Journal of Mathematical Sciences 3 (2016) 48-56 **Betty Jones & Sisters Publishing**
ISSN 2372-5214 **http://www.bettyjonespub.com**

Assumptions of Hypothetical Optimization Neural Network using a Genetic Algorithm to Predictive Applications

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Abstract: Optimization method of hypothetical neural network is used mainly to choose the best structures and construction of neural model. Implementation of genetic algorithm to create the structure of the neural network constitutes advanced tool solutions to optimization problems. Optimization process consists of using classical genetic algorithm to maximize the matching function objective (such as frequencies eras). First stage of optimization is choosing amount of initial solution constituting population genetic neural network. Consecutively in population is carried out section solutions for appropriate task. The best solution is subjected to cross-breeding to a random exchange of parameters between pairs of these solutions. Optimal solutions are submitted to mutation.

Key words: optimization, genetic neural networks, classical neural networks, prediction

1. Introduction

Management decision and forecasting events or processes puts in many years a subject of research scientists mathematical disciplines as well as a computer sciences. This is evidenced series of works including topics of evolutionary methods of searching for optimal solutions and decisions. In recent years, more often implemented application of forecasting in the social sciences, sports, economic, biological and the medical applications. At the borderline of as varied scientific fields created new lines of research creating interdisciplinary approach analytical process optimization.

Systems of “artificial intelligence” based on work neurobiology of human brain to mimic biological patterns in artificial data processing. Artificial intelligence mimics the brain and evolutionary progress has contributed to the application in solving many problems such as forecasting, spatial approximation, generalization, decision support management systems, medical diagnostics. Attractiveness of application artificial neural networks in issues predictive modeling are analytical capabilities of complex objects non-linear, approximation and generalization of any cross. They created out as a concurrent systems capable of processing the shared data based on the coexistence of multiple threads which promotes the acceleration of computation to solved tasks or problems. Another advantage of neural networks is to teach, not programming. Learning can take place with or without a teacher. Implementation of neural network learning is conducive to the implementation of complicated tasks without difficult mathematical representations of reality [1].

2. Mathematical Model of Neurons

Neural networks are artificial structures which construction and operation are designed to modeling the effects of a natural nervous system, especially the brain. In turn, method of the construction of a genetic algorithm is defining particular individual based on chromosome binary calculation value of matching function and selection chromosomes to reproduce. First operation is aggregation of neuron input. Neuron provided with a plurality of input data usually converted into a single output through the activation

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function [2]. Aggregation of input data can be effected in a manner:

- linear

$$S = \sum_{i=1}^{n} w_i x_i \quad (1)$$

$$s = g(w_i, x_i) \quad (2)$$

- radial

$$S = \sum_{i=1}^{n} (w_i x_i)^2 \quad (3)$$

$$i = 1, \dots, n$$

Model of artificial neuron consists of two main blocks: 1) simulation (∑); 2) activation (F).

Scheme of artificial neuron is shown in Figure 1.

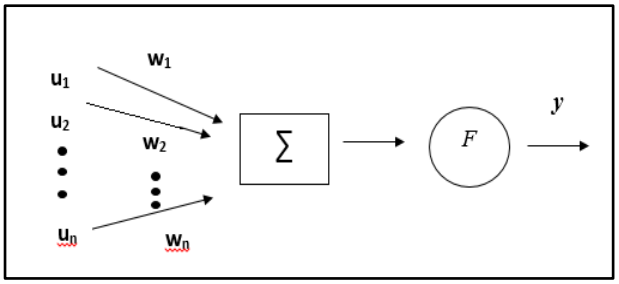

Fig. 1 Schematic structure of neuron.

Signals on the scheme designated as $u_{1...}\, u_n$ are the input values of external containing historical data, or the data output from other neurons [4]. Neuron in artificial network is referred as converter input signals multiplied by weight coefficients. Consequently, the process of the weighted input signals is summed to determine activity of neuron. The output signal is calculated from the formula [5]:

$$\varphi = \sum_{i=1}^{m} w_i u_i = w^T u^T \quad (4)$$

w^T – transposed vector of weighting factors

u^T – transposed vector of input signals

$i=0$ –threshold element

m – number of inputs neuron

Output signal processed by the block activation F describes linear or non-linear functions. The character of the linear function is expressed as:

$$y = k\varphi \quad (5)$$

k – remote factor

The specified form of the function is defined as a linear network called *Madeline*, and its constituent neurons are called as *Adaline* [3].

