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Expert systems – Introduction to Expert systems – Definition – Importance of Expert systemscharacteristics features of Expert system-application of Expert systems-Different categories of Expert systems – Case studies discussion of geographical problems

Expert systems

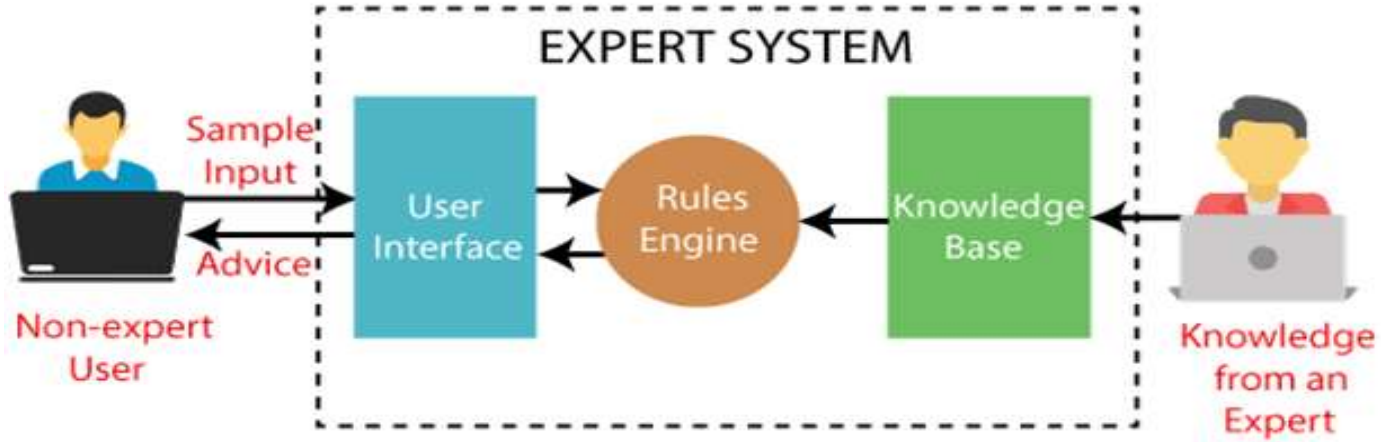
Introduction to Expert systems

What is an Expert System?

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert. It performs this by extracting knowledge from its knowledge base using the reasoning and inference rules according to the user queries.

The expert system is a part of AI, and the first ES was developed in the year 1970, which was the first successful approach of artificial intelligence. It solves the most complex issue as an expert by extracting the knowledge stored in its knowledge base. The system helps in decision making for compsex problems using **both facts and heuristics like a human expert**. It is called so because it contains the expert knowledge of a specific domain and can solve any complex problem of that particular domain. These systems are designed for a specific domain, such as **medicine, science,** etc.

The performance of an expert system is based on the expert's knowledge stored in its knowledge base. The more knowledge stored in the KB, the more that system improves its performance. One of the common examples of an ES is a suggestion of spelling errors while typing in the Google search box.



Below are some popular examples of the Expert System:

•**DENDRAL:** It was an artificial intelligence project that was made as a chemical analysis expert system. It was used in organic chemistry to detect unknown organic molecules with the help of their mass spectra and knowledge base of chemistry.

•**MYCIN:** It was one of the earliest backward chaining expert systems that was designed to find the bacteria causing infections like bacteraemia and meningitis. It was also used for the recommendation of antibiotics and the diagnosis of blood clotting diseases.

•**PXDES:** It is an expert system that is used to determine the type and level of lung cancer. To determine the disease, it takes a picture from the upper body, which looks like the shadow. This shadow identifies the type and degree of harm.
•**CaDeT:** The CaDet expert system is a diagnostic support system that can detect cancer at early **stages**.

Definition

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

Characteristics of Expert System

•**High Performance:** The expert system provides high performance for solving any type of complex problem of a specific domain with high efficiency and accuracy.
•**Understandable:** It responds in a way that can be easily understandable by the user. It can take input in human language and provides the output in the same way.
•**Reliable:** It is much reliable for generating an efficient and accurate output.
•**Highly responsive:** ES provides the result for any complex query within a very short period of time.

Expert System Features

There are a number of features which are commonly used in expert systems. These features allows the users to fully utilize the expert system's capability conveniently in providing the most logical and reasonable decision in a problematic situation.

- **Backward chaining** – an inference technique which continuously break a goal into smaller sub-goals which are easier to prove via IF THEN rules
- **Dealing with uncertainties** – the system has the capability to handle and reason with conditions that are uncertain and data which are not precisely known
- **Forward chaining** – an inference technique which deduce a problem solution from initial data via IF THEN rules
- **Data representation** – the method where the specific problem data is stored and accessed in the system
- **User interface** – that portion of the code which creates an easy to use system;
- **Explanations** – the ability of the system to explain the reasoning process that it used to reach a recommendation.

