

# Artificial Intelligence & Soft Computing

## CSC 703



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# Chapter 6

## Expert System

**Based on CO6:**

Apply Hybrid approach for expert system design.



# Outline of Expert system

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- **Hybrid Approach- Fuzzy Neural Network**
- **Expert system**
  - ✦ Introduction, Characteristics
  - ✦ Expert System Architecture,
  - ✦ Stages in the development of Expert Systems,.



# Hybrid Approach



# Hybrid Approach

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“A **hybrid intelligent system** is one that combines at least two intelligent technologies”.

**For example:** *Combining a neural network with a fuzzy system results in a hybrid fuzzy neural system*



# Hybrid Approach

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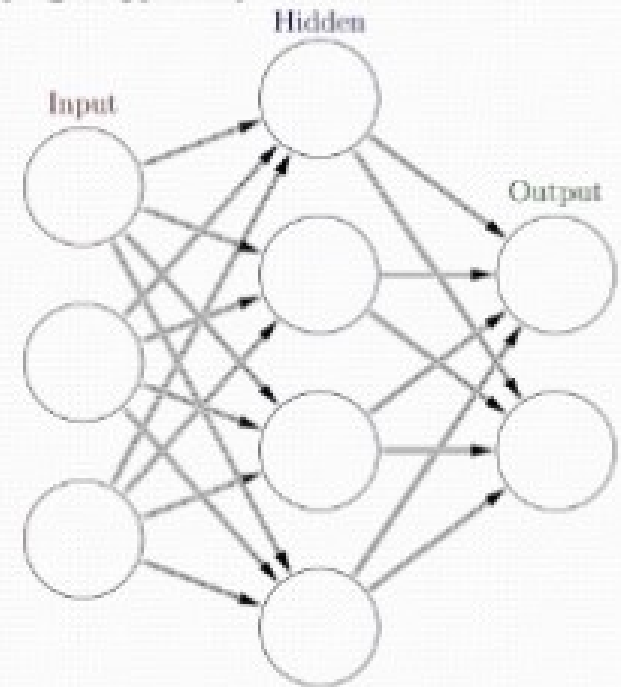
The combination of knowledge based systems, neural networks and evolutionary computation forms the core of an emerging approach to building *hybrid intelligent systems* capable of reasoning and learning in an uncertain and imprecise environment.



# Neural Network

An artificial **neural network** is an interconnected group of nodes, akin to the vast **network** of neurons in a brain.

Here, each circular node represents an artificial neuron and an arrow represents a connection from the output of one neuron to the input of another.



# Fuzzy Logic

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Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based.





# Fuzzy Neural Network

Fuzzy logic and neural networks are natural complementary tools in building intelligent systems.

While neural networks are low-level computational structures that perform well when dealing with raw data, fuzzy logic deals with reasoning on a higher level, using linguistic information acquired from domain experts.

However, fuzzy systems lack the ability to learn and cannot adjust themselves to a new environment. On the other hand, although neural networks can learn.



# Fuzzy Neural Network

Integrated neuro-fuzzy systems can combine the parallel computation and learning abilities of neural networks with the human-like knowledge representation and explanation abilities of fuzzy systems.

As a result, neural networks become more transparent, while fuzzy systems become capable of learning.

A neuro-fuzzy system is a neural network which is functionally equivalent to a fuzzy inference model. It can be trained to develop IF-THEN fuzzy rules and determine membership functions for input and output variables of the system.

The connectionist structure avoids fuzzy inference, which entails a substantial computational burden.



# Fuzzy Neural Network

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The combination of fuzzy logic and neural networks constitutes a powerful means for designing intelligent systems.

Domain knowledge can be put into a neuro-fuzzy system by human experts in the form of linguistic variables and fuzzy rules.

