

APPLICATION OF EXPERT SYSTEMS IN LIBRARY AND INFORMATION WORK.

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Abstract:

A new development in the field of Artificial Intelligence, a branch of computer science, enables computers to exhibit signs of intelligent behaviour to simulate problem-solving process of human beings. The method, known as Expert System, has had diverse applications in a number of fields and disciplines. The paper explores possible introduction of expert systems in library and information work. To help better appreciation, background information on the various connotations of the concept, and what constitutes expert systems is provided. It is observed that expert systems are gradually finding applications in cataloguing, reference service and information retrieval aspects of information work and some of these applications are reviewed.

INTRODUCTION

Recent developments in micro-electronic technology have reached a stage where practical application of software tools enable computers to be programmed to perform some basic intelligent functions. These ideas have been extensively developed in the field of Artificial Intelligence (AI), which is a branch of computer science that attempts to develop programs that enable computer systems not only to communicate fluently, but also to explain their actions and to handle unforeseen situations in addition to exhibiting signs of intelligent behaviour.¹ This is achieved using the approximate technique called heuristics. By this method a software is programmed by combining the factual information with experience, judgement and intuitive knowledge of an expert. The rationale is that by programming computers to perform some cognitive tasks research-

ers may come to understand the principles that make intelligence possible.

The motivation for building expert systems probably stems from the desire to capture the knowledge of experts as a way of guarding against their untimely death, or to relieve excessive calls on their time. Perhaps the most important reason is the formalization and clarification of knowledge that results from having the human experts make their reasoning explicit.² What is more, it is a way of synthesizing the knowledge acquired from many human experts in a subject domain into a shared knowledge base that can be studied for consistency and reliability. Thus, through computer-based expert systems enough knowledge could be captured and stored for use in solving and explaining certain complex problems. The development of these systems is based on the

premise that the problem-solving ability of the expert is an outgrowth of his or her knowledge base.

Considering the range of “intelligent” activities that are performed by human beings, it is obvious that the set of possible application areas for these systems are correspondingly diverse. Practical applications of expert systems abound in several disciplines, especially in areas that have relatively homogenous knowledge bases. For example, in the field of medical diagnosis and treatment, PUFF has been developed by the Stanford/Pacific Medical Center to assist with the diagnosis of pulmonary disorders. Also, in the area of chemical data interpretation and structure elucidation, the Stanford Mass Spectrometry Laboratory and the Stanford Heuristic Programming Project have developed DENDRAL for that purpose. In mineral exploration a programme known as PROSPECTOR which was developed by the Stanford Research Institute has been used extensively.

WHAT IS AN EXPERT SYSTEM?

Definition of expert systems by various authors display a wide diversity of interpretation and emphasis.³ This is illustrated by the following sample definitions: An expert system is a program which has a wide base of knowledge in a restricted domain, and uses complex inferential reasoning to perform tasks which a human expert could do.⁴ An expert system is a set of computer programs which emulate human expertise by applying the techniques of logical inference to a knowledge base. A knowledge base ... is distinguished from a database or computer file because it holds information about how to carry out tasks such as the rules which a human expert learns by experience, rather than just statements or facts.⁵ The term expert system refers to computer programs that apply substantial knowledge of specific areas of expertise to the problem-solving process.⁶ In the opinion of Clark and Cronin (1983), The major problem is the lack of a clear definition of

what expert systems are supposed to be.⁷ Worse still, the preponderance of synonyms, together with their ill-defined states make scanning the literature a complex task.

However, from the set of definitions above, it could be inferred that expert systems are usually designed to simulate the problem-solving processes of human experts and they reach the same conclusions that the human experts would when confronted with similar problems. These systems are sometimes referred to as knowledge-based systems, or pattern-directed inference systems, or rule-based systems. They are thought of as advice givers since they have explanatory capability which enable users to understand the rationale on which the advice is based. Again, they could be used as aids to assist users since the knowledge contained in them may not only be rare and difficult to pin down, but also very difficult to find in textbooks. Through the use of expert system technology, it is now possible to specify, elicit, and preserve some aspects of human expertise.⁸

COMPONENTS

Expert systems are basically made up of three components:

- i. The knowledge base which combines information, facts and data obtained from experts in the application area. This is the vital component of the system since it embodies the expert knowledge that the system uses to solve the problems.

Such knowledge can be represented in a variety of ways, e.g. facts, semantic networks and production rules.
- ii. The reasoning or inference engine (that is, a collection of decision rules or procedures) which applies the knowledge acquired to a defined set of rules and by so doing infer solutions, meanings and/or relationships.
- iii. The control or management function which

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monitors and distributes the power of the computer in order to operate the system. This incorporates the user interface which enables the system to send messages to the user, and the user to communicate with the system while at the same time it enables the explanation mechanism to explain to the user how and why a decision has been reached.

