Introduction to Expert Systems
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Topics

• What is AI?
• What is KBS?
• What is expert system?
• The structure of an expert system
• Characteristics of an expert system
• When are expert systems useful?
• The players in the expert system game
• Evolution of expert systems
What is AI?

ARTIFICIAL INTELLIGENCE (AI) IS A BRANCH OF COMPUTER SCIENCE THAT IS STUDYING HOW TO LET COMPUTERS PERFORM FUNCTIONS CONSIDERED TO BE HIGH LEVEL HUMAN ACTIVITIES.
What is KBS?

A KNOWLEDGE - BASED SYSTEM (KBS) IS A COMPUTER PROGRAM THAT USES KNOWLEDGE AND PROBLEM SOLVING TECHNIQUES.
What is expert system?

An expert system (ES) is a computer program designed to simulate the problem-solving behavior of an expert in a narrow domain or discipline.
What is expert system?(cont.)

ARTIFICIAL INTELLIGENCE PROGRAMS

Exhibit intelligent behavior by skillful application of heuristics

KNOWLEDGE-BASED SYSTEMS

make domain knowledge explicit and separate from the rest of the system

EXPERT SYSTEMS

Apply expert knowledge to difficult, real world problems
The structure of an expert system

Organizing Knowledge
EXPERT SYSTEM

KNOWLEDGE BASE
Domain Knowledge

FACTS
RULES

INTERPRETER
SCHEDULER

INFERENCE ENGINE
General problem-solving knowledge
Representing knowledge

- Rule-based methods
- Frame-based methods
Rules

- A rule is a formal way of specifying a recommendation, directive, or advice
- A rule is expressed as
  
  IF premise THEN conclusion

  or

  IF condition THEN action
A diagnostic rule

IF there are spots on leaves, and the color of spots is pale yellow, gray, or purple, and the shape of spots is bounded making acute angle with veins, and the season is spring

Then the disease is downy mildew - probability = 0.9
A treatment rule

IF the disease is downy mildew

THEN the treatment method is chemical spraying, and the material used is redomil+copper
Drawing inferences from rules

- Forward chaining
- Backward chaining
Frames

- A frame is a description of an object that contains slots for all of the information associated with the object
- Slots may contain (default) values, or procedures by which values may be obtained
## Soil Frame

<table>
<thead>
<tr>
<th>Slots</th>
<th>Facets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph</td>
<td>value type: real</td>
</tr>
<tr>
<td></td>
<td>single/multiple: single</td>
</tr>
<tr>
<td></td>
<td>possible value: $&gt; 0.0$ &amp; $14.0$</td>
</tr>
<tr>
<td>EC</td>
<td>value type: real</td>
</tr>
<tr>
<td></td>
<td>single/multiple: single</td>
</tr>
<tr>
<td></td>
<td>possible value: $&gt; 0.0$</td>
</tr>
<tr>
<td>Texture</td>
<td>value type: nominal</td>
</tr>
<tr>
<td></td>
<td>single/multiple: single</td>
</tr>
<tr>
<td></td>
<td>possible value: sand, loam, clay, heavy clay, gravelly, coarse sand,</td>
</tr>
<tr>
<td></td>
<td>silty clay, silty clay loam, salt loam, fine sand, sand clay loam,</td>
</tr>
<tr>
<td></td>
<td>silt loam, sandy loam, loamy fine sand</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>
Disorder hierarchy

Frames connected by IS-A relation

Disease
- Fungal
  - Leaf mold
  - Downy mildew
- Viral
- Mosaic
  - Green Mosaic

Mites
- Spiders
- Broad mite

Environmental
- Low temperature
- Heavy irrigation

Insect
- aphids
- Nitrogen
  - Iron
- Bromide
  - Bazamide

Nutrition Deficiency

Toxicity

Nematode
- Root knot
- Root lesion
Drawing inferences from frames

- Inheritance
- Procedure attachment
Characteristics of an expert system

Expert System

- Expertise
  - Exhibit expert performance
  - Have high level of skill
  - Have adequate robustness
- Symbolic reasoning
  - Represent knowledge symbolically
  - Reformulate symbolic knowledge
- Depth
  - Handle difficult problem domains
  - Use complex rules
- Self-knowledge
  - Examine its own reasoning
  - Explain its operation
When are expert systems useful?

- **Nature of the task**
  - Experts can do better than nonexperts
  - The task involves reasoning and knowledge, not intuitions or reflexes
  - The task can be done by a person in minutes or hours
  - The task is concrete enough to codify
  - The task is commonly taught to novices in the area
When are expert systems useful? (Cont.)

- Availability of knowledge
  - Recognized experts exist
  - There is general agreement among experts
  - Experts are able and willing to articulate the way they approach problems
The players in the expert system game

Tool builder

 Domain expert

 Expert System Building Tool

 Knowledge engineer

 EXTENDS AND TESTS

 Clerk Staff

 End-user

 Builds

 Interviews

 Builds

 Refines and tests

 Uses

 Uses
Expert system building tool

- Programming language
- Shell
## Shells VS Programming languages

<table>
<thead>
<tr>
<th>Features</th>
<th>Shells</th>
<th>Prog. Lang.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease &amp; speed of development</td>
<td>Higher</td>
<td>Less</td>
</tr>
<tr>
<td>KB Structure &amp; reasoning</td>
<td>Restricted by the tool</td>
<td>May be developed As needed</td>
</tr>
<tr>
<td>KB maintenance</td>
<td>Easier</td>
<td>Difficult</td>
</tr>
</tbody>
</table>
Shells VS Programming languages (Cont.)

<table>
<thead>
<tr>
<th>Features</th>
<th>Shells</th>
<th>Prog. Lang.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interfaces</td>
<td>Not always friendly or available</td>
<td>Have to be developed</td>
</tr>
<tr>
<td>Efficiency/Performance</td>
<td>Slower</td>
<td>Faster</td>
</tr>
<tr>
<td>Explanation</td>
<td>Restricted by the tool</td>
<td>May be developed as needed</td>
</tr>
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</table>
# Evolution of expert systems

<table>
<thead>
<tr>
<th>Development Stage</th>
<th>Description</th>
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<tbody>
<tr>
<td>Demonstration</td>
<td>The system solves a portion of the problem undertaken, suggesting that the approach is viable and system development is achievable. (test ideas)</td>
</tr>
<tr>
<td>Prototype</td>
<td>The system displays credible performance on the entire problem but may be fragile due to incomplete testing and revision. (test cases)</td>
</tr>
<tr>
<td>Research prototype</td>
<td>The system displays good performance with adequate reliability and has been revised based on extensive testing in the user environment. (test real problems)</td>
</tr>
<tr>
<td>Field prototype</td>
<td>The system exhibits high quality, reliable, fast, and efficient performance in the user environment. (extensive field tests)</td>
</tr>
<tr>
<td>Production model</td>
<td>The system is a production model being used on a regular commercial basis.</td>
</tr>
<tr>
<td>Commercial system</td>
<td></td>
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</tbody>
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