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信学技法
TECHNICAL REPORT OF IEICE.

# 電子商取引用知的なエージェントに関する研究開発

ベルーズ H. ファー†　河野 善彌

† 〒 338 埼玉県浦和市下大久保 255
埼玉大学情報システム工学科
Tel. 048-858-9612,　Fax. 048-858-3716
E-mail. far@cit.ics.saitama-u.ac.jp
http://www.cit.ics.saitama-u.ac.jp/~far/

あらまし:　現 在, 新たな商取引きの手段としてネットワーク上の電子商取り引きが注目されている. 本研究では，電子商取引を専門に行うエキスパートエージェントを複数構築し, 具体的に，顧客，サーチ，カタログ，小売，ベンダー，運搬エージェントなどを実現する．各エージェントの基本構成を統一することにより, システムの構築が容易になる．取り引き自体にユーザーが労力を使わずにすむようにするために, 電子商取引に必要となる作業を全てエキスパートエージェントに代行させる．これにより, ユーザーは電子商取引を行うための手順を知る必要がなくなり, ユーザー本来の目的である商品の売買や, 情報の収集といった作業に専念することができる.

和文キーワード　*WWW,* **電子商取引**, **ソフトウェアエージェント**

# Intelligent Agents for Electronic Commerce

Behrouz H. FAR†　Zenya KOONO

†Department of Information and Computer Science,
Faculty of Engineering, Saitama University
255 Shimo-okubo, Urawa 338, Saitama, Japan
Tel. +81-48-858-9612,　Fax. +81-48-858-3716
E-mail. far@cit.ics.saitama-u.ac.jp
http://www.cit.ics.saitama-u.ac.jp/~far/

Abstract:　In this project we have proposed an agent model for EC components that blends the traditional expert systems' reasoning engine with a multi-layer knowledge base, communication and documentation engines. EC is viewed as a society of software agents, such as customer, search, catalog, retailer, vendor, delivery and banking agents, that interact and negotiate with each other. Each agent has a knowledge-base and a reasoning engine, a communication engine and a documentation engine. The knowledge-base is organized in three layers: skill layer, rule layer and knowledge layer (S-R-K layers). For each EC agent, we identify the class of problems to be solved and build the knowledge base gradually for each layer. We believe that using this multi-layer knowledge base system will speed up the reasoning and ultimately reduce the operation costs.

Key words　*WWW, Electronic Commerce, Software Agent*

# 1 Introduction

A new challenge in AI is extending the functionality of traditional expert systems to be able to work on the WWW. Electronic Commerce (EC) is a potential application for such expert systems.

In the Ex-W-Pert Project we have proposed an agent model for Electronic Commerce (EC) components that blends the traditional expert systems' reasoning engine with a multi-layer knowledge base, communication and documentation engines.

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The structure of this paper is as follows. In Section 2 an agent oriented model of EC is introduced. In Section 3 a general model for EC agents is presented. Implementation issues are discussed in Section 4. Section 5 is a discussion on advantages and drawbacks and finally, a conclusion is given in Section 6.

# 2 Agent Model of EC

Conventional EC models are build upon functional components, such as *commodity information*, *ordering*, *payment* and *electronic brokerage* [Pyle, 1996].

*Commodity information* includes a showcase of goods and services offered, mainly in the form of a simple *home page* or a complicated electronic shopping mall. This is the heart of EC and must include interactive catalogs and directories. Electronic catalog system offers more flexibility as compared to the conventional catalog repository and can answer to search requests, etc. *WWW based ordering system* includes a mechanism for placing and collecting orders, processing and/or distributing them. *Payment system* features a fail safe mechanism for exchanging goods for electronic money. Finally, *electronic brokerage* involves special mechanism for offering a more efficient or safer service, and various add-on tasks such as bidding and bargaining.

In this project, EC is viewed as a society of software agents that are scattered over the WWW space and interact and negotiate with each other. We have devised 7 types of EC agents, namely: *customer*, *search*, *catalog*, *retailer*, *vendor*, *banking* and *delivery* agents. Each agent is called an *Ex-W-Pert Agent*. These agents either fully implement or share part of functions described above.

