Fundamentals and Characteristics of an Expert System

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Abstract: **This paper introduces the fundamentals and the basic characteristics of an expert system. The hierarchical process of developing expert system is presented in this paper as well as a characteristic of an expert system is also presented in this paper. In this paper we have just summarized the work done in the field of Intelligent Agent and tried to sum up through this introductory paper in the form of a general survey.**

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1. Introduction

Expert systems are computer applications which embody some non algorithm expertise for solving certain types of problem.

In this paper it is described a organized structure of a strategic process for developing successful expert systems. There are several topics in hierarchy of developing an expert system. The strategic process is recommended for anyone venturing into technology of expert systems from standpoint of training, research, or applications. This paper covers all the basic concepts of an expert system.

An expert system is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. The characteristics of expert systems that make them different from conventional programming and traditional decision support tools.

2. Steps for developing an expert system

There are several steps in developing an expert system.

1. Background
2. Concepts
3. Problem selection
4. Knowledge acquisition
5. Tool selection
6. Development process
7. Testing, verification, validation
8. Implementation, integration
9. Maintenance

These all tasks are doing step by step in terms of time.

3. Characteristics of an expert system

Various definitions of expert systems have been offered by several authors. A general definition that is representative of the intended functions of an expert system is:

An expert system is an interactive computer-based decision tool that uses both facts and heuristics to solve difficult decision problems based on knowledge acquired from an expert.

An expert system may be viewed as a computer simulation of a human expert. Expert systems are an emerging technology with many areas for potential applications. Past applications range from MYCIN, used in medical field to diagnose infection blood disease, to XCON, used to configure computer systems. These expert systems have proven to be quite successful. Most applications of expert systems will fall into one of following categories:

- Interpreting and identifying
- Predicting
- Diagnosing
- Designing
- Planning
- Monitoring
- Debugging and testing
- Instructing and training
- Controlling

Applications that are computational or deterministic in nature are not good candidates for expert systems. Traditional decision support systems such as spreadsheets are very mechanistic in the way they solve problems. They operate under mathematical and Boolean operators in their execution and arrive at one and one static solution for a given set of data. Calculation intensive applications with very exacting requirements are better handled by traditional decision support tools or conventional programming. Conventional computer programs are based on factual Knowledge, an indisputable strength of computers. Heuristic knowledge, composed of intuition,

judgement, and logical inferences, is an indisputable strength of humans. Successful expert systems will be those that combine facts and heuristics and thus merge human knowledge with computer power in solving problems. To be effective, an expert system must focus on a particular problem domain, as discussed below.

3.1 Domain specificity

Expert systems are typically very domain specific. For example, a diagnostic expert system for troubleshooting computers must actually perform all the necessary data manipulation as a human expert would. Special tools or programming languages are often needed to accomplish the specific objectives of the system.

3.2 Special programming languages

Expert systems are typically written in special programming languages. The use of languages like LISP and PROLOG in the development of an expert system simplifies the coding process. Some of distinguishing characteristics of programming languages needed for expert systems work are:

- Efficient mix of integer and real variables
- Good memory-management procedures
- Extensive data manipulation routines
- Incremental compilation
- Tagged memory architecture
- Optimization of the systems environment
- Efficient search procedures

3.3 Operates as an interactive system

- It responds for questions.
- Asks for clarifications
- Makes recommendations
- Aids the decision making process

3.4 Tools have ability to sift (filter) knowledge

- Storage and retrieval of knowledge
- Mechanisms to expand and update knowledge base on a continuing basis.

3.5 Make logical inferences based on knowledge stored

- Simple reasoning mechanisms is used
- Knowledge base must have means of exploiting the knowledge stored, else it is useless; e.g., learning all the words in a language, without how to combine those words to form a meaningful sentence.

3.6 Ability to explain reasoning

- Remembers logical chain of reasoning; therefore user may ask
  - for explanation of recommendation
  - factors considered in recommendation
- Enhances user confidence in recommendation and acceptance of expert systems.

3.7 Capabilities to assign confidence values

- Can deliver quantitative information
- Can interpret qualitatively derived values
- Can address imprecise and incomplete data through assignment of confidence values.

3.8 Cost effective alternative to human expert

- Expert systems have become increasingly popular because of their specialization, albeit in a narrow field.
- Encoding and storing the domain specific knowledge is economic process due to small size.
- Specialists in many areas are rare and the cost of consulting them is high; an expert system of those areas can be useful and cost effective.

