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An Overview on Structure, Characteristics and Development of an Expert System

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ABSTRACT
Expert systems are the most prevalent area of the artificial intelligence. It is the predecessor of the current day artificial intelligence, deep learning and machine learning systems. The Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if-then rules rather than through conventional procedural code. The expert systems are more efficient and accurate compared to human experts. The more experience entered into the expert system, the more the system can improve its performance AI is used in everything from gaming, to creating smarter computerized opponents, to robots that can assist humans in nearly every facet of life. Expert system provides solutions for the most complex issues in various domains.

Keywords : **- Expert System, Artificial Intelligence, Knowledge Inference, Knowledge Base**

I. INTRODUCTION

Artificial Intelligence is the study and development of machines that are capable of having intelligence equal to or better than a human being. In artificial intelligence, an expert system is a computer system that emulates the decision-making ability of a human expert. Category of programs that deals with assisting in decision- making in well-defined areas of knowledge are called expert systems. Expert systems have specific knowledge to one problem domain, e.g., medicine, science, engineering, etc. The expert's knowledge is called a knowledge base, and it contains accumulated experience that has been loaded and tested in the system. Much like other artificial intelligence systems, expert system's knowledge may be enhanced with add-ons to the knowledge base, or additions to the rules.

Artificial intelligence is a relatively young science. Emerged during sixties of the 20th century and from then until today, on its development and improvement are working teams of scientists from all parts of the world in specially equipped laboratories. Over time and developing, the computer data processing is increasingly turning to symbolic data, and less toward numerical. Artificial Intelligence is the study and development of machines that are capable of having intelligence equal to or better than a human being. As a result, AI has many different applications today and few of them are

MYCIN: It was based on backward chaining and could identify various bacteria that could cause acute infections. It could also recommend drugs based on the patient's weight.

DENDRAL: used for chemical analysis to predict molecular structure.
PXDES: used to predict the degree and type of lung cancer
CaDet: It can identify cancer at early stages
Pathfinder: It seeks and diagnoses lymph-node diseases.

II. NEED OF EXPERT SYSTEM

Human expert can resolve many issues based on expertise, intelligence and knowledge acquired within them. They can use decision-making capabilities to provide a solution for different problems and are also capable of expressing and reasoning in various situations. Over time and developing, the computer data processing is increasingly turning to symbolic data, and less toward numerical. An Expert System is an interactive and reliable computer-based decision-making system which uses both facts and heuristics to solve complex decision-making problems. It is considered at the highest level of human intelligence and expertise.

A human expert and expert systems differs in the fact that, expert system has the capability of making conclusions and can give explanation, can explain their actions, justify their conclusions and provide information about the knowledge they possess where as human experts are unpredictable and expensive. It's difficult to transfer the knowledge from them and sometimes hard to understand their actions, ideas and reasoning behind their decisions. Expert system helps to distribute the expertise of a human. It may contain knowledge from more than one human expert thus making the solutions more efficient. Emotions are involved

with human expert; they get tired and exhausted after working continuously and are perishable whereas expert systems are non-emotional and permanent. So, expert systems are more efficient and accurate compared to human experts.

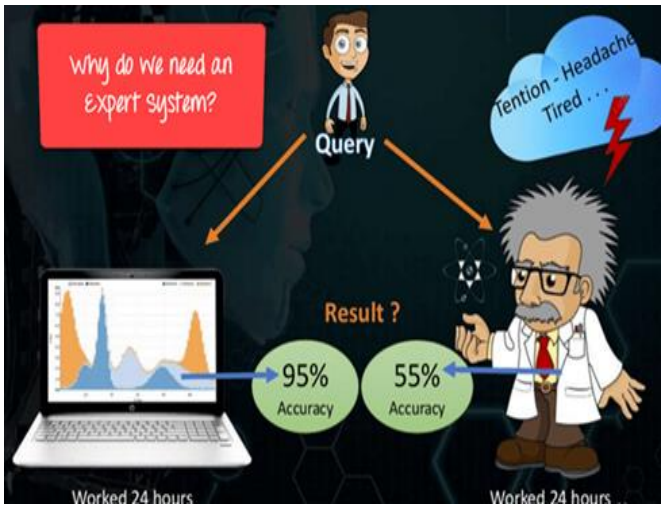

Fig. 1 Expert System

III. CHARACTERISTICS OF EXPERT SYSTEM

Following are important characteristic of Expert System:

