Ministerstwo Nauki i Szkolnictwa Wyższego

Organizacja IX Konferencji Modelowanie Matematyczne w Fizyce i Technice (MMFT 2017)
- zadanie finansowane w ramach umowy 829/P-DUN/2017 ze środków Ministra Nauki i Szkolnictwa Wyższego przeznaczonych na działalność upowszechniającą naukę.

MULTI-LAYER NEURAL NETWORKS FOR SALES FORECASTING

Magdalena Scherer
Department of engineering management, Czestochowa University of Technology, Czestochowa, Poland

Forecasting and the ability to assess future events play a key role in business operations. The uncertainty of the future and the time interval from the moment of the decision to its result, makes it necessary to find appropriate prognostic methods, which are burdened with the smallest error and are simple and inexpensive to use. With accurate and accurate forecasting, decision making becomes much easier, making enterprise management easier. Forecasts should be the basis for creating business action plans. Still, new methods of forecasting are being sought, where the results will be as small as possible, and the methods will be simple and cheap to use.

Neural networks are mathematical structures and their software or hardware models. The inspiration for their construction was the natural neurons connected by synapses and the entire nervous system, and in particular its central point – the brain. Artificial neural networks can be used in a broad spectrum of data processing issues, such as pattern classification, prediction, denoising, compression and image and sound recognition, or automation.

Neural networks have the ability to process incomplete data and to provide approximate results. They enable fast and efficient processing of large amounts of data. They are resistant to errors and damage.

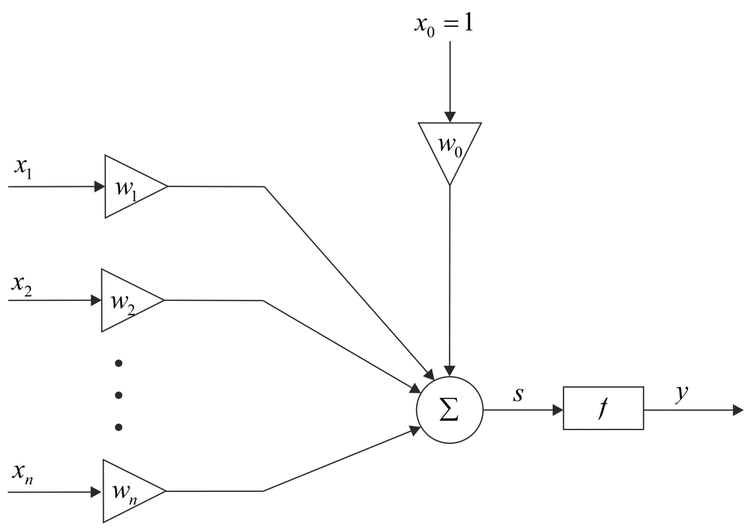

Fig. 1. Artificial neuron model

The basic element of the neural network is the neuron [4]. Figure 1 shows the neuron model, where *n* is the number of inputs to the neuron, $x_1, \ldots, x_n$ are input signals, $w_0, \ldots, w_n$ are synaptic weights, *y* is the output value, w_0 is bias and *f* is activation function. The operation of the neuron can be described using the formula

$$y = f(s),$$

where

$$s = \sum_{i=0}^{n} x_i w_i$$

The input signals $x_0, \ldots, x_n$ are multiplied by the corresponding weights $w_0, \ldots, w_n$. The resulting values are summed to produce a signal *s.* The signal is then subjected to an activation function that is usually nonlinear to create many layers. There are many models of neural networks. The neural network division can be made taking into account the following factors: learning method, direction of signal propagation in the network, type of activation function, type of input data and method of interconnection between neurons.

Neural network used in simulations had three inputs and one output for the predicted variable.

