ARTIFICIAL INTELLIGENCE

UNIT 6: EXPERT SYSTEM

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TOPICS

- Definition
- Model
- Characteristics
- Architecture
- Development process
- Limitations
- Examples of expert systems.

EXPERT SYSTEM

- 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.

Expert system = knowledge base+ problem-solving methods.

- A knowledge base that captures the domain-specific knowledge and an inference engine that consists of algorithms for manipulating the knowledge represented in the knowledge base to solve a problem presented to the system.

CHARACTERISTIC OF EXPERT SYSTEM

- Expert systems differ from conventional computer system in several important ways

1. Expert systems use knowledge rather than data to control the solution process.
2. The knowledge is encoded and maintained as an entity separate from the control program. As such, it is not complicated together with the control program itself.
3. Expert systems are capable of explaining how a particular conclusion was reached, and why requested information is needed during a consultation. This is important as it gives the user a chance to assess and understand the systems reasoning ability, thereby improving the user’s confidence in the system.

CHARACTERISTIC OF EXPERT SYSTEM

4. Expert systems use symbolic representations for knowledge and perform their inference through symbolic computations that closely resemble manipulations of natural language

5. Expert systems often reason with meta knowledge.

ARCHITECTURE OF EXPERT SYSTEM

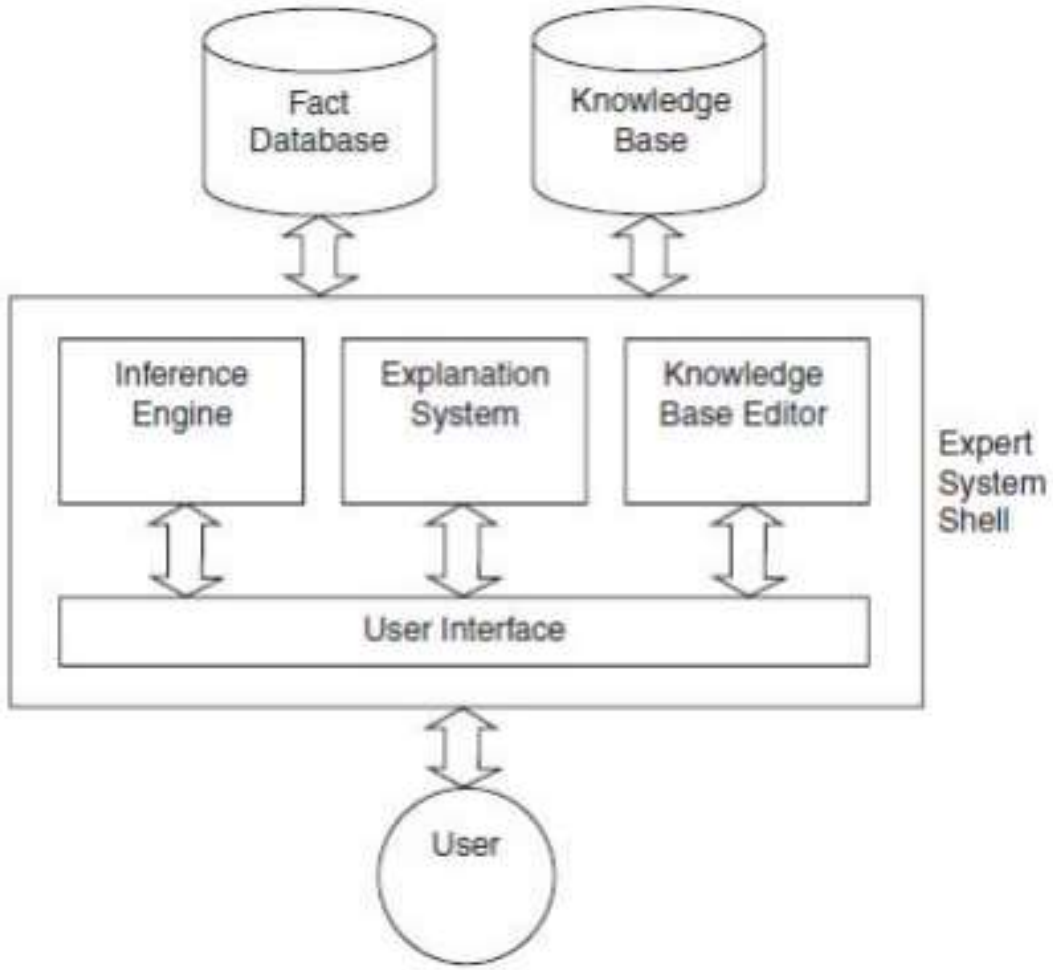


Fig Expert System Architecture

ARCHITECTURE OF EXPERT SYSTEM

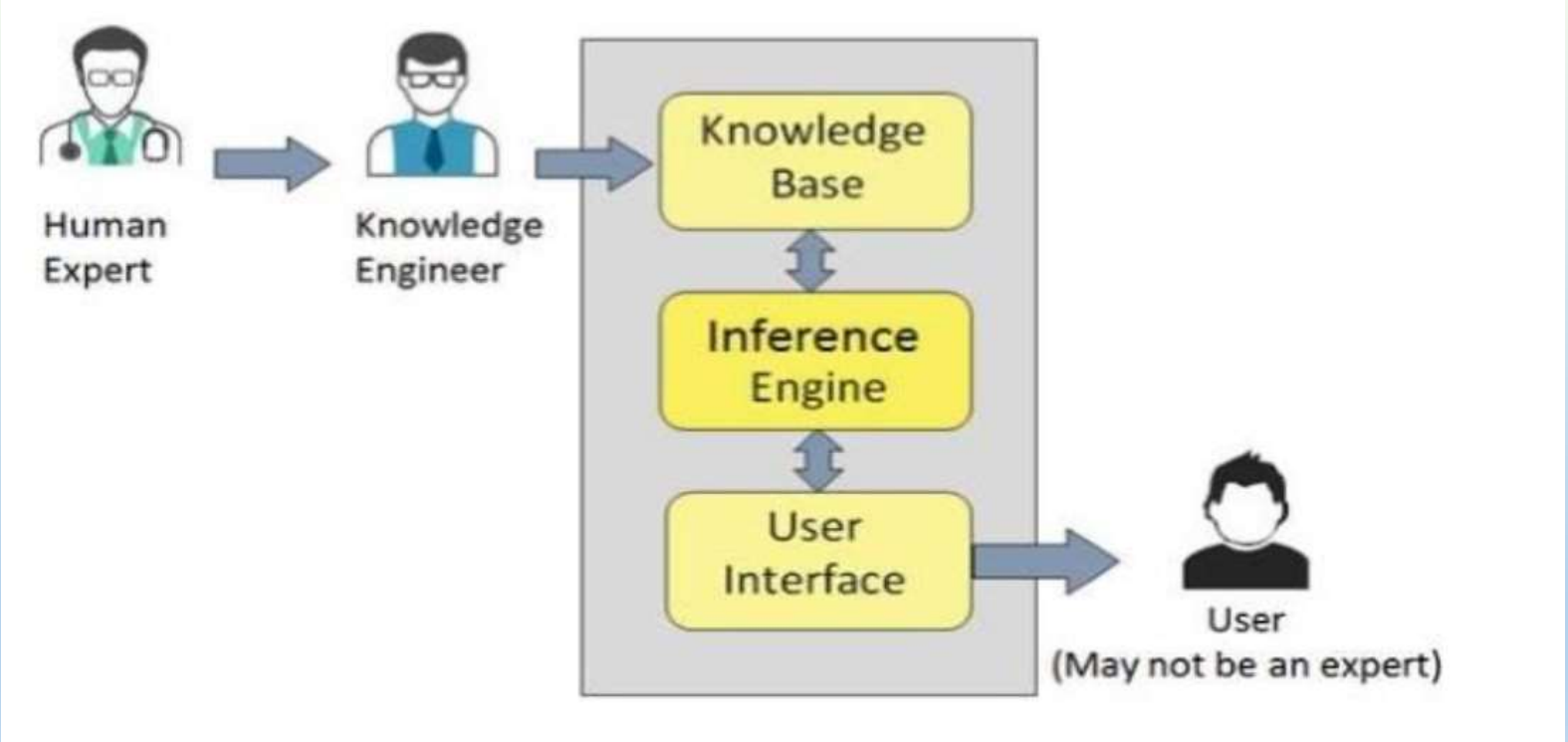
- The knowledge base contains the specific domain knowledge that is used by an expert to derive conclusions from facts.
- The explanation system provides information to the user about how the inference engine arrived at its conclusions.
- If the system has used faulty reasoning to arrive at its conclusions, then the user may be able to see this by examining the data given by the explanation system.
- The fact database contains the case-specific data that are to be used in a particular case to derive a conclusion.
- The user of the expert system interfaces with it through a user interface, which provides access to the inference engine, the explanation system, and the knowledge-base editor.
- The inference engine is the part of the system that uses the rules and facts to derive conclusions.
- The knowledge-base editor allows the knowledge engineer to edit the information that is contained in the knowledge base.

