Experiment No: 9

Title: Simple prototype for Expert System.

Objective: Understanding the composition of expert system for a given prototype

Theory:

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. They are one of the prominent research domains of AI. It is introduced by the researchers at Stanford University, Computer Science Department.

General Characteristics of Expert Systems

- High performance
- Understandable
- Reliable
- Highly responsive

Capabilities of Expert System

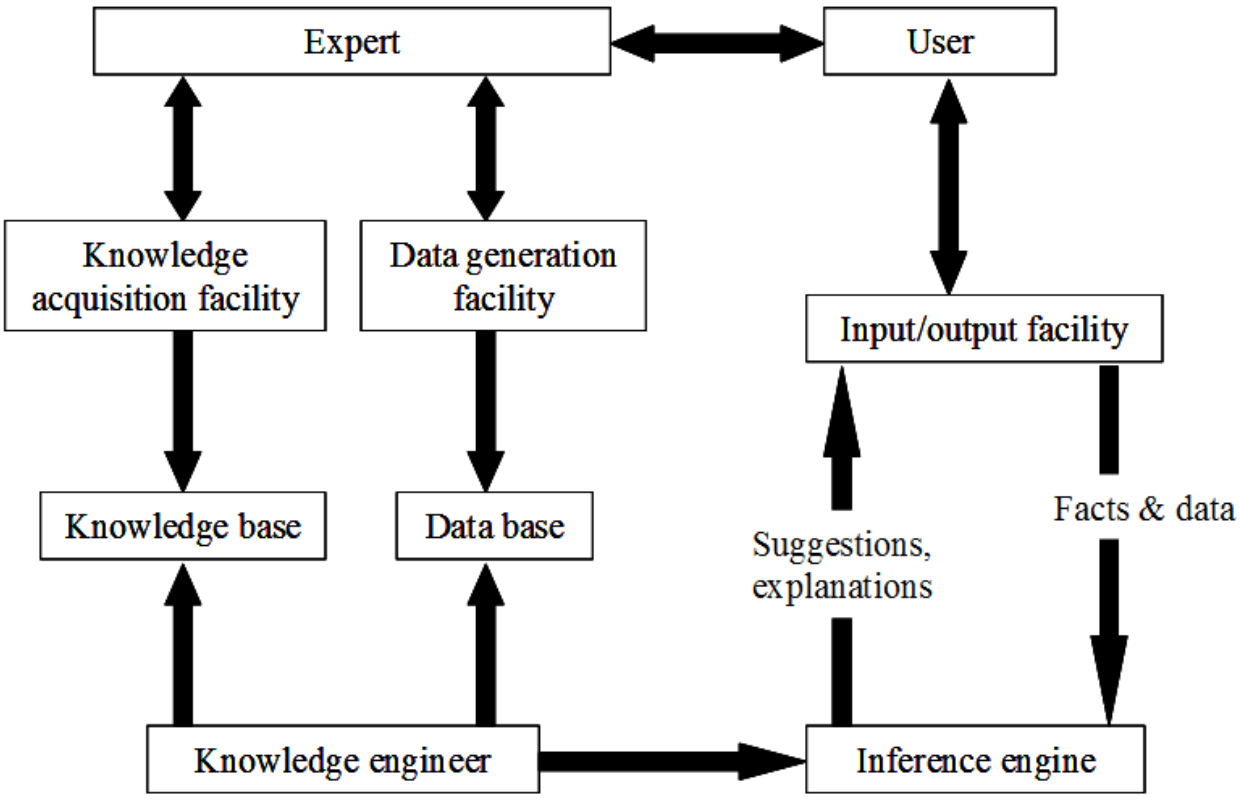
The expert systems are capable of

- 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

They are incapable of:

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

General Components of Expert Systems



General 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.

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.
- **Heuristic Knowledge** − It is about practice, accurate judgment, one's ability of evaluation, and guessing.

Knowledge representation: It is the method used to organize and formalize the knowledge in the knowledge base. It is in the form of IF-THEN-ELSE rules.

Knowledge Acquisition: The success of any expert system majorly depends on the quality, completeness, and accuracy of the information stored in the knowledge base.

The knowledge base is formed by readings from various experts, scholars, and the Knowledge Engineers. The knowledge engineer is a person with the qualities of empathy, quick learning, and case analyzing skills.

He acquires information from subject expert by recording, interviewing, and observing him at work, etc. He then categorizes and organizes the information in a meaningful way, in the form of IF-THEN-ELSE rules, to be used by interference machine. The knowledge engineer also monitors the development of the ES.