Next described criterion function neural network is non-linearity. There are two types of non-linear functions: sigmoidal unipolar and bipolar sigmoid (tangensoidal). The first of these take the form:

$$y = \frac{1}{1+e^{(-\beta\varphi)}} \quad (6)$$

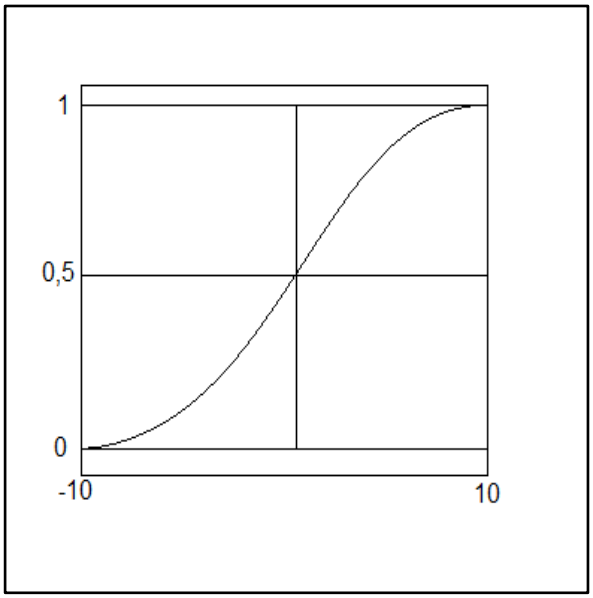

Fig. 2 Unipolar sigmoid function.

Unipolar sigmoid function dependencies($\beta\varphi$) are:

$$\beta\varphi \to \infty => y \to 1$$

$$\beta\varphi \to -\infty => y \to 0$$

$$\beta \to \infty => \frac{1}{1+e^{-\beta\varphi}} \to \| \varphi$$

Wherein$\| \varphi$ is funkcion Haviside'a:

$$\| \varphi = \begin{cases} 1, \varphi > 0 \\ 0, \varphi \le 0 \end{cases}$$

A second form of non-linear function is tangensoidal function (bipolar sigmoid):

$$y = \tanh(\frac{\propto\varphi}{2}) \frac{1-e^{(-\alpha\varphi)}}{1+e^{(-\alpha\varphi)}} \quad (7)$$

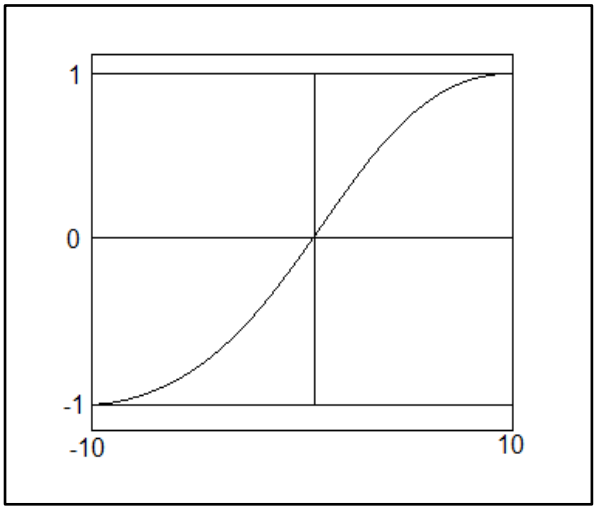

Fig.3 Function tangensoidal (sigmoid unipolar).

Tangensoidal function dependencies (sigmoid unipolar) $(\propto \varphi)$ are:

$$\propto \varphi \to \infty => y \to 1$$

$$\propto \varphi \to -\infty => y \to -1$$

$$\propto \to \infty => \tanh(\frac{\alpha\varphi}{2}) \to sgn(\varphi)$$

Whereins$gn(\varphi)$is a bipolar function signum:

$$sgn(\varphi) = \begin{cases} +1, \varphi > 0 \\ -1, \varphi \leq 0 \end{cases}$$

Advantages of implementing nonlinear function unipolar sigmoidal and bipolar sigmoid (tangensoidal) are the processes optimization and forecasting despite the static model building.

