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An expansion matching method to improve transaction effectiveness in the double auction market

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ABSTRACT

The double auction is an important transaction mechanism in electronic commerce. Buyers and sellers can interact and be matched with each other in a double auction e-market. Consequently, enhancing the effectiveness of the double auction market to help traders successfully complete their transactions is an important issue. In this research study, Trading Agent Competition (TAC) data were collected to examine double auction market mechanisms. The TAC is a worldwide, renowned competition in which intelligent agents are employed to simulate business/market operations, and the TAC Market Design (CAT) tournament is an individual TAC competition that focuses on the double auction market. Thus, we conducted simulation experiments on the CAT competition platform, and the transaction data were analyzed to identify the impact of market design strategies on market performance, such as market share, market profit and transaction success rate. Based on these results, we developed an expansion matching method to enhance market performance, and we conducted verification experiments to evaluate our method. The results show that our expansion matching method promotes improved performance of market policies in the double auction market.

1. Introduction

In electronic commerce (EC), information about commodities and transactions is transparent to buyers and sellers. Information transcends boundaries of geographical regions and human factors, and all traders can interact with each other and make deals in the e-market. EC can shorten supply chain nodes and increase procurement and marketing efficiency to achieve the goal of enhancing industrial competitiveness (Ghenniwa et al. 2005). In many EC business models, the auction mechanism promotes additional and new opportunities for business.

Typical auction mechanisms include the English auction, Dutch auction, first price sealed bid auction, second price sealed bid auction, and double auction (McAfee and McMillan 1987). The most significant difference between the double auction mechanism and the aforementioned types of auctions is that multiple buyers and sellers can simultaneously submit their bids in a double auction. The auction market specialist can establish conditions for the success of buyer and seller transactions according to the attributes of the auction object, which is referred to as the matching policy. For example, the matching policy can set the conditions to allow the buyer with the highest bid price and the seller with the lowest asking price to successfully complete the transaction. Labys and Granger (1970) assert that the double auction mechanism applies to the following situations: (a) The commodity in the transaction possesses is easily assessable and classifiable standard specifications; (b) Information disclosure allows the participants in the transaction to acquire consistent price information; and (c) The number of transactions of both sellers and buyers should be sufficient to allow continuous transactions.

Double auctions are further classified as either an asynchronous double auction (ASDA) or a synchronous double auction (SDA) (Friedman 1991, Friedman and Rust 1993); early double auctions were ASDAs. The New York Stock Exchange and Chicago Mercantile Exchange adopted this type of mechanism in the earlier phases of their operations. However, in recent years, academics in SDA research have placed more emphasis on the performance of trader agent strategies and market efficiency in the single market environment. Niu et al. (2007) indicated that in the real-world environment, several markets are often observed to be selling the same commodity, and the trader agents move between markets with the objective of buying low and selling high or avoiding risks. To compare the differences among market operation strategies, the authors employed the Java Auction Simulator API (JASA).[1] Niu compared the market share and profit performance of each market operation strategy with different trader agent strategies and market

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[1] http://sourceforge.net/projects/jasa/.

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selection strategies in the fixed charge market, homogeneous market, and heterogeneous market environments.

The Trading Agent Competition (TAC)[2] in the JASA project proposes a TAC Market Design competition platform (JCAT)[3] to study how market specialist agents could attain the best performance in the double auction market. JCAT encourages the research, design, and application of a market mechanism to increase market operation efficiency. The participating teams in the competition can design a market specialist agent to operate market strategies that facilitate automatically adaptation of the market to continuously changing conditions in the competitive environment.

As compared to the English auction and Dutch auction, the JCAT platform has more similarities to the futures market. In both JCAT and the futures market, buyers and sellers can shout a price at the same time. The market can charge a transaction fee by matching buyers and sellers to complete a transaction. Furthermore, traders can migrate among the markets to pursue the highest transaction profit and prospect for successfully transactions. In the JCAT platform, the system simulates the traders' shouting and market migration behaviors. However, JCAT is more attentive to the role of market policies. The market proprietor must consider how to implement an efficient policy that will attract the highest number of traders and match them in the market to gain the highest market share and profit.

