Artificial Intelligence

Lecture 31

Experts Systems in AI

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Lecture Outlines

- **Structure of an Expert System**
  - **To be ended**
- **Expertise and Expert**
- **Benefits and Limitations of Expert System**
- **Applications of Expert System**

The User Interface...

- The **user interface** provides interaction between user of the ES and the ES itself. It is generally Natural Language Processing so as to be used by the user who is well-versed in the task domain.

- The user of the ES need not be necessarily an expert in Artificial Intelligence. The **user interface** is the part of the system which takes in the user's query in a readable form and passes it to the inference engine.
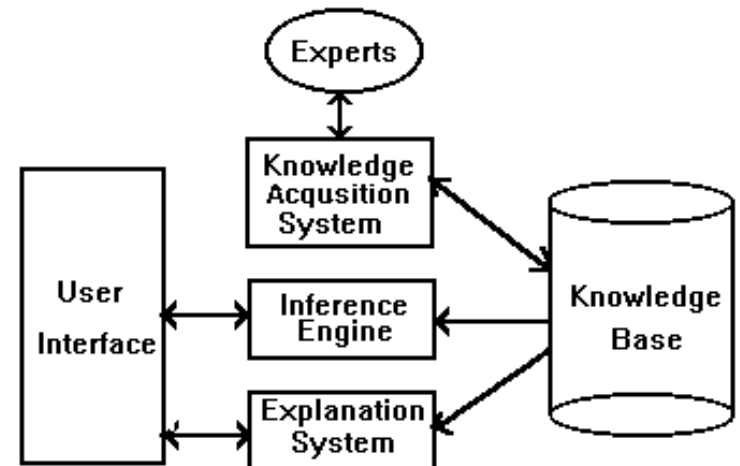
The User Interface

- An ES may obtain input from an online data source (database, text file, web page, etc.). It explains how the ES has arrived at a particular recommendation. The explanation may appear in the following forms –
    - Natural language displayed on screen.
    - Verbal narrations in natural language.
    - Listing of rule numbers displayed on the screen.
- Requirements of Efficient ES User Interface:
    - It should help users to accomplish their goals in shortest possible way.
    - It should be designed to work for user's existing or desired work practices.
    - Its technology should be adaptable to user's requirements; not the other way round.
    - It should make efficient use of user input.

Explanation System

- If the user is to have confidence in the output from an ES, it will be important for the ES to have ways of explaining how its conclusions were arrived at.

It will be useful to allow the user to ask

- In response to a question from the ES:
  WHY (did you ask that question)?

- After a conclusion has been presented:
  HOW (did you reach that conclusion)?

Blackboard

- This just means a place where temporary working may be stored, where it is accessible to various component parts of a large ES.

- This may include, for example, a (dynamic) 'agenda' --- a list of tasks to be done (by the ES).

- It may also include a list of intermediate conclusions, or results of searches, in order to avoid duplication of effort.

- Not all ES will use (or need) a blackboard.

Knowledge Refinement Subsystem

- Knowledge refinement means analyzing experience and adjusting the body of stored knowledge as a result.

- People do this all the time, and a good ES can do it too.

- This may consist merely of saving previous results for future reference, to avoid repeating searches or computations.

- OR it may involve feedback from the user, e.g.

- You (the ES) gave me this advice and it was BAD/GOOD

Desirable Features of an Expert System

- Dealing with Uncertainty
- Explanation
- Ease of Modification
- Transportability
- Adaptive learning

Limitations of expert systems...

- No technology can offer easy and complete solution. Large systems are costly, require significant development time, and computer resources.

- ESs have their limitations which include –
  - Limitations of the technology
  - Difficult knowledge acquisition, Knowledge not always readily available
  - ES are difficult to maintain
  - Only work well in narrow domains
  - High development costs
  - Can not properly learn from experience
  - Not all problems are suitable

Limitations of expert systems

- **Limitations of expert systems compared to human experts:**
    - A human expert is aware of the cultural factors.
    - Human experts are generally aware of the scope and limitations of their knowledge.
    - When faced with a new situation a human expert may develop a new and brilliant approach to solving the problem.
    - People wish to communicate with other people.
    - Human experts are more flexible.

Expertise and Expert...

- **What is Expertise?**
- **Expertise** is task-specific knowledge acquired and developed from training, reading and experience.
- It may consist of
    - Facts, theories, rules, procedures.
    - Guidelines (heuristics) based on intuition
    - Strategies or approaches
    - Meta knowledge
- Most organizations recognize the value of expertise but have difficulty in controlling or quantifying it.
- All individuals have expertise, but it is often unconscious, and there are different levels of expertise.

