UNDERSTANDING KNOWLEDGE

Data*:* - It refers to raw facts or observations about business transactions or physical phenomena. It can take a variety of forms including: numeric, text, voice, images etc.

Information: - This is data that has been converted into meaningful or useful context i.e. processed data. Processing refers to sorting, classifying, comparing, summarizing etc

Knowledge: - A theoretical or practical understanding of a subject or domain acquired through education or experience. It provides a hire level meaning about data and information. In A.I. it refers to a collection of facts, procedures and rules specific to a domain, extracted from various sources.

- Those who possess knowledge are called experts.
- Anyone can be considered a domain expert if he or she has deep knowledge (of both facts and rules) and strong practical experience in a particular domain. The area of the domain may be limited.
- In general, an expert is a skilful person who can do things other people cannot.

Classification of Knowledge

- Knowledge can also be classified on the basis of whether it is *procedural, declarative, semantic,* or *episodic*.
    - *Procedural knowledge* represents the understanding of how to carry out a specific procedure.
    - *Declarative knowledge* is routine knowledge about which the expert is conscious. It is shallow knowledge that can be readily recalled since it consists of simple and uncomplicated information. This type of knowledge often resides in short-term memory.
    - *Semantic knowledge* is highly organized, ``chunked'' knowledge that resides mainly in long-term memory. Semantic knowledge can include major concepts, vocabulary, facts, and relationships.
    - *Episodic knowledge* represents the knowledge based on episodes (experimental information). Each episode is usually ``chunked'' in long-term memory.
- Another way of classifying knowledge is to find whether it is *tacit* or *explicit*
    - Tacit knowledge usually gets embedded in human mind through experience.
- Explicit knowledge is that which is codified and digitized in documents, books, reports, spreadsheets, memos etc.

KNOWLEDGE BASED SYSTEMS

KBS: A software system capable of supporting the explicit representation of knowledge in some specific competence domain and of exploiting it through appropriate reasoning mechanism in order to provide high-level problem-solving performance. Therefore a KBS is a specific, dedicated, computer-based problem-solver, able to face complex problems, which if solved by man, would require advanced reasoning capabilities such as

- Deduction,
- Hypothetical reasoning,
- Model based reasoning,
- Analogical reasoning,
- Learning,
- etc.

Knowledge based systems are developed for a specific task domain

Task domain: The area of human intellectual endeavor to be captured in an expert system

- **Task**: Some goal-oriented, problem-solving activity.
- **Domain**: The area within which the task is being performed.

Typical tasks include

- Diagnosis,
- Planning,
- Scheduling,
- Configuration and design etc.

When to Use KBS

Only certain types of applications are suited to KBS implementation. The following criteria are used in identifying suitable domains.

- Should be able to be reduced to a series of rules rather than mathematical formulae or equations i.e. KBS is not applicable if the problem involves a large number of complex calculations.
- It is well understood so that well-defined knowledge can be formulated and represented in computer form.
- Should not encompass problems which take too short (i.e. less than half an hour) or too long (longer than, say, one week) a time to solve.
- There should be a general agreement among recognized experts in the domain to be computerized.
- The knowledge within the problem domain should be sufficiently large to warrant the development of a KBS.
- Any application that requires access to specialist knowledge is a potential area for KBS technology.

Characteristics of KBS

- High-quality performance i.e. no matter how fast the system can solve a problem; the user will not be satisfied if the result is wrong! On the other hand, the speed of reaching a solution is very important. Even the most accurate decision or diagnosis may not be useful if it is too late to apply, for instance, in an emergency, when a patient dies or a nuclear power plant explodes.
- KBSs apply **heuristics** to guide the reasoning and thus reduce the search area for a solution.
- A unique feature of a KBS is its **explanation capability**. It enables the system to review its own reasoning and explain its decisions.
- KBS employ **symbolic reasoning** when solving a problem. Symbols are used to represent different types of knowledge such as facts, concepts and rules.
- We should be aware that an expert is only a human and thus can make mistakes, and therefore, a KBS built to perform at a human expert level also should be "allowed" to make mistakes.
- In KBS, knowledge is separated from its processing (knowledge base and inference engine are split up). A conventional program is a mixture of knowledge and the control structure to process this knowledge.
- When an expert system shell is used, a knowledge engineer or an expert simply enters rules in the knowledge base. Each new rule adds some new knowledge and makes the KBS smarter.

In summary the following table gives comparison between Human Experts, KBS and Conventional Programs

Human Experts	*KBS*	*Conventional Programs*
Use knowledge in the form of rules of thumb or heuristics to solve problems in a narrow domain.	Process knowledge expressed in the form of rules and use symbolic reasoning to solve problems in a *narrow domain*.	Process data and use algorithms, a series of well-defined operations, to solve general numerical problems.
In a human brain, knowledge exists in a compiled form.	Provide a *clear separation of knowledge from its processing*.	Do not separate knowledge from the control structure to process this knowledge.
Capable of explaining a line of reasoning and providing the details.	*Trace the rules fired* during a problem-solving session and *explain how* a particular conclusion was reached and *why* specific data was needed.	Do not explain how a particular result was obtained and why input data was needed.
Use inexact reasoning and can deal with incomplete, uncertain and fuzzy information.	Permit *inexact reasoning* and can deal with incomplete, uncertain and fuzzy data.	Work only on problems where data is complete and exact.
Can make mistakes when information is incomplete or fuzzy.	*Can make mistakes* when data is incomplete or fuzzy.	Provide no solution at all, or a wrong one, when data is incomplete or fuzzy.

