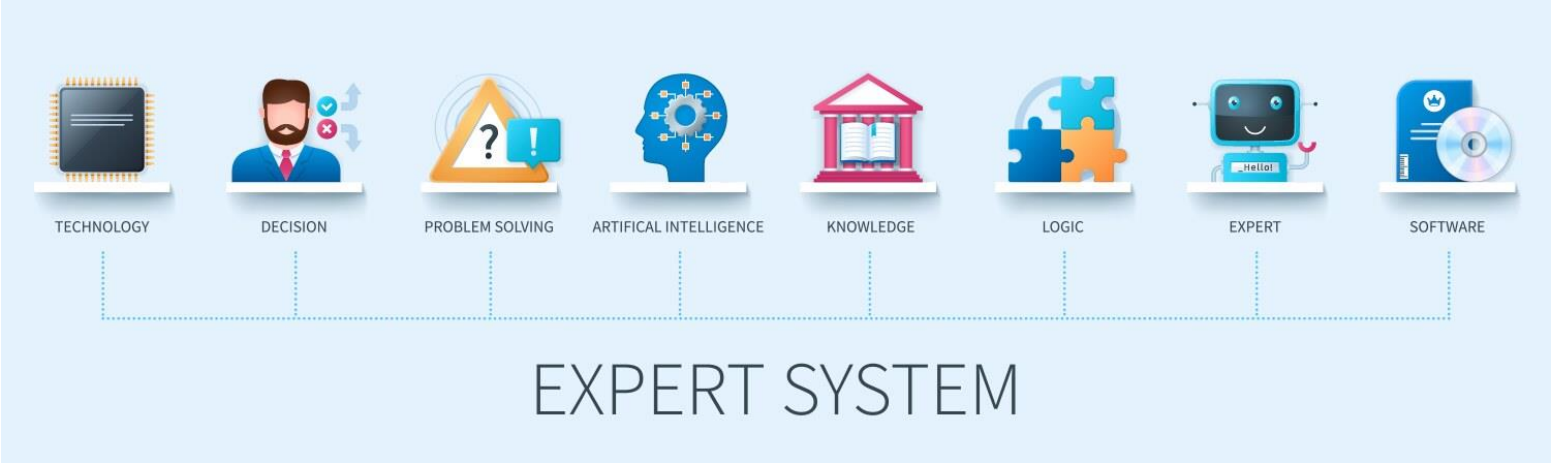
Knowledge Base

Lecture 2



Introduction:

Expert systems model the higher order cognitive functions of the brain. They can be used to mimic the decision-making process of human experts. Typical example applications include planning, scheduling and diagnostics systems.

Expert systems are normally used to model the human decision-making process. Although expert systems contain algorithms, many of those algorithms tend to be static, that is they do not change over time. While this provides some certainty in how the system will operate, it does mean that the expert system is not designed to learn from experience.

It is worth mentioning that expert systems are very often spoken of as synonymous with KBSs. However, expert systems are simply a category of KBS.

Like human specialists, expert systems focus on narrow domains by blending theoretical knowledge with practical experience. They utilize the same shortcuts, heuristics, and "tricks of the trade" that experts develop through years of hands-on problem-solving.

Because of their heuristic, knowledge-intensive nature, expert systems generally:

1- Support inspection of their reasoning processes, both in presenting intermediate steps and in answering questions about the solution process.

2- Allow easy modification in adding and deleting skills from the knowledge base.

3- Reason heuristically, using (often imperfect) knowledge to get useful solutions.

Expert systems are built to solve a wide range of problems in domains such as medicine, mathematics, engineering, chemistry, geology, computer science, business, law, defense, and education. These programs address a variety of problems; the following list a useful **summary of general expert system problem categories**:

