SKILRY

EXPERT SYSTEMS

What are Expert Systems?

The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

An expert system is a computer program that uses artificial intelligence (AI) technologies to simulate the judgment and behavior of a human or an organization that has expertise and experience in a particular field.

Expert systems are usually intended to complement, not replace, human experts.

The concept of expert systems was developed in the 1970s by computer scientist Edward Feigenbaum, a computer science professor at Stanford University and founder of Stanford's Knowledge Systems Laboratory. The world was moving from data processing to "knowledge processing," Feigenbaum said in a 1988 manuscript. That meant computers had the potential to do more than basic calculations and were capable of solving complex problems thanks to new processor technology and computer architectures,

Characteristics of Expert System

- **Knowledge Base:** Expert systems contain a knowledge base which stores both factual and heuristic knowledge. This knowledge is typically acquired from human experts in a specific domain and is represented in a structured format that the system can utilize.

- **Inference Engine:** The inference engine is the heart of an expert system. It applies logical reasoning techniques to the knowledge base in order to draw conclusions or make decisions. It uses rules, algorithms, and heuristics to simulate the human reasoning process.

- **Rule-Based Reasoning:** Expert systems often use rule-based reasoning, where knowledge is encoded in the form of "if-then" rules. These rules represent relationships between various factors and conclusions in the problem domain.

- **Explanation Facility:** Expert systems should be able to provide explanations for their reasoning process and the conclusions they reach. This transparency helps users understand why a certain decision was made.

- **Knowledge Acquisition: Expert systems are designed to acquire new knowledge and refine existing knowledge over time. This can involve learning from interactions with users, updating the knowledge base based on new data, or refining inference rules.**

- **Domain Specificity: Expert systems are typically designed for specific problem domains, such as medical diagnosis, financial analysis, or troubleshooting technical problems. They excel in tasks where human expertise is crucial.**

- **Limited Scope: Expert systems are not general-purpose AI systems. They are designed to excel within a specific domain but may struggle when faced with tasks outside their area of expertise.**

- **High Performance: Expert systems are expected to perform at a level comparable to or better than human experts in the same domain. This requires efficient reasoning mechanisms and accurate knowledge representation.**

Capabilities of Expert Systems

- Knowledge Representation: Expert systems encode and organize knowledge from human experts into a format that a computer can understand and use for decision-making.

- Inference Engine: The core component of an expert system, the inference engine, applies logical reasoning to the knowledge base to draw conclusions or make recommendations based on input data or user queries.

- Rule-Based Reasoning: Expert systems typically use a rule-based approach, where a set of "if-then" rules governs the system's behavior. These rules are derived from expert knowledge and define how the system should respond to different situations.

- Decision Support: Expert systems provide decision support by analyzing data and recommending actions or solutions based on the knowledge encoded within them. They can assist human users in complex decision-making processes by offering insights and suggestions.

- Learning and Adaptation: Some expert systems incorporate learning capabilities to improve their performance over time. This may involve refining existing rules, acquiring new knowledge from interactions with users or external sources, or adjusting their behavior based on feedback.

- Explanation and Transparency: Expert systems can often explain their reasoning process, allowing users to understand how they arrived at a particular recommendation or decision. This transparency is crucial for building trust and facilitating collaboration between humans and AI systems.

- Scalability and Consistency: Expert systems can be scaled to handle large volumes of data and complex decision-making tasks without sacrificing consistency or accuracy. They can maintain a high level of performance even when dealing with vast amounts of information.

Components of Expert System

- **Knowledge Base (KB):** At the core of an expert system lies its knowledge base. This is where all the domain-specific information is stored. It comprises facts, rules, heuristics, and other forms of knowledge, often represented in some logical or structured format. In traditional expert systems, this knowledge was typically encoded by human experts, but modern approaches, such as machine learning, might also involve extracting knowledge from large datasets.

1. The knowledge base can be further categorized into two types of knowledge:
2. Declarative Knowledge: This includes factual information about the domain, such as "Water boils at 100 degrees Celsius at standard atmospheric pressure."
3. Procedural Knowledge: This consists of rules and procedures for problem-solving or decision-making in the domain, such as "If the patient has a fever and sore throat, then they might have a cold."

- **Inference Engine: The inference engine is responsible for reasoning and drawing conclusions based on the knowledge stored in the knowledge base. It interprets and manipulates the knowledge to provide solutions or insights. Depending on the system's design, the inference engine may use various reasoning mechanisms like forward chaining, backward chaining, or fuzzy logic to derive conclusions from the available knowledge.**

1. **Forward Chaining: This involves starting with known facts and applying rules to infer new facts until a goal is reached.**
2. **Backward Chaining: Here, the system starts with a goal and works backward through the rules to find what facts would satisfy that goal.**
3. **Fuzzy Logic: In cases where the knowledge is imprecise or uncertain, fuzzy logic allows for reasoning with degrees of truth rather than strict true/false values.**

- User Interface: This component provides a means for users to interact with the expert system. It could range from a simple text-based interface to a more sophisticated graphical user interface (GUI) depending on the application and intended users. The interface should be designed to facilitate easy input of queries or problems and to present the system's responses or recommendations in a clear and understandable manner.

- Explanation Facility: Expert systems often need to justify their conclusions or recommendations to users. The explanation facility enables the system to explain how it arrived at a particular solution by tracing the reasoning process or providing supporting evidence from the knowledge base. This helps users understand the system's decision-making process and builds trust in its recommendations.

- Knowledge Acquisition Module: Acquiring and updating knowledge is essential for keeping an expert system relevant and effective. The knowledge acquisition module facilitates this process by providing tools and methods for capturing knowledge from domain experts or external sources. It may involve techniques such as interviews, surveys, knowledge elicitation, or even automated methods like data mining or natural language processing to extract knowledge from documents or databases.

- Knowledge Base Editor: This component allows knowledge engineers or domain experts to create, modify, and manage the knowledge base effectively. It provides a user-friendly interface for organizing and structuring the knowledge, adding new rules or facts, and validating the consistency and correctness of the knowledge base.

- Domain Model: Understanding the structure and dynamics of the domain is crucial for building an effective expert system. The domain model represents the conceptual framework of the domain, including its entities, relationships, constraints, and behaviors. It helps in organizing and structuring the knowledge base and guiding the reasoning process of the inference engine.