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Use of information systems in environmental management

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The features of information systems in environmental management. Established the feasibility of using neural network modeling for the development of environmental monitoring as an example for environmental monitoring roadside area highways.

Environmental management information systems , environmental monitoring, highway .

The main feature of environmental management is to harmonize the two highly complex dynamic systems - natural and man having a large number of internal relationships between elements and subsystems.

The need for development and improvement of environmental management information systems due to both internal (information support of decision -making environmentally sound management to implement the national environmental strategy, environmental policy) and external (compliance with international environmental obligations) needs.

The purpose of research - the study of specific features of information systems in the organization of environmental management , including environmental monitoring at local, regional, national and international levels.

Materials and methods research. In Ukraine, the formation of an environmental management information systems , as well as other components of the national information infrastructure must be in accordance with certain international standards.

The development of information systems in the social sciences and the environment in particular took place in three stages.

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Stage 1 . First-generation systems that overseas called " electronic data processing systems » (Data processing systems), and in Ukraine - " Instrumentation and Control " (ACS) , based on the use of " specified approach ." That is, to solve every problem in the system data separately formed and created appropriate algorithmic model. The disadvantage of such systems is their information and algorithmic redundancy because they are too focused on the application and automated "paper" technology.

Stage 2 . Of second generation known as " Management information systems » (Management information systems). The structure of such systems is focused on operational data processing, which is characterized by a structured flow of information , integration of data processing tasks . The advantage of such systems is the possibility of collective data access , creation of a single database with centralized management. Such systems are also called - " Database Management Systems " (DBMS). The main disadvantage of such a structure is the presence of excessive database and problem description of the data itself . Now there is an intensive development and wide dissemination of information systems, which are based on RDBMS.

Step 3 . The structure of the information systems of the third generation (act now) is focused on the overall analysis and algorithmic models of decision making , called " Decision Support Systems " (Decisiun Support Systems). They are computer automated systems , which aim to help people who make decisions in difficult conditions for complete and objective analysis of the subject activity. Decision Support Systems (DSS) resulting from the merger of management information systems and database management systems [3].

For the analysis and presentation of proposals in DSS use different methods of information retrieval, data mining, search for knowledge in databases , reasoning based on precedent , simulation, evolutionary computation , genetic algorithms , neural networks, situational analysis , cognitive modeling , and others. Some of these methods are developed within the artificial intelligence and are called intelligent DSS or ISPPR [1, 2].

The primary objective in the organization of environmental monitoring roadside area highways is to identify hazardous and potentially hazardous sections of the road to accommodate them points for environmental monitoring. Given the complexity and duration of the experimental studies , the nonlinearity changes the input parameters and the actual impossibility of internal change tracking system links it is advisable to synthesize the corresponding neural network, which would be under conditions of incomplete information and fuzziness expected quality of roadside space - carried out advisory and expert functions , using as criteria authenticity and reality of the results of experimental studies.

Results. Requires construction of this model were identified 5 variables that are incorporated into it . Work model defined by stable conditions with respect to area traffic climatic zoning category and type of road surface.

During the synthesis of probabilistic neural network for evaluating the quality of roadside space used as input values: the average speed of traffic flow , equality, intensity, turnaround time operation, longitudinal slope (Table).

Actual and target range change input values

S, km / h	P, cm / km	l. / Day M	L years	P, ‰
23 – 105	45 – 160	839 – 11162	1 – 29	0 – 20

The input data for the network is the number of categories (image) to which the resulting set of input variables. Neural network layer is adding one element for each category of training set data - 3. To all elements of this layer connections go only element layer of samples belonging to the corresponding image. Key element layer samples is determined by the formula.

$$O_j = \exp(\frac{-\sum (w_{ij} - x_i)^2}{\sigma^2}), \quad (1)$$

where w - the value of weighting coefficients ; □ - parameter that specifies the width of the function , xi - unknown input pattern.

Weighted value of bonds coming from the elements layer designs to add a layer of elements are fixed to 1. The element layer add summarizes the values of output layer samples. This amount gives an estimate of value density function probability distribution for a set of instances of the appropriate category . Original elements are threshold discriminators indicating element adding layer with maximum activation (ie, pointing to one of the 3 categories).