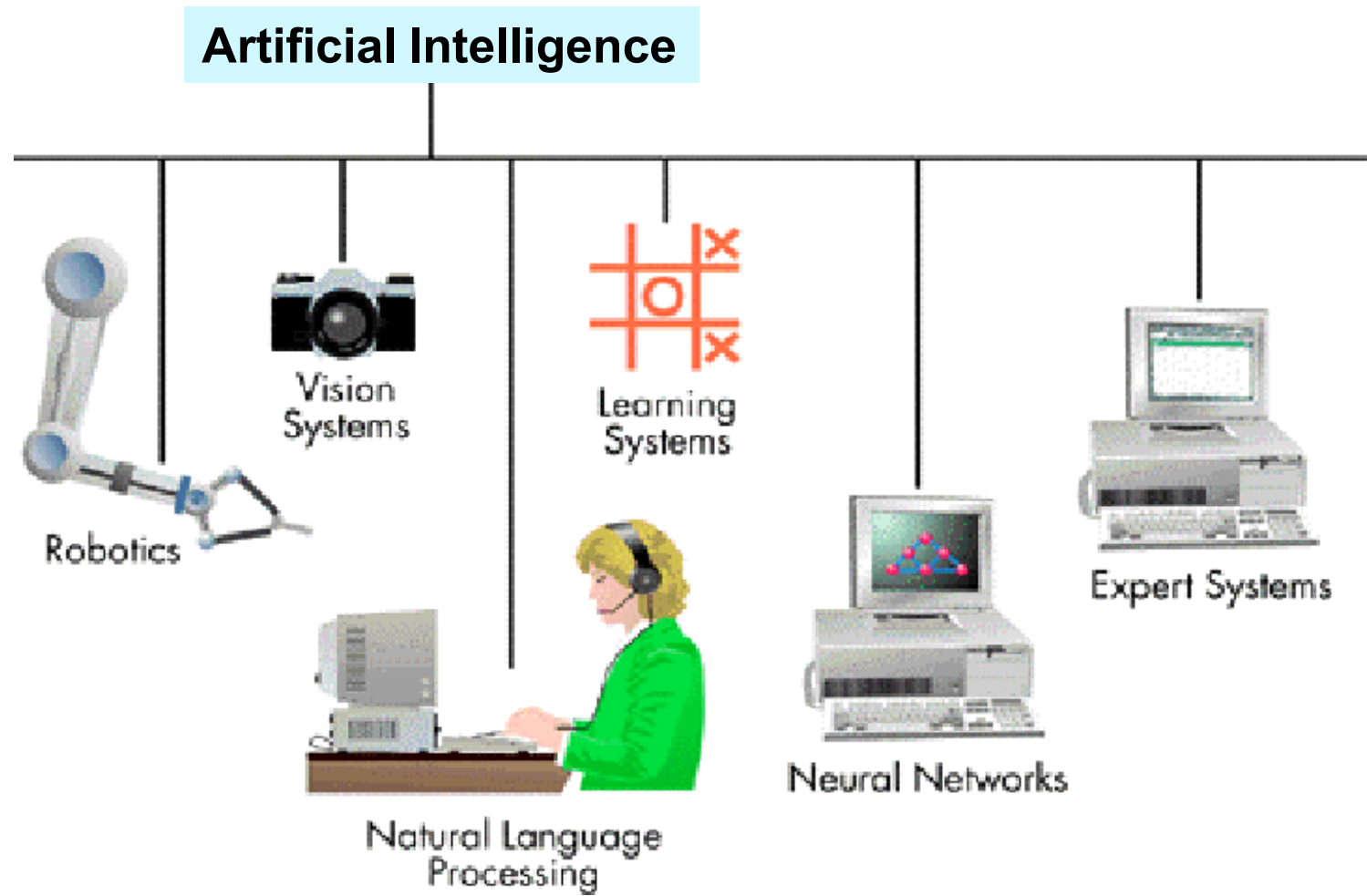


# Expert System

1. Draw general architecture of Expert system. Explain every component in detail with an example **Dec 2016 10 marks**
2. Draw and explain architecture of expert system. **May 2016 5 marks**



# Sub field of AI: Expert system



# Introduction to Expert system

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“An expert system is an intelligent computer program that *can perform special and difficult task* in some fields, at the level of a human expert.”



