Advances in Science and Technology Research Journal
Volume 7, Issue 18, June 2013, pp. 54–59
DOI: 10.5604/20804075.1051257

Original Article

MEMBRAIN NEURAL NETWORK FOR VISUAL PATTERN RECOGNITION

Artur Popko[1], Marek Jakubowski[2], Rafał Wawer[3]

[1] Fundamentals of Technology Faculty, Lublin University of Technology, ul. Nadbystrzycka 38, 20-618 Lublin, Poland, e-mail: a.popko@pollub.pl

[2] Management Faculty, Lublin University of Technology, ul. Nadbystrzycka 38, 20-618 Lublin, Poland, e-mail: m.jakubowski@pollub.pl

[3] University of Maria Curie Sklodowska, Multimedia Communications Lab. 20-011 Lublin ul. Narutowicza 12, Poland, e-mail: rafal.wawer@poczta.umcs.lublin.pl

Received: 2013.04.24
Accepted: 2013.05.24
Published: 2013.06.10

ABSTRACT
Recognition of visual patterns is one of significant applications of Artificial Neural Networks, which partially emulate human thinking in the domain of artificial intelligence. In the paper, a simplified neural approach to recognition of visual patterns is portrayed and discussed. This paper is dedicated for investigators in visual patterns recognition, Artificial Neural Networking and related disciplines. The document describes also MemBrain application environment as a powerful and easy to use neural networks' editor and simulator supporting ANN.

Keywords: Neural Network, pattern recognition, neuron model.

INTRODUCTION

Artificial Neural Networks (ANN) have been successfully employed in many applications of visual pattern recognition. Application areas include system identification and control (vehicle control, process control, natural resources management), quantum chemistry [1], game-playing and decision making (backgammon, chess, poker), pattern recognition (radar systems, face identification, object recognition and more), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications (automated trading systems), data mining (or Knowledge Discovery in Databases – KDD), visualization and e-mail spam filtering.

ANN deals with recognition and classification of characters from an image, especially in Optical Character Recognition. For the recognition to be accurate, certain topological and geometrical properties are calculated, based on which a character is classified and recognized [2].

A given pattern, its recognition/classification may consist of one of the following two tasks:

1) supervised classification (e.g., discriminant analysis) in which the input pattern is identified as a member of a predefined class,
2) unsupervised classification (e.g., clustering) in which the pattern is assigned to a hitherto unknown class [3, 4].

MemBrain is a neural network editor and simulator supporting neural networks of arbitrary size and architecture [5].

MEMBRAIN ARTIFICIAL NEURON NETWORK

The neuron and link model of MemBrain is very flexible: everything from simple time invariant Feed-Forward Networks to Nets with spiking neurons, arbitrary loopback connections and signal runtime delays on the links can be simulated. It is even possible to connect directly the output of a neuron to its own input. In principle, every net in MemBrain is a valid net. Through the consequent object-oriented approach every neuron and also every link in MemBrain can have different properties. Links can have user-defined logical lengths, so that real runtime behaviour can be simulated and visualized. The following learning algorithms are implemented in MemBrain. Supervised learning: Standard Backpropagation (only forward links are trained), Standard Backpropagation with momentum (only forward links are trained), Backpropagation with support for loopback links, Backpropagation with support for loopback links and with momentum, RPROP (Resilient Backpropagation) with support for loopback links, Cascade Correlation with support for loopback links (using Backpropagation with momentum), Cascade Correlation with support for loopback links (using RPROP), Trial and Error with support for loopback links. Unsupervised learning: Winner Takes it All for SOMs (Self Organizing Maps)

The aim of this paper was to determine and optimize the structure of neural network built to recognize six visual patterns (O, X, –, |, /, \). A required structure of Artificial Neural Network (Figure 1) was created in MemBrain application environment. Vectors of input and output data were generated with help of "lesson editor" tool (Figure 2). Asample of one pattern visualization was presented in Figure 3. Training algorithm - Standard Back Propagation was enabled and Target Net Error was established for value equal 0.01 (Figure 4). In order to achieve proper results during teaching the net has to be randomized before undergoing the first teaching process. Randomizing a net means that all the link weights and the neuron activation thresholds are initialized with small random values (unless the corresponding link or neuron properties are locked). The next stage of the research was to test the networks with the amount of 3–14 neurons in the hidden layer. The results are shown in Figures 5–16. Better result are obtained when the neural network requires less training.

