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Applications and Analysis of Expert Systems: literature review

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Abstract

Expert systems with a knowledge base that incorporate modern computing techniques to enhance and automate human activities. The common approach for creating knowledge-based expert systems has a number of challenges that continue to present up and may prevent effective deployments. If issues are found when gathering knowledge, a knowledge-based expert system might not always function properly. A knowledge-based expert system may also be difficult to maintain with the required time and resources once it is in place.
In order to create a more effective methodology, a variety of suggestions can be incorporated into the proposed method for extending the duration of knowledge-based expert systems. Although the fact that these methods are routinely used in different fields, knowledge-based expert systems have not frequently incorporated them into the duration of their systems. The suggested method's fundamentals were put to the test using a container-loading knowledge-based expert system. This investigation's goal is to examine how improvements to knowledge-based expert systems' life expectancy have been developed.

Key words: Knowledge-based Expert System, Knowledge Base, Inference Engine

1. Introduction

The first computer programme built expressly to identify solutions were created in the period between the years 1950 and 1960 [1]. One example of an application with began in those early programming is knowledge-based expert systems. Computer systems with their scientific knowledge, known as knowledge-based expert systems, are of value for rapidly evaluating and processing huge numbers of data [2]. They use information that has been compiled and stored in the knowledge base to deal with issues in the particular area for which they were designed. Due to personnel employee turnover, illness, or death, businesses constantly face the risk of losing professionals in essential parts of their day-to-day operations.By employing the knowledge accumulated over the duration of a person's employment by experts, also known as issue domain professionals, and storing it within a knowledge base, knowledge-based expert systems can help with reducing such risks. A knowledge-based expert system may speed up the process for creating responses by experts in the subject matter of a particular problem.A problem domain is a unique business process for which a knowledge-based expert system is created. Knowledge-based expert systems are made composed of various separate elements. Figure 1 shows how all the parts come together in order to resolve a challenge inside the problem area, as described by Gmsan and Hoplin [3]. Figure I takes arrows to show the path of data moving through the framework. The knowledge base, which is the initial element, contains both the heuristic data and relevant details about the topic [4] that is known to the subject are relevant experts. The inference engine, the second component, examines the knowledge base's rules in connection with a specific problem using the methods from the fields of scanning and filtering. This occurs by the inference engine seeking the knowledge base then employing the data that that is returned. The third part of the knowledge development module, makes it easier to transfer data into the knowledge base for usage afterwards. [5] [6] The end user interface, the fourth section, allows people to interface with the knowledge-based expert system by making questions to the engine for inference and evaluating the replies. The information is kept in the working storage, the fifth element of a knowledge-based expert structure, while it is being used for fixing a specific issue [7] and then merged with the data related to the replies.

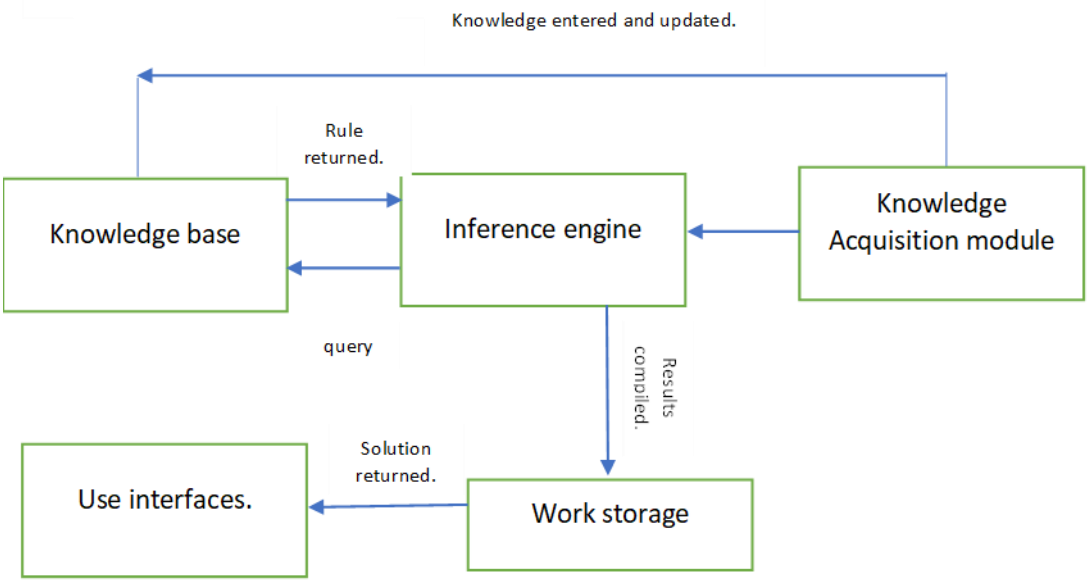

Figure 1: Knowledge-Based Expert System Components

Although knowledge-based expert systems offer a lot of benefits, they also have a range of significant limitations that may make it difficult to properly develop and carry out them. The system's capacity to perform its tasks properly may be affected by issues that occur during the knowledge assembling phase. However, as soon as it is a knowledge-based expert system can drop users and become obsolete due to the time and expertise needed for servicing it.