ARCHITECTURE OF EXPERT SYSTEM

- The primary people involved in building an expert system are the knowledge engineer, the domain expert, and the end user.
- The knowledge engineer is the AI language and representation expert. His or her main task is to select the software and hardware tools for the project, help the domain expert articulate the necessary knowledge, and implement that knowledge in a correct and efficient knowledge base.
- Often, the knowledge engineer is initially ignorant of the application domain.
- The domain expert provides the knowledge of the problem area.
- As in most applications, the end user determines the major design constraints.
- The skills and needs of the user must be considered throughout the design cycle: Will the program make the user's work easier, quicker, more comfortable? What level of explanation does the user need? Can the user provide correct information to the system? Is the interface appropriate?

COMPONENTS OF EXPERT SYSTEM

- Knowledge Base (KB)
- Inference Engine
- User Interface(UI)



COMPONENTS OF EXPERT SYSTEM

Knowledge Base

- It contains domain specific and high quality knowledge
- Knowledge is required to exhibit intelligence The success of any ES majorly depends upon the collection
- of highly accurate and precise knowledge

What is Knowledge?

- The data is collection of facts The information is organized as data and facts about the task domain Data,
- information, and past experience combined together are termed as knowledge

Components of Knowledge Base

- The knowledge base of an ES is a store of both, factual and heuristic knowledge
- Factual Knowledge It is the information widely accepted by the Knowledge Engineers and scholars in the task domain ..(Man is Mortal)
- Heuristic Knowledge It is about practice, accurate judgement, one’s ability of evaluation, and guessing

COMPONENTS OF EXPERT SYSTEM

Inference Engine

- Use of efficient procedures and rules by the Inference Engine is essential in deducting a correct, flawless solution
- In case of knowledge based ES, the Inference Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution
- In case of rule based ES, it Applies rules repeatedly to the facts, which are obtained from earlier rule application
- Adds new knowledge into the knowledge base if required
- Resolves rules conflict when multiple rules are applicable to a particular case
- To recommend a solution, the Inference Engine uses the following strategies

1. Forward Chaining
2. Backward Chaining

COMPONENTS OF EXPERT SYSTEM

User Interface

- User interface provides interaction between user of the ES and the ES itself
- It is generally Natural Language Processing so as to be used by the user who is well versed in the task domain
- The user of the ES need not be necessarily an expert in Artificial Intelligence
- It explains how the ES has arrived at a particular recommendation The explanation may appear in the following forms

➢Natural language displayed on screen

➢Verbal narrations in natural language

➢Listing of rule numbers displayed on the screen

•The user interface makes it easy to trace the credibility of the deductions

EXPERT SYSTEM

The expert systems are capable of −

- Advising
- Instructing and assisting human in decision making
- Demonstrating
- Deriving a solution
- Diagnosing
- Explaining
- Interpreting input
- Predicting results
- Justifying the conclusion
- Suggesting alternative options to a problem

EXPERT SYSTEM

They are incapable of −

- Substituting human decision makers
- Possessing human capabilities
- Producing accurate output for inadequate knowledge base
- Refining their own knowledge

EXPERT SYSTEM

The following table shows where ES can be applied.

