Chapter 82

A Hybrid Approach Based on Genetic Algorithm and Particle Swarm Optimization to Improve Neural Network Classification

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ABSTRACT

Artificial Neural Network (ANN) has played a significant role in many areas because of its ability to solve many complex problems that mathematical methods failed to solve. However, it has some shortcomings that lead it to stop working in some cases or decrease the result accuracy. In this research the authors propose a new approach combining particle swarm optimization algorithm (PSO) and genetic algorithm (GA), to increase the classification accuracy of ANN. The proposed approach utilizes the advantages of both PSO and GA to overcome the local minima problem of ANN, which prevents ANN from improving the classification accuracy. The algorithms start with using backpropagation algorithm, then it keeps repeating applying GA followed by PSO until the optimum classification is reached. The proposed approach is domain independent and has been evaluated by applying it using nine datasets with various domains and characteristics. A comparative study has been performed between the authors' proposed approach and other previous approaches, the results show the superiority of our approach.

1. INTRODUCTION

As life becomes increasingly complex, new techniques must be developed to facilitate these added complications, resolving all the problems that traditional methods cannot solve. Artificial Neural Network (ANN) is an information processing system that mimics the structure and function of the human brain

(Jia & Zhu, 2009; Azzam-ul-Asar et al., 2007). ANN has proved its success in solving a great number of problems across different fields. However, it also has some shortcomings related to the setting of the weights of the neural connections during the training phase that restricts its ability to solve specific problems. The weights of the ANN have to be optimized in order to reach a good and accurate output. Therefore, the training process should result in finding the weights associated to the minimum output error (Caputo, et al. 2010). One of the main shortcomings with ANN that prevents ANN from reaching a high accuracy is local minima. When an ANN learning algorithm causes the total error of the net to descend into a valley of the error surface, that valley may or may not lead to the lowest point on the entire error surface. If it does not, the minimum into which the total error will eventually fall is termed, "a local minima" (Wilson, 2012). The common objective in ANN classification is to reach the global optima.

Until now only few research projects have combined both PSO and GA to optimize the performance of ANN but for specific structure and domain (Juang, 2004; Chen, et al. 2008; Kuo, et al. 2009). This research proposes a new approach for combining PSO and GA to increase the ANN classification for any domain.

2. NEURAL NETWORK

Artificial neural network is an important part of artificial intelligence (Wang & Li, 2010). In addition, it is a mathematical model that mimics the structure and function of a human brain (Chogumaira & Hiyama, 2009; Jia & Zhu, 2009). The human brain consists of billions of neurons that are connected, communicating with each other by the use of electrical signals (Haron et al., 2012). ANN, like a human brain, consists of simple processing units, which are called neurons, organized in layers and connected to each other through connection weights and threshold value for information transmission and processing. The weights and thresholds are adjusted automatically in the learning process (Zhang et al., 2009; Shenglong & Tonghui, 2012). The concept of learning from inputs to outputs in ANN is similar to the way that the human brain learns from experience (Miao et al., 2010). There are many different types of ANN structures. One common structure is the Multi-Layer Perceptron (MLP), which is a feed forward type of the neural network. The typical MLP network model consists of a group of neurons with three categories, which are input neurons, hidden neurons, and output neurons. Each neuron is in one layer and is connected with all neurons of the adjusted layer. The operation of a typical MLP network can be divided into two phases, which are training and testing phases. The MLP network must be trained for its specific purpose using learning algorithms like backpropagation algorithm. After the step of training, the MLP network can be used to generate the outputs (Al-Shareef & Abbod, 2010).

Over nearly 20 years, neural network has achieved great success and progress in many research areas such as pattern recognition, forecasting, automatic control, signal processing, decision support, robotics, etc. (Jia & Zhu, 2009; Yong, et al. 2010; Qian & Zhang, 2010).

3. GA AND PSO

3.1. GA

A genetic algorithm is a kind of artificial intelligence and global optimization methods (Xin-hui et al., 2010). It is based on the concepts of natural selection and genetics, which was proposed in 1975 by

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