

SYSTEM OF PROCESSING OF TECHNOLOGICAL INFORMATION

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The problems of information processing in solving the technological preparation of production were considered. For this purpose use the effective methods of multivariate statistical analysis and artificial neural networks. Compression algorithms in the original array of information by factor analysis methods, component analysis and multidimensional scaling, classification algorithms and pattern recognition methods of discriminate and cluster analysis, as well as algorithms for modeling of group account of arguments and artificial neural networks were implemented with software. The programs are presented in the form of automated processing technology information. Structural scheme of the developed system, as well as the sequence of interface windows in the application of this system is shown.

Keywords - technological preparation of production, information processing, multivariate statistical analysis, method of group account of arguments, artificial neural networks.

В статті розглянуто питання обробки інформації при розв'язанні задач технологічної підготовки виробництва. Для цього пропонується використовувати ефективні методи багатовимірного статистичного аналізу і штучні нейронні мережі. Програмно реалізовано алгоритми стиснення початкових масивів інформації методами факторного, компонентного аналізу і багатовимірного шкалування, алгоритми класифікації і розпізнавання образів методами дискримінантного і кластерного аналізу, а також алгоритми моделювання методами групового врахування аргументів і штучних нейронних мереж. Вказані програми представлені у вигляді системи автоматизованої обробки технологічної інформації. Приведено структурну схему розробленої системи, а також послідовність інтерфейсних вікон при використанні даної системи.

Ключові слова - технологічна підготовка виробництва, обробка інформації, багатовимірний статистичний аналіз, метод групового врахування аргументів, штучні нейронні мережі.

Setting of problem

Technological preparation of production is characterized by the set of tasks. The quality of their decision on a computer significantly depends on the initial information for a specific task, the mathematical model of the object or process and the method of solving the problem. Analysis of scientific and technical domestic and foreign literature has shown that improving the efficiency of technological preparation of production is limited to insufficient use of modern information technologies at all stages of the design. For proper solving technological problems it is necessary to reduce the number of inputs, while retaining their original informative, perform classification, clustering and pattern recognition, modeling and prediction of output parameters.

There is a set of systems that can solve the abovementioned problems. The most common ones are the following systems: SPSS, STATISTICA, VORTEX, STATA, JMR, MINITAB and others. However, they are complex, multifunctional, expensive, and therefore their use for solving technological problems is not advisable.

Therefore, the task of creating a simple, easy to use, familiar to users and cheap automated system that would ensure implementation of necessary technological information processing functions.

Solution of the problem

Analysis methods of information processing showed that to meet the challenges of technological preparation of production appropriate to use statistical techniques are effective compression vast databases without loss of information content, methods of classification, clustering, and pattern recognition. [1].

Array's compressing of technical data, implemented methods factor, component analysis and multivariate scaling method can significantly improve information content of the results of studies simplify solving a number of problems of technological preparation of production by reducing attribute space and reduce the time solution of various technical problems and improve the quality of the solutions [2].

Classification, clustering and pattern recognition techniques are implemented cluster (hierarchical and fast) and discriminant analysis, can successfully solve problems of determination of construction material's characteristic that affect their technological properties, objectively classify the construction materials for a set of characteristics, given the choice of analogue construction materials selection process for the manufacture of new detail by the method of drawing a set of similar problems [3, 4].

Analysis and comparative evaluation of methods used mathematical modeling used in solving technological problems, has shown that the most promising methods of modeling and predicting process parameters and solve the problems of classification, pattern recognition and decrease the dimension of the factor space is the use of artificial neural networks and methods heuristic self-organization - group method taking into account the arguments [5].

These methods of multivariate statistical analysis and mathematical modeling made the core of the established system of automated processing of information technology [6].

The algorithms and programs that implement the specified methods of information processing that can perform the corresponding calculation, both independently and as part of an automated system.

System of automated processing of technological information consists of two main parts:

- Control unit initial information;
- Functional unit.

Block diagram of an automated system is shown in Figure 1.

Control unit initial information consists of programs to create tables of initial data, editing and deleting from the database.

The functional unit consists of a cluster of programs, discriminant, component analysis, multidimensional scaling, information analysis, mathematical modeling and forecasting.

The program of cluster analysis consists of routines hierarchical classification and classification by algorithm «k-Medium". Factor analysis is implemented using data compression routines, using the method of principal factors and maximum plausibility. Multidimensional scaling consists of routines for data compression methods of Thorherson and Orlochi.

