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PROSPECTS OF NEURAL NETWORKS IN BUSINESS MODELS

Abstract

In the article the analysis of existing protective coatings. Presents an algorithm synthesis of protective coating against electromagnetic radiation. The article is devoted to the problem of determining the prospects for the use of neural networks in business models. The possibilities for this most classical types of architecture of neural networks. A number of conditions which allows you to determine the feasibility of a particular type of neural network. It is shown that the development of business models neural networks should be used only to solve those tasks that belong to a class of pattern recognition, and optimal management of associative memory. It was determined that the greatest practical effect can be expected in the application of neural networks in the classification of sensory information outlines business models.

INTRODUCTION

Using neural networks (NN) in computer software engineering and economic systems has continued for several decades. Developed adequate theoretical and practical recommendations which provided a fairly accurate method of determining the network architecture according to the nature of application. Against this background, in recent years significantly increased interest in the use of NN in business models. There are studies that show some method of solving problems by using neural network.

However, the range of practical problems develop business models which should be solved by means of neural outlined clearly not enough. In addition, there is no general method determine whether the architecture and character of the use of neural applied to the task of developing a business model. For these reasons, the purpose of this article is identifying the practical problems of developing a business model, which should be addressed through NN and development of recommendations for the use that particular type of network.

1. PREREQUISITES USE OF ARTIFICIAL NEURAL NETWORKS

The term artificial neural understand network elements (artificial neurons), interconnected synaptic connections [1, 2]. Neurons and connections between them form a neural structure. NN with any structure shown in Figure 1 (Source: elaboration of the author).

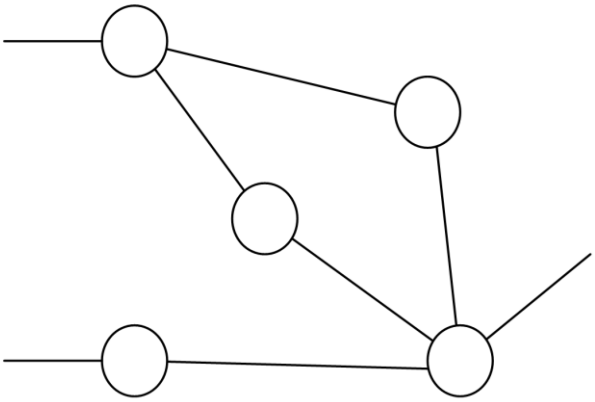

Fig. 1. *An example of arbitrary structure NN*

In terms of implementation methods of computational processes functioning neural modeling biological processes that occur in the human brain. However, compared to the modern human brain neural represent a significantly simplified abstraction. Work of NN is transform input data into a set of output signals. The transformation occurs by changing the internal state of NN. It NN typically operate digital values. Connections for which information is transmitted in the direction entrance exit called straight. Connections for which information is transmitted in the direction entrance exit called otherwise. Networks, which exist only direct connections, called direct distribution networks signal. Network called recurrent feedback. Quite often in isolated neural structure with the same group of neurons in neural connections layer. Example NN, consisting of three layers of neurons, as shown in Figure 2 (Source: elaboration of the author).

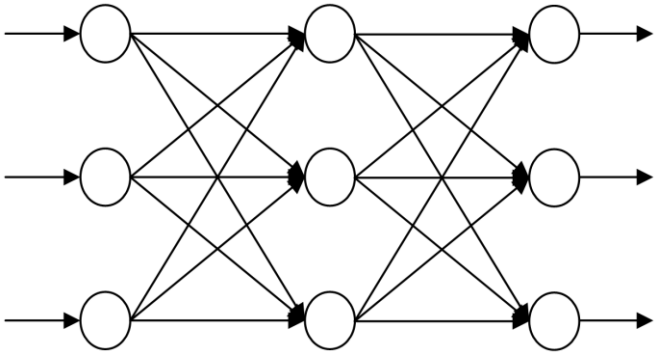

Fig. 2. *An example of a two-layer neural network*

NN common example, which consists of several layers of neurons are multilayered perceptron (MLP). The template that defines the links between individual neurons, called network topology [1,2]. There are fully connected and are not fully connected topology nm. Neurons that make up the messiah, are a simple processors, computing parameters are limited to certain rules of combination of input signals and activation rule, which allows you to define the output signal on the input together.