The Advantages of Using Expert System

Expert system has been reliably used in the business world to gain tactical advantages and forecast the market's condition. In this globalization era where every decision made in the business world is critical for success, the assistance provided from an expert system is undoubtedly essential and highly reliable for an organization to succeed. Examples given below will be the advantages for the implementation of an expert system in business:

1.Providing consistent solutions – It can provide consistent answers for repetitive decisions, processes and tasks. As long as the rule base in the system remains the same, regardless of how many times similar problems are being tested, the final conclusions drawn will remain the same.

2.Provides reasonable explanations – It has the ability to clarify the reasons why the conclusion was drawn and be why it is considered as the most logical choice among other alternatives. If there are any doubts in concluding a certain problem, it will prompt some questions for users to answer in order to process the logical conclusion.

3.Overcome human limitations – It does not have human limitations and can work around the clock continuously. Users will be able to frequently use it in seeking solutions. The knowledge of experts is an invaluable asset for the company.

Easy to adapt to new conditions – Unlike humans who often have troubles in adapting in new environments, an expert system has high adaptability and can meet new requirements in a short period of time. It also can capture new knowledge from an expert and use it as inference rules to solve new problems.

The Disadvantages of Using Expert System

Although the expert system does provide many significant advantages, it does have its drawbacks as well. Examples given below will be the disadvantages for the implementation of an expert system in business:

1.Lacks common sense – It lacks common sense needed in some decision making since all the decisions made are based on the inference rules set in the system. It also cannot make creative and innovative responses as human experts would in unusual circumstances.

2.High implementation and maintenance cost – The implementation of an expert system in business will be a financial burden for smaller organizations since it has high development cost as well as the subsequent recurring costs to upgrade the system to adapt in new environment.

Difficulty in creating inference rules – Domain experts will not be able to always explain their logic and reasoning needed for the knowledge engineering process. Hence, the task of codifying out the knowledge is highly complex and may require high

May provide wrong solutions – It is not error-free. There may be errors occurred in the processing due to some logic mistakes made in the knowledge base, which it will then provide the wrong solutions.

How Expert Systems Work?

Expert systems operate by following a structured approach:

1.Input Data: Users provide data or queries related to a specific problem or scenario.

2.Processing: The inference engine processes the input data using the rules in the knowledge base to generate conclusions or recommendations.

3.Output: The system presents the results or solutions to the user through the user interface.

4.Explanation: If applicable, the system explains how the conclusions were reached, providing insights into the reasoning process.

Applications of Expert Systems

1.Medical Diagnosis: Expert systems assist doctors by analyzing symptoms and medical history to suggest possible diagnoses or treatment options. For example, MYCIN, an early expert system, helped identify bacterial infections and recommend antibiotics.

2.Financial Services: In finance, expert systems are used for credit scoring, fraud detection, and investment advice. They analyze financial data and patterns to make informed decisions.

3.Technical Support: Expert systems can troubleshoot and provide solutions for technical issues. They guide users through problem-solving steps based on pre-defined rules and knowledge.

4.Manufacturing: In manufacturing, expert systems help optimize production processes, perform quality control, and manage inventory by analyzing data and making recommendations.

Different categories of Expert systems

In AI, expert systems are designed to emulate the decision-making abilities of human experts. They are categorized based on their underlying technology and application areas. Here are the primary types of expert systems in AI:

1. Rule-Based Expert Systems

•**Description**: Use a set of "if-then" rules to process data and make decisions. These rules are typically written by human experts and capture domain-specific knowledge.

•**Example**: **MYCIN**, an early system for diagnosing bacterial infections.

2. Frame-Based Expert Systems

•**Description**: Represent knowledge using frames, which are data structures similar to objects in programming. Each frame contains attributes and values related to a particular concept.

•**Example**: Systems used for knowledge representation in areas like natural language processing.

Fuzzy Logic Systems

•**Description**: Handle uncertain or imprecise information using fuzzy logic, which allows for partial truths rather than binary true/false values.

•**Example**: **Fuzzy control systems** for managing household appliances like washing machines and air conditioners.

4. Neural Network-Based Expert Systems

•**Description**: Use artificial neural networks to learn from data and make predictions or decisions based on learned patterns. They are often used for tasks involving pattern recognition and classification.

•**Example**: **Deep learning models** for image and speech recognition.

5. Neuro-Fuzzy Expert Systems

•**Description**: Integrate neural networks and fuzzy logic to combine the learning capabilities of neural networks with the handling of uncertainty and imprecision offered by fuzzy logic. This hybrid approach helps in dealing with complex problems where both pattern recognition and uncertain reasoning are required.

•**Example:** Automated control systems that adjust based on uncertain environmental conditions or financial forecasting models that handle both quantitative data and fuzzy inputs.