Knowledge-based expert systems have the limitations that their precision will depend on the information contained within the knowledge base.In order establish the essential features of the knowledge-based expert system, the acquisition of knowledge is described as the process of obtaining knowledge from professionals in the issue's domain.

The "bottleneck in the creation of expert systems" has been named the acquisition of knowledge [8]. The knowledge engineer and the area-of-expertise specialists in the challenges being solved are the two main parties involved in knowledge acquisition. The knowledge engineer asks concerns to domain specialists for domain-specific proficiency.

The capability of the system is limited by the level of detail and quality of the knowledge engineers' and issue domain experts' discussions [9]. To provide set standard frameworks for the information collecting procedure, research has been launched. Because the method still solely depends on the knowledge being manually transferred from the problem domain specialists to the knowledge engineer, the knowledge engineer's interviewing abilities are extremely important to the procedure's accomplishment [9].

Lack exchange of information is a common issue during the knowledge acquisition stage. This occurs because of on by a number of factors, starting with the knowledge engineer's lack of familiarity with specific concepts and the concern domain experts' mistakes. [10] During the interview phase, the knowledge engineer invests a significant amount of time paired with a topical domain expert or group of issues experts in the area. personality conflicts between subject-matter specialists and knowledge engineers can cause shortcomings in communication. They commonly think that a manual process can be developed to support their complex firm's activities. Additionally, issue domain specialists will be able to work with the knowledge engineer on the development process if they believe the knowledge-based expert system could damage their knowledge and cause them obsolete. Learning directly from specialists in the field usually stays a primary goal of the common approaches for learning knowledge. There were no traditional databases that contained records of the work done by issue domain specialists.

Modern specialists no longer primarily address issues using paper and a pen. Instead, they use a piece of software designed to assist them in thinking through the issue and coming close to a solution. When all knowledge is still under the hands of professionals, the procedure is still manual. accordance with current techniques. The fact that the domains in which knowledge-based expert systems have been developed are dynamic provides another issue.

The system needs to adjust to the changing situations inside the challenge area in order to keep being

successful. Knowledge-based expert systems are unable of applying independent adjustments or developing actually unique solutions for challenges [11]. The fact that the domains in which knowledge-based expert systems have been developed are dynamic indicates another problem.

The system needs to adjust to the changes occurring inside issues area in order to stay successful. Knowledge-based expert systems are unable of making independent adjustments or developing seriously original responses to issues [11].As soon as a new variable is added to the issue domain, the knowledge engineer has to work with experts in the field to ensure that the knowledge is appropriately updated in the base of knowledge.

This means that once the system has been built, knowledge engineers and experts in the relevant problem domain may need to invest a significant amount of time in knowledge base repair and maintenance. is rightly updated in the knowledge base. It also means that once the system has been constructed, knowledge engineers and experts in the relevant problem domain may need to invest a significant amount of time in knowledge base repair and maintenance.

The tools necessary to allow a knowledge engineer for working with specialists in the field on a problem as frequently as necessary sometimes are insufficient. The amount of time required to maintain a knowledge base could be very serious for a firm. The field of issue expertise may get stressed, die away, or leave the firm for a variety of reasons[11].

To ensure The professionals in information technology commonly work too much, the knowledge engineer needs to work with the subject matter experts as soon as a new variable is included in the issue's domain. Maybe there aren't the tools exist needed for a knowledge engineer to work together as regularly as necessary with experts in the field on a problem.

A knowledge-based expert system must be adopted effectively in order to address the mentioned problems[10]. This work will make using an number resources that are and approaches that are rarely utilized in the creation of knowledge-based expert systems in order to improve the technique developed specifically to decrease the risks mentioned above. The traditional strategy was subject to its first change, which involves the information taking phase. The second improvement is to change how knowledge base expert systems are maintained after use. By working with experts in the area, artificial intelligence may greatly decrease the time and resources required to maintain the knowledge base. Data mining and data warehousing means can be used to enhance and speed up the process of gaining knowledge.

