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CONTENTS

◇ Artificial Intelligence Research Frontiers on the Internet 1
Alexander Franz (Sony Corporation)

◇ WWW 情報検索サービスの技術展開 5
Information Retrieval Services on the WWW
林 良彦, 菊井玄一郎, 鷲崎誠司 (NTT 情報通信研究所)
Yoshihiko Hyayashi, Gen'itiro Kikui, and Seiji Susaki (NTT Information and Communication Systems Laboratories)

◇ EX-W-Pert System: WWW Based Intelligent Agents for Electronic Commerce 11
ベルーズ H. ファー, 河野 善彌 (埼玉大学 情報システム工学科)
Behrouz H. Far and Zenya Koono (Saitama University)

◇ 視点を利用した WWW 上の情報収集と活用 17
Information Gathering and Reusing on WWW with Reflecting Some Viewpoints
伊藤 史朗, 大谷 紀子, 柴田 昇吾, 上田 隆也, 池田 裕治 (キヤノン (株) 情報メディア研究所)
Fumiaki Itoh, Noriko Otani, Shogo Shibata, Takaya Ueda, and Yuji Ikeda (Media Technology Laboratory, Canon Inc.)

◇ ネットワーク型知識表現を利用したグリーンブラウザの実装 23
The Implementation of the Green Browser Using Network Based Knowledge Representation
蔵川圭, 桐山孝司, 馬場靖憲, 梅田靖 (東京大学), 小林英樹 ((株) 東芝)
Kei Kurakawa, Takashi Kiriyama, Yasunori Baba, Yasushi Umeda (University of Tokyo), and Hideki Kobayashi (Toshiba Corp.)

◇ Plangent I: インテリジェント・ネットワークエージェント 29
Plangent I: An Intelligent Network Agent System
永井保夫, 田原康之, 入江豊, 大須賀昭彦, 本位田真一 ((株) 東芝 研究開発センター システム・ソフトウエア生産技術研究所)
Yasuo Nagai, Yasuyuki Tahara, Yutaka Irie, Akihiko Ohsuga, and Shinichi Honiden

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EX-W-Pert System: WWW Based Intelligent Agents for Electronic Commerce

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Abstract: A major topic in the field of network and telecommunications is doing business on the World Wide Web (WWW), which is called Electronic Commerce (EC). Another major topic is blending Artificial Intelligence (AI) techniques with the WWW. In the Ex-W-Pert 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.

Key words *WWW, Electronic Commerce, Software Agent*

1 Introduction

The World Wide Web (WWW) allows people at remotely located sites to communicate and share their ideas using a common communication protocol that can handle text files, images, sounds, forms, etc. WWW embodies a tremendous amount of information and this amount is increasing rapidly [2]. What makes WWW more attractive and useful is the capability of handling URLs (Universal Resource Locators). Using WWW, one can address a file by simply calling the protocol (*HTTP*, *FTP*, gopher, etc.), host, access port and path, respectively. Presently, a common use of Web system is running a client application, using a browsing tool, pointing at a local or proxy server to browse data written in the hypertext format [6]. The hypertext files contain anchors addressing other URLs and making connection to other servers possible.

A major challenge is the prospects of Electronic Commerce (EC) using WWW, i.e., doing business on the WWW. This paper proposes a general model of EC as composed of intelligent software agents, each agent is an expert in its own field. The structure of this paper is as follows. In Section 2 an agent oriented model of EC is introduced. In Section 3 a viewpoint on implementing and applying human knowledge in such agents is given and based on this in Section 4 a general model for EC agents is presented. Section 5 is a discussion on advantages and drawbacks and finally, a conclusion is given in Section 6.

2 Agent Model of EC

2.1 Functional components of EC

The main functional elements in EC are summarized below. Software agents should be designed to implement these functions.

Commodity Information: This 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 requests for search, bargaining and bidding, etc.

WWW Based Ordering System: This includes a mechanism for placing and collecting orders, processing and/or distributing them.

Payment System: This features a fail safe mechanism for exchanging goods for electronic money.

