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Application of Kohonen self-organizing maps to the analysis of enterprises' employees certification results

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Abstract. The paper deals with the problem of analyzing enterprises' employees certification results. To solve the problem, it is proposed to use Kohonen self-organizing maps for in-depth data analysis. Also, the proposed method allows to visualize the company's employees certification results for its managers in order to support decision-making. As a result of experimental studies, an effective structure of the Kohonen network was identified, which was used to solve the real problem of analysis. The proposed approach can be implemented as part of an integrated automated system in order to save personnel management time by providing analysis results in a visual form.

1. Introduction

Certification is one of the most important functions of personnel management. Its role in the organization's management system is that on certification results the managing subject makes the appropriate decisions. [1, 2]

The main functions of certification are shown in figure 1, which are [3, 4]:

- Control of the employees' labor results and abilities workers.
- Initiation of communication between the manager and the employee.
- Staff promotion.
- Formation of highly qualified personnel.

As a result, personnel certification allows to increase the overall efficiency of the organization.

Thus, the problem of analyzing the results of certification becomes quite acute. The identification of factors causing unsuccessful results, as well as their analysis, will significantly improve the effectiveness of staff training.

2. Proposed approach

To solve this problem, it is proposed to develop an approach based on the data analysis method, which would not only accumulate all the information on specific certification documents, but also be able to cluster the data and submit reports in a user-friendly form.

The analysis is proposed to be based on employee certification information for past periods of time stored in relational database tables.

Currently, bio-inspired methods are successfully used to solve a wide range of data mining tasks, among which artificial neural networks (ANN) stand out [5, 6]. One of the types of ANN that solve visualization and clustering problems are Kohonen self-organizing maps.
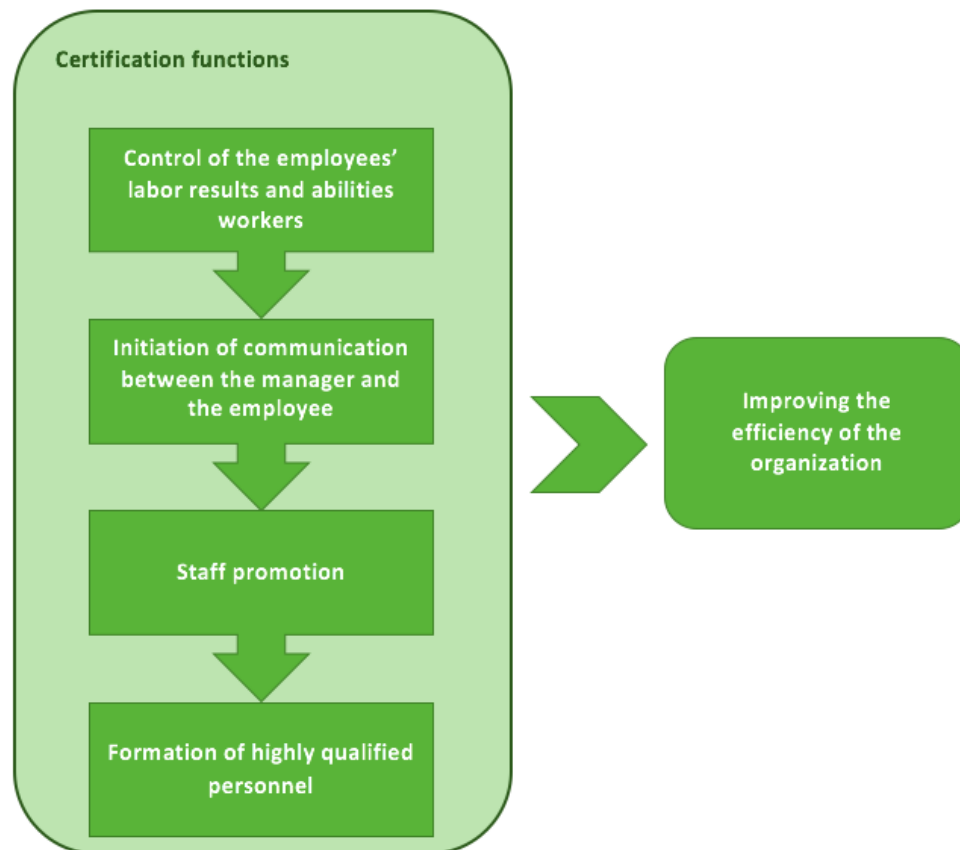

Figure 1. Basic certification functions.

The main purpose of cluster analysis is the partitioning of the objects set under investigation, characterized by a set of features, into homogeneous groups (clusters) in the corresponding understanding. This means that the task of classifying data and identifying the corresponding structure in it is being solved.

The advantages of this method include resistance to noisy data, as well as the ability to train a neural network without the participation of a "teacher". With such method, the training set consists of the values of the input variables, and in the learning process there is no comparison of the outputs of neurons with the desired values. [7 - 9]

3. Experimental study

For experimental research, data from the accountants' certification results of the particular company with several branches in different cities were used.