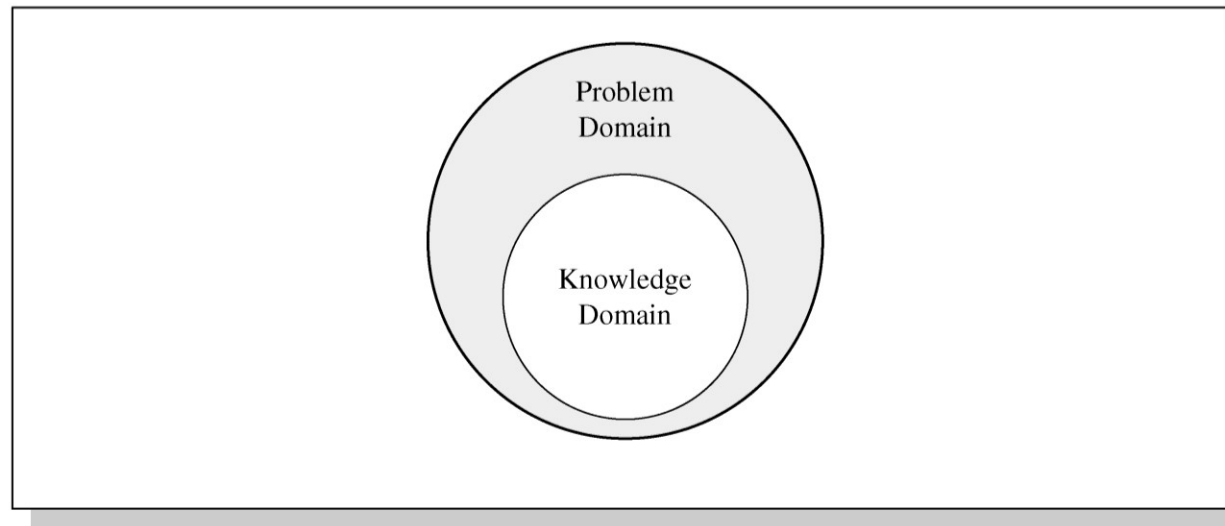
# Introduction to Expert system

- ✚ **Experts** are people who are very familiar with solving specific types of problems.
- ✚ **Expert System**  
Until now, no unified definition has been given.
- ✚ **Knowledge-based system**  
The fundamental function of the expert system depends upon its knowledge, therefore, the expert system is sometimes called knowledge-based system.



# Problem Domain vs. Knowledge Domain

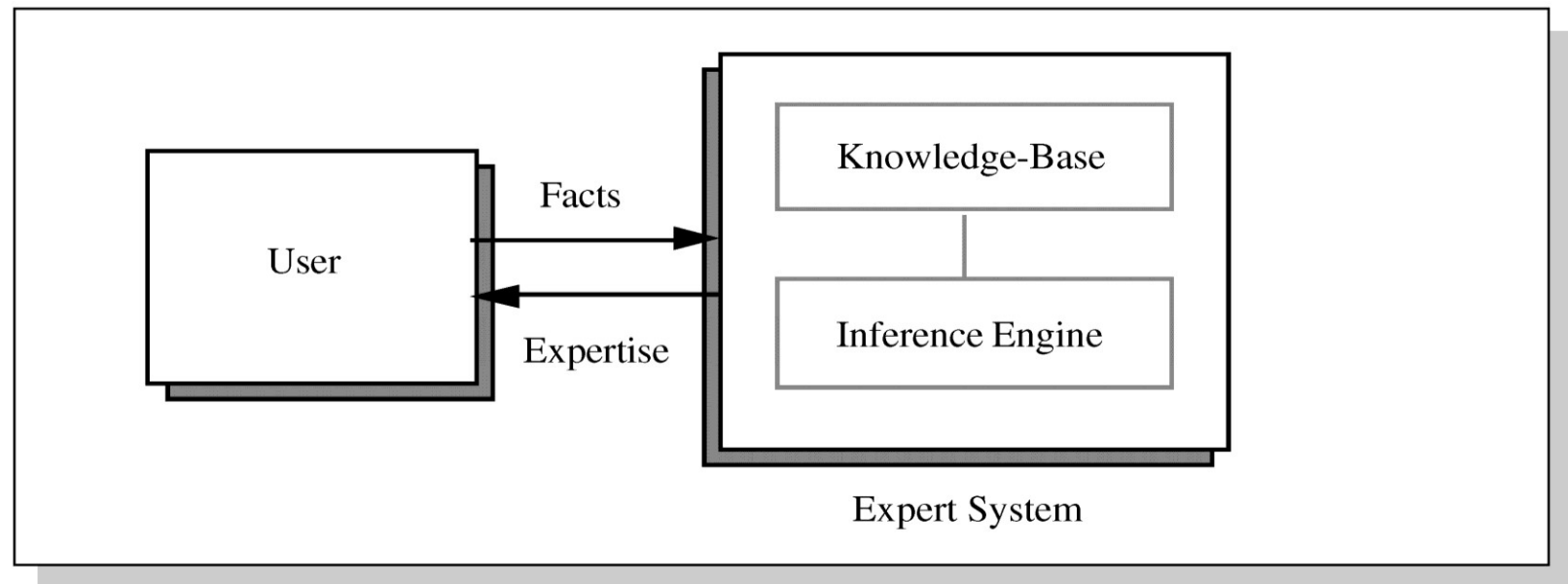
- An expert's knowledge is specific to one problem domain – *medicine, finance, science, engineering*, etc.
- The expert's knowledge about solving specific problems is called the **knowledge domain**.
- The **problem domain** is always a superset of the knowledge domain.