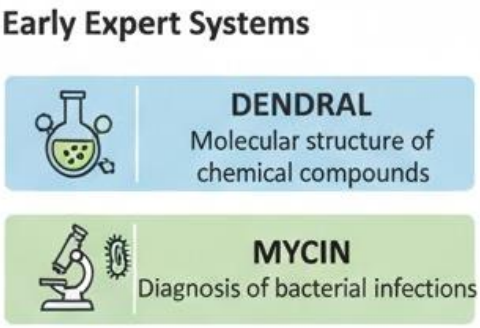
Interpretation	forming high-level conclusions from collections of raw data.
Prediction	projecting probable consequences of given situations.
Diagnosis	determining the cause of malfunctions in complex situations based on observable symptoms.
Design	finding a configuration of system components that meets performance goals while satisfying a set of design constraints.
Planning	devising a sequence of actions that will achieve a set of goals given certain starting conditions and run-time constraints.
Monitoring	comparing a system's observed behavior to its expected behavior.
Instruction	assisting in the education process in technical domains.
Control	governing the behavior of a complex environment.

History

The term expert system is used in a seminal paper by Alan Turing in 1937 related to a study in AI.

In 1960s Allan Newell and Herbert Simon wrote computer programs to test the hypothesis that intelligent behavior resulted from heuristic search.

It was quickly realized that the way to make progress was to focus on particular application domains, and expert systems started to appear.



An Expert System (ES) is a program that attempts to mimic human expertise by applying inference methods to a specific body of knowledge.

Expert Systems Applications	Conventional Systems Applications
Knowledge is fragmented and implicit, is difficult to communicate except in small “chunks”, and is often distributed amongst individuals who may disagree.	Knowledge is complete and explicit, and is easily communicated with formulas and algorithms.
Rules are complex, conditional and often defined as imprecise “rules of thumb”.	Rules are simple with few conditions.
The finished system captures, distributes and leverages expertise	The finished product automates manual procedures
Problem-solving demands dynamic, context-driven application of facts, relationship and rules	Problem-solving requires predictable and repetitive sequences of actions.
System performance is measured in degrees of accuracy and completeness where explanations may be required to establish correctness.	Simple criteria are used to determine accuracy and completeness.

Expertise is task-specific knowledge acquired and developed from training, reading and experience. It may consist of:

- Facts, theories, rules, procedures.
- Guidelines (heuristics) based on intuition
- Strategies or approaches
- Meta knowledge

Experts are people who have uncommon expertise. To be useful, experts must have other qualities also. They should be able to **Recognize and formulate problems**, **Explain**, **organize knowledge (make connections)**, **Determine relevance**, **Solve problems.**

Knowledge Engineer

-Interacts between expert and Knowledge Base

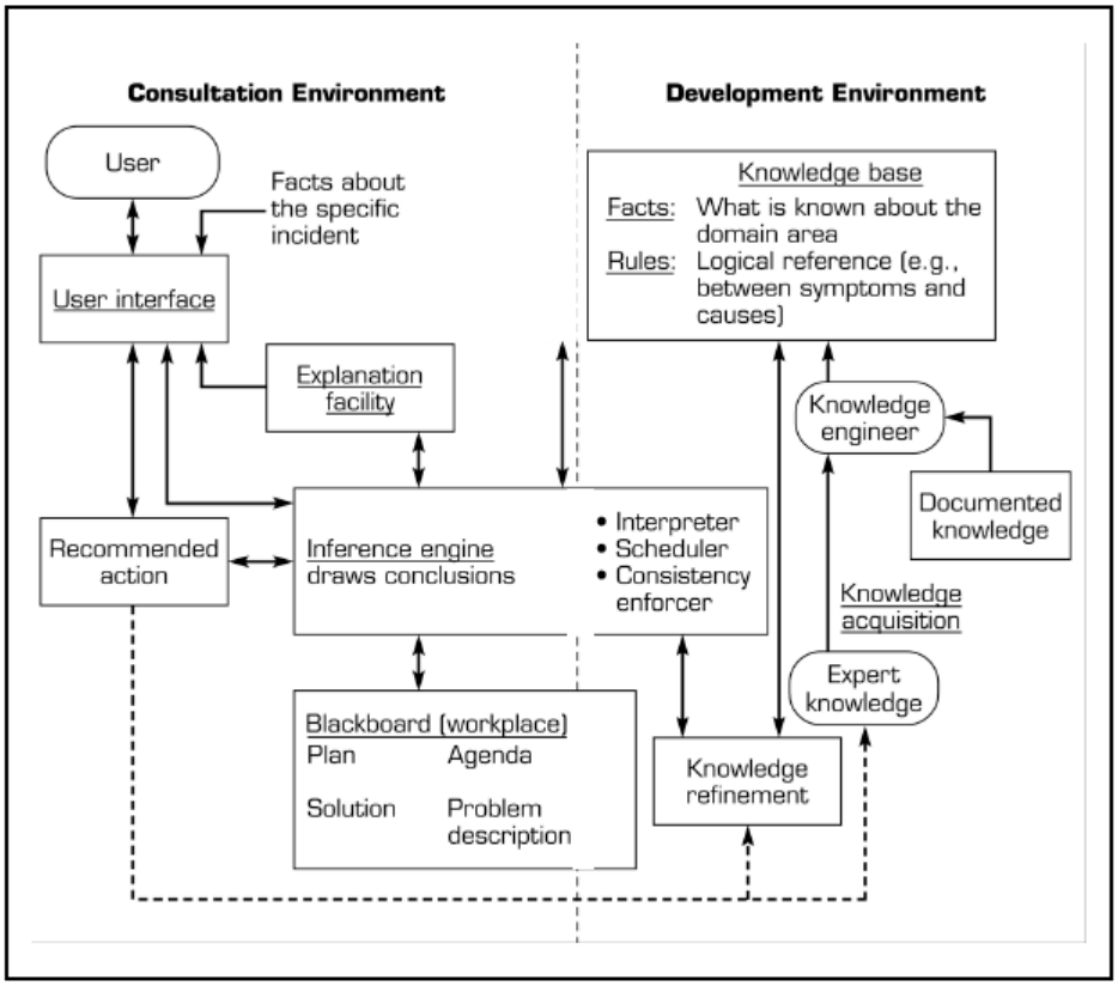
-Needs to be skilled in extracting knowledge

