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CURRENT APPROACHES TO COMPANY'S INVENTORY MANAGEMENT

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The basic parameters of the enterprise inventory management by means of a neural network are defined. An algorithm of selecting the best strategy for inventory management is given. It is determined that the results obtained using neural network best correspond to the hierarchical nature of economic indicators and allow to differentiate the space of alternatives to ensure the stability and high reliability of constraint equation parameters.

***Keywords**:* enterprise, management, inventory optimization, strategy, model, artificial network.

Statement of problem. Research is being carried out on the problem of optimizing finished goods inventory based on various combinations of such factors as demand, business implementation costs, business maintenance costs, material costs. The comparison of accuracy of improved model forecasting with the analog has been held and conclusions about their sufficient efficiency have been made. The proposed model allows to determine the optimal amount of inventory with great accuracy.

Analysis of recent papers. The analysis of recent researches and publications, with studies of stated problem, increases significantly with each year. V. V. Kulazhenko [1], M. P. Linderson , R. B. Chase, R. J. Carter, M. Christopher, J. Cooper [5,6] have made significant contribution to the development of inventory management.

The problem of creation and functioning of neural networks is examined in publications of Uossermen F. [2], Gorban A. N. [3], Ramazanov S. K. [4].

The combination of these two areas of research becomes a new analytical tool that generates information and makes the basis for management decisions.

Aim of the paper. Choosing the optimal strategy for inventory management of enterprise in conditions of uncertainty and substantiation of necessity of a certain method application is the purpose of the thesis. Switch from the study of the subject area to the formulation of the problem in mathematical form is an important part of the process of inventory management.

Materials and methods. Managed factors that delineate the space of analyzed alternatives are at the disposal of the inventory control manager. Managed factors represent axes and the alternative ways out in the form of certain space point. Identification of specific alternative involves determining the coordinates of the appropriate point in space of managed factors.

Difficulties because of providing the independence of alternatives do not appear when using the method of neural network programming.

Economic indicators depend on each other, so change of one indicator is accompanied by changes of related indicators. The nature of the neural networks' constructions coincides with the features of links of economic indicators. This allows to combine all the meanings of individual factors.

Neural network structure is fully consistent with the nature of links between economic indicators. Each neuron of random layer is connected to all neurons of the previous layer, with all the inputs of the neural network. Each neuron in network has its own structure. (Fig. 1).

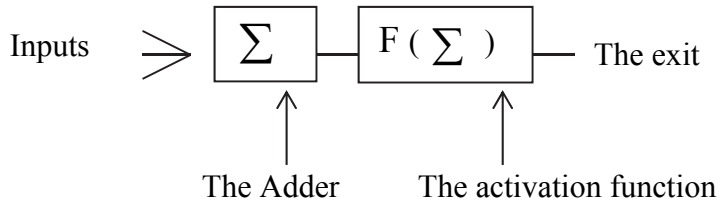


Fig.1 The structure of each neuron in network

Determination of the boundaries of factor's change comes down to the problem of the functional dependence of the analyzed factors on the factors that affect it.

The use of neural networks as the tool of component analysis determines the stability and high reliability of constraint equations' parameters.

Meaningful interpretation of synthetic components is simplified by their compliance with the basic aspects of inventory management:

1) probability of violation of the delivery schedule;

2) possibility of demand fluctuations;

3) seasonal fluctuations in the production of certain goods;

4) discounts for buying large quantities of goods;

5) rapid response to price fluctuations;

6) optimization of costs associated with placing the order;

7) possibility of steady implementation of manufacturing and distribution;

8) possibility of immediate customer service;

9) minimization of the quantity of devices in production due to lack of spare parts;

10) simplification of the management of production.

Significant difficulties arise only with the independence of alternatives, due to the nature of the economic indicators and their hierarchical interdependence. For example:

– availability of inventory: warehouse stocks, stocks of goods which are in the warehouses of various types and levels of certain parts of the logistics system, inventory in transit, transit stocks, stocks and other cargo, ect;

– turnover of inventory: current (regular) stocks, insurance (warranty) stocks, training (buffer) stocks, seasonal stocks, speculative stocks, obsolete (illiquid) stocks;

– the level of inventory control: point of order, normative level of reserves, the amount of individual purchases, frequency of purchases of stocks, replenished quantity of products.