٢.Expert Systems

A knowledge-based system with the primary goal of simulating human reasoning is known as an expert system [32]. This is achieved by Reproducing the decision-making capabilities of a human expert in a specific area. To solve problems that frequently require human ability, knowledge, facts, and reasoning abilities are constructed in a systematic way. The approachable gathering of knowledge is referred to as building a "knowledge base". In simple terms, this is a map of the knowledge that can be provided to a user during consulting. The knowledge base's data are used by the expert system to develop an opinion.

The inference engine serves for this. To develop new knowledge, specific data is studied investigated, and came together with user-provided input. Facts are created using some sort of language, while common representations include trees of choices, guidelines, graphs, and predictive calculus.[33] When expert systems are successful at sharing expert knowledge in a specific topic area, it is said to be successful. As a result, expert systems are frequently used across many different areas. Numerous business and industrial issues are presently resolved with expert system innovation.

2.1 Applications of Expert Systems

The technology is applicable for a range of tasks, which can be grouped into different categories [34] such as testing, fixing issues, forecasting, configuration reasons, taking decisions, information the publication's release monitoring and supervision, design and production, as well as debugging and training. Highly arranged rules are usually employed to allow systems in these classes to make decisions equivalent to those made by humans. Numerous healthcare facilities currently use medical diagnostic technology, network administrators use computer network diagnostic systems to detect problems with networks, soldiers use mission command platforms, and several groups use training and disaster management systems as examples of successful systems.

The apparent interest in merging expert system technology with current applications with a variety of topics has been covered in recent works [35]. Applications in the fields of medicine and education are also studied, as well as applications for accountancy and business management. The primary uses of expert system technology show how important ongoing research and development in this domain is.

2.2 Components of an Expert System

Knowledge bases, inference engines, and user interfaces are the three core components of expert systems. Some systems have a knowledge acquiring module which enables domain experts to add new knowledge to the knowledge base. The different elements of an expert system can be seen in Figure 2.

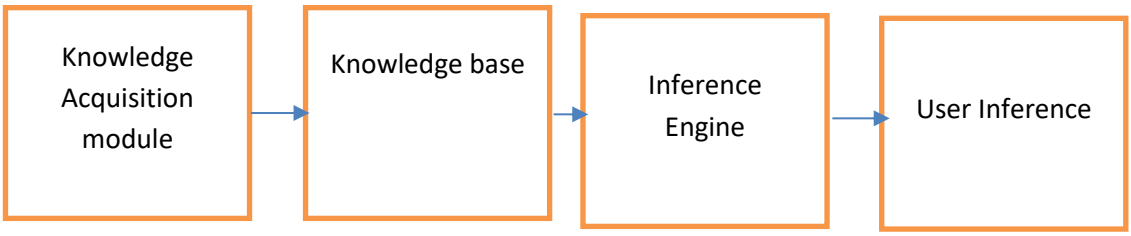

Figure2: shows the expert system's components.

٣OVERVIEW OF KNOWLEDGE-BASED EXPERT SYSTEMS

An overview of the basic concepts that support the enhanced knowledge-based expert system technique is given in this section. An accurate problem description must be created before a knowledge-based expert system can be implemented. Knowledge-based expert systems must find a solution to a problem that contributes all parties involved in order to be put into action. A organised procedure must be followed, just like with any software implementation, to guarantee that the requirements of every level of any organisation are achieved. The way software develops as it grows has an effect on the development of knowledge-based expert systems.[8] According to La Salle [12], continuous improvement is the technique used to create innovative knowledge-based expert systems. This process appears in Figure 3.

