however, some references are: Klemperer (2000a, 2000b), who collects together in two volumes most of the critical papers in the economic literature of auctions up to the year 2000; Krishna (2002), who gives an account of developments in the field in the 40

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