The output neuron can be transmitted to other neurons through synaptic network (weighted) connections, each of which corresponds to the weight, also called weight connection. Incoming connections of neurons called dendrites and axon outgoing communications. Neurons are intended for direct reception of information from the environment, called the front. Neurons that give information directly into the environment, called the weekend.

Other neurons called intermediate or hidden. They form one or more hidden layers of neurons. Typical tasks are a combination of

neuron input signals and output calculation. Combining neuron input signals is to calculate the sum of weighted values and some constants, named the landslide.

Typical formal neuron model shown in Figure 3 (Source: elaboration of the author). Combining inputs (connections) per neuron is the weighted sum of their values and some constants, named the landslide.

In general, the input signals, offset and weighting coefficients can take any value from the range of real numbers, but in practice their values determined by the specifics of a particular problem. Communications, which meant negative weights called braking and contacts with positive weights called exciting.

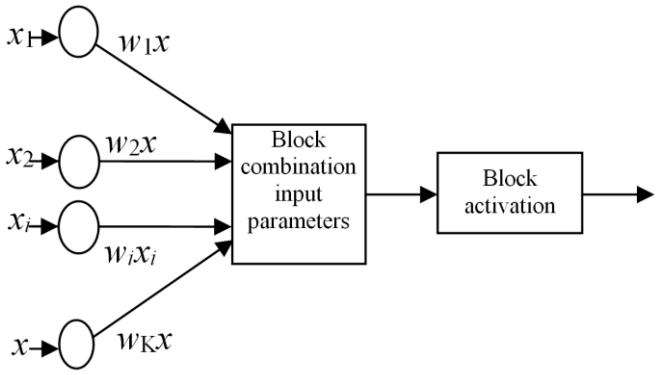

Fig. 3. *Typical formal neuron model*

The total input neuron (NET) is calculated as follows (Source: R. Callan The basic concepts of neural networks. - M .: Williams, 2003. p 20.):

$$NET = \sum_{i=1}^{K} x_i w_i \quad (1)$$

where K – number of incoming links, xi – the value of i-communication, wi – weight of i-communication.

In general, the input signals, offset and weighting coefficients can take any value from the range of real numbers, but in practice their values determined by the specifics of a particular problem. Communications, which meant negative weights called braking and contacts with positive weights called exciting. Block neuron activation is designed to calculate the output neuron. Typically, this total input be nonlinear transformation (Source: R. Callan The basic concepts of neural networks. - M .: Williams, 2003. p 22.):

$$OUT = F(NET - \theta) \quad (2)$$

where θ – limit value or shift, F – activation function.

Quite often interpreted as a shift in touch with weights equal to w0. In this case the expressions (1, 2) can be written as (Source: R. Callan The basic concepts of neural networks. - M .: Williams, 2003. p 24.):

$$NET = \sum_{i=0}^{K} x_i w_i \quad (3)$$

$$OUT = F(NET) \quad (4)$$

Characteristics of the most prominent features activated are presented in Table 1 (Source: Tereykovskyy I. Neural Networks in the media of information protection: monograph. - K.: PolihrafKonsaltynh. - 2007. p. 11).

