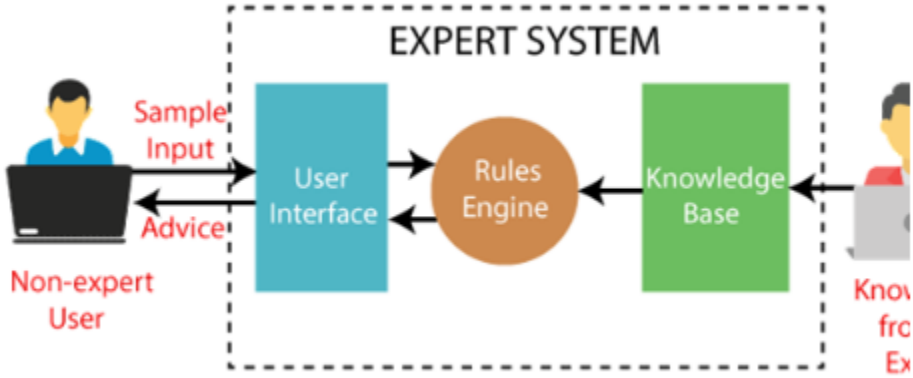
What is an Expert System?

- 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.



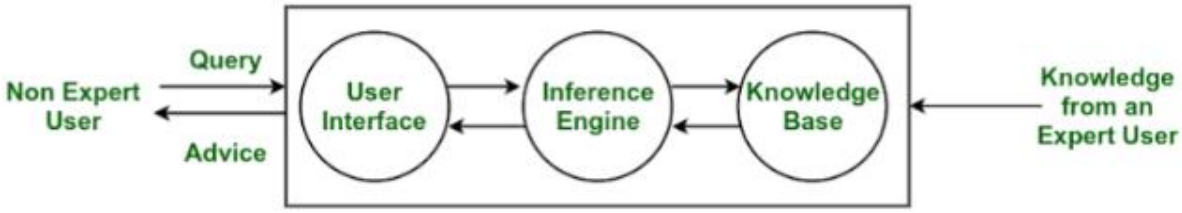
Below are some popular examples of the Expert System:

CaDeT: The CaDet expert system is a diagnostic support system that can detect cancer at early stages.

PXDES: It is an expert system that is used to determine the type and level of lung cancer.

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.



Architecture of an Expert System

Knowledge Base –

The knowledge base represents facts and rules. It consists of knowledge in a particular domain as well as rules to solve a problem, procedures and intrinsic data relevant to the domain.

Inference Engine –

The function of the inference engine is to fetch the relevant knowledge from the knowledge base, interpret it and to find a solution relevant to the user's problem. The inference engine acquires the rules from its knowledge base and applies them to the known facts to infer new facts. Inference engines can also include an explanation and debugging abilities.

Knowledge Acquisition and Learning Module –

The function of this component is to allow the expert system to acquire more and more knowledge from various sources and store it in the knowledge base.

User Interface –

This module makes it possible for a non-expert user to interact with the expert system and find a solution to the problem.

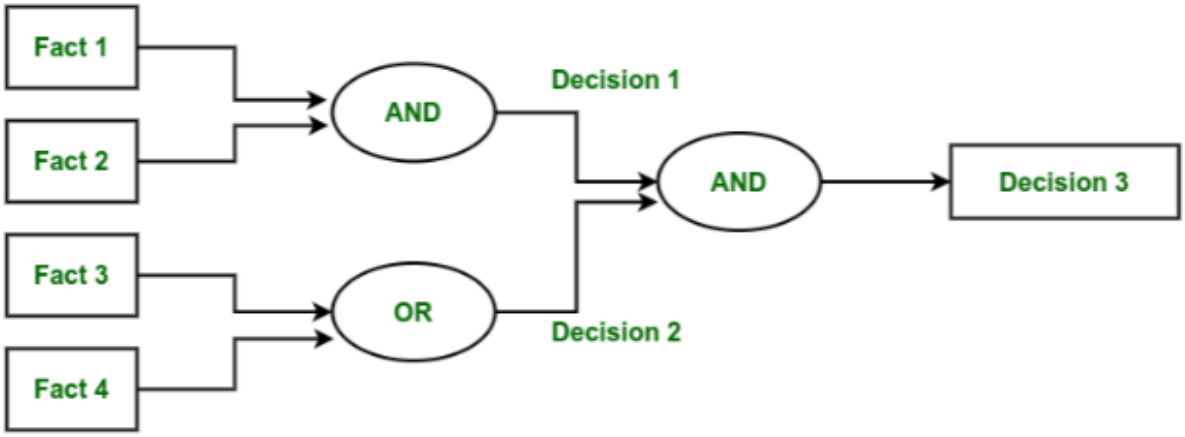
Explanation Module –

This module helps the expert system to give the user an explanation about how the expert system reached a particular conclusion.