Hidden layer neurons are the neurons that are between the input layer and the output layer. These neurons are typically hidden from view, and their number and organization can typically be treated

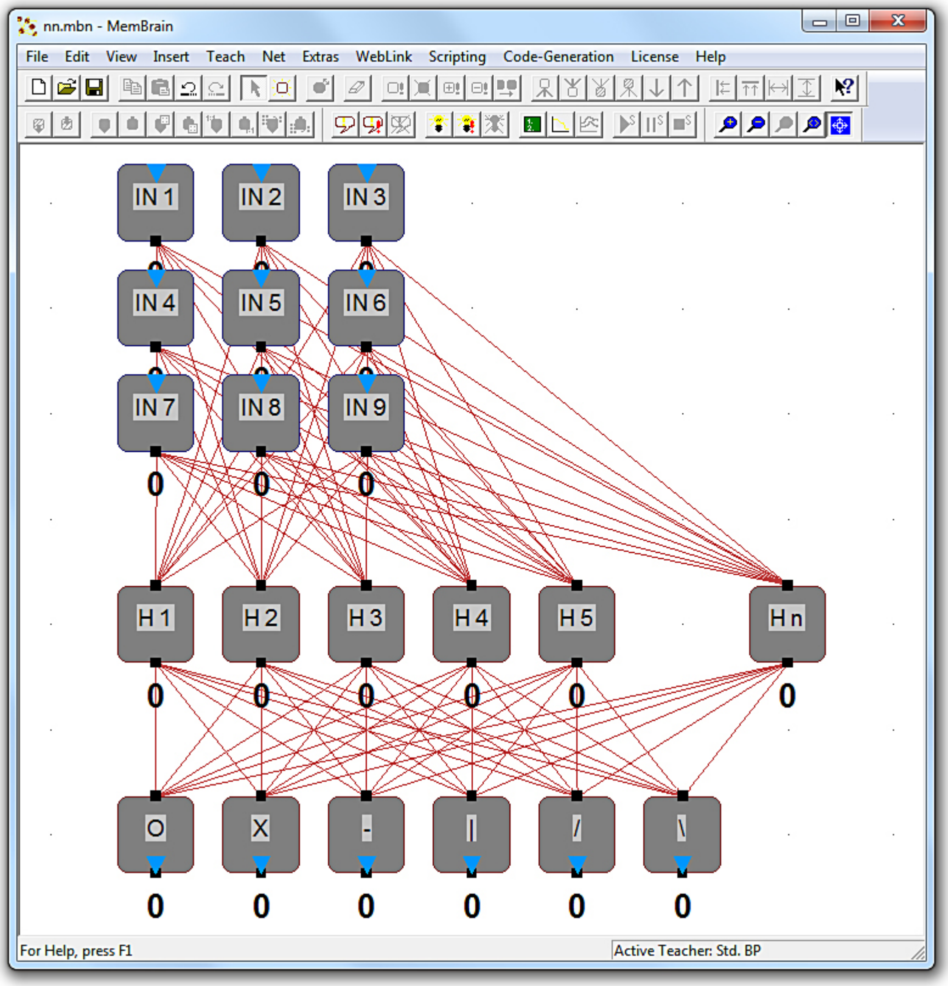

Fig. 1. Architecture of Artificial Neural Network

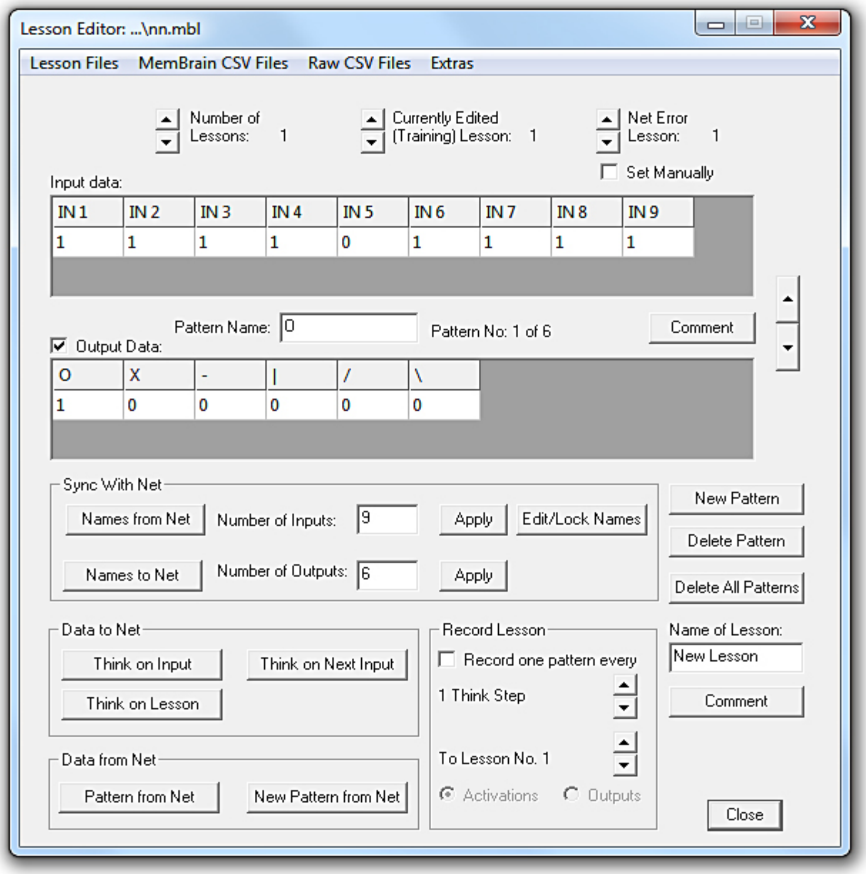

Fig. 2. View of "Lesson Editor" tool

