PSYCHOLOGY AND EDUCATION (2023) 60(2): 2599-2602
ISSN: 1553-6939

Information retrieval techniques using Artificial Intelligence and Expert Systems in information centers: A review Article

Djoumana, Lemounes, Baku State University, Baku, Azerbaijan,Joumana.lemounes@gmail.com

Abstract

Expert systems, a field of applied artificial intelligence, have revolutionized information management by enhancing indexation and improving abstraction. They analyze content, resulting in accurate indexes and saving time. Through the use of production rules, expert systems generate high-quality summaries. While the MRS Sharif system faced challenges in book classification at the University of Strathclyde, it contributed to training classifiers in libraries. Overall, expert systems have transformed information retrieval, boosting efficiency and accuracy. Ongoing research and development continue to shape their potential, playing a vital role in managing information effectively and supporting the globalization of the educational environment.

This study highlights the successful implementation of expert systems in indexation, enabling accurate content analysis and efficient indexing. Expert systems also refine summaries by employing production rules and specific techniques for better abstraction. However, applying expert systems in classification was limited to the MRS Sharif system, which encountered weaknesses and ultimately failed as a project. Nevertheless, it found a new purpose in training classifiers for libraries. These findings underscore the significant impact of expert systems in information management, emphasizing the ongoing necessity for further research and development.

Keywords: Artificial intelligence, Information management, Expert systems, information centers, Classification, abstraction, indexation.

1. Introduction

Artificial intelligence encompasses various applications that leverage knowledge collection and reasoning to tackle complex problems. Some notable applications include natural language processing, computer vision, pattern recognition, machine learning, problem-solving systems, knowledge acquisition, knowledge representation, and expert systems (or knowledge-based systems).

Expert systems have been utilized in information retrieval for several years. These systems aim to replicate the behavior of human experts and carry out intellectual tasks within specific domains. They are designed to perform tasks related to human expertise, including decision-making. In this study, we explore the concept of expert systems and their role in information management.

The main focus of this study is to examine significant expert system projects in the field of information management. These projects have demonstrated expert systems' ability to undertake operations traditionally considered exclusive to human capabilities. By delving into these projects, we aim to gain a comprehensive understanding of the scope and impact of expert systems in information management.

The importance of the study:

The study emphasizes the importance of expert systems in revolutionizing information management. By implementing expert systems in indexation, the study demonstrates their success in analyzing content and generating accurate indexes. This capability not only saves time and effort but also enhances the efficiency and accuracy of information retrieval.

Furthermore, the study highlights the role of expert systems in improving abstraction through the use of production rules and specific techniques. By refining the quality of summaries, expert systems contribute to better conception and understanding of complex information.

Although the study mentions limitations in applying expert systems in classification, explicitly referring to the challenges faced by the MRS Sharif system, it acknowledges its contribution to training classifiers in libraries. This demonstrates the adaptability and potential of expert systems in various information management contexts.

Overall, the findings underscore the significant impact of expert systems in transforming information management practices. They have the potential to provide intelligent solutions for managing information effectively, contributing to the globalization of the educational environment. The study also highlights the need for continued research and development in expert systems to enhance their capabilities further and address any limitations or challenges.

2. KNOWLEDGE-BASED SYSTEMS

Expert systems (ES) represent a domain within applied artificial intelligence (AI) that dates back to its inception in 1960. The primary goal of ES was to facilitate the transfer of human knowledge to computers, enabling them to execute designated tasks. Leveraging computational capabilities, computers could emulate human problem-solving abilities and derive insightful conclusions. This approach offers users a potent and adaptable methodology to make informed decisions, addressing complex challenges through social and technological lenses, surpassing conventional methodologies. The flexibility and power of ES have propelled it as an invaluable tool in various domains. [13]

Researchers engaged in developing expert systems have recognized that knowledge representation, utilization, and acquisition are essential aspects of artificial intelligence systems. However, the study of expert systems has encountered challenges that have exposed the limitations of AI, including narrow application domains, difficulties in acquiring knowledge, and reasoning mechanisms. With the emergence of neural networks and statistical learning, machine learning has become a promising research focus in AI. This leads to the belief that integrating machine learning techniques into expert systems can enhance their reasoning capabilities. Similarly, fuzzy logic, another emerging field, has been employed in specialist systems, contributing to the flourishing of expert systems and ushering in a prosperous era of research. Today, the demand for expert systems has grown as there is a desire to apply them to solve increasingly complex problems. Expert or knowledge-based systems are computer programs designed to emulate human problem-solving using artificial intelligence and a database of subject-specific knowledge. [6]

