Introduction to Artificial Intelligence

AI- Expert System

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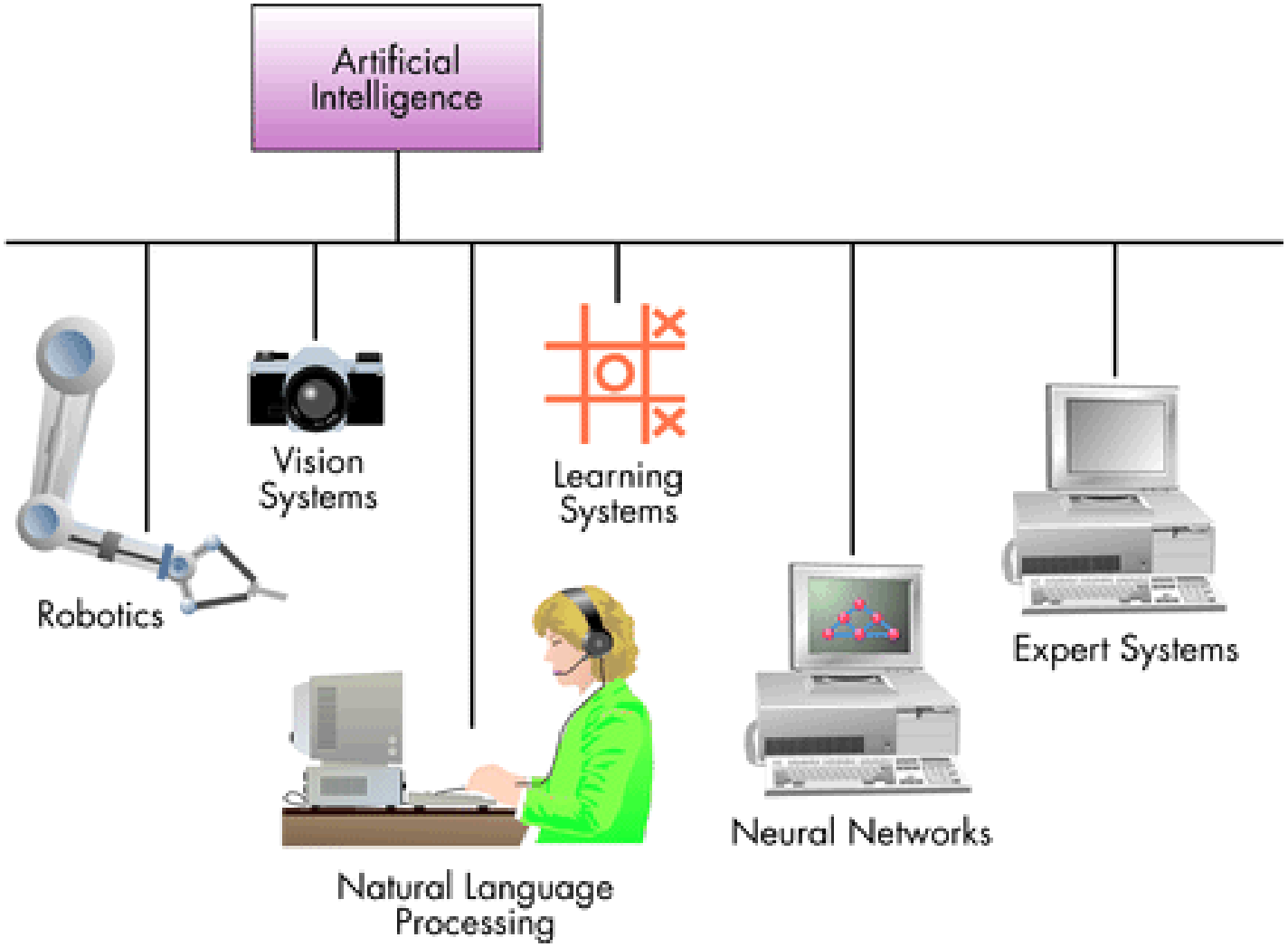
Areas of Artificial Intelligence



Difference B/w Natural & AI

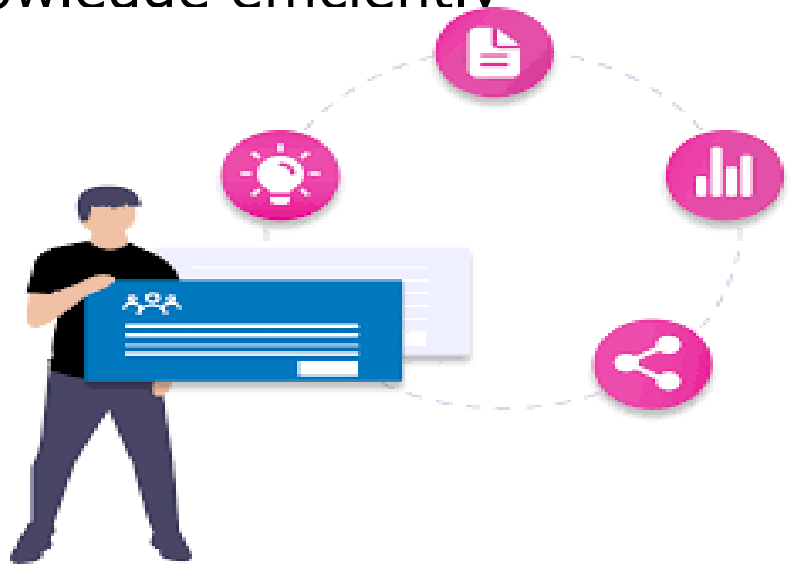
Attributes	Human	Machine
Use Sensors	High	Low
Creativity and Imagination	High	Low
Learn from Experience	High	Low
Adaptability	High	Low
Access external information	High	Low
Make complex calculations	Low	High
Transfer information	Low	High

What is an Expert?

- Solve simple problems easily.
- Learn from experience
- Ask appropriate questions (based on external stimuli - sight, sound etc).
- Reformulate questions to obtain answers.
- Explain why they asked the question.
- Explain why conclusion reached.
- Judge the reliability of their own conclusions.

What is an Expert?

- Talk easily with other experts in their field.
- Reason on many levels and use a variety of tools such as heuristics, mathematical models and detailed simulations.
- Transfer knowledge from one domain to another.
- Use their knowledge efficiently



Expert Systems?