Therefore, methods of component analysis, the construction of discrete incessant models do not meet the situation of generating alternatives in inventory management. Instead of this, it is proposed to use the programming neural networks.

The results of the application of neural networks in different areas allow to allocate such their advantages over traditional mathematical methods as the following [1]:

– no restrictions on the incoming data (as opposed to statistical data processing);

– ability to learn from examples in cases where the unknown patterns of situations in an uncertain dependence between the input and output data, as well as in cases of incomplete, not accurate and internally inconsistent input information;

– opportunity to find the optimal settings for a specific tool and construct the optimal for a given number of input parameters of forecasting model.

Moreover, the forecasting models are able to adapt and change according to the situation, which is particularly important for Ukraine, which is characterized by low predictability of processes at macro and micro level; more efficient data compression by constructing nonlinear mappings; automation of administration and processing of raw data; identifying of complex dependences between input and output data, and their generalizations, ensured by training of neural networks; neural network modeling is based only on actual data without a priori conditions and restrictions.

In this case input and output parameters should be enough for «training» of the neural network; building and training a neural network is enough to solve the direct problem, which

will also solve the inverse problem; neural networks solve the problem of interpolation, which greatly improves the reliability of the decision; an opportunity to solve several problems (if more than one output); opportunity to almost limitlessly build the capacity of a neural network (due to internal parallelism, which is inherited in neural networks); the potential sustainability of neural networks to failures; the slow decline of the quality of the neural network; the possibility of further optimization of various properties of the neural network by adding regularization criteria decision or optimization of the structure of the neural network (with the neural network training algorithms remain unchanged); prediction accuracy greater than 95%; the sphere of the use of neural networks is practically unlimited.

The greatest efficiency of neural network is shown in the following areas: pattern recognition, semantic search, forecasting stock prices and other financial instruments, security systems and others.

Among the tasks solved by the neural network are the following: participation in exchange trading, advertising on the Internet, spam filtering, checking suspicious conduct transactions with bank cards, security systems and video surveillance and more. However, sectors such as healthcare, advertising, marketing, economics and finance, information technology and telecommunications open perspectives for further theoretical and practical researches in the field of neural networks.

Programming of neural network is conducted in terms and with the use of matrix algebra [2–4].

Considering a dynamic system, it is given a set {u (t), y (t)}, where u (t) is the input control actions, and y (t) - output system at time t.

In control systems with the standard model there is a calculation of the input u (t), in which the system operates on a desired trajectory, which is given by reference model.

The exterior of the neural network for determination of the weight of the resulting component indicators (Fig. 2) illustrates the mechanism of compression-driven factors (inputs) to the first synthetic component (the first layer of neurons), and then the resulting index (second layer neurons).

The resulting indicator can become a reversibility of inventories and overall liquidity ratio that will meter management efficiency. It is reasonable to take turns to use all

