weights. In this way the computational time and the memory space, required for obtaining the weights, is optimized and simplified. The degree of correlation from a pattern with the prototypes may be controlled by the dynamical value of two parameters: the capacity parameter $\theta$ which is used for controlling the capacity of the net (it may be proved that the bigger is the $\theta_j$ component of $\theta$, the lower is the number of fixed points located in the $r_j$ energy line) and the parameter $\mu$ which measures the deviation to the prototypes. A typical example has been exposed, the obtained results have proved to improve the obtained when the classical algorithm is applied.

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# NEURAL NETWORKS DIAGNOSTICS IN HOMEOPATH SYSTEM

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*Abstract: We suppose the neural networks for solution the problem of the diagnostic in Homeopath System and consider the algorithms of the training.*

*Keywords: artificial intelligence, neural networks, training of neural networks, information granules.*

## Introduction

As a rule, as a consequence of the cerebrum study and mechanisms of its functioning there have been created new computer models, namely artificial neural networks (NN). The tasks of the office automation processes based upon the research in the sphere of the artificial intelligence (AI) are of current importance to present day. NN permit to solve applications such as pattern recognition, modeling, fast data conversion (parallel computational processes), identifications, management, and expert systems creation [Терехов, 2002, Барский, 2004].

Theoretically, NN can solve a wide frame of tasks in the specific data domain. (as it is the human brain model prototype), but it is still not practically possible to create the integrated universal NN for the specific data domain at present, since there is no integrated construction algorithm (functioning) of the NN. The moment to date the specific structure NN and with the defined learning algorithms are used for the solution of the concrete group of tasks out of the fixed data domain.

As it is well-known, each neuron has a number of qualitative characteristics, such as condition (excited or dormant), input and output connections. The one-way only connections, mated with the inputs of the other neurons are called synapses and the output connection of the given neuron from which the signal (actuating or dormancy) comes on the synapses of the other neurons are called axon. [Терехов, 2002] The neuron overview is presented on figure 1.

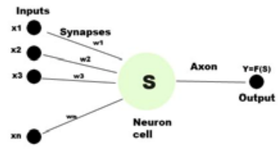


*Figure 1. General view of neuron*

Per se, the functioning of every neuron is relatively simple. As a rule, the set of the X=[x1,x2,x3,…xn] signals come to the neuron input. Each of the signals may be the output of the other neuron or source. Every input signal is multiplied on the corresponding angular coefficient W=[w1,w2,w3,…wn]. It complies with the force of the synapse of the biological neuron. The products of the wi*xi are summarized and come on the adding element. To initialize the networks, the input x0 (x0=+1) and the weighting factors of the synaptic ties w0 are specially entered. The neuron condition in the current moment is defined as the weighted total of its inputs:

$$S = \sum_{i=1}^{n} x_i w_i + x_0 w_0$$

The neuron output is the output of its condition:

Y=F(S)

The F function is the function of activation. It is monotonous, contiguously differentiable on the interval either (-1,1), or (0,+1).

In the multilayer neuronal networks (MNN) the basic elements outputs of each layer come to the inputs of all the basic elements of the next layer. The activation function F(S) is chosen as being the same for all the neurons of the network. In [1] the MNN it is determined in such a symbol form $N^{K}_{n_0,n_1,\dots,n_R}$, where K – the number of the layers in the network, $n_0$ - the number of the network inputs; $n_i (i = 1, K-1)$ - the number of the basic elements in the i-x interlayers, $n_K$ - the number of the basic elements in the output K layer and simultaneously the number of the outputs $q_1,\dots,q_{n_K}$ of the MNN. The intermediary a layer has $n_a$ neurons. There are no connections between the basic elements in the layer. The layer basic elements outputs come to the neurons inputs of only the next (a+1) layer. The output for any neuron is determined as being

$$q_i^{(a)} = f\left(\sum_{j=1}^{n_{a-1}} w_{i,j}^{(a)} q_1^{(a-1)} + w_{i,0}^{a} q_0^{(a-1)}\right) = f(s_i^{(a)})$$

## Specialized NN in HOMEOPATH system

The scientists have been into the development of the mathematical methods solutions of medicinal tasks for many years already. The effectiveness of the similar mathematical methods may be followed by the set of the medical diagnostics systems, developed in the last time. The general trait of these systems is their dependence on the specific methods of the group data processing, poorly applied to the unit objects and, also, on the features of the medical information [Горбань, 1998].