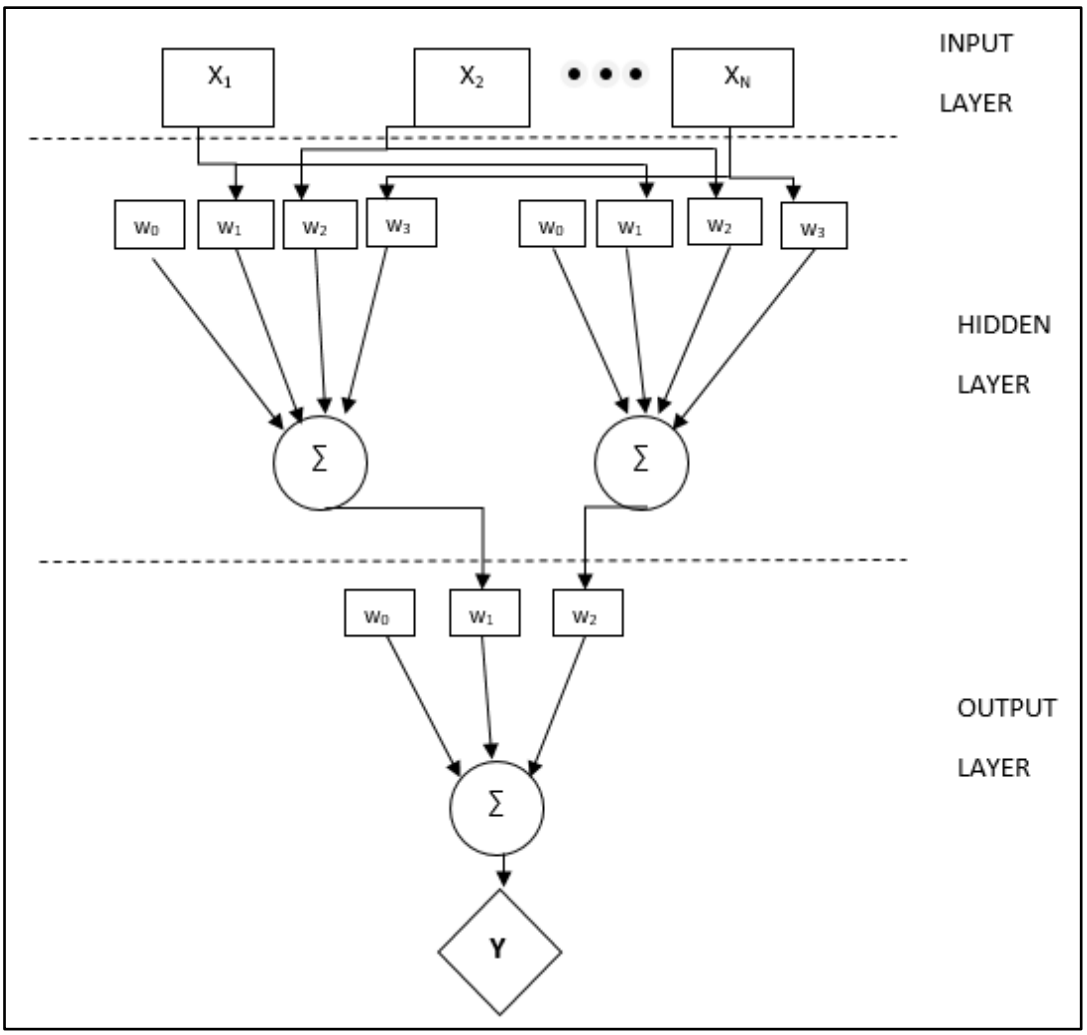

Fig. 4 Neural network model [6].

3. The Structure of Genetic Algorithm

Genetic algorithms belong to methods of random search of optimal solutions, whereby random selection is a sort of “guide” in targeted searches in coded solution space [6]. Optimization in perspective of genetic algorithms created based on the methods of natural selection. Thus, according to the research of Holland proved that genetic algorithms are resistant, and this means that genetic algorithms have the ability to act effectively in the search for solutions to complex in complicated spaces. Activity algorithm consists in transformation population genetic accordance with multidirectional searching for potential solutions to a given problem.