Analysis of initial information is made by correlation techniques implemented and one-factor analysis of variance.

Artificial neural networks for forecast of technological parameters are represented as a direct distribution network with learning of back propagation algorithm, namely the Levenberg-Marquardt algorithm, and for classification - probabilistic artificial neural network.

To solve the problems of mathematical modeling and forecasting technological parameters provided by group method of incorporation of arguments (GMIA), according to which the search for a model of optimal complexity by using multi-algorithm equating to zero the coefficients of a polynomial on each full row selection.

This system-functional block implemented in the programming language C + + Builder XE, which uses one of the fastest compilers of present time. This ensures high performance computing even on low-power computers.

To work in the established system developed user interface, the main menu is shown in Figure 2.

By default, all main menu items except item "File" and "About system" are locked, and the system reports that the database that contains the required data tables are not connected. To perform information processing operations need to connect related data by selecting the submenu "Select database" main menu item "File" (Figure 3).

After connecting the database, the system notifies you that the base is connected and enter the full path to the database, as well as its name.

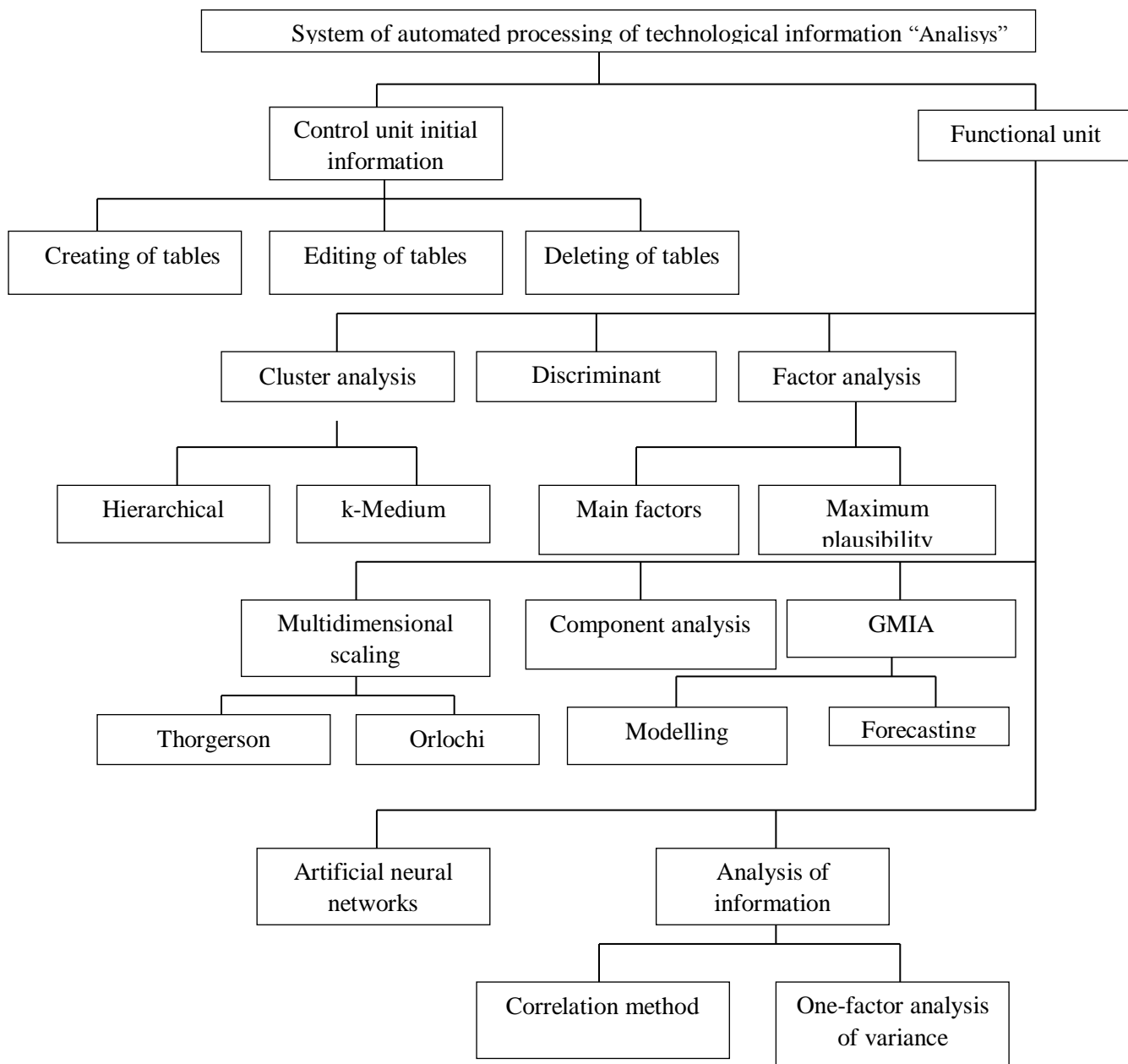


Figure 1. Block diagram of an automated system.

