A System for Analyzing and Processing Data on the Quantitative and Qualitative Characteristics of University Staff Based on the Apparatus of Soft Computing

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ABSTRACT

Models and algorithms for optimizing the description, identification of non-stationary objects, analysis and synthesis of tasks of intelligent personnel management systems have been developed that have the properties inherent in neuro-fuzzy networks and provide a convenient interface for decision-making. Methods for forming fuzzy rule bases, modeling membership functions and linguistic terms, synthesizing components of neuro-fuzzy networks are proposed.

KEYWORDS: *data mining, data processing, fuzzy inference, neural network, fuzzy rules, linguistic terms, identification.*

Relevance of the topic. Despite significant theoretical and practical advances in the field of application of data mining algorithms based on neural networks (NN), fuzzy set models, fuzzy inferences, neuro-fuzzy networks (NFN), there are practically no developments of intellectual analysis and processing of data on personnel in the activities of institution of higher education (IHE), complementing the functionality of analytical models [1,2].

Generalized IFMS model. The information presented in the intelligent frame management systems (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 interconnections [3,4].

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.

In general, the advantages of using fuzzy sets in modeling lies in the simplicity and generality of the description and presentation of the logic of the system operation. The essential difference between the classical method of approximate analysis of complex systems and the method based on fuzzy sets and NN is as follows. First, to simplify the description of the object, the same mathematical structure is used as that of a complex model, and simplification is achieved by discarding that part of the

model that is considered the least important. 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 [5].

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 [6].

Building systems for analyzing and processing data on personnel based on the NFN. Currently, the greatest success in the design of IFMS based on the NFN has been achieved for systems with the property of "intelligence in the small", where the description of a dynamic object is reduced to the determination of suitable fuzzy differential or difference equations according to the best fit criterion. IFMS with the property of "intelligence in small things" are not structurally organized and do not correspond to the system-wide design principles [7].

In the system under study, only knowledge about the object in the form of rules, the object model, its properties and behavior dynamics are used to overcome the uncertainty in the input information. 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 [8,9].

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 [10].

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 [11]. For example, when the output coordinate is “far” from the target value, one set of rules is applied, another set of rules is applied with more precise control, and so on until the required accuracy of data processing in the IFMS is achieved.

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 structure of the NFN with self-learning is shown in fig.1.

The main task of forming a knowledge base of fuzzy rules for IFMS is the synthesis of various models for describing the subject area that provide optimal control of the input random process.

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.

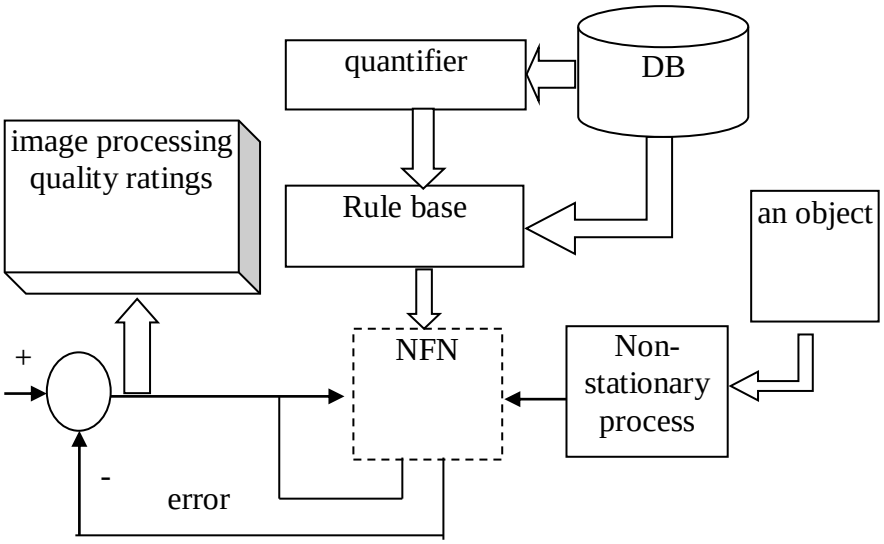

Fig. 1. NFN with self-learning.

As a basic mathematical model, a linguistic production model (LPM) is defined, the peculiarity of which is that it reflects the relationship between the variables of an object.

