

## Chapter 5.18

# Bounded Rationality and Market Micro-Behaviors: Case Studies Based on Agent- Based Double Auction Markets

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### ABSTRACT

*We investigate the dynamics of trader behaviors using an agent-based genetic programming system to simulate double-auction markets. The objective of this study is two-fold. First, we seek to evaluate how, if any, the difference in trader rationality/intelligence influences trading behavior. Second, besides rationality, we also analyze how, if any, the co-evolution between two learnable traders impacts their trading behaviors. We have found that traders with different degrees of rationality may exhibit different behavior depending on the type of market they are in. When the market has a profit zone to explore, the more intelligent trader demonstrates more intelligent behaviors. Also, when the market has two learnable buyers, their co-evolution produced more profitable transactions than when there was only one learnable buyer in the market. We have analyzed the trading strategies and found the learning behaviors are very similar to humans in decision-making. We plan to conduct human subject experiments to validate these results in the near future.*

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## **INTRODUCTION**

*It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest.*

*- Adam Smith, The Wealth of Nations, 1776.*

In the classic *An Inquiry into the Natures and Causes of the Wealth of Nations*, the great economist Adam Smith demonstrated that an individual pursuing his own self-interest also promotes the good of his community as a whole, through a principle that he referred to as “invisible hand”. Since then, the study of individual behaviors in a market economy has evolved into the field of *microeconomics*.

In a standard market, buyers and sellers interact to determine the price of a commodity or service. During the trading process, individuals maximize their own profits by adopting different strategies based on their experiences, familiarity with the commodity and the information they acquired. These differences in individual qualities in decision-making can also be explained by the concept of *bounded rationality* introduced by Herbert Simon (1997), who pointed out that perfectly rational decisions are often not feasible in practice due to the finite computational resources available for making them. As a result, humans employ heuristics to make decisions rather than a strict rigid rule of optimization. The difference in human qualities in decision-making is referred to as *the degree of rationality or intelligence*.

In a market that is composed of multiple self-interest traders, each of whom has a different degree of rationality, many unexpected behaviors may emerge. Our interest in studying the dynamics of these behaviors is motivated by the increasing popularity of Internet auction markets, such as *eBay* and *Amazon*. When designing an auction e-market, in addition to the maximization of macro market efficiency, the auction rules also have to consider the dynamics of auctioneers’ behaviors. In particular, would a rule create the

opportunity for an auctioneer to engage in unfair bidding practices? If so, how can we prevent them from happening?

This type of preventive study is not new in the Internet auction market business. For example, to prevent “sniping” (the act of submitting a slightly higher bid than the current one at the last-minute), *eBay* has incorporated software agents in the Internet bidding process. There, each auctioneer is asked to provide his/her highest bid to an assigned agent, who then carries out the auction on his/her behalf. By contrast, *Amazon* adopts a different approach by extending the auction period for 10 more minutes if a sniper appears at the end of an auction (Roth & Ockenfels, 2002). This type of preventive study is important in order to design fair and successful auction markets.

In this chapter, we present our work using an agent-based genetic programming (GP) system (Chen & Tai, 2003) to analyze the behavior of traders with different degrees of rationality in an artificial double-auction (DA) market. This approach is different from that of experimental economics (Smith, 1976) in that instead of conducting experiments using human subjects, software agents are used to represent traders and to conduct market simulations under controlled settings. This paradigm of agent-based computational economics complements experimental economics to advance our knowledge of the dynamics of micro market behavior.

The rest of the chapter is organized as follows. Section 2 explains market efficiency and double-auction markets. Section 3 summarizes related work. In Section 4, the three types of DA market we studied are described. Section 5 presents the agent-based GP system used to conduct our experiments. The analysis of the dynamics of trading behaviors is given in Section 6. Finally, Section 7 concludes the chapter and outlines our future work.

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