

# EXPERT SYSTEMS

## REFERENCES:

<http://www.geocities.com/siliconvalley/lakes/6007/Expert.htm>  
<http://www.sci.brooklyn.cuny.edu/~parsons/courses/716-spring-2003/notes/lect15.html>

# Expert Systems

- *An expert system acts or behaves like a human expert in a field or area.*
- *Expert systems can be used to solve problems in various fields or disciplines, and can assist in all stages of problem-solving.*

# Expert Systems Capabilities

★ *Expert systems capabilities include:*

- *Superior problem solving.*
- *Ability to save and apply knowledge and experience to problems.*
- *Reduced response time for complex problems.*
- *The ability to look at problems from a variety of perspectives.*

# Expert Systems Characteristics

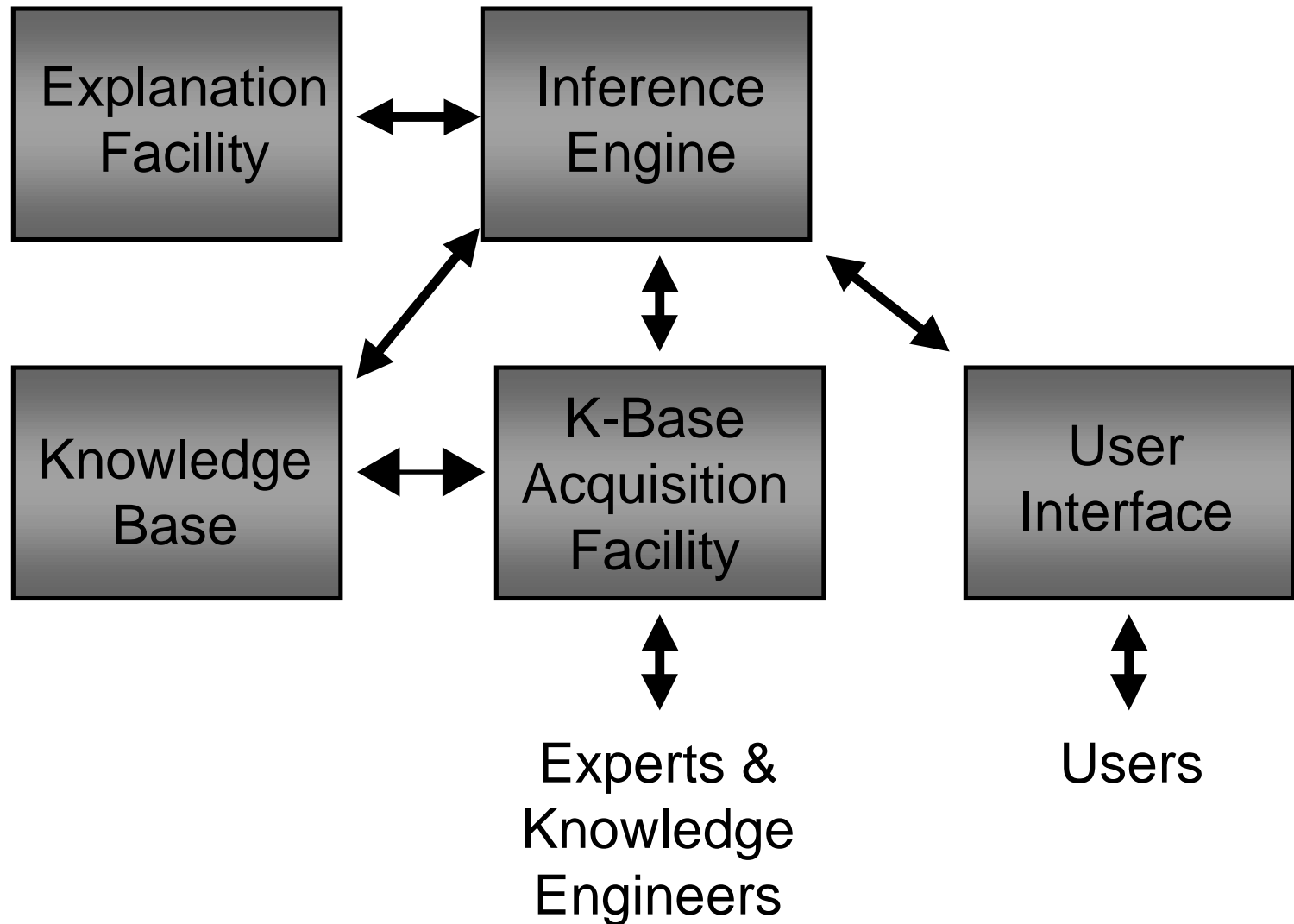
- ★ *Manipulate symbolic information and draw conclusions.*
- ★ *Provide portable knowledge.*
- ★ *Can deal with uncertainty.*
- ★ *Draw conclusions from complex relationships.*
- ★ *Explain their reasoning or suggested decisions.*
- ★ *Display “intelligent” behavior.*

