

Expert Systems

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Expert Systems: Introduction

- Expert Systems are computer programs built for commercial application using the programming techniques of AI which are developed for problem solving
- Built for varieties of purposes including Medical Diagnosis, Electronic Fault Finding, Mineral prospecting, Computer System Configuration, etc.

Definition of Expert System:

An Expert System is a collection of programs or Computer Software that solves problems in the domain of interest. It is called system because it consists of both problem solving component and a support component.

- The process of building Expert System is called knowledge engineering and is done by knowledge Engineer

Expert Systems: Introduction

- Knowledge Engineer
 - is a human with a background of computer science and AI who knows how to built an Expert System
 - decides how to represent the knowledge and helps programmer to write codes
 - creates a relation with human expert to elicit knowledge from him/her
- Knowledge Engineering
 - is the acquisition of knowledge from human expert or other sources
- Expert
 - evaluates the expert system and gives report to knowledge engineer
 - the process continues until the performance is found satisfactory by the experts

Expert system

Expert systems provide the following important features:

- Facility for non-expert personnel to solve problems that require some expertise
- Speedy solution
- Reliable solution
- Cost reduction
- Power to manage without human experts
- Wider areas of knowledge

Use of expert systems is specially recommended when:

- Human experts are difficult to find
- Human experts are expensive
- Knowledge improvement is important
- The available information is poor, partial, incomplete
- Problems are incompletely defined
- There is lack of knowledge among all those who need it
- The problem is rapidly changing legal rules and codes

Expert Systems: Characteristics

- High Performance:
 - The quality of the advice given to the system should be very high
 - The system must respond at the competency equal to or better than human expert
- Expertise
 - Real expert □ produce good solutions + fast
 - Must be skillful to produce efficient + effective solution eliminating wasteful or unnecessary calculations
 - Must be robust
- Adequate response time
 - Should respond within reasonable amount of time comparable to or better than time taken by human experts to reach the decision
 - For real time-system time, constraint specified on the performance is severe when response required is within certain time interval

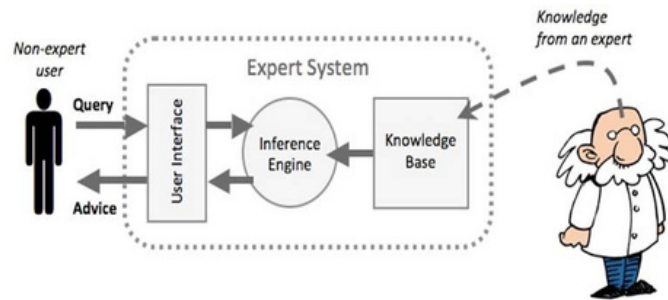
Expert Systems: Characteristics

- Good reliability
 - Must be reliable as that of human experts
- Self knowledge
 - Explanation facility is knowledge that explains how the system arrives its answer
 - The ability to examine their reasoning process and explain their operation is one of the innovative and important quality of expert system
 - Self-knowledge is important in expert system because:
 - User tends to have more faith in results and more confidence in system
 - System development is faster since the system is very easy to compile and debug
 - Effect of a change on the system operation is easily tested and predicted

Expert Systems: Characteristics

- Understandable
 - System should be able to explain the steps of reasoning while executing
 - Should have explanation capability similar to the reasoning ability of human experts
- Justification
 - Should justify the solution thus proposed
 - Justification is done via reasoning
 - Ex: if the system is rule based then it provides all the rules and facts that have been used to achieve the answer
- Flexibility
 - Huge knowledge □ must have efficient mechanism to add, change and delete knowledge

Architecture of an Expert System



Architecture of an Expert System

Knowledge Base

- It contains domain-specific and high-quality knowledge. Knowledge is required to exhibit intelligence. The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.
- What is Knowledge?
 - The data is collection of facts. The information is organized as data and facts about the task domain. Data, information, and past experience combined together are termed as knowledge.
- Components of Knowledge Base
 - The knowledge base of an ES is a store of both, factual and heuristic knowledge.
 - Factual Knowledge– It is the information widely accepted by the Knowledge Engineers and scholars in the task domain.
 - Heuristic Knowledge– It is about practice, accurate judgment, one's ability of evaluation, and guessing.

