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"Optimization of Artificial Neural Networks Algorithms"

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Abstract – In this paper we describes some artificial neural network (ANN) neuro modeling algorithms used in association with powerful optimization tools, such as natural optimization algorithms and wavelet transforms, which can be used in a variety of applications in Engineering. Genetic,particle swarm and ant colony techniques are currently the most widely used optimization techniques for neural networks; these techniques are severely limited in their ability to find global solutions.

Keywords: Artificial Neural Network, Optimization, Algorithms.

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INTRODUCTION

Artificial neural networks are capable of performing many classification, learning and function approximation tasks, yet in practice sometimes they deliver only marginal performance. Inappropriate topology selection and weight training are frequently blamed. Increasing the number of hidden layer neurons helps improving network performance, yet many problems could be solved with very few neurons if only the network took its optimal configuration. Unfortunately, the inherent nonlinearity of ANN results in the existence of many sub-optimal networks and the great majority of training algorithms converge to these sub-optimal configurations. To address these problems we must use an optimal algorithm to optimize the Artificial Neural Network. Here we use three evolutionary algorithms to optimize the neural network and compare their performance.

Rosenblatt (1958) perception is the most used artificial neuron in neural network configurations and is based on the nonlinear model proposed by McCulloch and Pitts (1943). In this model, neurons are signal processing units composed by a set of input connections (weights), an adder (for summing the input signals, weighted by the respective synapses of a neuron, constituting a linear combiner) and an activation function, that can be linear or nonlinear, The input signals are defined as *xi*, *i* = 0, 1,…, *Ni*, whose result corresponds to the level of internal activity of a neuron *netj*, as defined in (1), where *x0* = +1 is the polarization potential (or bias) of the neurons. The output signal *yj* is the activation function response ϕ(.) to the activation potential *netj*, as shown in (2) (Silva et al., 2010b).

$$Net_j = \sum_{i=0}^{Ni} w_{ji} . x_i \qquad \ldots\ldots\ldots\ldots 1$$

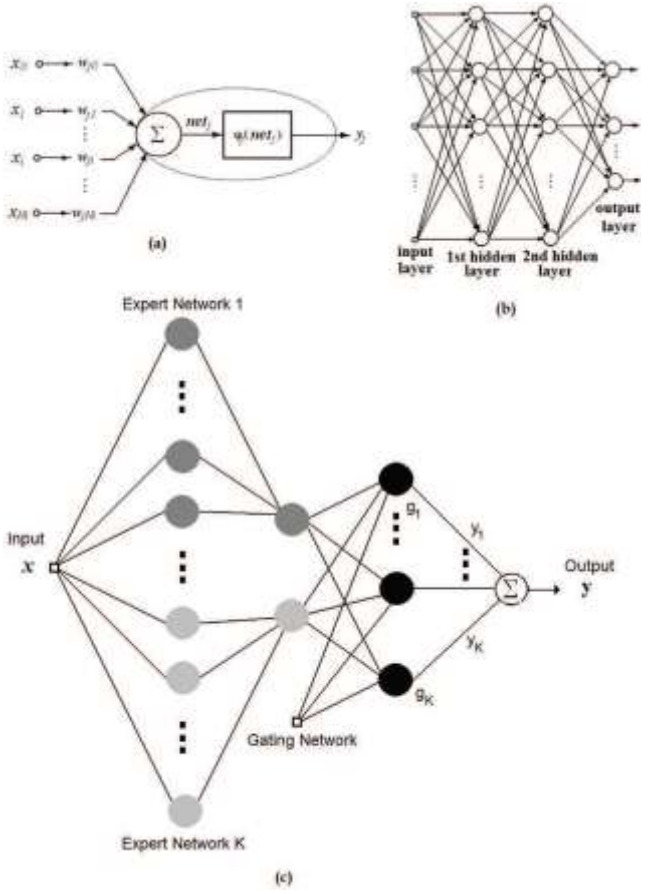
$$yj = \phi(net_j) \qquad \ldots\ldots\ldots\ldots 2$$

Modular artificial neural network is based on a principle commonly used: divided to conquer. This concept aims to divide a large and complex task in a set of sub-tasks that are easier to be solved. The modular artificial neural network could be defined, in summary, as a set of learning machines, also called experts, whose decisions are combined to achieve a better answer than the answers achieved individually, that is, a machine with a better performance.