Table 1: Agent components of EC and their functions

	Commodity Information	Ordering System	Payment System	Brokerage System
Customer Agents	Share	Share	Share	Share
Search Agents	Implement	—	—	Share
Catalog Agents	Implement	Share	Share	—
Retailer Agents	Implement	Share	Share	Share
Vendor Agents	Implement	Share	Share	Implement
Banking Agents	Share	Implement	Implement	—
Delivery Agents	Share	Share	Share	—

Electronic Brokerage: This involves special mechanism for offering a more efficient or safer service, and various add-on tasks such as bidding and bargaining.

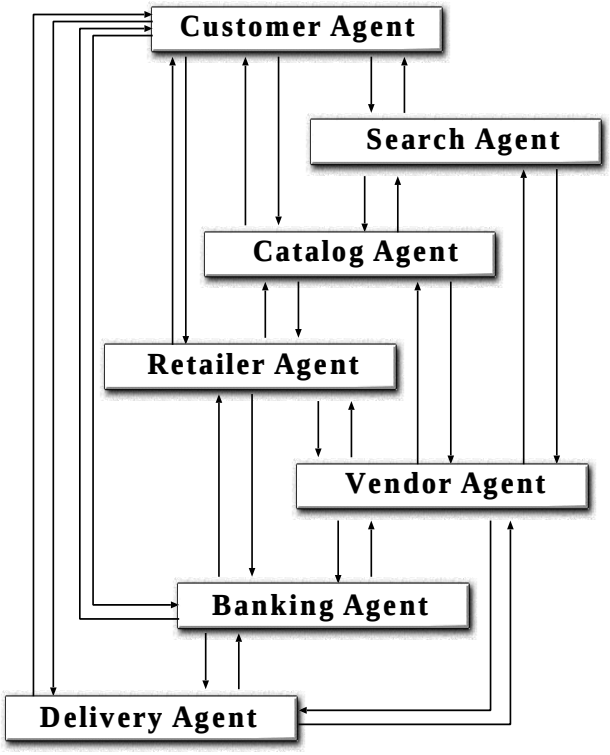

Figure 1: Agent components of EC

2.2 Agent components of EC

In our project, EC is viewed as a society of software agents that interact and negotiate with each other. We have devised 7 types of agents for EC, namely: *customer*, *search*, *catalog*, *retailer*, *vendor*, *banking* and *delivery* agents. Figure 1 depicts an artificial society of such agents. Each agent either fully implements or shares part of functions described above. Table 1 shows functions of each EC agent.

In order to have EC agents behave intelligently as of their human counterparts, they must embody knowledge at various levels of abstraction. This issue is discussed in the following section.

3 Hierarchical Model of Human Behavior

In this section we consider the way of building intelligence into the EC agents.

3.1 Problems

Let's consider a simple case of user attended search [5]. User attended search, by means of conventional browsing tools and search engines normally ends up with the *tunneling* effect of the *cognitive overload*. That is, humans show poor performance in keeping track of all simultaneous intermediate pieces of information, when interacting with the dynamic environment.

The cognitive overload is explained along with three components[3]:

Information accessibility : This problem arises when the effects of a decision is propagated along the decision chains until reaching the target on which the action cannot be direct.

Control-directness : This problem arises when information needed to make decision is not directly accessible and must be inferred along the decision chains.

Counter-intuition : This problem arises when the ability to anticipate a future state becomes limited by many factors such as non-linearities in the domain model, life time of data items, etc.

In building intelligence into the EC agents, we have devised the ways of imitating humans as close as possible. However, an intelligent agent should overcome the above mentioned problems in order to be found useful.

