

reduce the thinking required for each program by generalizing methods tested on various problems and supporting them in the system program. To find an appropriate load distribution method by experiment, you can take advantage of the unique function of KL1: that it allows the problem-solving algorithm and the processor work allocation unit to be programmed separately.

The present parallel wiring program groups objects making frequent communication and randomly allocates objects to processors in the units of these groups. The program runs on the experimental parallel inference machine Multi-PSI and attains a performance at least as good as programs running on general-purpose mainframe computers, though its performance could be improved further to correspond to the number of processors.

We plan to modify the program continuously with an eye to improving its performance several-fold on the parallel inference machine PIM. At the same time, we will concentrate our efforts on generalization of the load distribution method and its incorpo-

ration into the system.

■ 4. Conclusion

This paper has described some aspects of parallel programs developed for the research on parallel software. It has also introduced research and development of full-scale parallel application programs for demonstrating the applicability of Fifth Generation Computer Systems. Research and development of full-scale parallel software has a much shorter history than research on parallel hardware, so there are many research themes to be tackled. That is why this research is so interesting and worthwhile.

In the five years following the completion of the FGCS project, a super-workstation (= future PIM) that incorporates 1000 processors and has processing performance of 50G IPS or 1G LIPS will certainly be realized in a single frame. Whether we will be able to make use of this hardware at will depends on the achievements of parallel software research.

Introduction of Research Laboratory (2)

Working Towards the Construction of a Legal Expert System

— The Yoshino Laboratory and the Legal Expert Association —

Hajime Yoshino

Professor, Faculty of Law
Meiji-Gakuin University

Legal Philosophy and the Legal Expert Systems

The main subject of research in the Yoshino Laboratory is the development of a legal expert system. My speciality is legal philosophy and legal information science.

To clarify where my research fits in, I would like to discuss the connection between "legal philosophy", which for some people has the image of an archaic field of studies, and "legal expert systems", a newly emerging field.

My definition of philosophy is "studies to clarify the logical structure of human thought." Accordingly, legal philosophy can be defined as; the study of clarifying various thought structures in the legal domain (legal thought). Based on this definition, I have been attempting to clarify the structure of those legal thoughts that are expressed in legal terms, and those

that are assumed from reading between the lines, or by inferencing. As for direct clues, I have logically analyzed the language in the field of law; that is, the language expressions that are fixed on paper in the form of the texts of established law, precedents, and doctrines. I have also interviewed judges, lawyers, and legal scholars, etc. Central to my method of analysis is mathematical logic. Within mathematical logic, first order predicate logic is especially effective in analyzing terms and knowledge. I advocate a much wider application of first order predicate logic in the legal field and have been working toward promoting this.

The appearance of the logic programming language Prolog has enabled me to employ computers in analyzing legal predicate logic. With Prolog, including Extended Self-contained Prolog (ESP), computers can be used to



▲ Here a student is testing the "Legal Expert System LES 3.0" on the PSI-II in the Yoshino Laboratory. The operator is graduate student Ms. Iwami. On the left is the author (Hajime Yoshino), and behind is lecturer Mr. Kitahara.

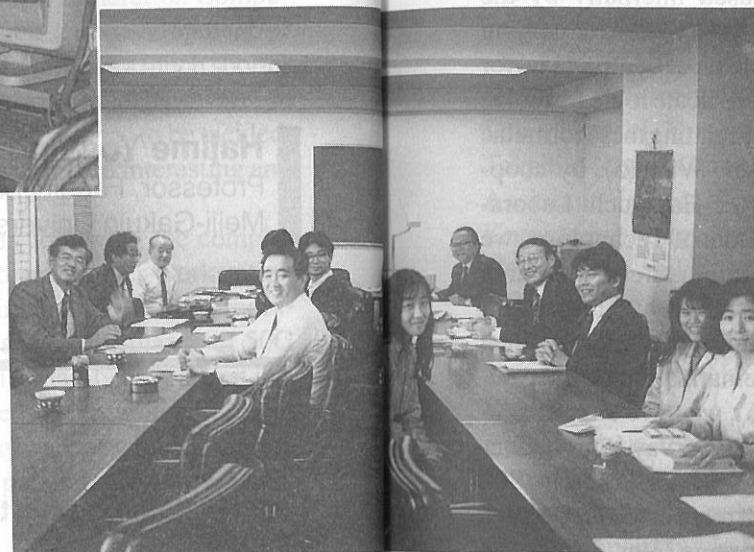
support the work of logical analysis of law, and they are proved to be effective tools for substantiating analytical results. The development of logic programming permits the results of a logical analysis of legal knowledge to be inputted in the form of logical formulae into a knowledge base which can be used to develop a legal expert system. In this expert system, inferences and conclusions derived from the application of laws can be stored. For the last seven years, development of such system has been the central theme of my research activities.

