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Punjab Technical University

B.Tech. – Computer Science & Engineering (Sem. – 7th)

Expert System

Subject Code: CS-424

Q:-1) What is Expert System?

Ans:-1) **Expert System**

Artificial Intelligence based system that converts the knowledge of an expert in a specific subject into a software code. This code can be merged with other such codes (based on the knowledge of other experts) and used for answering questions (queries) submitted through a computer.

Expert systems typically consist of three parts:

(1) **Knowledge Base** which contains the information acquired by interviewing experts, and logic rules that govern how that information is applied.

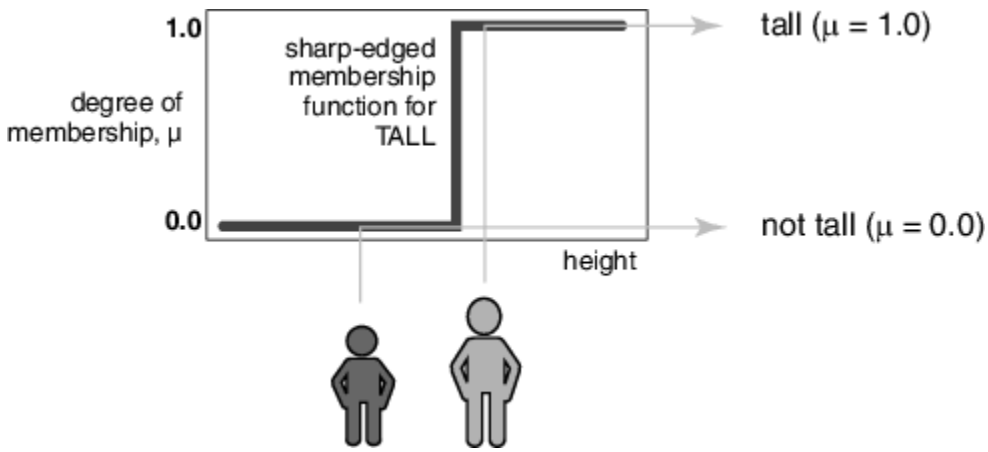
(2) **Inference Engine** that interprets the submitted problem against the rules and logic of information stored in the knowledge base.

(3) **Interface** that allows the user to express the problem in a human language such as English.

Q:-2) Define Fuzzy Sets? (May 2012)

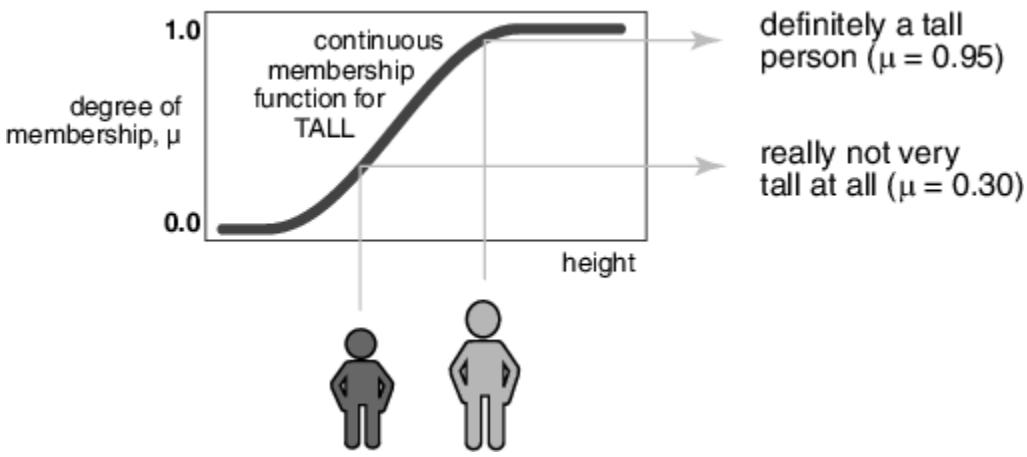
Ans:-2) **Fuzzy Sets**

In mathematics a set, by definition, is a collection of things that belong to some definition. Any item either belongs to that set or does not belong to that set. Let us look at another example; the set of tall men. We shall say that people taller than or equal to 6 feet are tall. This set can be represented graphically as follows:



The function shown above describes the membership of the 'tall' set, you are either in it or you are not in it. This sharp edged membership functions works nicely for binary operations and mathematics, but it does not work as nicely in describing the real world. The membership function makes no distinction between somebody who is 6'1" and someone who is 7'1", they are both simply tall. Clearly there is a significant difference between the two heights. The other side of this lack of distinction is the difference between a 5'11" and 6' man. This is only a difference of one inch; however this membership function just says one is tall and the other is not tall.

