Expert Systems

Basics, Tools, and Examples
An expert system is software that uses a knowledge base of human expertise for problem solving, or clarify uncertainties where normally one or more human experts would need to be consulted.

Expert systems are most common in a specific problem domain, and are a traditional application and/or subfield of artificial intelligence (AI). Expert systems may or may not have learning components.

Wikipedia, 2011
Rule Based Expert Systems

Components

- Originated from AI research in the 70s and 80s.
- Problem data stored as **facts**.
- “Reason” using IF…THEN…ELSE **rules**.

- **Rule Base** (knowledge base)
- **Working Memory** (fact base)
- **Inference Engine** (rule engine)
Expert System Components

- Working Memory
- Knowledge Base
- Inference Engine
- Intelligent Interface
- User

Expert Knowledge
Expert System Tools

- **Algorithmic languages.**
  (such as 'C', Pascal, Basic)

- **Symbolic languages.**
  (such as Prolog, LISP)

- **Development Environments.**
  (such as Art, KEE, LOOPS)

- **Expert System Shells.**
  (such as Crystal, XpertRule, Leonardo, Xi-Plus)
Algorithmic Languages

- Flexible and powerful
- They can be used to tailor a system exactly to an application
- Lacking in knowledge engineering framework.
Computer languages for logic programming must have structures for storing and retrieving known and deduced facts from a fact base or knowledge base, and they must have functions or procedures for deducing new facts.

- LISP
- Prolog
Symbolic Languages

LISP (LISt Processor): This language contains a set of primitive operators that enable it to carry out several kinds of deductions with lists containing arbitrary strings of characters representing predicates and their arguments (Charniak and McDermott 1985).

Prolog is a higher level language than LISP. It has built-in deductive and search capability. Prolog is based on Predicate Calculus Logic.
Expert system programming environments are special packages of pre-written code. They are "power tools" for building knowledge-based systems.

They provide a set of building blocks that cater for the programmers needs, and hence are known as ‘tool kits’.

In most cases, the price to pay is the loss of flexibility, however, in using a higher-level tool.
Expert System Shells

- Shells are tools for building expert systems that provide knowledge representation facilities and inferencing mechanisms.
- The programmer must gain detailed knowledge about a particular domain from an expert and information source.
- May be thought of as an expert system with all the domain specific knowledge removed and a facility for entering a new knowledge-base provided.
Expert System Shells

Typical implementation facilities provided by shells:

- A knowledge representation language
- A knowledge base editor
- Tracing and debugging facilities
- Range of user interface facilities
- Links to conventional / external programs
- Facilities for uncertain reasoning
- Rule induction facilities (possibly)
Expert System Shells

Why invest?

- Expert systems do not get tired.
- Expert systems allow the experts to concentrate on rarer, more interesting tasks.
- Expert systems provide a community memory for sharing and propagating knowledge.
- Expert systems, permit the standardisation of techniques, methods, requirements, and so on.
Problems with an Expert System

- Limited domain
- Systems are not always up to date, and don’t learn
- No “common sense”
- Experts needed to setup and maintain system
- Who is responsible if the advice is wrong?
Mortgage application for a loan for $100,000 to $200,000

If there are no previous credits problems, and
If month net income is greater than 4x monthly loan payment, and
If down payment is 15% of total value of property, and
If net income of borrower is > $25,000, and
If employment is > 3 years at same company

Then accept the applications

Else check other credit rules
Expert System Examples

- Diagnosing Why a Car Won't Start
- Choosing a Basic Dinner Wine
- MIT computer scientist Joseph Weizenbaum, 1966

- A program which he called ELIZA, after the character Eliza Doolittle in Shaw's Pygmalion

- Allowed the user to type any sentence (no restriction on content or grammar) at the keyboard and the computer would respond with a sentence of its own
Person: Men are all alike.
ELIZA: In what way?
Person: They're always bugging us about something or other.
ELIZA: Can you think of a specific example?
Person: Well, my boyfriend made me come here.
ELIZA: Your boyfriend made you come here.
Person: He says I'm depressed much of the time.
ELIZA: I am sorry to hear you are depressed.
Person: It's true. I am unhappy.
ELIZA: Do you think coming here will help you not to be unhappy?
Person: I need some help, that much seems certain.
ELIZA: What would it mean to you if you got some help?
Person: Perhaps I could learn to get along with my mother.
ELIZA: Tell me more about your family.
It produces good results, even though it is by no means a complicated program, but it is quite ‘clever’.

For example, if the user typed "My brother is mean to me".

ELIZA might respond, "Who else in your family is mean to you?" or "Tell me more about your family."
The rules were indexed by keywords so only a few had actually to be matched against a particular sentence.

- A further example: if the preceding sentence had been
  "I don't get along with my girlfriend's brother"
- sooner or later ELIZA would come up with
  "Does that have anything to do with the fact that your girlfriend's brother?"
Other Expert Systems

- **DESIGN ADVISOR**
  - Gives advice to designers of processor chips

- **DENDRAL**
  - Used to identify the structure of chemical compounds. First used in 1965

- **PROSPECTOR**
  - Used by geologists to identify sites for drilling or mining

- **MYCIN**
  - Medical system for diagnosing blood disorders. First used in 1979
Applications of Expert Systems

- Credit granting
- Information management and retrieval
- Plant layout
- Hospitals and medical facilities
- Help desks and assistance
- Employee performance evaluation
- Loan analysis
- Virus detection
- Repair and maintenance
- Shipping
- Marketing
- Warehouse optimization