# Main Components of Expert System

- **Knowledge Base** – obtainable from books, magazines, knowledgeable persons, etc.
- **Inference Engine** – draws conclusions from the knowledge base



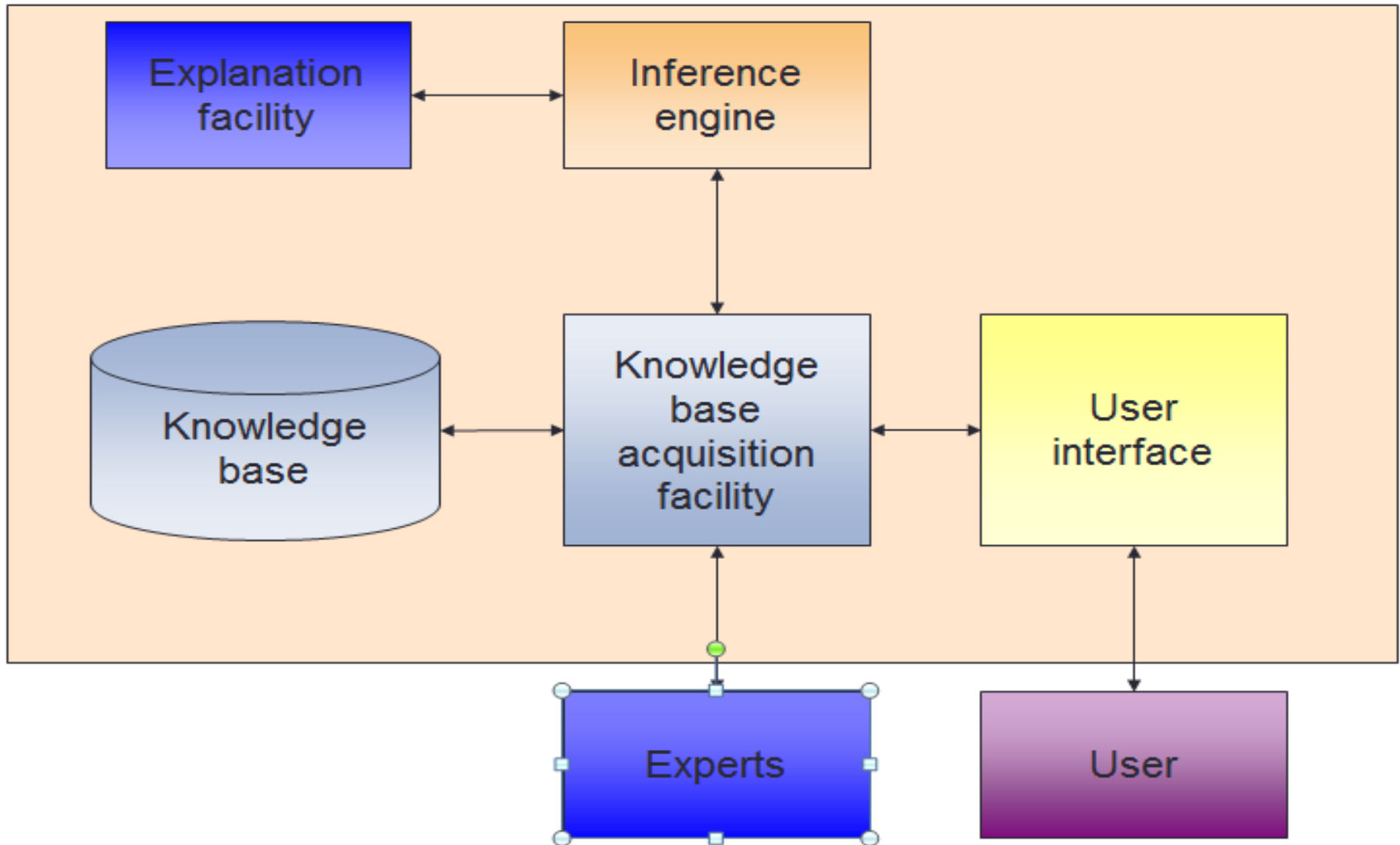
# Characteristics/Advantages of Expert Systems

