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# ПРИМЕНЕНИЕ ЭКСПЕРТНОЙ СИСТЕМЫ В КАЧЕСТВЕ ИНСТРУМЕНТА ПОДДЕРЖКИ ПРИНЯТИЯ УПРАВЛЕНЧЕСКИХ РЕШЕНИЙ

***Аннотация:*** *Статья посвящена экспертным системам, ее применению к задачам управления проектами. Представлена структура экспертной системы. Рассмотрены понятия базы знаний и базы данных. Подробно проанализирован механизм вывода, осуществляющий поиск подходящих правил в базе знаний и согласование их с фактами.*

***Ключевые слова:*** *экспертные системы, управление проектами, база знаний, база данных, продукционные правила.*

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# THE USE OF AN EXPERT SYSTEM AS A TOOL TO SUPPORT MANAGEMENT DECISION-MAKING

***Annotation:*** *The article is devoted to expert systems, its application to project management tasks. The structure of the expert system is presented. The concepts of knowledge base and database are considered. The inference mechanism that searches for suitable rules in the knowledge base and reconciles them with the facts is analyzed in detail.*

***Keywords:*** *expert systems, project management, knowledge base, database, production rules.*

In the process of preparing and implementing the project, the manager is compelled to make decisions in conditions of uncertainty, based on incomplete or inaccurate information about the current state and prospects for the development of the project. The quality of decisions made is largely determined by the experience of the manager.

It is possible to improve the quality of decisions made by integrating an intelligent component, an expert system, into the automated workplace of the project manager [2].

An expert system is a computer program that, based on the rules embedded in its knowledge base, can give reasonable advice, suggest a solution to a problem. The use of an expert system as a decision support tool is justified for solving problems that cannot be solved on the basis of analytical calculations.

With regard to the tasks of project management with the help of an expert system, the following tasks can be solved:

- specify the type of project;
- estimate the duration and cost of both the entire project as a whole and its individual stages and tasks;
- select the performers of the most important stages;
- allocate resources;
- conduct a risk analysis.

The expert system, the knowledge that is embedded in it, is a powerful tool for training and advanced training of middle managers. In the process of working on a project, using an expert system, the project manager, as it were, consults with an expert in the field of project management, receives and absorbs his experience.

In the works on artificial intelligence, an expert system is understood as a system that combines the capabilities of a computer with the knowledge and experience of an expert in such a form that the system can offer reasonable advice or implement a reasonable solution to the task [1]. The typical structure of the expert system is shown in Figure 1.

The basis of the expert system is the knowledge base about the subject area. The knowledge base contains knowledge – a collection of information about an object and its functioning. In most cases, the knowledge of the expert system is heuristic and is probabilistic in nature: there is some degree of uncertainty about the reliability of the fact or the accuracy of the rule. When building expert systems, three methods of knowledge representation are most often used: inference rules, semantic networks and frames. The representation of knowledge based on rules is based on the use of expressions of the form IF the condition is the conclusion, reflecting the natural course of the expert's reasoning. The rules provide a natural way to describe the subject area, the decision-making process. Semantic networks and frames are usually used to solve research problems of artificial intelligence.

