

Survey on Expert System and its Research Areas

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Abstract: Study in the area of artificial intelligence has given rise to the rapidly growing technology known as expert system. Expert system is an area of artificial intelligence which is having a huge impact on various fields of life. Expert system uses human knowledge to solve the complex problems in various areas as science, engineering, business, medicine, weather forecasting and the organizations employing the technology of expert system has seen an increase in the quality and efficiency. Expert system is computer software that emulates the decision making ability of a human expert. The expert system represents knowledge acquired from human expert as data or rules within the computer. These rules and data can be called upon to solve the complex problems. This paper gives an overview of this technology and will discuss a survey on various works done in different areas as agriculture, automobiles, biomedical, education, medicine, steel making industry using expert system.

Keywords: Expert system, Inference engine, ITS, Knowledge-Based System (KBS).

I. INTRODUCTION

Expert system is developed by artificial intelligence community and is a branch of artificial intelligence. One of the largest areas of applications of artificial intelligence is in expert system. Expert system has gained the interest of professionals in the number of fields as agriculture, computer science, chemistry, engineering, medicine, geology, space technology etc. Expert system has various advantages over the human expert as expert system is affordable, permanent, consistent, fast processing and quick replication whereas human expert is perishable, unpredictable, and expensive and has slow processing and reproduction. Expert systems are computer software programs that store knowledge in the form of data and rules from human experts.

II. LITERATURE REVIEW

[1] John Durkin "Application of Expert System In Science" says that An expert system is a computer program or a software that captures the knowledge of a human expert on a given problem, and uses this knowledge to solve problems similar to the expert. So the expert system can assist the expert during problem-solving. [2]Yasser Abdel amid "A Proposed Methodology for Expert System Engineering" Explained that the development methodology of an expert system has two aspects: Knowledge engineering and Software engineering. In the software engineering there are four activities for expert system development: requirements, specification, design, implementation, and testing. [3]Mario A Garcia, "An Expert System in Diabetes"

describes the ESDIABETES. In U.S.A. the cost of diabetes is estimated to represent 5.8% of total personal health-care expenditures. Also Saudi Arabia is the third country around the world in which is where diabetes is most prevalent among the adults. ESDIABETES was developed by computer science graduate students at Texas to help people control the blood glucose level.

III. CONFIGURATION OF EXPERT SYSTEM

The process of building expert systems is often called knowledge engineering. The knowledge engineer is involved with all components of an expert system [7]. The internal structure of an expert system consists of three parts: the knowledge base, the database, the rule interpreter.

Expert system=Knowledge base+ Inference engine

Knowledge-based systems and its applications: The components of KBS are usually distinguished as: a knowledge base, a knowledge engineering tool, an inference engine and user interface. Its applications include the following: medical treatment, waste management, personal finance planning, production management, knowledge management, financial analysis, business game, climate forecasting, agricultural management, decision making and learning, chemical process controlling, plant process control, outage locating planning, crop production planning, troposphere chemistry modeling.

A. The Knowledge base: The knowledge base contains specialized knowledge on a given subject that makes the human a true expert on the subject. This knowledge is obtained from the human expert and encoded in the knowledge base using one of several knowledge representation techniques. One of the most common techniques used today for representing the knowledge in an expert system is rules [4].

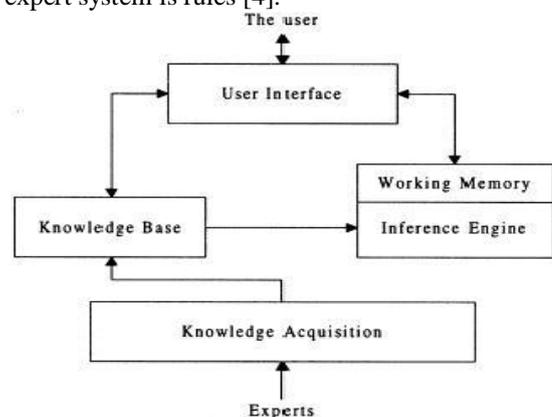


Fig 1: Configuration of an Expert System [13]

A. The Working Memory: The working memory has both the facts entered by the user and facts inferred by the system. The information in the working memory is from spreadsheets, databases which are used by the expert system to conclude additional information about the complex problems.