Tab. 1. *Function activation artificial neurons*

Name	Formula	Scope of Use
Linear	$F(NET) = NET \times a$	Input neurons all types NN.
Logistics (sigmoid)	$F(NET) = \frac{1}{1+e^{-a \times NET}}$	All types of networks with direct signal distribution, including MLP
Linear repayment negative pulses	$F(NET) = \begin{cases} NET \times a, \exists NET > \theta \\ 0, \exists NET \le \theta \end{cases}$	Input neurons all types NN
Threshold	$F(NET) = \begin{cases} 1, \exists NET \ge \theta \\ 0, \exists NET < \theta \end{cases}$	Single-layer Perceptron, Hopfield NN and Casco
Hyperbolic tangent	$F(NET) = \frac{e^{a \times NET} - e^{-a \times NET}}{e^{a \times NET} + e^{-a \times NET}}$	All types of networks with direct signal distribution, including MLP
Gaussian curve	$F(NET) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{NET}{2\sigma^2}}$	Intermediate neurons to neural and probabilistic neural network of radial basis function
Hysteresis	$F(NET) = \begin{cases} 1, \exists \theta > NET, \\ NET \times a, \exists \theta > NET > 0, \\ 0, \exists NET \le 0 \end{cases}$	Hamming NN

where θ – threshold (shift), a – steepness factor, σ – radius Gaussian function.

The figures in Table 1 activation functions are mainly used in NN with classical architecture. In many modern complex neural activation function used. For example, a semantic neural network (SNM) as a function of activation using advanced features fuzzy logic. In practice, the choice of activation function determined by the specific task, efficient computer algorithm implementation and training NN. Universally selection algorithm activation function currently exist, with some known limitations of the use of certain functions [3].

Note that the mechanisms of information processing in the formal neuron models (1-4) largely differs from their biological prototype. The main differences are as follows:

There is no mechanism for determining delay implementation of the output signal.

No modulation input level density of nerve impulses.

In most neural synchronization is not used effect the functioning of neurons.

No stranger-type mechanism of hormonal regulation of neuronal activity that regulates the functioning of the messiah as a whole.

Not used dynamic adjustment mechanism of activation threshold and weighting coefficients in the operation Messiah.

Used only excitatory and inhibitory connections between neurons.

Due to these differences using neural network for modeling dynamic systems requires additional elements that are not part of the network. You should also expect that neural plasticity and its adaptation to changes in external conditions significantly inferior biological counterparts.

Most models require training NN, during which determined such internal network settings, in which she solves the task admirably. Most training messiah is to calculate weight coefficients of synaptic connections between neurons, and neural structure (number of neurons and the links between neurons) determined before training. The training network presented case studies, each of which corresponds to eigenvector signs. It weights are changed so that it meets the best messiah example. The change is implemented coefficients predetermined learning algorithm.

Some algorithms, such as "neural gas" ratios provided in addition to modifications change the number of neurons in the network. There are two main types of direct learning NN training data processing and iterative [1, 2, 4]. In the first case the weights determined by direct processing parameters disposable training examples.

The second case is characterized by multiple case studies presenting NN. The weights specified during the show each example unless the network will not carry out its functions with a given quality. Iterative learning based on examples, which include only inputs NN, called the study "without a teacher". If in addition to examples of input raw data are expected, such a study called education "the teacher". In addition, there are lesser known intermediate teaching methods, such "reinforcement". When priori given terms of quality, the main characteristic of teaching methods are the dates, which depends on the number of iterations. Today is the most powerful messiah who study on methods of teaching " the teacher". Note that the possibility of use of a technique of training depends on the availability of training data, topology NN, regulations combination of input signals and the type of neuron activation function. For example, NN with neurons that use a threshold activation function can not be taught by the method of "reverse distribution of errors," which is the most famous of teaching methods "with the teacher". After learning of NN can recognize unknown input or bear some other meaningful activity. Information obtained during the training experience is stored in the form of weighting coefficients ties.

The main design parameters of NN is the number of input, hidden and input neurons, structure connections (network topology) rules for distribution of signals in the network, for combining signals within the neuron, rules for calculating the output neuron and rules of training, corrective conn bandages online.