The fuzzy set approach to the set of tall men provides a much better representation of the tallness of a person. The set, shown below, is defined by a continuously inclining function.



The membership function defines the fuzzy set for the possible values underneath of it on the horizontal axis. The vertical axis, on a scale of 0 to 1, provides the membership value of the height in the fuzzy set. So for the two people shown above the first person has a membership of 0.3 and so is not very tall. The second person has a membership of 0.95 and so he is definitely tall. He does not, however, belong to the set of tall men in the way that bivalent sets work; he has a high degree of membership in the fuzzy set of tall men.

Q:-3) What is Quantifiers? (May 2012)

Ans:-3) **Quantifiers**

To express the truth value of a predicate with respect to a set of objects, we use **quantifiers.** Quantifiers refer to quantities such as some, all, none. They tell us for how many elements a given predicate is true.

Here 'how many" is not a particular number. A quantified statement tells us if the predicate is true for all the elements in the set, or for some of the elements, or for none of the elements.

1. **Universal quantifiers (∀)**

   Consider the statement: All human beings are mortal.

   Here, the property "being mortal" refers to **all** human beings.

   The symbol ∀ is used to denote the quantity "all" of objects for which a given predicate is true. Since it represents quantity, it is called **quantifier**. Since the quantity is "all" (the property is true for all objects) it is called **universal quantifier.**

   We write:

   ∀ **x** ∈ S, x is mortal, or ∀ **x** ∈ S mortal(x)
   where S is the set of all human beings.

   In English the quantity **all** can be represented in several ways: *"for all, "all", "each", "every".*

   When we **quantify universally** a predicate, we **get a statement** (can be true or false)

2. **Existential quantifiers (∃)**

   Consider the statements:

   Some people are students at Simpson College.
   There are some students at Simpson.
   There exists at least one student at Simpson College.

All these statements are equivalent in that they claim the existence of at least one
object for which the predicate simpson_student(x) is true.

The symbol ∃ is used to denote the quantity "at least one" of objects for which a given predicate is true.
Since it claims the existence of an object with a given property, it is called **existential quantifier**.

We write:

∃ a person **s**, such that **s** is a student in Simpson College.

or:

∃ s ∈ S, such that Q(s),
where S is the set of all people, Q(s) is "being a student in Simpson College."

Q:-4) State some Advantages of Expert System? (May 2012)

Ans:-4) **Advantages of Expert Systems**

- Expert advice available all the time
- Knowledge of expert staff can be captured to some extent before they move on.
- Can be used as a training aid to increase the expertise of staff
- Does not get tired or overworked.
- Efficient way of getting answers as it does not involve additional help staff e.g. automated help systems
- Natural language interface would make the expert system more human friendly

Q:-5) Define Fuzzy Logic? (May 2011)

Ans:-5) **Fuzzy Logic**

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based. The idea of fuzzy logic was first advanced by Dr. Lotfi Zadeh of the University of California at Berkeley in the 1960s. Dr. Zadeh was working on the problem of computer understanding of natural language. Natural language (like most other activities in life and indeed the universe) is not easily translated into the absolute terms of 0 and 1. (Whether everything is ultimately describable in binary terms is a philosophical question worth pursuing, but in practice much data we might want to feed a computer is in some state in between and so, frequently, are the results of computing.)

Fuzzy logic includes 0 and 1 as extreme cases of truth (or "the state of matters" or "fact") but also includes the various states of truth in between so that, for example, the result of a comparison between two things could be not "tall" or "short" but ".38 of tallness."