The results of the implementation of IFMS in the IHE. To analyze the effectiveness of the developed intelligent system for analyzing and processing data, the following indicators were used, presented by the personnel department of the Samarkand State University of the Republic of Uzbekistan: 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 [12]. 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.

Experimental studies were carried out on the basis of a database of personnel, which are necessary in the analysis of the influences of various age groups within the limits of variation. In table. The data shown in table 1 show how much the number of researchers in the age groups 36-45 and 46-55 has changed over the years, taking into account admission, dismissal, natural transitions to the next age group and from the previous age group. The minus sign indicates a reduction in the number of researchers in the age group.

Table 1. Change in the number of university researchers by years

Age group	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
35-45 years old	-31	-9	-16	-8	-7	-8	-6	0
46-55 years old	5	-2	3	2	-10	-9	-14	-6
Total	-26	-11	-13	-6	-17	-17	-20	-6

As can be seen from the table, there is a steady decrease in the share of researchers in the age groups of 36-45 and 46-55 years, as well as an equally stable increase in the share of employees over 55 years of age. Figure 2 shows the unambiguous dynamics of the curve of the total scientific rating of scientific personnel, which has ups and downs.

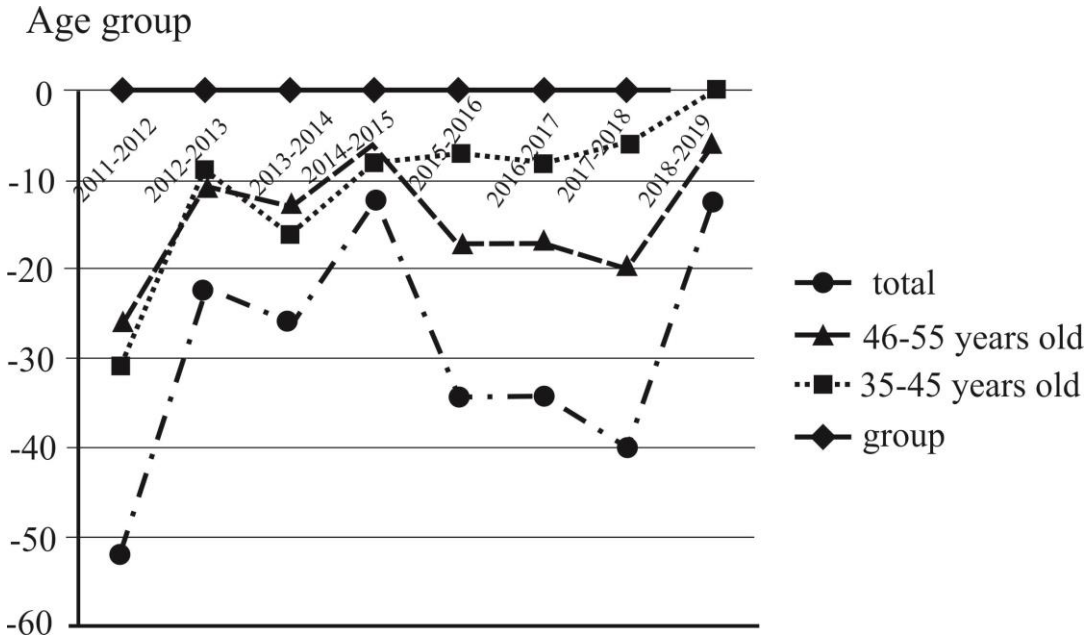

Fig.2. Dynamics of rating indicators of scientific work

The increase in the rating indicator is explained by the introduction of a scoring system for evaluating scientific activity [13].

It has been determined that scientists of the older generation are more actively involved in scientific activities. This is natural, as with age, scientists accumulate a solid knowledge base, often scientific schools function under their leadership [14].

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, methods for their synthesis form the scientific and methodological basis for designing effective and promising technologies for intellectualizing the analysis and processing of data on personnel in universities, focused on using the unique properties of neural networks, statistical and dynamic characteristics of information. The studied features and distinctive features of the analysis and synthesis methods for solving IFMS problems, as well as the proposed models, make it possible to use self-organizing systems for analyzing and processing data based on the mechanisms for generating bases of fuzzy rules, selecting membership functions for the boundaries of the corresponding linguistic terms and intervals of fuzzy sets, as well as algorithms for inference.

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