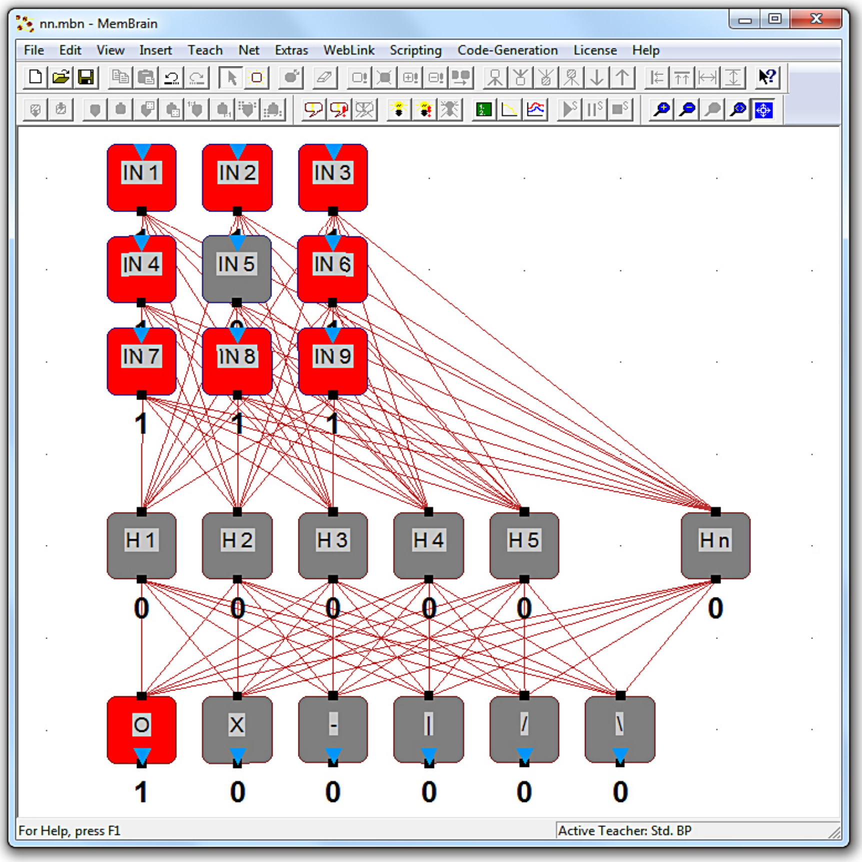

Fig. 3. Sample of pattern visualization

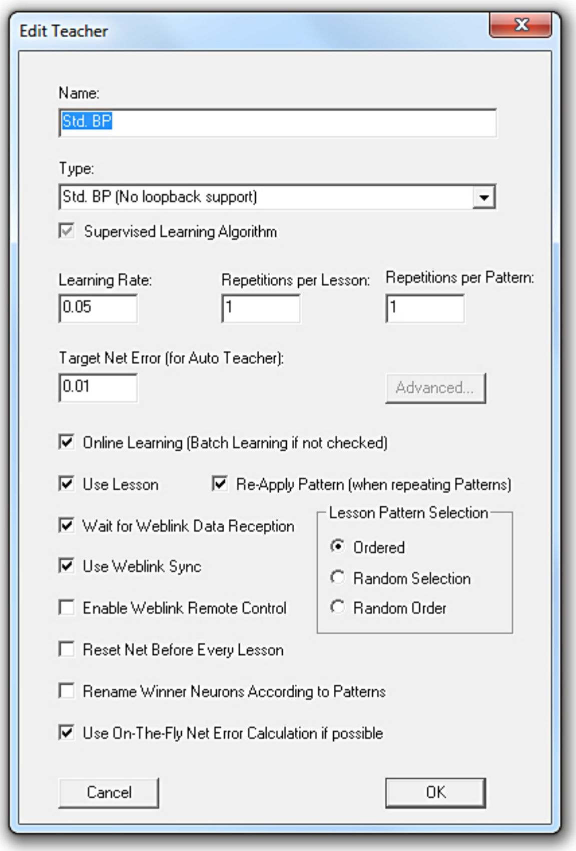

Fig. 4. View of "Edit Teacher" tool

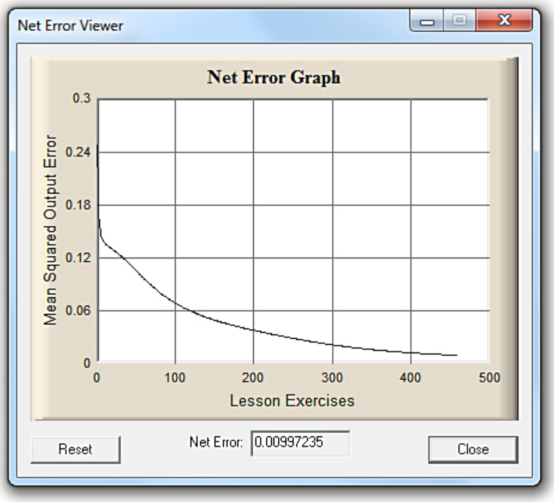

Fig. 5. 3-hidden neurons ANN test results

as a "black box". Using additional layers of hidden neurons enables greater processing power and system flexibility. This additional flexibility comes at the cost of additional complexity in the training algorithm. Having too few hidden neurons can prevent the system from properly fitting the input data, and reduces the robustness of the system. Having too many hidden neurons, the system is over specified, and is incapable of generalization.