CREATION OF EXPERT SYSTEMS

Although expert systems vary considerably from one another in terms of design and capabilities, they tend to have many features in common. In the design and development of an expert system the services of a *knowledge engineer* is required. It is him who cooperates with the *domain expert(s)* to build the knowledge base as well as derive the inference rules. The knowledge engineer is able to accomplish these tasks by interviewing the expert(s) to find out his/her personal experience(s) of past problems solved, the method(s) used, and the reasons for choosing this/these method(s). Based on the interview(s), the knowledge engineer extracts the relevant information with which to program the computer using either the PROLOG (PROgramming in LOGIC) or LISP (LIST Processing) software package. These packages are the popular languages that have been specifically designed for AI applications, and they enable formal logical statements to be used for making precise descriptive ones.

Recent advances in expert system technology have addressed the issue of reducing the involvement of knowledge engineers, and providing tools for the users/experts to build their own knowledge bases. For example, research into the use of "text" as a source of knowledge base has began, and the idea is to reduce the time required in collecting and structuring the knowledge. It has been realized from experiments that knowledge acquisition from text is very difficult since this is not presented in a format (that is, rules, frames, logic etc.) that can be directly used to load a knowledge base.⁹

Generally, there are no absolute guidelines for selecting an expert system application. However, in order to construct one in any application area, there must be humans who are recognized as having expert skills in that area. There should also be agreement among these experts about how to solve problems in the field and what constitutes an appropriate solution to a particular problem. All the applications that have been successful have tended to involve problem domains that are narrow, discrete, homogenous, and with a limited number of entities and relations.

EXPERT SYSTEMS IN LIBRARIES?

One argument often used by those who advocate for the introduction of expert systems in library and information work is that, if a computer is able to diagnose bacterial infection and prescribe treatment then it could be used to diagnose information needs and prescribe reference book(s) to solve a problem. Others argue that expert systems are needed in the libraries to cut cost when resources are low. These arguments certainly sound plausible. However, a critical examination of the way expert systems operate reveals that they are particularly useful when there are many possible answer to a question or when a question has to be answered quickly. Incidentally, these are the very conditions that surround library reference work. It has been suggested that successful application of expert systems would minimize delays at the reference desk especially when the reference librarian is busy attending to other clients.¹⁰

The importance of expert systems in libraries may be obvious now that more and more information is being stored in electronic databases which are located at distant places. The need for intelligent methods to access them becomes increasingly necessary. Consequently, developing intelligent interfaces based on the expert systems concept would make information seekers less dependent on human on-line search intermediaries.¹¹

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APPLICATIONS

A noteworthy development took place in the 1980s on the emergence of research work in expert systems for libraries. Interest was shown in the topic by librarians and information scientists by the formation of an AI/Expert Systems Group within the Library and Information Technology Association of the American Library Association.¹⁹ Although little, if any, progress has been made in developing expert systems for the intellectual activities of professional library work, the interest shown in these developments is worth sustaining. With advances in computer science and AI research, intelligent information systems are gradually becoming a reality. To date, some of the areas of library work where expert systems have been experimented on include cataloguing, classification, reference service, collection development, and information retrieval activities.

Cataloguing

The main thrust of cataloguing work could be said to be the consistency with which authoritative forms of names, subjects, and other headings are applied and maintained. This is one area of library work which proponents of expert systems in libraries have identified for serious experimentation. There are factors which make this domain a possible area for consideration; namely:

- i. there are recognized experts who are demonstrably better than amateurs;
- ii. the task of cataloguing a book takes an expert a few minutes to a few hours;
- iii. the task is primarily cognitive; and
- iv. the skills could be routinely taught to a neophyte¹²

Almost all the attempts at building expert systems in this domain have been based on the Anglo-American Cataloguing Rules (AACR2). The basic assumption has been that with these rules cataloguing could be thought of as rule-based.

Incidentally, the point often overlooked is that

the automation of the AACR2 rules would not make cataloguing a largely an automated process since certain portions are still the subject of intense debate. In this regard, the cognitive processes involved in its interpretation may not be fully acceptable. It has been suggested that further studies should be carried out to consider some heuristics for some of the rules.¹²

In spite of these problems some attempts have been made at trying to introduce expert systems into the cataloguing domain. These include a project which demonstrated through a program written in PROLOG that the AACR2 rules for determining access points could be restated as the production rules incorporating explanation facilities.¹³ However, the program was not implemented to find out whether it would work. Another attempt built a cataloguing advisory system to provide advice on completing catalogue data entry forms.¹⁴

Reference Service

Much of the experimentation done in this area of library and information work has involved the development of systems with relatively shallow models of reasoning. This might be due to the fact that reference work involves several tasks which cut across so many activities; including:

- i. responding to requests for factual information;
- ii. carrying out literature searches;
- iii. assisting with the interpretation of bibliographic references;
- iv. locating materials on shelves;
- v. obtaining materials through inter-library loans.