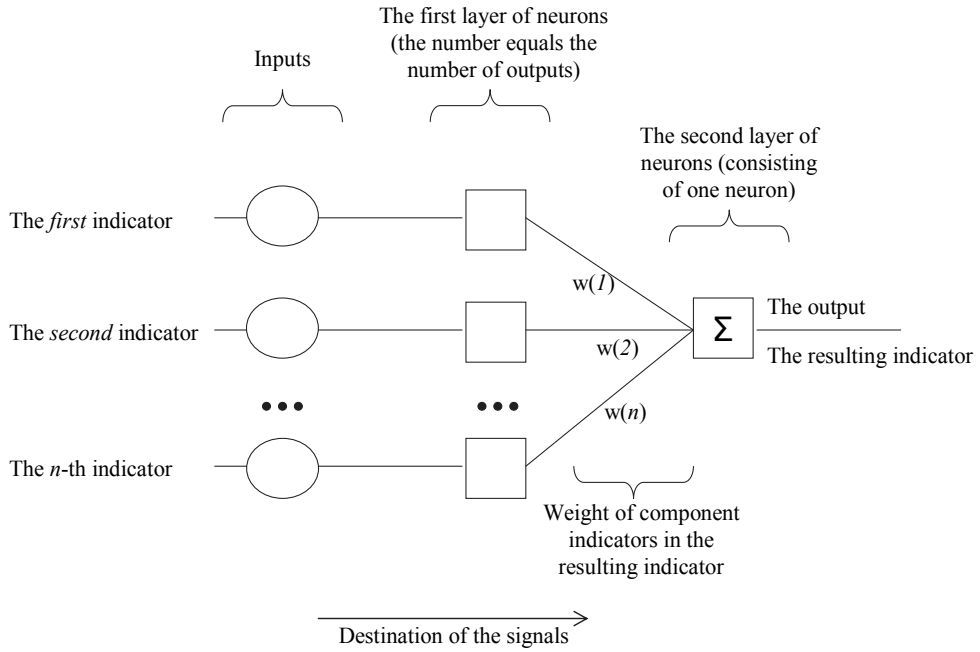


Fig. 2 The exterior of the neural networks for determination of the weight of component indicators

possible values for a more complete list of alternatives.

But it is impossible to guarantee that the resulting network is the optimal network. Application of neural networks requires the developer perform a number of conditions: the set of

data that includes information that can adequately describe the problem; respectively fixed-sized set of data for training and testing the network; understanding the basic nature of the problem to be solved; selecting adder function, transfer function and learning methods; understanding of the developer tools; appropriate treatment capacity.

The adder serves as a compilation of inputs, then this amount becomes the argument of the activation function. For input and output neurons there is a function F = X (X – amount of inputs), and for neurons and layers ns nscorr. This function (sigmoid) provides compression of any value of X in range from 0 to 1 and has a simple derivative of (F '= F * (1-F)), which is used for the correction of weighting coefficients during training the neural network.

When creating algorithm for determining the weight factors in the controlled synthetic components and the resulting indicator based on neural networks' unit (neural network learning algorithm) back distribution procedure is used (signals distributed from the outputs of the neural network to its inputs in the direction opposite to that signal distribution in normal operation) [2].

The result is a specific measurement scale for alternative indicators that, in contrast to the input, are clearly delineated, and their number is reduced.

Their numerical values characterize the diversion of this component from the average level in the aggregate, which is under study.

For example, if the decision was made to increase the level of components «inventory turnover» (respectively k-th version control) to 0.5 units, the scope of the specific changes are not yet clear. But after solving the problem of the choice of control options (using the modified matrix changes from game theory) is held back for the weekend shift indicators. The exterior of the neural network for the return from the resulting figure to outgoing is given on Fig.3.