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- Increased availability
- Reduced cost
- Reduced danger
- Performance
- Multiple expertise
- Increased reliability
- Explanation
- Fast response
- Steady, unemotional, and complete responses at all times
- Intelligent tutor
- Intelligent database



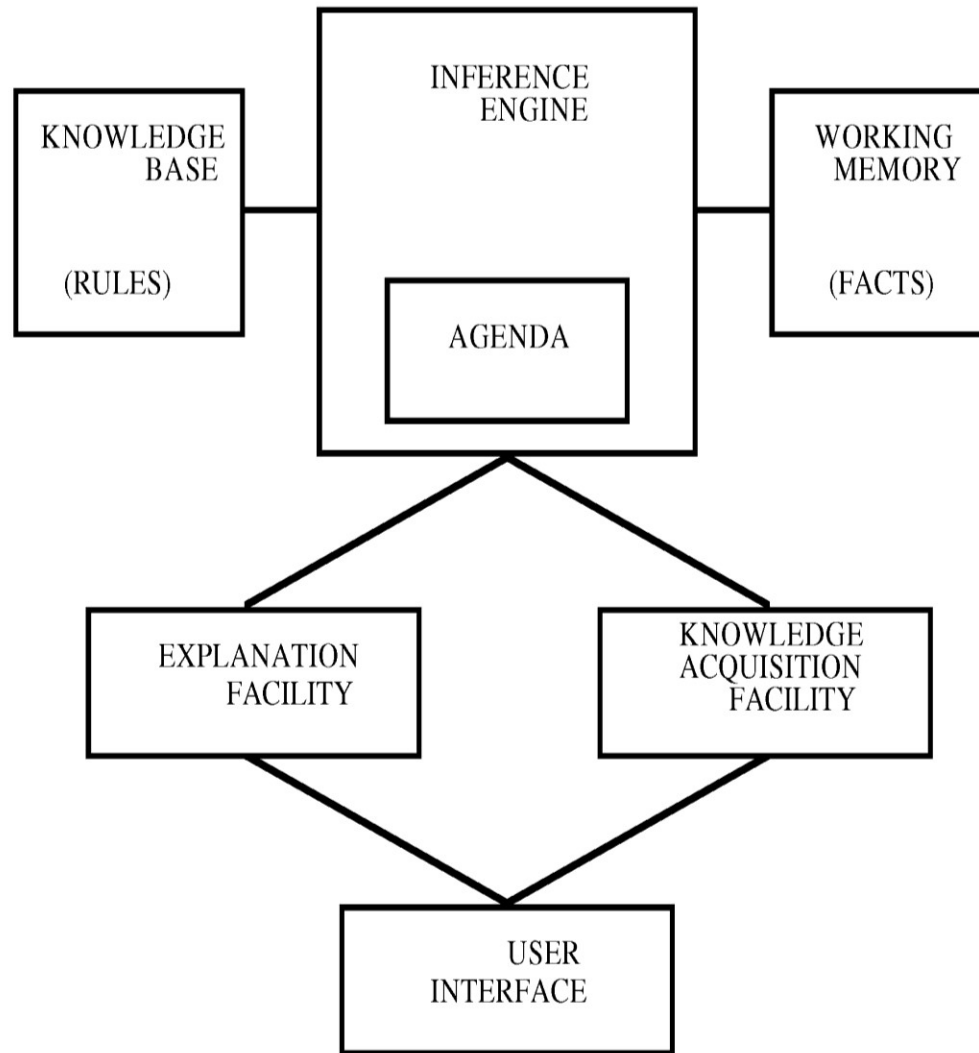
# Expert System Architecture



# Components of an Expert System

- **Knowledge base**
  - Stores all relevant information, data, rules, cases, and relationships used by the expert system
- **Inference engine**
  - Seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions in the way a human expert would
- **Explanation facility**
  - A part of the expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results
- **Knowledge acquisition facility**
  - Provides a convenient and efficient means of capturing and storing all components of the knowledge base





