Chapter 19
Heuristic Approach Performances for Artificial Neural Networks Training

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ABSTRACT

This chapter aimed to evaluate heuristic approach performances for artificial neural networks (ANN) training. For this purpose, software that can perform ANN training application was developed using four different algorithms. First of all, training system was developed via back propagation (BP) algorithm, which is the most commonly used method for ANN training in the literature. Then, in order to compare the performance of this method with the heuristic methods, software that performs ANN training with genetic algorithm (GA), particle swarm optimization (PSO), and artificial immunity (AI) methods were designed. These designed software programs were tested on the breast cancer dataset taken from UCI (University of California, Irvine) database. When the test results were evaluated, it was seen that the most important difference between heuristic algorithms and BP algorithm occurred during the training period. When the training-test durations and performance rates were examined, the optimal algorithm for ANN training was determined as GA.

INTRODUCTION

The term Artificial Intelligence (AI), which is based on imitation of human processes of thinking and acting as the starting point, was first introduced to the literature by McCarthy at a conference on the subject in Dartmouth, USA in 1956 (McCarthy, Minsky, Rochester, & Shannon, 2006). The purpose of the AI is to implement human behavior in machines. The sub-branch that applies AI algorithms to machines is called Machine Learning. Artificial Neural Network (ANN) is a field of study in machine learning. ANN approaches that try to create a new system inspired by the neurons in our brain are used in classification problems (Öztemel, 2003).

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ANNs are computer systems that can learn events using data determined by people and determine the response to unlearned events. They are successfully applied in areas that human brain can easily realize such as learning, classification, association, optimization, feature determination and generalization (Öztemel, 2003).

ANNs are currently used to solve a variety of problems. ANNs are successfully applied in areas as classification, estimation and modeling. ANN can be used to process or analyze all kinds of data. They are successfully applied in business life, finance, industry, education and scientific areas with complex problems, in solving problems that cannot be solved by fuzzy or simple methods, and in nonlinear systems (Çetin, 2007).

BACKGROUND

Various methods have been used for training of ANNs. These methods are widely classified into two sets as supervised and unsupervised learning. In training ANNs with supervised learning, both the input data and the output data are provided. In unsupervised learning, only the input data are provided in training ANNs and it is expected to estimate outputs (Nabiyev, 2003). The Backpropagation training algorithm (or generalized delta rule) technique, which is a gradient-descent method, is one of the most popular training algorithms in the domain of neural networks (Rumelhart, Hinton, & Williams, 1988). The back propagation algorithm is a family of methods used to efficiently train artificial neural networks by following a gradient-based optimization algorithm using the chain rule (Kahramanli & Allahverdi, 2008). As ANNs generate complex error surfaces with multiple local minima, BP tends to converging into local minima rather than global minima (Gupta & Sexton, 1999; Valian, Mohanna, & Tavakoli, 2011). Many advanced learning algorithms have been proposed in recent years in order to overcome the shortcomings of gradient based techniques (Valian et al., 2011). These algorithms include direct optimization method using a polytope algorithm (Curry & Morgan, 1997), Evolutionary Algorithms (EA), a class of general search technique (Salchenberger, Cinar, & Lash, 1992) and genetic algorithm (GA) (Sexton, Dorsey, & Johnson, 1998). Other techniques, such as EA, have been applied to the ANN problem in the past (Cantú-Paz, 2003; Cotta, Alba, Sagarna, & Larrañaga, 2002) and they have tried to avoid the local minima in the error that usually occurs in complex problems.

Many researchers have preferred meta-heuristic optimization algorithm since conventional numerical methods have some computational drawbacks in solving complex optimization problems. In recent years, various meta-heuristic algorithms have been successfully applied to various engineering optimization problems. When compared to conventional numerical methods, EA has provided better solutions for most complicated real-world optimization problems (Valian et al., 2011). In meta-heuristic algorithms, many rules and randomness are combined to imitate natural phenomena. These phenomena include the biological evolutionary processes such as the Genetic Algorithm (GA) (Goldberg & Holland, 1988; Holland, 1992), Evolutionary Algorithm (EA) (Fogel, 1998), Artificial Immunity (Hofmeyr & Forrest, 2000) and Differential Evolution (DE) (Storn, 1996) animal behavior such as Ant Colony Algorithm (ACA) (Dorigo & Di Caro, 1999) and Particle Swarm Optimization (PSO) (Shi & Eberhart, 1999), human's intuition such as Tabu Search Algorithm (Glover, 1977); and physical annealing processes, such as simulated annealing (SA) (Valian et al., 2011).