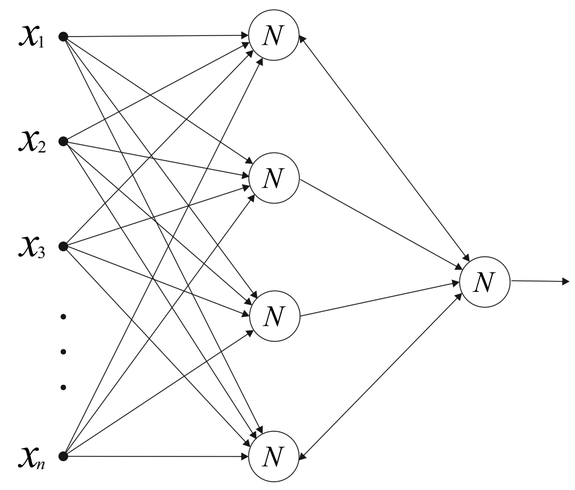

Fig. 2 Neural network used in the paper.

We predict the sale volume in the following month on the basis of three previous months. We picked the best network to have 15 neurons in the hidden layer and one output neuron.

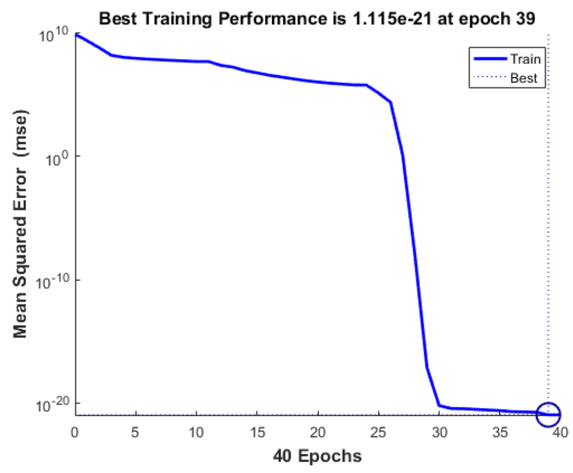

Fig. 3 Neural network learning error.

After 40 epochs of learning with the backpropagation algorithm we acheived RMSE error 3.3391e-11.

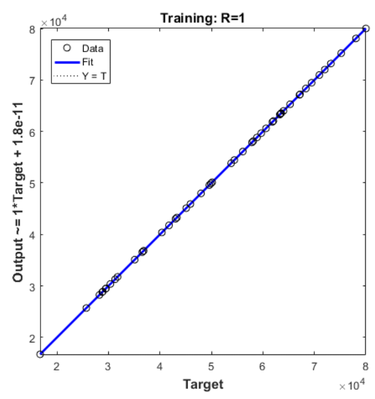

Fig. 4 Training data vs NN output.

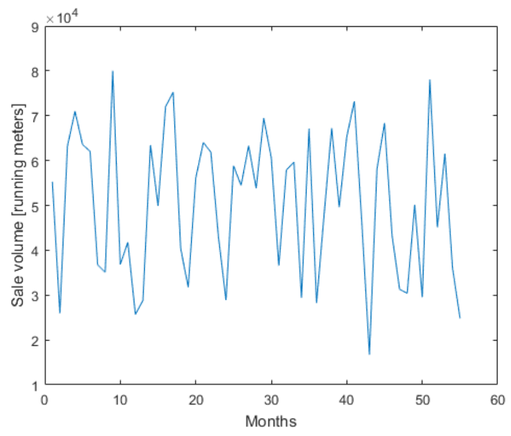

Fig. 5 Trainingdata.

Conclusion

This paper concerns forecasting sales volume in monthly intervals in a medium Polish company. The data from previous months were used to train feedforward neural network (full-connected) with the backpropagation algorithm [1]. We achieved a good prediction accuracy what allows to use the outcome to increase the effectiveness of the company management.

References
[1] Rumelhart, David E.; Hinton, Geoffrey E.; Williams, Ronald J. (8 October 1986). Learning representations by back-propagating errors, Nature. 323 (6088): 533–536.
[2] Ke Y., Hagiwara M., An English Neural Network that Learns Texts, Finds Hidden Knowledge, and Answers Questions, Journal of Artificial Intelligence and Soft Computing Research, Volume 7, Issue 4, pp. 229-242.
[3] Bologna G., Hayashi Y., Characterization of Symbolic Rules Embedded in Deep DIMLP Networks: a Challenge to Transparency of Deep Learning, Journal of Artificial Intelligence and Soft Computing Research, Volume 7, Issue 4, pp. 265-286.
[4] Bishop, Christopher M. Neural networks for pattern recognition. Oxford university press, 1995.