Artificial Intelligence

Lecture - 8

Knowledge Representation

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Lecture Outlines

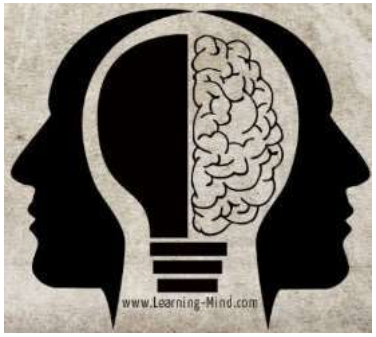
- Knowledge
- Knowledge with AI
- Knowledge Engineering
- Knowledge Acquisition
- Sources of Knowledge
- Inductive vs Deductive Reasoning
- …

What is Knowledge?

- *Knowledge is a general term.* Knowledge is a description of the world.
- Knowledge is an abstract term that attempts to capture an individual's understanding of a given subject.
- In the world of intelligent systems the domain-specific knowledge is captured. Domain is a well-focused subject area.
- Cognitive psychologists have formed a number of theories to explain how humans solve problems. This work uncovered the types of knowledge humans commonly use, how they mentally organize this knowledge, and how they use it efficiently to solve a problem.

Knowledge with AI…

- **Intelligence requires knowledge**.
- But knowledge possesses some less desirable properties, which includes the following:
  - It is voluminous
  - It is hard to characterize accurately
  - It is constantly changing
  - It differs from data by being organized
- There are many ways of categorizing knowledge types:
  - **induced;** It means *to cause or influence something* or *to infer*.
  - **deduced;** It means *to arrive at a conclusion through logic and reasoning*.



> *Induce* relates to *induction*;
> *deduce* related to *deduction*.

- A machine may store knowledge without necessarily processing intelligence; **an intelligent machine that had no knowledge is impossibility**.
- Thus, a machine can be imbued with knowledge is fundamental to all aspects of AI.

Knowledge with AI

- Key issues confronting the designer of an AI system are:
  - Knowledge acquisition
  - **Knowledge representation**
  - Knowledge manipulation
- **Knowledge acquisition:** the transfer and transformation of potential problem-solving expertise from some knowledge source to a program. The process referred to as expertise transfer involves the extraction of knowledge from a variety of sources and its representation.
- **Knowledge manipulation:** It occurs primarily through inference and deduction and the often search-oriented control strategy or inference engine (which determines the items of knowledge to be accessed, the deductions to be made, and order of steps to be used).
- **Knowledge representation**

