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COMMENTS ON KNOWLEDGE ACQUISITION AND LEARNING

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Introduction

This paper surveys knowledge acquisition techniques and tools in Japan, as compared with [1] . The first section describes a methodology for building a knowledge-based system obtained by the KAS (Knowledge Acquisition System) working group of ICOT. The second section introduces several knowledge acquisition support techniques and tools developed in Japan. The third section shows an experimental knowledge acquisition support system implemented in Prolog by the authors.

Knowledge-based System Methodology

From analysis of the case studies [10] about knowledge acquisition in the expert systems, it becomes clear that knowledge acquisition generally consists of the following steps:

1) Selecting problems: The possibility and value of building a system is evaluated, and problems are selected.
2) Evaluating current software technology: For selected problems, current AI technology is evaluated, and necessity of the introduction of current AI software is inquired.
3) Identifying knowledge sources: The necessary knowledge for solving selected problems is evaluated, and so is the possibility of solving them. The quality and quantity of knowledge per knowledge source are analyzed.
4) Identifying expert models: If the main knowledge sources are human beings, then how the experts use their knowledge (their problem-solving techniques and inference methods) is clarified.
5) Identifying user models: What the users expect the system to do and how they use it are clarified.
6) Selecting knowledge representation form: Appropriate knowledge representation form is selected based on the results of steps 3) to 5).
7) Extracting knowledge: Knowledge in the form selected in step 6) is extracted from the knowledge sources.
8) Transforming knowledge: Knowledge obtained in step 7) is transformed to a format usable in the computer and stored in the knowledge base.
9) Managing the knowledge base: Consistency of knowledge added to the knowledge base is checked, and knowledge explaining added knowledge is automatically generated in the knowledge base.

Among the above nine knowledge acquisition steps, steps 1) to 6) are system analysis phase in system engineering, and steps 7) to 9) system modelling one in it. Note that system analysis is more important than system modelling for a problem requiring a more advanced expert system. The most important task at present is to combine the system analysis and modelling methods for a given problem most appropriately.

Techniques and Tools

There exist several types of knowledge acquisition support techniques and tools in Japan. They are classified into the following classes:

(1) Fundamental Techniques and Tools : The above-mentioned methodology arouses Pre/Post method based on the EXPERT MODEL [17] and knowledge acquisition method by observation [18]. ES/SDEM (Software Development Engineering Methodology for Expert Systems) [12] is an another methodology for building a knowledge-based system. SAKAS (Semi-Automatic Knowledge Acquisition System) [19] designed by ES/SDEM is an interactive knowledge-based system construction adviser. CTAS (Classification Task Acquisition System) [20] is an ETS-type tool for supporting knowledge acquisition baseed on generic task structure. MISAKO [2] is a new software tool for constructing consultation systems in Japanese. It determines the basic meaning of Japanese sentences to automatically extract new knowledge.

(2) Hypothesis-based Reasoning Techniques and Tools : The hypothesis-based reasoning system uses unknown hypotheses and known facts to form consistent explanations of observations. A hypothesis is a subset of the possible hypotheses which are consistent for given facts, and a union of the hypothesis and facts should imply given observations, as shown in *Fig. 1*. Poole [14] showed a theoretical framework of such a system. As the author *et al* [11] gave

a general framework of the hypothesis-based reasoning system and implemented its typical example from an abduction-based point of view, there are a lot of hypothesis-based / assumption-based reasoning systems in Japan. The author is interested in Ishizuka's system [4] and Inoue's system [3] from a logical point of view.

(3) KJ Method Support Techniques and Tools : In Japan, there is a famous manual knowledge abduction technique, i.e. KJ method [6], which is a method for getting new ideas from given data. Many experimental KJ method support systems have been implemented, and they are now in rapid-prototyping level. They are CONSIST (a system for CONstruction Support of Information STructure) [16], KJ Editor [5], and YUAI [15].

Knowledge Acquisition Functions

This section describes the relationship between the hypothesis-based reasoning system [11] and the knowledge acquisition support system, shown in *Fig. 2*, which were investigated by the authors, as a basic function of the problem-solving and inference and the knowledge base management system in the Japanese Fifth Generation Computer Systems. The systems are implemented in DEC-10 Prolog. To support deductive and/or inductive inferential knowledge acquisition, the system fundamentally employs three kinds of knowledge acquisition functions: knowledge assimilation [9,13], knowledge accommodation [7,9], and knowledge transaction control [8].

As shown in *Fig. 2*, knowledge assimilation means adding new facts or rules to the knowledge base, without violating its consistency. Knowledge accommodation means consistently modifying the knowledge base, using Shapiro's model inference system, when adding new correct facts or rules to it. In the knowledge accommodation process, given added facts or rules are supposed to be absolutely true, while, in the knowledge assimilation process, a given knowledge base is supposed to be consistent. The essential problem in assimilation and accommodation is to keep the entire knowlewdge base consistent and non-redundant. Knowledge transaction control means an adjustment of knowledge assimilation and knowledge accommodation in a given transaction span. If one knowledge assimilation process is triggered, then often another related knowledge accommodation process is to be applied, because they are mutually dependent in the transaction span.

Conclusion

In conclusion [1,10], we should go back to the starting point in an approach to a problem, that is to "first the problem, then the tool." The object to be solved should be looked at squarely, an appropriate system analysis methodology united with a system modelling methodology, and the knowledge acquisition support techniques and tools per application domains applied.

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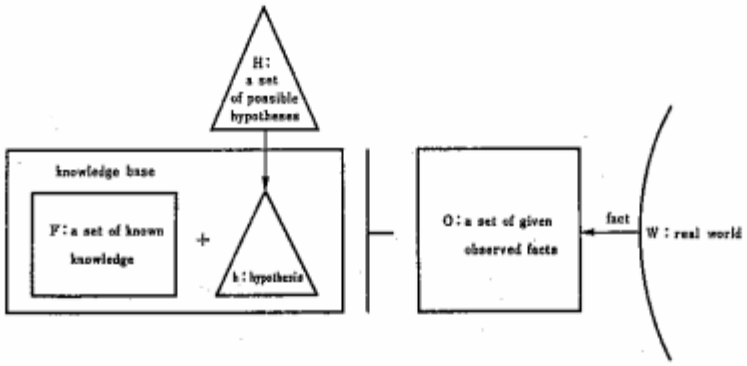

Fig. 1 A Framework of Hypothesis-based Reasoning

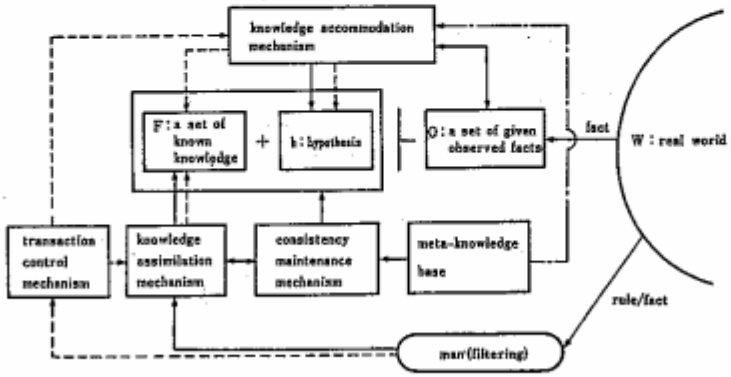

Fig. 2 Hypothesis-based Reasoning and Knowledge Acquisition