THE ANALYSIS OF POSSIBILITIES OF MODERN NEURAL NETWORK SIMULATOR SOFTWARE FOR REALIZATION OF LOCAL INTELLECTUAL REGULATORS

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Abstract. A research objective is the analysis of possibilities of the software of modern stimulators of neural networks. By application of methods of the system analysis the best packages on the basis of twelve criteria are revealed. The gained results can be applied for implementation of local intellectual regulators.

Keywords: neural networks, software simulators, algorithms of learning.

Introduction. Now in the world a rather big amount of powerful neural network simulators is worked out [1]. The main differences between them consist in an amount of neuron architectures, topologies and methods of supported studies, limitations in relation to filling of network, presence of programmatic interface with widely spoken languages or programming (as MS Visual C++, Delphi, C++ Builder, C#, etc.), environments for organization of data exchange and possibility of integration into own software projects.

Thus, most known and powerful are such software projects [2-6]:

- NeuralWorks Pro II/Plus (Aspen Technology, Inc.);

- Neuro Solutions (NeuroDimension, Inc.);

- MATLAB Neural Network Toolbox (MathWorks, Inc.);

- STATISTICA Neural Networks (Statsoft, Inc.);

- Brain-Maker Pro (California Scientific Software, Inc.);

- NeuroLand (Institute of mathematical machines and systems, Ukraine).

There is also an enormous amount of less known, simplified or specialized packages (i.e. for supercomputers, clusters, GRID-calculations, etc.). For example, Deductor Academic, JavaNNS, Neuro Office, Neuro Pro, Neuro Shell, NNC, NNW, Sim Brain, T-System, Nimfa, SNNS, SNC (Software Neuron Computer), etc. [8].

Materials and Methods. With the aim of analysis of the marked neural simulators and the choice of the most suitable for application in the process of programmatic realization of neural structures for local intellectual regulators of the type [9, 10] the methodology [4, 7] was used. On the first plan the criteria, related to simplicity of the use of neural packages, evidence of presentation of information and possibilities of the use of typical neuron structures, criteria of optimization and algorithms of studies of neural networks were put in the forefront. Unlike the work [4], it was appraised and taken into account the cost of licenses of software of all packages.

Except universality a neural package must be simple in the use, have intuitively clear interface and provide evidence of presentation of information. On the basis of these requirements such criteria of comparison are set forth:

- simplicity of creation and studies of neural network, intuitively clear interface;

- simplicity of preparation of educational selection;

- the evidence and plenitude of presentation of information in the process of creation and studies of neural networks;

- amount of standard neuron paradigms, criteria and algorithms of studies of neural networks;

- possibility of creation of original neuron structures;

- possibility of the use of original criteria of optimization;

- possibility of the use of original algorithms of studies of neural networks;

- possibility of programmatic expansions of neural packages;

- cost of licenses, presence of trial version.

The estimation of neural packages on the marked criteria was conducted by a ten-point scale. Research of authors was also taken into account in end-point of testing of the above-mentioned neural packages [1-3]. On the basis of comparison such results are received.

The NeuroSolutions is a universal neural package intended for design of a wide circle of artificial neural networks. Basic dignity of the marked neural package consists in its flexibility: except traditional of neural networks paradigms (as full coherent multi-layered neural networks or a self-organizing map of Kohonen) a neural package contains powerful editor of the visual planning of neural network that allows creating practically any own neuron structures and algorithms of their studies. Especially it should be noted that this neural package allows the user to enter its own criteria of studies of neural network, not limiting to only widespread, but far from being optimal criteria of a minimum of a mean-square error. The neural package of NeuroSolutions is equipped by powerful and well carefully thought-out facilities of visualization (it is possible to control practically all the parameters, beginning from a neuron network structure and ending with a process and result of studies). The presence of powerful facilities of visualization destroys a neural package on the level of CAD-systems. Thus NeuroSolutions can be considered a valuable and all-sufficient planning system and design of neural networks.

The package of NeuroSolutions is intended for work in the operating systems Windows'9x/NT/2000/XP/2003/Vista/7-10. Except the correctly organized facilities of co-operating with the operating system (OLE2 is supported) a neural package is also provided with a generator of initial code and facilities that allow using the external modules for planning and studies of neural network. A package supports the programs, written by means of the language C++ for the most known compilers (Microsoft Visual C++ and Borland C++) and also a program as an executable code (libraries of DLL). Thus, the package of NeuroSolutions shows a flexible open system that can be complemented and modified, if necessary. There is a built-in macro language in the package that allows doing practically any conceivable tuning of package under a task. Except adequate facilities of visualization this neural package is equipped with powerful quality facilities.