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

EXPERT SYSTEM

Expert System Technology

- Expert systems technologies include −
- **Expert System Development Environment** − The ES development environment includes hardware and tools.

1. Workstations, minicomputers, mainframes.
2. High level Symbolic Programming Languages such as List Processing (LISP) and PROgramming in LOGIG (PROLOG).
3. Large databases.

EXPERT SYSTEM

Tools − They reduce the effort and cost involved in developing an expert system to large extent.

- Powerful editors and debugging tools with multi-windows.
- They provide rapid prototyping
- Have Inbuilt definitions of model, knowledge representation, and inference design.

Shells − A shell is nothing but an expert system without knowledge base. A shell provides the developers with knowledge acquisition, inference engine, user interface, and explanation facility. For example, few shells are given below −

- Java Expert System Shell (JESS) that provides fully developed Java API for creating an expert system.
- Vidwan, a shell developed at the National Centre for Software Technology, Mumbai in 1993. It enables knowledge encoding in the form of IF-THEN rules.

EXPERT SYSTEM

Development of Expert Systems: General Steps

The process of ES development is iterative. Steps in developing the ES include −

Identify Problem Domain

- The problem must be suitable for an expert system to solve it.
- Find the experts in task domain for the ES project.
- Establish cost-effectiveness of the system.

Design the System

- Identify the ES Technology
- Know and establish the degree of integration with the other systems and databases.
- Realize how the concepts can represent the domain knowledge best.

Develop the Prototype

From Knowledge Base: The knowledge engineer works to −

- Acquire domain knowledge from the expert.
- Represent it in the form of If-THEN-ELSE rules.

EXPERT SYSTEM

Test and Refine the Prototype

- The knowledge engineer uses sample cases to test the prototype for any deficiencies in performance.
- End users test the prototypes of the ES.

Develop and Complete the ES

- Test and ensure the interaction of the ES with all elements of its environment, including end users, databases, and other information systems.
- Document the ES project well.
- Train the user to use ES.

Maintain the ES

- Keep the knowledge base up-to-date by regular review and update.
- Cater for new interfaces with other information systems, as those systems evolve.

RULE BASED EXPERT SYSTEM

- Rule-based expert systems represent problem-solving knowledge as *if.. then...* rules.
- This is one of the oldest techniques for representing domain knowledge in an expert system.
- In case of rule based ES, it –
- Applies rules repeatedly to the facts, which are obtained from earlier rule application.
- Adds new knowledge into the knowledge base if required.
- Resolves rules conflict when multiple rules are applicable to a particular case.

RULE BASED EXPERT SYSTEM

- Mycin is a computer program that was developed in the 1970s at Stanford University.
- It was one of the first expert systems, and was designed to diagnose and treat infections in humans. Mycin was written in the Lisp programming language, and used a rule-based system to make decisions.
- Mycin was able to make diagnoses by asking questions about a patient's symptoms, and then comparing the answers to a database of known infections.
- If Mycin could not find a match in the database, it would ask additional questions in an attempt to narrow down the possibilities.
- Once Mycin had a list of potential diagnoses, it would rank them according to the severity of the infection and the likelihood of the patient being infected with each one.
- Mycin would then recommend a course of treatment, which could include antibiotics, surgery, or other medical procedures.

RULE BASED EXPERT SYSTEM

- The MYCIN rule-based expert system introduced a quasi-probabilistic approach called certainty factors, whose rationale is explained below.
- A human, when reasoning, does not always make statements with 100% confidence: he might venture, "If Fritz is green, then he is probably a frog". This type of reasoning can be imitated using numeric values called confidences.
- For example, if it is known that Fritz is green, it might be concluded with 0.85 confidence that he is a frog; or, if it is known that he is a frog, it might be concluded with 0.95 confidence that he hops.
- These certainty factor (CF) numbers quantify uncertainty in the degree to which the available evidence supports a hypothesis.
- They represent a degree of confirmation, and are not probabilities in a Bayesian sense.
- The CF calculus, increases or decreases the CF associated with a hypothesis as each new piece of evidence becomes available.
- It can be mapped to a probability update, although degrees of confirmation are not expected to obey the laws of probability.

THANK-YOU