Genetic algorithms developed during the evolution of computing in artificial intelligence in artificial conditions searching for optimal solutions (using a computer).These solutions have sprung up to as soon as possible find the result of a solution. Furthermore, the problem of find a local optimum has been solved because the genetic algorithm largely avoids the pitfalls local minimum. Schematic structure of the genetic algorithm is shown in Figure 5.

Commonly selected to the population chromosomes with binary encoding, chromosomes are an input data describing problem considered in terms of the binary vector arranged in strings of genes. In turn, the gene is a single element genotype, that is the structure of the chromosomes of an individual in the population. The population thus determines the size of a set of individuals coded in the form chromosomes for the parameters of the problem. Reproduction is the process of duplicating the individual strings of code compared depending on their value, which assumes for these strings function of match. Higher adaptation of the code string than higher probability implementation of one or more descendants a new population [6].

The process of neural network supporting by genetic algorithms has application such as:

- choice of characteristics or transformation space used by the neural network to classify,
- choice of learning rules or parameters to control learning in neural network,
- neural network analysis.

Activities involving the classification obtained by the selection of characteristics or space transformation and to select optimal learning rules or parameters to control teaching are conducted in order to obtain better network. Whereas an analysis of neural network is designed for explanations and interpretations activities of network or its analysis.

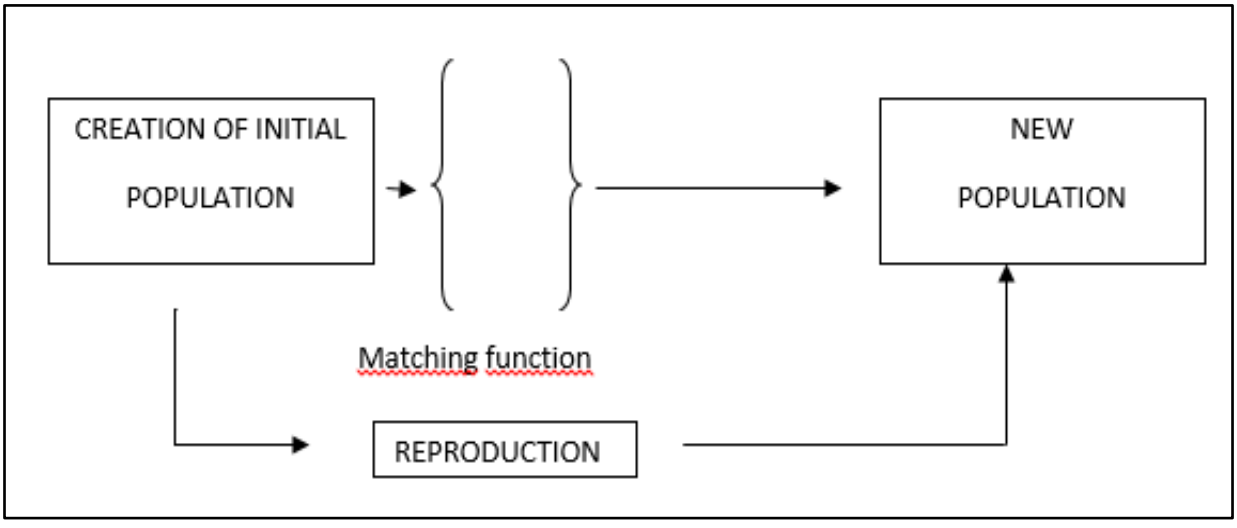

Fig. 5 The structure of the genetic algorithm.

4. Procedure Genetic Optimization of Neural Network

Neural Network and genetic algorithms are an methods of solution of optimization problems. Consists in determining the best solution to the problem of the allowable solutions due to the criterion of quality, through a combination genetic algorithms with neural network models obtained by genetic neural networks (*Genetic Neural Networks - GNN*) in the conception process optimization or events [7]. Predominance of genetic neural networks over classical neural networks, is the selection of the optimal structure of the neural network and the input vector while undergoing optimization classical neural network is performed only learning the same network [8]. Genetic algorithms can find several solutions to this problem.