These parameters are used as classification criteria nm. For example, on the criterion of structure of relations, distinguish between single and multi nm. Also apply a number of additional classification criteria nm. For example, among emit monotone multilayer neural network. The totality of these parameters define the network architecture. There are several architectures that have become classic network search maximum input and output star single layer perspetron, MLP network of radial basis function (RBF) networks, Hopfield, Hamming, Kosko, McCulloch-Pyttsa, Kohonen and Hrosberha [4]. Enough known probabilistic networks and network ART. In addition, a significant number of specific architectures recursive autoassociative memory module NN, Kognitron, neocognitron, networks, using fuzzy logic, SNM, different types of recurrent networks and many others. In addition, for each class of applications using its own neural architecture.

In terms of practical applications, the most important characteristic of the messiah, which generally determines the possibility of practical use, an error recognition. This term we mean error in the classification of network input image (vector), as one of the reference images. In theory NN analogue recognition error is an error of generalization network. Note that characterizes generalization property opportunities NN conduct proper classification of input images that were not represented in the training data. Estimated expression generalization error consists of two parts describe the mistakes and errors approximations training data. Thus, the error of generalization characterizes not only the unknown image recognition error, but an error NN on training data. In certain models of NN approximation error is primarily dependent on the method and algorithm learning network. In the case of iterative learning algorithms approximation error also depends on the maximum number of iterations.

For modern NN might achieve sufficiently low values of error of approximation. For example, the maximum difference between the model and input data in the approximation of nonlinear functions using MLP is about 1%. Note that in many cases reduce approximation error proportional increase capacity nm. That is necessary to achieve the approximation error is recommended to increase the number of neurons, neuronal layers and the number of synaptic connections.

Error characterizes describe the adequacy of the constructed neural those processes that underlie the formation of input images. The magnitude of the error depends on the formal description of neuron model, topology NN, NN capacity, adequacy of educational information. Here are common ways to reduce describe the error:

The use of neural architecture that best meets the specifics of application. Today the choice of architecture is empirically and depends largely on its traditional sphere of application and the available software and hardware. Most often using NN jne of the traditional architectures. Sometimes developing NN with original architecture, which includes formal neuron model that differs from the known models (1.1-1.4).

The use of several possible NN topology given the least powerful. This minimum allowable power network is based on a maximum error of approximation of training data. Meanwhile approximation error can be calculated only in teaching already constructed nm. So often determine NN sufficient power is realized experimentally.

The unknown input images should not be significantly different from the training data. For example, the approximation function of the form $y = f(x)$ interval training data $X_н = [a, b]$ should overlap interval of unknown data $X_p = [c, d]$. However, in general, a clear algorithm for determining compliance training and unknown input data does not currently exist.

Basic law, which should be modeled network should proslidzhuvatys well as training data, not zatinyuvatys them irrelevant laws. For this study data before using a neural preprocessing pass. Under this treatment refers to normalization data, filtering and encoding.

It is believed that in many areas is not practical to achieve generalization error of 90% with simultaneous approximation error 98-100%. Thus one of the main prerequisites for using NN is the difficulty of formalizing practical problem that leads to ineffective use of classical mathematical methods to solve it. In theoretical works devoted NN, noted that use them in appropriate tasks:

Classification images. The task is to calculate accessories input image presented feature vector, one or more pre-defined classes.

Clustering/categorization. The problem is different from the image classification only that classes are not defined in advance, although in many cases the number of classes is still pre-specified.

Approximation functions. The task is to find the function assessment on the known sample of parameters and values. NN recommended when sample distorted noise and find an analytic solution is difficult. At the same time solved the problem of data filtering, ie allocation signal from background noise.

Forecasts. It should be based on a plurality of discrete samples {f(t1), f(t2),.f(tj)} expected value f(tj+1) at time tj+1.

Optimization, ie finding solutions that satisfy the system constraints and maximize or minimize the objective function. NN recommended when it is impossible to form a clear functional relationship to limitations and/or objective function.

Management with the standard model. In order to manage these tasks is the calculation of such input control actions on a managed system in which it follows the desired trajectory determined by the reference model.

Creation of information-computing systems with shared memory content addressable (associative memory). In such systems, memory can be retrieved by partial or distorted content. Use asso-

ciative memory can solve the problem of data compression, data recovery and increases the survivability of computing systems.