An Outline of the Laboratory

First, I shall discuss the physical aspects of the Laboratory. The Yoshino Laboratory is situated on the Shirogane campus of Meiji Gakuin University at Shiroganedai, Minato Ward, in Tokyo. Originally, the Laboratory room belonged to the Faculty of Law. As with other general offices in the Social Sciences in general, we have not had the same facilities or

environment that the Information Engineering School had. We renovated a professor's office which had been somewhat cramped even before, so that the staff could install several computers in order to carry out research together. In addition, we established a "legal information room" (Room 436) within the faculty. Currently, we use these spaces together with the laboratory of the Information Processing Research Center to proceed with our research into legal expert systems. At present, we are operating several UNIX work stations, several personal computers, and a PSI-II from ICOT for commissioned research.

Having looked at the physical aspects, I would now like to describe the staff. The



▼ This is the 40th ordinary meeting of the Legal Expert System Association held at Meiji Gakuin University on October 27, 1990. In front of the blackboard is the speaker Kiichi Nishino (Professor, University of Niigata, Law Department, previously a Niigata local court judge). The theme was "The Judgement Process of the Court." The author is standing to the right of Prof. Nishino.



▲ This is a photograph of a work seminar on the "Systematization of Legal Analogy" with Tokyo Institute of Technology Associate Professor Makoto Haraguchi and tutor Seiichiro Sakurai (held in the Yoshino Laboratory in October 1990). In this rear, in the middle is Dr. Haraguchi; second from the right is Dr. Sakurai.

research is supported by the cooperation of a lecturer, postgraduate students, sub-assistants, students, graduates and part-timers. All students in my seminar learn Prolog in their third year and, write and submit a variety of legal inference systems before graduating. Every year several of these become system and programming specialists.

The research of the Yoshino Laboratory is unique in that the core members of the Legal Expert System Association also actively participate in joint research. With the Legal Expert System Association and the Yoshino Laboratory, there is an integrated relation of both sides wherein the former supports the latter, and the latter supports the former. Next,

I would like to introduce the Legal Expert System Association.

Legal Expert System Association

The Legal Expert System Association (LESA) is an interdisciplinary research team composed of legal scholars and legal practitioners and researchers in the fields of philosophy (logic and linguistics) and engineering (information engineering and knowledge engineering). The aim of the Association is (1) to analyze the structure and function of law scientifically, 2) to carry out development research on legal expert systems based on the analysis by applying logic linguistics and information science. And through these re-

search activities, we shall contribute to the spread of law, legal education and legal business, as well as various sciences connected to information, thereby contributing to the development of a democratic society" (LESA Agreement Article 3). This was set up with my initiative in 1985, and since then I have served to represent the Association.

In addition to regular monthly study meetings, the research association has a working seminar as occasion demands and holds an annual symposium. Some of the outcomes of these meetings are mentioned in the publication "The Foundation of the Legal Expert System" (compiled by Hajime Yoshino, published by Gyousei). A pilot system, the "Legal Expert System LES-2" has also been created on a personal computer. The system deals with the field of contract law in Japan Civil Code (LPC '86).

Research Activities and Results

The Yoshino Laboratory/Legal Expert System Association has been carrying out further research in the following main areas: (1) examination of results of state-of-the-art research in logic, linguistic theory, and knowledge technology, (2) methods of legal knowledge analysis and representation, (3) actual legal knowledge analysis and structuralizing, (4) construction of a legal knowledge base for civil law and United Nations Convention on Contracts for the International Sale of Goods (UNCCIS), (5) structural analysis of legal analogy and systematization, (6) design for a full-scale legal expert system, and (7) development of "Legal Expert System LES-3".

