Introducing Virtual Futures Market System "U-Mart"

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Abstract

In This paper, we introduce the overview of virtual or artificial futures market named "U-Mart" and the activities of U-Mart Project. U-Mart system consists of 4 main tools and some other utilities. Activities of U-Mart Project can be divided into 3 parts, investigations, educations and organizing open experiment (competition). These activities are related each other.

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1. U-Mart

1.1 Introductions and Organization of U-Mart Project

U-Mart is a generic name for an artificial futures market, using related tools and activities. In the artificial futures market, Human Agents and Machine Agents may coexist and buy/sell via LAN or Internet with an underlying asset J30. Economic and social systems including financial markets are typical complex systems. And designing such systems is a difficult and urgent issue for us. In various levels, we will measure the influence of constraints on information availability and trade rules, to find a way to control the market indirectly.

In order to design a financial market system, we have to consider "cross-references" mechanism in which individuals and organizations with different abilities, technologies and experiences join and influence each other while learning and creating. In order to resolve this difficult issue, we have to invite researchers from various fields such as engineering, economics or psychology to approach from various aspects such as artificial intelligence, artificial market, cognitive science, or learning theory in addition to conventional market research. U-Mart has been developed aiming at providing a common test bed that can be used by researchers who are interested in the motions of economical and social systems like the financial market or behaviors of economic entities under such systems.

Currently, the artificial futures market, developed for a study purpose, is also being used as a courseware for programming practice or market analysis at universities. At the same time, while providing many experimental data and opportunities for investment program collections, we have held open experiments to provide many researchers from various fields with discussion opportunities.

1.2 Activities of U-Mart Project

Now, activities of U-Mart project can divide into 3 direction, 1) research, 2) education and 3) open experiment (competition). These 3 activities are associated with each other. Open experiment has been one of the most important events of U-Mart project. U-Mart Organizing Committee and U-Mart System Operating Committee were organized to plan and hold international open experiment.

Research: As one of Japanese top artificial market research projects, many researchers join this project and do various activities. The major objective of this project is to design a financial market system. More specifically, we hope to establish market control methods by controlling the extent and scope of information disclosure with elements such as circuit breakers including commission rate and price movement limits, market maker, indicative price calculation methods, and changes in information update intervals. We measure information value and information tradeoffs (e.g. liquidity or stability) to do basic research to use information disclosures timing and scope as market control parameters.

Education: U-Mart System is used as an excellent courseware for engineering and economics. Engineering educational institutions use the U-Mart system for programming practices. Also the investment program is very useful for practice because it can actually be operated, is open to set objectives from very simple motivates students by providing opportunities for competitions and other events (open experiments).

Open Experiment (competition): Experiments open to the public inviting public machine agents and human agents, and related discussions inviting experts from various fields are categorized as event activities. In recent years, UMIE 20xx series international open experiments and U-mart20xx series domestic open experiments are periodically held. Also, we have special for tutorial sessions at international and domestic conferences hosted by NAACSOS, ISAGA, and Japan Association for Evolutional Economics, and Information Processing Society of Japan. At each event, we collect and report the results of U-Mart research as well as provide experts from various fields with discussion opportunities by having panel discussions.

These three types of activities are inseparably tied. Part of their relationships is shown in the above figure. Machine agents invited to open experiments are necessary to increase the diversity of agent sets used for research. The diversity motivates researchers from various fields to have symposiums and workshops to gather and it serves as a springboard for another open experiment or joint research. The set of tools developed for educational purposes are used for research and events. Many machine agents have been developed through educational courses and have contributed to agent sets used for further research. More economics students join U-Mart as human agents, and more experiment opportunities are given. Also, the students have proposed GUI improvement ideas and have contributed to help develop new tools used for event activities. As more open experiments are held, more problems must be resolved using the artificial market are found as well as logs to be analyzed. Also as the research progressed more, purposes of open experiments have become clearer, and rules & systems have changed.

2. U-Mart System

The U-Mart System contains tools to be used for connecting human and machine agents via LAN or Internet at the same time for trading, and set of tools used for practicing transactions and developing machine agent with user's own PC. There are five main tools. All tools have almost the same look & feel, and can share parts and machine agents each other.

Market Server: It is the core of the U-Mart System. It acts as a marketing tool (i.e. calculate total sum of orders to realize the trade) and as an agent's asset management tool. It sends various data including market conditions, individual agent's asset quality, and ordering trends via network. Also you can view these data using this tool.

Human Agent Trading Terminal: A tool necessary for a human agent to join trading. It sends orders and shows a variety of information from the server.

Market Simulator: It is used for learning the outline of U-Mart trading or for practice when a user tries to join the market as a human agent. These tools have the same look & feel as the Human Agent Trading Terminal for network. You can compete with a built-in machine agent.

Machine Agent Adapter: It works for communication functions of machine agent that only includes strategic parts. Machine agents use this tool to join in trades from client PCs.

Machine Agent Viewer: It is used to let the user's self-made agent compete with a built-in machine agent within the user's own PC. You can use it to trace the self-made agent's asset conditions and orders stepwise to check if it behaves as expected or you find any unexpected conditions.