- **The Highest Level of Expertise:** The expert system offers the highest level of expertise. It provides efficiency, accuracy and imaginative problem-solving.
- **Right on Time Reaction:** An Expert System interacts in a very reasonable period of time with the user. The total time must be less than the time taken by an expert to get the most accurate solution for the same problem.
- **Good Reliability:** The expert system needs to be reliable, and it must not make any mistake.
- **Flexible:** It is vital for expert system to be flexible. An expert system must have flexible strategies for problem solving to remain flexible.
- **Effective Mechanism:** Expert System must have an efficient mechanism to administer the compilation of the existing knowledge in it. It must have the ability to easily update the knowledge, with the aim of increasing knowledge and improving the model.
- **Capable of handling challenging decision & problems:** An expert system is capable of handling challenging decision problems and delivering solutions.
- **Performance:** Expert systems demonstrate high performance through the mechanism of appropriate problem solving.
- **Ability to explain decision:** Expert system has the capability to explain how the decisions are made. It must have the ability to explain what they did and why they did it, in the same way how humans-experts explain their actions.

IV. STRUCTURE OF THE EXPERT SYSTEM

Expert System consists of Development Environment and Consultation Environment.

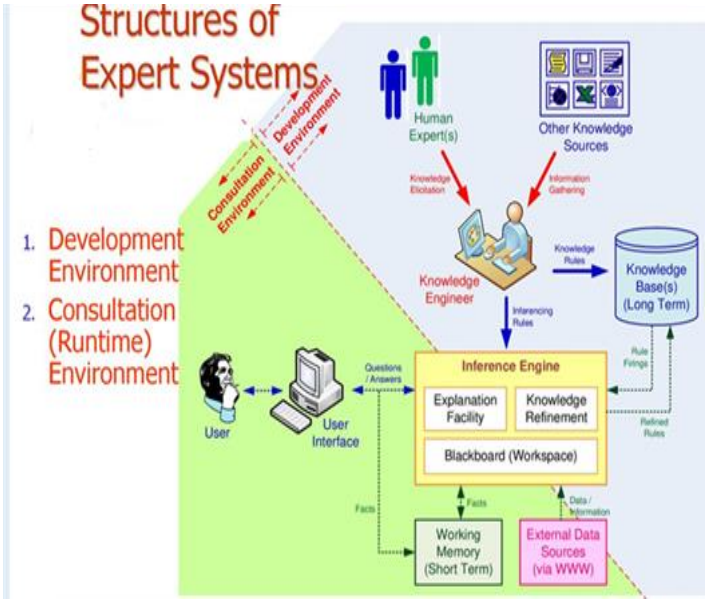

Fig. 2 Structure of Expert System

A. *User Interface*

The user interface is the most crucial part of the expert system. This component takes the user's query in a readable form and passes it to the inference engine. After that, it displays the results to the user. In other words, it's an interface that helps the user communicate with the expert system**.**

B. *Inference Engine*

The inference engine is the brain of the expert system. Inference engine contains rules to solve a specific problem. It refers the knowledge from the Knowledge Base. It selects facts and rules to apply when trying to answer the user's query. It provides reasoning about the information in the knowledge base. It also helps in deducting the problem to find the solution. This component is also helpful for formulating conclusions.

C. *Knowledge Base*

The knowledge base is a repository of facts. It stores all the knowledge about the problem domain. It is like a large container of knowledge which is obtained from different experts of a specific field. Thus we can say that the success of the Expert System mainly depends on the highly accurate and precise knowledge.