# Limits of Expert Systems

★ *Some of the drawbacks of expert systems include:*

- *Limited to relatively narrow problems.*
- *Cannot readily deal with “mixed” knowledge.*
- *Cannot refine its own knowledge base.*
  - › *In other words, it cannot learn.*

# Expert System Components



# The Knowledge Base

- ★ *The knowledge base stores all relevant information, data, rules, cases, and relationships used by the expert system.*
- ★ *A knowledge base can combine the knowledge of multiple human experts.*

# Knowledge Base Contents

- ★ *A **rule** is a conditional statement that links given conditions to actions or outcomes.*
- ★ *A **frame** is another approach used to capture and store knowledge in a knowledge base. It relates an object or item to various facts or values.*



# Knowledge Base Contents

- ★ *Fuzzy logic* - entails dealing with ambiguous criteria or probabilities and events that are not mutually exclusive.
- ★ *A semantic network* is a collection of items or nodes linked together to show the relationship between items in the knowledge base.
- ★ An expert system can use **cases** in developing a solution to the current problem or situation.

# The Inference Engine

- ★ *The purpose of the inference engine is to seek information and relationships from the knowledge base and to provide answers, predictions, and suggestions the way a human expert would.*
- ★ *The inference engine must find the right facts, interpretations, and rules and assemble them correctly.*

# Inference Methods

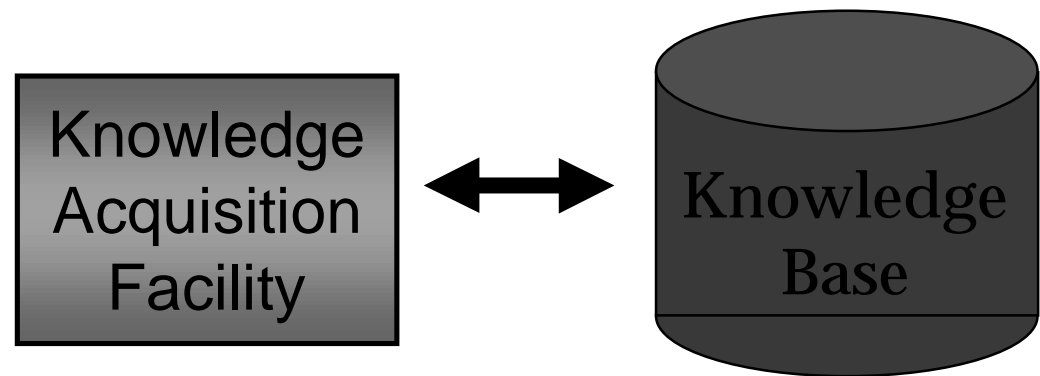
- ***Backward chaining*** is the process of starting with conclusions and working backward to the supporting facts.
- ***Forward chaining*** starts with the facts and works forward to the conclusions.

