

# The Methodology of Expert Systems

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## Summary

The article considers design methodology of expert systems, structure of the base components, studies stages of expert system's creation, provides basic data on the ways of representation of knowledge in expert systems.

### Key words:

*expert systems, knowledge database, software, intelligent interface*

## 1. Introduction

Nowadays there are no uniform methods, models and tools for creating expert systems. More accessible software tools are required, which would support a standard design technology application of expert systems, allow detailed analysis at the stage of systems design or even bring a negative result. The purpose of the study is to develop programs that get results that are not inferior in quality and efficiency with the solutions obtained by an expert. Scientific innovation is reflected in an attempt to build a common methodology for the design of expert systems, allowing creating cluster expert systems to solve problems in a variety of subject areas. The practical relevance of these results is to implement a method of constructing intelligent expert system. The basic idea is to create theoretical, technological and organizational development techniques of expert systems.

## 2. The main problem of creating expert systems technology

The expert system is a system of artificial intelligence, which is built on the basis of deep expertise of a certain subject area (obtained from experts and specialists in the area). Expert systems are one of the few types of artificial intelligence systems that are widely used and have found practical application. Expert systems are a progressive trend in the field of artificial intelligence. The increased interest is determined by the possibility of their application to problems of different fields of human

activity. Development of expert systems is very different from conventional software development.

The software tools that are based on the technology and techniques of artificial intelligence greatly expand the range of practically important problems that can be solved by computers, and their solution brings significant economic benefits. First, there is a problem that requires combining different techniques and technologies into a single coherent system, in which all the means and tools must be used optimally. Second, the problems of the single representation of knowledge in the integrated environment remain unsolved; there are no methods for organizing data exchange processes between expert systems that are parts of it, no query processing techniques to expert systems. There is no methodology of designing an expert system as a whole. An overwhelming number of expert systems, which were developed by the classical architecture, are integral. Therefore, there is a situation where you need to make changes in the composition of the expert system, redesign expert systems, change methods of handling requests, etc., which often requires changes in the system and leads to a deadlock. The experience of creating expert systems shows that the use of the methodology adopted in the traditional programming overly delays the process of creating expert systems. Thirdly, there is no precise method of designing expert systems.

## 3. Technology of the creating expert systems

Expert systems are one of the fields of artificial intelligence (Artificial Intelligence - AI). Research in this area is focused on the development and implementation of computer programs that can emulate (imitate, reproduce) those human activities that require thinking, some skills and gathered experience. These include the problem of decision-making [1], image recognition and understanding of human language.

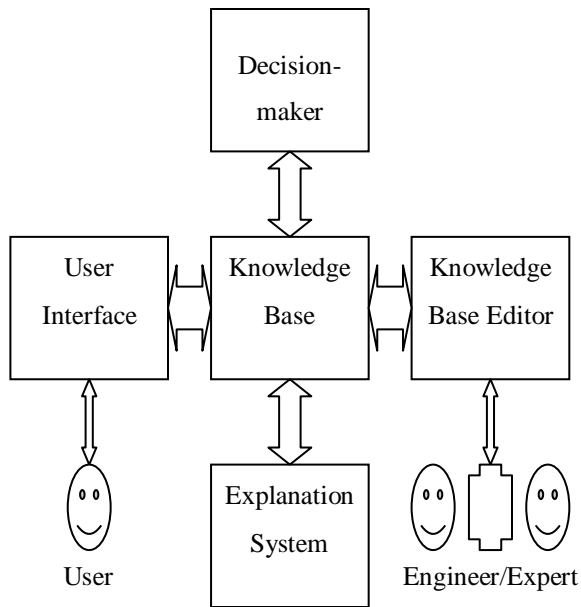


Figure 1. The typical structure of an expert system

Development of expert systems is possible for a particular application if the following requirements are met:

- 1) there are experts in this field, who solve the problem much better than the novice professionals;
- 2) the experts agree on the proposed assessment solutions, otherwise it is impossible to evaluate the quality of developed ES;
- 3) the experts are able to express in natural language and explain the methods used by them, otherwise it is difficult to count on the fact that the knowledge of experts will be "removed" and put in the ES;
- 4) the solution of the problem requires only the reasoning, not action;
- 5) the problem should not be too difficult (i.e., the decision making should take a few hours or days for expert);
- 6) the problem should be "clear" enough and structured, i.e. there should be marked basic concepts, relationships, and well-known (at least for expert) methods of obtaining solutions of the problem;

The use of expert systems in the application is possible and justified by one of the following factors:

- the solution will bring a significant effect, such as economic;
- the use of a human-expert is not available either because of lack of experts or the need to carry out the examination at the same time in different places;

- the use of ES is appropriate in those cases where during the transfer of information to expert unacceptable loss of time or information occurs.

Herein solvable problem must have a set of the following characteristics:

- 1) The problem can be solved by a natural manipulation of symbols (i.e., using symbolic arguments), and not by manipulation of numbers, as is customary in mathematical techniques and traditional programming;
- 2) The problem must have a heuristic nature, and not algorithmic, i.e. its decision shall require the use of heuristics rules;
- 3) The problem must repay expenditures of developing ES. However, it should not be too difficult (decision making takes hours for expert, but not weeks), so ES can solve it;
- 4) The problem should be practically significant.

