SYSTEM FOR ANALYZING AND PROCESSING DATA ON UNIVERSITY STAFF BASED ON A FUZZY CONTROLLER WITH A FIXED KNOWLEDGE BASE

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ABSTRACT:

Scientific and methodological foundations for processing data on personnel in universities based on the use of neural networks, fuzzy inference models, knowledge bases, and databases have been developed. Methods for forming fuzzy rule bases, modeling membership functions and linguistic terms, synthesizing components of neuro-fuzzy networks are proposed. Inference algorithms have been tested on the example of various functions that reflect the nonlinear input-output dependencies of neuro-fuzzy networks. The results are implemented in the form of data processing software modules.

Keywords: personnel management, data processing, fuzzy inference, neural network, fuzzy rules, fuzzy controller, identification.

RELEVANCE OF THE TOPIC:

At present, thanks to the development of artificial intelligence, classical ones are being replaced by new systems based on the use of fuzzy logic models, fuzzy inference, and neural networks (NN), as well as their synthesis. However, despite significant theoretical and practical progress in the field of application of neuro-fuzzy networks (NFN), there are practically no developments of intelligent systems for analyzing and processing data on personnel in the activities of universities, which successfully complement the functionality of systems built on the basis of analytical models [1, 2].

This article is devoted to the development of models and algorithms for optimizing the description, identification of non-stationary objects, analysis, and synthesis of tasks of intelligent frame management systems (IFMS), which have the properties inherent in the NFN and provide a convenient interface for decision making [3,4].

GENERALIZED IFMS MODEL:

The information presented in the IFMS describes a dynamic process, belongs to the class of weakly structured data with the following characteristics: uniqueness; continuity by nature of origin, qualitative and quantitative parameters; heterogeneity (diversity) of measurement scales; non-linearity and multi-level hierarchical organization of relationships. Methodical issues of building systems for analyzing and processing data on personnel in universities are aimed at developing models of computational intelligence, the mathematical apparatus of soft computing, and taking into account the real characteristics of non-stationary objects for data processing with the required accuracy [5,6].

Figure 1 shows a diagram of the functioning of the IFMS with the adaptation program according to the data of non-stationary objects.
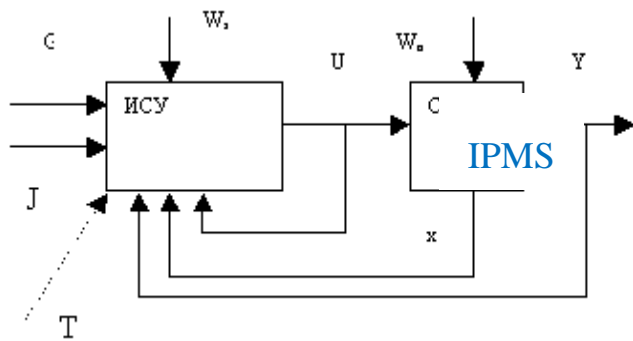
Figure 1. Generalized model of IFMS functioning.

The figure shows the following system parameters: X – internal state of the object, Y – output parameters, Ws, Wo – disturbing influences on the control systems and the object, G – target actions, U – Control actions, J – quality indicators, T – moments of time.

The design of IFMS methods involves the solution of two interrelated tasks:
- Analysis of a non-stationary object and construction of a description model;
- Synthesis of structural components of IFMS.

Since a non-stationary process is considered in the system under study and it is believed that the IFMS models reflect the dynamic behavior of the object, we will define the problems of analysis and synthesis of the IFMS in a discrete representation [7,8].

Based on the above scheme in fig. 1, the task of analyzing the IFMS is to determine the mapping

PFP:
$$U_k \times Wo_k \times X_k \rightarrow X_{k+1},$$
$$U_k \times X_k \rightarrow Y_k. \qquad (1)$$

And the task of synthesis of IMCS is to form a mapping

MS: $G_k \times J_k \times Ws_k \times X_k \times T_k \rightarrow U_k.$
$$(2)$$

where k is the quantization step (a unit of time for making a decision or issuing a control action).