# The Explanation Facility

- *The **explanation facility** allows a user or decision maker to understand how the expert system arrived at certain conclusions or results.*

# The Knowledge Acquisition Facility

- *The overall purpose of the **knowledge acquisition facility** is to provide a convenient and efficient means for capturing and storing all components of the knowledge base.*



# The User Interface

- *Specialized user interface software is used for designing, creating, updating, and using expert systems.*
- *The purpose of the user interface is to ease the use of the expert system for developers, users and decision makers.*

# Expert Systems Development

★ *Steps in the expert systems development process include:*

- Determining requirements.*
- Identifying experts.*
- Constructing expert system components.*
- Implementing results.*
- Maintenance and review.*

# ES Development Participants

- ★ *The **domain expert(s)** has the expertise or knowledge to be captured in the expert system.*
- ★ *The **knowledge engineer** has training and/or experience in the design, development, implementation, and maintenance of an expert system.*



# ES Development Participants

- *The knowledge user is the individual or group who uses and benefits from the expert system. Knowledge users need little, if any, previous training in computers or expert systems.*

# Expert System Shells

- ★ *An **expert system shell** is a collection of software packages and tools used to design, develop, implement, and maintain expert systems.*
- ★ *Advantages of ES shells:*
  - *Easy to develop and modify.*
  - *Able to deliver satisficing vs. optimized results.*
  - *The use of heuristics.*
  - *Development by knowledge engineers and users.*

# Functional Applications of Expert Systems

- ★ *Accounting-related systems.*
- ★ *Capital resource planning.*
- ★ *Loan application analysis.*
- ★ *Financial management.*
- ★ *Manufacturing.*
- ★ *Strategic marketing applications.*

# Other Applications of Expert Systems

- ★ *Development of strategic objectives.*
- ★ *Information management and retrieval.*
- ★ *Integrating expert systems.*

## MYCIN

- One of the most important expert systems developed was MYCIN
- This is a system which diagnoses and treats bacterial infections of the blood.
- The name comes from the fact that most of the drugs used in the treatment of bacterial infections are called:
  - “Something”mycin
- MYCIN is intended to be used by a doctor, to provide advice when treating a patient.
- The idea is that MYCIN can extend the expertise of the doctor in some specific area.

- Rules in MYCIN are of the form:

IF

1. The gram stain of the organism is gramneg, and
2. The morphology of the organism is rod, and
3. The aerobicity of the organism is anaerobic

THEN

there is suggestive evidence that the identity of the organism is bacteroides.

- Another example:

IF

1. The identity of the organism is not known with certainty, and
2. The gram stain of the organism is gramneg, and
3. The morphology of the organism is rod, and
4. The aerobicity of the organism is aerobic

THEN

there is strongly suggestive evidence that the identity of the organism is enterobacteriaceae.

- The antecedent is allowed to be a mixture of AND and OR conditions.

- We can also have OR in the consequent of the rule:

IF

The identity of the organism is bacteroides

THEN

I recommend therapy chosen from among the following drugs:

1. clindamycin
2. chloramphenicol
3. erythromycin
4. tetracycline
5. carbenecillin



## How MYCIN works

- MYCIN has a four stage task:
  - decide which organisms, if any, are causing significant disease.
  - determine the likely identity of the significant organisms.
  - decide which drugs are potentially useful.
  - select the best drug, or set of drugs.
- The control strategy for doing this is coded as meta-knowledge.

## Explanation in MYCIN

- An important feature of any expert system is that it can explain how it comes up with conclusions.
- This allows users to understand what the system is doing, and so see that it is doing sensible things.
- One of the advantages of rules is that they make it possible to generate good explanations.
- Essentially the explanation is just a presentation of the *proof tree*.
- We can illustrate this with an example explanation dialogue from MYCIN.

34) Was penicillinase  
added to CULTURE-1?

\*\* Why?

[3.0] This will aid in  
determining whether  
ORGANISM-1 is a contaminant.  
It has already been  
established that:

[3.1] the site of  
CULTURE-1 is blood, and

[3.2] the gram stain of  
ORGANISM-1 is grampos

## Other Kinds of Expert System

- Many expert systems are rule-based like MYCIN.
- However, there is no reason why expert systems cannot be based on other forms of knowledge representation:
  - Frames
  - Semantic networks
  - Bayesian networks
- What makes a program an “expert system” is not its use of rules, but its expert level performance.