Each EC agent is and expert in its own field and may interact with its human counterpart or behave autonomously. For instance, a *customer agent* receives instruction from a user to search the WWW space, to find a catalog and vendor for a desired product and to sign a contract. A retailer agent, on the other hand, identifies a customer's needs and takes parts in bidding to win the contract. A *delivery agent* competes to get a shipment contract, etc.

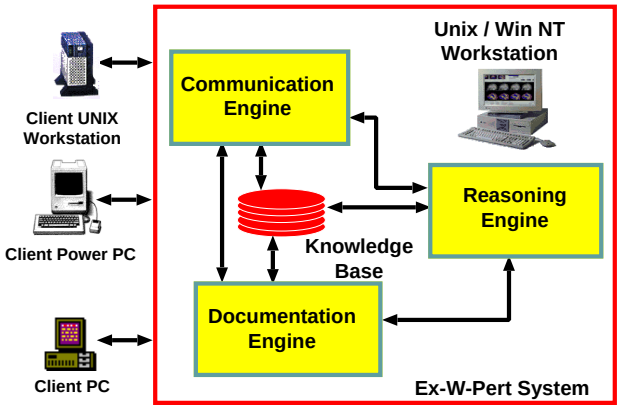


Figure 1: A General Purpose EC Agent

# 3 A Model for EC Agents

Figure 1 shows an overview of the Ex-W-Pert agents. Similar to conventional expert systems, each agent, no matter local or remote, has its own *local knowledge-base* and *reasoning engine*. As compared to the conventional expert systems, a main difference is that all agents have an additional *communication engine* and a *documentation engine*. The communication and documen-

tation engines facilitate communication and navigation on the internet. A typical message pass among the agents is depicted in Figure 2. Each agent processes a request that is within its own capabilities and reports the results to the other agents.

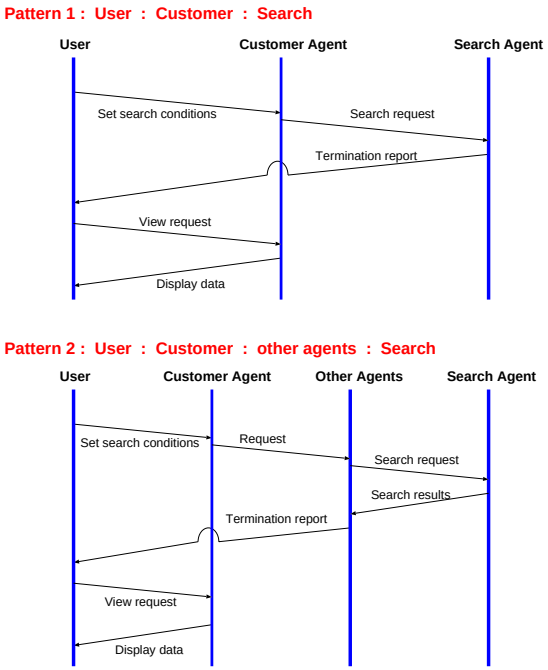


Figure 2: Typical interaction of EC Agent

### 3.1 Reasoning engine and knowledge base

In order to have EC agents behave intelligently as of their human counterparts, they must embody knowledge at various levels of abstraction.

Human experts when engaged with a goal oriented task, try to achieve the goal within the constraints imposed by the task and avoid *cognitive overload* through selective utilization of their accessible knowledge.

It is believed that human experts possess a conceptual (mental reference) model of how the objects in the external world interact based on standard operating procedures. Such models can further be applied to novel or unanticipated situations. The structure of the conceptual model is hierarchical.

Conceptual models have a hierarchical structure defined best by the Skill-Rule-Knowledge (S-R-K) levels[Rasmussen, 1985].

*level–1:* Skill-based level:
At this level a query of an agent is accepted and by searching the knowledge-base, proper immediate action is selected. For instance, in case of a search agent, the query comes in the form of a list of keywords, submitted by the customer agent. Then search agent finds related keywords and conducts search using the new set of keywords.