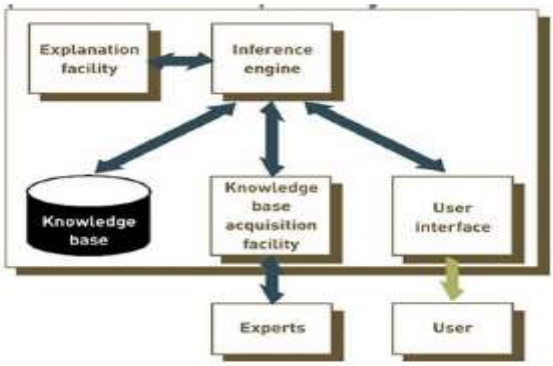

Figure 1Expert system

The expert system (E.S.) is composed of three key components: a knowledge base, a user interface, and an inference engine. When users pose queries, the system utilizes the knowledge base to infer and

derive relevant insights. The inference engine acts as the core processing component, extracting pertinent information from the knowledge base to provide meaningful responses and solutions to user queries. By integrating these three stages, the expert system effectively combines user input, domain-specific knowledge, and reasoning mechanisms to facilitate intelligent decision-making and problem-solving. [7] [38] [17] [20]

In conclusion, Expert systems aim to solve complex problems by reasoning knowledge [8]

However, many authors indicated that expert systems apply knowledge-based systems. They also used the terms advising systems and consultant systems to describe E.S.. [9]

- An expert system is a computer program. [10]
- It's one of A.I.'s essential branches.
- Its prominent role is to solve problems.
- It uses experts' experiences and knowledge.
- It can be used as an assistant for experts or people in general.
- It is used in several areas and specialties, such as agriculture, chemistry, computer science, electronics, and information management.

3. The CLASSIFICATION:

Classification is defined as (regrouping similar things together and separating different things. [1] In other words, it is the collection and arrangement of things according to be identical or different from this and that. The Classification of information resources means (collecting Similar resources together and separating different resources. [3] The similarity or difference is determined based on objective similarity. And therefore, it is the art of discovering the subject of the information resource and then selecting The topic following classification rules and methods. The classification system is considered one of the critical processes and Technical

procedures used permanently in libraries. [2] In addition to the constant need for a mechanism to help in the training of beginners in the field of Classification, the classification field is needed technology To assist in selecting classification numbers that fit the topics.

It is noted that some efforts have been made in this field, but they have been specialized In a specific cognitive domain [5], such as:

1. In the field of mathematics, an expert classification system model was developed to facilitate the transition from the American Association of Mathematics' classification system to the Department of Mathematics' classification system, specifically in the context of the Dewey Decimal Classification. This model included the construction of a knowledge base that enabled mathematicians to access the library's classified resources according to the Dewey Decimal System. An interactive interface was also designed to enhance the usability and accessibility of these resources for mathematicians.

2. Similarly, in the field of mineralogy, an expert classification system was developed based on the international decimal classification system. The system was designed to accommodate various attributes such as the type of metal, characteristic features, and the Universal Decimal Classification (UDC) of minerals. This approach allowed for a more precise and efficient classification of mineralogy resources, enabling researchers and professionals in the field to effectively navigate and retrieve relevant information.

3. Another notable project in the domain of classification systems is the development of an expert automatic classification system that incorporates

artificial intelligence techniques and applications, specifically utilizing the Dewey Decimal Classification. This system, known as the SMART system, focuses on classifying web pages and

internet resources by assigning appropriate classifications based on the subject matter. While still in the experimental stage, the SMART system demonstrates the potential of leveraging AI and classification methodologies to enhance the organization and accessibility of online resources. [4]

4. Expert systems have been developed to classify documents outside the scope of libraries, such as The expert system that was developed to classify the files of the International Civil Aviation Authority. It is a Simplified system, and it was successful due to the narrowness of the field in which the system was built and the lack of complexity. [6]

However, it has not been very successful, so the classification field can be considered a field that needs developing and applying Expert systems. Still, it is one of the weak fields that wasn't successful. It is expected that this may be due to:[6]

1. One of the challenges in incorporating classification systems into expert system knowledge bases is the difficulty of accurately representing the intricacies and nuances of these systems. Classification systems often involve various treatments and criteria for organizing and categorizing information resources, making it challenging to capture all the necessary rules and dependencies within the knowledge base of an expert system.

2. Classification systems, by nature, can be complex and extensive, resulting in a substantial volume of knowledge that

needs to be incorporated into an expert system. The comprehensive representation of a classification system within the knowledge base requires careful consideration of the hierarchical structures, relationships between classes, and specific classification rules. Managing and updating a large knowledge base can pose logistical and computational challenges.