- **User interface** – mechanism by which user and system communicate.
- **Exploration facility** – explains reasoning of expert system to user.
- **Working memory** – global database of facts used by rules.
- **Inference engine** – makes inferences deciding which rules are satisfied and prioritizing.
- **Agenda** – a prioritized list of rules created by the inference engine, whose patterns are satisfied by facts or objects in working memory.
- **Knowledge acquisition facility** – automatic way for the user to enter knowledge in the system bypassing the explicit coding by knowledge engineer.
- **Knowledge Base** – includes the rules of the expert system

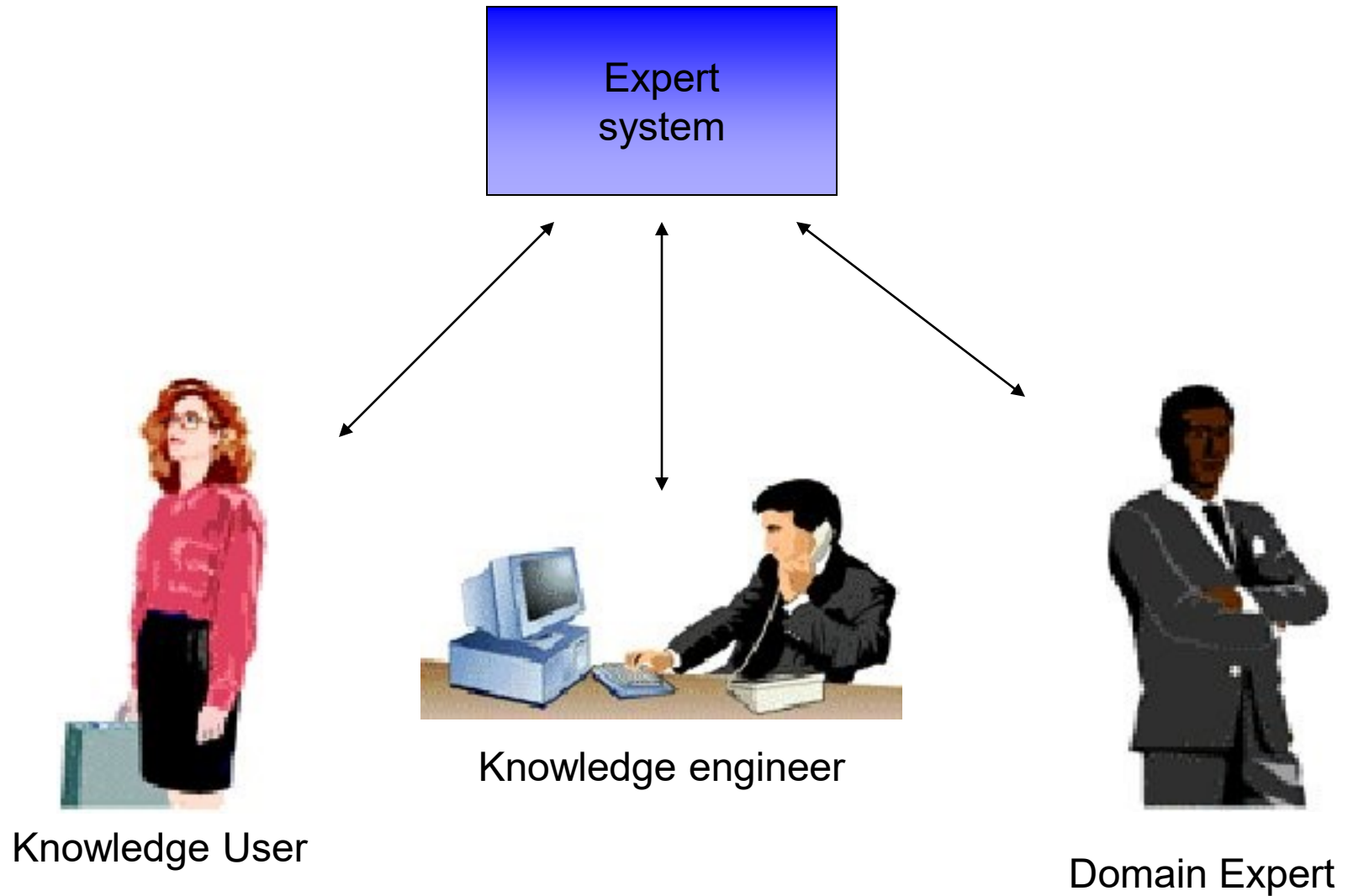
# Users in Expert Systems

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- **Domain expert**
