

Methodology of expert system building

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Abstract. The object of scientific research is the methodology of construction of expert systems. This article focuses on the main aspects and principles of expert systems. After that, there are considered the stages of development of expert systems. Expert systems, like other information systems, have the following stages of development: identification, conceptualization, formalization, execution, adjustment and testing, application. This article deals with specific stages of development of expert systems.

Keywords - expert systems; information systems; methodology; expert; artificial intelligence; system

1. Introduction

The study of expert systems has reached such a level that it is possible to form quite general scientific and methodological principles of their construction. ES is a complex software program based on specialized knowledge and able to provide acceptable solutions to individual problems in a narrow topic area. [1] In most cases, the successful application of ES in various fields, which are difficult to form or do not have a clear algorithmic description, can be explained by the results of research in the field of artificial intelligence in previous years. [2] They are briefly explained by the following principles:

- The effectiveness of ES is primarily determined by the size of the knowledge base and its ability to be enriched with new knowledge; methods of obtaining a solution are not so important. Experience has shown that more general knowledge is required than a general extraction procedure.
- The knowledge used in the ES, which is based on the knowledge of a human expert, is mainly heuristic (empirical), fuzzy, incomplete and indeterminate. In practice, this is consistent with the nature of the subject area under study. [3]
- The low level of problem solving and the heuristic nature of the knowledge require the user to have a systematic dialogue. [4]

There are different stages for setting up each system. Generally, the period of expert systems installation includes the following steps:

- Identification;
- Conceptualization;
- Formation;
- Realization (execution);
- Adjustment and testing;
- Testing and Application.

The design of the system in operation during the period given, it was noted that the stages. Now, let's look at each of these stages separately.

2. Materials and Methods

2.1. Identification

At the stage of identification, the goals of the creative ES and the issues to be solved are announced. In this case, the difference between the purpose for which the system is created and the issues it will address must be clearly stated. The main goals of the ES can be considered: the formation of expert knowledge, improving the quality of problem solving in relation to the solution obtained by the expert-person, automation of large-scale work performed by the expert-person, increasing the circulation of expert knowledge. [5]

The identification phase allows you to identify important features of the problem. These include: the type and scale of the problem, the participants in the design process, the timing of the work and the technical means required. The most relevant of these is the determination of the type and scale of the problem. Often in the next steps it becomes clear that the initial goal and setting are very complex and need to be simplified. Experience has shown that if the researcher focuses on a number of simple problems at the beginning of the work, the global goal is temporarily set aside and a real solution is found, the investment can get a clearer idea of the complexity of the overall problem. [6]

The knowledge engineer and the expert work closely together in the identification process. The knowledge engineer, together with the expert, clarifies the basic concepts and notions of the informal description of the problem. The expert gives a detailed description of the problem, explaining how to solve the problem and what ideas are based on this solution. The knowledge engineer and expert obtain a final and informal description after several stages of discussion. This means that participants identify and describe the knowledge needed to solve a problem by identifying key elements for the description of knowledge. [7]

Time is the most important resource. As an expert, a knowledge engineer must spend many months to get the first version of a working system. if any of them have difficulty understanding other methods and concepts, additional time may be required.

Provision of technical and instrumental means is also very important. Both are guaranteed to be available for two years or more. In addition, it is important to remember that software plays an important role as a hardware tool.

It should be noted that currently in the development of ES (especially dynamic ES) is a cooperative design process that results in the participation of key users in this process.

2.2. Conceptualitation

At the conceptualization stage, it is clarified what concepts, relationships and management mechanisms are needed to describe the issues identified. The following special attention is given:

- The essence of the hypotheses and strategies used;
- The structure of relationships (hierarchical scheme, cause-and-effect, part-complete, etc.);
- Type of restrictions;
- Types and structure of knowledge used. [8]

In order to determine the listed characteristics of the issue, it is expedient to compile a detailed protocol of the expert's judgment and action in the process of resolving at least one issue. Such a protocol provides the knowledge engineer with vocabulary terms (objects) and some approximate descriptions of strategies used by the expert. In addition, the protocol helps to answer many questions that arise in the course of the project. At this stage, the knowledge engineer looks at questions related to the description of knowledge and solution methods. However, at this stage, the choice of specific methods and techniques is not considered. [9]

The most important issue at this stage is the correct description of knowledge. Researchers usually try to present their knowledge fully and completely. However, experience shows that, as in the previous stage, it is more useful to move quickly to the next stage using a simplified description.

In the field of medicine, which is taken as a subject, first of all, the facts (eg syndromes, diseases, symptoms) in the field of the subject (for example, the relationship between symptoms and diseases) are determined in an accurate and complete manner before an expert doctor and engineer are created.

2.3. Forming

The purpose of the formulation phase is to describe the basic concepts and relationships derived from conceptualization in any accepted formal language. The formal description depends on three main factors:

- From the structure of the search space;
- From the model of the solution process;
- From the data properties of the problem. [10]

The structure of the search space becomes clear after forming a mathematical description of the concepts of the subject area. The following questions must be answered here:

- Do the concepts have a simple or complex internal structure?
- What is the nature of the relationship between the concepts: causal or space-time type?

- Can hypotheses be expressed in simple terms or should they form a hierarchy?
- How are the accuracy ratios shown and where is the extraction strategy used?
- Should the abstract level of concepts and hypotheses be one or more?