With respect to (1), we have been paying special attention to the results of ICOT research and to their development trends. Concerning (2), we have established methods of detailed analysis and representation of legal knowledge by the application of predicate

logic. Concerning (3), we have clarified circumstantially the logical relationships between meta knowledge controlling legal reasoning and object knowledge. Also, as well as a detailed analysis of internal structure (case structure) of various structures, we are attempting to build a system for converting legal knowledge representations in natural languages into predicate logic formulae, which are the expressions used internally by the system. With respect to (4), we are changing Japanese and English texts of contract law for the sale of goods into predicate logic formulae by provisions and accumulating these formulae in the knowledge base. With (5), by cooperative research with the Haraguchi Laboratory at the Tokyo Institute of Technology, we are closely examining various areas of research in legal case-based reasoning systems, as well as grouping for methods of applying legal analogies and of systematization of interpretation. Concerning (6), we have already presented summaries in "A Survey Report Concerning Legal Expert Systems," March 1988 and March 1989. With respect to (7), we have implemented a pilot system (Ver. 3.0) on the PSI-II, (report, March 1990). This system records part of the legal knowledge of the field of contract for sale in Japanese civil law and the UNCCIS, which constitutes an international treaty. The system uses the mechanism for deductive inferencing to perform legal meta inference based on meta knowledge. We envisage further development of this system and the creation of a full-scale system.

Although much of this research has been carried out by the Yoshino Research Group, members of the Legal Expert System Association, and notably the core members, have shouldered much of that load. The leading figures in the Legal Expert System Association are; Hajime Yoshino and Munenori Kitahara, Meiji Gakuin University, Legal Information Science; Shigeru Kagayama,

Osaka University, Civil Law; Yoshiyuki Matsumura, Hokkaido University, Legal Sociology; Hiroyuki Matsumoto, Kaijō Hoan University, Political Science; Makoto Haraguchi and Seiichiro Sakurai, Tokyo Institute of Technology, System Science; Ryosaku Nishiwaki, Keio University, Logic. Furthermore, the following people are supporting this research as active members: Yasuo Takeuchi, Meiji Gakuin University, Legal Sociology; Katsuzou Ohta, Nagoya University, Code of Civil Procedure; Kazuaki Sono, Hokkaido University, International Private Law; Hiroshi Komatsu, Attorney-at-Law; Takahito Natsui, Chiba Local Court of Justice, Assistant Judge; Katsumi Nitta, ICOT, Knowledge Engineering; Kaoru Hirota, Hōsei University, Measurement Control; Hirosato Nomura, Kyushu Institute of Technology, Knowledge Information; Kohei Yamaguchi, Shizuoka University, Systems Engineering.

The main feature of this Association is the realization of true interdisciplinary joint research, which is rather rare in Japan. Researchers majoring in Sociology/Humanities and Natural Science/Engineering get together for the sole purpose of exchanging opinions with a view "to create a legal expert system." It is rewarding to see that cooperative research can be accomplished. It is interesting to note that one of the elements supporting interdisciplinary communication between lawyers and engineers is the logical programming language Prolog.

The Association and ICOT

Many researchers of ICOT including Dr. Fuchi, Director of ICOT Research Center, Dr. Furukawa, Deputy Director of ICOT Research Center, and Dr. Katsumi Nitta, Chief of 7th Laboratory (mentioned above) lecture at symposia or regular research meetings, and pro-

vide advice on research for activities of the Legal Expert System Association. The results of ICOT research such as the PSI-II as well as ESP, is gradually becoming usable for our legal expert system development research. I would like to point out that funding for the research by the Legal Expert System Association is partially supported by commissioned research for ICOT. For this, I would like to express my gratitude.

Expectations for ICOT

ICOT's Fifth Generation Computer Project will map out a page in the history of computer development. I am also convinced that it will also have an enduring importance in cultural history. This is no exaggeration. It is expected that the new computer technology researched and developed by ICOT will become the fundamental technology for realizing artificial intelligence systems of knowledge information which consists of a natural language like that of law and in which inference has significance. This technology should bring the computer from the world of natural science closer to the world of humanistic studies such as law. It should be noted at this stage that law is a phenomenon related to the value of justice; it is a cultural phenomenon. If new computer technology becomes useful as a basis for knowledge information processing systems in the legal field, then the computer will also be able to make a contribution to culture.

In conclusion, I sincerely hope that, as it leads up to the final report, ICOT will expand its comprehensive and conclusive research in the field of legal expert systems through various fifth generation computer research results. The Yoshino Laboratory and Legal Expert System Association are ready and willing to do anything to contribute.