Genetic optimization neural network may take a very long time, and course sometimes is stormy, due to the fact that random searching for good network makes the network can dramatically improve ordecline.

Optimization of a hypothetical neural network with optimal parameters consists of using classical genetic algorithm based on the maximization function adaptation to the purpose formed by the steps [6]:

- Initiation—random selection of initial population of chromosomes binary predetermined length.
- Estimating adaptation of chromosomes—calculations of values the matching function individually for all chromosomes in terms of expected solutions to examination problem. The quality of the chromosome is very good at maintaining its high value.
- Verification of stop condition—consist to stop the algorithm after obtaining the expected value of optimal solution, as well as the stopping can occur when there is no improvement obtained values and choose the best that has been achieved.
- Qualification of chromosomes—adoption of "best" to take attending in creating descendants to the next generation.
- Implement genetic operators—creating a new population of chromosomes selected in the previous step (classification) by the crossover and mutation.
- New population—creating population using by chromosomes resulting of implementation genetic operators. This population becomes current for the chosen iteration of a genetic algorithm.
- Derivation of the best chromosome—selection of chromosome with the best value adaptation function. Consist to selection of chromosomes obtained in the process of crossbreeding and mutation when the algorithm will stop and selected the best chromosome becomes the optimal solution to the problem.

Genetic algorithm optimizing network to assess the quality adaptation functions non-linear neural models. This reduces the risk of the elimination the most important non-linear compounds during the course genetic optimization of the neural network.

Stages of optimization hypothetical neural network using a genetic algorithm is based on four assumptions and below presented scheme (Figure 7).

The first step of a population refers to the search and the selection amount of the initial solution forming the population of genetically neural network. The population includes a neural network with input data and a hidden layer neurons. During the selection of the most commonly used rule is roulette. Worth mentioning that force classifier chromosomes is an indicator of adaptation, and the population is no longer in their entirety, care should be taken in the choice of replace similar elements. Crossbreeding is looking for new potential best solutions that can be subjected to tests exchanges in search of better results. After the random exchange parameter between pairs of solutions, optimal solutions are subject to mutation [5, 9]. This

means that mutations preventing the elimination of optimum solutions which can be eliminated by overzealous solution. Below shows a detailed diagram of genetic neural network (Figure 8).

Scientific achievements reported that the genetic operations on neural networks have proven to be effective in the issues of optimization, as well as computational methods are not complicated [6].