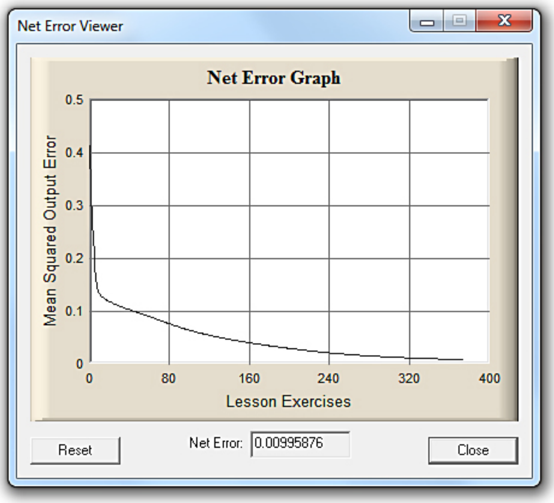

Fig. 6. 4-hidden neurons ANN test results

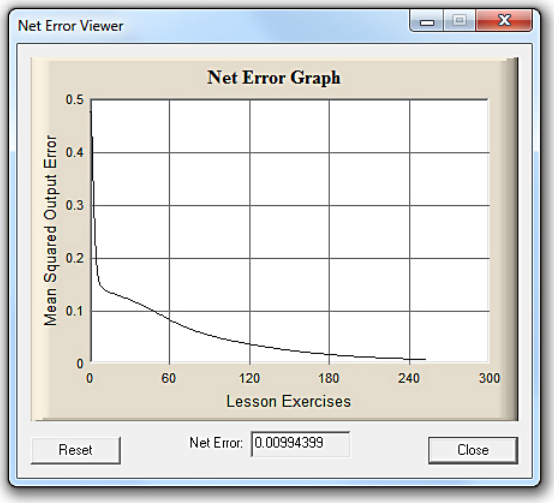

Fig. 7. 5-hidden neurons ANN test results

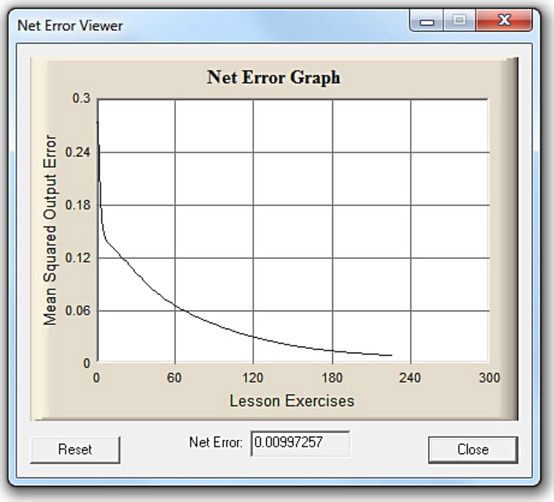

Fig. 8. 6-hidden neurons ANN test results

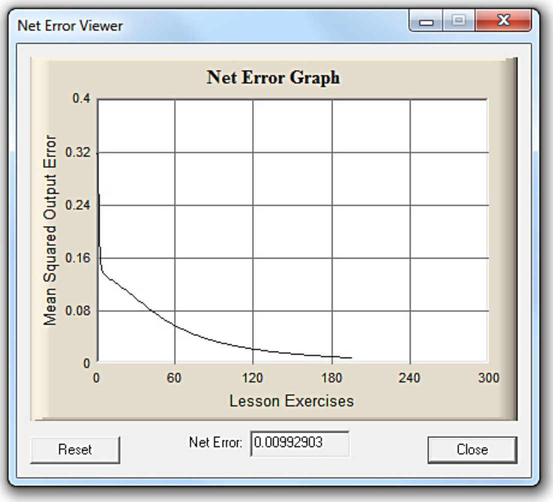

Fig. 9. 7-hidden neurons ANN test results

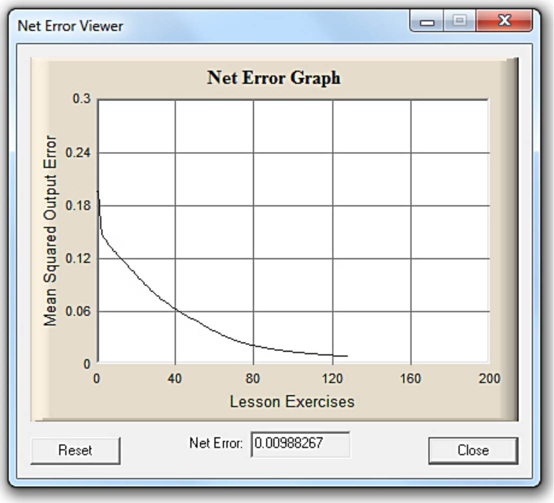

Fig. 12. 10-hidden neurons ANN test results

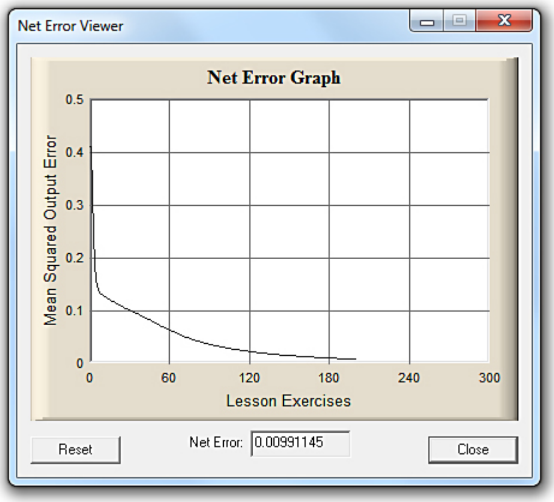

Fig. 10. 8-hidden neurons ANN test results

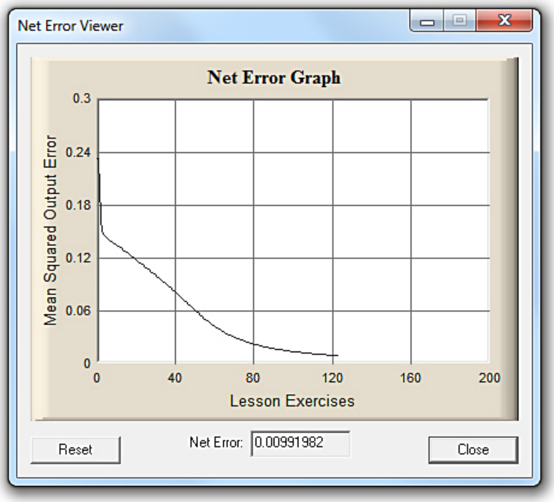

Fig. 13. 11-hidden neurons ANN test results

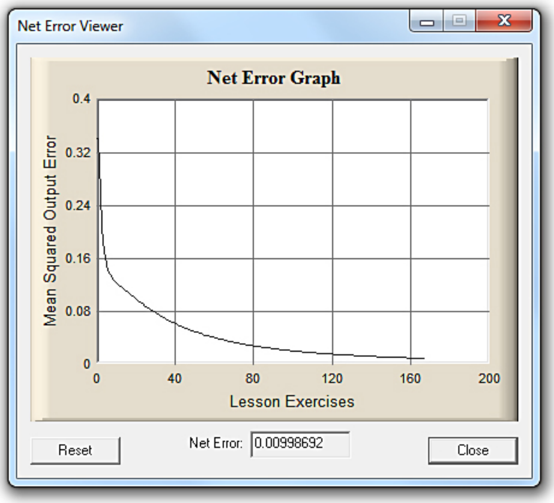

Fig. 11. 9-hidden neurons ANN test results

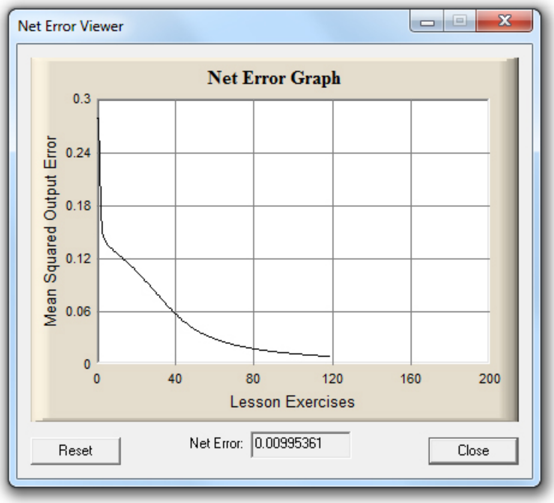

Fig. 14. 12-hidden neurons ANN test results

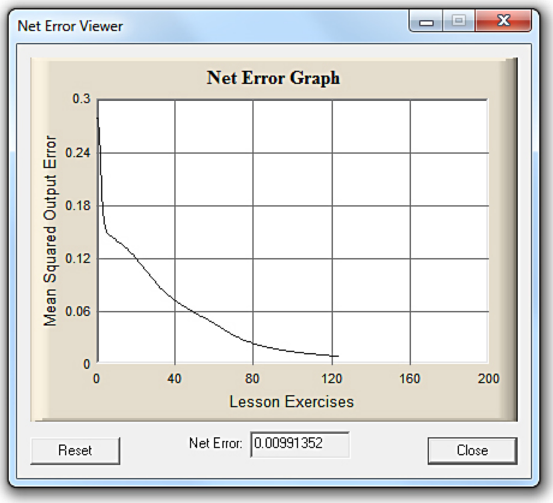