The list of conditions and the traditional applications of neural confirm the feasibility of using them for solving forecasting of financial markets and the valuation of real estate. First, the control parameters of the financial markets is a challenge because vazhkoformalizuyemoyu subjective processes that are the basis of changes in these parameters. Second, recognizing the critical state of financial activity and optimization of the parameters of this protection include those tasks where NN is already proven effective.

It should take into account the restrictions on the use of NN. This is particularly true for tasks developing business models for the solution of which there is a formal mathematical apparatus. In addition, some experts warn that the messiah is largely analogous to the methods of statistical analysis of information and, consequently, tend to be wrong in the analysis of subjective factors. However, in many cases reverse the effects of such factors can be prevented in the problem statement.

Also in [3, 5] states that the presentation of NN as a simple statistical filter is a bit superficial. However, the addition of new types of neural realized the analogy with the classical tools of artificial intelligence, such as semantic networks. Therefore, one should expect that modern types messiah will truly diagnose situations that were not present in the original statistics. Outlining the scope of the messiah should be noted that network capabilities depend heavily on its architecture. The development of modern NN is by adapting the basic architectures to solve practical problems. However, a number of classic architecture has lost its leading position and used only as a subsidiary. Therefore, you should focus on adapting NN the most promising basic architecture of the problems of monitoring parameters management business model. Based on the findings [2, 4, 5] and analyzing this problem, we choose to consider MLP (Figure 4), RBF (Figure 5), Kohonen (Figure 6), PNN (Figure 7), neural adaptive resonance theory (ART) network Hamming, Hopfield, and Kosko. Block diagrams Kohonen, MLP, RBF and PNN shown in Figures 4, 5, 6 and 7 (Source: the development of the author).

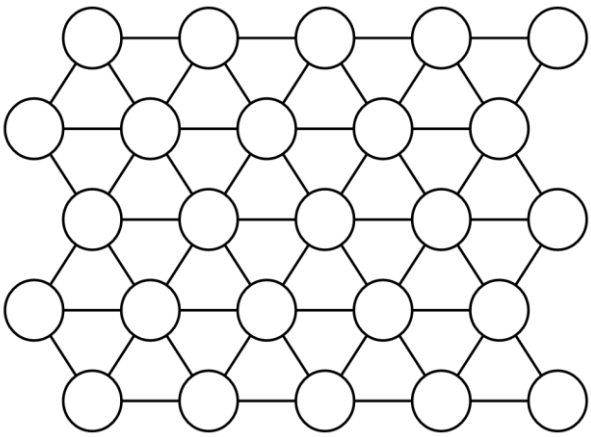

Fig. 4. *A simplified scheme Kohonen network*

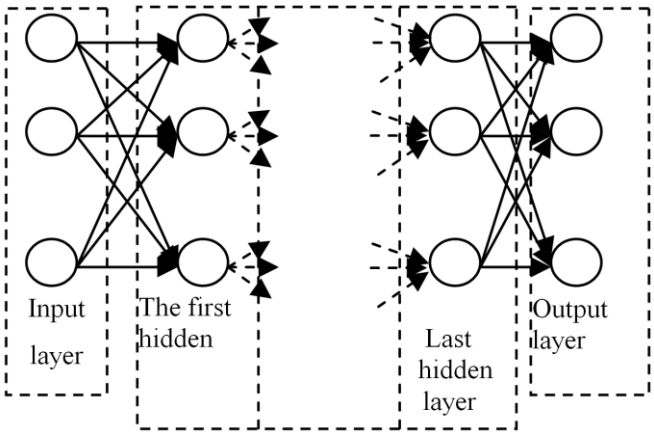

Fig. 5. *The structure of the multilayer perceptron*

Note that the selected network ill-suited to the tasks of analyzing time series data that need to be addressed for recognizing voice signals and photos. Therefore, in addition to classical architecture, it is appropriate to consider deep neural networks, which successfully used the field of acoustic and visual information [4].