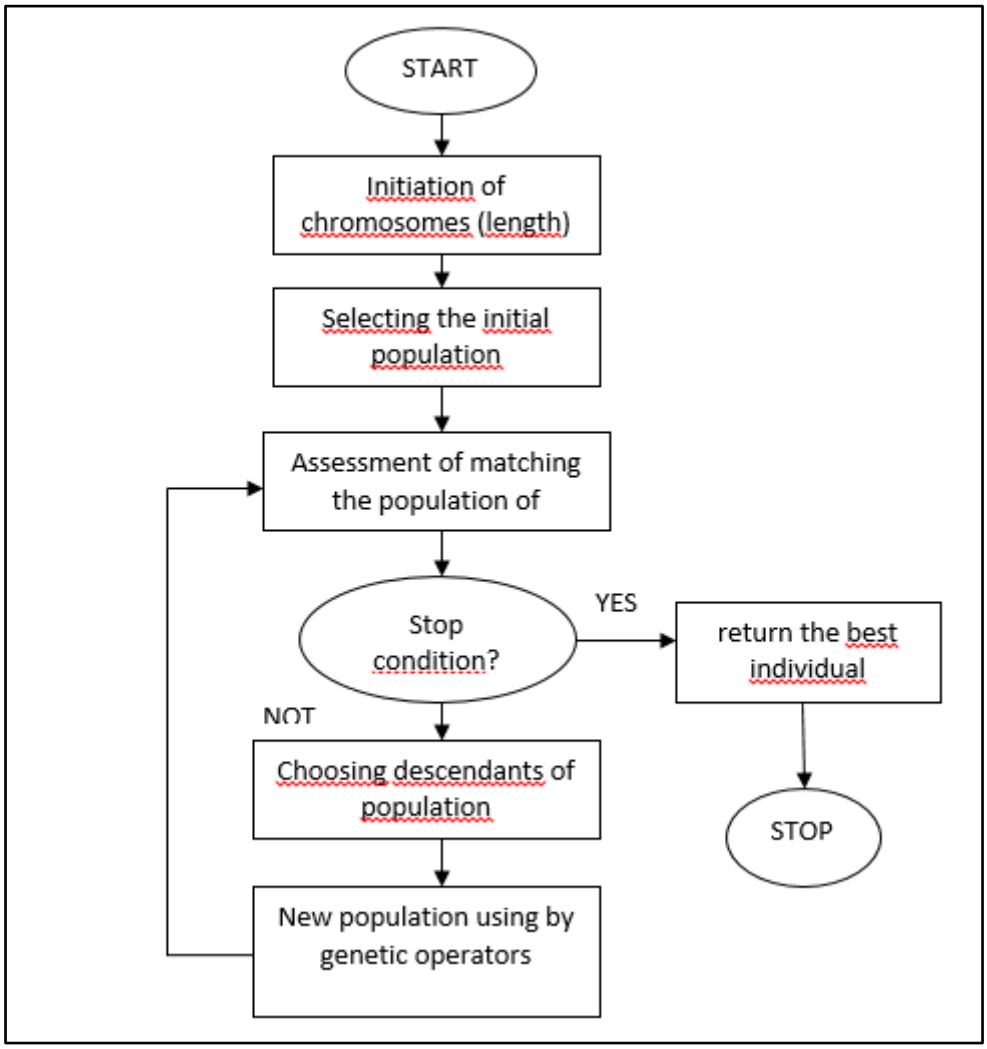

Fig. 6 Course of action genetic optimization network [6].

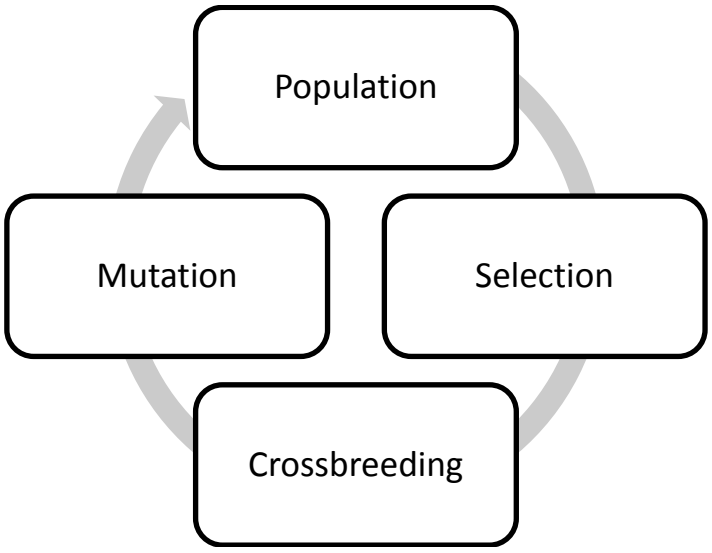

Fig. 7 Stages of optimizing a neural network using a genetic algorithm.