Architecture of an Expert System

Inference Engine

- Use of efficient procedures and rules by the Inference Engine is essential in deducting a correct, flawless solution.
- In case of knowledge-based ES:
 - the Inference Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution.
- In case of rule based ES, the inference engine:
 - Applies rules repeatedly to the facts, which are obtained from earlier rule application.
 - Adds new knowledge into the knowledge base if required.
 - Resolves rules conflict when multiple rules are applicable to a particular case.

Architecture of an Expert System

User Interface

- User interface provides interaction between user of the ES and the ES itself. It is generally Natural Language Processing so as to be used by the user who is well-versed in the task domain. The user of the ES need not be necessarily an expert in Artificial Intelligence.
- It explains how the ES has arrived at a particular recommendation. The explanation may appear in the following forms –
 - Natural language displayed on screen.
 - Verbal narrations in natural language.
 - Listing of rule numbers displayed on the screen.
- The user interface makes it easy to trace the credibility of the deductions.

Goals

- The basic goals targeted while developing the expert systems include
 - substitution of unavailable human experts
 - combining the knowledge and experiences of several human experts
 - training new experts
 - providing requisite expertise on projects that do not attract or retain experts
 - providing expertise on projects that can not afford experts

Basic Activities

- Expert systems are built to solve different types of problems
- Basic activities can be categorized into following:

Category	Problem Addressed
Interpretation	Inferring situation description from sensordata
Prediction	Inferringthe likely consequences of given situation
Diagnosis	Inferring systemmalfunction from observations
Design	Configuring object under constraints
Planning	Designing actions
Monitoring	Comparing observationsto expected outcomes
Debugging	Prescribing remedies doe malfunctions
Repair	Executing plans for administer prescribed remedies
Instruction	Diagnosing,Debugging and Repairing
Control	Governing overall system behavior

Advantages

Some of the advantages of using expert systems are:

- ☑Increased availability : Expert system is mass production of expertise which is available in any suitable computers
- ☑Reduced cost : Expert system costs much cheaper than real human Expert
- ☑Reduced Danger : can be used in environment that might be hazardous to human
- ☑Permanence :unlike human expert which might retire, quit and die expert system's knowledge lasts indefinitely
- ☑Multiple Expertise : Knowledge of many expert system could be made work simultaneously and continuously on a problem
- ☑Increased Reliability : Expert system could provide second option or break a tie in case of disagreement among human experts.

Advantages

- Explanation :Expert system can explicitly explain the reason that leads to conclusion
- Fast Response : Depending on the software and hardware used, an expert system may respond faster and be more available than human expert
- Steady, unemotional, Complete response at all times : important in real-time and emergency situations when human experts can not operate on its peak due to stress or fatigue or some sentimental influence
- Intelligent tutor : allow students to run samples and explain its reasoning
- Intelligent database : Expert system can be used to access databases intelligently

Development of Expert System

The process of ES development is iterative. Steps in developing the ES include –

- Identify Problem Domain
 - The problem must be suitable for an expert system to solve it.
 - Find the experts in task domain for the ES project.
 - Establish cost-effectiveness of the system.
- Design the System
 - Identify the ES Technology
 - Know and establish the degree of integration with the other systems and databases.
 - Realize how the concepts can represent the domain knowledge best.
- Develop the Prototype
 - From Knowledge Base: The knowledge engineer works to –
 - Acquire domain knowledge from the expert.
 - Represent it in the form of If-THEN-ELSE rules.

Development of Expert System

- Test and Refine the Prototype
 - The knowledge engineer uses sample cases to test the prototype for any deficiencies in performance.
 - End users test the prototypes of the ES.
- Develop and Complete the ES
 - Test and ensure the interaction of the ES with all elements of its environment, including end users, databases, and other information systems.
 - Document the ES project well.
 - Train the user to use ES.
- Maintain the ES
 - Keep the knowledge base up-to-date by regular review and update.
 - Cater for new interfaces with other information systems, as those systems evolve.