Knowledge Engineering

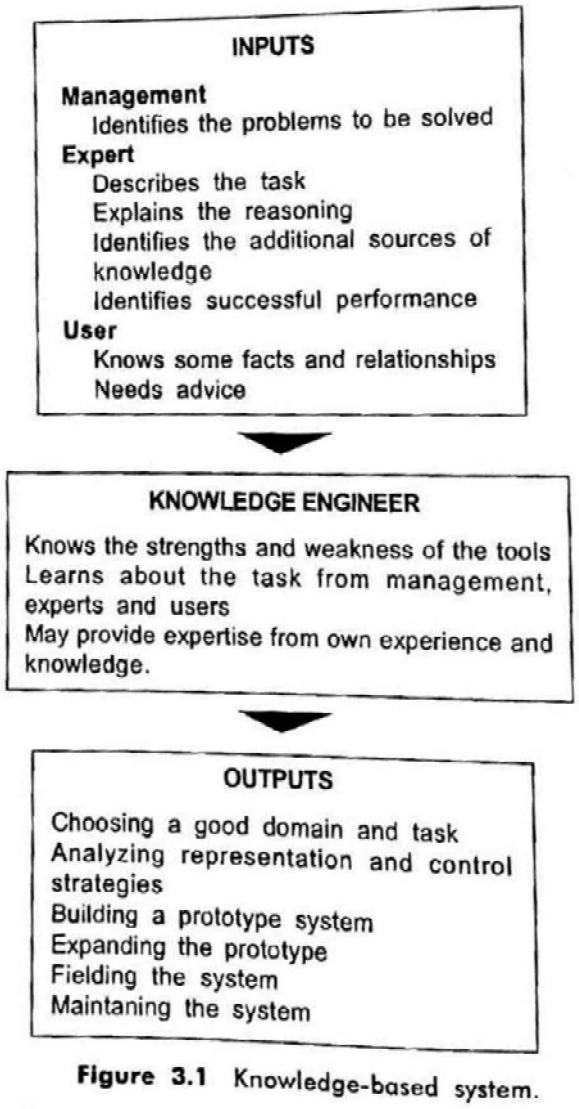
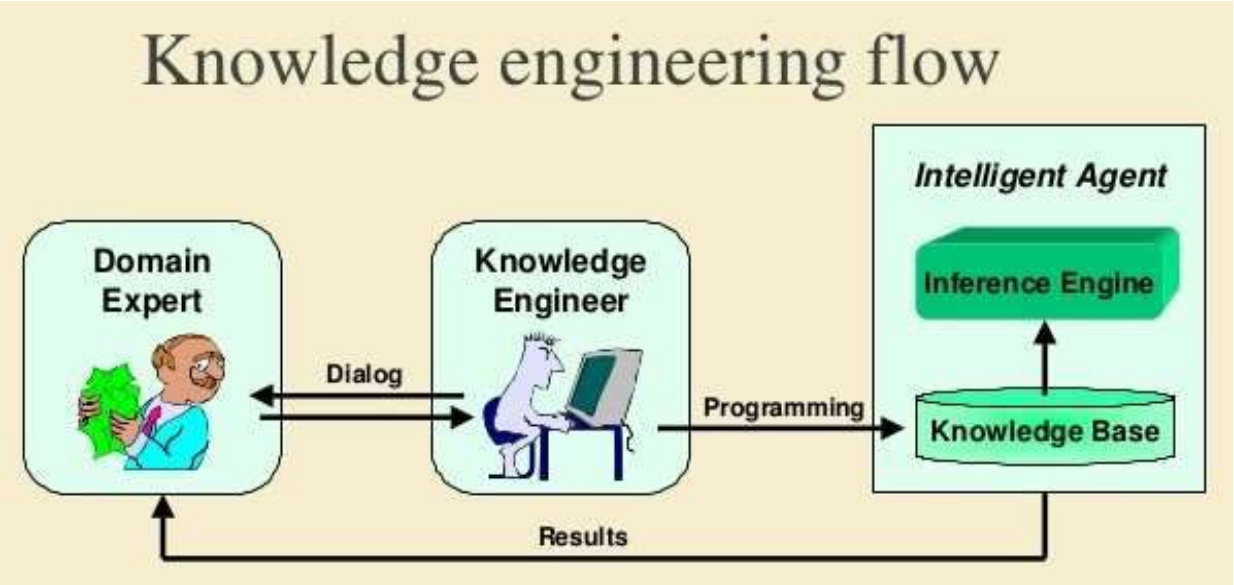


Figure 3.1 Knowledge-based system.

- **The field of** KE can be defined as the process of:
  - assessing problems,
  - acquiring knowledge and
  - building knowledge-based systems.