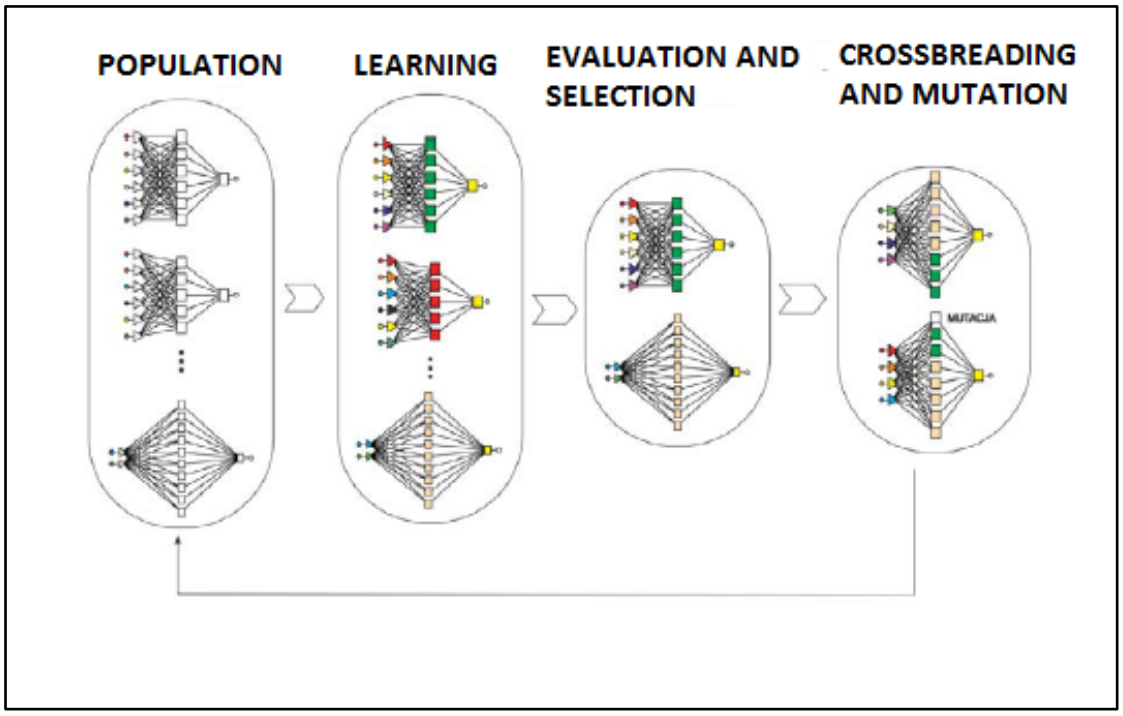

Fig.8 Scheme genetic neural network [1].

5. Applications Classical and Genetic and Neural Network

As evidenced in science genetic neural networks have wide applications optimization, and their popularity grew, which resulted in the implementation of networks in ever-increasing amounts of scientific panels. Genetic learning model has succeeded as the ranking system in the prediction of international events during tests conducted by Schrodt in 1986 [10, 11].

Optimization course of structure neural network is based on the reduction and expansion of the network. First stage is simplifying redundant network architecture during learning or after completion by

reducing amount weight. This reduction can be done using the OBD (Optimal Brain Damage). In the second stage expansion of the network structure accepts a small number of neurons, which in the course of learning is increased [9]. For the network expansion are used algorithms: Mezarda-Nadal, Marchand, Li-Thuftsa, cascade correlation Fahlmana [12]. Satisfactory results received Grad (2006) in research on optimizing a multi-layered one-way artificial neural network using genetic algorithms. It turned out that the best structure optimization was the modification of hidden layers and the adoption function assessed 1,000 epochs, and the error was only one component. After performing training in the first thousand eras network achieved the best result after tenfold long learning [12]. Therefore, the error of the network structure decreases as alignment the number of periods to 1000.

Forecasting shall be considered as an optimization problem [3]. Effectiveness tools of artificial neural networks have been confirmed in studies on assisted financial decision-making process. Research Hankus-Kubica (2013) has proven to minimize risk, diagnosis decision-making problems, identify and predict the value of cash flows and interest [13].

In the research of cosmic phenomena was achieved promising results by Kalarus (2003) conducted at the Center for Space Research on effectiveness application of genetic neural networks in the prediction of coordinates x, y pole Earth. Neural models based on the optimization operations on explaining variables are released from the correlations which contributes to get rid of very adverse developments in predicting which is collinear variables [14]. Known that a neural network with better quality are characterized by non-linearity.

Somewhat different announcement scientific is effectiveness of prediction financial indicators. Research conducted by Jasinski report about the advantages and limitations posed by neural networks in the financial analysis [15]. Appeared that neural networks can be a good tool to assist in prediction equity prices, moments purchase and sale, or inflation especially in short periods of time. Limitation in interpreting results is to assess quality of network in actions not like in classical analysis on the evaluation of errors or variances.

Genetic neural networks by searching optimal solution have a better quality than classical neural networks. However, application of these networks constitutes approximation of certain regularities in particular events or problems.

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