Expert Systems

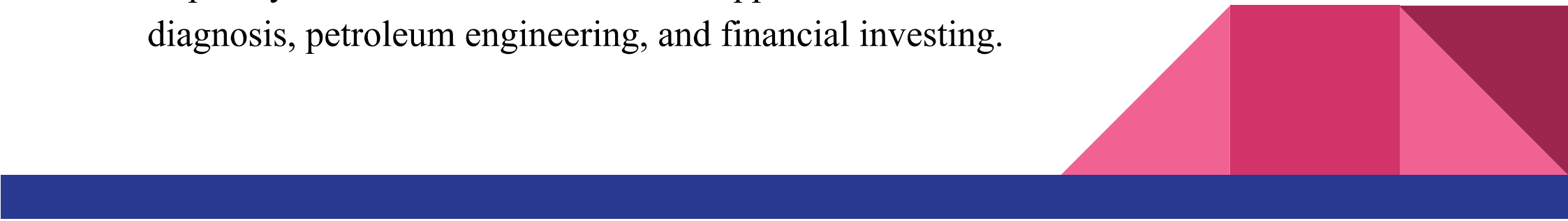
Module 5

Expert Systems

- An expert system is a computer program that uses artificial intelligence methods to solve problems within a specialized domain that ordinarily requires human expertise.

- The first expert system was developed in 1965 by Edward Feigenbaum and Joshua Lederberg of Stanford University.
- Their system known as Dendral was designed to analyze chemical compounds.

- Expert systems now have commercial applications in fields as diverse as medical diagnosis, petroleum engineering, and financial investing.



Expert Systems

- An expert system relies on two components: a knowledge base and an inference engine.
- A knowledge base is an organized collection of facts about the system's domain.
- An inference engine interprets and evaluates the facts in the knowledge base in order to provide an answer.

Expert Systems

- Facts for a knowledge base must be acquired from human experts through interviews and observations.
- This knowledge is then usually represented in the form of “if-then” rules.
- The knowledge base of a major expert system includes thousands of rules.

What is an Expert System?

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.

Examples of Expert Systems

Following are the Expert System Examples:

- **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. It is one of the best Expert System Example.
- **DENDRAL:** Expert system used for chemical analysis to predict molecular structure.
- **PXDES:** An Example of Expert System used to predict the degree and type of lung cancer
- **CaDet:** One of the best Expert System Example that can identify cancer at early stages

Typical tasks for expert systems

Some typical existing expert system tasks include:

1. The interpretation of data such as sonar data or geophysical measurements

2. Diagnosis of malfunctions such as equipment faults or human diseases

3. Structural analysis or configuration of complex objects such as chemical compounds or computer systems

4. Planning sequences of actions such as might be performed by robots

5. Predicting the future such as weather, share prices, exchange rates

Architecture of Expert Systems

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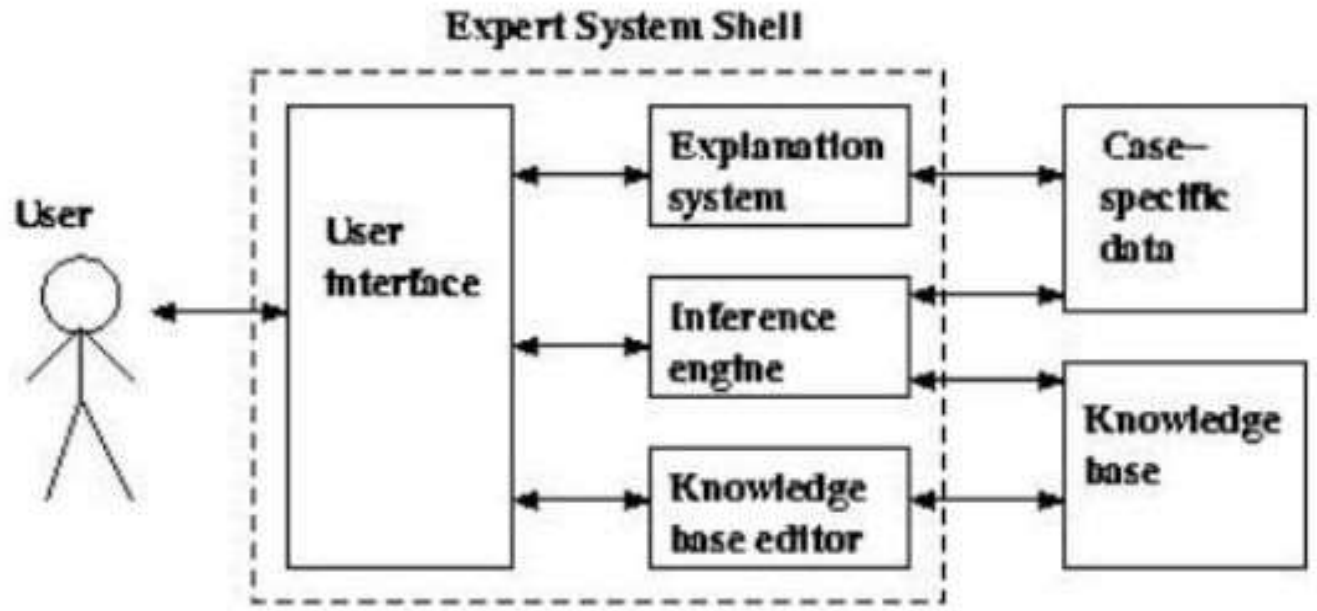