The problem-solving process can be described through various models. In this case, both mathematical and behavioral models can be used. If the behavioral model can justify decision-making, it allows you to build the necessary understanding and relationships. The mathematical model allows you to organize the output route and reflect the relationships between the elements of the knowledge base.

The main issues in the formation process are from the structuring of the primary issue, especially the structuring of the general issue related to the sub-issues; structuring declarative and procedural knowledge; consists of structuring the subject area based on the hierarchy of classes and structuring application programs based on the “part / complete” hierarchy.

2.4. Realization (execution)

The purpose of the implementation phase is to create one or more prototypes of the ES that solve the required problem. Then, according to the results of the testing and trial operation phase, the final product suitable for industrial use is formed at a given stage. The development of a prototype consists of programming its components (or selecting them from existing tools) and setting them aside until a complete understanding of the knowledge base structure and all test samples. However, this difficult part of the work is postponed to the next stages. The knowledge acquisition process allows for clarification of the concepts and connections used, so the acquisition of knowledge should begin with the development (or selection) of tools that allow you to work with a simple description of knowledge and a simple management structure. This approach allows you to get started as soon as possible on individual sub-issues and determine the importance of additional knowledge to solve them. The first prototype of the expert system (ES-1) should appear 1-3 months after the start of work. The development of a prototype is an extremely important step in the creation of an ES. Some fragments of the prototype may be included in the final version of the ES, but this may not be the most important goal in the creation of the prototype. The main thing is to ensure that the ideas, methods and description methods selected in the prototype created ES are tested for adequacy to the problems to be solved.

Conducting experiments on the ES-2 variant and analyzing their results allows to identify system shortcomings and develop tools to eliminate them. This iterative process can take several months, depending on the complexity of the subject matter, the flexibility of the chosen image, and the degree to which the control mechanism is relevant to the problem at hand. In some cases, it may be necessary to create an ES-3 version.

In general, iterative design is not an approach to the implementation of the system as a single, monolithic, integrated system, but as a series of successful approximation of prototypes. Iterative design is especially effective for systems characterized by features that are not sufficiently precise. Because similar projects are

not sufficiently developed in terms of system analysis, designers discover new system requirements once they start a project. If the design is done in an iterative approach, then the costs are relatively small to adapt the system and adjust the next work plan. On the other hand, when initiating the immediate development of a complete system, the discovery of new system requirements in the project process may cast doubt on its feasibility.

2.5. Tuning and testing

The setup and testing phase is included in each phase of the application system prototype development. Although testing is seen as the final stage of system development. The process of prototyping, which is characterized by significant changes in the project and changes in the specifications of the system of application, places special demands on the verification of the system and its compliance with the requirements (conceptual testing-validation). These two issues need to be addressed in parallel with the ES design process. According to traditional software system testing technology, the verification process (logic testing) can be interpreted as a beta testing phase, while conceptual testing (although ES testing is different from traditional testing) can be interpreted as a beta testing phase. While the initial specifications of a traditional software system allow the programmer to do this work freely, it is necessary to engage an expert in the subject matter to test the ES.

Experts approach ES testing from three perspectives:

- Initial data testing;
- Logical testing of the knowledge base;
- Conceptual testing of the application system.

Testing of primary data involves the verification of factual information used for examination. The data set used during testing should cover the area of possible situations investigated by the ES.

Logical testing of the knowledge base results in the detection of logical errors (excess, periodic and conflict rules; rules of omission and intersection; unrealized conditions), regardless of the subject area. The formal nature of these errors allows automation of the testing process. There are a large number of tools available to verify (verify) the full knowledge base and set of rules. However, if the chain of rules used in the extraction process is not long (rules 3 to 10), the verification process is performed manually.

Conceptual testing is conducted to check the overall structure of the system. At this stage, it is not possible to test the application without involving end users of the system.

2.6. Test operation and application

During the test phase, a variant prepared for different values of the initial data is executed and its quality is evaluated. The researcher conducts this stage together with the expert in the field. As a result of the tests, a decision is made to rework one or another stage or to adjust the accepted concepts and attitudes and relationships. The trial phase must confirm or deny the following.

- Decisions made by the system are considered acceptable by experts;
- The rules of extraction are complete, error-free and unambiguous;
- The decision-making sequence coincides with the expert's intervention;
- The system can explain its decision quite clearly;
- In the testing phase, the system can solve possible problems - from the simplest to the most difficult that can be expected within the boundaries of the subject area.

The assessment of the quality of the system developed during the testing phase is ambiguous. The same system can be evaluated differently by a knowledge engineer (the main researcher of the system), an expert in the subject area, and the average user. The expert is primarily interested in the accuracy and completeness of the extraction rules, the knowledge engineer - the overall efficiency of the system, and the average user - the ease of working with the system and the importance of the results obtained.

Explains whether the ES developed in the practical application phase is suitable for use by the average user.

These include:

- Working with ES is not tiring;
- The system can be adapted to users of different skill levels;
- The system maintains the working state in case of user misbehavior.

At this stage, the overall usefulness of the system is also assessed.

If the results of the practical application phase are considered successful, the developed ES can be considered a commercial system.

3. Results

ES must be a "specialist" in a narrow field. There should be general and specific extraction rules so that it is possible to get a directional solution route. In addition, the ES must follow general rules of intellectual behavior. Rules of intellectual behavior are based on the principles of "symbolic thinking". Also, the initial formulation of the issue should be able to be updated after the development of expert rules.

The participation of users in the cooperative design process is very beneficial, and it will allow a better analysis of automated operations.

Finally, the ES must understand its decision and be able to explain it.

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