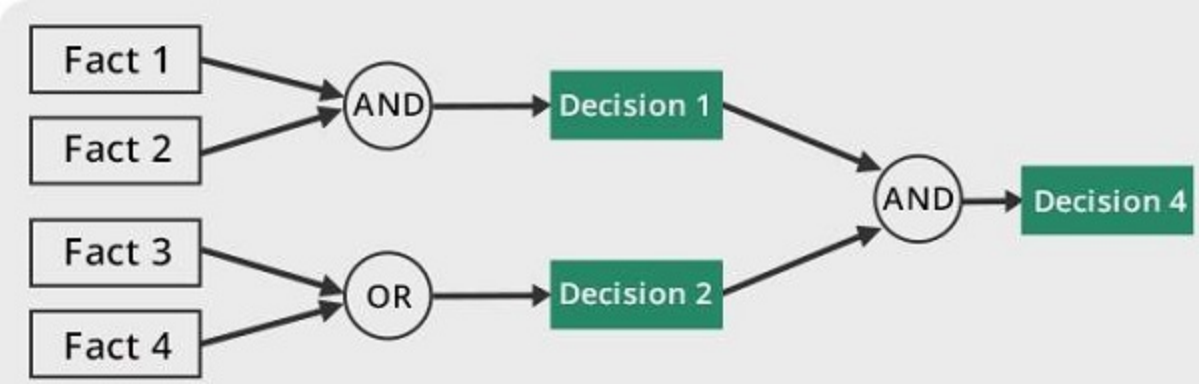
General Inference Engine: Use of efficient procedures and rules by the Inference Engine is essential in deducting a correct, flawless solution. In case of knowledge-based ES, the Inference Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution.

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 −

- **Forward Chaining**: It is a strategy of an expert system to answer the question, **"What can happen next?"**

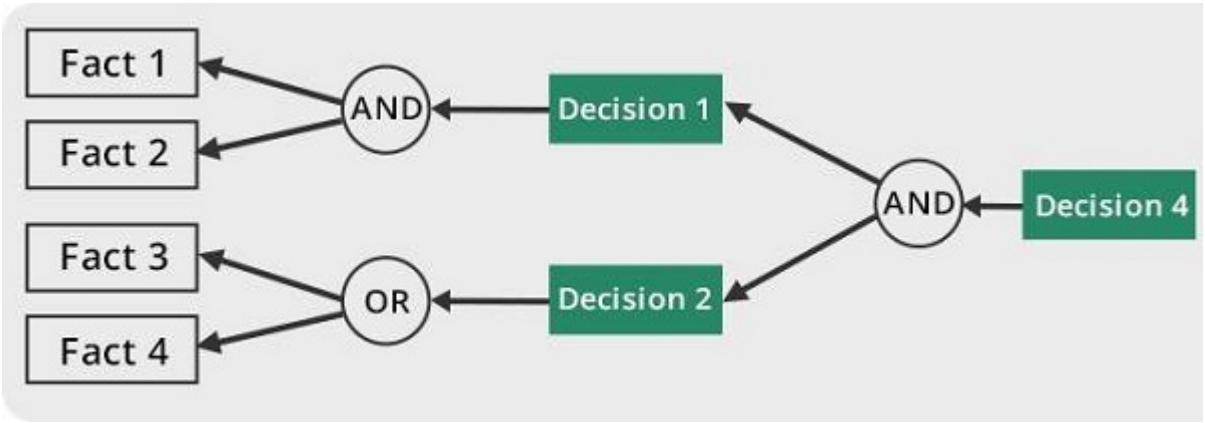


Forward Chaining in ID3

Here, the Inference Engine follows the chain of conditions and derivations and finally deduces the outcome. It considers all the facts and rules, and sorts them before concluding to a solution.

This strategy is followed for working on conclusion, result, or effect. For example, prediction of share market status as an effect of changes in interest rates.

- **Backward Chaining**: With this strategy, an expert system finds out the answer to the question, **"Why this happened?"**



Backward Chaining in ID3

On the basis of what has already happened, the Inference Engine tries to find out which conditions could have happened in the past for this result. This strategy is followed for finding out cause or reason. For example: diagnosis of blood cancer in humans.

This concludes the inference engine part. The next component is User interface.

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.

Requirements of Efficient ES User Interface

- It should help users to accomplish their goals in shortest possible way.
- It should be designed to work for user's existing or desired work practices.
- Its technology should be adaptable to user's requirements; not the other way round.

Benefits of Expert Systems

- **Availability** − they are easily available due to mass production of software.
- **Less Production Cost** − Production cost is reasonable. This makes them affordable.
- **Speed** − they offer great speed. They reduce the amount of work an individual puts in.
- **Less Error Rate** − Error rate is low as compared to human errors.
- **Reducing Risk** − they can work in the environment dangerous to humans.
- **Steady response** − they work steadily without getting motional, tensed or fatigued.

Expert Systems Limitations

No technology can offer easy and complete solution. Large systems are costly; require significant development time, and computer resources. ES's have their limitations which include

- Limitations of the technology
- Difficult knowledge acquisition
- ES are difficult to maintain
- High development costs

Applications of Expert System

Design Domain:

- Camera lens design
- Automobile design.

Medical Domain:

- Diagnosis Systems to deduce cause of disease from observed data
- Conducting medical operations on humans.

Monitoring Systems:

- Comparing data continuously with observed system
- Prescribed behavior such as leakage monitoring in long petroleum pipeline.

Process Control Systems:

- Controlling a physical process based on monitoring.

Knowledge Domain:

- Controlling a physical process based on monitoring

Finance/Commerce:

- Detection of possible fraud
- Suspicious transactions
- Stock market trading
- Airline scheduling
- Cargo scheduling

Post Lab Assignment:

1. What is the domain of the expert system, and what knowledge is required to develop it?
2. What is the purpose of the expert system, and what problems does it aim to solve?
3. What is the knowledge representation method used by the expert system, and how is the knowledge base structured?
4. What inference mechanism does the expert system use to reason about the input data, and how is the reasoning process controlled?
5. How is the expert system validated, and what techniques are used to ensure its correctness and reliability?