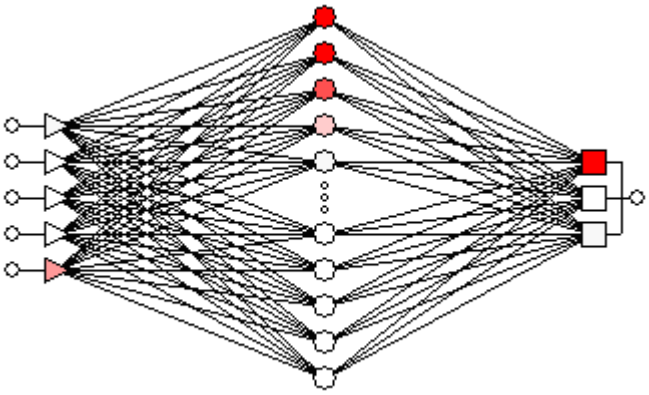
In the context of the work task requires not so much a discrete classification as getting value adding output layer , which calculates the probability density distribution for a set of instances of the appropriate category. That is, the output of this layer is the ability to track the dynamic changes or potential changes belonging to one of the 3 categories. It does not happen strict indication categories, and the probability of belonging . By creating a calibration scale can be in terms of Bayesian statistics to know the quantitative assessment of contamination.

An important limitation of this approach is the lack of statistical framework encompassing all theoretically possible range of values for assessing the quality of roadside space: 1,0 - 4,0 points. However, the study selected typical areas of roads , which can with some certainty to conclude that the other within the region. Given the feature modeling using neural networks, their ability to synthesis , informal and approximate conclusion , we can state that sufficiently accurate simulations carried out in the range of greater than at least 20% of budget : 1.35 - 3.45 points.

For the synthesis and study of appropriate neural network used software package Statistica 7.0 Neural Networks. Functional criterion is to minimize the error of the neural network in the absence of retraining.

In order to test operation of the neural network in each categorical units during the study were randomly excluded two sets of input and output variables for use in checking the work synthesized probabilistic neural network.

Architecture probabilistic network constructed within the work contains 5 neurons in the input layer , 51 neuron layer calculate the density distribution and 3 output neurons (Fig. 1).



Rice. 1. Architecture probabilistic neural network quality assessment roadside space

Optimization of parameters neuromodels based on linear approaches and methods simulating "annealing" to the Gibbs probability distribution:

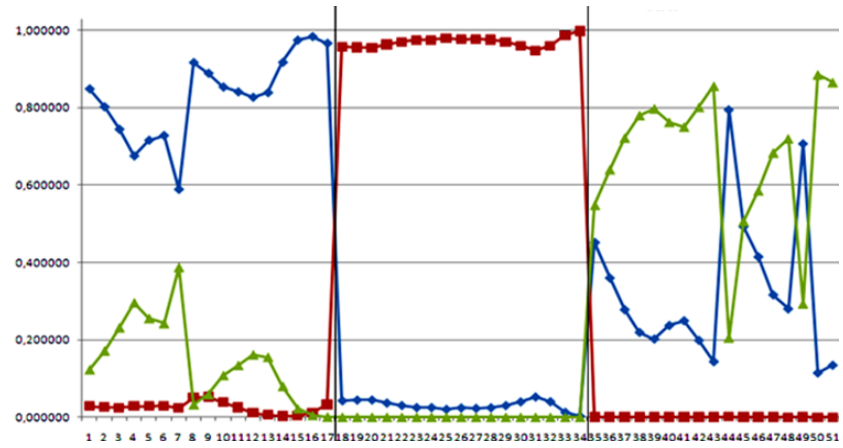
$$P(\overline{x^*} \to \overline{x_{i+1}} \mid \overline{x_i}) = \begin{Bmatrix} 1, F(\overline{x^*}) - F(\overline{x_i}) < 0 \\ \exp(-\dfrac{F(\overline{x^*}) - F(\overline{x_i})}{Q_i}), \; F(\overline{x^*}) - F(\overline{x_i}) \geq 0 \end{Bmatrix}, \qquad (2)$$

where Qi> 0 - elements arbitrarily decreasing to zero sequence ; F (x) - probability density function.

Based on empirical considerations smoothing coefficient - 0.25.

Having creation and training of probabilistic neural network for evaluating the quality of roadside space, got the following values of mean square error learning in terms of output : a training unit - 0.16 %, the control unit - 0.17 %, the test unit - 0.15 %. That is , neural network "not zavchyla " sample training data , classification accuracy is 96.1 %. The quality of the simulation obtained during training satisfies the technology requirements .

This analysis charting the probability distribution shows that the neural network "feels " a certain affinity sites "A" and "C" (Fig. 2).



Rice . 2. Charts density probability distribution

Analysis of the results that were obtained during the test work on samples of neural network data that were not used during the study showed deterioration of the simulation, which is common in network processing unknown sets. Of the six data sets correctly classified 5: precision operation established probabilistic neural network - 83.3 %. Also at 10 - 25 % reduction in the density of probability distribution category winners . However, the overall quality of the simulation remained sufficient for practical application of established neural network.