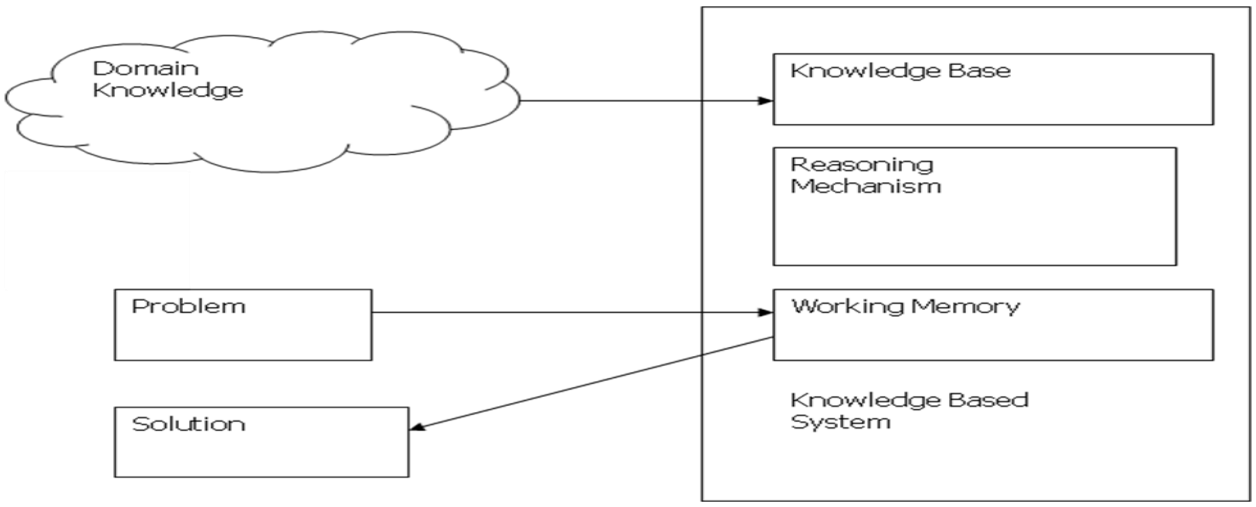
Enhance the quality of problem solving via years of learning and practical training. This process is slow, inefficient and expensive.	Enhance the quality of problem solving by adding new rules or adjusting old ones in the knowledge base. When new knowledge is acquired, *changes are easy* to accomplish.	Enhance the quality of problem solving by changing the program code, which affects both the knowledge and its processing, making changes difficult.

CONCEPTUAL STRUCTURE OF A KBS (CONCEPTUAL SCHEMA)

A knowledge-based system is generally composed of two parts:

- **Central Part (Kernel)**
  - This implements the basic problem solving capabilities of the knowledge-based system.
  - The kernel is in turn composed of three main components:
    - Knowledge base (KB)
    - Reasoning mechanism-inference engine.
    - Working memory
- **Peripheral Part**
  - This provides additional functions necessary for a practical and effective use of the knowledge based system e.g. **user interface**, **explanation system**, **learner**, **knowledge acquisition facility**, etc.

Diagram-Conceptual Schema



Components of A Knowledge Based System

- Based on the conceptual scheme above, a typical knowledge based system has the following components.
  - A knowledge base
  - An inference engine
  - A user interface
  - Explanation facilities
  - Learning facilities

KNOWLEDGE ENGINEERING

Knowledge Engineering refers to the discipline in which knowledge is integrated into a computer system to solve complex problems normally requiring high level of expertise, while Knowledge Engineers is an I.S. specialist responsible for the technical side of developing an expert system. This indicates a professional approach to development with respect to

- Qualifications
- Skills
- Personality
- Attributes

Knowledge engineering Activities

It consists of following five activities:

i). **Knowledge Acquisition: -** Involves extracting knowledge from various sources

ii). **Knowledge Validation: -** The knowledge is validated and verified until it's quality is acceptable. Test cases results are usually shown to the expert to verify the accuracy of the expert system.

iii). **Knowledge Representation: -** Designing and implementing programs for holding the knowledge in the form of a knowledge base

iv). **Inferencing: -** Involves the design of a software to enable the computer to make inferences based on the knowledge and specific facts of the problem.

v). **Explanation facility: -** Designing and implementing programs to explain questions such as how and why.

TASKS OF KNOWLEDGE ENGINEERS

- Extracting knowledge from people. (KA)
- Representing knowledge in some form. (KR)
- Including knowledge in a computer program which makes use of the knowledge.
- Validating the software system produced.

TYPES OF KNOWLEDGE BASED SYSTEMS

In general, KBS are classified according to the human behavior they attempt to mimic.

Expert Systems

- They model the higher order cognitive functions of the human mind
- They are used to mimic the decision making process of the human mind.

Neural Networks

- They model the brain at the biological level
- They are adept at pattern recognition and introduce the concept of learning into computing.

Case Based Reasoning

- Models the human ability to learn from past experience
- They borrow from the legal system where past cases are used as a basis for making decisions in the present cases.