The Inference Engine generally uses two strategies for acquiring knowledge from the Knowledge Base, namely –

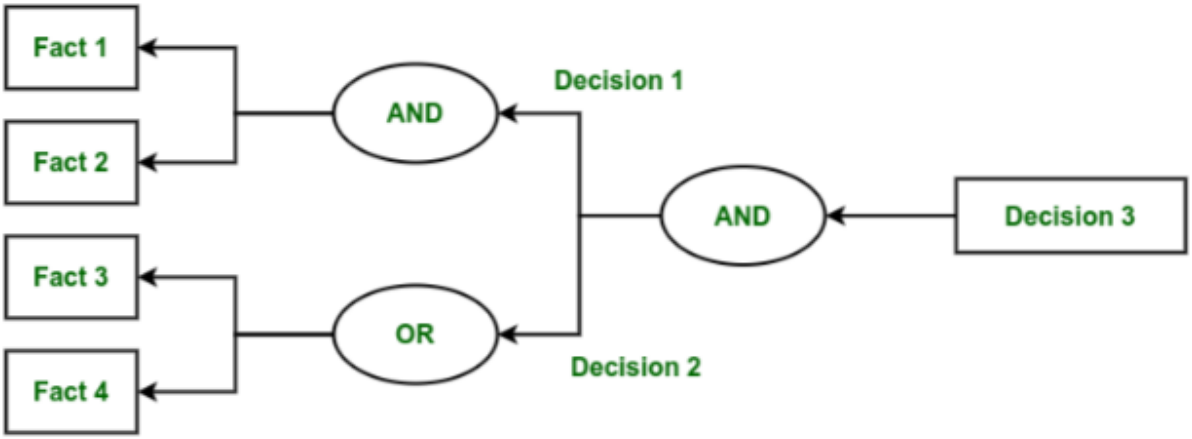
Forward Chaining –

Forward Chaining is a strategic process used by the Expert System to answer the questions – What will happen next. This strategy is mostly used for managing tasks like creating a conclusion, result or effect. Example – prediction or share market movement status.



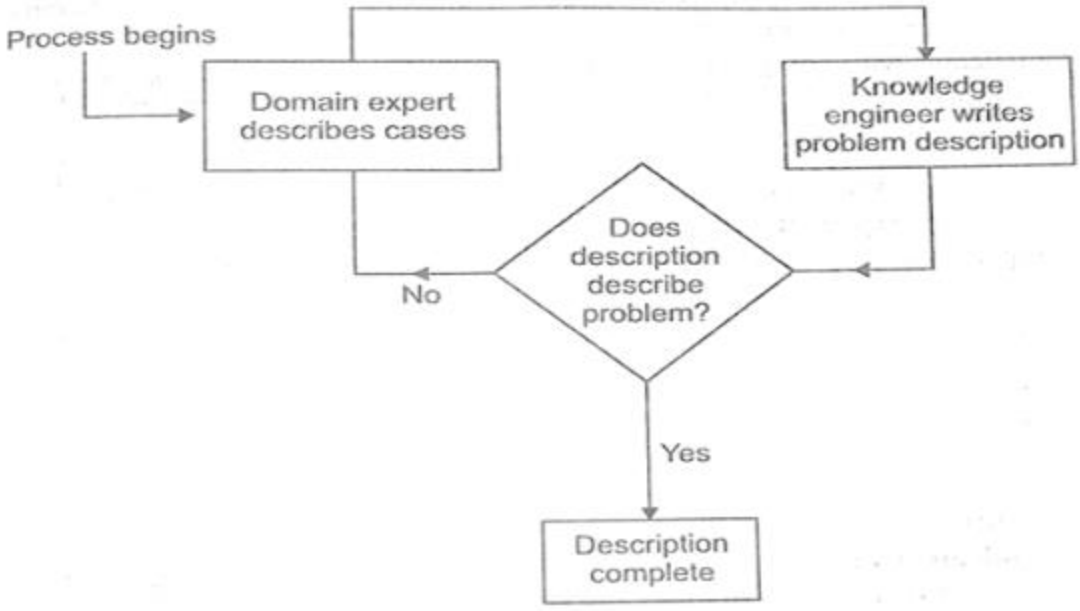
Backward Chaining –

Backward Chaining is a storage used by the Expert System to answer the questions – Why this has happened. This strategy is mostly used to find out the root cause or reason behind it, considering what has already happened. Example – diagnosis of stomach pain, blood cancer or dengue, etc.



Steps to Develop an Expert System:

Step1: Identification: Determining the characteristics of the problem.



Step2: Conceptualization: Finding the concept to produce the solution.

