



# Expert System Architecture in Artificial Intelligence

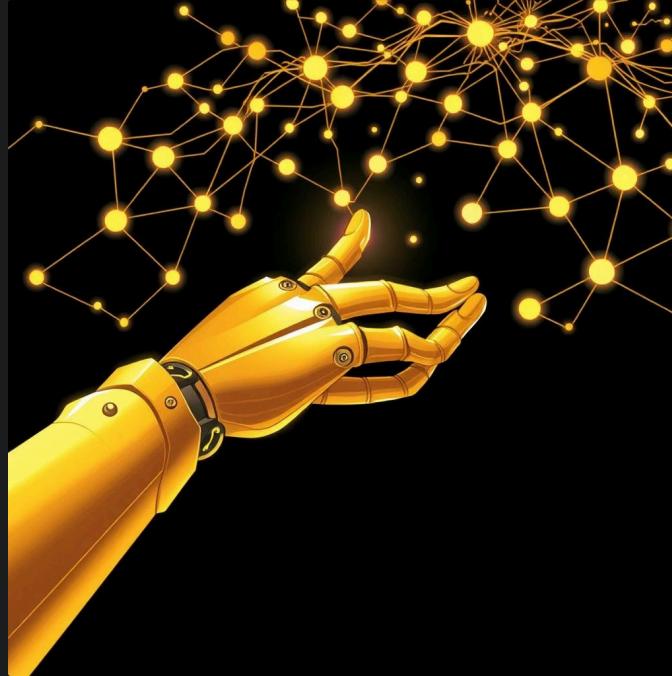
MCA – Mahatma Gandhi University, Kottayam

Prepared by: Adarsh Prakash

# Introduction to Expert Systems

Expert systems are AI programs designed to emulate human expert decision-making within specialized domains. They operate by leveraging a vast knowledge base and applying advanced reasoning techniques to solve complex problems.

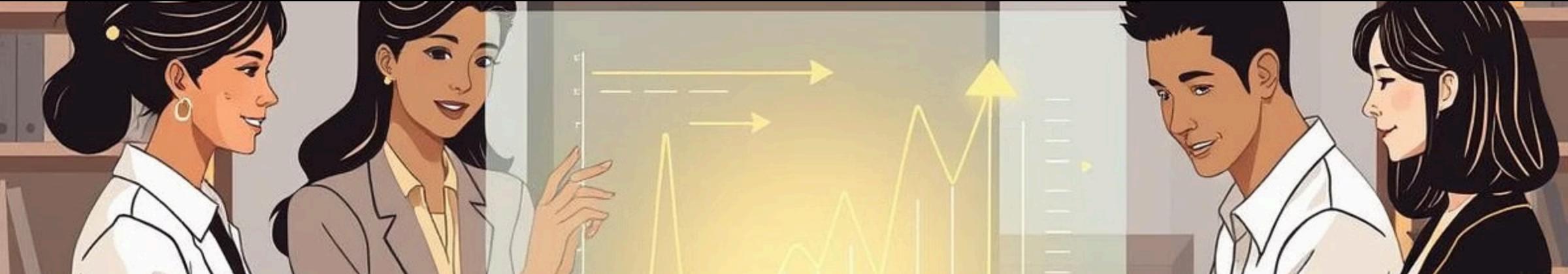
These systems represent a significant advancement in artificial intelligence, tackling problems that typically require human intellect and experience.



## Key Characteristics:

- Simulate human decision-making in specialized domains.
- Utilize codified knowledge and reasoning mechanisms.
- Solve complex problems requiring human-like intellect.

Pioneering examples include MYCIN (medical diagnosis) and DENDRAL (chemical structure elucidation).



# The Imperative for Expert Systems

Expert systems address critical challenges by augmenting or replacing human expertise in complex scenarios.



## Address Scarcity

Provide expertise when human experts are scarce or unavailable.



## Ensure Consistency

Guarantee consistent decisions, eliminating human biases and errors.