Knowledge Acquisition

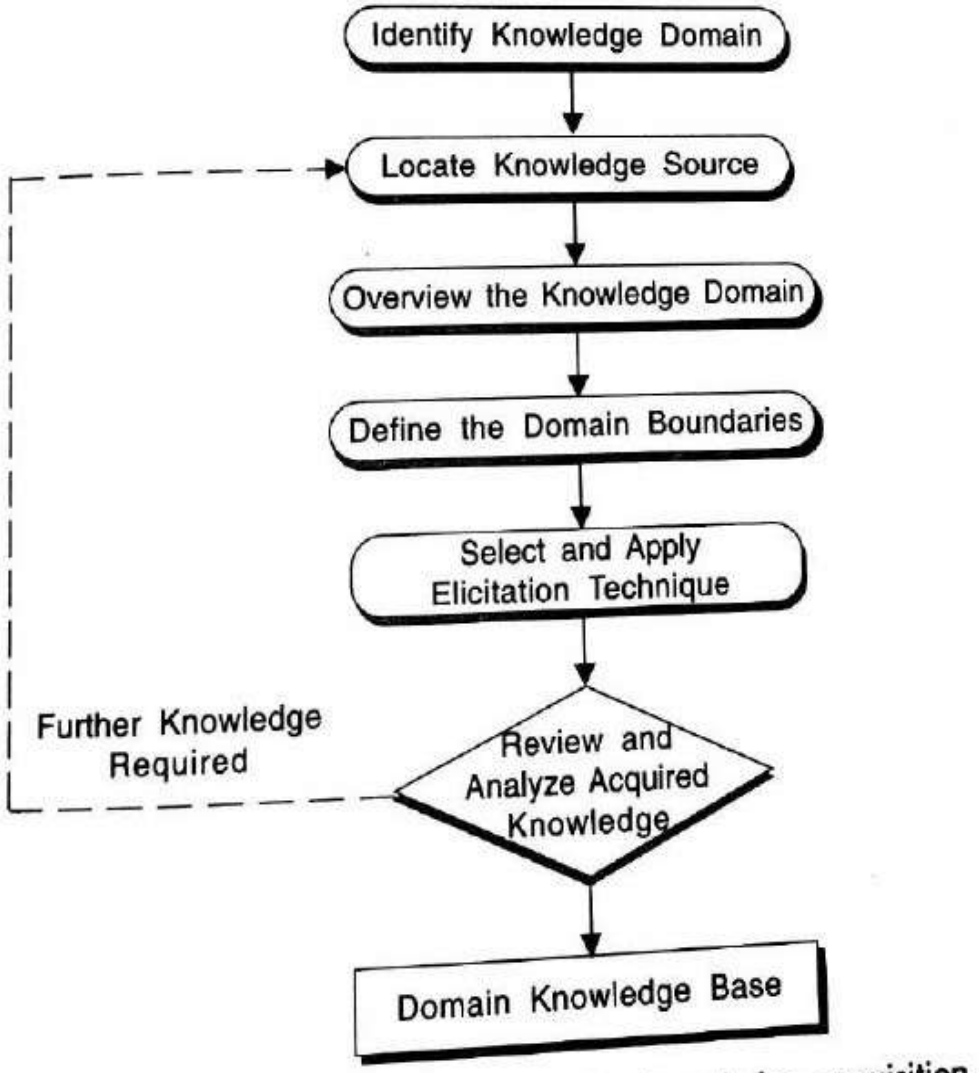
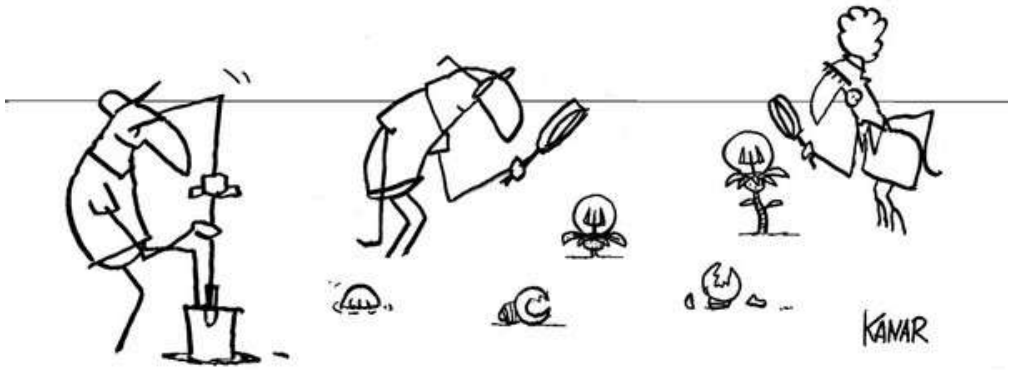


Figure 3.2 Procedure for knowledge acquisition.

