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Reports on FGCS'94 Workshop on Heterogeneous
Cooperative Knowledge-Bases

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Reports on FGCS'94 Workshop on Heterogeneous Cooperative Knowledge-Bases

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During the Japanese FGCS (Fifth Generation Computer Systems) project (1982 – 1992) and its Follow-On project (1992 – 1994), ICOT (Institute for New Generation Computer Technology) and its related groups in computer manufacturers, national research institutes, and universities, have been engaged in research and development on knowledge information processing. For the target, we have developed various systems: a database management system, *Kappa*, a knowledge representation language (or a deductive object-oriented database system), *QUILXOTE*, a constraint logic programming language, *GDCC*, and many knowledge information processing applications such as genetic information processing and legal reasoning.

To develop large scale applications, we focused on integration of various languages and systems, started up a project, *Helios*, for heterogeneous distributed cooperative problem solving systems, and have discussed various technical problems in the HKB-TG (Heterogeneous Knowledge-Base Task Group), the members of which are researchers in various fields from universities and research institutes. The task group decided to hold an international workshop to discuss many related problems more deeply by international researchers after the last international conference, FGCS'94. It is FGCS'94 Workshop on Heterogeneous Cooperative Knowledge-Bases (HCKB-Workshop), which was held on 15th and 16th December, 1994 in Tokyo.

Generally speaking, it is obvious that heterogeneous distributed cooperative system will play an important role not only in the future information systems but also in the present ones. This topic relates with so many re-

search areas including distributed artificial intelligence (DAI), AI, programming languages, databases, operating systems, and distributed processing systems. Many researches are carrying out in those areas, but interchange among those areas are not so sufficient. This workshop aims at gathering researchers in those areas for making fruitful discussions from knowledge processing point of view. That is, it is neither a mini DAI workshop nor a mini database workshop. That is why we planned the workshop internationally.

In spite of a short term of the preparation, 38 papers were submitted from twelve countries including Australia, Brazil, Canada, China, France, Germany, Japan, Korea, Poland, Spain, U.K., and U.S.A. The number shows that the interest in heterogeneous cooperative knowledge-base systems has been increasing and that many people around the world are working on it. The program committee increased the number of accepted papers which had been expected at first: 8 long presentations and 9 short presentations. In the workshop, there were 116 participants including 26 from abroad that was the largest participants among six workshops in conjunction with the symposium. This also shows great interest to the topic of the workshop.

We had four invited talks in the workshop.

First, Michael N. Huhns at MCC gave a talk under the title "Global Information Management via Local Autonomous Agents". His talk was about how a set of autonomous computational agents can cooperate in providing coherent management of information in environments where there are many diverse information resources.

Second, Mike Papazoglou at Queensland University of Technology gave a talk under the title "Using Reflection as a Means for Achieving Cooperation". His talk was about overcoming difficulty of using conventional databases in cooperating systems by introducing a layer of special reflective objects which surround each local database system.

Third, Gio Wiederhold at Stanford University gave a talk under the title "Interoperation, Mediation, and Ontologies". His talk was about addressing the problem of interoperation at a semantic level: the problem is resolved by mediation and ontologies help to give formal model of processing in mediation.

Finally, Les Gasser at University of Southern California gave a talk under the title "Agent Organizations for Information Retrieval and Electronic Commerce: The Next Frontier". His talk was about importance of constructing formal models of wide range of informal conceptual models of organization that we have.

Besides those invited talks, we had sixteen presentations; ten from Japan, and six from abroad. Workshop consisted of six sessions: Application (1) and (2), Cooperation Framework, Knowledge Sharing and Databases, Communication and Cooperation, and CSCW.

In the following, we will list some presentations among them.

Michael R. Genesereth, Narinder P. Singh, and Mustafa A. Syed at Stanford University gave a talk of the title "A Distributed and Anonymous Knowledge Sharing Approach to Software Interoperation". In this presentation, a new approach to software interoperation based on specification sharing was presented. Software components are agents that can be realized in different programming languages, and run on different machines. Furthermore, agents can join to or leave from the system at run time. This system uses the declarative specification for agents to coordinate their interoperation automatically.

