Using neural network technologies to reduce information asymmetry

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Abstract. The article discusses an approach to the analysis of static information based on the use of neural network technologies. Kohonen maps were constructed on the basis of data on the yields of the main agricultural crops in four adjacent areas of the Volga region over 30 years. As a result, based on the analysis of the maps obtained, three clusters were identified: a cluster with high, medium and low yields for the main crops. Also, on the basis of a comparative analysis, regions were identified for which similar results were observed for different crops. The results obtained have a significant impact on the process of making managerial decisions regarding the use of the agricultural insurance tool.

Keywords: Kohonen maps, correlations, clusters, decision making.

1 Introduction

Information asymmetry is characterized by uneven access to the same information by the parties of economic relations. It turns out that one party, when making management decisions, has more opportunities to calculate potential risks or to assess the amount of possible income. Greater awareness can be caused, for example, by the level of professional knowledge, accumulated experience, knowledge of the specifics of a product or service, as well as their hidden properties, etc. The presence of information asymmetry negatively affects both the economy of a particular industry, and as a whole, and can also lead to the failure of the market in a particular area, as there is a shift in the optimal price of a product or service [6; 11]. The party that owns more information gets a significant share of the profit at the expense of less risk, while the other party suffers losses due to the lack of similar access to information, which may ultimately lead to bankruptcy or refusal to interact with a specific product or service [1; 3].

The problems of studying and overcoming the asymmetry of information are dealt with by both domestic and foreign specialists [2; 5]. So, in the article [10] deals, price signals and efficiency in markets with information asymmetry, where there are two situations: uninformed sellers set high prices, and uninformed buyers are ready to buy at low prices, and when uninformed sellers set low prices, and uninformed buyers are willing to buy at high prices. In the article, they show that the largest number of transactions is observed in the second situation. The article [9] examines the foreign exchange market, where the authors find convincing evidence of heterogeneous excellent information on agents, time and currency parameters, which is consistent with the theory of asymmetric information and fragmentation of the OTC market. A trading strategy based on constant price influence, capturing the risk of asymmetric information, gives high returns even after taking into account the risk, transaction cost and other general risk factors described in the foreign exchange market literature. There is also research on the awareness of management decision makers. The article [7] states that there is a perception asymmetry among politicians from urban to village levels, which leads to the fact that disaster management programs do not become a priority when using rural funds.

2 Materials and methods

To overcome uncertainty in individual areas, it is necessary to correctly identify groups of similar objects, which will allow identifying their unique characteristics. In the scientific literature, three methods of object classification are traditionally distinguished: hierarchical, faceted, descriptor. However, in recent years, neural network technologies have been increasingly used in the study and clustering of objects. One way to reduce uncertainty and reduce information skewness is self-organizing Kohonen maps, which is an unsupervised learning model designed for applications where it is important to maintain a topology between input and output spaces. Figure 1 shows the structure of the Kohonen map, on which the input and output levels are present. It is also worth noting that all input neurons are connected to all neurons in the output layer.

In this network, neurons learn on their own, without anyone's control, since competition is at the heart of the network and learning. Only vectors are fed into the input, which make up the training sample. The activation of a neuron is calculated as the distance between its weight vector W and the input pattern X. Distance can be defined as dot product or Euclidean distance. Two training rules may apply: Winner-Take-All (WTA) where only the winner's weights change, or Winner-Take-Most (WTM). Then there is a change in the weights of all neurons in the neighborhood, but this change depends on the distance between the winner and the neuron in the neighborhood. In this case, the network is called a self-organizing map [4; 8].

3 Results

The authors collected statistical data on the yields of three main agricultural crops (spring wheat, winter wheat, spring barley) for 30 years in the context of the municipal districts of four regions of the Volga region (Samara, Saratov, Penza and Ulyanovsk regions). Based on the data obtained, self-organizing Kohonen maps were constructed for each culture separately. Maps were built according to data from 110 municipalities. The size of the map was chosen 7 by 8, based on the experiments carried out, this size is optimal for such a number of objects. Figures 2-4 show maps of three crops.

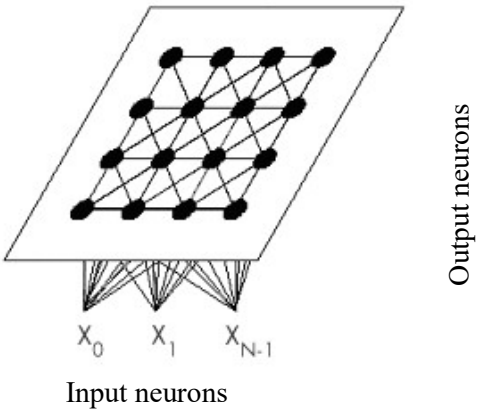

Fig. 1. The structure of the neural network of a self-organizing Kohonen map.

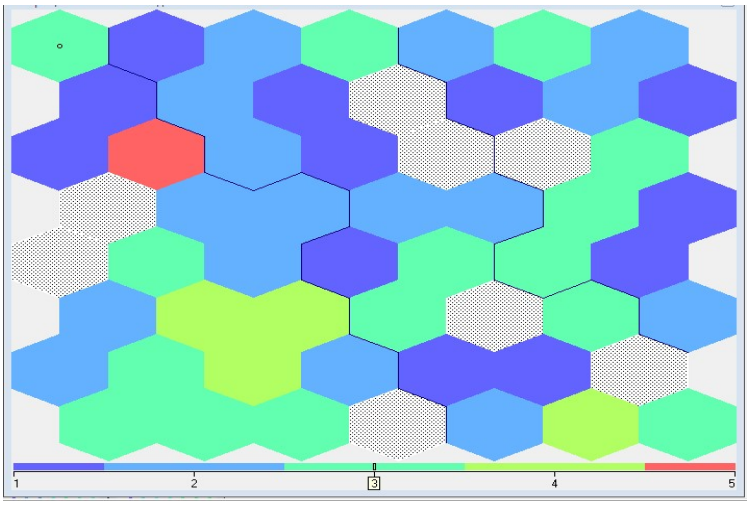

Fig. 2. Kohonen's map of spring barley.