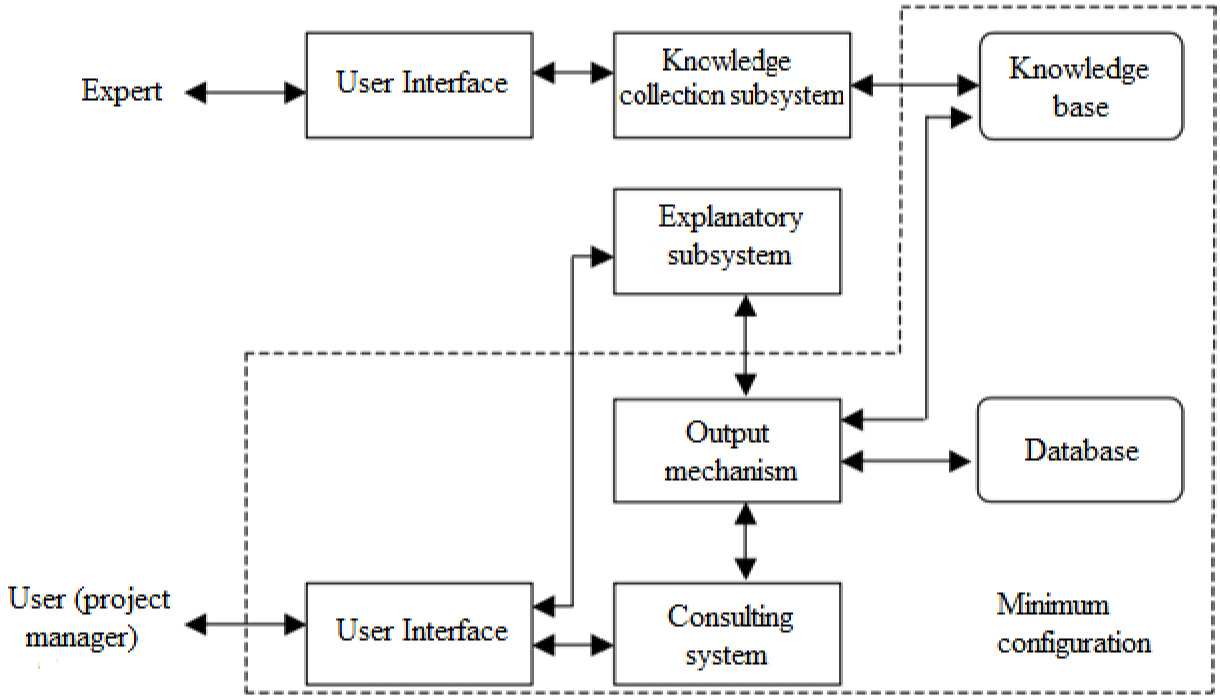


***Figure 1. Structure of the expert system***

The database of the expert system contains facts – information about the current state of the object. The facts appear in the database during the consultation process as a result of the user's response to the expert system's questions. They can also be produced by the expert system itself (the inference machine) in the process of agreeing on facts and rules.

An important part of the expert system is a mechanism or inference machine that searches for suitable rules in the knowledge base and reconciles them with the facts. The inference mechanism provides the construction of conclusions. The action of the inference mechanism is similar to the reasoning of a human expert. The inference mechanism is a rule interpreter that uses rules and facts to solve the problem. He carries out the formation of problematic hypotheses and checks them for compliance with the goal. The knowledge collection subsystem and the developer interface provide access to knowledge and data bases and are used by the developer of the expert system to fill the system with rules. During the operation of the expert system, the knowledge collection subsystem can be used to adjust the rules, to change existing rules and add new ones. The consulting subsystem and the user interface are designed to ensure the user's interaction with the system during the consultation. The explanatory subsystem allows the user to realize, "see" the chain of logical inference. The presence of this component significantly increases the user's confidence in the recommendations of the expert system.

Experience in the development and use of expert systems, including for troubleshooting complex technological facilities, suggests that when developing an expert system, the principle of openness should be adhered to, which implies the possibility of making changes to the system during its operation. This implies the possibility of adjusting the rules of the knowledge base.

The most open for making changes is a system in which knowledge is presented as a set of rules and facts and in which knowledge is separated from the program code implementing the output mechanism.

Rules are statements of the form:

$$A \leftarrow B1, B2 \ldots Bn,$$

where $n \geq 0$, A is the title of the rule, the sequence Bi is the body of the rule, and the elements of Bi can represent both facts and rules.

In natural language , the rules in general form can be represented as follows:

Rule N: If

Object1 = Value1, CD1=k1

Object2 = Value2, CD=k2

. . .

Object J = Value J, CD=KJ

To

Object3 = Value3, CD=k3

where: Rule, If, Then and CD are keywords used when writing rules;

Object and Value – respectively, an object from the subject area and its value,

CD is the confidence coefficient (degree of confidence), a fractional number from the range [0,1] corresponding to the degree of confidence that the state of the object is characterized by the specified value. The values of the confidence coefficient are used to calculate the confidence coefficient of the conclusion according to the Bayes formula.

When forming the knowledge base, it should be taken into account that during the consultation, in the process of coordinating facts with rules, the inference mechanism selects rules from the knowledge base in the order in which they are in the knowledge base, starting from the first. Therefore, the knowledge base should begin with the rules describing the most likely results of the consultation.

Let Pi – probability of obtaining the i–th conclusion corresponding to the rule with the number i. Then the rules in the knowledge base should be arranged so that the condition is met

$$P1 \geq P2 \geq ... \geq Pi \geq ... \geq Pk$$

It is impossible to accurately determine the probability of obtaining the i-th conclusion. At the same time, we can distinguish a group of rules for which the probability of obtaining conclusions is approximately equal: Pj=Pj+1=....=Pm

Each rule links several hypotheses to a conclusion. It takes a certain amount of time to test each hypothesis. Let's denote: tij is the time required to test the j-th hypothesis of the i-th rule. The total time Ti of testing hypotheses of the i-th rule is equal to the sum of the testing times of each of the hypotheses

$$T_i = \sum_{j=1}^{n_i} t_{ij}$$

where: ni is the number of hypotheses of the i-th rule.

For each rule, you can calculate a coefficient equal to the ratio of the probability of conclusion and the total time of hypothesis testing:

$$K_i = \frac{p_i}{T_i}$$

The coefficient Ki is greater, the higher the probability of a conclusion associated with the i-th rule and the shorter the time required to test hypotheses. Thus, in order to shorten the consultation time, the rules in the knowledge base of the expert system should be arranged in such an order that the sequence of coefficients (K1, K2, .. Ki, Kn) calculated by formula (2) is not increasing. Using the above approach allows you to streamline the rules in the knowledge base, make the expert system user-friendly due to the fact that the system will offer answers to questions that identify the most likely situation.

Conclusions:

It is possible to improve the quality of decisions made by integrating an intelligent component – an expert system - into the automated workplace of the project manager.

For knowledge representations (decision-making algorithms) in an expert system, rules should be used as the most open way to introduce changes in knowledge representation. It is possible to take into account the uncertainty of facts and the probabilistic nature of conclusions using the confidence coefficient.

The consultation time depends on the order of the rules in the knowledge base of the expert system. To reduce the consultation time, the rules in the knowledge base should be arranged in such an order that the sequence of coefficients (K1,K2, .. Ki, Kn) calculated by formula (2) is not increasing.

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