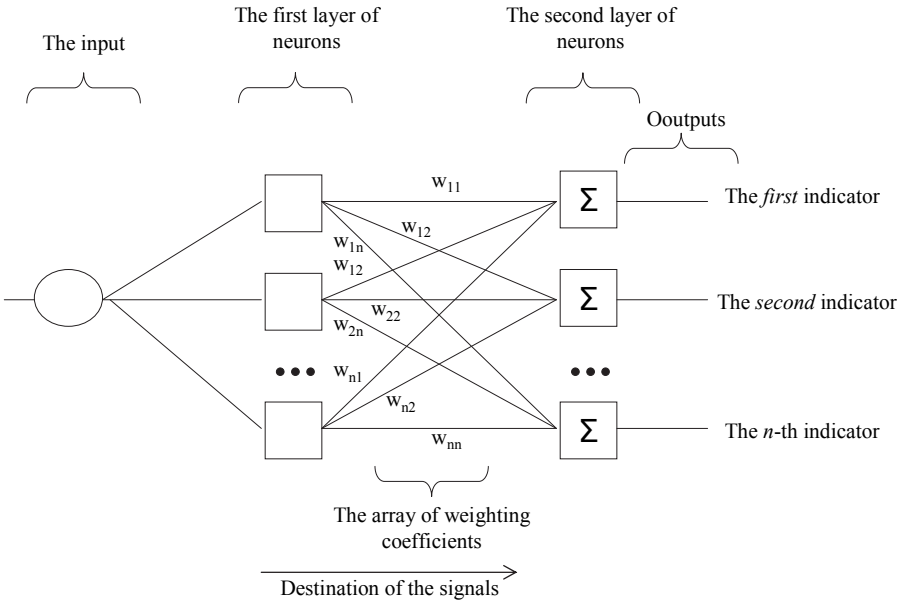


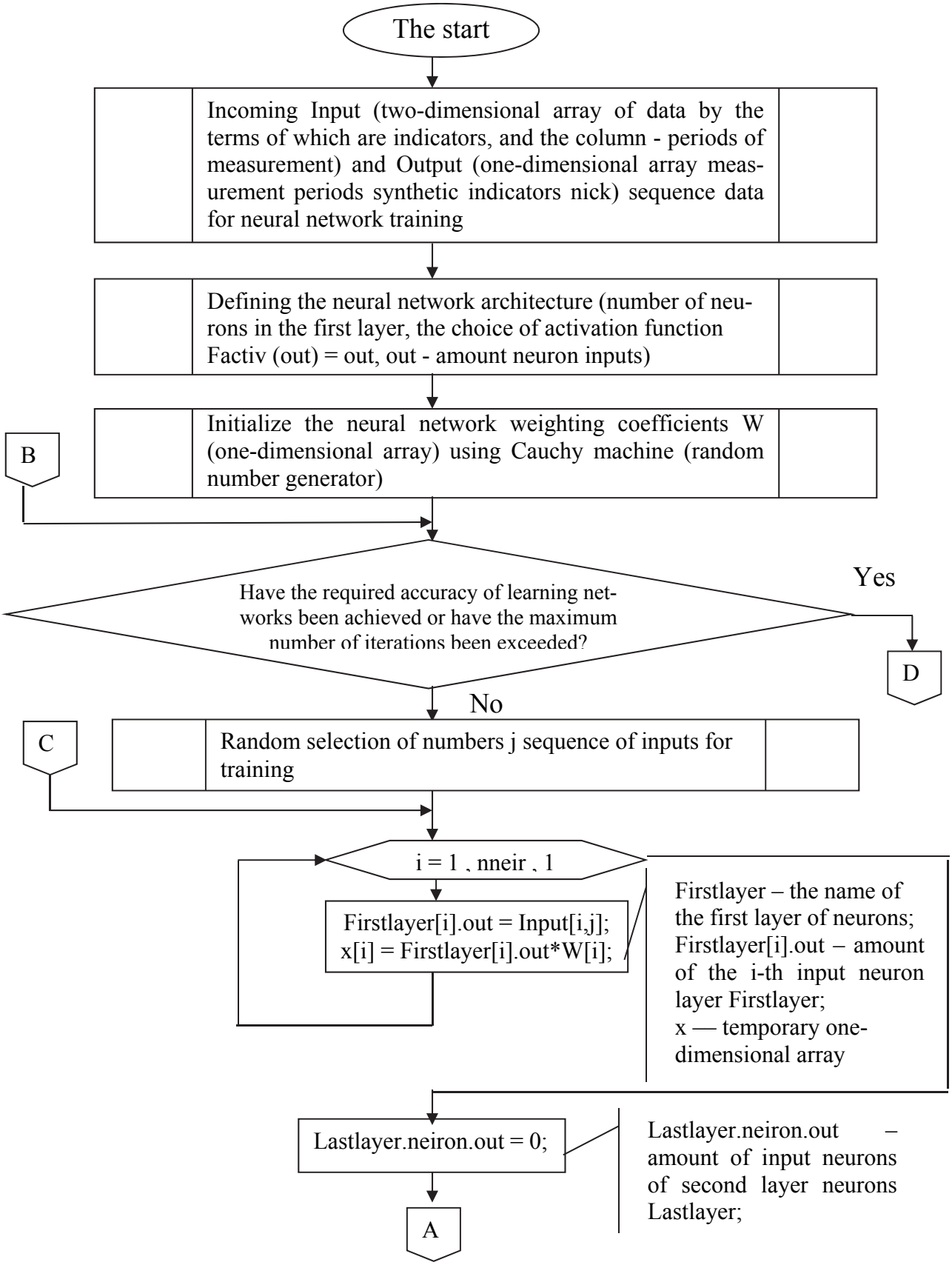
Fig.3. The exterior of the neural network for the return from the resulting figure to outgoing one

The mentioned algorithm (Fig.4) allows to pass from the abstract to outgoing synthetic component factor indicators, allowing to model dependent's parameters.

Neuro programming could be the basis for determining the optimal scale for a particular company stock of the company. Identified groups of indicators (synthetic components) are subject to the inspection by the golden section.

The real power of neural networks is evident when the trained network is able to provide good results for data, which the network has never seen before, data that were not in cluded in the training process. This set of observations is called the test data. A high correlation between the test data and the network prediction indicates that the model has not only been able to learn the nature of the economic relation-

ships, but also has succeeded in generalizing the relationships and providing successful results. It is important to monitor the performance of the testing sample at different stages of the training process and stop the training at the point wee the test sample provides the best result. In order to increase the probability of a stable model, a minimum of two test samples is required.