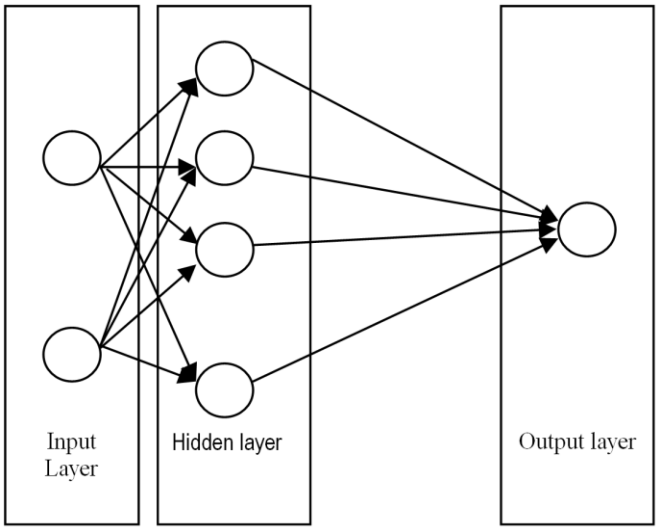

Fig. 6. *A simplified scheme of RBF network*

Note that due to the volume of a given publication ostayutsya ignore some other, perhaps promising but not sufficiently tested and theoretically studied architecture. For example, will not be considered Kognitron and neocognitron.

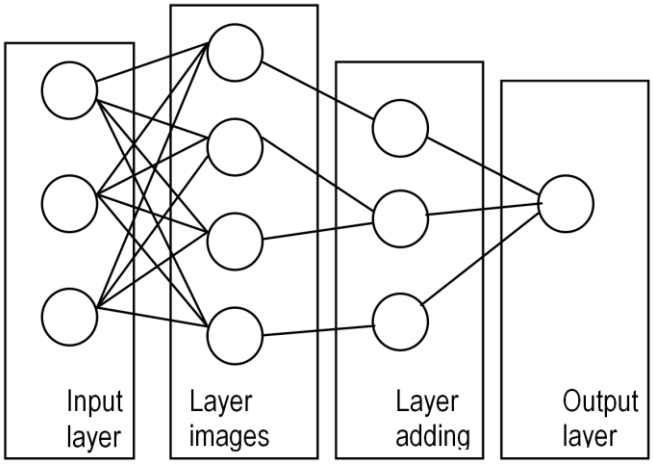

Fig. 7. *Block diagram of the network PNN*

2. OBJECTIVES APPLICATION OF NEURAL NETWORKS IN BUSINESS MODELS

Conclusions [1, 3, 5] show that neural traditionally used business models related areas of the economy, Internet technologies, business models, automation, security and processing. A list of practical problems solved with the help of NN are summarized in Table 2 (Source: the development of the author).

Tab. 2. *A list of practical problems that are solved by NN*

Sphere	Problems applying neural network
Economy	prediction markets automated dealing, risk assessment of loan defaults, bankruptcy prediction, valuation of real estate, identifying over- and undervalued companies, ratings of auto, portfolio optimization, optimization of commodity and cash flows, automatic reading of checks and forms, the security of transactions on plastic cards.
Internet technologies	associative search for information, personal digital assistants and agents in the network by filtering information in the push-systems, collaborative filtering, headings news feeds, and targeted advertising, direct marketing for e-commerce
Production automation	optimization of the production process, a comprehensive diagnosis of the quality of products, monitoring and visualization of multidimensional data dispatching, emergency prevention, robotics
Political technologies	analysis and compilation of polls, predicting the dynamics of ratings, identifying relevant factors, the objective of the electorate clustering, visualization of the social dynamics of population
Security	system identification, voice recognition, faces in the crowd, license plate recognition, analysis of aerial satellite images, the monitoring of information flows, the detection of counterfeits
Data processing	processing of handwritten checks, recognition of signatures, fingerprints, and voice input into the computer of financial and tax documents

Data analysis and results Table 2 [4, 6-10] suggest that the main objective application of NN in business models is the classification of sensory information to its subsequent transfer to the control circuit.