## Manage Knowledge

Efficiently handle large, intricate knowledge bases.



## Explain Reasoning

Explain their reasoning to users, fostering trust and comprehension.

# Core Pillars of Expert Systems

Expert systems are built from interconnected modules, each crucial for overall functionality.

## Knowledge Base

Repository of facts and rules.

## Uncertainty Handling

Handles imprecise information.

## Explanation Facility

Justifies conclusions.

## Inference Engine

Reasoning mechanism.

## User Interface

Communication gateway.

## Knowledge Acquisition

Incorporates new knowledge.



# The Knowledge Base: Foundation of Expertise

The Knowledge Base acts as the central memory of an expert system, storing all domain-specific knowledge needed for problem-solving. It primarily holds two types of knowledge and employs various representation methods.

## Factual Knowledge

Verified truths and accepted information within the domain (e.g., medical symptoms, chemical properties).

## Heuristic Knowledge

Expert rules of thumb, educated guesses, and experiential IF-THEN rules (e.g., "IF fever AND cough THEN consider flu").

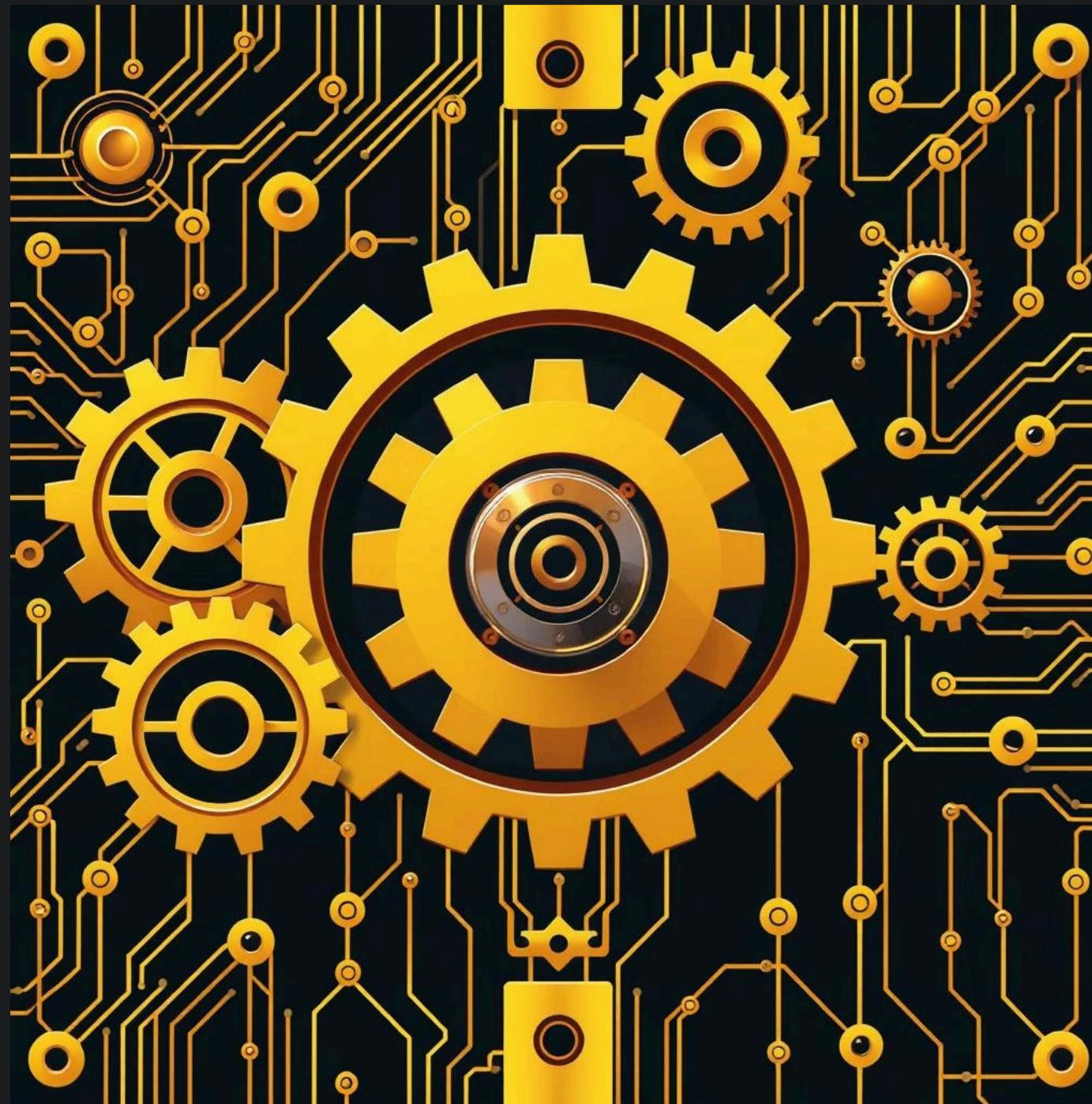
## Knowledge Representation

Methods for structuring this information, including logic statements, semantic networks, frames, and production rules.



# The Inference Engine: The Brain of the System

The Inference Engine acts as the "brain" of an expert system, applying logical reasoning to the Knowledge Base to make decisions and recommendations. It employs search strategies to navigate the knowledge base, selecting and applying relevant rules to reach conclusions.



## Forward Chaining

A data-driven approach: starts with known facts and deduces new conclusions. Ideal when the goal isn't predefined or all outcomes need exploring.

## Backward Chaining

A goal-driven approach: starts with a hypothesis and seeks evidence to support it. Efficient for answering specific questions.

# User Interface: The Human-System Connection

The User Interface (UI) is the critical communication channel between human users and the expert system. Its design ensures easy interaction, clear query input, and understandable responses.

A robust UI often explains the system's reasoning, enhancing user trust and facilitating learning.

