Chapter 13: Expert System

Expert systems are computer programs designed to review a set of facts and apply a set of rules (knowledge base) to arrive at the same conclusion that a team of experts would make if presented with the same set of facts.

I - Expert system architecture
- User interface: allow interaction between users and the system
- Knowledge base: set of facts, rules derived from expert knowledge. Most often it is "if --- then ---" rules)
- Inference engine: allow reasoning from interpreting the contents of the *knowledge base* and *case specific data* (i.e. data that is specific to the particular problem being solved).
- Development engine: system for creating the expert system.

Figure 13.1

Expert systems work by making *deductive inferences*. The main advantage of deductive inference is that it allows specific facts to be derived from general information
Notes: *inductive inference*, on the other hand uses specific facts to generate general hypothesis

	Expert system
All men are mortal (general information)	Rule
Socrates is a man (observation)	Fact
Socrates is mortal (specific information)	New fact

The user interface
1) Expert system inputs:
   - Menus
   - Commands
   - Natural language
   - Customized interfaces
2) Expert system outputs:
   - Explanation of questions: the user asks why the information is needed and the expert system provides an explanation.
   - Explanation of the problem solution: display reasoning steps leading to solutions.

Knowledge base: contain facts and describe the problem area, and knowledge representation techniques that describe how the facts fit together in a logical manner.

1) Rules: specify what to do in a given situation and consist of two parts:
- Condition
- Action (taken when the condition is true)

All of the rules contained in an expert system are called the *rule set*.

2) Networks of Rules:
- The rule set can be illustrated with a hierarchy
- Hierarchical diagram.
- The rules at the bottom of the hierarchy provide evidence for the rules on the upper levels, and enable rules on the upper levels to produce conclusions.

3) The problem of rule selection
   How to select rules efficiently from the knowledge base? E.g. (1) Enter parameters that narrow the rule selection. (2) Inference strategies

Inference strategies: the portion of the expert system that performs reasoning by using the contents of the knowledge base in a particular sequence.

Ruled-based system can be either *goal driven* using *backward chaining* to test whether some hypothesis is true, or *data driven*, using *forward chaining* to draw new conclusions from existing data. Expert systems may use either or both strategies; by the most common is probably the goal driven/backward chaining strategy.

2 methods:
1) Forward reasoning/chaining (Data driven)
Inference engine checks the contents of working memory from time to time to see if the question has been answered.
Rule evaluation: examine the condition is true/false/or unknown then the rule is fired or not.
Figure 13.2

The iterative reasoning process: examine one rule after another until the all rules in the rule set are examined.

If no more rules can be fired then the reasoning process is stopped.

2) Backward reasoning/chaining (Goal Driven)
Inference machine starts with the original question and seeks to answer it by matching it with the consequence of a rule.
Figure 13.3

The first logical path is pursued:

The next logical path is pursued:

The procedure is repeated until the original question is answered or a sub-goal cannot be solved.

By using goal driven rule-based expert system, relevant questions can be more easily identified.

3) Comparing forward and reverse reasoning:
Reverse reasoning proceed faster than forward reasoning because it does not have to consider all of the rules and does not make multiple passes through the rule set. Especially when:

- Multiple goal variables
- Many rules
- All or most of the rules do not have to be examined in the process of reaching conclusion.

II - The system development process

- Initiate the development process: study the problem domain; decide whether the development work should continue.
- Develop the expert system prototype: define the problem, specify the rule set, test the prototype, and construct the interface
- *Analyst work with experts.*
- User participation: user test the prototype (with training)
- Expert system maintenance: reflect the change in nature of the problem domain and to achieve greater efficiency

III - The problem with expert systems:

- They are brittle. When faced with a problem which bends the rules, they are unable to cope
- They are unable to fall back on the details of their experience, find a similar case and apply it
- They are unable to use similarities between tough problems and previous experience to update their rules i.e they are not able to learn from experience.

IV - Guidelines for choosing a problem

- Need for a solution must justify the costs involved in development (benefits>costs)
- Human expertise is not available in all situations where it is needed
- The problem may be solved using symbolic reasoning techniques
- The problem is well structured and does not require common sense knowledge
- The problem cannot be easily solved using more traditional computing methods
- Cooperative and articulate experts exist
- The problem is of proper size and scope (manageable)

V - Advantages and Disadvantages of Expert system

Advantages

To manager:

- Consider more alternatives: can track more stocks, and improve productivity.
- Apply a higher level of logic; using the same logic of experts
- More time to evaluate decision results: obtain advices quickly, leaving more time to consider results.
- More consistent solutions: consistent reasoning process.

To the firm:

- Better performance for the firm:
- Maintain control over the firm's knowledge: make knowledge of experienced employees available in the firm for less experienced ones.

Disadvantages

- Can not handle inconsistent knowledge
- Can not apply judgment and intuition that we recognize importance e.g. customer relation.

VII - Criteria for expert systems development (similar to IV - Guidelines for choosing a problem)

- Task does not require common sense
- Task requires only cognitive skills
- Expert can articulate their methods
- Genuine experts exist
- Experts agree on the solution
- Task is not too difficult
- Task is poorly understood