A neural network is designed as a set of the neurons connected together. The function of activating a neuron can be selected from five standard functions (piece-linear, function of a sign and three types of sigmoid) and also set in an optional kind by user.

The connections between neurons are set optionally on the stage of planning of neural network, here they can be simply enough changed in the process of work with a neural network. A neural package supports all known types of connections: lines cross and reverse. The neural package of NeuroSolutions also has rather powerful facilities for organization of educational selections. The built-in converters of data support graphic images in BMP format, ordinary text files with numeric or symbol data and also the functions of continuous argument (for example, time), set in an analytical kind or as a selection of values.

A neural package allows using the wide set of learning criteria – discrete and continuous (for example, by use of integrating neurons). Besides, it's possible to enter your own criteria. By studies it is possible to use both a built-in back-propagation algorithm or delta-rules, and your own. A correctly built system of visualization of learning process allows conducting the analysis of weight coefficients and their direct changing in the learning process and bringing in corresponding adjustments. By means of neural package it is possible to enter noise description not only by testing of neural network, but also by its studies.

For acceleration of work the neural package of NeuroSolutions contains the generator of standard architectures (Neural Wizard). By means of this generator it is possible to set architecture of neural network quickly, pick up an educational selection, criteria and methods of studies. The most known neural networks paradigms are supported: multi-layered networks, RBF, net of Kohonen, self-organizing structures and others.

A cost of base licenses of package of NeuroSolutions according to the data [3] for all

operating systems depends on their level. First level (Educator) 195$ – mastering of MLP of neural nets. Second level (Users) 495$ – recognition of static patterns. Third level (Consultants) 995$ – recognition of dynamic patterns and prophecy. A fourth level (Professional) 1495$ – generation of Visual Basic code for application in the software. The fifth level (Developers) 1995$ – includes initial libraries on C++. The additional program (195 - 1495$ depending on a level) generates DLL-libraries of neural networks created in NeuroSolution.

Results. The final estimation of this package and other simulators was made by a ten-point scale. End-point received taking into account the data [7] are presented in tab. 1.

Unlike NeuroSolutions in the package of NeuralWorks Professional II/Plus the main attention is concentrated on application of standard neuron paradigms and learning algorithms; exactly herein this package excels all others. For this purpose 28 standard neuron paradigms are realized herein that are used by solutions of applied tasks. Almost all of them are quite widespread and known as of today.

The neural packages contain plenty of learning algorithms of neural networks also including user's algorithms made with the use of facilities of simulator. The UDND module (User Define Neural Dynamics), that is supplied additionally, allows the user to create his own neuron structures and work with them by means of neural packages.

As well as NeuroSolutions, NeuralWorks Professional has a well organized system of data visualization (graphic reflection of functioning of neural networks) and diagnostic facilities. There is a procedure of auto correction of weights coefficients in the learning process, change of learning error and correlation of weights of neural network while learning are realised herein. Automatic optimization of the hidden layer of neurons is hereby provided. The latter is a unique possibility that is given only by NeuralWorks Professional package and is useful enough by analysis of behaviour of neural network during studies and further work.

As well as NeuroSolutions, NeuralWorks Professional is an open system where it is possible to integrate the external programmatic modules written by users. The package has a built-in code generator that supports the compiler of Microsoft Visual C++.

The cost of license of NeuralWorks Professional is from 1995 to 4995 $ depending on a platform (DOS, Windows, NT, Sun, RS6000, SGI). The professional variant (9995 - 14995 $) executed as a specialized environment of development allows to generate the external C++ code and to use programming with C++. Thus, here it is possible to develop any new neural networks and it also includes additional packages for real-time applications together with fuzzy logic and genetic algorithms.

MATLAB + Neural Network Toolbox (NNT). It allows to rationally combine the possibilities of powerful mathematical package and simultaneous work with neural networks (NN). The set of types of neural networks is standard. There is possibility of flexible constructing of NN standard in NNT environment, including probabilistic and regressive neuron to the network. There is a rather large set of standard learning algorithms and possibility of writing of own ones by means of MatLab internal language.

The main disadvantages are: command-oriented interface as a basic method of work in the environment, necessity of perfect possessing the internal programming language for work with more difficult types of neural networks, considerable level of resources utilization.

