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Toolset of intellectual analysis of economic status of enterprise with application of pattern recognition

Sustainable development of the enterprise assumes that effective management decisions based on experience and knowledge. The optimal approach to the implementation of the problem is proposed on the basis of use of system analysis, the theory of pattern recognition in conjunction with tools for the intellectual analysis of economic data.

Existing methods of analysis, forecasting and decision-making for enterprise management are characterized by the universality of application and a sufficiently small range of tasks. A systematic approach to optimal management assumes the use of data mining tools to find qualitative solutions to classification, ranking, optimization, to identify hidden regularities and to develop effective management algorithms to achieve the economical goals.

The paper proposes to present a mathematical model for estimation the enterprise status not in the form of a system of formulas, but in a structural form (in the form of a decision tree). The basic concept of obtaining a solution is cognitive [1]. It is proposed to use the structural-analytical method of pattern recognition for implement the cognitive approach to the analysis of economic data and the management decisions making at the enterprise [2]. The model of status of management object (production situation) has the form of a decision tree (graph) and is made up in the learning process.

The reasons for using the theory of pattern recognition for the purpose of economic analysis of production situations are:

– the ability to search for hidden regularities based on the analysis of archival data and classifiers;

– the data verification or the detection of errors in operationally incoming data, it means, that approximate forecasts are constructed and compared with the input data;

– the absence of a sufficiently representative number of statistical sampling;

– the presence of mixed information (quantitative and qualitative);

– requirement of flexibility of the process for monitoring the enterprise status;

– the managerial decision making with elements of uncertainty;

– the need for two stages in the process of the decision obtainment and making, it is the decision obtaining as a result of the work of information technology and as a solution controlled by a specialist;

– obtaining meaningful results with a small amount of source information with the possibility of further improvement of the model as new data become available.

For intellectual investigation of the enterprise status an integrated system of automated processing of production situations with data measured in various scales (quantitative, logical, order and names) is created by the author [3]. The proposed toolset is based on the structural-analytical method of pattern recognition, statistical data processing and test theory.

The source information is represented by a training sampling in the form of an experimental data table for which the number of training sample objects, the number of different types of features and the number of classes are known. The rows of the table are the realization in the multidimensional space of different types of features. Information about the belonging of any object from the training sampling to a certain class (image) is formed as a vector of teacher instructions.

A binary decision tree is a hierarchical structure where terminal separating functions (inequalities or equalities) are located at nodes, and the vertices contain the class numbers (enterprise status). The left branch of the tree is identified with the true statement about the separation of the class, and the right is identified with erroneous statement.

In general, the task of constructing an optimal rule for the classification (grammar) of images G is posed as the problem of choosing from a grammars set G^0 a some grammar G^*, which minimizes the quality criterion

$$u = \arg\min W(G) \,|\, X^n, Y, F, B, W_0,$$

where X^n – the space of features;

Y – the set of elements of the recognizable classes alphabet;

(F, B) – pair of parametric reflections;

$F: X^n \rightarrow F(X)$ – the closure ratio X^n, which postulates the data structure and the defining element of the classification rule structure in the form of the attribute-predicate;

$B: F \rightarrow \{0,1\}$ – the reflection on the Boolean algebra, characterizes the logical structure of the pattern;

W – the cost of the classification system;

W_0 – specified admissible value of classification costs.

Terminal separating functions describe local regularities of the structural pattern in the subject domain under study. For one training sampling, it is possible to construct several classification rules having different structural complexity. Structural complexity is determined by the number of terminal separating functions. According to the structural-analytical method of pattern recognition, the classification rule is reconstructed pursuant to a binary table in which columns contain the truth values of individual terminal separating functions from a given functions set and the lines correspond to fragments of patterns in the feature space. The classification rule can be evaluated before it is restored.

The scheme of the intellectual integrated system of enterprise status recognition includes such blocks:

1. Data read-in and pre-processing.
2. Data classification.
3. Building a decision tree and evaluating its quality:

– obtaining an informative set of features with a given value for evaluating structural completeness [4];

– issuing an informative set of training sampling features;

– definition of the basic terminal separating functions which are related to all sets of classification functions for constructing a decision tree.

4. Formation of a decision tree bank.

5. Obtaining of the expert system the decision as recognition of the new enterprise status.

The classification rules are formed by the decision trees according to the format of «if – to». Such an analytical expression for describing the enterprise status contains a list of features of this status, the type of relationship with the values of their changes and logical functions of the type «AND» and «OR». According to the structural-analytical method of pattern recognition, one of the variations in the classification rule is used to identify the new enterprise status.

Conclusions. The structural-analytical pattern recognition model is an effective tool for describing the structure of complex objects in the space of various types of features and obtaining a decision tree that most fully satisfies the requirements for pattern recognition systems. In this case, decisive rules can be stored in a certain base for carrying out theoretical experiments and practical application in solving real problems, such as the formation of an informative set of indicators of the effective business activity, the diagnostics of business entity and the estimation the level of economic security [5].

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