F-Trade: An Agent-Mining Symbiont for Financial Services

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ABSTRACT
The interaction and integration of agent technology and data mining presents prominent benefits to solve some of challenging issues in individual areas. For instance, data mining can enhance agent learning, while agent can benefit data mining with distributed pattern discovery. In this paper, we summarize the main functionalities and features of an agent service and data mining symbiont -- F-Trade. The F-Trade is constructed in Java agent service following the theory of open complex agent systems. We demonstrate the roles of agents in building up the F-Trade, as well as how agents can support data mining. On the other hand, data mining is used to strengthen agents. F-Trade provides flexible and efficient services of trading evidence back-testing, optimization and discovery, as well as plug and play of algorithms, data and system modules for financial trading and surveillance with online connectivity to huge quantities of global market data.

Categories and Subject Descriptors
I.2.11 [Distributed Artificial Intelligence]: *Multiagent systems.*

General Terms
Design, Economics.

Keywords
Agent-mining interaction, open complex agent system, finance.

1. INTRODUCTION
In the past twenty years, two of most prominent, dynamic and exciting research areas ---- autonomous agent and multi-agent systems (AAMAS) [1] and data mining (or knowledge discovery in databases (KDD)) [2] have emerged and developed separately. These two independent research streams have been created and originally evolving with separate aims and objectives. In recent years, people in respective areas realize some issues are challenging and can be complemented by techniques in the other area. For instance, intelligence emergence of agent systems may be greatly enhanced by introducing machine learning capability into agents. This is evidenced by an increasingly trend emerged. The trend is the interaction and integration between agent and mining [3]. Its development is towards a first-class citizen in the science and technology family [3].

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In this paper, we present a system – F-Trade, which is an agent and mining symbiont. In agent area, we claim and model F-Trade as a kind of open complex agent systems [7,8], which present special system complexities. In particular, the F-Trade shows the complementary advantages by integrating agent-driven data mining with data mining-driven agents, as well as dealing with mutual issues in agent and mining interaction. The F-Trade is flexible and effective to serving for financial data mining for trading and surveillance decision-support in the real world.

2. RELATED WORK
The emergence of agent-mining interaction is driven by mutual needs from agent and mining areas. In AAMAS, agent is short of means for in-depth data analysis, efficient data processing, intelligence emergence, learning capability, user modeling, and decision optimization. While the roles of data mining in agent systems are limited in aspects such as system infrastructure and support, distributed management, preprocessing and learning. Agent-mining interaction has potential to complement each other, and create super-intelligent systems that cannot be reached by respective efforts. This fosters the birth of agent-mining symbiosis and agent-mining systems. The agent-mining interaction website[1] presents a comprehensive survey of research on the topics.

3. F-Trade INFRASTRUCTURE
3.1 F-Trade Functions
The F-Trade [2] [4-6] is originally the initialism of Financial Trading Rules Automated Development and Evaluation. Now it is evolved into a web-based data mining infrastructure for trading and surveillance support in capital markets. Its users include traders, fund managers, data mining and financial researchers.

The F-Trade supports online automated plug and play of, and automatic input/output interface construction for, trading rules and data mining algorithms, data sources, and system components. It also supports personalized system reconstruction, and dynamic system and function expansion. It also offers remote data connection, management, extraction, processing and multi-level presentation. The F-Trade provides flexible supports for online back-testing, training/test, optimization and evaluation of trading strategies and data mining algorithms. Users can plug in, subscribe, supervise and optimize trading and mining algorithms in an either human-machine cooperated or automated manner.

3.2 Open Complex Agent Systems
The above-mentioned functions of the F-Trade indicate that it presents system complexities such as a great many of system

[1] www-staff.it.uts.edu.au/~lbcao/amii/amii.htm
[2] www.f-trade.info, www.ftrade.info

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constituents, openness, distribution, interaction, hierarchy, integration, socialization, uncertainty and human involvement. An agent-based problem-solving system tackling such complexities belongs to *open complex agent systems* (OCAS) [7,8]. OCAS is critical because they can tackle some complex problems that cannot be handled by simple agent systems.

The system analysis and design of OCAS is not a trivial task. In [7,8], we proposed *organization and service oriented analysis and design* (OSOAD). It consists of a set of mechanisms for *organizational abstraction* (OA), *organization-oriented analysis* (OOA), *agent service-oriented design* (ASOD). Following the OCAS and its OSOAD methodology, the F-Trade was modeled.

3.3 Agent Service-Based F-Trade

As discussed in [4-6], the implementation of the F-Trade is based on the integration of agent-based system and service-oriented computing. The agent-based service-oriented computing involves agent service description, ontology and metadata, location and directory, mediation and transport, as well as discovery. The F-Trade is built in Java agent services with Windows/Linux/Unix. System configuration and metadata management is based on XML. A super-server serves for the application server, another one acts as data warehouse. It is constructed with online connectivity to distributed data sources including huge stock data from CMCRC, SIRCA and AC3[3] as well as user-specific data.

4. AGENT-MINING INTERACTION

4.1 Agent-Driven Data Mining

Major roles played by agents in the F-Trade consist of agent service-based architecture, agent-driven human involvement, agentized trading strategies and data mining algorithms. Agent is used for data source management and data collection. Data request/response and message passing are conducted by agents roaming between clients, the application server and remote data sources. Agent and service recommenders provide optimum parameters, and algorithms/rules to users. It is shown agents can enhance KDD (knowledge discovery in data) in many aspects.

4.2 Data Mining-Driven Agents

In the F-Trade, data mining assists the system in aspects such as KDD-driven trading rule/algorithm recommender agents, KDD-driven user services, KDD-driven trading agent optimizers, mining actionable trading rules in generic trading pattern set, parameter tuning of algorithm agents through data mining, etc. The use of KDD greatly enhances agent intelligence.

4.3 Mutual Issues

Mutual issues refer to those in both agent and mining, which are necessary for agent-mining interaction. In the F-Trade, the following issues have been studied: ontology-based domain knowledge representation and transformation to problem-solving terminology [9], human involvement, and agent-based human interaction for algorithm supervision, optimization and evaluation, etc. The studies of these issues can benefit not only respective areas, but the emergence of super-intelligent systems.

[3] www.cmcrc.com, www.sirca.org.au, www.ac3.com.au

5. PERFORMANCE EVALUATION

The performance of the F-Trade is evaluated from two aspects. First, the F-Trade presents distinct system features including open infrastructure, supporting dynamic human involvement and supervision, flexible and personalized system reconstruction, plug and play of agents-based algorithms, data sources and system modules, and services such as iterative back-testing, optimization, recommendation and user services in a flexible and efficient way.

The other side is industry testing and output actionability. In the F-Trade, trading strategies and data mining algorithms are trained and tested in real data guided by domain requests and users. The output therefore is very practical. In particular, we emphasize the actionable capability of algorithms, output and the system. The F-Trade has been demonstrated to academic events such as IAT 2004 and PAKDD2004, business companies like Credit Swiss and CMCRC, and colleagues in Hongkong, Berlin, Sydney, etc.

6. CONCLUSIONS

This paper presents an agent-mining symbiont – the F-Trade. It involves agent technology for system analysis, design and implementation, and supporting data mining. It also offers data mining capability for the optimization and recommendation of trading rules and mining algorithms, and agent intelligence enhancement. The F-Trade offers trading and surveillance services for financial markets linking to real data.

We are now implementing the research findings of KDD-based rule optimization, parallel computing into the F-Trade. More work is on the OSOAD and agent-mining complementation.

7. ACKNOWLEDGMENTS

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