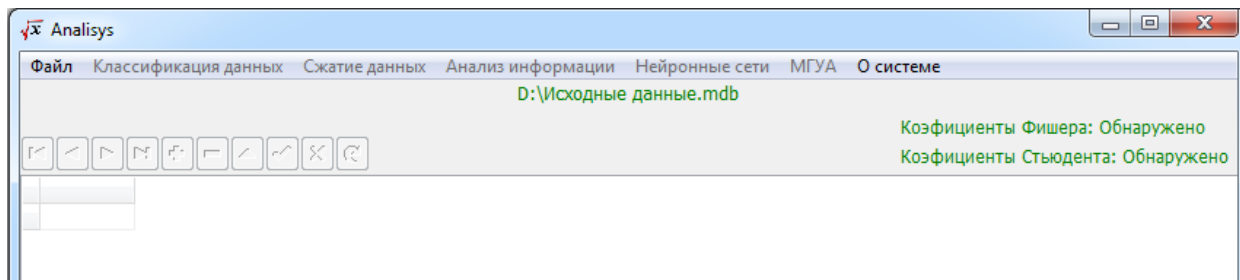


Figure 2. Window with main menu of system.

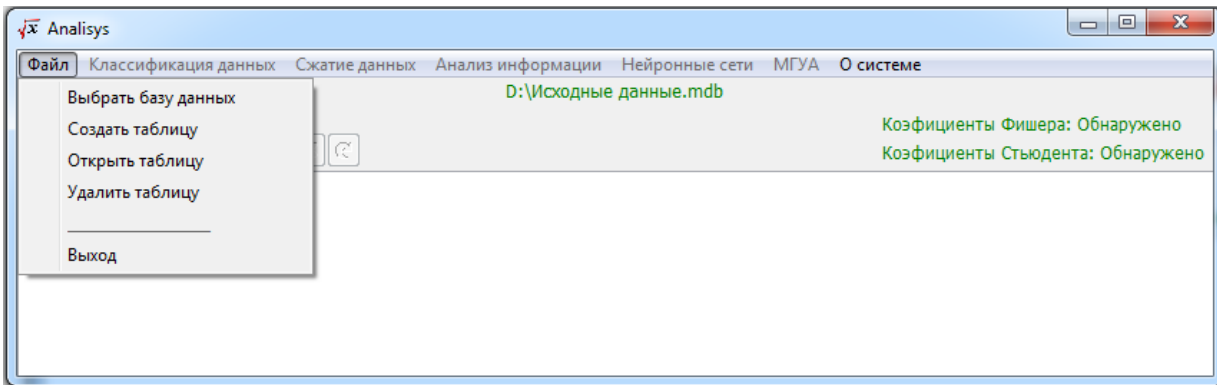


Figure 3. Window of database choice

When you create a new table of data on the screen will appear window with information which proposes a table's name and number of parameters that characterize it (Fig. 4).

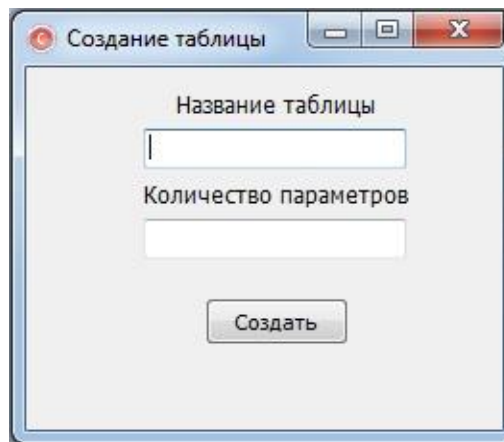


Figure 4. Window of table's name and quantity of parameters

After creating a new data table must select the submenu item "Open Table" to fill it with the necessary information. After the procedure input arrays receive initial information window systems prepared for processing the information provided array of information.

If necessary calculations based on an existing database information array must select menu "File" - "Open Table" (Figure 5).