B. The Inference Engine: The inference engine works with the data contained in the working memory and in the knowledge base to derive new information about the problem to be solved. Two principal techniques are evolved in the inference engine-backward chaining and forward chaining. Forward chaining Works from a set of facts and rules towards the conclusion and when the fact will match the rule, the rule will be fired and conclusion will be added. If there is more than one rule than use the conflict resolution strategy. In the conflict resolution strategy the rule having the higher priority and the rule that is most recently added to the database will be selected. Then the chosen rule will be activated and accordingly an item will be added or deleted from the working engine. We use backward chaining when proving a particular conclusion. In this we work from a conclusion to the original fact.

C. The User Interface

The user interacts with the system through a user interface. The Expert System user interface usually consists of two basic components:

- The Interviewer Component: It controls the dialog with the user and allows data to be read into the system.
- The Explanation Component: It makes the system's operation transparent by providing the user with reasoning information. It gives the result and also the set of rules that was used to derive the result.

IV. RESEARCH AREAS OF EXPERT SYSTEM

A) Research Work of ES in Bio-Medical Area

1.1) Diagnosis of Heart Disease

Case-Based Reasoning (CBR) is a general artificial intelligence paradigm for reasoning from experience. There are four key issues in the developing of any CBR system, namely: (a) case representation and identifying key features, (b) indexing and retrieving similar cases from the case memory, (c) measuring case similarity to select the best match, and (d) modifying the existing solution to fit the new problem [1].

Retrieval Using Induction Technique: The common retrieval technique in heart diseases involves a process called induction. Machine learning researchers developed the induction technique in which rules are extracted or decision trees are constructed from the past data. In CBR systems, the casebase are analyzed to produce a decision tree by an induction algorithm that classifies the cases. ID3 is the most widely used induction algorithm in

CBR. In this decision trees are built from the databases of cases. To find the most promising attribute on which to divide the casebase, it uses a heuristic called information gain. It depends on pre indexing as the decision tree is made off-line before the start of retrieval. There is one disadvantage of using this technique if case data is missing or unknown, it may not retrieve a case at all.

Retrieval Using Nearest-Neighbor Technique: when all the patient's report attributes are given, the system will suggest a diagnosis for a new patient case. The cases that match will be searched. To retrieve the closest match cases, Nearest-neighbor algorithm will be used. This algorithm will find the closest match of the new cases to the already stored cases in the database using a distance calculation. So the nearest neighbor technique will determine the similarity between the two cases by comparing their features.

1.2) Diagnosis of Eye Diseases: This is an expert system designed for diagnosis of eye disease using **CLIPS(C Language Integrated Production System)**. A set of rules is created where each rule contains an IF part that has the symptoms and in THEN part has the disease that should be realized. The inference engine (forward reasoning) is a mechanism through which rules are selected to be fired. It is based on a **Pattern Matching Algorithm** whose main purpose is to associate the facts (input data) with applicable rules from the rule base. The scope of this ES is the following eye diseases: Discharge from the Eye, Bulging Eye, Double Vision and Dropping Eyelid [12].

1.3) Expert System for Determining Diabetes

Treatment: It is well known that the incidence of diabetes is increasing. The research show that in Saudi Arabia 17% of the citizens are diabetics and 28% of them are vulnerable to be diabetics. Then the cloud computing technology was exploited in which the design was introduced and novel expert system for treatment of diabetes is implemented which depends on cloud computing platform "Google App Engine". ESDIABETES was also developed by computer science graduate students to help people control the blood glucose level.

B) Research work of ES in Automobile Area

2.1) Diagnosing Heavy-Duty Diesel Engine Faults: The major aim of Heavy Duty Diesel Engine Expert System(HDDE-ES) is to provide instant expert guidance in dealing with HDDE problems when time is limited and when decisions have to be made in a situation where a mechanic specialized in a sub-system of HDDE is not available[10].HDDE Expert system is built on Bayesian Belief Network(BBN) technology which is a "causal reasoning" tool and it summarize a problem as a set of nodes interconnected with arcs from a dependent structured network. The HDDE expert system has a graphical user interface that constitutes a problem

selection interface and a problem diagnose interface. We use Bayesian network to tell about the faulty components and also suggest solutions for different Engine problems.