  - The individual or group whose expertise and knowledge is captured for use in an expert system
- **Knowledge user**
  - The individual or group who uses and benefits from the expert system
- **Knowledge engineer**
  - Someone trained or experienced in the design, development, implementation, and maintenance of an expert system



# User in Expert Systems





# Expert Systems Development- Representing knowledge

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The knowledge of an expert system can be represented in a number of ways, including IF-THEN rules:

IF you are hungry THEN eat



# Expert Systems Development- Knowledge Engineering

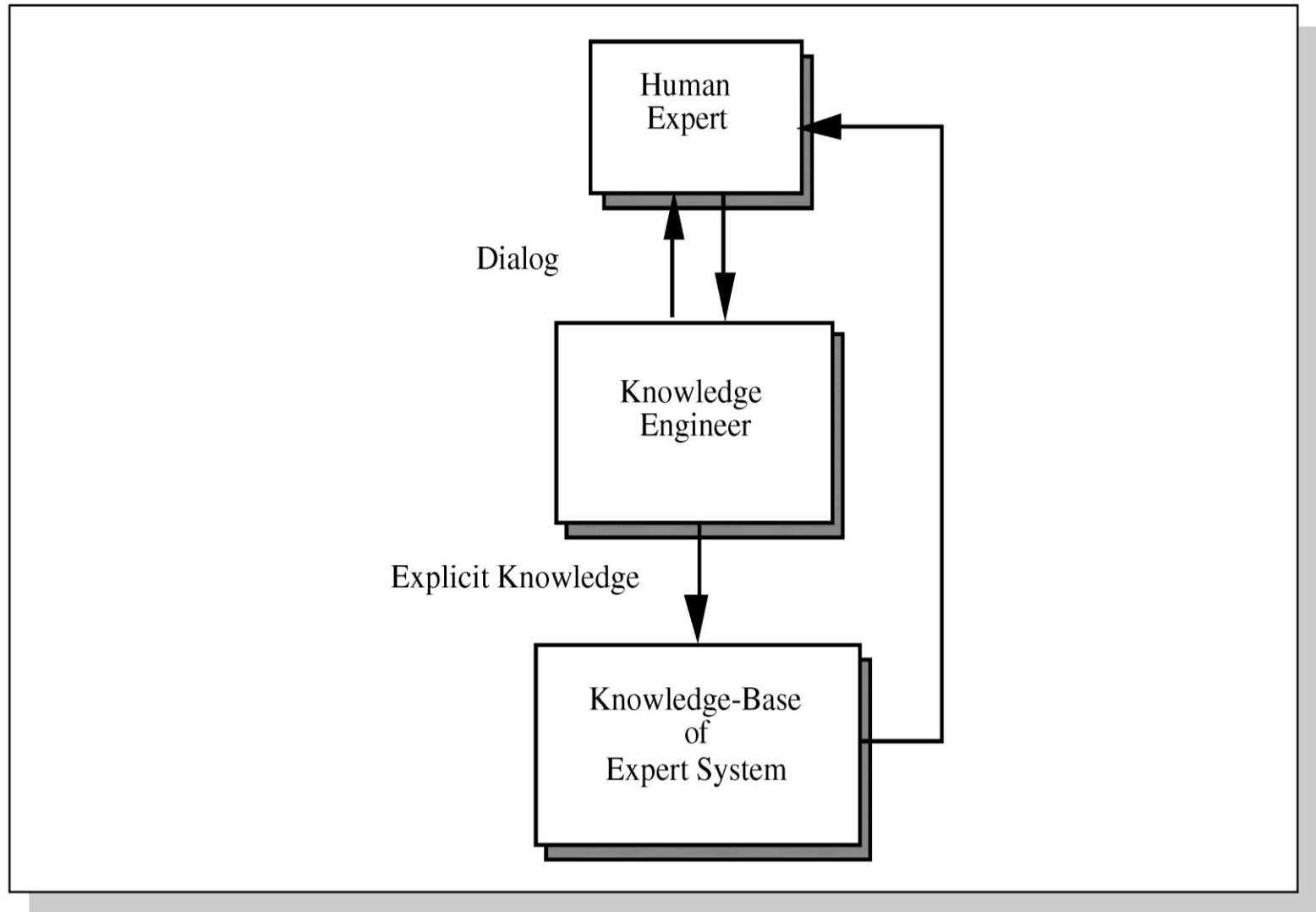
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## **The process of building an expert system:**