The price of standard basic licenses makes: for one package of Neural Network Toolbox – up to 2000$, kernel of MATLAB – up to 3500$. The neuron package of STATISTICA Neural Networks has identical possibilities by interface, a set of architectures of standard networks and algorithms of studies with NeuroSolution package. The absence of possibility to create recurrent neural networks and also the absence of built-in macro language as well as generators of text of programmatic code that describes the work of the trained NN with using of standard programming languages can be considered the disadvantages of the package.

Table 1- Integrated estimation of neural packages

Criteria for comparison	Neural packages					
	Neuro-Solutions	Neural Works	MATLAB NNT	Statistica Neural Networks	Brain-Maker Pro	NeuroLand
1. Simplicity of use	9	9	8	10	6	9
2. Simplicity of forming of educational selection	9	9	7	8	7	9
3. Evidence of presentation of information	10	9	7	6	4	7
4. Standard neuron paradigms and algorithms of studies are realized	8	10	5	8	6	7
5. Possibility of creation of own neuron structures	10	8	5	5	5	8
6. Possibility of the use of own criteria of studies	8	7	9	0	0	7
7. Possibility of the use of own algorithms of studies	10	7	6	0	4	6
8. Exchange information between neural packages and operating system	10	8	5	8	5	5
9. Openness of neural packages	10	10	3	2	0	2*
10. Generator of initial code	10	10	10	10	0	0
11. Presence of macro language	10	0	10	0	0	0
12. Price, presence of trial version	8	6	7	9	10	**
Total estimation	**112**	**93**	**82**	**66**	**47**	**60**

(*) – Information may be incomplete; (**) - information misses.

The approximate cost of one license for STATISTICA Neural Networks makes: 475$ (minimum); 995$ (standard); 2665$ (complete version).

The BrainMaker Pro neuron package (California Scientific Software) is simple enough by design of multi-layered neural networks that teach by means of the algorithm of reverse error distribution. The main advantage of BrainMaker Pro neuron package may be an option to adjust the parameters of learning algorithm of neural networks, including the training with limits on weights coefficients. As of the rest it does not have a high level that may be seen evidently from the analysis of the table 1. Especially it concerns the evidence of presentation of information and friendliness of interface.

The price of the license is from 195$ for an ordinary version up to 795$ for professional one (for Windows-platform). There is separate collection of original texts of basic 20 neural networks in C++ language amounting to 1500$.

The domestic neural computer NeuroLand constructed in 2000-2003 at the Institute of mathematical machines and systems of the National Academy of Sciences of Ukraine (Kyiv) by the team of Prof. Reznik A.M. also causes sufficient interest. It is necessary to notice that at the time of completion of development this was a powerful enough simulator. In particular here first according to description [6] it was programmatic realized the reverse associative memory (memorizing and deleting of data without repetition), the associative memory de-saturation (memorizing of data flow in

real time), the modular growing neural nets (associative memory for large numeric data arrays), new original mathematical methods and developed tools (for faster visual design of new neural applications). Other of its basic to property such:

- Simulating behaviour of 10000 neural cells;

- Using neural nets with various types of architectures (Feed Forward, Cascade Feed Forward, Associative Memory, Modular Networks, Cascade Associative, etc.);

- Main neural paradigms (Associative Memory, Bidirectional Associative Memory, Heteroassociative Memory, Modular Associative Memory, Cascade Heteroassociative Memory);

- Basic learning algorithms (Back Propagation and Quick Propagation, Adaptive Algorithm Based on Delta rule, Extended Delta-Bar-Delta, Cascade Net, Hybrid Cascade Net, Second Order Methods);

- Export/import data formats (*.bmp, *.db, *.csv and binary files);

- Total number of designed network neuron up to 32767;

- Maximum number of Feed Forward network layers = 5;

- Maximum number of inter-neuron connections = 2^{32};

- Maximum number of Associative Memory neurons during processing uninterrupted data flow = 4096;

- Maximum number of Cascade Neural Network layers = 128;

- Maximum size of modular Associative Memory = 128 modules;

- Operating systems MS Windows'9x/NT.

The package of NeuroLand has a high enough final estimation (tab. 1). Unfortunately, now there is not any information about further development of this project unlike other neuron simulators of this rating.

Conclusions. It is possible to draw conclusion on the basis of estimations of neuron packages that most powerful, universal and simple in use are neuron packages of NeuroSolutions and, in less degree, NeuralWorks Professional. Therefore, exactly these neuron simulators can be recommended for the use and quality analysis of behaviour of neural networks in the systems of intellectual control.

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