Even though it has not been possible to develop an expert system which can perform all these functions at once, some of the few developments have concentrated on certain aspects of the reference processes that a reference librarian goes through in choosing a book to satisfy a user's information

needs. One such system is the POINTER which was developed at the State University of New York (SUNY) in Buffalo.¹⁵ The system is used to provide reference assistance to federal documents in a separate government documents department in an academic library.

Another system that has been developed in the reference service domain is the ANSWERMAN.¹⁶ This is a microcomputer-based system which assists users to obtain answers to ready reference questions. It is based at the National Agricultural Library of the United States of America and is used to supplement pointers to reference books which are likely to contain answers to specific kinds of questions. Recent development have made it possible for the system to be linked to external programs that provide online access to databases containing bibliographic citations and full-text files that can furnish answers to questions, rather than just providing the name of relevant reference book.

From the on-going research activities several other aspects of the reference work have been considered in proposals or prototype systems. These include the design of systems to help users to refine their search strategies and the design of systems that could function as automatic readers' advisors to assist users in selecting materials that are of interest to them. While these developments do enhance reference work, the librarian's ability to switch mental gears instantly and place each new inquiry in its proper context in a natural environment is yet to be replicated in an automated form.

Information Retrieval

This is the most active area that has attracted the largest number of research and development (R & D) activities. This could be attributed to the diverse databases which have been developed as a result of on-line systems. These databases have created complex environments for users who want to gain access. To assist them, work is going on in developing expert intermediary systems

which would make on-line systems more directly accessible without going through human intermediaries. Some of the developments are aimed primarily at assisting users with query formulation, search strategy selection, and evaluation of retrieved documents. Although these attempts have been labelled as "expert search intermediaries", it could be inferred from the definition of expert systems that they do not fit such a classification. They do not capture the expertise of one or several experts in a restricted domain. Instead, the systems experiments are structured with a knowledge base either in a flat file or as semantic network, and the inference engine is made up of the "decision rules or work patterns of the information specialist".¹⁷ However, as has rightly been pointed out, the expertise of human intermediaries is centred not on the subject of queries but on the tool and techniques for finding information.¹⁸ Consequently, no expert system intermediary can perform the same function as good as human intermediaries.

A critical examination of information retrieval systems reveal that these are usually based on controlled vocabulary in which selected terms are used to index and to retrieve data. The usual practice is that the indexer always selects the right set of terms to be used for searching in the database. However, at the searching stage where R&D activities into expert systems are currently focused, the problem that may confront an inquirer when using an intelligent intermediary to search a database will be his ability to select the same set of terms used by the indexer. Since information retrieval is based on the concept of perfect match between the query and the index terms, it is necessary to select the specified index terms to ensure a high recall ratio. Therefore, the problem of vocabulary should be an important issue which should be taken into consideration when an expert search intermediary or intelligent interface is being designed for an information retrieval system.

Significant developments have taken place in the

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attempts to introduce intelligent intermediaries into the information retrieval process. One such attempt designed a system that simulated the role played by a highly trained human search analyst. It derived specifications for an intelligent interface from a study of real life human intermediary information interactions.³ The methods used included functional analysis of real user-human intermediary interactions system simulation, classification of problem and knowledge types, and retrieval "test". The results of these investigations have led to specification for a distributed expert system architecture, identification and specification of the necessary functions and proposals for a problem-structure driven human-computer dialog.

Given the complexity of developing a truly expert search intermediary, it is only natural to be wary of commercial products that claim to be "expert". The problem lies in the difficulty of formalizing the knowledge of human intermediaries which can be used in designing an efficient access structure to support multiple search strategies and representations. Consequently, it has been suggested that answers should be sought to the following questions when assessing claims:¹⁹

- i. For which decisions in formulating a search strategy does the interface offer assistance?
- ii. What form does this assistance take (i.e. is the decision made automatically by the computer or interactively with the computer offering advice to users)?
- iii. What expertise underlies the assistance offered by the interface?
- iv. How well does the system model the expertise of a skilled human intermediary, and what ways is it deficient?

In spite of the difficulties the application of expert systems in library and information work is gradually becoming a reality.

THE FUTURE

There are other AI research topics with implications for libraries. Some of the potential areas in which they might be applied are the use of expert systems in Management Information Systems (MIS) for library management, automatic translations from foreign languages and educational applications²⁰. The implications of the development of expert systems to library and information work is worth noting by the professionals since there are many rule-based activities which could be enhanced by this application. Although the present levels of research and expertise make it too soon to attempt to implement such systems, the profession has been advised that it is certainly not too soon to consider possible research directions. Expert systems need careful study for future implementation.

Considering the rate at which companies are investing in these systems, it is expected that by the beginning of the twenty first century, they would be supplementing and transforming the functions of professionals in the knowledge industry including libraries. The application of expert systems within libraries along with the application of many other advances in information control and transfer, will certainly play an important role in the evolving definition of the profession.²¹

As expert systems find a home in many areas of the library and information profession, it is important to perceive them not as a threat to the human and humane elements of the profession; but as that which can improve the level and depth of service in the traditional areas of library functioning.²⁰

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