*level–2:* Rule-based level:
At this level a query of an agent is accepted and a case data base is consulted to determine the action. For example, in case of a search agent, the initial query comes in the form of a sentence with reduced and restricted grammar. This is adopted to avoid unnecessary overload of natural language processing. Then a set of similar cases are searched and cases matching the needs of the user are retrieved. Further search is conducted based on the instructions recorded on the matched cases.

*level–3:* Knowledge-based level:
At this level a query is accepted and the agent uses its knowledge base to interact with the other agent and identify the actual needs. After this problem identification level, the proper action is determined by consulting other agents. For example, a search is conducted by consulting a catalog agent, which in turn, contacts the vendor and retailer agents for proper information.

### 3.2 Communication and Documentation engine

The EC agents interact based on a 3 step protocol composed of *agent identification*, *query processing* and *payment processing*. In the agent identification step, necessary data for identifying an agent is submitted and acknowledged. In query processing step the kind and contents of the required service is specified and in the payment processing step the price and payment method is negotiated.

The communication engine is mainly responsible for maintaining connection to the other agents and managing messages. The above mentioned protocol is handled by a message management

mechanism whose multi-thread implemetation is depicted in Figure 3. With an incoming message, a new thread is created and the message handler decides upon a proper process by consulting the reasoning engine and appropriate layer of the knowledge base.

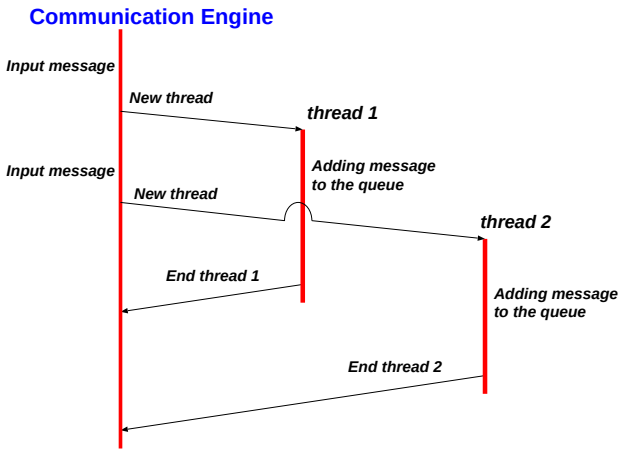


Figure 3: Multi-thread implementation of the Communication Engine

The documentation engine perform three main tasks:

- Acquiring data from the other agents, as requested by the reasoning and communication engines.
- Preparing and reformatting data items to be appropriate for transferring over the internet.
- Maintaining index of data items transferred and/or retrieved.

Using documentation and communication engines, the local knowledge can be shared with the agents.

Note that communication through the *HTTP* requires all the transferable information be first written into a hypertext file and then transmitted. Therefore the documentation engine is responsible for preparing the information and rewriting the information in the hypertext form before delivering it to the WWW system.

# 4 Implementation

From implementation point of view, each agent is actually composed of:

- A data translator for converting the input requests to an internal data structure and conversely, convert the internal structure to output data.
- A reasoning engine together with customization and learning modules.
- A local multi-layer knowledge base, as described in Section 3.1, including domain rules, case data base, etc.
- An interface module that can be plugged into a window-based user interface for interacting with the user and reporting thus fulfilled jobs.
- A documentation engine for converting data to and from the hypertext and other formats suitable for transferring over the WWW.
- A communication engine, for launching http, ftp, etc., applications, managing I/O messages and communicating to the other agents.

There is a physical *home* for each agent, i.e., a platform that the agent can use its resources to run and offers user interface facilities. Many agents may share the same home, but due to security concerns, an agent cannot have more than one home.

All the transaction and communication activities are done at the background and the user is not required to be aware of the *HTTP* connections. Therefore, it is not necessary for the user to have networking and WWW knowledge in order to use and interact with the system. However, advanced users can activate the preference and customization functions in order to get more advanced features of the system.