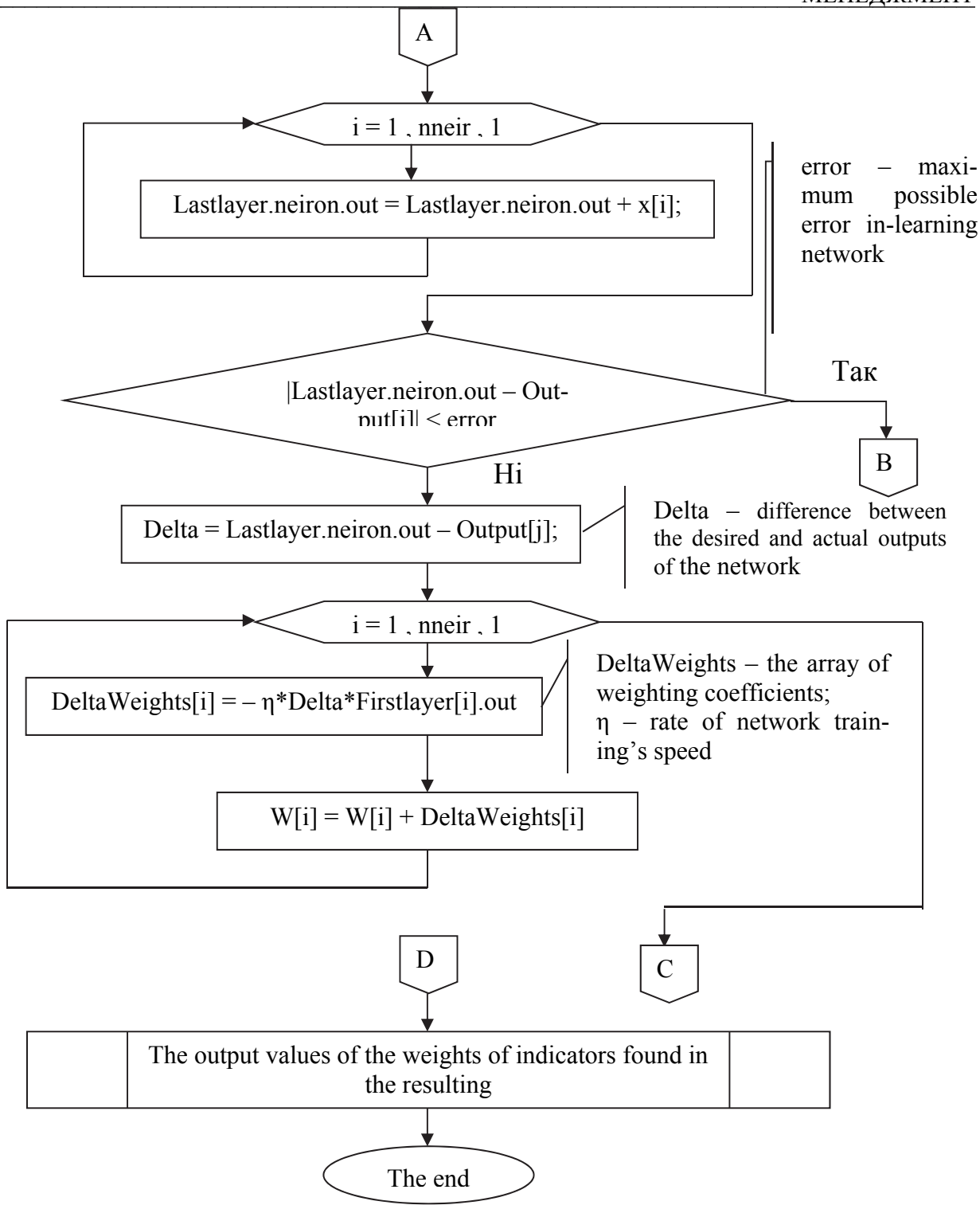


Fig. 4. The algorithm for the weight of driven factors in synthetic components and the resulting indicator.

In expanded form generalized model of the decision on the choice of control options have an equation system.

