An Approach To Exploiting A Database As A Frame-Like Knowledge Base

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Few of the existing expert-systems-building tools (or so-called expert system shells) have an interface to an external database management system (DBMS) and most of them embody only one reasoning mechanism and knowledge representation technique. One approach to expanding the representation facilities and handling a large knowledge base is to combine a knowledge-based system and a DBMS. The databases of the DBMS can be exploited as frame-like knowledge bases and default reasoning becomes easy and efficient. To implement this approach, our system PAIS (an expert system shell developed by us, see Jiang and Wee, Proc. ASEE-NCS, 1985) has been extended to support the direct access to a relational DBMS (We call it VR-I, VAX/VMS Relational, it was developed by us on our VAX/VMS system) and to embody the mechanism for interpreting the databases as knowledge bases.

I. Introduction

Knowledge bases (KB) in Artificial Intelligence (AI) and databases of Database Management Systems can contribute techniques and mechanisms to each other. One of the important differences between a KB system and a DBMS is that in general, databases in a DBMS represent specific knowledge (knowledge that can be expressed as ground Well-Formed-Formulas (Wffs) in Predicate Calculus) and a DBMS typically lacks any form of reasoning component or means for dealing with general knowledge (knowledge that has to be represented as Wffs with universal or existential quantifiers). One approach to dealing with these two kinds of knowledge is to build two separate knowledge bases: one for representing general knowledge, and the other for representing specific knowledge, such as the KM-I system (C.Kellogg, AAAI-82). Our approach is different from that of the KM-I system. Our PAIS system is a complete expert system shell, independent of the VR-I DBMS. PAIS supports rule-based knowledge representation and goal-directed backward-chaining mechanism. It is written in Pascal and highly portable. On the other hand, VR-I is a relational database management system, which supports most operations of relational algebra. Now with these two independent systems, how can PAIS exploit the databases of VR-I as knowledge bases? Our approach is to modify the PAIS system and give it the capability of direct access to the VR-I DBMS and the capability of interpreting a relational database as a frame-like knowledge base. As a result, the PAIS system can run on any machine with a Pascal compiler as a rule-based backward-chaining expert system shell, and it also can be combined with VR-I and runs on the VAX/VMS system taking the advantage of the large amount of information stored in a database and supporting default reasoning.

This block architecture will greatly increase the flexibility of the PAIS system and will make it easy to build a powerful expert system in order to handle the complicated problem-solving tasks.

II. The PAIS System with a Direct Access to the DBMS

Like most existing expert system shells, the PAIS system uses production rules to represent domain knowledge and employs a goal-directed backward-chaining control strategy. In addition to the rules dedicated to handling the interface with the DBMS, there are three types of production rules corresponding to the three probabilistic relationships. In our tree-like structure, each rule is represented as a node, whose type corresponds to that of production rules it represents. In order to have access to the VR-I DBMS, the tip nodes are classified into two groups. When the control of PAIS reaches the tip nodes of the first group, the system will ask the end-user to input necessary data. On the other hand, when the system control reaches the tip nodes of the second group, the associated databases will be searched and the corresponding procedures will be invoked. Because the DBMS has the capability of handling a large amount of data efficiently, we can store a lot of specific knowledge in the databases and make use of it for reasoning.

III. Database as a Frame-like Knowledge Base

There are some similarities between a frame in AI knowledge representation and a relation in relational DBMS. Attributes of a relation can be thought as slots. Some slot may have to have a specific value, like the primary key in a relation, the values of other slots may be absent (in this case they may be assumed to have their default values), like those of non-key attributes in a relation. But it should be emphasized that the reasoning power of frames as a form of knowledge representation comes from the procedural information associated with their slots. How can this mechanism be implemented in a DBMS? Our approach is to modify the expert system shell, other than the DBMS. All kinds of information related to each frame will be expressed as production rules or procedures under the control of PAIS. Thus the databases of VR-I only store the information, just like the databases of any other DBMS. All the responsibilities for interpreting the information and reasoning with it are taken by the expert system itself. This approach has several advantages: The two systems are relatively independent, VR-I can still be used as a DBMS; the expert system can take the advantage of the DBMS for handling a large volume of information efficiently. Without a DBMS, it is probably impossible for a knowledge-based system to deal with much information so efficiently.

In summary, to efficiently handle a large amount of knowledge, it is appropriate to exploit a database as a frame-like knowledge base. For the reason of flexibility, it seems better to keep the relative independence of the expert system and the DBMS. All procedural information associated with this frame-like knowledge base will be expressed as production rules and procedures within the expert system itself. Under the control of these rules, the database of the DBMS can be used as a large knowledge base and the default reasoning can be carried out easily and efficiently.