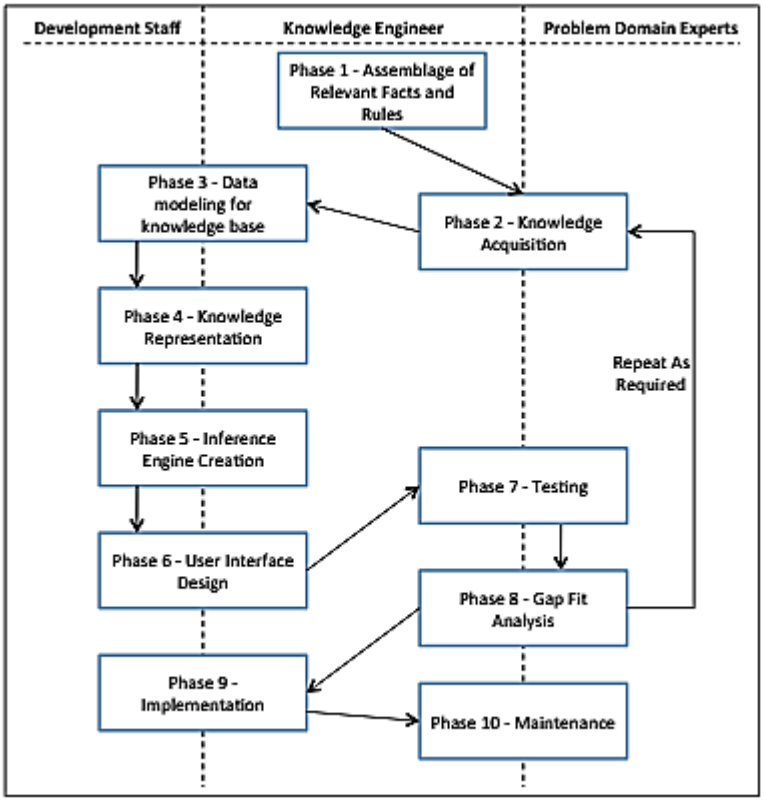

Figure 3: Knowledge-Based Expert System Life-cycle

The team responsible for development, the knowledge engineer, and experts in the field in the issue field are the main actors involved during the building and execution phases of a knowledge-based expert system, as illustrated at the top of Figure 3. The expert system's segment pieces are required to be built among the creation team according to with the knowledge engineer's design[12].
They are unlikely to have much experience with it, thus they will need the knowledge engineer's support in defining the issue's domain and the related strategies. The knowledge engineer serves as a point of contact between the development team and the area of expertise specialists. Both the technical understanding of the development team and the expertise of the problem domain specialists must be available to the knowledge engineer. To create the knowledge base, the knowledge engineer must collect system requirements from the experts and extract specific details about the issue that exists domain[17].
The challenge is that domain experts are also the system's end users and are aware of the specifications and specialties required to build a knowledge-based expert system. The development team, the knowledge engineer, and the experts in the field in the problem domain are the three main players during the development and implementation phases of a knowledge-based expert system, as illustrated at the top of Figure 3. The group of people of the expert system's component pieces in accordance with the knowledge engineer's design is the responsibility of the development team. Considering they won't be experts on the subject, a knowledge engineer will be needed to characterise the problem domain and any related procedures.
The knowledge engineer functions as a point connection between the development team and the experts in the field [12] [18], and both the technical know-how of the development group and the expertise of the problem domain specialists must be performed available to the knowledge engineer. For the knowledge base to be filled with relevant information, the knowledge engineer must obtain the system needs and obtain specific challenge domain knowledge from the experts.
area [13] is an illustration of the data obtain process, seen in Phase 2 of Figure 3 [14]. A collection of system requirements and the outlining of the knowledge necessary to build the knowledge base are the goals of the knowledge acquisition stage. In order to correctly deal with issues in the subject area, the knowledge engineer has to collect the full range and variation of data collected from the area of concern experts[19].

Phase 2 of Figure 3 illustrates the data capture methodology. A fully developed and precise knowledge base must exist for a data-based expert system to work well. Experts in the area of concern apply a variety of techniques to fix issues, which the knowledge engineer must identify and then convert into specific needs for the development team. During the knowledge capture section, the knowledge engineer frequently does a number of interviews with experts in the field for the subject area[13].
A variety of approaches for interviews can be used to help the knowledge engineer indicate information from the issue sector experts. Figure 3's Phase 3 demonstrates the following stage of improvement, which is the creation of data models for the knowledge base of operations.The data structure required to continuously apply the information is created by knowledge engineers employing current data modelling approaches, like logical and physical modelling, using the data gained during the knowledge collection phase.
The best option for storing and managing knowledge in knowledge bases as knowledge-based expert systems have progressed is databases [1] [21]. The knowledge engineer can start the knowledge images phase, which is shown in Phase 4 of Figure 3, once the information being collected and knowledge base data modelling stages have concluded. Data transformation into a way that can be for computers is recognized as storage of knowledge [13] [22]. This step involves creating the data structure for the knowledge base using the information that was got from issue experts in the field during the knowledge collecting phase.

The preparation of the data necessary for the knowledge base's initial implementation is the goal of this stage of development. Repeated steps are the greatest way to put knowledge-based expert system methodologies into reality. Knowledge engineers frequently lack knowledge about or experience with the methods that ensure the accomplishment of the knowledge capture phase. [12] Therefore, until the knowledge base precisely reflects the full range and breadth of knowledge in the topic area, the information accumulating, data modelling, and knowledge presentation phases can be repeated..
The knowledge engineer can gradually handle the complexity of the issue area by running through the knowledge mining, data modelling, and knowledge symbolism phases [121 [23]. Building the inference engine is the next stage of creation, as indicated in Phase 5 of Figure 3. The fundamental task of the inference engine is to deal with the issue via looking up appropriate guidelines in the knowledge base. The requirements that the knowledge engineer obtained

from the subject topic specialists must be met by the inference engine.

