

EXPERT SYSTEMS

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Abstract

In recent decades IT and computer systems have evolved rapidly in economic informatics field. The goal is to create user friendly information systems that respond promptly and accurately to requests. Informatics systems evolved into decision assisted systems, and such systems are converted, based on gained experience, in expert systems for creative problem solving that an organization is facing.

Expert systems are aimed at rebuilding human reasoning on the expertise obtained from experts, stores knowledge, establishes links between knowledge, have the knowledge and ability to perform human intellectual activities. From the informatics development point of view, expert systems are based on the principle of the knowledge separation from the treating program. Expert systems simulate the human experts reasoning on knowledge available to them, multiply the knowledge and explain their own lines of reasoning.

Keywords: expert systems, artificial intelligence, knowledge, expertise.

1. Defining an expert system

Expert systems are a branch of artificial intelligence and it first appeared in 1970, being the first successful applications of AI.

Expert systems are based on artificial intelligence techniques that stores knowledge from human experts in a defined field and use them to solve problems in a specific area. An expert system is trying to emulate the human expert judgment through artificial reasoning.

Expert systems are a particular class of systems based on artificial intelligence, aiming to reproduce with the computer the knowledge and reasoning of a human expert.

Expert systems are artificial intelligence systems for solving difficult problems of a practical nature at the human expert level of performance. ³

An expert system is a program that examines and deliberates knowledge in order to deliver results in a difficult task, usually undertaken only by human experts.

Functionally speaking, an expert system is a program whose main characteristic is derived from the knowledge base together with a search algorithm specific for the reasoning method.

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³ (Bodea, 1998)

Expert systems are a branch of AI that makes extensive use of specialized knowledge to solve problems at the level of human expert. An expert is a person who has expertise in a certain area.⁴

An expert system is a program that uses knowledge and inference procedures in order to solve difficult problems that normally require the intervention of a human expert to find the solution. An expert system is a particular software program incorporating a knowledge base and an inference engine. The program acts as an intelligent adviser in a particular field.⁵

Briefly, expert systems are programs that store specialized knowledge, introduced by the experts. Expert systems are a part of artificial intelligence, designed to solve difficult problems with the same level of performance as a human expert.

Based on these ideas we can define an expert system as a system that uses the artificial intelligence techniques and it's trained to imitate human reasoning through artificial means in order to obtain the best results in a particular area.

From a conceptual point of view expert systems are aiming at restoring human reasoning based on expertise obtained from experts and they have the knowledge and ability to carry out human intelligence activities.

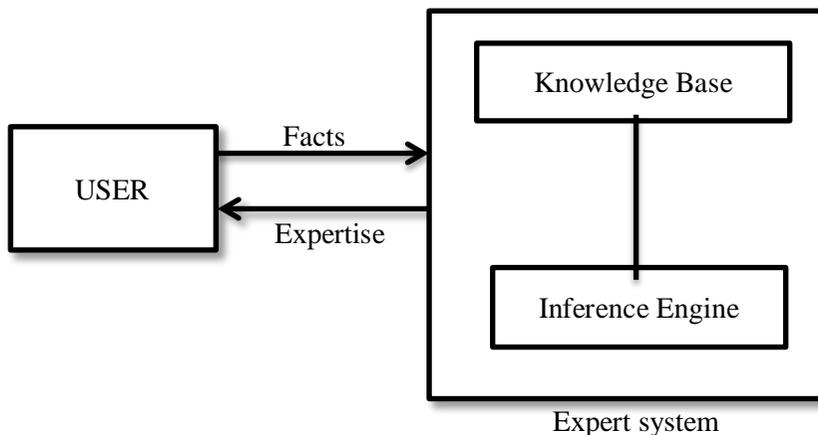


Figure 1 - Basic concept of an expert system function⁶

An expert system has the following characteristics:

- Knowledge is independent from the reasoning mechanism, they don't depend on each other and changing an item does not affect the reasoning;
- Unlike ordinary programming, where we have to explicitly describe all the processing, the expert system approach is characterized by a statement specifying the information's independent from each other and they'll be exploited in a dynamic way by the reasoning mechanism;

⁴ (Giarratano & Riley, 2005)

⁵ (Karkan & Tjoen, 1993)

⁶ (Giarratano & Riley, 2005)

- An expert system must be able to explain and justify the reasoning made and the solutions obtained in a similar manner to human experts;
- The information's handled by an expert system is mainly symbolic unlike the traditional programs that are using mostly numeric data;
- Expert systems are using empiric methods based on experience that leads to the best solutions;
- Expert systems are specialized in a particular field.