Sources of Knowledge…

- Three main sources of knowledge:
  - Literature
  - Experts
  - Examples
- Three different bases of knowledge:
  - Scientific laws
  - Experience
  - Models



Sources of Knowledge

- Few engineering problems (KB systems) are purely heuristic and the following knowledge sources in addition to the human expert must be investigated:
  - Expert opinion
  - Historic data
  - Codes of practice
  - Standard engineering procedures
  - Experimental data
  - Technical literature
    - Textbooks
    - Journals
    - Manuals
    - Manufacturers information
  - Established engineering equations

What to Represent?

- What kinds of knowledge need to be represented in AI system?
  - **Objects:** Facts about objects in our world domain.
  - **Events:** Actions that occur in our world.
  - **Performance:** A behavior.
  - **Meta-knowledge:** Knowledge about what we know.
- To solve AI problems, two entities to deal with:
  - **Facts:** Truths about the real world and what we represent.
  - **Representation of the facts:** Which we manipulate.
- We can structure these entities at two levels:
  - **The knowledge level**, at which facts are described.
  - **The symbol level**, at which representation of objects are defined in terms of symbols that can be manipulated in programs.

Why and where to use?

- Where knowledge is used in AI systems:
  - **Learning:** Means acquiring knowledge.
  - **Retrieval:** The representation scheme used can have critical effect on the efficiency of the method.
  - **Reasoning:** Infer facts from existing data.

Inductive vs Deductive *reasoning*…

- *Inductive and deductive reasoning are the two ways* in which we think and learn, helping us to develop our knowledge of the world.

- **Deductive reasoning** is the most solid form of reasoning which gives us concrete conclusions as to whether our hypothesis was valid or not. When we use this form of reasoning, we look for clear information, facts, and evidence on which to base the next step of the process.
- Example:
  - *Premise 1:* Socrates is a man
  - *Premise 2:* All men are mortal
  - *Conclusion:* Socrates is mortal

Inductive vs Deductive *reasoning*…

- **Inductive reasoning** is the exact opposite of deductive reasoning because it does not rely on solid evidence to form conclusions.
- When we use inductive reasoning, the propositions used are strong evidence for a certain conclusion, but a certain amount of guessing is necessary. By using inductive reasoning, we assume a certain conclusion to be true, but we cannot prove it definitively. The conclusion can even be false if all the propositions are true.
- It is difficult to use in scientific exploration; but inductive reasoning is most used in real life reasoning rather than in science or fields where conclusions must be clearly valid.
- Example:
  - *Premise:* Sarah leaves the house at 7.30 and she arrives late for work
  - *Conclusion:* Sarah concludes that every time she leaves the house at 7.30 she will be late for work.
  - This conclusion, however, does not always follow from Sarah leaving the house at 7.30. Sarah's being late may depend on other factors such as traffic conditions or the weather. It does not always follow that Sarah will be late every single time she leaves the house at 7.30.

Inductive vs Deductive *reasoning*…

- Key Differences between Inductive and Deductive Reasoning:
  - Deductive reasoning depends on facts and evidence; inductive reasoning looks at patterns.
  - Deductive reasoning provides solid, repeatable conclusions. Inductive reasoning makes general, most probable conclusions about evidence that has been observed.
  - Inductive reasoning may not always have strong conclusions on the validity of its hypothesis. Deductive reasoning will always have strong conclusions as to whether the premise is valid or invalid.
  - Inductive and deductive reasoning are two important kinds of logic that we use in everyday life. They are very different from one another and therefore give different kinds of conclusions.
  - **However, it is important to understand both to understand how we have come to a conclusion and the knowledge we obtain.**

Knowledge Representation

TO BE CONTINUED…