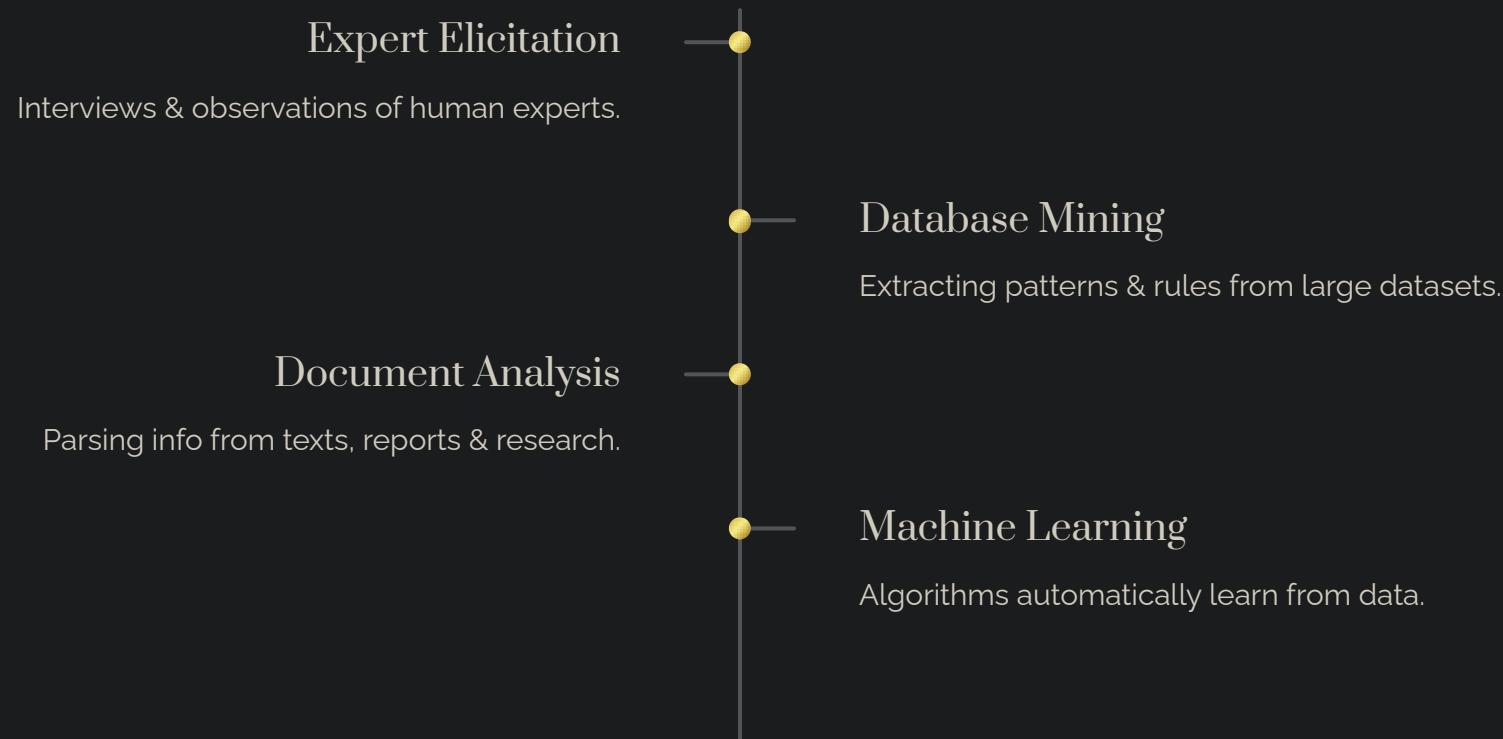


## Key Functions:

- Accepts user queries and input data.
- Displays solutions and recommendations clearly.
- Translates complex system processes into understandable explanations.

# Knowledge Acquisition: Keeping Systems Dynamic

Knowledge Acquisition continuously gathers, structures, and integrates new information into an expert system's knowledge base, ensuring its evolution and relevance.



This iterative process ensures the expert system remains accurate, up-to-date, and responsive to new challenges.

# The Explanation Facility: Building Trust and Transparency



Expert systems use an Explanation Facility to justify conclusions and reasoning steps. Unlike "black-box" AI, they articulate **"why"** a decision was made and **"how"** a conclusion was reached.

## Justifies Decisions

Clarifies the "why" and "how" behind system conclusions and logic.

## Builds Trust

Enhances user confidence in recommendations and system credibility.

## Facilitates Learning

Provides insights, aiding knowledge transfer and user understanding.

## Aids Development

Supports debugging and refinement of the system's knowledge base.



# Navigating Ambiguity: Handling Uncertainty

Expert systems often deal with real-world problems involving uncertainty, ambiguity, or incomplete information.

## Probabilistic Reasoning

Utilizes statistical methods to assign likelihoods to events and conclusions.

## Fuzzy Logic

Deals with degrees of truth rather than absolute true/false statements, mimicking human intuition.

## Non-monotonic Reasoning

Allows for conclusions to be retracted when new, contradictory information arises.

## Truth Maintenance Systems

Mechanisms to keep track of dependencies between beliefs and to manage contradictions.

These techniques enable expert systems to deliver robust solutions despite imperfect data, mirroring human decision-making.

# Expert Systems: Summary & Outlook

Expert systems remain a crucial bridge between human knowledge and automated decision-making, offering profound advantages in specialized domains.

## Core Strengths

- Preserve and disseminate expertise.
- Ensure consistent, unbiased decisions.
- Provide transparent, explainable reasoning.
- Handle complex, uncertain data.

## Diverse Applications

- Medical diagnosis and treatment planning.
- Financial fraud detection and investment advice.
- Industrial process control and fault diagnosis.
- Personalized education and tutoring systems.

## Future Directions

- Integration with modern AI/ML for hybrid intelligence.
- Enhanced adaptive learning capabilities.
- Broader adoption in niche, high-value sectors.
- More intuitive and natural user interfaces.

# THANK YOU