

## Nomination for INFORMS ISS Design Science Award 2012

### **NOMINEE Information**

Wolfgang Ketter, Erasmus University

John Collins, University of Minnesota

Maria Gini, University of Minnesota

Alok Gupta, University of Minnesota

Paul Schrater, University of Minnesota

### **SUBMITTER's Information**

Wolfgang Ketter, Erasmus University

To whom it may concern,

I would like to nominate the project:

“Design of automated agents capable of recognizing and forecasting the economic environment”

executed by the above research team for the INFORMS ISS Design Science Award 2011. The project has made, and is continuing to have, high impact in academia and practice over the years. A summary of the project and supporting documents are attached to this nomination.

If you have further questions, please don't hesitate to contact me.

Best wishes,

A handwritten signature in blue ink that reads "W. Ketter". The signature is written in a cursive, flowing style.

Wolf Ketter

Associate Professor of Information Systems

Erasmus University

**Project Title:**

Design of automated agents capable of recognizing and forecasting the economic environment to facilitate decision-making

**Project Summary:**

Many enterprises that operate in dynamic markets need to make product pricing and resource utilization decisions in real-time. To seek competitive advantage, firms increasingly employ sophisticated decision support systems. These systems often involve software agents that can act rationally on behalf of users or assist in a variety of tasks. Software agents are able to analyze many more possibilities in shorter time frames than their human counterparts, but are often limited in their ability to make strategic decisions. Strategic decisions require the ability to make long term predictions from past data.

To give agents improved ability to support strategic decisions, we have developed methods for software agents to characterize the economic environment they operate in and predict its future conditions. These economic conditions, or *economic regimes*, have clear qualitative interpretations (such as shortage, oversupply, etc.) and can guide an agent to adjust its objective functions (e.g., liquidate inventory if an economic downturn is predicted in the future) depending on the predictions. In various papers (examples attached as supporting documents) we demonstrate how to compute economic regimes using historical data, and how to use them in real-time to characterize observed market conditions and to predict their evolution over multiple time scales. We use the Trading Agent Competition for Supply Chain Management (TAC SCM) testbed to demonstrate the efficacy of our conceptual framework and computational models. TAC SCM is a supply chain environment characterized by competitive procurement and sales markets and dynamic pricing, which provides a low cost realistic multi-echelon environment simulating many modern flexible manufacturing environments. Our results show that regime models are effective in informing both short-term pricing and long-term resource allocation decisions. The predictions made by regime models outperform the predictions made using more traditional short- and long-term predictive modeling approaches. In TAC SCM agents make fully automated decisions, but in a real application they can be used instead to assist a human decision maker by providing predictions of future economic conditions and guidance on decisions.

Our agent itself is an artifact designed to support a research agenda ranging from computer science to decision support and human-computer interaction. To maximize flexibility, virtually all decision processing is performed by a network of configurable, composable modules that do a variety of data analysis, modeling, and prediction tasks. These are composed at runtime to support agent decision-making. We have demonstrated how this design approach can be used in a variety of intra-firm and inter-firm contexts to enable users to compose decision behaviors from components, allowing dynamic construction of analysis and modeling tools from small, single-purpose evaluator services.

This work clearly falls in the realm of Information Systems oriented design science, as it fits all three definitions provided in the appendix that emphasize the artifact's importance in organizational context. The supporting documents cover "end-to-end" design realization of the IT artifact, including the design of various modules, the architecture of the agent, the decision models of the agents, the models for characterizing regimes using historical data, the real-time implementation of the regime model, and the evaluation of decisions made using regimes.

### **Verification:**

The project has been conducted entirely for educational purposes by faculty and students.

### **Supporting Documents**

#### **Journal Publications**

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, Paul Schrater, "Real-time tactical and strategic sales management for intelligent agents guided by economic regimes," Accepted, *Information Systems Research*, 2011.

John Collins, Wolfgang Ketter, and Maria Gini, "Flexible decision support in dynamic interorganizational networks," *European Journal of Information Systems*, 19(4):307–318, 2010.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, Paul Schrater, "Detecting and forecasting economic regimes in automated exchanges," *Decision Support Systems*, 47 (4), 2009, 307–318.