## 4.1 Customer and Search agents

Fig. 4 shows how the customer agent receives an instruction and transfer it to a search agent, and how the search agent retrieve and summarize the acquired data by attending to the user's questions, clarifying the needs, conducting search, fetching data, selecting relevant data items, arranging and ordering the data, and making a report of the results.

A user interacts with the customer agent by either specifying a number of keywords or an input query. The system considers activating the relevant level of skill-rule-knowledge based

search. In each case a proper set of keywords and search attributes are identified. The "WHERE" package is used to communicate with the other index servers on the internet. The outcome of inquiry comes in the form of lists of candidate URLs that possibly contain the data. These lists may have superfluous and partially unrelated data items that are trimmed and based on the scoring algorithm a proper list of URLs is devised. Then the "RETRIEVE" package is used to actually fetch the data and the "REPORT" package is used to index and make a report of the thus acquired data. This report is displayed to the user on demand. Figure 5 shows the implemented modules of the Search and Customer Agents and their prime functions.

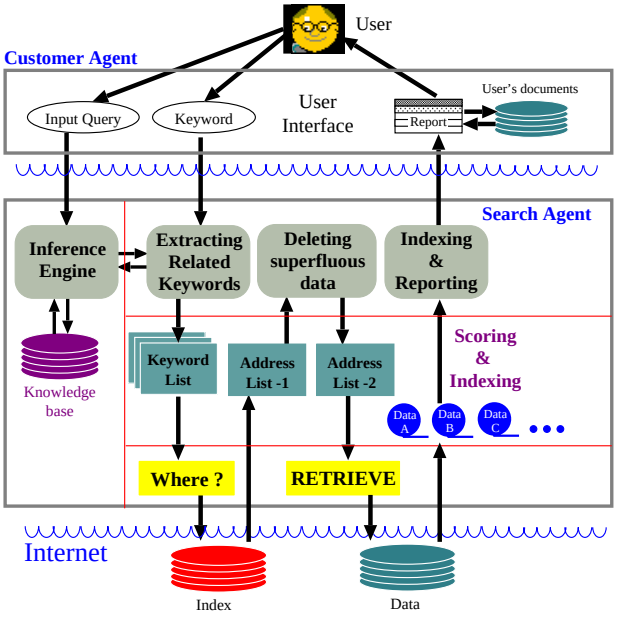


Figure 4: Search and Customer Agents

Here, we have considered building a window based user interface to serve both the beginner and advanced users. Fig. 6 shows examples of the user interface windows for the search agent [**?**]. The interface unit is composed of a set of hierarchically related windows. It starts with the most simple functions and becomes more complicated as going down the hierarchy. Usually, the first interface window depicts the main functions of the system together with troubleshooting and help menus. By clicking on a button, another window is popped up that offers more detailed functions.

| Program Name | Main Functions |
|---|---|
| Search.class | Overall control program of Search Agent |
| ├ QManager.class | Message Manager |
| ├ ComEgn.class | Communication Engine |
| │ └ IDmanager.class | User ID manager |
| ├ ReaEgn.class | Reasoning Engine |
| │ ├ Case.class | Case-base reasoning module |
| │ ├ Tree.class | Similarity reasoning module |
| │ ├ RequestAd.class | Consulting external search engines |
| │ ├ FormatList.class | Merge and revise of URL lists |
| │ └ UrlGetter.class | Fetch URLs |
| └ DocEgn.class | Documentation Engine |
| └ MakeIndex.class | Index and report generator unit |
| Customer.class | Main class of the Customer Agent |
| └ Maingamen.class | Control of main screen |
| └ Kensaku.class | Control of search screen |
| ├ Kensakusu.class | Control of search set window |
| ├ Kanrendo.class | Control of relational keywords window |
| ├ Shikyudo.class | Control of urgency set window |
| ├ Shushulevel.class | Control of search case set window |
| ├ Jikoku.class | Control of time set window |
| ├ Hozon.class | Control of save set window |
| ├ Inputkey.class | Control of input window |
| └ Kakunin.class | Control of confirmation window |

Figure 5: Program modules of the Search and Customer Agents

### 4.2 Catalog agent

Figure 7 shows how a catalog agent interacts with an active data base of goods in order to retrieve the kind of information which is not available through conventional search engines. For example, dealers List, bidding and bargaining information.