D. *Blackboard*

It records intermediate hypotheses and the decisions that expert system manipulates.

E. *Explanation Facility*

This facility explains the reasoning of the system to a user.

F. *Knowledge Refinement*

It is the process of evaluating, analyzing and optimizing knowledge to be stored in a repository.

V. GOAL OF EXPERT SYSTEM

The goal of an expert system is to transfer expertise from an expert to a computer and then to the user. This expertise transfer involves four activities:

A. Knowledge Acquisition

Capturing domain knowledge of a problem domain is the first step in building an expert system. Knowledge acquisition refers to the process of extracting, structuring, and organizing domain knowledge from domain experts into a program. A knowledge engineer is an expert in AI language and knowledge representation, who investigates a particular problem domain, determines important concepts, and creates correct and efficient representations of the objects and relations in the domain. In general, the knowledge acquisition process through a knowledge engineer can be divided into four phases:

1) Planning**:** The goal is to understand the problem domain, identify domain experts, analyse various knowledge acquisition techniques, and design proper procedures.

2) Knowledge Extraction**:** The goal is to extract knowledge from experts by applying various knowledge acquisition techniques.

3) Knowledge Analysis**:** The outputs from the knowledge extraction phase, such as concepts and heuristics, are analysed and represented in formal forms, including heuristic rules, frames, objects and relations, semantic networks, classification schemes, neural networks, and fuzzy logic sets. These representations are used in implementing a prototype expert system.

4) Knowledge Verification: The prototype expert system containing the formal representation of the heuristics and concepts is verified by the experts. If the knowledge base is incomplete or insufficient to solve the problem, alternative knowledge acquisition techniques may be applied, and additional knowledge acquisition process may be conducted.

B. Knowledge Representation

Knowledge representation incorporates findings from psychology about how humans solve problems and represent knowledge in order to design formalisms that will make complex systems easier to design and build. Knowledge representation and reasoning also incorporates findings from logic to automate various kinds of reasoning, such as the application of rules or the relations of sets and subsets. Examples of knowledge representation formalisms include semantic nets, systems architecture, frames, rules, and ontology. Examples of automated reasoning engines include inference engines, theorem provers and classifiers.

C. Knowledge Inference

An expert system (ES) is a knowledge-based system that employs knowledge about its application domain and uses an inference (reasoning) procedure to solve problems that would otherwise require human competence or expertise. The brain of an expert system is the inference engine that provides a methodology for reasoning about information in the knowledge base. Inference can be performed using semantic networks, production rules, and logic statements.

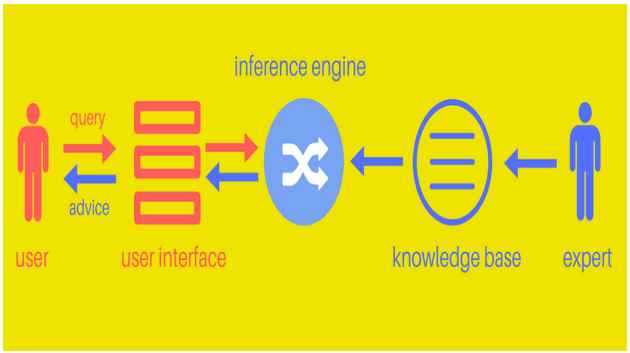

Fig. 3 working of inference engine

Inference Engine combines the facts of a specific case with the knowledge contained in the knowledge base to come up with a recommendation. In a rule-based expert system, the inference engine controls the order in which production rules are applied and resolves conflicts if more than one rule is applicable at a given time.

It also directs the user interface to query the user for any information it needs for further inference. The facts of the given case are entered into the working memory, which acts as a blackboard, accumulating the knowledge about the case at hand. The inference engine repeatedly applies the rules to the working memory, adding new information (obtained from the rules conclusions) to it, until a goal state is produced or confirmed.