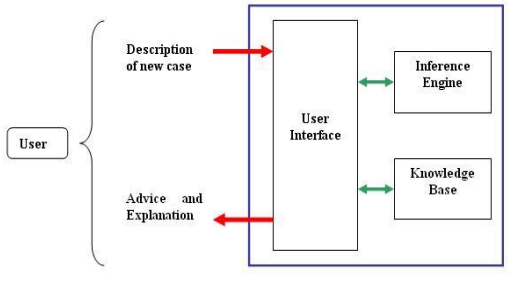
4. Expert system structure

In order for the computer to be able retrieve and effectively use heuristic knowledge, the knowledge must be organized in an easily accessible format that distinguishes among data, knowledge, and control structures. For this reason, expert systems are organized in three distinct levels:

1. *Knowledge base* consists of problem solving rules procedures, and intrinsic data relevant to the problem domain.
2. *Working memory* refers to task-specific data for the problem under consideration.
3. *Inference engine* is a generic control mechanism that applies the axiomatic knowledge in the knowledge base to the task specific data to arrive at some solution or conclusion.

The inference engine, such as VP-Expert, may come from a commercial vendor. The knowledge base may be a specific diagnostic knowledge base compiled by a knowledge base is the nucleus of the expert system structure.

The knowledge base constitutes the problem solving rules, facts, or intuition that a human expert might use in solving problems in a given problem domain.

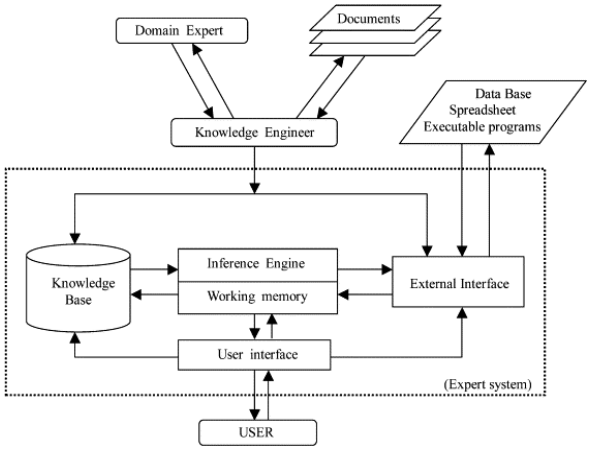


1. *Expert system organisation and operating environment*

4.1 Functional integration of expert system components

A good expert system is expected to grow as it learns from user feedback. Feedback expert is incorporated into the knowledge base as appropriate to make the expert system smarter. The dynamism of the application environment for expert systems is based on the individual dynamism of the components. This can be classified as follows:

- *Most dynamic: working memory*. The contents of the working memory, sometimes called the data structure, changes with each other problem situations.
- *Moderately dynamics: knowledge base.* The knowledge base need not change unless a new piece of information arises that indicates a change in the problem solution procedure. Changes in the knowledge base should be carefully evaluated before being implemented.
- *Least dynamic: inference engine*. Because of the strict control and coding structure of an inference engine, changes are made only if absolutely necessary to correct a bug or enhance the inferential process.



2 Integration of expert system components

5. Need of expert system

Expert systems are necessitated by the limitations associated with conventional human decision-making processes, including:

1. Human expertise is very scarce.
2. Humans get tired from physical or mental workload.
3. Humans forget crucial details of a problem.
4. Humans are inconsistent in their day-to-day decisions.
5. Humans have limited working memory.
6. Humans are unable to comprehend large amounts of data quickly.
7. Humans are unable to retain large amounts of data in memory.
8. Humans are slow in recalling information stored in memory.
9. Humans are subject to deliberate or inadvertent bias in their actions.
10. Humans can deliberately avoid decision responsibilities.
11. Humans *lie, hide*, and die.

6. Heuristic reasoning

Expert System to arrive at a good solution quickly and efficiently. Expert systems base their reasoning process on symbolic manipulation and heuristics inference procedures that closely match the human thinking process.

6.1 Search control methods

All expert systems are search intensive. Many techniques have been employed to make these intensive searches more efficient. Branch and bound, pruning, depth first search and breath first search techniques that have been explored.

6.2 Forward chaining

This method involves checking the condition part of a rule to determine whether it is true or false. If the condition is true, then the action part of the rule is also true. This procedure continues until a solution is found or a dead end is reached. Forward chaining is commonly referred to as data driven reasoning.

6.3 Backward chaining

Backward chaining is the reverse of forward chaining. It is used to backtrack from a goal to paths that lead to the goal. Backward chaining is very good when all outcomes and known and the number of possible outcomes is not large. In this case, a goal is specified and the expert system tries to determine what conditions are needed to arrive at the specified goal. Backward chaining is thus also called goal driven.

7. Benefits of expert system

There are several benefits of expert systems:

1. Increase the probability, frequency, consistency of making good decisions.
2. Help distribute human expertise.
3. Facilitate real time, low cost expert level decisions by the non expert.
4. Enhance the utilization of most of the available data

5. Permit objectivity by weighing evidence without bias and without regard for the user's personal and emotional reactions
6. Permit dynamism through modularity of structure
7. Free up the mind and the time of the human expert to enable him or her concentrate on more creative activities
8. Encourage investigations into the subtle areas of a problem

8. Conclusion

In this paper we have studied various researches done in the field of Expert System, and the fundamentals of the system. Here in this paper we have pen down few characteristics and the need of the Expert System.

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