#### 4. The scheme of expert system design

In general, the expert system consists of the following typical subsystems: knowledge acquisition, knowledge management classification as belonging to a local expert systems, knowledge management subsystem output, output management expertise in a cluster expert system using a mathematical model for constructing a tree inference; subsystems forming opinions and recommendations, a set of local expert systems derived from the decomposition of knowledge chosen subject area. A distinguishing feature of expert systems is their ability to accumulate knowledge and experience of the most qualified specialists (experts) in a narrow subject area. Then with the help of this knowledge ordinary skilled users with the help of expert systems can solve their current problems as successfully as it would make the experts themselves. This effect is achieved due to the fact that the expert system in their work plays roughly the same line of argument, which typically uses a human expert in the analysis of a problem. Thus, expert systems allow you to copy and distribute knowledge, making the unique experience of high quality professionals available to a wide circle of ordinary skills. Level of expert systems users may vary over a wide range. Functions that are applied in the users' expert systems also depend on their activities.

Expert systems are built on the three "pillars"[3]:

- Knowledge gained from the experts;
- Mapping method in the knowledge database;
- Methods of using the knowledge databases for logic conclusion.

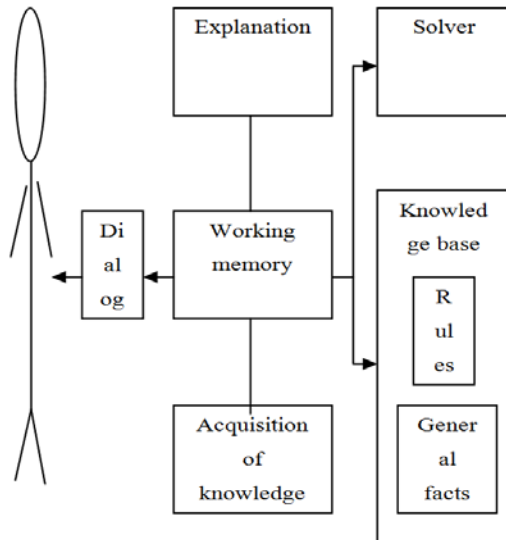


Figure 2. The scheme of the expert system

A list of typical problems, which can be solved by expert systems, includes [2] following:

- Extracting information from the raw data (such as signals from the sonar);
- Fault diagnostics (as in technical systems as well as in humans);
- Structural analysis of complex objects (for example, chemical compounds);
- Selecting the configuration of complex multi-component systems (e.g. distributed computing systems)

store, search, and deliver knowledge. Knowledge databases are often applied in the context of expert systems, where they are used to represent the skills and experience of experts engaged in practical activities in the related field (such as medicine or mathematics).

Inference mechanism - this software tool receives the request converted into internal representation from intellectual interface, forms a specific algorithm of problem solution from knowledge database, and performs an algorithm. The intelligent interface then obtains the received result for a response to a request.

Mechanism of knowledge acquisition is below. The knowledge database reflects experts' knowledge (specialists) in this area of concern about the actions in various situations or processes of specific task solutions. Identification of such knowledge and subsequent submission to the knowledge database is performed by experts called knowledge engineers.

Mechanism of knowledge explanation - in process of solving or according to the results of the problem, user can request an explanation or justification of the solving process. For this purpose ES should provide an appropriate explanation mechanism.

Intelligent interface - is the user interface that is additionally equipped with software that can perform basic functions of analysis, synthesis, comparison, compilation, storage, and training of all components involved in the process of interaction with the user.

## 5. Technology of expert systems development

Technology of expert systems development includes six following steps (Fig. 2): identification, conceptualization, formalization, implementation, testing, and trial operation.

On the stage of identification the development process of a prototype system is planned [4], the sources of knowledge (books, experts, and methodologies), goals (distribution of experience, automation of routine operations), classes of problems solved and other things are determined. The result of identification is a response to a question of what is needed to be done and what resources are required to be used.

During the stage of conceptualization profound analysis of the problem domain is conducted, the definitions and their relationships are identified, and methods of problem solving are defined. This stage is completed by the creation of the domain model (software) that includes basic concepts and relationships [5]. The following problem characteristics are defined during the stage of conceptualization:

