

# Competition between Markets and the CAT Tournament: Introduction to the Special Issue

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## Abstract

We introduce the Special Issue of on Market Competition and the CAT Market Design Tournament.

The rapid rise of automated trading systems has demonstrated the interconnectedness of the world's financial markets. Events in one market may quickly have ramifications in others, as traders seek opportunities for arbitrage or to exploit temporary information advantages. With financial trading a global activity, markets find themselves in fierce competition with one another, as traders and investors are able to move capital and trading activity rapidly from one market to another. The rules, procedures and fees of marketplaces therefore become part of their sales proposition as providers of transaction services to potential traders. The discipline of Economics has, until recently, mostly ignored competition between marketplaces, perhaps because, as Mirowski suggests [5], economists abstract too far away from the specific rules and operations of particular marketplaces, looking only at one abstracted market in isolation. For computer scientists interested in engineering and managing online trading systems, however, these are very important issues, because market rules and processes may greatly impact competitive performance. In a major research project, *Market-Based Control of Complex Computational Systems (MBC)*, a team of computer scientists and economists from the Universities of Birmingham, Liverpool and Southampton, UK, and from the

companies, BAE Systems, British Telecommunications, and Hewlett-Packard, set out to study these questions.<sup>1</sup> The long-term aim of this research project was to develop the science and engineering needed for the automated design of market mechanisms, an objective well beyond one team of researchers or one research project. To encourage others to participate in this research effort, the project partners created an open, international research tournament, the *CAT Market Design Tournament*. The CAT Tournament has run annually five times since 2007, for three years hosted at the University of Liverpool, UK, and then for the last two years, at the University of Melbourne, Australia.<sup>2</sup> The CAT Tournament has been held in association each year with the Trading Agent Competitions of the International Trading Agent Research Association, and has attracted entries from all six continents.

In the traditional trading agent competitions, which have operated since 1999, the conference organizers provided one or more marketplaces, and game entrants wrote software traders to participate in these marketplaces. The CAT Tournament is the reverse of this: the game organizers provide the software traders, while the entrants host competing marketplaces seeking to attract traders and to successfully match potential buyers with potential sellers. The Tournament is run using a software platform, called *JCAT*, designed and created by a virtual team of researchers from the Universities of Liverpool and Southampton and Brooklyn College, City University of New York. This platform is available for free download as open-source software<sup>3</sup>, so that entrants may test their entries ahead of time, and also as a market simulation platform for research purposes.<sup>4</sup> In its five years of successful operation, the CAT Tournament has been successful in promoting crowd-sourced research into automated and adaptive mechanism design, and in helping to focus and coalesce a computational research community in Catallactics, the science of economic exchanges. Research papers arising from the CAT Tournament have already been published as stand-alone papers in conferences and journals in e-commerce, in artificial intelligence, and in multi-agent systems, e.g., [15, 13, 8], and several PhD dissertations in the area have now been completed, e.g., [3, 10, 11, 12]. The aim of this special issue of *Electronic Commerce Research and Applications* is to bring together into one place new, original research initiated by the CAT Tournament or using the JCAT Platform, so as to provide a published focus for this emerging area of computational economics.

There are three papers in this special issue, selected after two rounds of rigorous reviewing by anonymous expert referees.<sup>5</sup> It is indicative of the global reach of the CAT Tournament that the authors of these papers are from Australia, China, Greece, Taiwan, the UK and the USA, with two papers comprising multi-national teams of authors. All three papers contribute to the science of automated mechanism design, although they consider different aspects. In two cases, the authors focus on the design

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<sup>2</sup>For more details, see: [www.marketbasedcontrol.com](http://www.marketbasedcontrol.com)

<sup>3</sup>From: <https://sourceforge.net/projects/jcat>

<sup>4</sup>Details of the design of the JCAT platform and operations of the CAT Tournament can be found in the reference documents: [1, 7, 9].

<sup>5</sup>Referees were selected and editorial decisions made for each paper by a paper-specific subset of the special issue editors, in order to ensure that no editor was involved in decisions on his own papers.

of market mechanisms, while the other paper considers how traders may best select markets to trade in. The papers are published in alphabetical order by surname of first author.

The first paper, *An expansion matching method to improve transaction effectiveness in the double auction market* by Deng-Neng Chen and Jung-Yu Yu [2], proposes a novel method for adaptive market design in the CAT Tournament. The performance of markets in the Tournament is assessed each trading day by a combination of three criteria: share of traders attracted, share of system profits (both relative to competing marketplaces), and transaction success rate (i.e., of those traders attracted, the proportion that are matched to a counter-party by the market that day). Success in the Tournament requires market policies which maintain a continuing balance between these competing criteria: fees too low, for instance, will likely attract traders to your market, but may also decrease your market's profit. Chen and Yu propose a method for changing market policies dynamically while maintaining the approximate balance between the three performance criteria. They assess this method using simulations undertaken on the JCAT platform. By looking at particular market policies in an environment of competing trading markets, this paper continues a prior thread of research due to Niu *et al.* [8], Sohn *et al.* [13], Stavrogiannis and Mitkas [14], and Vytelingum *et al.* [15].

The second paper, *An assessment of strategies for choosing between competitive marketplaces* by Timothy Miller and Jinzhong Niu [4], considers the situation from the trader's perspective. Faced with a choice of competing double auction marketplaces on which to trade, how should a software trader choose between them? In this paper, the authors use simulations over the JCAT platform to compare performance of several selection methods. Selecting between  $N$  different marketplaces is similar to the classical (static) *N-armed bandit problem* with this difference: the various payoffs from trading in different marketplaces are dynamic, dependent both on the particular rules, matching processes, and fees of each market, and on the particular combination of traders these markets attract at any one time. The dynamic *N-armed bandit problem* is in general unsolved, and any approach is likely only to be optimal for specific application domains. The authors compare several automated selection methods for in the competing market domain of CAT.

The third paper, *A grey-box approach to automated mechanism design*, by Jinzhong Niu, Kai Cai, Simon Parsons, Maria Fasli and Xin Yao [6] considers the problem of automated design of double auction market mechanisms by first parametrizing the space of double auctions. The authors then undertake a search through this space using evolutionary computational methods, with the three performance criteria of the CAT Tournament as the means to assess mechanism fitness. The parameterization of the double auction space allows the performance of components to be assessed, as well as the performance of a market design as a whole. This method appears to be a promising step towards the goal of fully automated market mechanism design, and could enable near-real time dynamic optimization of mechanisms.

We believe the study of competition between markets is important and exciting, and we commend these papers to readers for an exciting introduction to the novel research being undertaken in this domain. We hope that the special issue will also act as a springboard for future research into this multi-disciplinary area. We thank all the authors (both successful and unsuccessful) for their contributions, and the anonymous re-

viewers for their work in assessing and reviewing submitted papers. We also thank the editors of *Electronic Commerce Research and Applications*, particularly Robert Kauffman and Terry Payne, for their support and assistance in bringing this special issue to fruition. We also wish to thank the many CAT Tournament entrants, as well as the various people who helped create the JCAT Tournament Platform and have helped run the annual Tournaments: Benjamin Broix, Ronan Bouiche, Kai Cai, Dan Cartwright, Ken Chan, Arthur Coussy, Mathieu Lassalle, Tim Miller (CAT Gamemaster 2010 and 2011), Thierry Moyaux, Jinzhong Niu (JCAT Lead Developer), Steve Phelps, Dave Shield, and Elizabeth Sklar. We hope that you enjoy reading the papers in this special issue as much as we have.

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