Determining the decision-making process within the inventory control in the form of a system of interrelated elements offered in the following way (relationships are simplified, illustrating the complexity of formalizing the decision process): in a problem situation S_o, available time T and resources Q necessary to formulate the system goals A, identify controlled factors X, uncontrolled factors S, probability distributions of environment states P; based on the analysis of relations f and F to determine the result vector Y; based on the criteria system K and utility functions L to determine

the usefulness of evaluation results *Z*; based evaluation functions expected effect of actions *E* and comprehensive assessment *KA* to determine the optimal solution *x**, which satisfy the constraints *C*.

Particular attention should be paid to improving the analytical part of choosing the best variant of management. The purpose of this phase is to create a list of alternatives that has the best plan for inventory management. Method of programming neural networks complement traditional methods of decision theory, business analysis and provides a concrete results towards identifying alternative spaces.

Identifying a list of alternatives refers to the economic aspect of the mechanism of company's inventory management. In models of optimal control and mathematical programming options are the plans, strategies, and a set of options to be compared, given limitations.

Alternatives actions, environmental conditions, the probability distribution of environment states and results of alternatives in specific environmental conditions are the basic elements of the decision process, as reflected in the basic model of decision-making and characterized as «right results» in terms of risk (Table 1).

Table 1

The base model of decision making in the inventory management

Ambient environment / Alternatives Action	Environmental conditions						
	s_1	s_2	…	s_j	…	s_m	
	Chance of environmental conditions						
	p_1	p_2	…	p_j	…	p_m	
x_1	y_{11}	y_{12}	…	y_{1j}	…	y_{1m}	Field of results
…	…	…	…	…	…	…	
x_i	y_{i1}	y_{i2}	…	y_{ij}	…	y_{im}	
…	…	…	…	…	…	…	
x_n	y_{n1}	y_{n2}	…	y_{nj}	…	y_{nm}	

The base model corresponds to the process of standard solution's making: we have a limited number of alternative courses of action and the full set of independent states of the environment, the results of alternatives vector has only one component *Y* which uniform quality within the entire set of environmental conditions and quantified, the numerical values of which y_{ij} is the basis design decisions taken.

Results of the alternatives evaluated for their conformity to the set of these purposes. Substituting in the base model of the indicator results y_{ij} their estimated useful-ness z_{ij}, get «right decision» in terms of risk: $z_{ij} = L(y_{ij})$.

To simplify the results of implementing the alternatives are measured in terms of utility on the set goal ($z_{ij} = y_{ij}$). Thus, in the basic model, decision field coincides with result field**.** The results obtained by this method will consist of primary factor indicators, and have a specific value the resulting characterizing the efficiency of inventory management company. Quite a large number of iterations will produce a high quality modeling results in the optimal size of inventory.

Conclusion. In theory, neural networks should be able to duplicate, and in some cases, exceed the performance of regression techniques. Neural networks can be seen as a wide class of flexible nonlinear regression and discriminant models, data reduction models and nonlinear dynamical systems. For the purpose of economic forecasting neural networks have some clear advantages over regression analysis. Thus, applying of the neural networks method is not only more appropriate to the nature of the hierarchical structure of economic indicators, but also simplifies the definition and delimitation of space inventory management alternatives.

The coincidence of management areas with groups of factors (synthetic components) simplifies the understanding of the process of identifying alternatives and their connection with current situation on enterprise for agents of management.

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У статті визначено основні параметри управління запасами підприємства за допомогою нейронних мереж та продемонстровано переваги даного методу. Запропоновано алгоритм вибору найкращої стратегії управління запасами. Визначено, що результати, отримані за допомогою нейропрограмування, найбільш повно відповідають ієрархічному характеру економічних показників, дозволяють розмежовувати простір альтернатив, забезпечувати стабільність та високу надійність параметрів рівнянь зв'язку.

***Ключові слова**:* підприємство, управління, оптимізація запасів, стратегія, модель, штучна мережа.

В статье определены основные параметры управления запасами предприятия с помощью нейронных сетей. Предложен алгоритм выбора лучшей стратегии управления запасами. Определено, что результаты, полученные с помощью нейропрограммирования, наиболее полно отвечают иерархическому характеру экономических показателей, позволяют разграничивать пространство альтернатив, обеспечивать стабильность и высокую надежность параметров уравнений связи.

***Ключевые слова**:* предприятие, управление, оптимизация запасов, стратегия, модель, искусственная сеть.

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