Availability of information in the information system's window activates the main menu items System - "Classification of data", "Compression of data", "Analysis of information", "Neural network" and "GMIA" (Fig. 6).

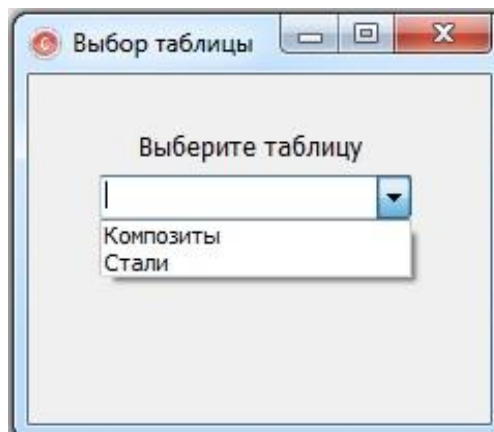


Figure 5. Window for choosing table's name with existing information array.

The system allows you to select one of the methods for processing arrays of initial information that will be available to the user when displaying this information in the main window of the system (Fig. 6).

Название	Группа	C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B
Сталь_45ХН2МФА	0	0,46	0,28	0,65	1,5	0,025	0,025	1	0,3	1420
Сталь_34ХН3М	0	0,35	0,28	0,65	3	0,035	0,03	0,9	0,35	885
Сталь_30ХН2МА	0	0,31	0,28	0,45	1,5	0,025	0,025	0,8	0,3	980
Сталь_50	0	0,5	0,25	0,65	0,25	0,04	0,035	0,25	0,25	530
Сталь_55	0	0,55	0,28	0,65	0,25	0,04	0,035	0,25	0,25	570
Сталь_40	0	0,4	0,28	0,65	0,25	0,035	0,035	0,25	0,3	520
Сталь_58	0	0,59	0,2	0,2	0,25	0,04	0,035	0,15	0,25	600
Сталь_40ХН2МА	0	0,38	0,28	0,45	1,5	0,025	0,025	1,45	0,3	1080
Сталь_40ХГНМ	0	0,4	0,28	0,65	0,9	0,035	0,035	0,8	0,3	980
Сталь_20ХГНМ	0	0,2	0,28	0,9	0,6	0,035	0,035	0,6	0,25	1450
Сталь_20ХГНР	0	0,35	0,28	0,9	1	0,035	0,035	0,9	0,3	1420
Сталь_12К	0	0,12	0,28	0,65	0,3	0,04	0,04	0,3	0,3	350

Figure 6. System's window, which is prepared for processing of information array.

The results of each method of processing information can be displayed on screen or saved to a file. To do this, after data processing, it is necessary in the window that appears, choose the appropriate way to display the results (Fig. 7).

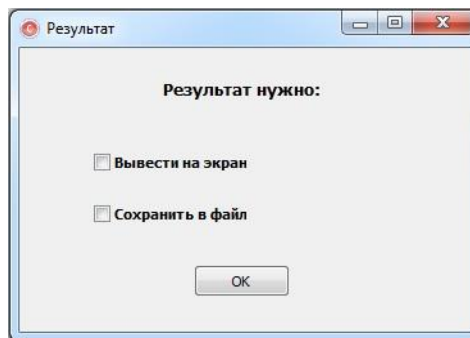


Figure 7. Window for choosing output method for results of processing.

As an example, in Figure 8, the window of choosing objects classification method by cluster analysis using a hierarchical classification or rapid cluster analysis (k-medium method).

Figure 8. Window of choosing classification method by cluster analysis.

In the case of object classification by method of k-medium system will prompt the user to specify the number of clusters (Fig. 9), which must share objects that are listed in the main window of the system.

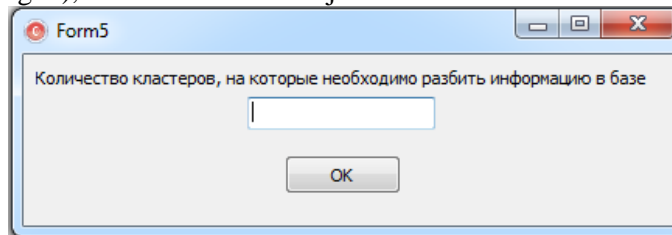


Figure 9. Window for input quantity of object classification groups.

The initial data containing the chemical composition, physical and mechanical properties of construction alloy steel and construction carbon steel and results of information compression by component analysis are shown in Figures 10 and 11.