Vendors and dealers first record their good in the data base and the catalog agent retrieves the relevant data items from the data base and produces a hypertext catalog document that fits the customer's needs. This document is produced on the fly, based on the instructions given by the customer agent.

## 5 Discussion

Some current issues in EC are mentioned in [Adam *et al.*, 1996], [Pyle, 1996], [Tatenbaum, 1997] and [Kambil, 1997]. The traditional idea of Electronic Commerce, by means of electronic data interchange (EDI) and private or local area networks (LAN) has been around for some years. What internet based EC adds to this is changing from private networks to a global network together with interactive data interchange, with a reasonable cost, but at the expense of lower security. Moving to a global network implies less control over the kind and amount of data available. Most of the research in EC is concentrated

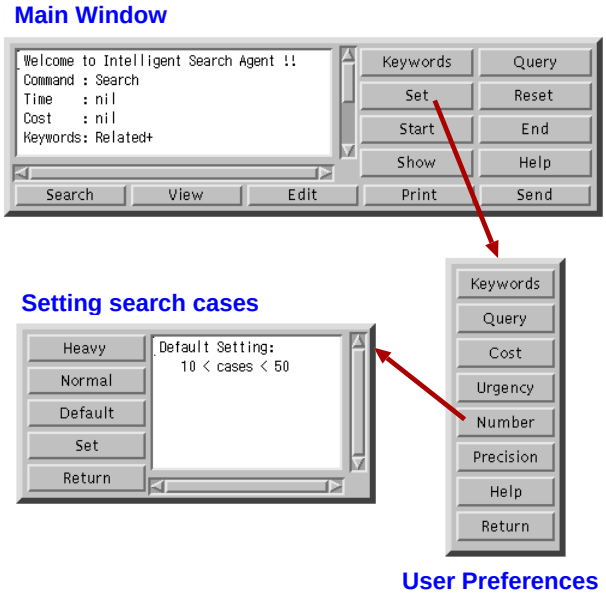


Figure 6: User Interface

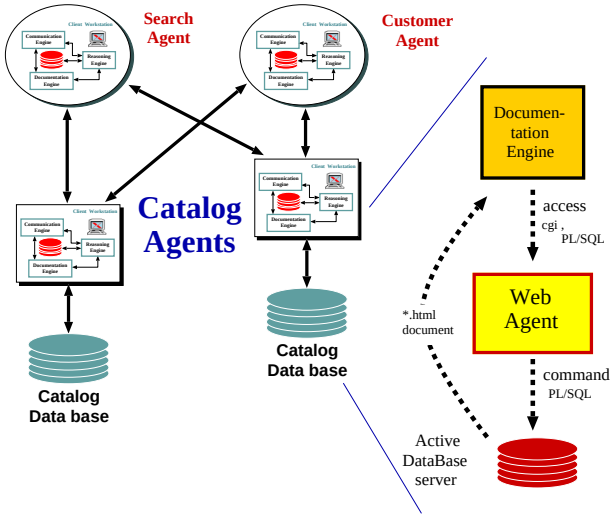


Figure 7: Catalog Agent

on identification and implementation of EC functions. We think that implementing and applying AI techniques to EC is a new and challenging task for both fields.

In this project we propose application of the Ex-W-Pert system architecture [Far *et al.*, 1996] for such implementation, that is, adding the communication and documentation engines to the conventional expert systems. In this project various hardware (PC, Workstation, Mac, etc.) with various operating systems (MAC, WINDOWS, UNIX, etc.) and various methods of connection to the internet (LAN, VAN, Internet) are considered and a mechanism for communication and cooperation is proposed.

## 6 Conclusion

In this paper, a general model for Electronic Commerce (EC) components was introduced and the ways of implementing intelligence into a WWW based search engine was discussed. An architecture for WWW based multi-layer intelligent EC agents was demonstrated. Basic techniques for implementing transaction processing, planning, security are investigated and software agents of the EC family are currently under active development.


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