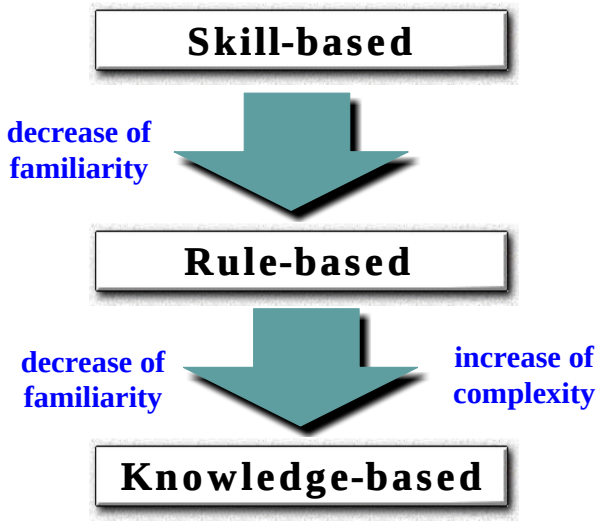

Figure 2: Hierarchical model of human behavior

3.2 The model

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[9] (see Fig. 2). In the S-R-K perspective, skill based level denotes almost routine performance. In this level, human performance is governed by stored patterns of predefined instructions. Such context specific patterns are called *rules-of-thumb* (or symptomatic rules), that map directly from an observation to a ready-made solution.

Rule based level represents more conscious behavior when handling familiar or similar problems. Rule based behavior is conventionally described by case data bases, decision tables, digraphs, fuzzy sets and natural language models [7]. The model for this level is a set of stored *if-then-else* rules.

Knowledge based level accounts for tasks for which common patterns in stored knowledge form do not exist and reasoning should start from the so called *first principles*, starting from problem identification.

In this project, for each EC agent, we identify the class of problems to be solved belonging to each level, build the knowledge base gradually for each level. We believe that using this multi-layer knowledge base system will speed up the reasoning and ultimately reduce the operation costs.

4 A Model for EC Agents

Figure 3 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*. Compared to the conventional expert systems, a main difference is that all agents have additional *communication engine* and *documentation engine*. The communication and documentation engines facilitate communication and navigation on the internet.

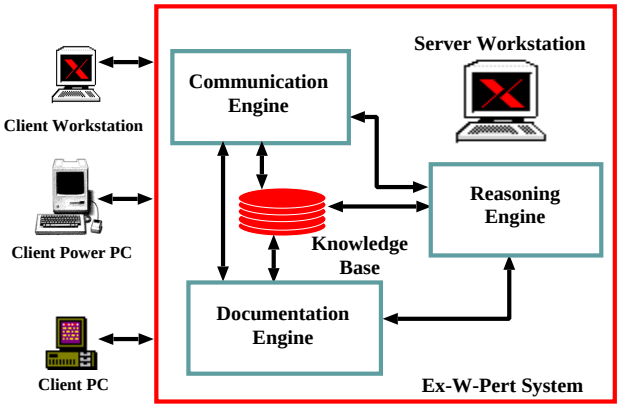

Figure 3: A General Purpose EC Agent

4.1 Reasoning engine and knowledge base

Figure 4 shows the multi-layer structure of the reasoning engine and knowledge base, using the S-R-K model.

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 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 of an agent 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. In case of a search agent, the search is conducted in two phases: object phase and electronic commerce phase. In the object phase ordinary search is practiced as described before. In the electronic commerce phase, the search is conducted by consulting a catalog agent, which in turn, contacts the vendor and retailer agents for proper information.

4.2 Communication engine

The communication module is mainly responsible for maintaining connection to the other agents and managing messages. Figure 5 depicts a mechanism for message management in the communication engine. As it is shown, incoming messages are processed by consulting the knowledge base.

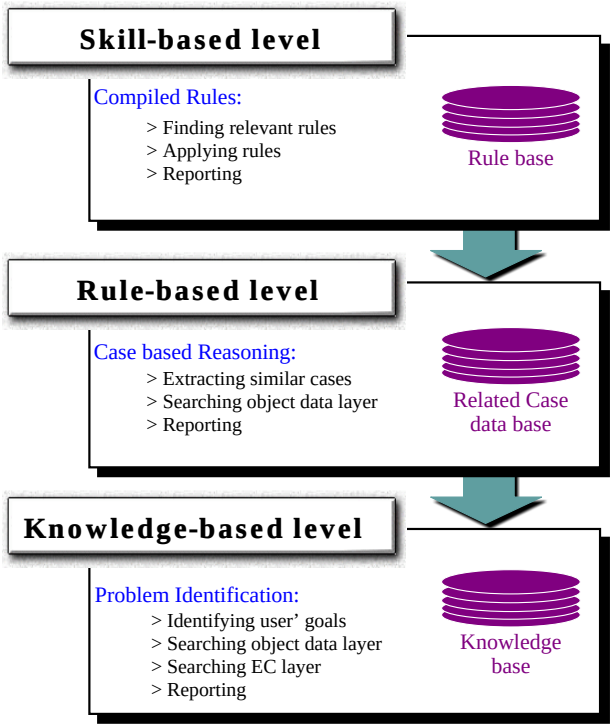

Figure 4: Knowledge base and reasoning engine

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.