In this research study, we use the JCAT platform to investigate the impact of different double auction market policies on trader agents. We propose an expansion matching method to modify the shout accepting policy to improve market performance. The aim of this study is to improve existing matching policies, thus enabling market specialists to adapt to competitive situations and achieve equilibrium between market share and transaction success rate. The remainder of this paper is organized as follows. In Section 2, the TAC Market Design competition is introduced, and the policies of market specialists and traders are summarized. In Section 3, the evaluation experiment design and results are described. The evaluation experiment is conducted to study the impact of shout accepting policy on market performance; the results can be applied to design a better policy. In Section 4, our expansion matching method is discussed in detail. The verification experiments are conducted to evaluate our method, and the experiment results are presented in Section 5. Finally, implications and conclusions are discussed in Section 6.

2. Double auction and TAC Market Design

This study uses the TAC Market Design (CAT) tournament to investigate the effect of specialist policies of market operation on the transaction behavior of trader agents. The CAT tournament operates on the JCAT platform. All market specialists and traders (buyers and sellers) can run on the platform; consequently, we can obtain operation data to analyze the effects of market design policies on the transaction results (Phelps 2007). In our study, an adaptive specialist strategy is applied to the specialist agent to correspond to the rapidly changing competitive environment of an auction market. Because the CAT platform is identified as a type of simulated market, the operation mechanism and the market selection strategy selected by the trader agent are carried out according to the relevant parameters that define the experiment platform. Therefore, in this section, relevant policies of the experiment platform that can be used as the basis for analysis of the subsequent simulation are summarized.

Phelps (2007) described CAT competition as being comprised of two groups of members, traders and market operation specialists. Each specialist operates one auction market that provides the trading platform for traders to buy and sell commodities. At the beginning of each trading day, specialists announce the list of fees to be imposed for that day. The specialists can also access the list of fee categories of other specialists. The traders evaluate the operation effectiveness of the specialist and the expenditures incurred during the previous day to select a market. An auction round starts with the traders calling out their bid price while the specialists match the submitted price of the buyer and asking price of the seller according to the shout accepting policy. After the traders, i.e., buyers and sellers, are matched, they can decide to accept the matching or not. A new auction round starts again after the transaction is complete for the previous round. Several rounds of auctions can be carried out daily in this manner. At the end of the auction day, the system announces the transaction information for the market operated by each specialist, including price, quantity, matching rate, market share, profit, and transaction success rate. The specialists can adjust their operation policy for the next day based on this information. CAT permits and encourages the specialists to adopt an intelligent learning method to adjust their operation policy on a timely basis to address market changes.

The daily operation performance of each specialist is scored based on the profit gain, market share, and success rate. After the competition is over, CAT determines the range of days for the scores to be calculated, and the specialist with the highest total scores is the winner. Vytelingum (2006) and Gerding et al. (2007) described traders and specialists as follows:

2.1. Trader

Traders include buyers and sellers. CAT allocates each trader agent privileges for possessing bidding strategies, market selection strategies and setting private values for commodities. In a fair and consistent competition, each commodity is the same and inseparable. The quantity of supply and demand for each trader agent is also consistent. A trader agent can only select the auction market operated by one particular specialist each day and set the private value (reserved price) only once. In addition, a trader agent has a daily budget with an upper limit to prevent the specialist agent from adopting an unreasonable fee charging strategy that leads to trader agent loss. An outline of bidding strategies and market selection strategies is shown in Table 1.

2.2. Specialist

Each specialist operates an auction market and competes with other specialists. CAT permits and encourages the specialist to adopt an intelligent learning method to adjust their operation policy on a timely basis to address market changes and attract traders to complete transactions in their own market. Specialist operation policies are listed in Table 2.

Table 1
Strategies employed by trader agents.

Strategy classification	Strategy
(1) Bidding strategies	(a) Gjerstad–Dickhaut bidding, GD
	(b) Zero-intelligence constrained bidding, ZIC
	(c) Zero-intelligence plus bidding, ZIP
	(d) Roth–Erev bidding, RE
(2) Market selection strategies	(a) Random-market selection strategy
	(b) Static-market selection strategy
	(c) Stimuli-response market selection strategy

[2] http://sics.se/tac.
[3] http://www.jcat.sourceforge.net.