John Collins, Wolfgang Ketter, and Maria Gini, "Flexible decision control in an autonomous trading agent," *Electronic Commerce Research and Applications*, 8(2):91–105, 2009.

#### **Book Chapters**

Wolfgang Ketter, John Collins, and Maria Gini. "Coordinating decisions in a supply-chain trading agent," In *Agent-Mediated Electronic Commerce and Trading Agent Design and Analysis*, Eds: Wolfgang Ketter, Han La Poutre, Norman Sadeh, Onn Shehory, and William Walsh, Lecture Notes in Business Information Processing (LNBIP) 44, pages 161–174, Springer Verlag, Berlin, Germany, 2010.

John Collins, Wolfgang Ketter, and Maria Gini. "Flexible decision support in a dynamic business network", In *The Network Experience*, Eds: Peter Vervest, Diederik van Liere, and Li Zheng, pages 233–246, Springer Verlag, Berlin, Germany, 2008.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, and Paul Schrater. "Strategic Sales Management Guided by Economic Regimes," In *Smart Business Networks*, Eds: Peter Vervest, Eric van Heck, and Kenneth Preiss, pages 245–264, Erasmus Research Institute of Management (ERIM) Press, 2008.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, and Paul Schrater. "Identifying and forecasting economic regimes in TAC SCM," In *Agent Mediated Electronic Commerce and Trading Agent Design and Analysis*, Eds: Han La Poutre, Norman Sadeh, and Sverker Janson, Lecture Notes in Artificial Intelligence 3937, pages 113–125, Springer Verlag Berlin Heidelberg, 2006.

#### **Conference Publications**

John Collins, Wolfgang Ketter, and Maria Gini. "Flexible decision support in a dynamic business network", In *Smart Business Networks Conference*, Beijing, China, May 2008.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, and Paul Schrater. "A predictive empirical model for pricing and resource allocation decisions," In Ninth International Conference on Electronic Commerce (ICEC), Minneapolis, MN, USA, August 2007.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, and Paul Schrater. "Strategic sales management guided by economic regimes," In Smart Business Networks Conference, Putten, The Netherlands, June, 2006.

Wolfgang Ketter. "Dynamic regime identification and prediction based on observed behavior in electronic marketplaces," In Twentieth National Conference on Artificial Intelligence, pages 1646 - 1647, Pittsburgh, PA, July 2005.

Wolfgang Ketter, John Collins, Maria Gini, Alok Gupta, and Paul Schrater. "A computational approach to predicting economic regimes in automated exchanges," In The Fifteenth Annual Workshop on Information Technologies and Systems (WITS-05), pages 147–152, Las Vegas, Nevada, December 11th 2005.

### **Awards**

- MinneTAC - 3rd place in the 8th Trading Agent Competition for Supply-Chain Management, Harvard University, Boston, USA, June 2010.
- Best Paper Award Nominee, 11th International Conference on Electronic Commerce (ICEC-09), Taipei, Taiwan, August 2009.
- MinneTAC - 3rd place in the 7th Trading Agent Competition for Supply-Chain Management, Pasadena, USA, July 2009.
- Smart Business Network award (Best Paper and Best Presentation Award), 5000 EUR Research Grant, Smart Business Network Conference, Beijing, China, May 2008.
- MinneTAC - Finalist of the 4th Trading Agent Competition for Supply-Chain Management, Hakodate, Japan, May 2006.
- Best research award for most commercially innovative research, Computer Science Research Conference, University of Minnesota, Minneapolis, Minnesota, USA, March 2006.
- MinneTAC - Finalist of the 3rd Trading Agent Competition for Supply-Chain Management, Edinburgh, Scotland, August 2005.
- Selected for the Tenth SIGART/AAAI Doctoral Consortium and AAAI Conference Scholarship based on excellent doctoral research, Pittsburgh, Pennsylvania, USA, July 2005.
- Best research design award, Computer Science Research Conference, University of Minnesota, Minneapolis, Minnesota, USA, Oct. 2004.
- International Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), Conference Scholarship based on excellent research paper, Columbia University, New York City, USA, July 2004.