Fuzzy logic seems closer to the way our brains work. We aggregate data and form a number of partial truths which we aggregate further into higher truths which in turn, when certain thresholds are exceeded, cause certain further results such as motor reaction. A similar kind of process is used in artificial computer neural network and expert systems..

It may help to see fuzzy logic as the way reasoning really works and binary or Boolean logic is simply a special case of it.

Q:-6) Write a Short Note on MYCIN?

Ans:-6) **MYCIN**

1. MYCIN is an expert system for treating blood infections.
2. MYCIN would attempt to diagnose patients based on reported symptoms and medical test results.
3. Its job was to determine the nature of disease and recommend treatment for certain blood infections.
4. MYCIN represented its knowledge as a set of IF-THEN rules with certainty factors.
5. MYCIN was written in LISP and its rule is formally represented as LISP expression.
6. MYCIN is a goal -directed system, using the basic backward chaining reasoning strategy.
7. Useful for junior or non specialized doctors.
8. Never actually used in practice due to ethical and legal issues related to the use of computers in medicine.

It has following organizational features-

1. **Knowledge Representation:** Production rules implemented in LISP.
2. **Reasoning**: Background chaining, goal driven reasoning, uses certainty factors to reason with uncertain information.
3. **Heuristic**: MYCIN examines each candidate diagnosis in a depth first manner.

   Heuristic are used to limit the search , including checking all premise of a possible rule to see if any one of these is known to be false.
4. **Dialog explanation:** It is computer controlled. Explanations are generated by tracing back through the rules which have been triggered. Both "how" and "why" explanations are supported.

Q:-7) Explain Various Stages in Knowledge Acquisition.

Ans:-7) **Knowledge acquisition** is the process of extracting, structuring and organizing knowledge from one source, usually human experts, so it can be used in software such as an ES. This is often the major obstacle in building an ES.

There are three main topic areas central to knowledge acquisition that requires consideration in all ES projects. First, the domain must be evaluated to determine if the type of knowledge in the domain is suitable for an ES. Second, the source of expertise must be identified and evaluated to ensure that the specific level of knowledge required by the project is provided. Third, if the major source of expertise is a person, the specific knowledge acquisition techniques and participants need to be identified.

General suggestions about the knowledge acquisition process are summarized in rough chronological order below:

1. Observe the person solving real problems.
2. Through discussions, identify the kinds of data, knowledge and procedures required to solve different types of problems.
3. Build scenarios with the expert that can be associated with different problem types.
4. Have the expert solve a series of problems verbally and ask the rationale behind each step.
5. Develop rules based on the interviews and solve the problems with them.
6. Have the expert review the rules and the general problem solving procedure.
7. Compare the responses of outside experts to a set of scenarios obtained from the project's expert and the ES.

Q:-8) Explain Components of Expert System.

Ans:-8) Components of Expert System

The User Interface

The user interface is the means of communication between a user and the expert systems problem-solving processes. A good expert system is not very useful unless it has an effective interface. It has to be able to accept the queries or instructions in a form that the user enters and translate them into

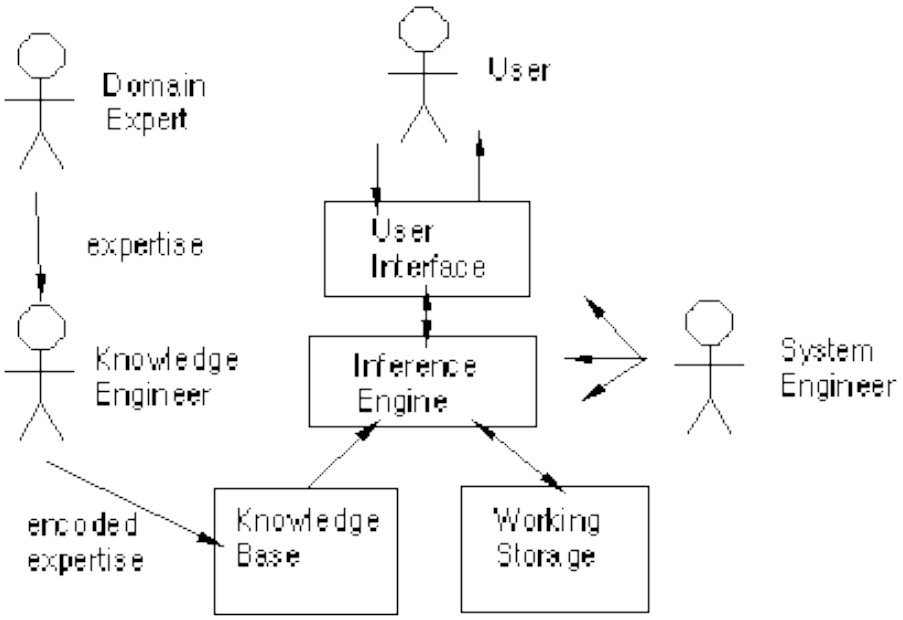
working instructions for the rest of the system. It also has to be able to translate the answers, produced by the system, into a form that the user can understand. Careful attention should be given to the screen design in order to make the expert system appear 'friendly' to the user.