- Expert Systems (ES) are one of the prominent research domains of AI.
- It is introduced by the researchers at Stanford University, Computer Science Department.
- ES are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise

Expert Systems?

“An expert system is a computer system that emulates, or acts in all respects, with the decision-making capabilities of a human expert.”

Professor Edward Feigenbaum

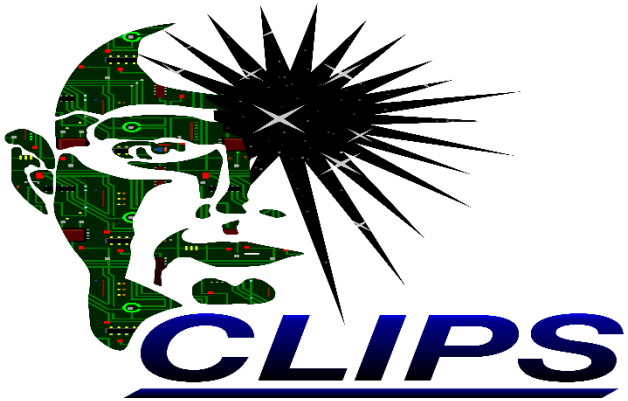
Stanford University

Expert Systems... More Definitions

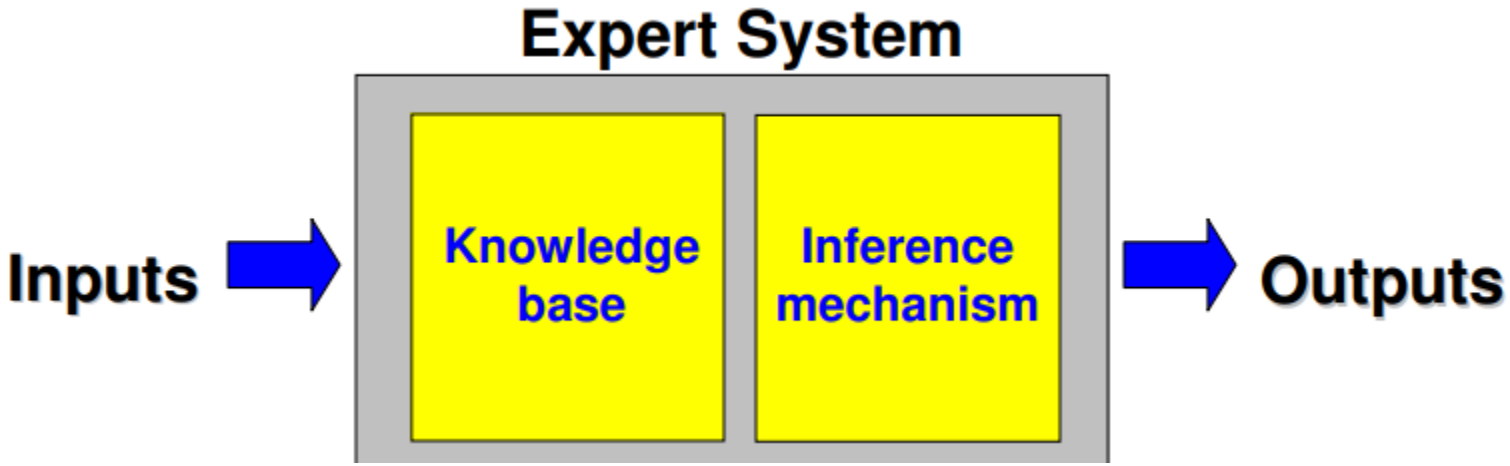
- **Computer software that:**
  - Emulates human expert
  - Deals with small, well defined domains of expertise
  - Is able to solve real-world problems
  - Is able to act as a cost-effective consultant
  - Can explains reasoning behind any solutions it finds
  - Should be able to learn from experience.

Expert Systems

- An Expert System Technology may include:
  - **Special expert system languages** – CLIPS - C Language Integrated Production System
  - **Programs**
  - **Hardware** designed to facilitate the implementation of those systems