Fig. 15. 13-hidden neurons ANN test results

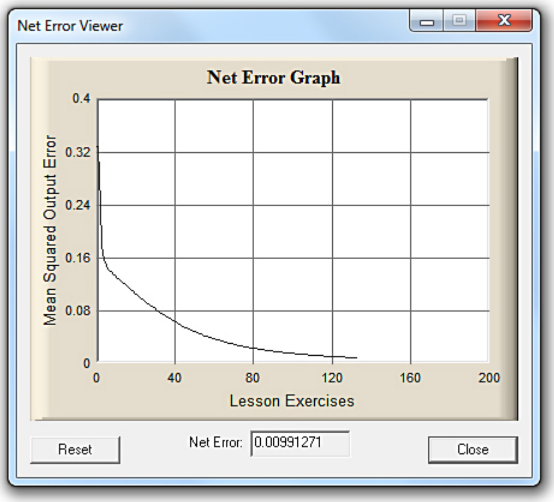

Fig. 16. 14-hidden neurons ANN test results

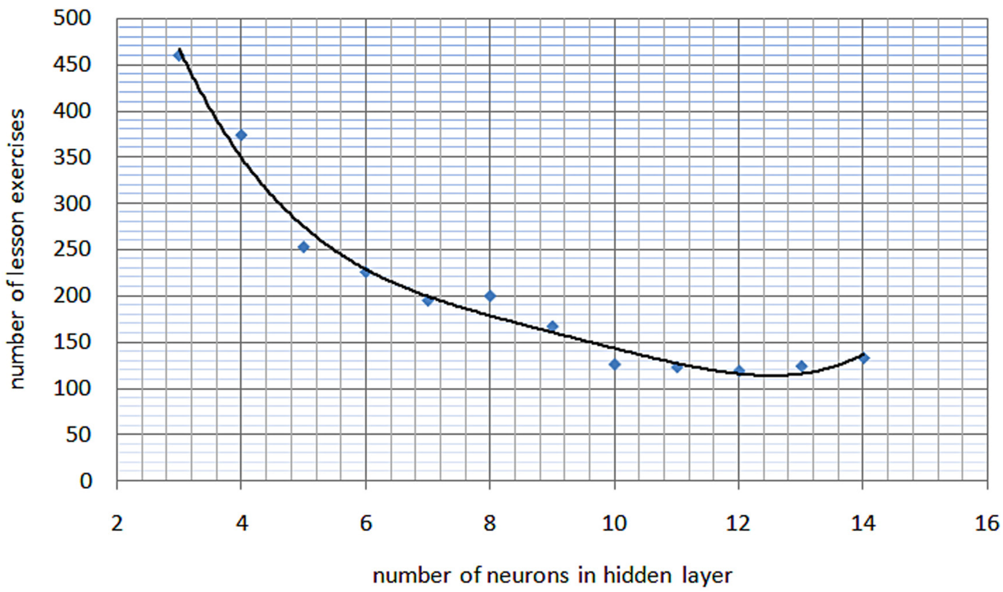

Fig. 17. Dependence of the number of lesson exercises and neurons in hidden layer

The final resulting dependence of number of lesson exercises and number of neurons in hidden layer is shown in Figure 17.

CONCLUSIONS

Most effective architecture of tested ANN consist of 12 neurons in a hidden layer. The number of lesson exercises in this case was smallest and was equal 119. The constructed and tested neural network recognizes visual patterns without errors. MemBrain is a powerful and easy to use neural network editor and simulator supporting neural networks of arbitrary size and architecture, it can be also very helpful in teaching in Artificial Neural Networks.

REFERENCES

1. Balabin R.M., Lomakina E.I.: Neural network approach to quantum-chemistry data: Accurate prediction of density functional theory energies. J. Chem. Phys., 131(7), 2009: 74-104.
2. Shrivastava V., Sharma N.: Artificial Neural Network Based Optical Character Recognition. Signal & Image Processing. An International Journal (SIPIJ), 3(5), 2012.
3. Basu J. K., Bhattacharyya D., Kim T.: Use of Artificial Neural Network in Pattern Recognition. International Journal of Software Engineering and Its Applications, 4(2), 2010.
4. Dung L., Mizukawa M.: Designing a Pattern Recognition Neural Network with a Reject Output and Many Sets of Weights and Biases. Pattern Recognition Techniques, Technology and Applications, 2008.
5. http://www.membrain-nn.de/english/details_en.htm (May 2013).