Three key requirements must be followed to via an ideal inference engine: completion, accuracy, and timeliness. The knowledge engineer and development team will decide which implementation to build for an inference engine based on the issue area [11] [24]. Phase 6 of Figure 3 shows the knowledge-based expert system journey after building the inference engine and before creating user interfaces. Users can provide problems for the system to solve, evaluate the solutions, and update the knowledge base through user interfaces. [12] [26]. A range of methods, such as the usage of web pages, application forms, or other methods for content removal, can be used to construct the user interface.

Figure 3's Phase 7 depicts the testing of the system after the building of the user interfaces. Comparing to a problem that has been manually solved by experts in the field is the most popular testing technique. A gap fit study, as seen in Phase 8 of Figure 3, would need to be carried out by the knowledge engineer if the solutions disagreed. The knowledge engineer would then adjust the knowledge base's or the inference engine's algorithms if the gap was suitable for measuring the cause of the variation.

By employing additional progressive phases, such as testing and gap fit analysis, the knowledge engineer and development team can come closer to the final item.To make sure that the knowledge-based expert system's findings agree with those of the problem specialists, many problems from every issue domain must be examined [27].

It is possible to employ the knowledge-based expert system to resolve new problems after it has successfully resolved problems that the problem specialists have already resolved. Early implementations, Phase 9 of Figure 3, are similar to testing in that the problem area specialists will work together to resolve the issue to make sure the system works as planned [28]. After all, the knowledge-based expert system is prepared to operate on its own after a successful initial implementation.

The knowledge-based expert system's duration has not ended after its initial implementation.Knowledge-based expert systems need maintenance when in use, as Phase 10 in Figure 3 illustrates. Knowledge-based expert systems are never developed for specific topic domains. Knowledge-based expert systems must adapt along with the issue domains. The maintenance of the system's effectiveness becomes dependent on the knowledge acquisition module. Experts in the problem domain must continuously examine newly introduced conditions and update relevant information bases. The knowledge-based expert system will become outdated, ineffective, and possibly wrong if the knowledge base is not updated and environmental changes are not taken into consideration.

Attempts at Knowledge Base Automation

Research and development efforts have been focused on developing technologies that enable the automated construction of knowledge bases in an effort to meet issues with collecting details.

EXPERT SYSTEM CREATOR

One of the tools used to develop expert systems is referred to as Expert System Builder [14]. It is an active growth and integration atmosphere for managing knowledge, developing and evaluating expert systems, and merging databases. The structure can be integrated with outside tasks in addition to the previous tasks thanks to Expert System Builder. Producing rules, decision graphs, and tree classes can all be used to express subject matter expertise. The application is created using Java programming [13] [29]. Expert System Builder gives rise to C/C*F and Java code for choosing among tables and trees in addition to using CLIPS and JESS expert system shells for the analysis procedure [15].

The usage of this type widely used instruments enhances the integrity of the output and user satisfaction with the entire system. Given the current state of graphics and assistance for automatic documentation for project development, based on Pop et al. [24], additional improvement is planned. The present issues in presenting data are predicted to be agreed by improvements in Expert System Builder by integrating fuzzy logic engines and using enhanced features to speed up the process of acquiring data. The efficiency of Expert System Builder is also said to be enhanced by the addition of powerful reporting capabilities.

To maximise efficiency, integration with other systems appears to be the main goal. Even while it can contribute to extra problems, when done properly, it can produce significant improvements. It's essential to understand that effective options like Expert System Builder have built-in limitations on flexibility and modification. Expert System Builder has been selected as the primary tool for a variety of development projects, illustrating the range of opportunities it offers [16] [31] and enhancing its main benefits. For an expert system to be powerful during discussion, information corporation is vital [8].

The necessity for such tool and method study and creation is clear: these tools aid in the development

of both direct and indirect knowledge visualization and collecting mechanisms. It is additionally expected that the possibility of a variety of tools and methodologies to aid the modelling of knowledge process would lead to the development of highly efficient methods with exclusive levels of conclusion.

4 .CONCLUSION

concerning the significance of knowledge storage in the building of expert systems. A variety of information representation techniques have been studied with gaining data deemed to be the main bottleneck in the creation of expert systems. We discussed alternative solutions for the topics we found with the knowledge form and obtaining process. We listed their advantages, negative effects, and variation. Finally, methods and tools that could aid in the construction of systems of this kind were evaluated.

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