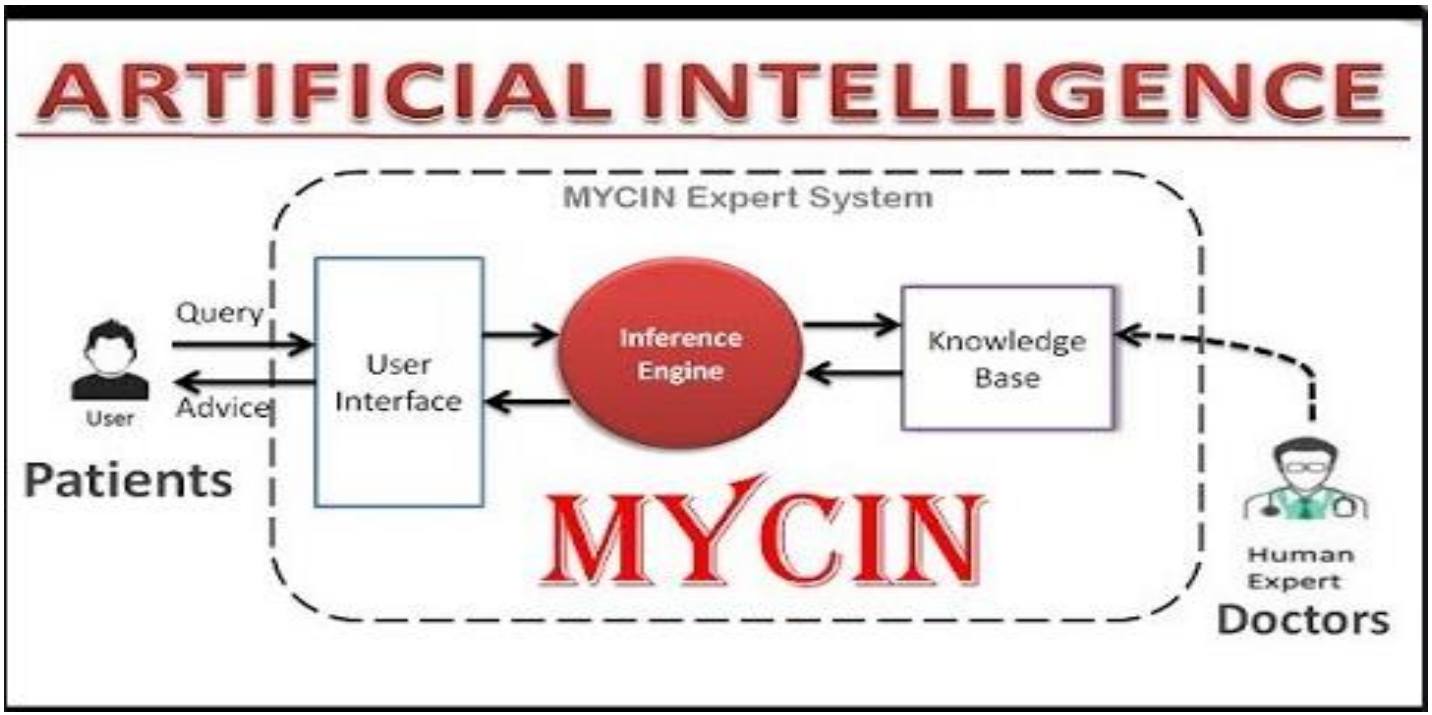
Expert Systems



• ***Notes:*** – The process mimic human experts when they solve a specific problem

Examples of Expert System

- **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.



Examples of Expert System

- **DENDRAL:**
  - An early expert system, developed beginning in 1965 by the artificial intelligence (AI) researcher Edward Feigenbaum and the geneticist Joshua Lederberg, both of Stanford University in California
  - Used for **chemical analysis .**
  - Used to predict **molecular structure**.
  - .

Examples of Expert System

- **PXDES:**
  - Used to determine the type and level of lung cancer.
  - To determine the disease, it takes a picture from the upper body, which looks like the shadow.
  - This shadow identifies the type and degree of harm.

Examples of Expert System

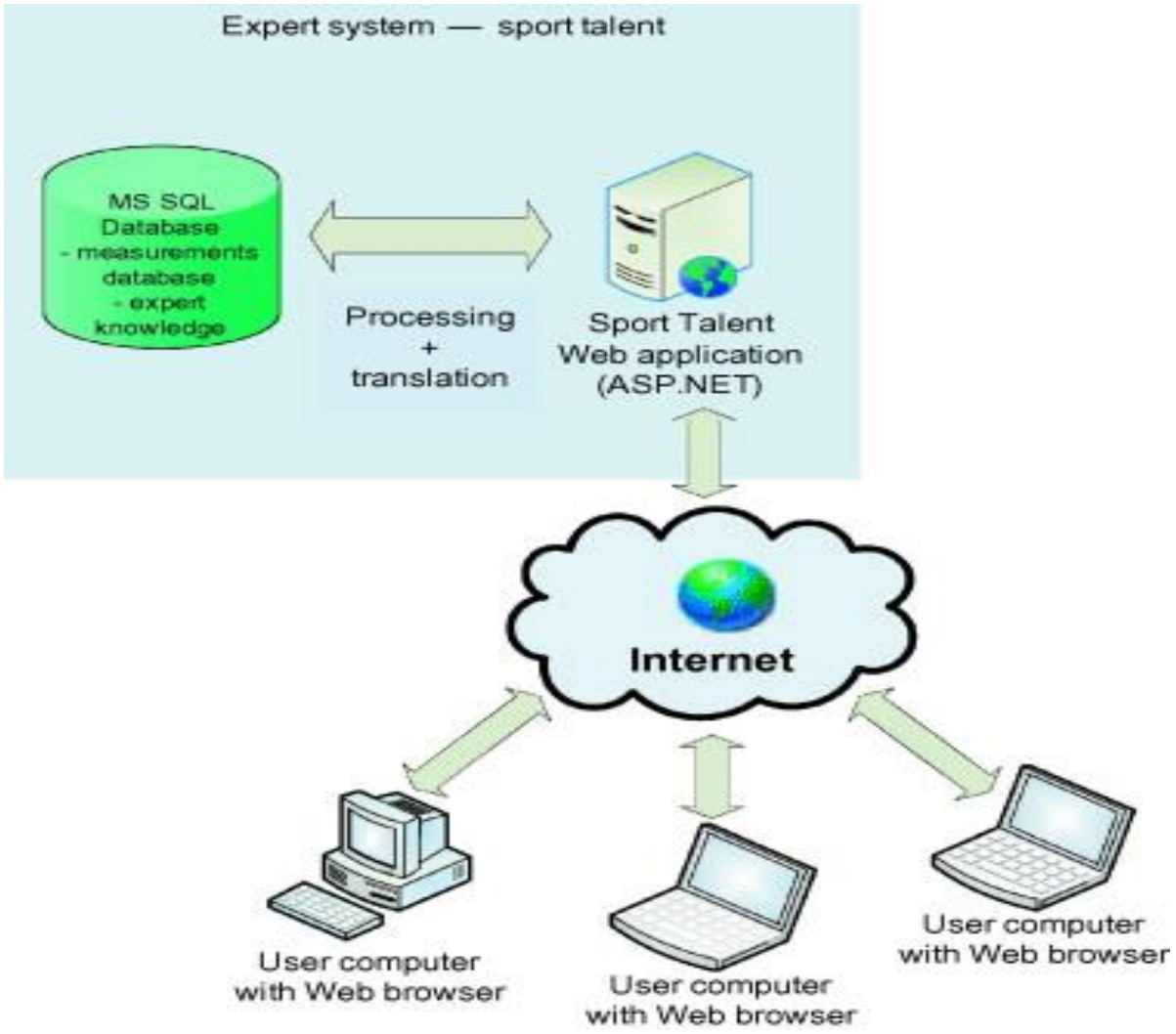
- **CaDet:** Expert system that could identify cancer at early stages