Figure 10.1: Typical architecture of an expert system

User Interface

- With the help of a user interface, the expert system interacts with the user, takes queries as an input in a readable format, and passes it to the inference engine.
- After getting the response from the inference engine, it displays the output to the user.
- In other words, **it is an interface that helps a non-expert user to communicate with the expert system to find a solution**.

User interface

- The user interacts with the system through a user interface which may use menus, natural language or any other style of interaction.
- This is the dialogue component of the system.
- One side of the dialogue involves the user questioning the system and on the other side the system must be able to question the user to establish the existence of evidence.
- The dialogue component has two functions; determines which question to ask next and keep record of the previous questions.

Architecture of Expert Systems

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.
- 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.

Architecture of Expert Systems

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 acquisition component allows the expert to enter their knowledge or expertise into the expert system, and to refine it later as and when required.

Architecture of Expert Systems

Historically, the knowledge engineer played a major role in this process.

• The **knowledge acquisition** process is usually comprised of three principal stages:

– Knowledge elicitation is the interaction between the expert and the knowledge engineer/program to elicit the expert knowledge in some systematic way.

– The knowledge thus obtained is usually stored in some form of human friendly intermediate representation.

– The intermediate representation of the knowledge is then compiled into an executable form (e.g. production rules) that the inference engine can process.

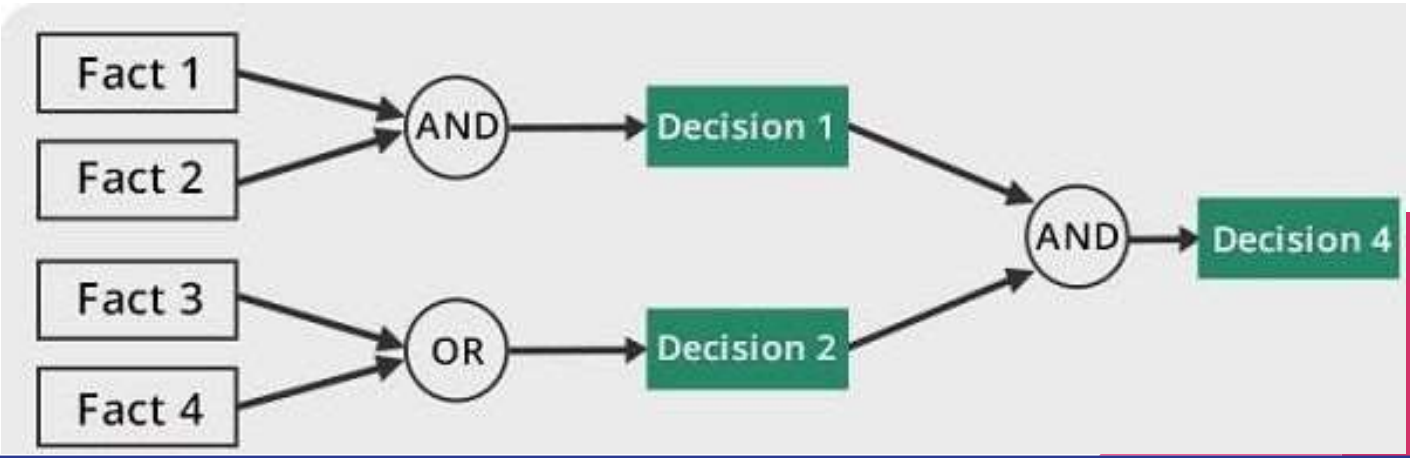
Inference Engine(Rules of Engine)

- The inference engine is known as the brain of the expert system as it is the main processing unit of the system.
- It applies inference rules to the knowledge base to derive a conclusion or deduce new information.
- It helps in deriving an error-free solution of queries asked by the user.
- With the help of an inference engine, the system extracts the knowledge from the knowledge base.

Inference Engine(Rules of Engine)

Forward Chaining

- Forward Chaining -What can happen next?" 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.