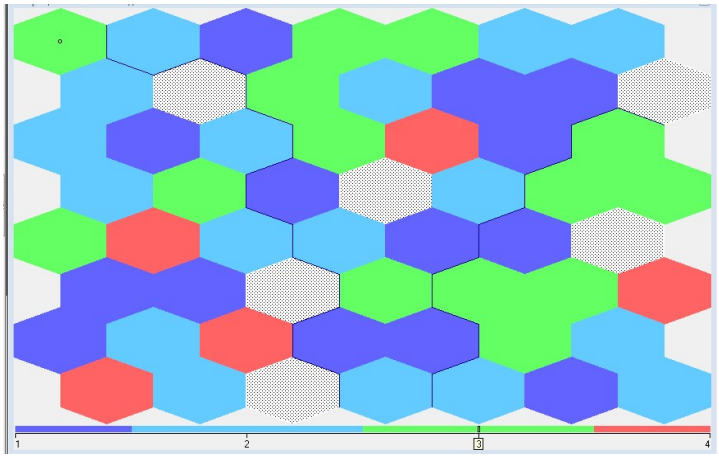

Fig. 3. Kohonen's map for spring wheat.

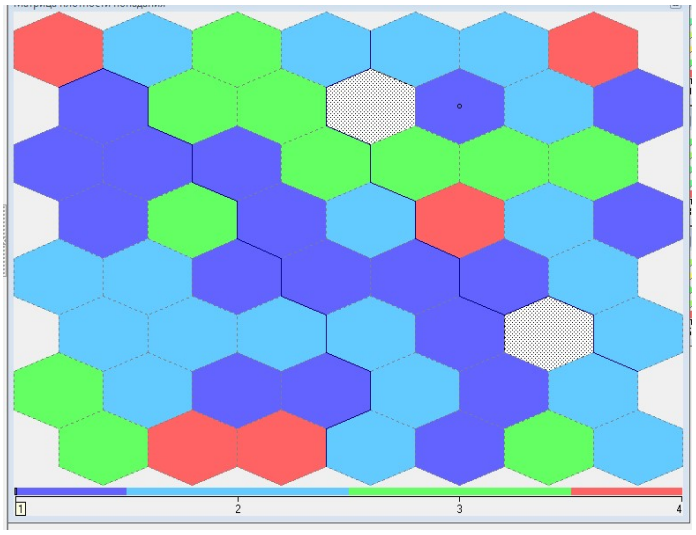

Fig. 4. Kohonen's map for winter wheat.

As a result of building Maps, three clusters (with high, low and medium productivity) were obtained for each crop. More details are presented in Table 1.

Table 1. Distribution of districts by clusters based on the results of constructing Kohonen maps.

Culture	Cluster	The number of districts of the region			
		Penza region	Samara Region	Saratov region	Ulyanovsk region
Spring barley	tall	17	2	1	9
	middle	8	13	8	5
	low	1	12	28	6
Spring wheat	tall	23	1	–	6
	middle	2	17	12	8
	low	1	9	25	6
Winter wheat	tall	17	7	3	6
	middle	6	16	12	8
	low	3	4	22	6

As a result, municipalities were singled out that fell into the same cluster for three cultures at once. So, 17 municipalities got into the "high" cluster (13 from the Penza region, 3 from the Ulyanovsk region and one from the Samara region), 27 municipalities got into a cluster with low productivity (2 from the Samara region, 20 from the Saratov region and 5 from the Ulyanovsk region). oblast) and 66 municipalities fell into the cluster with an average yield (13 from the Penza region, 24 from the Samara region, 12 from the Ulyanovsk region, 17 from the Saratov region).

4 Discussion

The results obtained can be used by insurance companies and agricultural enterprises to assess the prospects of using the agricultural insurance tool in their activities. If an enterprise has been operating for some time, then it has accumulated experience, it knows the specifics and features of the territory in which it conducts economic activity, but if the enterprise expands the boundaries of production or moves to other regions or territories, then the lack of objective data will limit it in making management decisions. Based on the data obtained, knowing the territory, it is possible to assess the prospects and expected average results for this zone, and also to determine which cluster the processed territory will belong to. A cluster with high yields for three crops speaks of favorable agro-climatic conditions for growing the studied crops and these territories are interesting for the insurance company, and a lower tariff can be offered for them. For a cluster with low yields for three crops, we can talk about not very favorable agro-climatic conditions for growing the studied crops and for the insurance company these territories are risky, since they will increase the losses of the insurance company, as a result, they will offer them a higher tariff to ensure break even work. The cluster with an average yield, in turn, is not a stable category, since it includes areas in which both low, high and medium yield are observed, however, a more detailed analysis of the production structure will allow choosing the optimal insurance rate.

5 Conclusion

Further research will focus on the inclusion of other crops. The construction of Kohonen maps for new cultures will make it possible to more accurately identify clusters, to determine the specialization of specific territories. Also, work in the future will be aimed at building geographic information systems that take into account not the subject of identity, but the similarity of agro-climatic, technological, technical and other characteristics of agricultural production.

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