Examples of Expert System

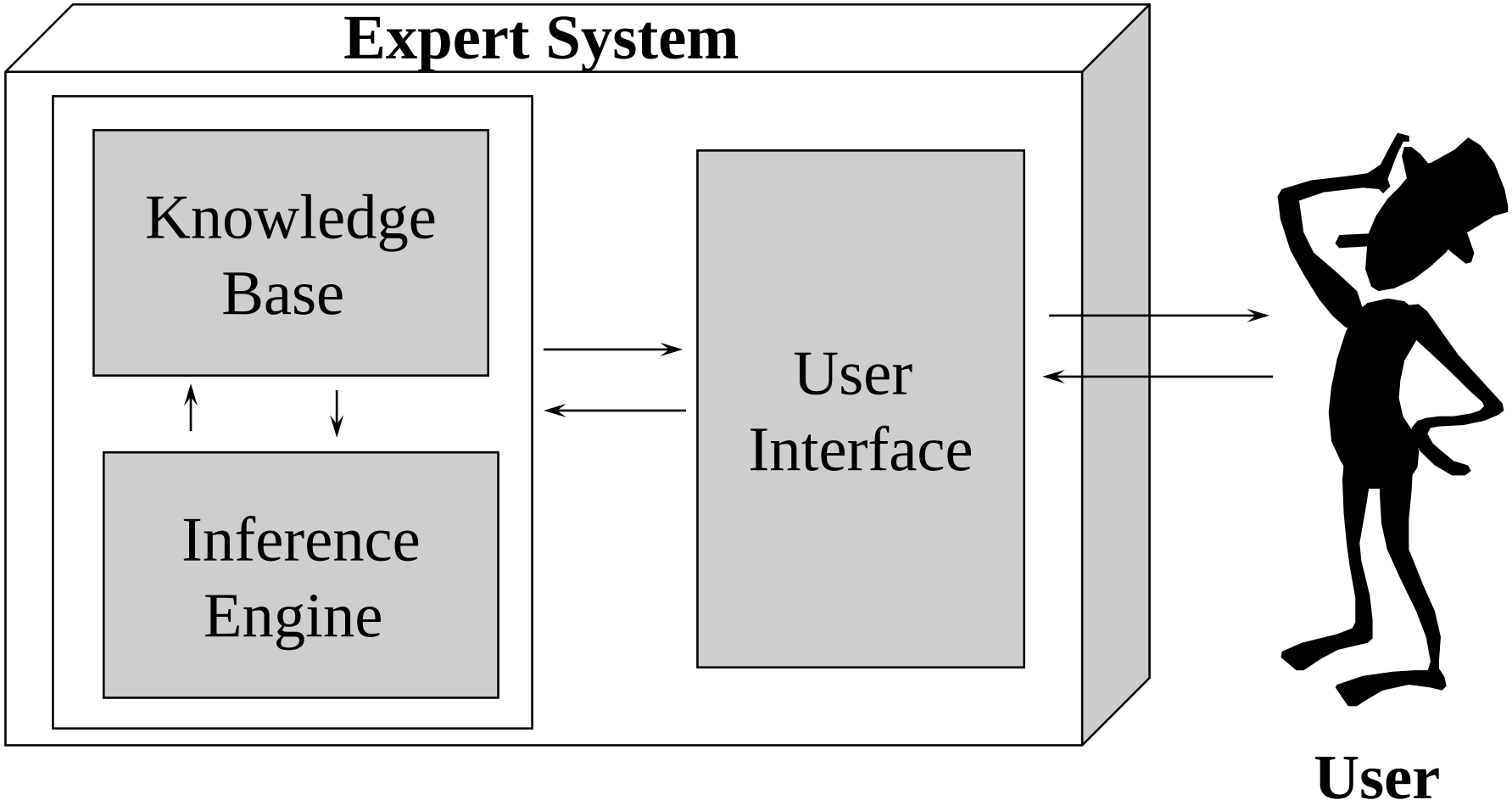
- **DXplain**
  - Diagnostic decision support program, with a new World Wide Web interface, designed to help medical students and physicians formulate differential diagnoses based on clinical findings.
  - It covers over 2000 diseases and 5000 clinical manifestations.

Examples of Expert System

- **Sport Expert System**



Components of ES



1. Knowledge Base

- The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.
- It contains
  - Domain-specific and
  - High-quality knowledge.
- Knowledge is needed to reveal intelligence.
- Obtainable from books, magazines, knowledgeable persons, etc.

Components of Knowledge Base

- The knowledge base of an ES is a store of both, factual and heuristic knowledge.
  - **Factual Knowledge**
  - **Heuristic Knowledge**

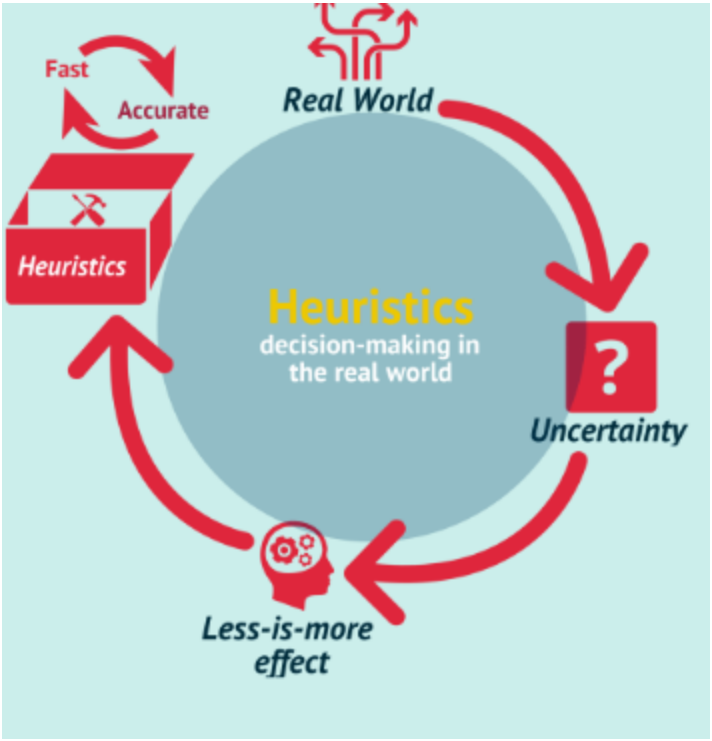
Components of Knowledge Base

– **Factual Knowledge** – It is the information widely accepted by the Knowledge Engineers and scholars in the task domain.

Components of Knowledge Base

– **Heuristic Knowledge**

It is about practice, accurate judgement, one's ability of evaluation, and guessing



Components of Knowledge Base

- **Knowledge representation**
  - It is the method used to organize and formalize the knowledge in the knowledge base.
  - It is in the form of IF-THEN-ELSE rules.

Components of Knowledge Base

- **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 base is formed by readings from various experts, scholars, and the **Knowledge Engineers**.
- The knowledge engineer is a person with the qualities of understanding, quick learning, and case analyzing skills.

Components of Knowledge Base

- **Knowledge Acquisition**
- knowledge engineer acquires information from a subject expert by recording, interviewing, and observing him at work, etc.
- knowledge engineer then categorizes and organizes the information in a meaningful way, in the form of IF-THEN-ELSE rules, to be used by the interference machine.
- The knowledge engineer also monitors the development of the ES.