Inference Engine(Rules of Engine)

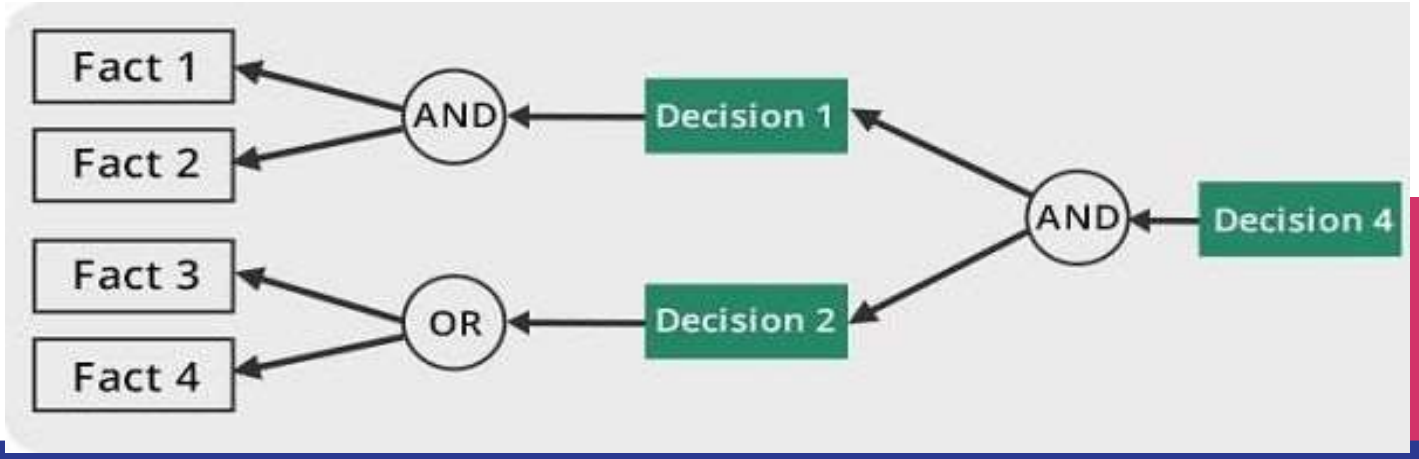
Backward Chaining

• Backward Chaining - An expert system finds out the answer to the question, “Why this happened?”

• 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



Case specific data

- The case specific data includes both data provided by the user and partial conclusion based on this data.
- In a rule-based system the case specific data will be the elements in working memory.

Explanation system

The explanation system allows the program to explain its reasoning to the user.

It is not acceptable for an expert system to take decisions without being able to provide an explanation for the decisions it has taken.

Users using these expert systems need to be convinced of the validity of the conclusion drawn before applying it to their domain.

They also need to be convinced that the solution is appropriate and applicable in their circumstances.

Explanation system

Knowledge engineers building the expert system also need to examine the reasoning behind decisions in order to access and evaluate the mechanisms being used.

If explanation component is not provided it would not be possible to judge whether the expert system is working as desired or intended.

Knowledge base editor

Most expert systems provide a mechanism for editing the knowledge base.

In the simplest case, this is just a standard text editor for modifying rules and data by hand.

But many tools include other facilities in their support environment.

Knowledge base editor

Another common facility in knowledge base editors is syntax checking, where the editor uses knowledge about the grammatical structure of the expert system language to help the user input rules with the correct spelling and format.

When the user enters an ungrammatical rule or command, the editor catches it and explains what is wrong.

Roles of individuals who interact with expert systems

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Domain expert The domain experts are the individuals who are currently experts in solving the problem which the system is intended to solve.

Knowledge engineer

The knowledge engineer is the person who encodes the expert's knowledge in a declarative form that can be used by the expert system.

Roles of individuals who interact with expert systems

User

The user is the person who will be consulting with the system to get advice which would have been provided by the expert.

System engineer

The system engineer builds the user interface, designs the declarative format of the knowledge base, and implements the inference engine.

Limitations of the Expert System

- Unable to make a creative response in an extraordinary situation
- Errors in the knowledge base can lead to wrong decision
- The maintenance cost of an expert system is too expensive
- Each problem is different therefore the solution from a human expert can also be different and more creative

Applications of Expert Systems

Some popular Application of Expert System:

- Information management
- Hospitals and medical facilities
- Help desks management
- Employee performance evaluation
- Loan analysis
- Virus detection
- Useful for repair and maintenance projects
- Warehouse optimization
- Planning and scheduling
- The configuration of manufactured objects
- Financial decision making Knowledge publishing
- Process monitoring and control
- Supervise the operation of the plant and controller
- Stock market trading
- Airline scheduling & cargo schedules