3. DETERMINING THE FEASIBILITY OF A PARTICULAR TYPE OF NEURAL NETWORK

Analysis of the current state of neural network technology allows us to formulate a conclusion that the feasibility of a particular type NN should be determined on the basis of comparison of the terms of the characteristics of network application. To these characteristics of the messiah are:

Parameters training data.
The general limitation learning process NN
Requirements for neural computing power
Requirements for initial information NN.
Restrictions technical implementation NN.
Scope.

Consider these characteristics from the perspective of application business models.

The main options include training data:
Number of parameters characterizing an educational example.
Type options, discrete (symbolic) or continuous (numeric).
The total number of training examples.
Errors (noise) in the training examples.
Correlation case studies.

The possibility and necessity of pre-processing the input data for the purpose of normalization and noise removal.

Ability to display voters in the training of all aspects of the process that is modeled. For example, is it possible to reflect in the training of all voters signatures crisis in financial markets.

Proportionality case studies that correspond to different aspects of the process that is modeled. For example how many training examples correspond to a situation of type A, and as examples of situations type B.

General restrictions stipulated learning process:
The maximum period of study.

The need representation in educational output data expected messiah. So determined type of training possible with or without a teacher of teachers.

The ability to automate the process of learning, which is determined by the number and importance of empirical parameters. Displayed opportunity largely determines the conditions of application NN. Networks in which the learning process is not automated and can be used only in laboratory conditions.

The possibility of relearning during operation.

The demand for quality education, which is usually judged by the size of the maximum and average error recognition training and test data. This test data should not significantly different from the training.

Learning opportunity NN in the laboratory. For example, in the laboratory may potentially teach NN recognize financial crisis situation type. Feasibility studies in vitro explained optimal mechanism needs to create and update the knowledge base NN.

In practice requirements for computing power determined by the maximum number of examples (memory), you can remember the network to achieve the required reliability decision. In turn, the reliability of the decision is characterized by the maximum permissible value and average error on real data network which in general may go beyond the training data set.

Accordingly, the challenge of learning outcomes NN extrapolation beyond the case studies. Note that the computing power of the network depends on its type and learning algorithm. Another requirement can be output immutability network for different examples of the same parameters.

Requirements for initial information NN indicate in what form should this information be presented. For example, when the financial crisis recognizable situations it may be necessary not only to determine the situation "the situation and the possible" but also calculate the probability of this situation.

Regarding classification of securities NN output information can be displaying the results on a plane that will carry out the final classification of the user. Another requirement may be the need to determine the relationships between verbal input and output information.

Restrictions relating to the technical implementation NN:
Speed of decision making.

The scope and complexity of program implementation. To reduce the amount of code can be divided to study the network of code that is responsible for its operation.

The integration of development tools into existing business models.

Scope defines the business model in which the messiah will be used. Today sufficiently explored is the use of neural network for pattern recognition and optimization during calculations. Note that the pattern recognition system are fundamentally different from the systems analysis of time series data that they output number and combinations of input parameters fundamentally limited. In systems analysis of time series data this number is essentially unlimited. Accordingly, in the processing of sensory information with a fixed number of parameters to be used for the intended neural pattern recognition. In contours business models where this number can vary, for example when analyzing text documents may use neural designed for analysis of time series data. In systems manage your business models to be applied NN designed for optimization calculations. In addition, the scope is determined by the autonomous adaptability to network operation. For this architecture NN should be provided the opportunity to fully automate the process of relearning to use.

Qualitative assessment of conformity of the main characteristics of NN applications in terms of business models for emerging types of networks are given in Table. 3 (Source: the development of the author). In Table 3 no characteristics that although used in the construction of the network, but do not affect the choice of type NN. Ratings accordance exhibited in numerical form on trohbalniy system (-1 minimal, 0 average, 1 maximum).

The values are calculated estimates as a result of comparative analysis considered types of NN conducted in [1, 2, 6]. The lack of assessment means that its determination requires additional research.