2.2) Car Failure Diagnosis:

The Car Failure and Malfunction Diagnosis Assistance System is having three parts first is the knowledge acquisition part it gets the knowledge from expertise sources and the retained knowledge is kept in the knowledge base storage. It has the following components: human expert, knowledge engineer, external sources of data and system users, as shown in Figure2. Secondly in the Graphical User Interface (GUI) we have all the required interfaces in performing system functionality. Third part is the system modules which are responsible for finding the solutions for the problems and for reasoning. System module has the four components: Reasoning Specification module, the Inference Engine, the Knowledge Base and the User Adviser module. For car failure diagnosis we also have a proposed system that divides car failures into 3 major types i.e. Start-Up State, problems that may occur when a person try to start-up the car; Run-Stable State, problems that may occur after starting the car; and Movement-State, problems that may occur while the car is moving[2]. The system is having 150 rules for different types of failures and causes and can detect over 100 failures types. Through the user interface, communication between system and user is done which is represented as a menu that displays questions to users and in response the user replies yes or no. The knowledge is stored in the form of rules in the CLIPS(C Language Integrated Production System).

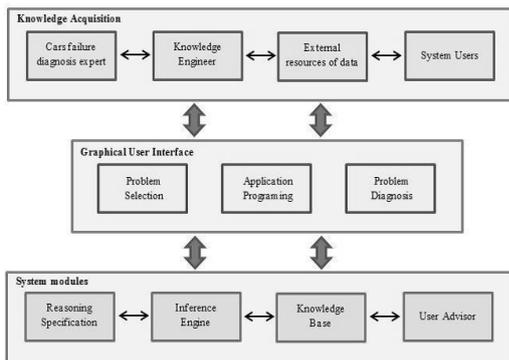


Fig 2: Car Failure and Malfunction Diagnosis Assistance System [11]

C) Research work of ES in the field of medicine

MYCIN: Medical system for diagnosing blood disorders. First used in 1979.

DENDRAL: Used to identify the structure of chemical compounds. First used in 1965.

PUFF: Medical system for diagnosis of respiratory conditions.

PROSPECTOR: Used by geologists to identify sites for drilling or mining [3].



Fig 3: Mycin

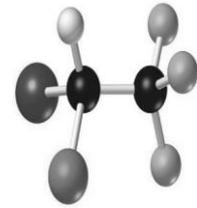


Fig 4: Dendral

D) Research Work of ES in Agriculture Area

4.1) Diagnosis of Diseases and Pests in Pakistani

Wheat: We all know local names of wheat are Kanak and Gandum. Wheat is a *Rabi* crop that is it is grown in winters. The most commonly recognized disease in wheat is rust like Flag Smut, Stem Rust, Leaf Rust, etc. it is facing difficulties because wheat production rate could not catch-up with the population growth rate because several factors such as weather, insects, viruses, fungi, bacteria and weeds etc. are affecting wheat production. The rule-based expert systems have been successfully used previously. Rules are made on the basis of the hierarchy and these rules lead to diagnoses of desire disease. For example, in diagnosing diseases of wheat, the top level involves the following typical symptoms and recommendations.

Problem in leaves→disease may be Stem rust

Problem in leaves→disease may be Flag smut [5].

The knowledge base for e2glite expert system shell consists of simple if-then rules. The internal logic of inference engine determines which rules are to be fired. In rule-based expert systems forward and backward chaining are used for reasoning. Forward chaining is data driven whereas backward chaining is goal driven.

4.2) Diagnosis of Diseases in Rice Plant:

ESTA (Expert System for Text Animation) shell is used for development of this expert system. The process of developing expert system using ESTA is a multi-step process which aims at developing a domain specific knowledge base [14].The steps involved in developing a knowledge base are identification of the input problem, knowledge acquisition and representation of knowledge into the knowledge base. Simple if-do rules are used instead of if-then rules in backward chaining. Start section is the first section in ESTA, when the conditions are fulfilled advice is given. Flow of control is determined by the parameters which can be number, Boolean or text.