The next step is the creation of advisory systems generate program code neural network that can be used in other environments , which were used functionality of the package Statistica Neural Networks and recoded neural network programming language C + +. However, given the lack of fullness of domain experimental data , initially using only neural models for qualitative analysis is inadequate. Therefore, processing the output of the neural network will make the appropriate regression equation (Fig. 3), which was obtained by processing the input data (Fig. 2).

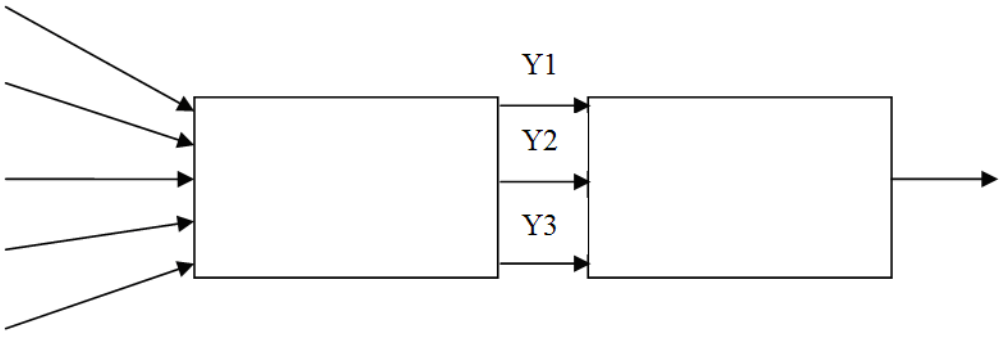


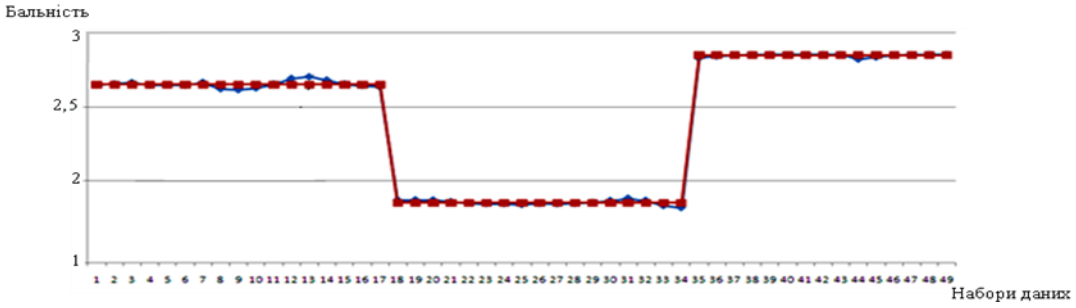
Рис. 3. Структура нейромережево-регресійної моделі оцінки якості

придорожнього простору

Незалежними змінними є виходи трьох шарів додавання нейронної мережі (Y1, Y2, Y3), які вираховують щільності розподілу ймовірності для сукупності примірників відповідної категорії, залежною змінною – значення бальності.

Обробка експериментальних даних здійснювалась у програмному пакеті Statistica 7.0 Neural Network, одержано нелінійне рівняння регресії для бальності; при рівні ймовірності 0,95, коефіцієнті множинної детермінації 0,997, коефіцієнті множинної кореляції 0,998, стандартному відхиленні оцінки 0,126 (рис. 4).

$$B = -3{,}60804 + 13{,}02108 \cdot Y1 - 6{,}76729 \cdot Y1^2 - 0{,}8476 \cdot Y2 + 6{,}26728 \cdot Y2^2 + 6{,}45207 \cdot Y3^2 \quad (4)$$



Rice . 3. The structure of neural network - regression model quality assessment roadside space

The independent variables are the outputs of three layers neural network add (Y1, Y2, Y3), who calculated the density of the probability distribution for a set of instances of the respective category , the dependent variable - value balnosti .

Processing of the experimental data was performed with the software package Statistica 7.0 Neural Network, a non-linear regression equation obtained for balnosti , with equal probability of 0.95, the coefficient of multiple determination 0,997 , multiple correlation coefficient 0.998 , standard deviation estimates 0,126.

Conclusions

1. It is the third generation of information systems in their capabilities and capacity meet the class of problems facing the environmental management system . The implementation of such systems is designed to provide a new quality management , improve its efficiency, effectiveness and character features more responsible environmental management. In Ukraine , such methods have increasingly theoretical application.

2. A more practical value today for national environmental management systems have modernization and development of specialized information systems ecological considered ranyshe - namely, state nature inventories , Environmental monitoring , environmental mapping , environmental and economic balance areas, geographic information systems , and more.

3. We prove the feasibility of neural modulation for the development of environmental monitoring of roads in terms of incompleteness and fuzziness of information.

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