The first expert system developed in applied domains was DENDRAL, designed for the analysis of molecular structures, MYCIN, an expert system for diagnosis and treatment of blood infections, EMYCIN, HEADMED, and CASNET for the medical field and TEIRESIAS for intelligent acquisition of knowledge.

Rule based expert systems are developed and implemented in many fields of activity, including the financial-accounting one: audit, tax planning, financial diagnosis, financial reporting, credit analysis, risk analysis, managerial accounting, etc.

2. The components and objectives of an expert system

The main components of an expert system are:

- The Knowledge Base is represented as a data structure that contains all the specialized knowledge introduced by the human experts. It is used to store all parts of knowledge – facts, rules, solving methods, specific for the applicative domain, taken from the human experts or from other sources.

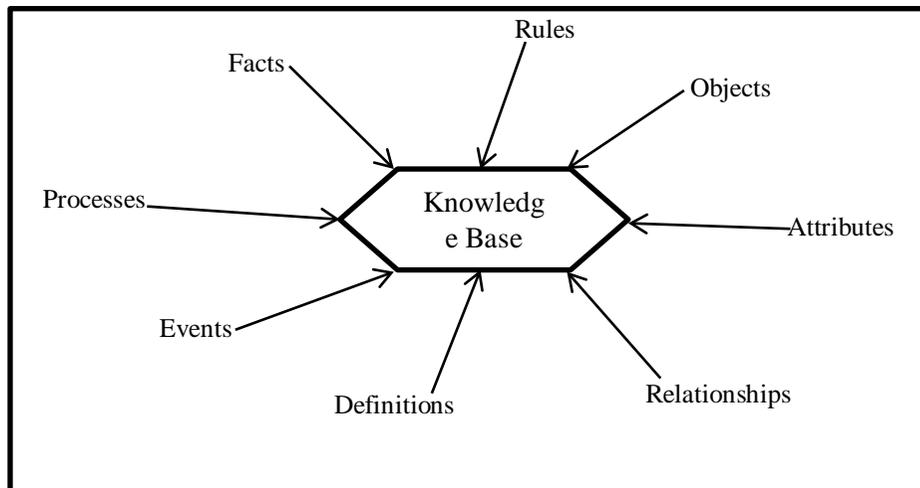


Figure 2 - the knowledge base components

- The inference mechanism take knowledge used to construct reasoning from the knowledge base, and is developing a plan to solve the problem and perform the actions provided in the resolution plan. The inference mechanism, also known as the inference engine is a program that includes procedural or operative knowledge for exploiting the knowledge base for making judgments in order to obtain solutions, recommendations or conclusions. The inference engine has two main components:

the knowledge base management that performs automatic operations, controls and updates the knowledge, and the symbolic inference processor that provides a processing method through which reasoning lines are provided.

- The Facts Base is the auxiliary memory that contains all users' data – initial facts statements describing the problem to be solved, and intermediate results produced during the process of deduction. The whole facts stored in the expert system forms the fact base. The facts are available and generally accepted by one or more experts. The rules show the link between facts, according to which inferential processes take place. They are recorded in the knowledge base in a slight order. The rules reflect the expert processing judgments and how to put the facts in relation in order to reach conclusions or actions.
- User interface ensures the dialogue between the user and the system.
- Knowledge acquisition module takes the specialized information provided by human experts into a form that is not specific for the internal representation.
- Explanation module allows tracing the reasoning path followed by justifying the solutions obtained, highlighting the error cause or failure reasons.

Knowledge representation methods are declarative and procedural. Each method corresponds to a model called the knowledge structure that can be processed by the inference engine. Declarative models are semantic networks, frames, and objects and they are used to represent facts and assertions. Procedural models include mainly rules and they are used to represent actions or processes.

Unlike most computer programs, which require complete information for decision making, expert system are designed to find the best solution, based on available data. There are two components in the expert system: a broad data base and a set of rules that search into this base in order to find the best solution for a problem. The database and the set of rules are developed by questioning the human experts on the issue. Functionally speaking, an expert system is a program whose main characteristic is derived from the knowledge base, together with a specific reasoning search algorithm.

An expert system is based on two complementary and different components:

- Programming technologies that enable a great deal of knowledge and the inferential ways;
- Building and developing methodologies that allow using these technologies.