2. Inference Engine

- A tool used to make logical deductions about knowledge assets.
- Applies logical rules to the knowledge base to infer new information from known facts.
- It is mostly considered a component of a knowledge base.
- Inference engines are useful in working with all sorts of information, for example, to enhance business intelligence
- The use of efficient procedures and rules by the Inference Engine is essential in **deducting a correct, flawless solution.**

2. Inference Engine

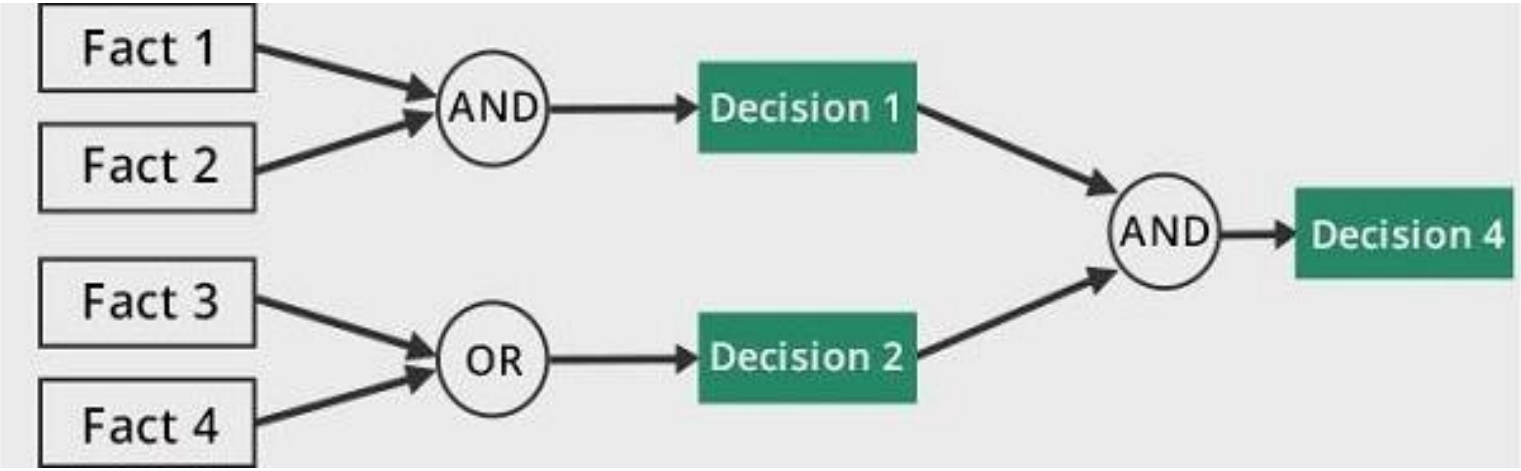
- **In the case of knowledge-based ES**,
  - the Inference Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution
- **In the case of rule-based ES, it –**
  - **Applies rules repeatedly** to the facts, which are obtained from earlier rule applications.
  - Adds new knowledge into the knowledge base if required.
  - **Resolves rules conflict** when multiple rules are applicable to a particular case.

2. Inference Engine

- **Strategies of Inference Engine**
  - To recommend a solution, the Inference Engine uses the following strategies
    - Forward Chaining
    - Backward Chaining

2. Inference Engine

- **Forward Chaining**
  - It is a strategy of an expert system to answer the question, **"What can happen next?**
  - 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

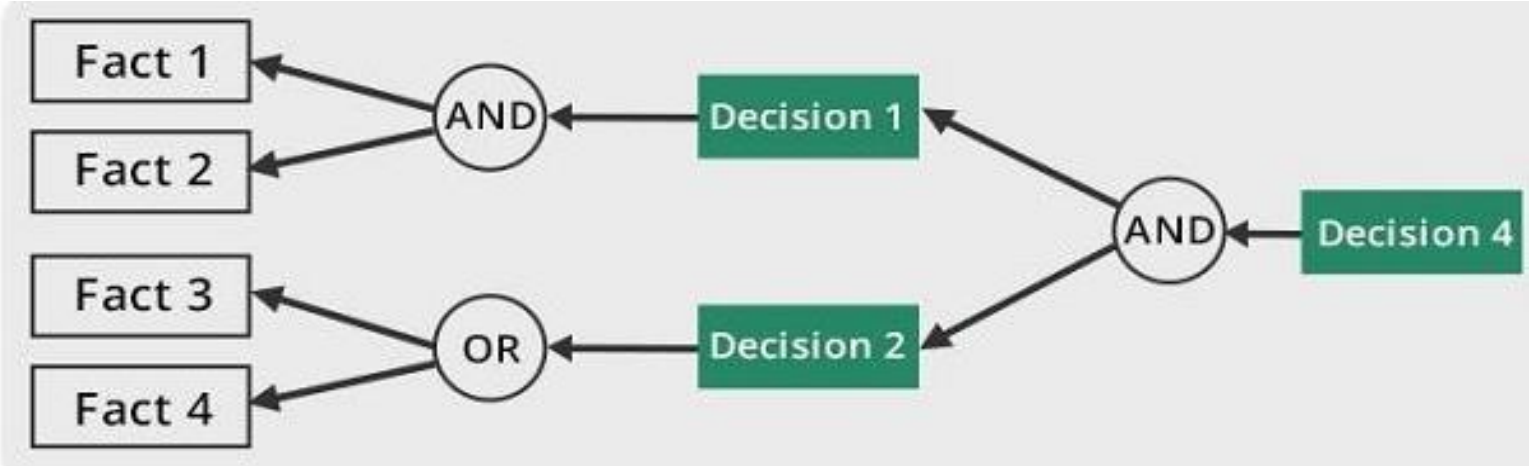


2. Inference Engine

- **Forward Chaining characteristics**
  - It is a **down-up approach**, as it moves from bottom to top.
  - It is a process of making a conclusion based on known facts or data, by starting from the initial state and reaches the goal state.
  - Forward-chaining approach is **also called as data-driven** as we reach to the goal using available data.
  - Forward-chaining approach is commonly used in the expert system, such as CLIPS, business, and production rule systems.

2. Inference Engine

- **Backward Chaining**
  - With this strategy, an expert system finds out the answer to the question, **"Why this happened?"**
  - Backward-chaining is also known as **a backward deduction** or backward reasoning method when using an inference engine.
  - A backward chaining algorithm is a form of reasoning, which starts with the goal and works backward, chaining through rules to find known facts that support the goal.