-Uses a variety of techniques

Structure of an Expert System

An ES will normally have two aspects:

- A development environment: used by the system builder to modify the system.
- A consultation environment: used by the non-expert to obtain knowledge or advice.

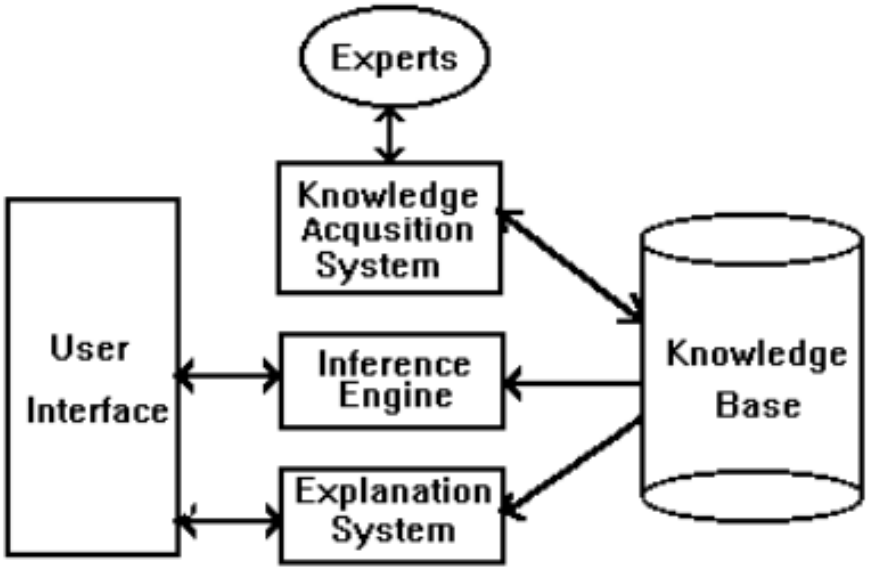


Three major components in ES are:

- Knowledge base
- Inference engine
- User interface

ES may also contain:

- Knowledge acquisition subsystem
- Blackboard (workplace)
- Explanation subsystem (justifier)
- Knowledge refining system



Architecture of ES

The User Interface

-The user of an ES can be a tester, a tutor, a pupil, or a customer.