Table 3

Qualitative assessment of conformity NN application in terms of business models

Condition	MLP	RBF	Kohonen	ART	DNN	PNN	Associative
1	2	3	4	5	6	7	8
Study data							
Admissibility noise	1	0	1	-1	1	0	-1
Admissibility correlation	1	1	1	1	1	1	-1
The need for all aspects of	-1	1	1	-1	-1	1	0
Need proportional presenting examples	1	-1	-1	-1	1	-1	0
General limitation learning process							
Short term training (small amount of training iterations)	-1	0	1	1	-1	1	1
The need for representation in educational examples of expected income	1	-1	0	1	1	1	0
Automating the process of learning	0	1	1	1	1	1	0
The opportunity to study	1	0	0	1	1	1	1
Quality education							
Computing power							
Memory	1	-1	-1	-1	1	-1	0
Extrapolation of learning outcomes	1	-1	-1	-1	1	-1	1
Continuing results	1	1	0	1	1	1	0
The output							
The possibility of interpretation as the probability of exit	1	0	-1	-1	1	1	0
The possibility of interpreting the output in graphical form	-1	-1	1	-1	-1	-1	-1
The possibility of verbalization	1	0	-1	-1	-1	0	-1
Restrictions technical realization NN							
Speed decision	1	1	1	1	0	1	-1
The amount of program implementation	-1	1	-1	0	-1	-1	0
Aprobovanist systems							
Pattern recognition systems	1	1	1	1	0	1	1
Text analysis systems	-1	-1	1	0	1	0	-1
Management systems	-1	-1	1	-1	-1	-1	1
Adaptation to autonomous operation	-1	-1	-1	1	1	-1	-1

Integral assessment according to the characteristics of neural network conditions applied problem might set using the following expression (Source: own development)

$$S = \sum_{i=1}^{I} s_i \quad , \tag{5}$$

where S - integrated assessment, I - the number of significant conditions of the neural development problems in applied business model, si - i-type and assessment of the Messiah to the i-th significant conditions.

To solve this problem you should use the kind of Messiah for which integrated the highest score.

It should be noted that in tasks that add up to pattern recognition in the absence of restrictions on the use of teaching method "with the teacher," term training, relearning, autonomy of operation, presentation of results of recognition, the amount of program implementation, the number and quality of training data is the most effective use of multilayer perceptron. Its effectiveness is due most computing power, the ability to automate the process of learning and verbalization of the results. However, other types of NN should be used for rapid preliminary analysis or in specific cases that are characterized by certain limitations.

4. FEASIBILITY

Consider the task of selecting the type of neural network that is designed to recognize voice signals in the user interface of the computer system. In accordance with the results of [5] significant conditions of application are: the admissibility of noise in the training data, admissibility correlation case studies, the need for mapping in the training sample all aspects of the process, the need for representation in educational examples of expected output, the ability to automate the process of training, the maximum quality of education, minimizing the volume of memory 'memory, the possibility of extrapolating the results of learning, the ability to exit NN interpretation as probability and maximum speed of decision making. Exhibited by the formula (5) Integrated assessment of conformity to type NN these conditions are shown in Table 4 (Source: own development).

Tab. 4. *Integrated assessment of the type NN phoneme recognition task*

Type NN	MLP	RBF	ART	PNN	DNN	Koho-nen	Associative
Rating	7	-1	-3	3	6	1	-3

Data analysis Table 4 indicates that the highest integrated assessment with MLP and DNN. Accordingly, these types of NN most adapted to recognize voice signals in the user interface of the computer system.

CONCLUSIONS

In developing business models NN should only be used for the solution of problems relating to the class of pattern recognition and optimal management of associative memory.

In terms of the theory of neural greatest practical effect can be expected when applied to the classification of sensory information outlines business models.

Identify the fundamental feasibility of one or more types of NN possibly based on analysis of their compliance with the conditions set out in Table 2. The final decision to use a particular type NN should be taken after the experiments.

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