2. Inference Engine

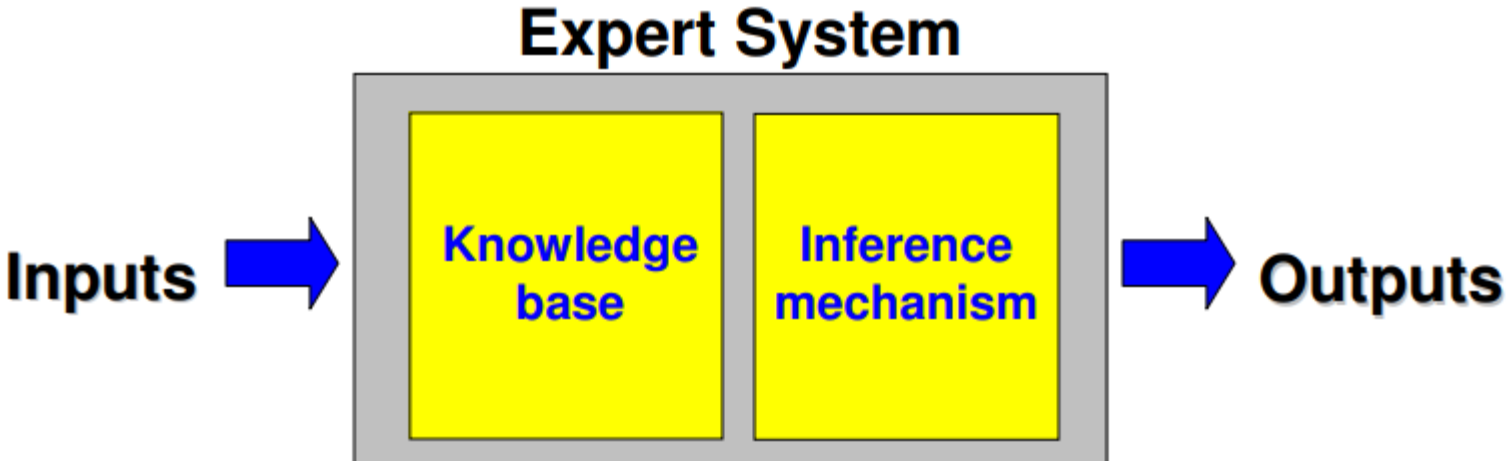
- **Backward Chaining Characteristics**
  - It is known as a top-down approach.
  - In backward chaining, the goal is broken into sub-goal or sub-goals to prove the facts true.
  - It is called a goal-driven approach, as a list of goals decides which rules are selected and used.
  - Backward -chaining algorithm is used in game theory, automated theorem proving tools, inference engines, proof assistants, and various AI applications.
  - The backward-chaining method mostly used a **depth-first search** strategy for proof.

3. User Interface

- It enables the users to enter instructions and information into the expert system and to receive information from it.
- The information is in the form of values assigned to certain variables.

3. User Interface

- The user interface has two parts –
  - **Expert System Input:** A user can use method for input command, natural language and customize the interface.
  - **Expert System Output:** Expert systems are designed to provide output or solution for a



Expert System Characteristics

- Expert systems were among the first truly successful forms of artificial intelligence (AI) software
- Expert systems can solve complex problems by deducing new facts through existing facts of knowledge, represented mostly as if-then rules rather than through conventional procedural code.

Expert System Characteristics

- **High performance**
  - The response at a level of competency equal to or better than an expert
- **Adequate response time**
  - Perform in a reasonable time, comparable to or better than HE's time 3.
- **Good reliability**
  - Must be reliable and not prone to crashes or else it will not be used

Expert System Characteristics

- **Understandable**
  - Have an explanation capability
    - a. Sanity/ Rationality check
    - b. Accuracy validation of the knowledge
- **Flexibility**
  - Important to have an efficient mechanism for adding, changing, and deleting knowledge

Advantages of Expert System

- **Increased availability**
  - Expertise is available on any suitable computer hardware
- **Reduced cost**
  - The cost of providing expertise per user is greatly lowered
- **Reduced danger**
  - Can be used in environments that might to hazards for a human
- **Permanence**
  - The knowledge will last indefinitely

Advantages of Expert System

- **Multiple expertise**
  - The knowledge of multiple experts can be made available to work simultaneously & continuously on a problem at any time of day or night
  - The level of expertise may exceed that of a single human expert (HE)
- **Increased reliability**
  - Increase confidence by providing a 2nd opinion
  - When HE is tired or under stress she will make the mistake

Advantages of Expert System

- **Explanation**
  - Can explain in detail the reasoning that leads to a conclusion
  - A human may be too tired, unwilling, or unable to do this all the time
- **Fast response**
  - May respond faster and be more available than HE
  - Real-time ES : Emergency situations
- **Indirect benefit**
  - Knowledge is explicitly known instead of being implicit in the expert's mind

Advantages of Expert System

- **Steady, unemotional, and complete response at all times**
  - May be very important in real-time and emergency situations
  - HE may not operate at peak efficiency because of stress or fatigue
- **Intelligent tutor**
  - Letting the student run sample programs & explaining the system's reasoning
- **Intelligent database**
  - Can be used to access a database in an intelligent manner Ex.: data mining

Limitations of Expert System

- Not widely used or tested
- Difficult to use
- Limited to relatively narrow problems
- Possibility of error
- Cannot refine its own knowledge
- Difficult to maintain