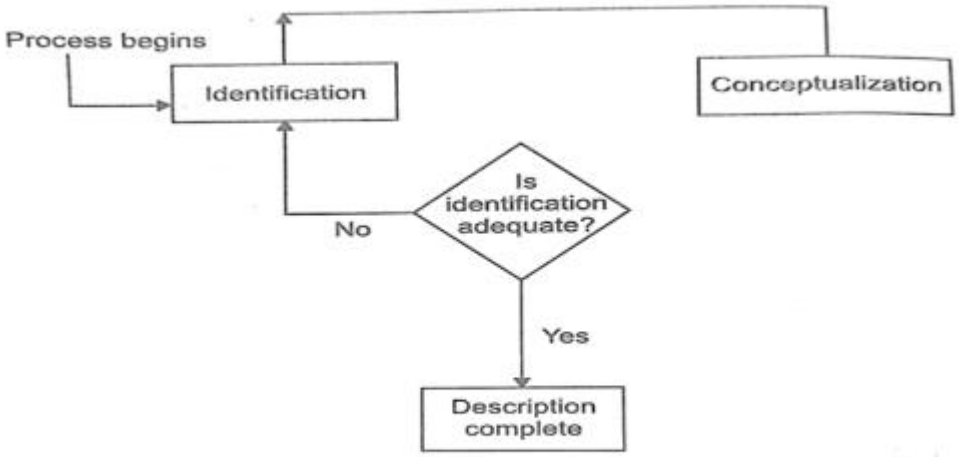


Fig: Conceptual Phase of Expert System Development Life Cycle

Step3: Formalization: Designing structures to organize the knowledge.
Step4: Implementation: Formulating rules which embody the knowledge.

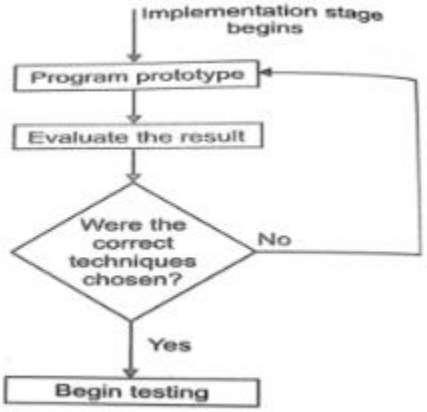


Fig: Implementation Phase of Expert System Development Life Cycle

Step5: Testing: Validating the rules. Testing includes are:
i. The system implements correctly or incorrectly.
ii. Rules implement correctly or not.
iii. The System uses for testing for both simple and complex problems by domain experts to uncover more defects.
iv. An Expert System is finally tested to be successful only when it is operated at the level of a human expert.

What is machine vision?

- Machine vision, also known as computer vision, is a branch of artificial intelligence (AI) that deals with enabling computers to interpret and understand visual information from the world, such as images and videos.
- It involves the development of algorithms, models, and systems that can automatically extract meaningful information from visual data.
- Machine vision has a wide range of applications, including image and video analysis, object recognition and tracking, navigation, and inspection in manufacturing, and medical imaging and diagnosis.

Steps

- **Lighting.** Lighting illuminates the object or scene to make its features visible.
- **Lens.** This captures the image and delivers it to the sensor in the camera as light.
- **Capture board, frame grabber or sensor**. These devices work together to process the image from the camera and convert it to a digital format as pixels. Image sensors convert light into electric signals using either complementary metal-oxide semiconductor technology or a charge-coupled device.
- **Processor.** The processor runs software and related algorithms that process the digital image and extracts the required information.
- **Communication**. These systems enable the machine vision cameras and processing system to communicate with other elements of the bigger system, usually using a discrete input/output signal or a serial connection.

APPLICATION

Electronic component analysis. Machine vision is used in the construction of circuit boards for tasks such as solder paste inspection and component placement.

Optical character recognition. OCR enables a computer to extract printed or handwritten text from images.

Handwriting and signature recognition. With these features, a computer can detect patterns in images of handwriting and signatures.

Object recognition. In the automotive industry, self-driving cars use object recognition on images taken by cameras to identify obstacles on the road. Machine vision systems also determine the position of objects, such as the proper placement of a label on a pill bottle.

Pattern recognition. Medical imaging analysis uses pattern recognition to make diagnoses based on technologies such as magnetic resonance imaging, blood scans and brain scans.

Materials inspection. Machine vision capabilities in materials inspection systems ensure quality control. Machine vision checks for flaws, defects and contaminants in a range of materials and products. For example, these systems can inspect pills and tablets for issues during manufacture.

Currency inspection. Machine vision is used to analyze currencies to detect counterfeit notes.

Item counting. This capability is used to tally items such as pills in a packet or bottles in a case.

Machine vision in AI

AI is used in machine vision to expedite the decision-making process. AI is able to process a large number of images and data information that was previously too difficult to gather.

Examples of how AI is used with machine vision are the following:

Signature and character recognition require a level of nuance that AI can assist with.

In manufacturing, AI helps with object recognition and materials inspection to enable machine vision systems to understand acceptable variations in the shape and texture of an object or material.

In quality assurance, an AI-enabled system can interpret acceptable anomalies rather than rejecting anything that doesn't rigidly fit one specification.

Machine vision in robotics

Machine vision, paired with AI and deep learning, expands the role of robots in performing production-line tasks, such as picking, sorting, placing and performing a manufacturing line scan. This combination of technologies also enables robotics to operate in other environments, such as supermarkets, hospitals and restaurants.