ARTIFICIAL NEURAL NETWORKS IN IMAGE PROCESSING

Artificial Neural Networks (ANNs) play an essential role in the medical imaging field, including medical image analysis and computer-aided diagnosis, because objects such as lesions and organs in a medical image may not be represented into an accurate equation easily. One of the main uses of Artificial Neural Network in Medical Image analysis is to classify lesions into some classes such as normal or abnormal, malignant or benign and lesions or non-lesions. Genetic Algorithm and Antcolony algorithm which are population based search methods are inspired from nature are effective in optimization with a large number of design variables and low cost function evaluation. In case of Genetic Algorithm its performance can be improved using various schemes such as fast full wave methods, micro- Genetic

Algorithm and Parallel Genetic Algorithm using parallel computation. Ant colony optimization is inspired by the social behavior of ants. Ants find a shortest route to the food particles from their nest. Particle swarm optimization algorithm was inspired by the social behavior of animals, such as bird flocking or fish schooling (Rossana *et al*., 2011). In PSO, each solution is a 'bird' in the flock and is referred to as a 'particle'. As a chromosome in Genetic Algorithms, a particle is in POS. Unlike Genetic Algorithms, in the process of evolution the PSO does not create new child from Parents, instead the particle in the population evolve to its social behavior and there by finds a path towards the destination (Jiang *et al*., 2007).



Nonlinear representation of an artificial neuron

ANALYSIS OF THE EVOLUTIONARY ALGORITHMS

Genetic Algorithms

Genetic algorithm is an evolutionary computing technique that can be used to solve problems with a vast solution space (Cao and Zhang, 2010). A solution to a given problem is represented in the form of a string, called 'chromosome', consisting of a set of elements, called 'genes', that hold a set of values for the optimization variables. As a preparation to start the optimization process, a Genetic Algorithm, requires a group of initial solutions as the first generation. The first generation is usually a group of randomly produced solutions created by a random number generator. The population, which is the number of individuals in a generation, should be big enough so that there could be a reasonable amount of genetic diversity in the population.

Particle Swarm Optimization

PSO was developed by (Hansen *et al*., 2008). PSO is inspired by the group of birds flying together to an unknown destination. In PSO, each solution is a 'bird' in the group and is referred to as a 'particle'. As a chromosome in Genetic Algorithms, a particle is in POS. PSO actually imitates a group of birds that communicate with each other when flying together to an unknown destination. Initially each bird flies in a specific direction, but changes its direction when communicates with the other birds. All other birds will follow a particular bird which they think has found out the best direction to the destination. At this point all the birds fly towards that particular bird by changing their current velocity. Each bird then explores its new local position. This process of choosing one bird in the group which is well acquainted with the current location is continued till the birds reach the desired destination. It has to be noted that the birds learn from their own intelligence and from the experience of the other birds.

Ant Colony Optimization

ACO was developed by (Geetha and Srikanth, 2012) based on the fact that ants are able to find the shortest route between their nest and a source of food. Ants use pheromone trails to communicate with each other. An ant roaming in various directions leave this pheromone on the ground making a path it followed by this trail. An isolated ant when encounters the previously laid trail decides to follow the trail with a high probability of finding a food particle. When it follows the previously laid trail it enforces its trail over it making the trail more intensive. The ant which found a food particle will return to its nest with a shortest route laying the pheromone trail. The remaining ants will follow this shortest route to the food and also they leave their pheromone tail. Ants therefore can find optimal solutions using the local state knowledge and about the effects of actions that can be performed in the local state.

CONCLUSION:

In this paper, we have reviewed the optimization algorithms for neural networks based on their accuracy, training time and testing time and we analyzed that amongst the three optimization algorithms used, GA has performed well in all the evaluations. It is also evident that the Genetic algorithm is most suitable for training the neural network with minimum time and minimum mean square error. We recommend Genetic algorithm as

most suitable algorithm for optimization of neural network.

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