The Knowledge Base

The knowledge base stores all the facts and rules about a particular problem domain. It makes these available to the inference engine in a form that it can use. The facts may be in the form of background information built into the system or facts that are input by the user during a consultation. The rules include both the production rules that apply to the domain of the expert system and the heuristics or rules-of-thumb that are provided by the domain expert in order to make the system find solutions more efficiently by taking short cuts.

The Shell or Inference Engine

The inference engine is the program that locates the appropriate knowledge in the knowledge base, and infers new knowledge by applying logical processing and problem-solving strategies.



Q:-9) Show the Expert System Shell. (Dec. 2011)

Ans:-9) Expert System Shell

The E.S shell simplifies the process of creating a knowledge base. It is the shell that actually processes the information entered by a user relates it to the concepts contained in the knowledge base and provides an assessment or solution for a particular problem. Thus E.S shell provides a layer between the user interface and the computer O.S to manage the input and output of the data. It also manipulates the information provided by the user in conjunction with the knowledge base to arrive at a particular conclusion.

Q:-10) What is a Fuzzy Expert System?

Ans:-10) A **Fuzzy Expert System** is an expert system that uses fuzzy logic instead of Boolean logic. In other words, a fuzzy expert system is a collection of membership functions and rules that are used to reason about data.

Unlike conventional expert systems, which are mainly symbolic reasoning engines, fuzzy expert systems are oriented toward numerical processing.

The rules in a fuzzy expert system are usually of a form similar to the following:

if x is low and y is high then z = medium

where x and y are input variables (names for know data values), z is an output variable (a name for a data value to be computed), low is a membership function (fuzzy subset) defined on x, high is a membership function defined on y, and medium is a membership function defined on z. The part of the rule between the "if" and "then" is the rule's premise or antecedent. This is a fuzzy logic expression that describes to what degree the rule is applicable. The part of the rule following the "then" is the rule's _conclusion_ or _consequent_. This part of the rule assigns a membership function to each of one or more output variables. Most tools for working with fuzzy expert systems allow more than one conclusion per rule.

A typical fuzzy expert system has more than one rule. The entire group of rules is collectively known as a Rule base or knowledge base.

Q:-11) Explain various components of an Expert System and the role of each one of these?

Ans:-11) **Basic Components:**

User interface:

