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博 士 論 文 概 要

論 文 題 目

Study on Bidding Strategies using Genetic Network Programming

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Due to the explosive development of the global network structure, electronic commerce is increasingly playing an important role in many organizations and individual consumer's daily life. It offers opportunities to significantly improve the way for businesses interactions between both customers and suppliers. More and more large scale and decentralized e-commerce mechanisms have emerged in industrial and commercial domains in a wide range.

In particular, among all these applications, online auctions, which are flexible pricing mechanisms over internet, make the physical limitations of traditional auctions disappear. They gain their extra popularity in the daily life and attract globally dispersed users due to having the characteristics of "bargaining" and "negotiation" besides all of the convenience. Thus, online auctions become one of the most widely studied and employed negotiation mechanisms today. Traditionally, in most current online auction applications, the traders are generally humans who operate all the behaviors to make transactions. These behaviors may involve observing the auctions, analyzing the auction information and bidding the suitable price for the items. However, facing the increasingly demanding requirements and complexity of online trading, this kind of manual operation does not reveal the full potential of this new mode of commerce. Thus, in order to relieve the users and to be more effective, exploring possible types of online auctions and automating the behaviors in online auctions attract high interest.

Now, the agent-oriented auction mechanisms with its emphasis on autonomous actions and flexible interactions arise as an effective and robust model for the dynamic and sensitive commerce environment. In such systems, the agent acts flexibly on behalf of its owner and is capable of local decision-making based on the environment information and pre-knowledge about the system.

Among many different types of online auctions, two of the most popular and studied types are Multiple Round English Auctions (MREA), which is single side auction, and Continuous Double Auction (CDA), which is double side auction. These auctions are newly emerged in e-commerce era based on the traditional auction types. They allow multiple agents to participate and one agent can deal with several auctions continuously or simultaneously, which are effective auction types to save time and relieve the users. The major challenge to automatic bidding strategies of these types is to improve the degree of automation and optimize the agent's bidding behavior in order to maximize the owner's profit, because there is no centralized system-wide control. Most of the related researches have been conducted by using heuristic methods and

fixed mathematical functions to compute the final optimal bidding price for the items or to compute how much the bid should be submitted at each time step. Nevertheless, these approaches are not flexible enough for the dynamic environments, and there is no dominant strategy, because auction environments are complicated and highly dynamic due to many factors affecting each other.

Against this background, this thesis is concerned with developing the intelligence of autonomous agent's bidding strategies in order to make the agent to be more efficient and competitive for agent-based online auction mechanisms, especially in Multiple Round English Auctions (MREA) and Continuous Double Auction (CDA). In order to be more flexible and better exploit the market information, Genetic Network Programming (GNP) is firstly employed to the agent's bidding strategies since its applicability and efficiency have been clarified in complex and dynamic problems in many other fields. GNP is one of the evolutionary optimization techniques developed as an extension of Genetic Algorithm (GA) and Genetic Programming (GP), which uses compact directed graph structures as solutions. Basically speaking, in the proposed method, the GNP population represents the group of potential bidding strategies, and each individual uses the if/then decision-making functions to judge the auction information and guides the agent to take the suitable actions under different situations. Thus, it could be flexible and adaptive to various auction situations. During the evolution, the GNP structure will be systematically organized, and finally, the individual which can obtain the highest profit is selected as the optimal bidding strategy at the end of the training phase.

In chapter 2, we introduced the concept of MREA and CDA in detail, which is mainly studied in this thesis. The related researches are also introduced.

In chapter 3, the bidding strategy for the auction agents in MREA is proposed using GNP. The performance of GNP-based agents is evaluated and studied in two situations: MREA is no time limit (NTL), and MREA is time limit (TL). Furthermore, according to the amount of money each agent has, each situation is divided into 2 cases: general case and poorest case. All the participating agents in the simulations use GNP strategy. This chapter aims to study and analyze the capability and effectiveness of GNP for guiding bidding actions through the simulations. The simulation results reveal that the agents using GNP strategy can understand various environments well through experiences and become smarter through evolution.

In chapter 4, as an extension of the bidding strategy in chapter 3, an enhanced bidding

strategy for MREA is developed using GNP in order to improve the agent's intelligence and sensitivity. Firstly, the GNP structure is modified to be able to judge more kinds of information and more situations at a time. Secondly, the strategy is improved to be able to consider the bidder's attitude towards to each good, which makes the strategy to be more personalized for each bidder and could make the bidder more satisfied with the auction results and profits. The proposed strategy is compared with the previous GNP strategy and the other conventional strategies in the simulations. The simulation results demonstrated that the proposed method can outperform the previous one and is more competitive than the agents based on mathematical functions.

In chapter 5, GNP with rectify nodes (GNP-RN) has been applied to CDA bidding strategy being combined with proposed heuristic rules, which are derived based on the common believes for assisting agents' bidding behaviors. GNP-RN is developed aiming to guide the agent to be competitive under different CDA environments, and maximize the agent's profits without losing chances for trading. Rectify Node (RN) is a new kind of node, which is used for bringing more flexible and various options for bidding action choices. 4 groups of simulations are designed to compare GNP-RN with conventional GNP and other strategies in CDA. In each simulation, the kinds of opponent agents are different in order to fully analyze the agents' performance. The simulation results show that the proposed method can outperform all the other strategies and achieve high success rate as well as high profits even when the situation is highly competitive.

In chapter 6, as an extension of GNP-RN, GNP with adjusting parameters (GNP-AP) for developing bidding strategy in large-scale CDAs is proposed and studied. In large-scale CDAs, much more history information can be obtained than small-scale CDAs. In order to enhance the sensitivity for large-scale CDAs and the capability of judging abundant information, the parameters used by GNP-AP decision-making functions are adjusted during the evolution instead of being fixed in GNP-RN. Moreover, the structure of GNP-AP is designed more comprehensively so that the number of branches of some kinds of nodes is increased to adapt to the complicated environment situations. The simulation results show that GNP-AP can obtain a good guidance for the large-scale CDAs and could be very efficient for the markets.

In chapter 7, after giving the objectives and motivation of each research topic, some conclusions about the proposed algorithms are described based on the simulation results.