Convectional Vs Expert System

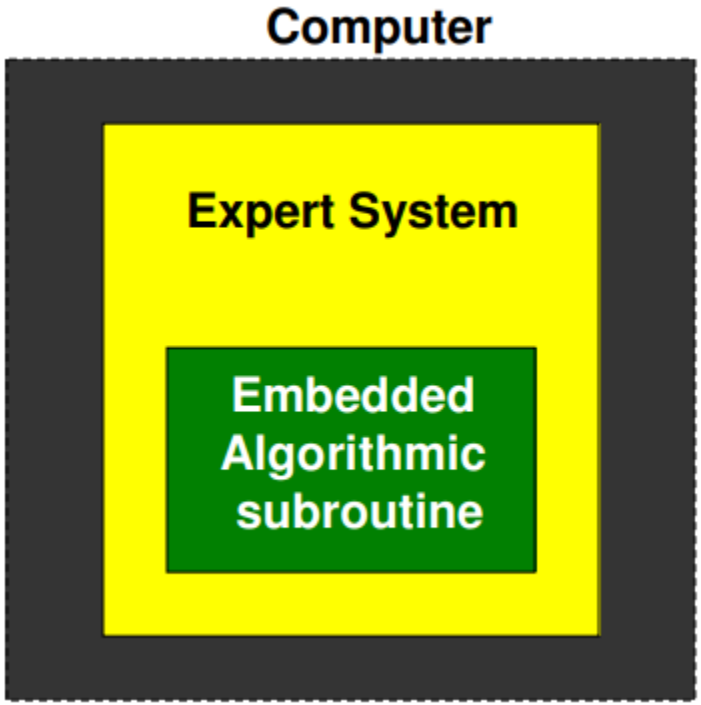
Conventional System	Expert System
Information and its processing are usually combined in one sequential program	Knowledge base is clearly separated form the processing (inference) mechanism
Program doesn't make mistakes	Program may make mistake
Explanation is not a part of most conventional system	Explanation is part of most ES
The system operates only when it's completed	The system can operate with only a few rules (as the first prototype)

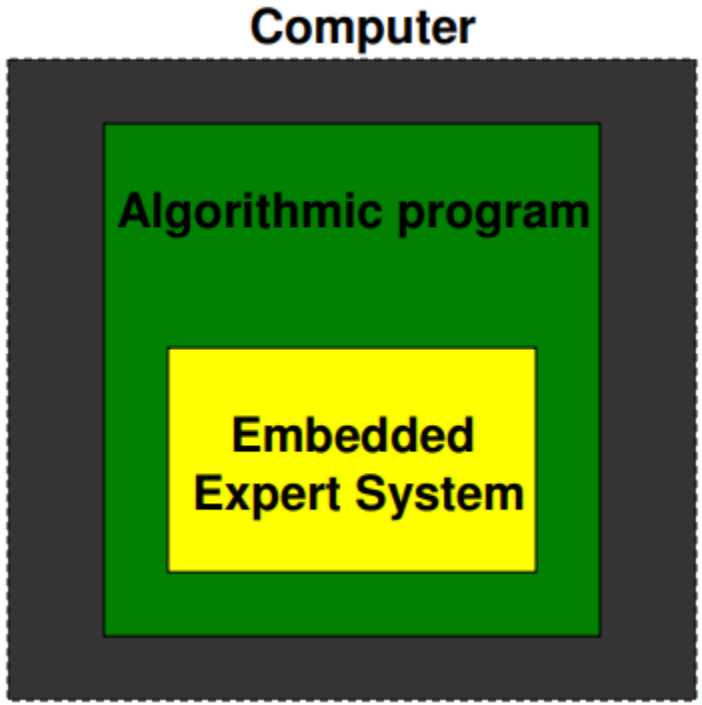
Convectional Vs Expert System

Conventional System	Expert System
Execution is done on a step by step (algorithmic)	Execution is done by using heuristic and logic
Need complete information to operate	Can operate with incomplete or uncertain information
Effective manipulation of large database	Effective manipulation of large knowledge bases
Representation and use of data	Representation and use of knowledge
Efficiency is a major goal	Effectiveness is a major goal

Basic Types of Expert System

- **Stand-alone**
  - When the computer is running a program, it is totally dedicated to it
- **Embedded**
  - The ES is just a portion of another larger program





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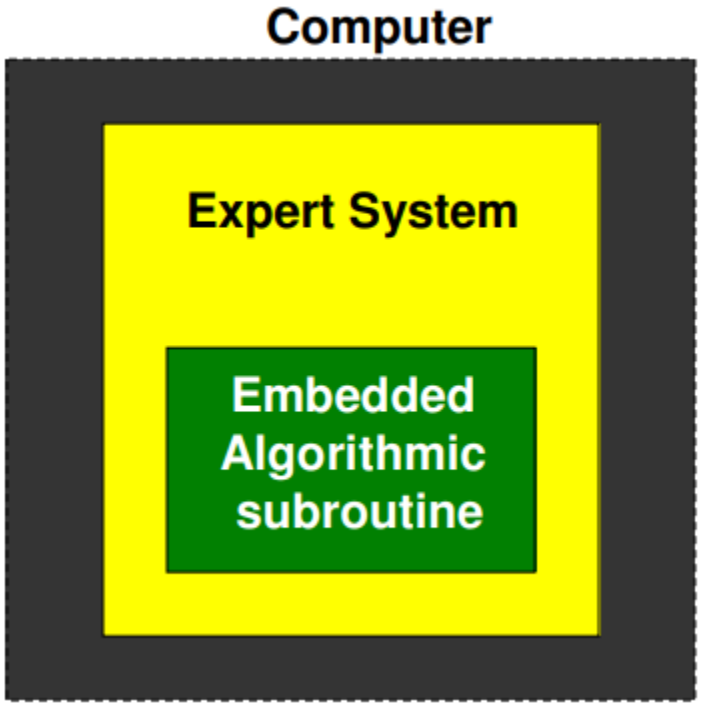
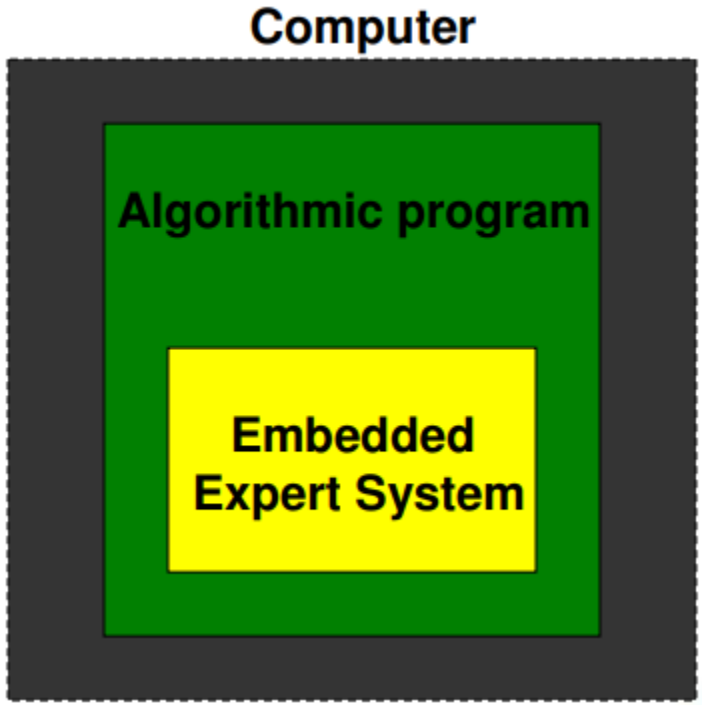
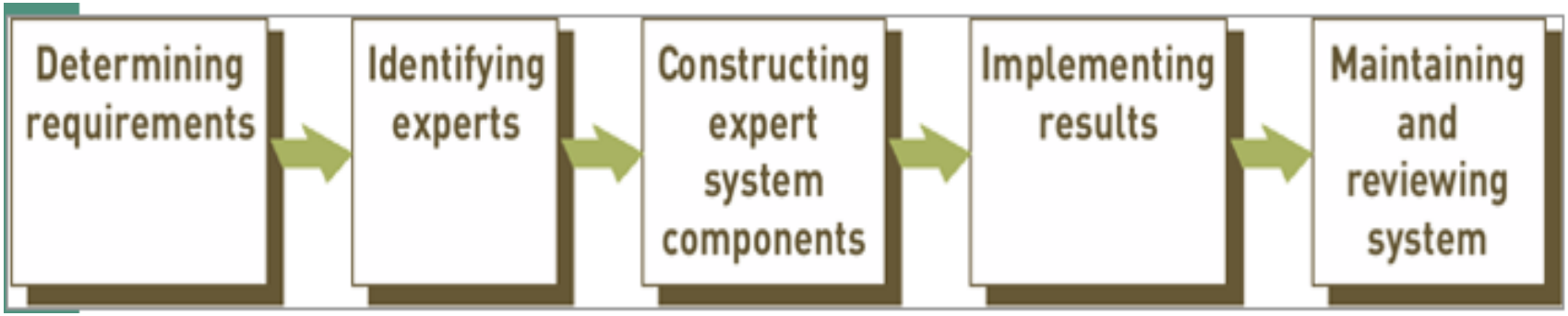