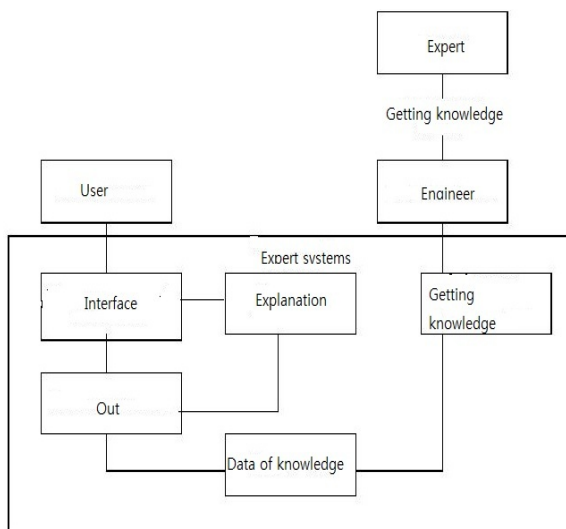


Figure 3. The architecture of an expert system

**Knowledge database** is a special kind of database designed to manage the metadata, which is, to collect,

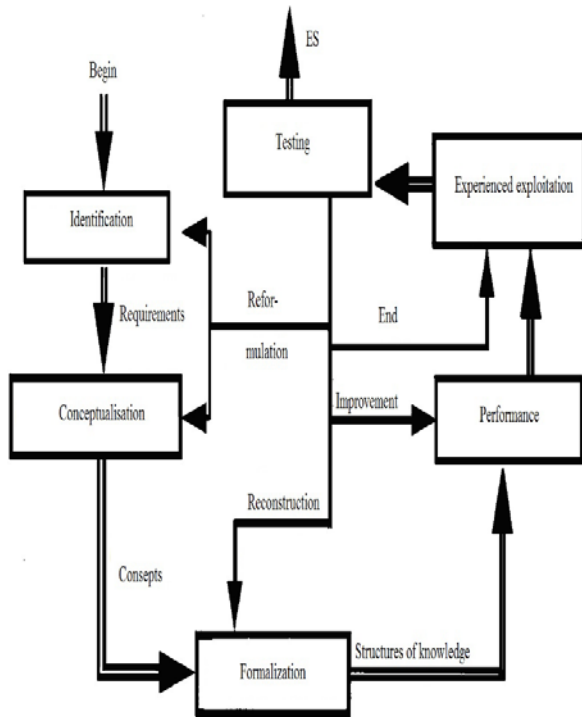


Figure 4. Methods of expert systems development

- Types of data available;
- Source and output data, sub problems of general problem;
- Applied strategies and hypotheses;
- Types of relationships between software objects, types of used relations (hierarchy, cause - effect, part - whole, etc.);
- Processes used in the solutions;
- Knowledge content used in problem solution;
- Types of constraints imposed on the processes used in the solutions;
- Knowledge content used in the decision explanations [5].

During the stage of formalization IP is selected and ways of presentation of all kinds of knowledge are determined, basic concepts are formalized, ways of knowledge interpretation are defined, system operation is simulated, and adequacy of the objectives concerning the system of fixed definitions, solving methods, ways of presentation and knowledge manipulation is evaluated [6]. The output of formalization stage is a description of how the problem can be represented in the selected or developed formalism (frames, scripts, semantic networks, etc.) and an understanding of manipulation methods of this knowledge (the logical conclusion) [7].

During the performance stage which is filling database with expert. The process of acquiring knowledge is performed by a knowledge engineer on the basis of

experts' actions towards the real problem solutions. The purpose of this stage – is the creation of one ES prototype. Subsequently after the testing results and trial operation a final product that is suitable for industrial use is created at this stage [8]. Prototype development consists of its components' programming or their selection among famous software tools and filling the knowledge database [9].

Thus, nowadays the process of situation assessment and decision-making is one the most time-consuming and, therefore, the expert systems development methodology considers following necessities to be the most important concern:

- 1) Correct formulation of the problem;
- 2) Knowledge systemization for its transfer to the computer system;
- 3) The development of management tools for knowledge database, inductive inference and simplified dialogue interaction.

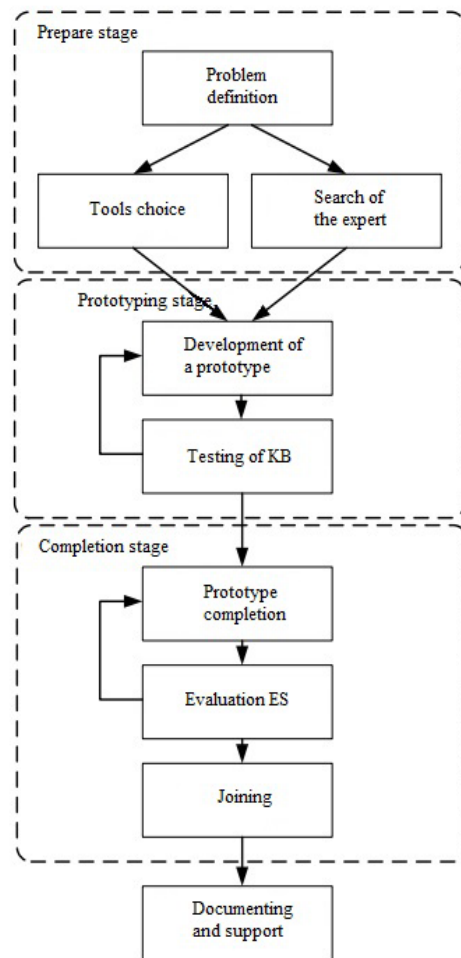


Figure 5. Stages of expert systems development

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