Eight factors were chosen as input variables for the clustering algorithm $(x_1,\ldots,x_8)$:

- x_1 – gender of employee (male or female);
- x_2 – department in which the employee works;
- $x_3, \ldots, x_7$ – number of points scored by an employee when passing certification for each of the five sections;

- x_8 – mark about passing or not passing certification by an employee;

The experiment used a sample of 56 records. A fragment of the source data is presented in table 1.

Table 1. Fragment of initial data on certification of employees.

	Input variables							
	x1	x2	x3	x4	x5	x6	x7	x8
Example 1	Male	Lenin	60	79	60	72	63	Yes
Example 2	Male	October	60	61	30	5	17	No
…	…	…	…	…	…	…	…	…
Example 55	Female	Lenin	60	61	30	66	58	No
Example 56	Male	Barnaul	85	78	72	70	85	Yes

As a result of an experiments series, it was found that the most convenient for the subsequent analysis is the splitting of the set of employees into 4 clusters.

Therefore, when solving a problem, the structure of artificial neural network will consist of two neurons' layers (figure 2):

- Input layer with 8 neurons.
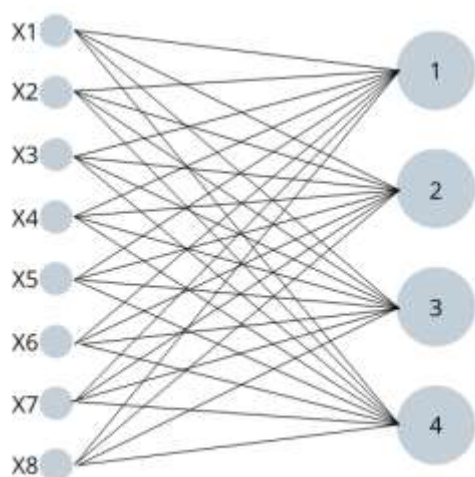- Output layer with 4 neurons.

Figure 2. Structure of Kohonen neural network for clustering employees.

At the stage of data preprocessing, the linear normalization of the input variable values was carried out within [0, 1] as follows:

- Gender of employee: 0 - female, 1 – male.
- Department: 0 - October, 0.25 - Sverdlovsk, 0.5 - Leninskoye, 0.75 - Novosibirsk, 1 - Barnaul.
- Whether the employee is certified: 0 - no, 1 - yes.

The Deductor Studio Academic analytical platform was used to work with Kohonen maps.

As a result of clustering, map colorings for each of the input factors were obtained, as well as the distribution of sample objects by clusters. Maps for the 4 most significant factors are presented in figure 3:

- Gender.
- Department.
- Results of the "Accounting" module.
- Results of the "Taxation" module.

4. Example of the certification results analysis

As a result of the information analysis of the enterprise's employees certification, the following division into clusters was obtained:

- Cluster 1: employees who have passed certification, or employees who lacked a small number of points for its passage. Errors are likely in the tests of certification tests; re-passing is required.
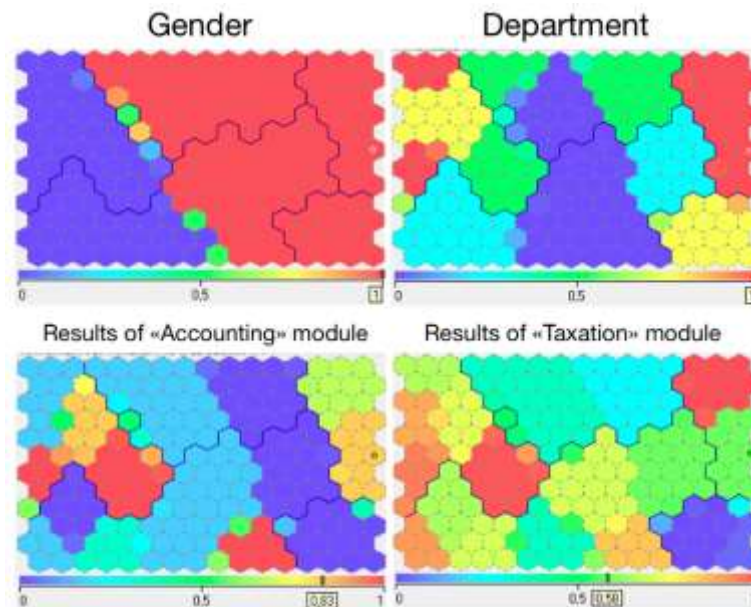

Figure 3. Data image from Kohonen maps.

- Cluster 2: employees who have not passed certification. Full mismatch of the position. Requires in-depth additional training.
- Cluster 3: employees, men, certified. Relevance to the position.
- Cluster 4: employees, women who have passed certification. Relevance to the position.

Based on the analysis performed, it is possible to rank the departments by the rating of the employees who work in them. In this case, the worst prepared were the staff of the Lenin branch. Most of its employees were in cluster 2. Accordingly, in this department, it is necessary to conduct a set of measures for additional training of employees or a review of personnel policy is necessary.

5. Conclusion

The paper solves the problem of enterprises' employees certification results analysis, the solution of which using Kohonen self-organizing cards allows for in-depth data analysis, as well as visualizing the results for managers of the organization in order to support their decisions.

The proposed methodology can be implemented as part of an integrated automated personnel certification system in order to save personnel management time by providing analysis results in a visual form.

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