The neuronal networks (NN) are easy-to-use instruments of the information models presentation. In the general case, the network receives some input signal from the outer world and passes it through itself with the conversion in each of the neurons. Hence, the signal processing is being made in the process of its passage through the network connections, the result of which is the specific output signal. For the purposes of the neuronal network designing in the system of HOMEOPATH there has been chosen the mostly spread structure of the neuronal networks – multilayer one. This structure imports that every neuron of the arbitrary layer is connected with all the outputs and inputs (axons) of the preceding layer or with all the NN inputs in the case of the first layer. In other words, the network has the following structure of the layers: the input, the intermediate (latent) and output. Such neuronal networks are also called fully connected [Барский, 2004].

For the solution of the diagnostics task in the system of HOMEOPATH the NN of the following architecture is being used (Figure 2).


*Figure 2. Architecture neuron network*

The task of the habituation of the MNN in classical form could be presented as following. Let there is specified some series of $x^*$ input data. It is requested to find such solution $x$, with which it is possible to classify the newly presented input data. The criterion $R(x, x^*)$ determines the quality of solution. The variety of solutions $x$ is determined by the choice of the weighting factors $w_i^{(a)}$ adjustment algorithm. Under such problem definition, the training process is comes to the receipt of the best solution out of the series of possible ones. In other words, the MNN training – is the process of data $x^*$ accumulation and, concurrently, the process of the solution $x$ choice.

## The algorithm of training

The NN of the HOMEOPATH system uses the algorithm of the inverse distribution the gist of which is in the distribution of the error signals from the NN outputs to its inputs in the direction, back to the direct signals distribution in the usual mode of operation (identification regime). In other words, we use the technologies of the series tuning of neurons starting with the last output layer and finishing with the tuning of the first layer elements. The NN habituation may be done the necessary number of times. For the habituation the so called $\delta$ -rule is used, which lies in the realization of the training strategy with the "teacher". Let us label as $y^*$ - the required neuron output, y – the real output. The error of the training is calculated according to the following formula $\delta = y^* - y$ in the algorithm of the gradient descent (the weighted factor) $w_i(k+1) = w_i(k) - \gamma\delta x_i$, $\gamma > 0$, where $\gamma$ -is the "strengthening of the algorithm" factor, $x_i$ - the i input of the neuron synaptic connection.

The algorithm of the NN training for the determination of the diagnostics tasks in the HOMEOPATH system is in the following order of steps:

Algorithm:

1. In the context of the data domain the input signals vector is made: $x = \langle x_1, x_2, \ldots x_n \rangle$, where $x_1, x_{2,} \ldots, x_n$ are the patient symptoms.
2. The vector corresponding to the correct definitions (required) $y^* = \langle y_1, y_2, \ldots, y_n \rangle$, formed by an expert in the data domain.
3. The algorithm of the direct spread of the signal x through the network is executed. As a result of the algorithm execution the weighted sums $S_{jn}$ are determined and the activators for each cell.
4. The algorithm of the inverse signal distribution through the cells of the output and intermediary layer is executed. The errors $\delta_0$ calculation is performed for the output cell and $\delta_i$ for the encapsulated cells.
5. The neurons weights renovation is performed in the network, where $S_{jn}$ – is the weighted sum of the output signals of the n layer n (the activation function argument).

The NN habituation is in the presentation of the training examples out of the little group of the desired actions. This is performed by the way of the algorithm of the inverse distribution performance with the account of the desired result and real result.

The network functions in two regimes: in the regime of habituation and in the regime of identification. In the regime of habituation the so called logical chains formation is made. In the regime of identification according to the specific input signals with the high range of validity the NN determines, which actions to undertake.

The habituation of the neuronal network is performed upon the limited number of examples, then, they permit it to independently generate the behavior in other situations. The ability to generate correct reaction on various symptoms, which are not in the training set, is the key factor in the creation of the NN. The data for testing is some scenarios with the set of possible actions. In the result, the network has to calculate the reaction on the inputs and perform an action, which will be similar to the training scenarios.