Similarly, the system implements all the other information processing in accordance with the methods described in the main menu system.

Название	Группа	C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T
Сталь_36Х2Н2МФА	0	0,37	0,28	0,35	1,5	0,025	0,025	1,5	0,3	1180	1
Сталь_45ХН2МФА	0	0,46	0,28	0,65	1,5	0,025	0,025	1	0,3	1420	1
Сталь_34ХН3М	0	0,35	0,28	0,65	3	0,035	0,03	0,9	0,35	885	
Сталь_30ХН2МА	0	0,31	0,28	0,45	1,5	0,025	0,025	0,8	0,3	980	
Сталь_50	0	0,5	0,25	0,65	0,25	0,04	0,035	0,25	0,25	530	
Сталь_55	0	0,55	0,28	0,65	0,25	0,04	0,035	0,25	0,25	570	
Сталь_40	0	0,4	0,28	0,65	0,25	0,035	0,035	0,25	0,3	520	
Сталь_58	0	0,59	0,2	0,2	0,25	0,04	0,035	0,15	0,25	600	
Сталь_40ХН2МА	0	0,38	0,28	0,45	1,5	0,025	0,025	1,45	0,3	1080	
Сталь_40ХГНМ	0	0,4	0,28	0,65	0,9	0,035	0,035	0,8	0,3	980	
Сталь_20ХГНМ	0	0,2	0,28	0,9	0,6	0,035	0,035	0,6	0,25	1450	
Сталь_20ХГНР	0	0,35	0,28	0,9	1	0,035	0,035	0,9	0,3	1420	1
Сталь_12К	0	0,12	0,28	0,65	0,3	0,04	0,04	0,3	0,3	350	

Figure 10. System's window with initial information for data compression.

Средние значения											
C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T	E	a
0,308	0,295	0,606	1,083	0,034	0,042	0,756	0,366	853,594	661,563	7,964	12,259
Стандартные отклонения											
C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T	E	a
0,139	0,171	0,254	1,198	0,006	0,056	0,519	0,482	326,971	350,919	33,948	0,533
Кoeffициенты корреляции											
C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T	E	a
1,000	0,039	0,129	-0,345	0,176	0,216	-0,313	0,077	-0,151	-0,196	0,082	-0,049
0,039	1,000	-0,074	-0,054	-0,054	-0,011	0,317	-0,003	0,156	0,140	-0,016	0,065
0,129	-0,074	1,000	-0,311	0,250	0,064	-0,271	-0,140	0,060	0,032	-0,147	-0,332
-0,345	-0,054	-0,311	1,000	-0,756	-0,191	0,727	0,090	0,528	0,497	0,062	-0,317
Собственные значения											
4,414	2,031	1,539	1,134								
Собственные векторы матрицы											
C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T	E	a
0,144	-0,075	0,096	-0,368	0,427	0,140	-0,452	-0,170	-0,410	-0,415	-0,155	0,172
0,127	-0,009	-0,242	-0,105	-0,025	-0,027	-0,007	0,617	-0,154	-0,152	0,627	0,305
0,432	-0,045	0,541	-0,206	0,064	0,304	-0,079	0,212	0,180	0,185	0,206	-0,468
-0,251	-0,874	0,097	0,237	-0,057	-0,113	-0,161	0,077	-0,100	-0,080	0,081	-0,192
Главные компоненты											
C	Si	Mn	Ni	S	P	Cr	Cu	Sigma_B	Sigma_T	E	a
0,303	-0,158	0,202	-0,773	0,898	0,294	-0,950	-0,356	-0,862	-0,871	-0,325	0,361
0,181	-0,013	-0,346	-0,149	-0,036	-0,038	-0,011	0,879	-0,219	-0,216	0,893	0,434
0,536	-0,056	0,672	-0,255	0,080	0,377	-0,097	0,263	0,223	0,230	0,256	-0,581

Figure 11. Results of data compression by component analysis.

Conclusions

1. Improving the quality of problem solving technological preparation of production can be achieved targeted processing technology information through the use of multivariate statistical analysis methods and modern methods of modeling and forecasting was established.

2. The algorithms of multivariate statistical analysis methods and their software implementation has created an automated system to handle information technology were made.

3. The proposed automated system for processing of technological information is different from the existing statistical system simplicity, ease of operation, low cost and small requirements for technical equipment. It provides the performance necessary functions of processing information in solving problems of technological preparation of production.

4. The designed system is proposed to include in the application package used in the technological preparation of production.

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