3. Effective classification of information containers requires expertise and skills similar to those possessed by classifiers. It is essential to develop expert systems that can emulate the decision-making processes and classification strategies employed by human classifiers. This includes capturing the ability to analyze content, interpret metadata, apply contextual understanding, and make informed judgments to accurately classify information resources based on their attributes and characteristics. Incorporating these skills into expert systems can enhance the accuracy and efficiency of information classification.

4. The INDEXATION :

The first expert system in indexation was in 1983[11], named the FASIT system by Martin Dillon and Lora Macdonald. [12] After that, Reiter company developed another system that helps reduce indexing time. It was so famous back then because it was accurate and precise. It used A.I. to build instructions. The system analyzed all published news and indexed it in 1/3 second. Before that, the company operated 200 indexers to do the same process, complaining that 30 percent left their job in the first year. However, the system was 90 pour cent efficient as a human being.

In 1983., the city university created AUTOCAD. [9] expert system (the Department of information studies). The federal ministry sponsored it for research and technology. The responsible for the project was Paul Burton from 1985 till September 1987...[12]

An expert system was created at the American petroleum institute in petroleum studies that improved the automatic indexation.

Humphrey [14] and Miller developed an expert system called the Indexing Aid system as a part of the ACRP program. [13] The American national library of Medicine made this system through the computer science department. The main goal was to introduce a computer program that helps index medical periodicals for indexers in MEDLINE by analyzing and adding specialty terms. As it

is well known, NLM has worked in indexing periodicals for over a century. It created a medical literature retrieval system in 1963. That produces a date base named MEDLARS ONLINE (MEDLINE). In 1989, Another E.S. in the medical was created by the University of Pittsburg. The national library of Medicine was responsible for funding this system that helped doctors retrieve information about cancer from the Madeline database...[9]

They put specific codes to the terms in the database and link them to the system to create a cognitive framework. The result would be a list of words related to each other with relations in a pyramid system.

They organize the cognitive framework in a particular method that includes many lists that shows every feature of the term.

5. The ABSTRACTION :

Abstracting is analyzing the contents of an information resource to provide the critical parts such as Main ideas, information..etc.

An abstract is a brief and accurate presentation of the content of the resources.

The first automatic abstract was in 1958 by Luhn. Even after that, many scientists tried to produce summaries by regrouping sentences that match the original work using these methods: [12]

- The method of detecting The repetition of keywords.
- The method of the title keywords.
- Deterring the sentences in which certain words repeat, such as best, better, or greater.

Then the system rechecks words to know how precise it is.

The first work in automatic abstracting was Named FRUMP by De Junk in 1982. He made a system that analyzes articles from journals using scripts to collect the necessary information to make abstracts...[12]

In 1989, another system was developed by RAU called SCISSORS. It analyzes texts and builds a language network. Again, he was able to create an abstract using Natural language processing.

The First expert system that could create abstracts without human interference was in Canberra, Australia, in 1989. Besides the above, we can mention several systems: [9]

Project	Year	Field
Remlhart expert system	1977	-
NPX (SMITH PJ and Chingell MH)	1984	Chemistry abstracts
TOPIC (halm and Reimer	_	Texts abstracts
RAN expert system	1989	_
BLACK expert system	1990	_

Table N: 1 Abstracting E.S. systems

6. FINDINGS AND COMPARAISON:

Expert systems in Classification primarily delves into classifying information resources and the challenges associated with representing classification systems in expert system knowledge bases. It emphasizes the need for technology to assist in classification and presents specific examples of expert classification systems developed in mathematics and mineralogy. It also mentions an ongoing project utilizing artificial intelligence techniques for automatic classification. The text highlights the importance of expert systems in the classification field and acknowledges the difficulties encountered in their implementation.

Expert systems in indexation highlight the significance of automating the indexing process and mention notable examples of expert systems developed for efficient and accurate indexing. The FASIT system is highlighted explicitly for its ability to analyze and index news articles with high precision and speed. The text also mentions the AUTOCAD expert system developed by the City University and an expert system developed in the petroleum industry. These examples showcase the successful application of expert systems in the indexation domain.

Expert systems in Abstraction focus on automatic abstracting systems and developing expert systems for abstract generation. It describes the methods used in automatic abstracting, such as detecting keyword repetitions and identifying significant sentences. The text mentions the FRUMP system as an early example of an expert system that analyzes articles and generates abstracts. It also refers to the SCISSORS system developed by RAU, which utilizes natural language processing for abstract creation. The text highlights the first expert system that could create abstracts without human intervention, further emphasizing the advancements made in the field.