Expertise and Expert...

- **What is an Expert?**
- **Experts** are people who have uncommon expertise. To be useful, experts must have other qualities also. They should be able to
    - Recognize and formulate problems
    - Explain
    - Organize knowledge (make connections)
    - Determine relevance
    - Solve problems
- We may regard such abilities as desirable in programs or systems which aim to be 'expert'

Expertise and Expert

- **What are the Roles of an Expert?**
  - **Recognize, formulate and solve problems**
  - Solve complex problems easily, in a simpler way.
  - Ask appropriate questions (based on external stimuli - sight, sound etc).
  - Reformulate questions to obtain answers.
  - Explain why they asked the question, and why conclusion reached.
  - Judge the reliability of their own conclusions.
  - Talk easily with other experts in their field, and learn from experience.
  - Use their knowledge efficiently
  - Transfer knowledge from one domain to another.
  - Reason on many levels and use a variety of tools such as heuristics, mathematical models and detailed simulations.

Expert System Technology...

- There are several levels of ES technologies available. Expert systems technologies include –

- **Expert System Development Environment** – The ES development environment includes hardware and software tools. They are –
    - Workstations, minicomputers, mainframes.
    - High level Symbolic Programming Languages such as **LIS**t **P**rogramming (LISP) and **PRO**gramming in **LOG**ic (PROLOG).
    - Large databases.

Expert System Technology

- **Tools** – They reduce the effort and cost involved in developing an expert system to large extent.
  - Powerful editors and debugging tools with multi-windows.
  - They provide rapid prototyping
  - Have Inbuilt definitions of model, knowledge representation, and inference design.
- **Shells** – A shell is nothing but an expert system without knowledge base. A shell provides the developers with knowledge acquisition, inference engine, user interface, and explanation facility. For example, few shells are given below –
  - Java Expert System Shell (JESS) that provides fully developed Java API for creating an expert system.
  - *Vidwan*, a shell developed at the National Centre for Software Technology, Mumbai in 1993. It enables knowledge encoding in the form of IF-THEN rules.

Development of Expert Systems: General Steps...

- The process of ES development is iterative. Steps in developing the ES include –

   1. **Identify Problem Domain**
   2. **Design the System**
   3. **Develop the Prototype**
   4. **Test and Refine the Prototype**
   5. **Develop and Complete the ES**
   6. **Maintain the System**

Development of Expert Systems: General Steps...

- **Identify Problem Domain**
  - The problem must be suitable for an expert system to solve it.
  - Find the experts in task domain for the ES project.
  - Establish cost-effectiveness of the system.

- **Design the System**
  - Identify the ES Technology
  - Know and establish the degree of integration with the other systems and databases.
  - Realize how the concepts can represent the domain knowledge best.

- **Develop the Prototype**
  - From Knowledge Base: The knowledge engineer works to –
  - Acquire domain knowledge from the expert.
  - Represent it in the form of If-THEN-ELSE rules.

Development of Expert Systems: General Steps

- **Test and Refine the Prototype**
  - The knowledge engineer uses sample cases to test the prototype for any deficiencies in performance.
  - End users test the prototypes of the ES.

- **Develop and Complete the ES**
  - Test and ensure the interaction of the ES with all elements of its environment, including end users, databases, and other information systems.
  - Document the ES project well.
  - Train the user to use ES.

- **Maintain the System**
  - Keep the knowledge base up-to-date by regular review and update.
  - Cater for new interfaces with other information systems, as those systems evolve.
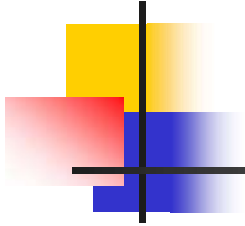
Benefits of expert systems

- **Availability**
  - They are easily available due to mass production of software.
- **Less Production Cost**
  - Production cost is reasonable. This makes them affordable.
- **Speed**
  - They offer great speed. They reduce the amount of work an individual puts in.
- **Less Error Rate**
  - Error rate is low as compared to human errors.
- **Reducing Risk**
  - They can work in the environment dangerous to humans.
- **Steady response**
  - They work steadily without getting motional, tensed or fatigued.

Applications of Expert System

- The following table shows where ES can be applied.

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

Expert Systems

THE END