An expert system is developed by using methodologies aiming at three main objectives and three derived objectives.⁷

The main objectives are:

- Easy knowledge acquisition by directly expressing the expertise obtained from the human experts.
- Exploiting effectively the knowledge collection by combining and chaining the knowledge in order to infer new information by judgments, demonstrations, decision, and predictions, or by taking in order the way that new knowledge is inferred.

⁷ (Andone & Tugui, 1999)

- Supporting with ease the full range of knowledge operations – adding, modifying and removing items.

The derived objectives are:

- Reducing the risk is possible by integrating a large volume of information, experience and knowledge from various valid sources.
- Increasing creativity is possible by identifying in advance the strong potential actions.
- Storing knowledge through learning and use it in multiple ways for dynamic management tasking. Learning ensures the evolving nature of the expert systems.

An expert system has the following basic concepts: the expertise, the experts, expertise transferring, inference rules, and explaining ability.⁸

The expertise is a deeper understanding of a specific problem, acquired through training, reading and long experience. The expertise includes the following types of action:

- Facts and theories about the problem;
- Rules and procedures regarding the problem;
- Rules about a specific situation given for solving the problem;
- Global strategies for solving different types of problems;
- Meta knowledge.

All these types of knowledge allow experts to make faster and better decisions.

The human expertise includes a wide range of activities like:

- Recognizing and formulating the problem;
- Solving the problem quick and clearly;
- Explaining the solution;
- Learning from experience;
- Knowledge restructuring;
- Rules fragmentation;
- Determining the relevance;
- Limits awareness.

From these activities it emerges the idea that human experts can take a random problem and convert it into a form that leads to a quick solution.

| Factor | Human expert | Expert system |
|----------------------|---------------------|--|
| Available time | Working days | Any time |
| Spatial location | Only local | Everywhere, especially in environments unsuitable for humans |
| Information security | Irreplaceable | Replaceable |
| Perishability | Yes | No |
| Performance | Variable | Permanent consistency |
| Working speed | Variable | Fast |
| Costs | High | Acceptable |

Table 1 - Comparison between human experts and expert systems⁹

⁸ (Varlan & Enache, 2008)

⁹ (Durkin, 1994)

Expertise transferring is the objective of an expert system. The transfer occurs from human experts to computer and from expert users to non-expert users. This process involves:

- Knowledge acquisition from experts and / or other sources;
- Computer knowledge representation,
- Inference the stored knowledge;
- Transferring the knowledge to the user.

Most expert systems are working with rules like: IF ... THEN... ELSE, and they are stored in the knowledge base. Inference is a unique yet major feature, is the reasoning ability of an expert system. Based on the expertise and knowledge based stored in the program, the computer is programmed to make inferences. Inferences are made by the inference engine, which has procedures and procedural knowledge about the problem.

Explaining ability is an important feature of expert systems; recommendations can be explained or alternative decision making results can be argued.

These basic concepts of expert systems make the difference between expert systems and traditional programming and between procedural and declarative programming.

| Traditional Informatics Systems | Expert Systems |
|--|--|
| Data and data processing are combined into a sequential program. | Knowledge base information is separated from the inference engine. |
| Programs don't have errors. | Programs may have errors. |
| Doesn't explain if input data and results are necessary. | The explaining part is integrated in the expert system. |
| Program changes are difficult to make. | Changes in the knowledge base are easy to do. |

Table 2 - Features of expert systems compared to traditional systems

3. The advantages of an expert system

Expert systems have many advantages and they can vary depending on their type or on the domain in which they are used.

The main advantages of expert systems are:

- The expertise is available to all users have access to it.
- Multiple expertise which includes knowledge from several experts.
- Low costs – the cost regarding expertise per user is greatly reduced.
- The expertise is available at any time and unlike human experts, who may retire, quit, or die, the expert system knowledge will last indefinitely.¹⁰
- The reasoning that led to conclusions can be explained in details, leading to the reliable idea that the decision made was correct.
- In emergency situations can give quick answers.