The texts cover different aspects of expert systems in information management, including classification, indexation, and abstracting. They provide examples of expert systems developed in various domains and highlight their contributions to enhancing efficiency, accuracy, and accessibility in information retrieval.

7. CONCLUSION AND DISCUSSION :

Artificial Intelligence (AI) has emerged as a transformative force in various fields, including information management. In the realm of information management, AI technologies offer tremendous potential for enhancing efficiency, accuracy, and decision-making processes. From data classification and retrieval to knowledge extraction and analysis, AI is revolutionizing how organizations handle and leverage information.

One area where AI has made significant contributions is in automating repetitive and time-consuming tasks involved in information management. AI-powered algorithms can analyze and process vast amounts of data quickly and accurately, reducing the burden on human operators. For instance, AI can be used to automatically classify documents based on their content, extract relevant metadata, and organize them in a structured manner. This streamlines the process of cataloging and indexing information, making it easier to search, retrieve, and manage data within digital libraries.

Furthermore, AI enables intelligent search and recommendation systems that significantly enhance information discovery and access. Natural Language Processing (NLP) techniques

allow AI systems to understand and interpret human language, enabling users to interact with information repositories through voice commands or textual queries. These systems can provide personalized recommendations based on user preferences, behavior patterns, and contextual information, thereby improving the overall user experience and increasing the relevancy of search results.

AI also plays a crucial role in knowledge extraction and analysis from unstructured data sources such as text documents, images, and multimedia content. Machine Learning algorithms can automatically extract key insights, sentiment analysis, and entity recognition from large volumes of data, enabling organizations to uncover valuable information and trends that would otherwise remain hidden. This capability is particularly useful in academic and research environments, where scholars can leverage AI-powered tools to extract relevant information from scholarly articles, patents, and other research materials, aiding them in their studies and advancing scientific discoveries.

Moreover, AI-based analytics tools enable advanced data visualization, predictive modeling, and decision support systems. By leveraging machine learning algorithms and statistical techniques, these tools can analyze historical data, identify patterns, and make predictions about future trends. This allows organizations to make data-driven decisions, optimize resource allocation, and anticipate potential challenges or opportunities in the
educational environment. For example, universities can use AI to analyze student performance data, identify at-risk students, and provide timely interventions to support their academic success.

However, as with any emerging technology, there are also challenges and considerations associated with the use of AI in information management. Ethical concerns, privacy issues, and biases in AI algorithms are among the critical areas that need to be addressed. It is important to ensure transparency, accountability, and fairness in AI systems to maintain trust and mitigate potential risks.

AI technologies are revolutionizing information management in universities and educational institutions. From automating routine tasks to enabling advanced data analysis and decision support, AI has the potential to transform how information is managed, accessed, and utilized. By leveraging AI capabilities effectively and addressing associated challenges, universities can harness the power of AI to create more efficient, personalized, and globally connected educational environments.

In the realm of information management, expert systems have demonstrated notable successes, particularly in the areas of indexation and abstraction. In the field of indexation, expert systems have proven to be highly effective tools for creating indexes by analyzing the content of information resources and identifying relevant keywords. This has significantly streamlined the indexing process, saving both time and effort. By automating the indexing process, expert systems have revolutionized the way information is organized and retrieved.

Similarly, expert systems have made significant contributions to the field of abstraction. Information experts have long recognized the potential of expert systems in improving the quality of abstracts. Through the application of specific techniques, experts have formulated rules and instructions, known as production rules, to enhance the abstraction process. These

rules enable the system to extract the most pertinent information from a source and summarize it accurately and concisely. The integration of expert systems in the abstraction process has resulted in more refined and informative abstracts, facilitating efficient information retrieval.

While expert systems have demonstrated success in indexation and abstraction, their application in the field of classification has been relatively limited. One notable attempt was the MRS Sharif expert system for book classification at the University of Strathclyde in 1988. However, this project encountered certain limitations and weaknesses, which necessitated further studies and refinement. Despite its initial failure, the MRS Sharif system later served as a valuable resource for training classifiers in libraries, highlighting the potential for future development and improvement in the field of classification using expert systems.

Overall, expert systems have played a significant role in enhancing information management processes. Their application in indexation and abstraction has yielded notable benefits, streamlining the organization and retrieval of information. Although their utilization in classification has been more limited, there is ongoing potential for further exploration and improvement. As technology continues to advance, expert systems are poised to play an increasingly vital role in shaping the future of information management, offering efficient and intelligent solutions to complex challenges in the field.

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