4.3 Documentation engine

The documentation module 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.

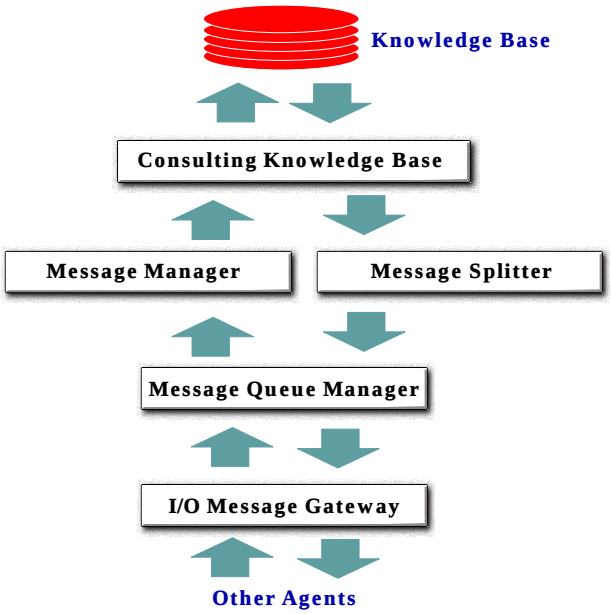

Figure 5: Communication Engine

4.4 Implementation

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

- A data translator for converting the input data to an internal frame data structure and conversely, convert the internal frame structure to output data.
- A reasoning engine together with customization and learning modules.
- A local multi-layer knowledge base, as described above, 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.

This EC agents reside in a network of engineering workstations and personal computers that are connected by the Local Area Network (LAN), or internet in general and communicate using the NFS and/or HTTP protocols. The main communication protocol is HTTP. All the local units need not run a HTTP daemon if there is a HTTP server workstation supporting them all. However, remote units serving data and documents, must be equipped with a running HTTP server daemon. Free and commercial HTTP server daemons are available for Unix, Mac and Windows platforms.

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.

4.5 User interface

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 [5]. 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.

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.

5 Discussion

Some current issues in EC are mentioned in [1], [8] and [10]. 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

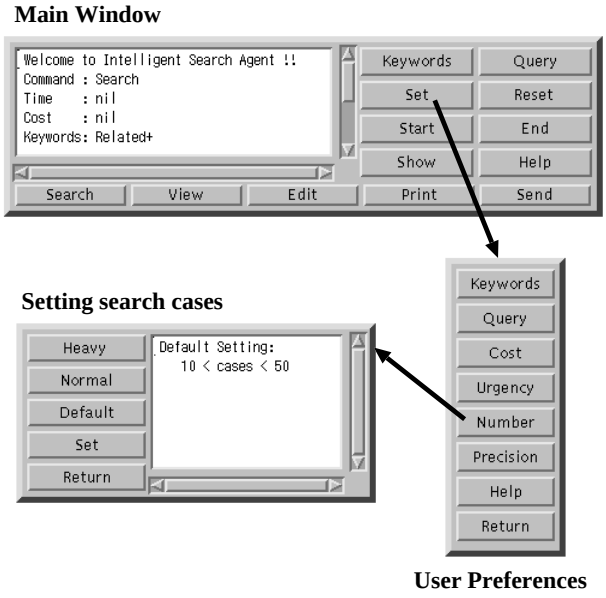

Figure 6: User Interface

over the kind and amount of data available. Most of the research in EC is concentrated on identification and implementation of EC components. 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 [4, 5] 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. Software agents of the EC family are currently under active development.

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