For the network habituation the following examples were used (Table 1).

| *Sympt1* | *Sympt2* | *Sympt3* | *Sympt4* | *Preparation* |
|---|---|---|---|---|
| *1* | *1* | *0* | *1* | *P1* |
| *1* | *1* | *0* | *1* | *P2* |
| *0* | *0* | *1* | *0* | *P3* |
| *1* | *0* | *1* | *1* | *P4* |
| *0* | *0* | *1* | *1* | *P5* |

*Table 1. Input data*

| *Sympt1* | *Sympt2* | *Sympt3* | *Sympt4* | *Preparation* |
|---|---|---|---|---|
| *1* | *1* | *0* | *1* | *P1* |
| *1* | *2* | *0* | *1* | *P2* |
| *0* | *0* | *1* | *1* | *P3* |
| *1* | *1* | *0* | *1* | *P4* |
| *0* | *1* | *0* | *1* | *P5* |

*Table 2. Output data*

In order to test the NN, the networks should be presented with the new examples. This allows determining how the network will react upon the scenarios, of which nothing is known. The similar tests permit to know hoe qualitatively the NN can react on the unforeseen situations and perform the necessary actions. To test the NN it is necessary to present new examples (Table 2).

The distinguishing property of the HOMEOPAT system is it's possibility to follow the strategy of construction (and following check of differentiated diagnosis), used by a clinicist. Such a diagnostic model includes the two-level procedure, which builds hypothesis of illness, based on input patient data, and processes the data estimation based on additional symptoms, which should be common for the possible illnesses. The search for the needed information to form the image of illness is performed through the knowledge base using the mentioned specialized NN.

## Features of NN design in the HOMEOPAT system

The processes of defining, extraction and structurization of information are known to be the most important in artificial intelligence system building. Implementation of each process has a great distinction, depending on the information storage environment, organization of information and the concepts of NN design for searching and analyzing the required data. In HOMEOPAT system main informational blocks consist of general patient's state, symptoms and recommended drugs. Taking into consideration the fact that system uses the concept of granular NN design [Bargiela, 2003], based on the information granules creation process with their following processing. Information granules are defined as the map

$$A : X \to \delta(x)$$

where A - illness, X – the space on possible symptoms, $\delta$ – the space of homeopathic drugs.

The detail level of artificial information granules is defined be the number of elements in the granule. The level of precision is defined through the integral

$$card(A) = \int_X A(x)dx$$

where – A – examined granule. The more powerful granule is, the more precise will be the result of illness distinction using the given symptoms and less specific.

Let $A = \{A_1, A_2, ...A_c\}$ - where "c" is the precision level in naturally common illnesses in the form of granule set. The initial data can have a different level of precision. For example, $B = \{B_1, B_2, ...B_p\}$, where "p" is the level of precision, which is much higher, then of a granule with level "c. Such a transition from the granule of the selected level of precision to the granule with another level of precision brings up the mechanism of dealing with so-called dynamical information granules, or the mechanism of new granular space building.

For example, the evolution of granular space $< X, G, A' >$ into $< X, G, A'' >$, where $A''$ is more precise than $A'$, in the HOMEOPAT system can mean the gathering of some new information about the illness, and consequently a dynamic change of corresponding information granule. Depending on the problem, granules in the system are grouped into layers. The given information network in the basis for the NN design in the HOMEOPAT system. In addition we should point out that hidden layers of NN in such a case represent the agents of granular environment, responsible for interaction between different objects.

Formally the granular environment with the interaction layer can be defined the following way $G =< X, G, A, C >$. Let's examine the general structure of data-model in terms of information granulation on example of simplified model of NN functioning. The upper generalized level of granular space could be represented in the form of the following information granules: structure of input data for the NN, which is represented as an array of illnesses symptoms, is the first element of informational granulation, which has a corresponding array of drugs, which could be used to cure the current symptoms, which is the second element of informational granulation. Formally this can be described so $G_{net} = \{X_{net}, G_A, In_{G1}, In_{G2}...\}$, where $G_{net}$ - neural network of granulation, $G_A$ – agent of granulated environment, $X_{net}$ - artificially represented space of informational granules, $In_{G1}$ - informational granule containing an array of symptoms, $In_{G2}$ - informational granule containing an array of drugs.

As conclusion we note that the simultaneous usage of main terms of informational granulation and neural networks gives a bunch of new possibilities in designing of the mentioned specialized neural network. Exactly: more precisely design the architecture of the network, number of hidden layers and the method of representation of learning set and the following work with the real data.

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