-User Interface style could be menu-driven, question and answer, natural language or graphics interface

-User interface facilities are designed to recognize

- The mode of the user
- The level of the user's expertise
- Nature of the transaction

Knowledge-base

-The power of problem solving is primarily the consequence of the knowledge base and secondarily on the inference method employed.

-A storehouse of knowledge primitives. The design of knowledge representation scheme impacts the design of the inference engine, the knowledge updating process, the explanation process and the overall efficiency of the system.

-Therefore, the selection of the knowledge representation scheme is one of the most critical decisions in ES design.

Inference Engine

The inference engine controls the reasoning involved when the system is run.

It has its own mechanism for interpreting the stored knowledge (in the appropriate form), and for sequencing the steps involved in reaching conclusions.

Inference here means any of the methods by which the system reaches conclusions.

-Facts All animals breathe oxygen.
All dogs are animals.

-Infer All dogs breathe oxygen.

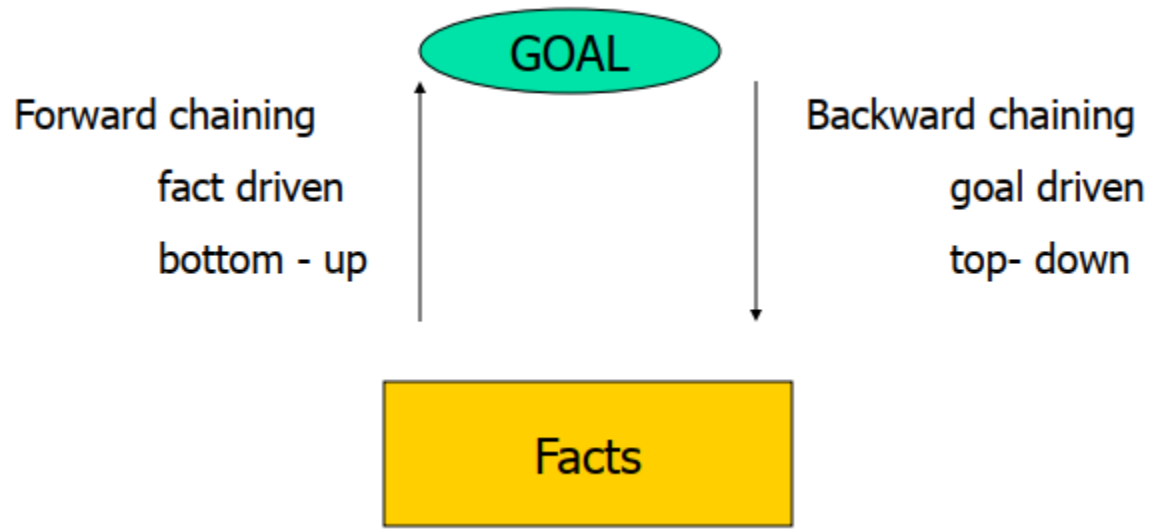
inference methods:

1. Forward Chaining (Data-Driven)

Forward chaining starts with the available data (the "IF" part) and uses rules to extract new data until a goal is reached. It is often used in real-time monitoring and classification.

2. Backward Chaining (Goal-Driven)

Backward chaining starts with a hypothesis or goal (the "THEN" part) and looks back through the rules to see if there is data to support it. This is the classic approach for diagnostic systems (like medical or troubleshooting tools).