D. Knowledge Transfer to the user

Knowledge transfer to the user in an Expert System is done through a user interface. Even the most sophisticated expert system is worthless if the intended user cannot communicate with it. The component of an expert system which communicates with the user is known as user interface. The communication performed by a user interface is bi-directional as shown in the below figure.

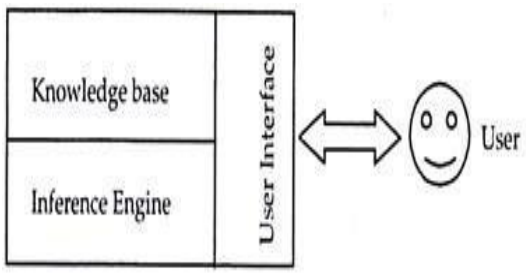

Fig. 4 *Knowledge Transfer to the user*

At the simplest level, a user must be able to describe the problem to the expert system and the system must be able to respond with its recommendations. In practice a user interface for the system is expected to explain its 'reasoning' or the system may request additional information about the problem from the user.

Designing a user interface involves Design of dialog and Input/output modes and their effectiveness with transparency. Most user interfaces make heavy use of natural language processing techniques. This technique shows how to communicate with an expert system in ordinary English and enable the computer to respond to us in the same language. This type of user interface is sometimes called a natural language front-end. Even graphics or multi-media interfaces are also used though not very common.

VI. BENEFITS OF EXPERT SYSTEM

- Improves the decision quality
- Cuts the expense of consulting experts for problem-solving
- Provides fast and efficient solutions to problems in a narrow area of specialization
- Can gather scarce expertise and use it efficiently
- Offers consistent answer for the repetitive problem
- Maintains a significant level of information
- Helps to get fast and accurate answers
- Able to provide proper explanation of decision making
- Ability to solve complex and challenging issues
- Steadily work without getting emotional, tensed or fatigued.

VII. APPLICATIONS OF EXPERT SYSTEMS

AI has many different applications today. AI is used in everything from gaming, to creating smarter computerized opponents, to robots that can assist humans in nearly every facet of life. Expert systems are proficient in reasoning, classification, configuration, pattern matching, diagnosis, and planning. This proficiency are applied in areas like Finance, healthcare, customer care, aviation, education etc.

- Medicine: Expert systems are in use for diagnosis and the planning of treatment in specialized fields. These include certain types of cancer, kidney diseases and some vital infections. Expert systems for use by general practitioners in diagnosis and treatment are under investigation.
- Geological Prospecting: Expert systems have already proved their worth in oil prospecting. Now they are being used for other minerals.
- Designing Computer Configurations: Digital Equipment Corporation uses an expert system to design the computer configuration required when an order for a VAX minicomputer is placed. The expert system ensures that a compatible set of equipment is delivered which meets the requirements of the customer.

- Chemistry: The analysis of chemical structures from mass spectrometer data is often done with the aid of an expert system.

- Legal Advice: Expert systems which give general legal advice and assist in such matters as making social claims are at present under development.

- Management Systems: Management Systems contains several classes of expert systems as it must be able to interpret the current situation, predict the future, controls the execution of the plan, diagnose errors and plan future goals and activities.

VIII. CONCLUSION

In artificial intelligence, an expert system is a computer system that emulates the decision-making ability of a human expert. It is an interactive and reliable computer-based decision-making system which uses both facts and heuristics to solve complex decision-making problems. An expert system is able to, draw reasoned conclusions from a body of knowledge in a particular field, and communicate to the user, the line of reasoning by which it has reached a conclusion. It is considered at the highest level of human intelligence and expertise. It is a computer application which solves the most complex issues in a specific domain. It is based on knowledge acquired from an expert. It is also capable of expressing and reasoning about some domain of knowledge. Expert systems are replacing many traditional systems and will have a bigger impact in every aspect of life in the days to come.

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