The essential difference between the classical method of approximate analysis of complex systems and the approach based on

fuzzy sets and neural networks is as follows. First, to simplify the description of the object, the same mathematical structure is used as that of the complex model, and simplification is achieved by discarding that part of the model that is considered the least important [9,10].

Secondly, there is a transition to the use of other mathematical structures that allow us to consider the object as a whole, but at a less detailed level. Simplification is achieved by eliminating non-essential details.

An important feature of neuro-fuzzy models is that they serve as a bridge between two approaches - quantitative and qualitative modeling, and are an effective optimization mechanism in the description of an object, analysis and synthesis of IFMS [11,12].

Construction of systems for processing data on personnel based on NFN. Technical analysis tools are a common way to process frame data in the form of time series. The fundamental disadvantage of such systems is that they are based on an extensive retrospective of the predicted series and it does not explicitly use the information on other factors [13]. Technical analysis is too hard a limit, which in reality is often not met.

The most valuable property of the NFN is the ability to successfully solve analysis problems in which it is difficult, often impossible, to find analytical relationships between input and output parameters; find optimal indicators of time series dynamics; build an optimal prediction strategy based on them; work in multidimensional spaces, including spaces of mixed type, in which some of the variables are continuous, and some are discrete.

The key element of such an IFMS is fuzzy controllers (FC) that operate on the basis of computational schemes of the NFN. At the same time, the use of fuzzy models provides a relatively simple way to control complex systems that have significant non-linear

behavior. The fuzzy rules that make up the fuzzy controller represent the knowledge or experience of the operator. FCs with a fixed knowledge base (KB) is known as static fuzzy controllers [14]. In this case, the knowledge base of the controller (control rules) is formed on the basis of the knowledge of the operator who followed the course of the process. The next direction in the development of FC as adaptive controllers is the creation of self-organizing fuzzy logic controllers [15].

A design scheme for a self-organizing controller with quantifiers has been developed, the main purpose of which is to set up the rule base for various situations. The rule base for different situations may contain not only different rules but also different values of the characteristics of fuzzy sets and the corresponding linguistic variables.

Conclusions based on the results of information processing are determined by an expert and may include not only deviations of the output coordinate from the required value, but also take into account various restrictions regarding the general nature of the system functioning.

The most complete is the self-learning scheme for constructing the NFN, which includes a heuristic knowledge base in the form of a set of tables, fuzzy controller rules, where each of the tables is determined by its own rules for inclusion in the control loop, the actual database, the main purpose of which is to identify new patterns in the practical process control. At the same time, with the help of the database, the knowledge base is trained, the boundaries of the intervals of the values of linguistic variables in the quantifiers are determined.

The main task of forming the KB of fuzzy rules of the IFMS is the synthesis of various models for describing the subject area, which provide optimal control of the input random process.

KNOWLEDGE BASE NFN MODELS:

It has been determined that among the known models of logical, production, frame, neural and semantic, production models of knowledge are most suitable for describing the subject area under consideration, with the help of which it is possible to naturally describe the declarative experience of a person, his intuition and logic of behavior. In this regard, we define the linguistic production model (LPM) as the basic mathematical model. A feature of the model is that it reflects the relationship between the variables of the object. Figure 2 shows NFN with self-learning.
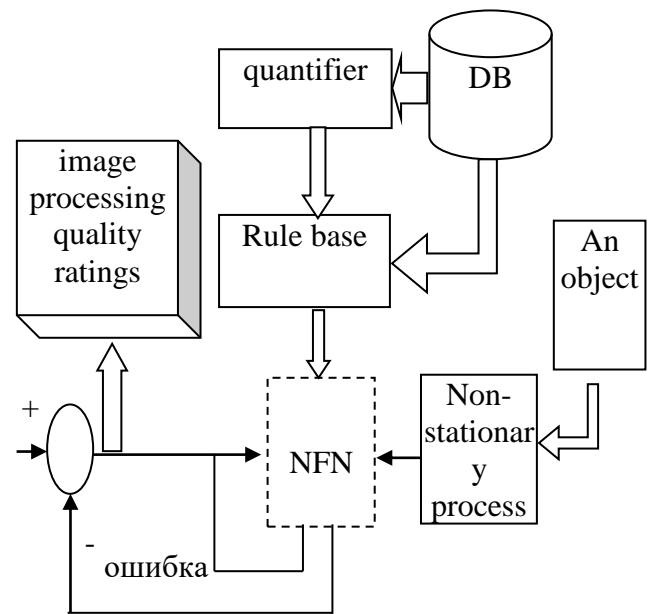

Figure 2. NFN with self-learning.