Akira Aiba, Kazumasa Yokota, and Hiroshi Tsuda at ICOT made a presentation of the title "Heterogeneous Distributed Cooperative Problem Solving System Helios and Its Cooperation Mechanisms". This presentation is on a system for heterogeneous distributed cooperative problem solving system called *HELIOS*. Agents are encapsulated problem solvers that can be databases, constraint solvers, and application programs realized in different programming languages with different data types. The encapsulation module called a capsule gives transformation methods to make agents communicatable each other, and a module that provides a common space of agents and dispatches messages called an environment gives common data types.

Hideaki Takeda, Kenji Iino, and Toyooki Nishida at NAIST gave us a talk titled "Agent Communication with Multiple Ontologies". They presented on roles of ontologies for building a distributed and heterogeneous knowledgebase system called Knowledgeable Community. First, ontology is a minimum requirement for each agent to join the system. Second, a special agent called mediator analyzes undirected messages and infer candidates of recipient agents by consulting ontology. Third, ontology can be modeled by combination of aspects representing ways of conceptualization.

R. L. Grossman, W. Kohn, and A. Nerode at University of Illinois at Chicago made a presentation titled "Nonlinear Systems, Automata, and Agents: Managing their Symbolic Data Using Light Weight Persistent Object Managers". This presentation is on using "light-weight" persistent object managers and specialized algorithms exploiting them for managing both continuous and discrete data. Managing these data is required since a hybrid

system is a network of continuous input-output systems and discrete digital automata. Introducing external agents that play a role of introducing new digital automata into a hybrid system are also considered.

Shuji Narazaki, Hiroomi Yamamura, and Norihiko Yoshida at Kyushu University made a presentation of the title "Strategies for Selecting Communication Structures in Cooperative Search". They presented on strategies for selecting agents' communication structure in cooperative search using their local histories as a model of their computational environment. Two strategies are proposed in this paper, and their effectiveness are examined by simulations using the traveling salesman problem. These two strategies are extended so as to separate them from application programs using meta-object programming in Object-Oriented Programming Languages.

Shusaku Tsumoto and Hiroshi Tanaka at Tokyo Medical and Dental University gave us a talk of the title "Integration of Heterogeneous Knowledge-Bases in Medical Domain". This is on a system called COBRA. Since medical data consist of many kinds of data from different resources, such as natural language data, sound data from physical examinations, numerical data from laboratory examinations, time-series data from monitoring systems, and medical images for example, X-ray etc., medical databases should be implemented as multidatabases. COBRA is a system for supporting diagnosis and information retrieval of congenital malformation diseases, and integrating natural language data, sound data, numerical data, and medical images into multidatabases on syndrome of congenital malformation.

Keith L. Clark, and Tzone I. Wang at Imperial College made a presentation titled "Distributed Object Oriented Logic Programming". They introduced a programming language/system called DK_Parlog⁺⁺. It is a concurrent logic programming language, and an experimental testbed for distributed applications.

Paul-André Tourtier at INRIA gave us a talk having the title "A flexible facilitator-based cooperation framework". His presentation was about the design of a flexible framework allowing distributed, autonomous, heterogeneous agents to cooperate through communication and interaction. By using a cooperation framework proposed in his presentation, peer-to-peer and client-server interactions, data sharing, use of facilitators, etc. can be provided.

Toru Ishida at Kyoto University told under the title "Bridging Human via Agent Networks". In his talk, he proposed an architecture of agent networks. Each agent learns the preferences of the owner and acts on behalf of the owner in maintaining his/her organizations. He presented about

supporting such an agent network a human organization.

Hisayuki Masui, Masakazu Nomoto, and Yahiko Kambayashi at Kyoto University gave us a talk titled “Representation of Active Rules in Cooperative Work Environment”. In their talk, they discussed how to realize user coordination under the assumption that ECA (Event Condition Action) rules are available. Situation of the systems are presented for users for negotiation among users, since automatic user coordination is impossible. To represent active rules, three models are compared and a generalized IDEF0 model is proposed.

This workshop showed that many researchers in different areas have similar problems and take similar approaches in different terms. We could enjoy stimulus discussions. We concluded that this workshop is very successful, and we expect that there will be many workshops with similar aims.