¹⁰ (Giarratano & Riley, 2005)

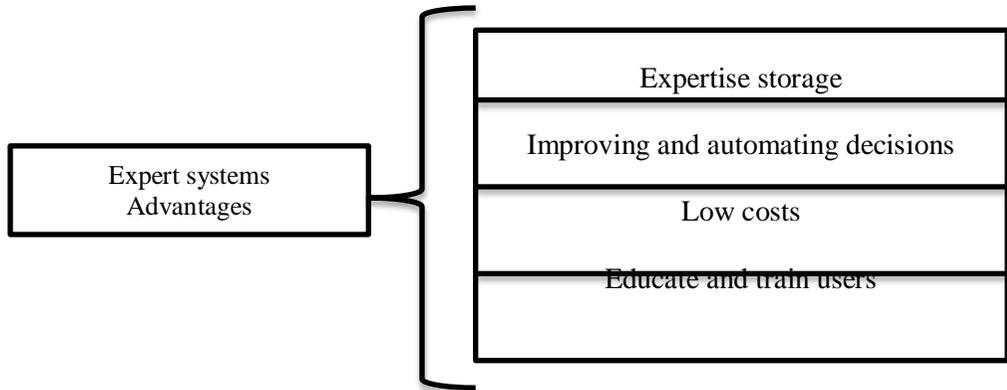


Figure 3 - The advantages of an expert system

Learning and training users means that the expert system is always an excellent teacher for all users, and not only for the expertise field, and also it's natural way in explaining reasoning.

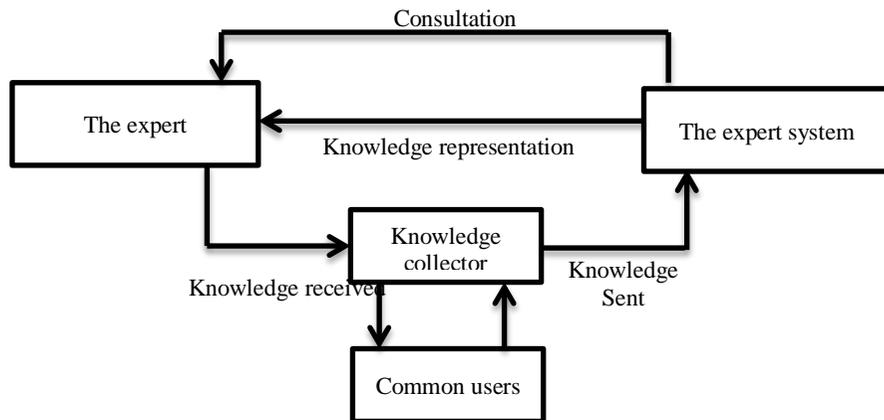


Figure 4 - Informational flow¹¹

Implementing in an organization an expert system leads to another advantages, such as:

- Increasing the performance by reducing the human errors caused by the discovery of all the relevant facts and identical cases that always leads to the same result.
- Increasing skills for the non-expert users and productivity for the experts, all through removing the barren expertize and helping the expert with the more simple cases.
- Maintaining and expanding the knowledge base by: archiving critical business skills, explaining the existing knowledge, combining knowledge from multiple sources inside the company, knowledge dissemination through duplication and purchase widely recognized expertise.

4. Expert system application in economy

Expert systems applications in economy are divided into:

¹¹ (Varlan & Enache, 2008)

- Administration field – expert systems are introduced in all company functions: production, marketing, research and development, financial accounting, human resource management. Expert systems used in this area are:
 - APEX in sales management,
 - CONCEPT for management, planning models and consumer goods marketing,
 - MIT in enterprise management and human resources control ,
 - DESIGN TOPPRODUCT used in production management,
 - IMET for industrial management and
 - ISIS used in production management.
- For financial domain there are expert systems built for banking, insurance, brokerage:
 - SMERITOS for customers' accounts management,
 - CLASS used in commercial lending activity,
 - MAX used for financial marketing industry,
 - SAFIR used for financial analysis and,
 - SCARON used in insurance field.
- In accounting, for auditing, managerial accounting, taxing, financial accounting and accounting information systems:
 - CAPEX for audit planning and,
 - NEEDHAM for processing financial accounting transactions and management services.

5. Conclusions

Knowledge based expert systems are the first developments in artificial intelligence. For software developers, especially in fields like medicine and engineering, the decision process was important because in the decision process were used symbols instead of numbers. Classification and diagnosis tasks were the first to have benefits from expert systems development.

The work of a human expert can be automated in a proportion of 80%. Simple, repetitive or procedural operations, but also more complex operations, specific to deductive, inductive or mixed reasoning, are easier, fast and effective to solve through an expert system.

Even if some expert systems are designed for experts only, others are designed for knowledge dissemination and responsibility decentralization. They allow using less qualified personnel to carry out performance expert tasks. So, due to knowledge sharing, the company operates efficiently even with less qualified persons.

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