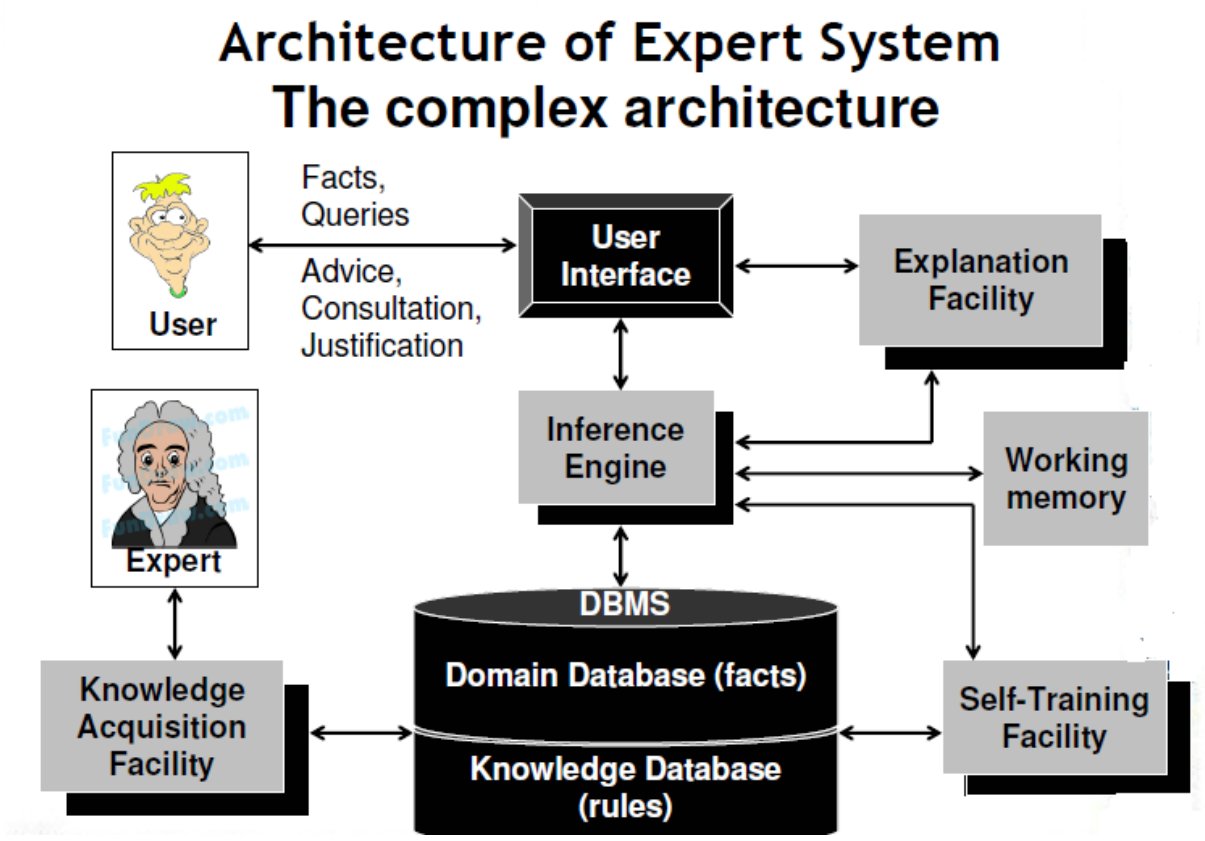
- A Software that provides for the communication exchange between user and the system
- User: input facts, ask the system
- System: ask new facts, give answer or advice

Knowledge base:

- Contains expert-level knowledge on a particular subject
- Stored in a knowledge representational form

Inference engine:

- A software that performs the inference reasoning tasks
- It uses the knowledge in the knowledge base and
- information provided by the user to infer new knowledge



The Other Components

Working memory:

- A global database of facts used by the rules

Knowledge database:

- Contains rules about the behavior of the elements of a particular subject

Domain database:

- Contains facts about the ES's subject

Explanation facility:

- Explain the reasoning of the system to a user

Knowledge acquisition facility:

- An automatic way for the expert to enter knowledge in the system rather than by having the knowledge engineer explicitly code the knowledge

Self-training facility:

- An automatic way of the system to add new facts and/or rules in the system

Q:-12) What is Artificial Neural Network?

Ans:-12) An **Artificial Neural Network** is a computational simulation of a biological neural network. These models mimic the real life behaviour of neurons and the electrical messages they produce between input (such as from the eyes or nerve endings in the hand), processing by the brain and the final output from the brain (such as reacting to light or from sensing touch or heat). There are other ANNs which are adaptive systems used to model things such as environments and population.

The systems can be hardware and software based specifically built systems or purely software based and run in computer models.

Q:-13) What is Shell?

Ans:-13) A **Shell** is a special purpose tool designed based on the requirements of particular applications. User should supply the knowledge base to the shell. Example for the shell is *EMYCIN* (Empty MYCIN) shell. Shell manages the input and output. It processes the information given by the user, relates it to the concepts contained in the knowledge base, and provides solution for a particular problem.