To solve the problems of analysis and synthesis of IFMS, we introduce into consideration an algebraic system, with the help of which model (1) or (2) can be replaced by some algebraic structure.

In general terms, the data of the table of linguistic rules are mappings of terms - the set S onto itself, that is, mappings of the form

$$S \times S \to S \tag{3}$$

Realizations of the laws of composition of an algebraic system for the term set S={NB,NM,ZE,PM,PB} are obtained, which are given in Table. 1,2.

$+: S \times S \to S$	NB	NM	ZE	PM	PB
NB	NB	NB	NB	NM	ZE
NM	NB	NB	NM	ZE	PM
ZE	NB	NM	ZE	PM	PB
PM	NM	ZE	PM	PB	NB
PB	ZE	PM	PB		NB

Table 1. Internal law of composition

$x: \Omega \times S \to S$	NB	NM	ZE	PM	PB
-2	PB	PB	ZE	NB	NB
-1	PB	PM	ZE	NM	NB
-1/2	PM	ZE	ZE	ZE	NM
0	ZE	ZE	ZE	ZE	ZE
1/2	NM	ZE	ZE	ZE	PM
1	NB	NM	ZE	PM	PB
2	NB	NB	ZE	PB	PB

Table 2. External law of composition

IMPLEMENTATION OF IFMS IN THE UNIVERSITY:

The stated theoretical provisions, methods and algorithms of data processing are implemented as independent software modules as part of the software of an intelligent system for analyzing and processing data based on the NFN. Appropriate databases have been created for the functioning of IFMS at Samarkand State University.

The database "Personnel of the University" includes the full volume of accounting and questionnaire indicators of the professorial teaching staff and researchers, normative reference books of the university, various structural divisions, etc.

The content of the databases makes it possible to calculate the scientific rating of each employee for any period, as well as the aggregate ratings of the university departments.

The following indicators were used for the analysis: the number of researchers; average age of researchers; the number of employees in each age group; the volume of scientific products (cumulative scientific rating) issued for the selected period; the average scientific rating of each age group.

The dynamics of the indicator "the degree of relevance of scientific topics", the reduction in the number of researchers, scientific publications, the dynamics of the age structure of scientific personnel have been studied.

The distribution of research workers by age groups is determined. The following age groups of researchers have been adopted: up to 35 years; 36-45 years old; 46-55 years; 56-65 years old; over 65 years old. Note that when conducting experimental studies on the available databases, to take into account the influence of different age groups, the boundaries were varied.

It has been determined that scientists of the older generation are more actively involved in scientific activities. This is natural, since, with age, scientists accumulate a solid knowledge base, often scientific schools function under their leadership, etc.

The quantitative and qualitative analysis carried out on the basis of actual data made it possible to identify both positive and negative trends in the activities of scientific personnel and professorial teaching staff.

CONCLUSION:

The developed NFN models and methods for their synthesis form the scientific and methodological basis for designing effective and promising technologies for intellectualizing the analysis and processing of personnel data in universities, which are focused on using the unique properties of

neural networks, statistical and dynamic characteristics of these non-stationary objects. The studied features and distinctive features of the methods of analysis and synthesis for solving IFMS problems, the proposed models made it possible to build self-organizing systems for analyzing and processing personnel data based on the formation of fuzzy rule bases, the selection of appropriate linguistic terms and the development of inference algorithms. Based on the proposed methods of analysis and synthesis of models, the IFMS software was developed, which was tested on real examples.

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