BILETA
BRITISH & IRISH
LEGAL
EDUCATION
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ASSOCIATION

9th BILETA Conference
Building Systems

1st & 2nd April 1993
John Moores University
Liverpool

HyperReasoner: An example of hypermedia-based expert Systems development

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Abstract: The project HyperReasoner aimed to find out how hypermedia technology can contribute to improving expert systems. The focus was on the well-known limitations of existing approaches in relation to the user interface and the process of knowledge engineering which have turned out to be still far to complicated to be handled directly by lawyers (cf. Erdmann, Haft, Fiedler and Traunmüller, 1987). The paper describes the structure of the developed system and evaluates the achievement of goals.

Introduction

HyperReasoner is an expert system shell which has been developed with the aims of investigating how hypermedia systems can contribute to overcoming the shortages of conventional expert systems approaches (cf. Erdmann, Haft, Fiedler and Traunmüller, 1987 and Quirchmayr and Traunmüller, 1987). The focus of the project has been on the development of the user interface, providing tools for integration and the maintenance of the knowledge base.
There are two solutions to the problem of knowledge engineering:

- direct translation of natural language into rules, which is definitely the most desirable, but also the most difficult one to achieve;
- an easy to handle graphical interface based on a browser concept.

A full-scale natural language interface cannot yet be implemented efficiently on a personal computer; that is why the knowledge acquisition and maintenance component of HyperReasoner had to be based on the second approach.
The overall system architecture follows the general concept defined for expert systems, which means that the following components are provided (Fiedler, 1984):

- dialogue components (user mode and knowledge engineering mode)
- inference engine
- knowledge base (rules and facts)
- knowledge acquisition component
- explanation component (at the current state rather rudimentary)

The user interface of HyperReasoner

The user interface of HyperReasoner was designed with the aim of making knowledge engineering as easy to handle as possible (a previous prototype is described in Quirchmayr and Kappes, 1990). The interface therefore had to be merely graphically oriented and mouse driven. The formulation of rules was kept as simple as possible. A major problem in existing expert system shells is that negation is possible in a limited way only, an insufficiency which does often lead to an unnecessarily complicated definition of rules and does consequently produce questions (asked of the user) which

can easily be misunderstood, because they do contain hidden negations (for a more general survey of the deficiendes of first generation Systems cf. Susskind, 1987 and Fiedler and Traunmüller, 1989).

The definition of rules is based on the concept of graphically assembling legal concepts and connecting them by logical expressions (AND, OR, NOT). In contrast to most of the existing expert system shells it is possible to use NOT not only for for the negation of facts (QUESTIONS in the above screen print), but also for the negation of nodes (INFERENCES in the above screen print). The type of connection is chosen by clicking the AND-, OR-, and NOT-buttons respectively. GOALS and ARGUMENTS are specified by selecting elements from the lists of ANSWERS, INFERENCES and QUESTIONS.
To allow the review of defined rules we have implemented a flexible browser concept which allows the knowledge engineer to scan through the rules by either selecting a designated node or by starting from the top level of the system and going down step by step.

The knowledge engineering paradigm of HyperReasoner

The knowledge engineering component of HyperReasoner was designed with two goals in mind: keeping it as simple as possible in order to make in usable by people not experienced in knowledge engineering and allowing knowledge engineers to use true negation. Given the capabilities of Hypermedia technology, the first goal could be solved in a relatively quick and uncomplicated way. For providing true negation, an old trick originally developed for defining confidence factors had to be revived: truth values are assigned to each node, depending on its logical structure and on the number of its arguments. Once truth values have been assigned to the basic nodes (QUESTIONS) by the user, these values can be propagated through a classical AND-/OR-tree. The key to making the values computable is to internally assign numeric values (1 for TRUE, 0 for UNKNOWN, -1 for FALSE). The use of truth values also offers the possibility df expanding the inference mechanism by incorporating techniques which allow the representation of fuzzy values.
The underlying concept of the system is therefore designed as follows:

The knowledge engineer
accesses the *main page*
which uses the *fact editor*
the *rule editor* which access *fact and rule pages*
the *browser*
The end user
also accesses the *main page*
which uses *the query page*
the result page which access *fact and rule pages*
the fact page

The fact and rule pages are created from the fact and rule base, which is stored in dBase and ASCII format toallow access to external sources of information. This strategy was chosen with the purpose of being able to use the shell as add-on to database applications and office information systems. In order to provide a way for storing the user interaction already undertaken, consultations can be saved and resumed later at the point where they were interrupted.

Lessons learned and future plans

Basing HyperReasoner on a hypermedia system is a possible solution to some of the worst limitations of traditional expert systems. The price having to be paid for this approach has been rather high, because inference strategies had to be developed from scratch; performance also is a major problem, because implementing the system in a script language has resulted in giving up a lot

of efficiency provided by implementation tools based on compiler instead of interpreter technology. One positive consequence was that experiments with extensions of HyperReasoner have shown that Hypermedia systems offer a new and relatively easy way of integrating expert systems with existing environments such as database systems and text processors (as far as integration is concerned Quirchmayr and Traunmüller, 1991).
Hypermedia systems are the best tool for quick implemention of high level user interfaces and for building bridges between expert systems and traditional environments. Due to their occasionally inefficient script languages, however, time critical components should be. implemented using classical compiler languages.

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