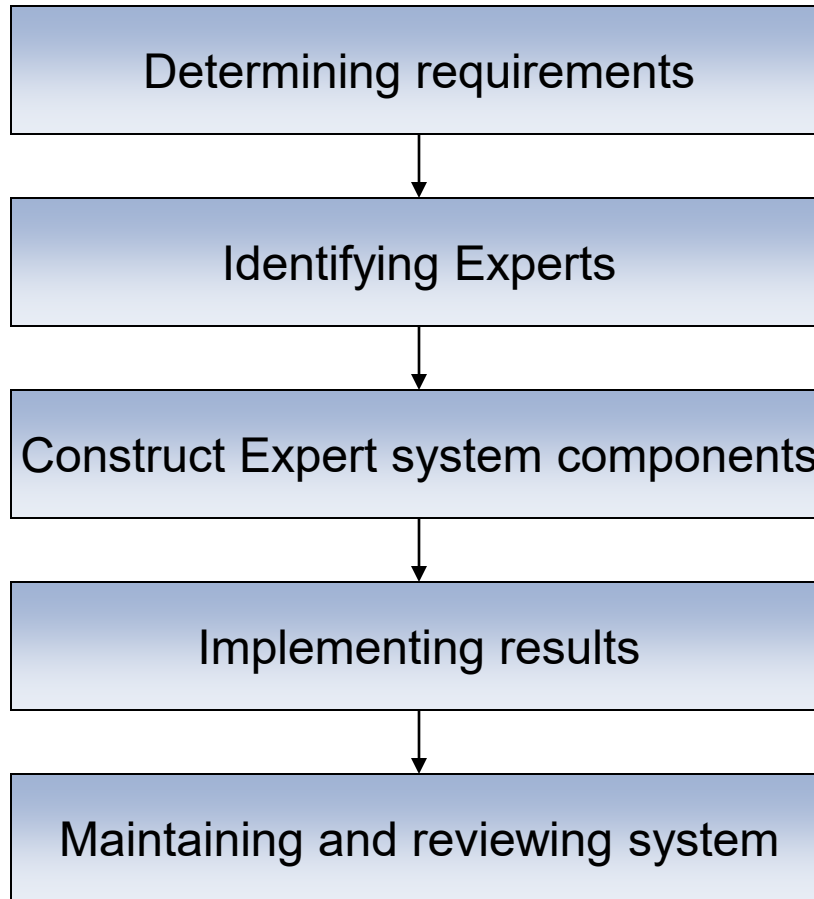
1. The knowledge engineer establishes a dialog with the human expert to elicit knowledge.
2. The knowledge engineer codes the knowledge explicitly in the knowledge base.
3. The expert evaluates the expert system and gives a critique to the knowledge engineer.



# Expert Systems Development



# Phases in Expert Systems Development



## Domain

- The area of knowledge addressed by the expert system.



# Limitations of Expert Systems

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- Typical expert systems cannot generalize through analogy to reason about new situations in the way people can.
- A knowledge acquisition bottleneck results from the time-consuming and labor intensive task of building an expert system.



# Early Expert Systems

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1. DENDRAL – used in chemical mass spectroscopy to identify chemical constituents
2. MYCIN – medical diagnosis of illness
3. DIPMETER – geological data analysis for oil
4. PROSPECTOR – geological data analysis for minerals
5. XCON/R1 – configuring computer systems



# Thank you