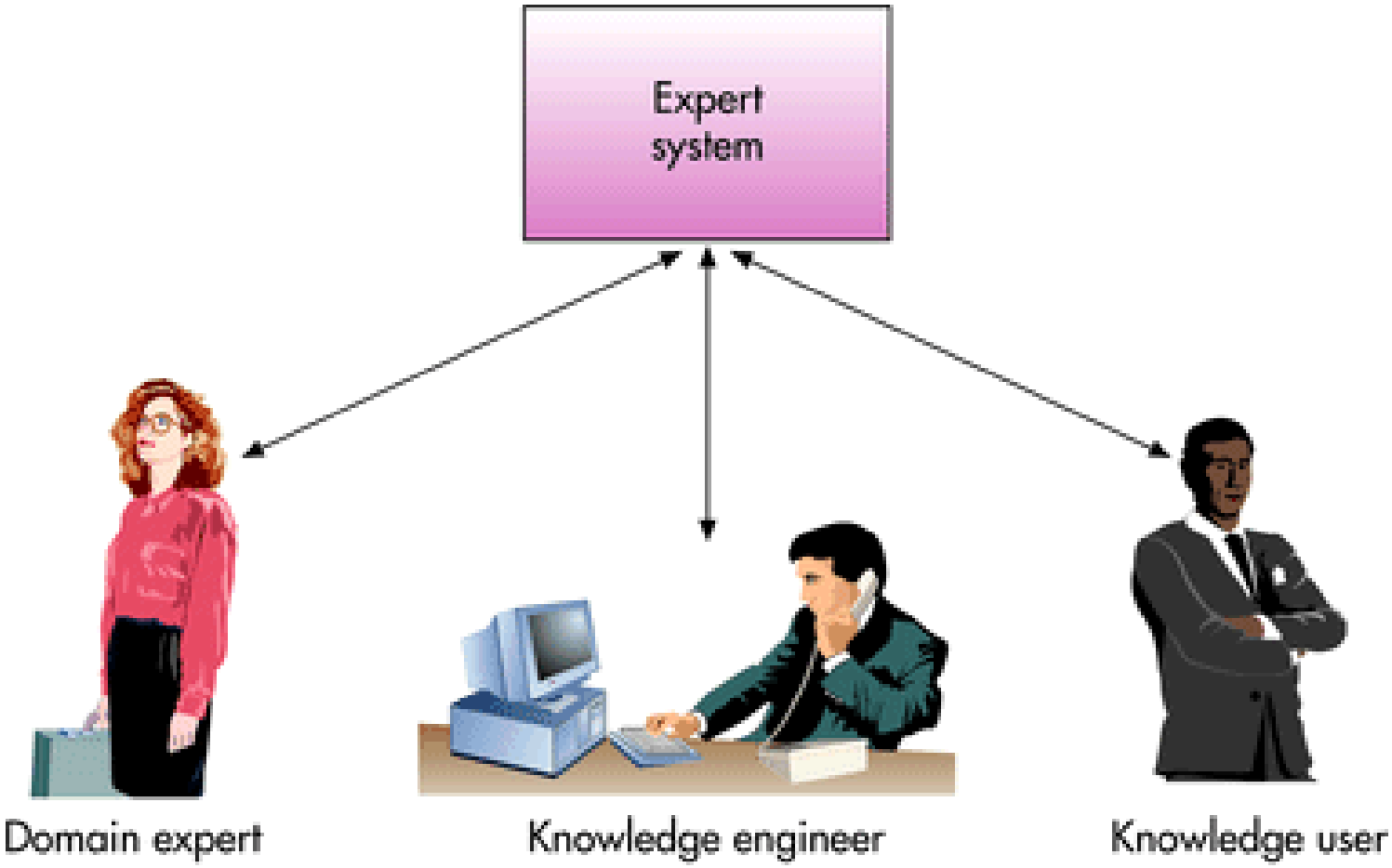


Expert System Development

- **Steps in the Expert System Development Process**



Participants in Expert System Development



Participants in Expert System Development

- **Domain**
  - The area of knowledge addressed by the expert system
- **Domain Expert**
  - The individual or group who has the expertise or knowledge one is trying to capture in the expert system
- **Knowledge Engineer**
  - An individual who has training or expertise in the design, development, implementation, and maintenance of an expert system
- **Knowledge User**
  - The individual or group who uses and benefits from the expert system