3. Open Experiment (Competition)

In the U-Mart Project, open experiments are periodically held. Open experiments have served as prefaces to U-Mart's new researches, educational targets for programming or financial investment classes, or test cases of various researches. So far we have done seven open experiments as follows:

PreU-Mart2000 Machine Agent, at SICE Souhatu Summer School
U-Mart2001 Machine Agent and Human Agent, at SICE Souhatu Summer School
UMIE2002 Machine Agent, at CASOS conference
U-Mart2002 Machine Agent and Human Agent, at SICE emergence system symposium
UMIE2003 Machine Agent, at NAACSOS conference
U-Mart2003 Machine Agent and Human Agent, at ISAGA conference
UMIE2004 Machine Agent, at AESCS conference

We held the first open experiment, PreU-Mart 2000 to see if U-Mart's System would work as designed. So "Pre" meant that it was not a formal one. We had many things to confirm – Would a machine agent designed based on "U-Mart Protocol"(SVMP) operate correctly? Would the U-Mart Server appropriately process various commands received from several agents concurrently? Would U-Mart work as a futures market? ...etc. Participants brought their own machine agents and laptop PCs to the experiment site to connect to the U-Mart System for the first time. They managed to do all of the planned tasks and completed the experiment over night. As a result, many agents went bankrupt, because inflation and collapse occurred often, although most functions of the system including communication using the M-Mart Protocol, U-Mart Market and accounting functions worked correctly. Contrary to our expectations, we found problems with the system as a market through the results of experiments. One of the problems was, for example, random agents (agents randomly selling and buying at around the spot price) developed for debugging always led the market.

One year after the first experiment, our first formal experiment in U-Mart2001 was held to research the artificial futures market. Human and machine agents participated in this experiment according to the first purpose of the U-Mart Project. Machine agents were collected prior to the experiment and participated in several competitions using five types of the time series (i.e. random, up, down, reverse, oscillate), and excellent machine agents were awarded. And on the day of the experiment, the "actual" competition was held and both machine and human agents participated. At the experiment, the absence of random agents led to inflation and collapse, but less frequently than Pre-Mart2000. The market became stable after random agents joined. As the result, we found that agents with abundant assets were strong when inflation or collapse occurred and random agents were very strong in any situation. Because the random agents placed stop orders at around a spot price, naturally their transactions worked like arbitrage trading, so that they were able to secure stable profits and at the same time contributed to the market's stabilization. Although machine agent development kits (to be described later) had been distributed prior to the experiment, the time required to do the pre-experiment was same that of an ordinal experiment (60 minutes), because machine agents who directly corresponded to the U-Mark Protocol also participated.

In 2002, the first international open experiment was held. Taking this occasion, the purposes of the open experiment were clarified and its contents were largely improved. The most major change was that positions of two types of open experiments were clarified: only machine agents can participate in an international open experiment (UMIE 200X), and both human agents and real-time processing machine agents can participate in domestic open experiments (U-Mart200X). As for international open experiments, participating strategic-class machine agents can be transferred via e-mail, so that the participants can join the market from everywhere in the world at any time. If we know that participants are all machine agents in advance, we can invite only machine agents who are free from concern about itayose (a trading method used when orders are flooded in a market: selling/buying orders are collected until the number of both orders. Through these experiments, positions and rules of open experiments becomes the same while adjusting the price according to the volume of orders, then at last, all are sold/bought at the same price) interval, to have an acceleration experiment. In fact, only strategic-class machine agents using machine agent development kits (developed by Professor Kita, etc., Tokyo Institute of Technology, for use in class) were invited to the first international open experiment. If you use a machine agent development kit, five types of data (time series of futures market price, time series of spot price, number of future goods currently retained, current cash balance, and remaining possible number of itayose) are automatically given and you can develop a machine agent only by creating a class implementing the strategic part for order output. The agent simulator that is developed in the same way is also included in the kit. The agent simulator enables a user to compete with a maximum of ten machine agents simultaneously using his/her own PC, analyze competitors' logs and track their selling/buying activities. With these features, actions of machine agents are traceable step-by-step so that more practical algorithm development and more detailed tuning are possible. As an acceleration experiment can be conducted smoothly, evaluation criteria for agents have changed. Conventionally, agents who made the biggest were regarded excellent and awarded, but that meant high-risk, high-return investing was more advantageous in the competition. We thought that was not a preferable and improved evaluation method. We set four criteria (winning percentage, maximum gain, average gain, and bankruptcy percentage) and evaluate the scores comprehensively based on Pareto-

ranking concept. In 2002, the first international open experiment UMIE2002 was held. And among the participants, an agent developed by students of Tokyo University as a task in class and an agent implementing the decision-support system that was using an on-line learning ability developed by Osaka Prefecture University had remarkable scores.

On the other hand, domestic open experiment U-Mart 200x provides university or graduated school students who have used the U-Mart System in classes with good opportunities to gather and compete. Thus, students are more motivated by working toward this open experiment. And because more human agents who are seriously working on investments participate in the experiment, much more practical data is collected. This experiment is also good for testing machine agents with real-time processing functions. Since data/actions the agents developed by the agent development kit (Strategic-class agents) can use or take are limited, they are not allowed to try many ideas like using data changing time to time (e.g. other agents' order information) or investing in collaboration with other agents. Participants are allowed to bring their own PCs and the experiment is a good opportunity for them to compete with other challenging machine agents. In 2002, another domestic open experiment, U-Mart 2002 was held and students of Osaka Sangyo University who had used U-Mart for an investment practice in the class, students of Chuo University, and graduate students who had developed machine agents participated. Especially students who had achieved excellent   performance in the class of Osaka Sangyo University (so called "speculators") also scored high marks on the experiment. Among real-time processing machine agents, an agent that exchanged data with other agents and chose the most appropriate strategy on the spot, the development by Team Sawa from Tokyo Institute of Technology, was outstanding. In 2003, teams who had learned from the results of the previous open experiment received high scores. Especially, among machine agents, "agents who used short-run trends" and "agents with on-line learning ability" mostly achieved high scores. At both UMIE 2003 and U-Mart 2003, Tokyo Institute of Technology's agent that was developed based on the experience at the previous experiment won first prizes. Prototype of U-Mart System Version 2.0 was first used at the domestic open experiment in 2003, U-Mart 2003.

4. Acknowledgement

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