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Some Approaches of Improving the Quality of Artificial Neural Networks Training

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Some approaches of improving the quality of artificial neural networks' training

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Abstracts. The paper is devoted to a problem of regular improving the quality of artificial neural networks' (ANN) training. The object of study is a complex neural network consists of 2-dimensional Kohonen network and Wilshaw and von der Malsburg network. These networks are applied to timetable problem for transport systems. The main existing results of using optimal control theory for ANN training are analyzed; authors suggest a new technique based on direct neural control. Authors give comparative values of error during training process for traditional methods and the new approach. It is presented that the new technique is better than traditional one for considered neural networks.

1. About optimal control in neural networks tasks

Last time the area of neural networks' applying has been significantly extended. The most popular tasks are synthesis of control systems, identification tasks, data processing, information recovery tasks, scheduling problems and other original activities e.g. creating new pictures and arts.

Despite of routine modification of structure and topologies of ANN and training methods ANN is a system which is controllable only using sets of recommendations, based on heuristic approaches [2], numerical experiments etc. Majority of authors directly notes that quality of ANN training and creating of neural network solutions is a complicated scientific problem. Sometimes we may see attempts of combined use ANN and optimal control theory as a rigor mathematical method for any tasks.

The paper [3] is devoted to constructing the optimal time sequences consists of weights between neurons of a dynamic ANN. In [3] the two-point boundary value nonlinear problem is solved. It yields optimal rules of the ANN training. The weight matrix of the ANN in every time step (epoch) is set as an optimal time sequence. Authors note that in the best case the weight matrix at the final time step relates to the symmetric matrix constructed by J.J. Hopfield for associated memory [4].

Initial conditions are set as an input vector concatenated of several training samples.

The functional (the criterion) of quality minimizes the value which is an opposite value of correlation between the output of the neuron and desired output of the neuron at the final time step of controlling. During the time interval between the first step and the last step of controlling the functional penalize miscorrelation level between the desired output and the answer of activation function of each neuron.

In this case optimal control strategy is founded as Lagrange problem for a task of an optimal program control of the multilayered perceptron with sigmoid activation function.

The goal of the paper is to increase the quality of training Kohonen neural networks and ANN based on such type. The general model of the considered ANN is described in [1] and looks like 2-dimensional modification of the Kohonen and Wilshaw and von der Malsburg network. This kind of ANN is used to create timetables for various processes including transport applications.

2. Direct Neurocontrol for multilayers artificial neural networks

Except the traditional training algorithm authors suggest a direct neurocontrol mode for training. The controllable object is a multilayered ANN with variable signal conductivity [1], a three layer perceptron with sigmoid activation functions is considered as a controller.

The main scheme is given in the fig.1.

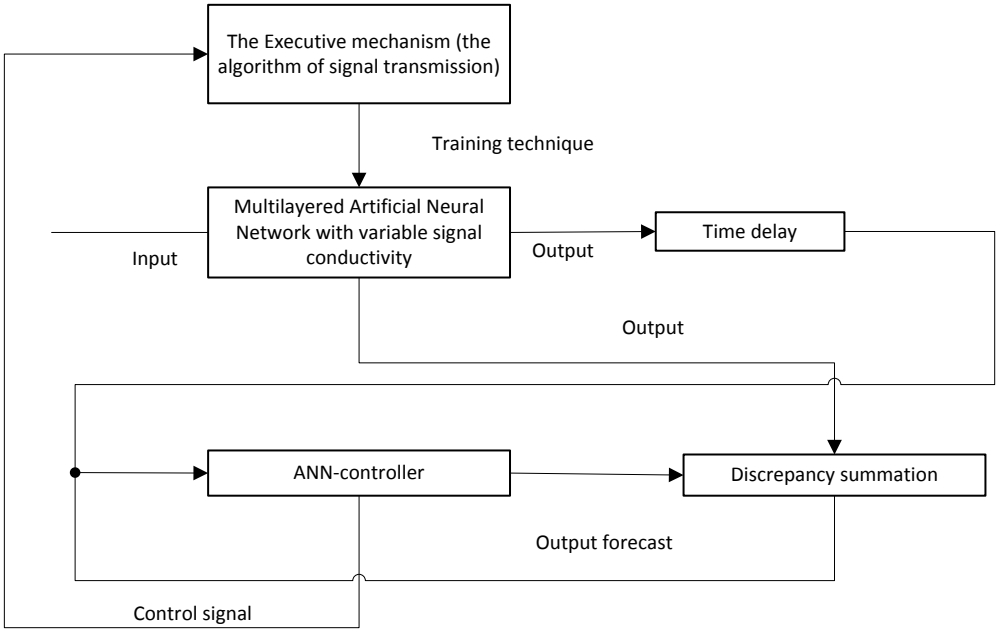

Fig.1 – The scheme of direct neurocontrol

The ANN-controller is trained by aggregation of triple sets “Level of error per epoch” – “Level of error at previous moment” – “The control signal from previous time step to present time step” or “The previous level of error” – “The current level of error” – “The control signal”.

The current error signal of the ANN and the previous one are gathered and entered the trained and ready multilayer perceptron. An answer signal of the ANN-controller entered the discrepancy summation and actuating mechanism (an algorithm). Hereinafter the value of summated discrepancy is also fed by the ANN-controller.

The control scheme described above was tested for the concrete scheduling problem (the railway branch Arkhara – Volochaevka, 27 railway stations). The task included 185 trains per 24 hours.

The results of testing are given in the table 1.

Table 1. – A comparison of different training methods

Training error (points)	Traditional algorithms	Direct neurocontrol
Min	75	193
Max	134795	57895
Median	5469	210
Average	16548	384
SD	6687	1180
Rate of error overshoot (per 100 epochs)	50	0,4

3. Conclusions

Thus the paper shows us the principal opportunity to control of the multilayered artificial neural network with variable signal conductivity. The three layered perceptron with sigmoidal activation function can be considered as a controller. The quality of solutions achieved by multilayered artificial neural networks with direct neurocontrol shifts the level of solutions with traditional training algorithms.

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