Creating an Expert System

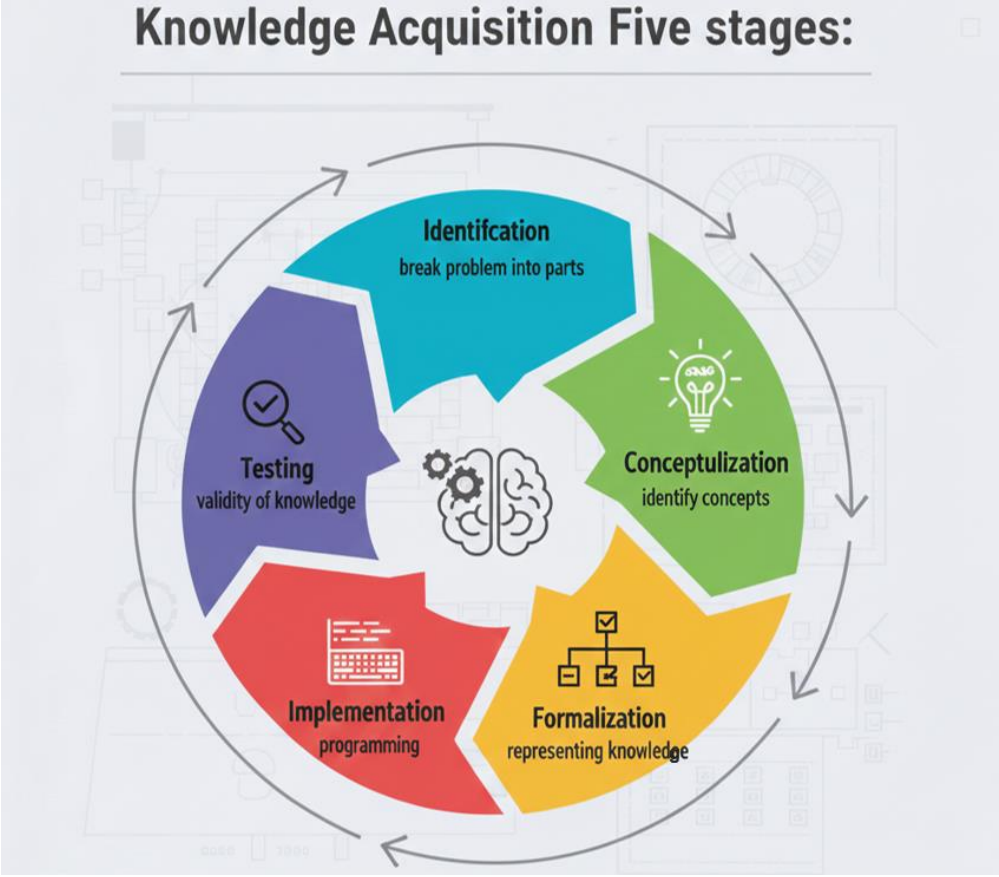
-Two steps involved:

1. extracting knowledge and methods from the expert **(knowledge acquisition)**

2. reforming knowledge/methods into an organized form **(knowledge representation)**

Knowledge Acquisition

Knowledge acquisition is the process by which knowledge available in the world is transformed and transferred into a representation that can be used by an expert system. World knowledge can come from many sources and be represented in many forms.



Sources of Knowledge

Documented

books, journals, procedures

films, databases

films, databases

Undocumented

people's knowledge and expertise

people's minds, other senses

Levels of Knowledge

Shallow Level

very specific to a situation

Limited by IF-THEN type rules

Rules have little meaning

No explanation

Deep Knowledge

problem solving

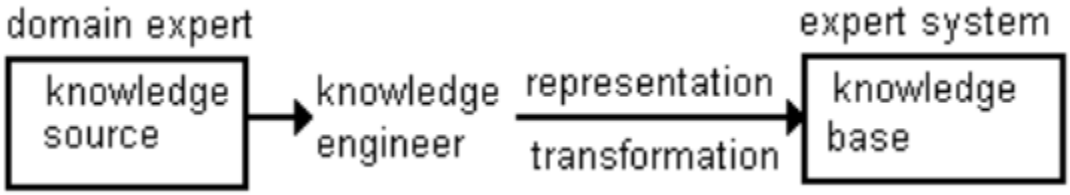
Internal causal structure

Built from a range of inputs

• emotions • common sense intution

difficult to build into a system

Knowledge engineering:



Blackboard (workplace)

An area of working memory set aside for the description of a current problem and for recording intermediate results in an expert system.

Explanation subsystem (justifier)

The component of an expert system that can explain the system's reasoning and justify its conclusions.

It will be useful to allow the user to ask

-In response to a question from the ES:

WHY (did you ask that question)?

-After a conclusion has been presented:

HOW (did you reach that conclusion)?

Knowledge-refining system

A system that has the ability to analyze its own performance, learn, and improve itself for future consultations.

This may consist merely of saving previous results for future reference, to avoid repeating searches or computations.

OR it may involve feedback from the user, e.g.

> You (the ES) gave me this advice and it was BAD/GOOD