E) Research Work of ES in Steel Making Industry

In steel making industry expert systems are preferred over the other software systems as the maintenance of expert system is easier than that for other software

systems. The following four expert systems are partly in use:

5.1) In the rolling mill expert system was developed to casting schedules for the steel plant.

5.2) In the steelmaking plant a scheduling expert system was developed to support the dispatchers.

5.3) A computer aided quality control (CAQC) system produces dependent on customer orders and steel grades prescriptions to achieve the desired steel quality. These are not complete in aspects like process routings and settings of process parameters for heats in steel making plants.

5.4) An expert system for the diagnosis of the blast furnace was developed. The system works interactively and does not control the furnace directly [8].

F) Research Work of ES in Education Area

6.1) Teacher's Performance Evaluation Using Fuzzy Logic:

Expert system using fuzzy logic is used to evaluate teachers performance by using numerically weighted linguistic terms as good, very good, medium, high, low, bad, satisfied, unsatisfied etc. The proposed ES consists of various aspects of teachers attribute or features like research and publication, teaching learning process, personal skill & abilities etc. To enhance the performance and reliability in decision making Fuzzy logic can be incorporated into ES.

6.2) Intelligent Tutoring System (ITS): This expert system is based on fuzzy logic and was developed to guide first year engineering students.

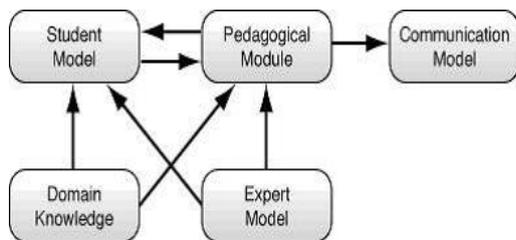


Fig 5. Components of Intelligent Tutoring System [13]

This expert system helps the engineering students to help the students to have deep understanding of the topics in engineering field. The Student model is used for storing records of the students. Domain Knowledge is the knowledge that the tutor shares with the students. Pedagogical Module describes the teaching process model. Communications Module is used for interactions with the learner which includes the dialogue and the screen layouts. Expert Model is an extension of the domain knowledge.

6.3) Intelligent Pascal Tutoring System (IPTS): Since the first development of CAI program, a lot of research has been done on CAI to build up expert systems which are more efficient and fast. In 1970s, a new breed of CAI became popular: Intelligent Computer Aided Instruction (ICAI) which is widely used for educational rationale.

One of the ICAI that is particularly used for teaching Pascal computer language is Intelligent Pascal Tutoring System (IPTS). This expert system is used for independent teaching of Pascal to computer scholars [13]. IPTS also contains the knowledge base for solving queries of users. IPTS teaches the students as well as keeps the students database to check the performance.

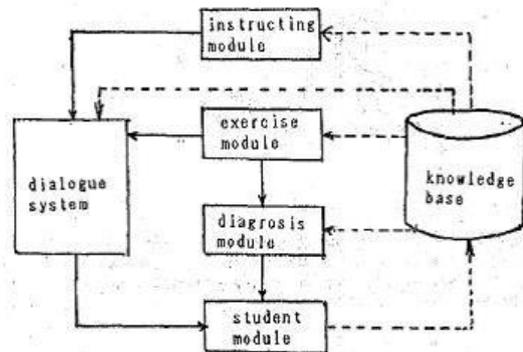


Fig 6. Components of IPTS [13]

Through dialogue system the user interacts with the system. The classification and execution of tutoring process is done in the Instructing Module. Exercising module is used for providing a learning and convenient way for students to enhance their programming skills. Diagnosis modules are used for explaining student causes and types of errors in programming. Student Module handles the record of students.

V. CONCLUSION

Tremendous contribution to the various areas has been made by the expert system from the last fifteen years. Expert system will continue to play an increasingly important role in the various fields. In the survey done in this paper biomedical, automobile and agriculture areas comes under the diagnosis and the other areas such as education that uses the fuzzy logic comes under the decision area of expert system. Opportunities for new job areas can be created with the help of expert system as everyone can find the application potential in the field of expert system. This paper is based on the review of the expert system and the important research area of expert system and the readers can do further individual expert system research. This system is an open source so researchers can add to it as applications of expert system in the science are expected to increase in the near future.

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