

## Chapter 13

# Optimization Algorithms

### ABSTRACT

*In this chapter, the basic definition of Genetic Algorithm (GA) and some of the main operations applied in GA are explained. In addition, Swarm Intelligence (SI) is briefly explained as the new branch of intelligent behavior of nature phenomena. Although PSO has been explained in past chapters, this chapter explains PSO in detail and an example of the way PSO works is provided for better understanding. Some of the differences of Particle Swarm Optimization (PSO) and GA are provided and readers will learn how to use GA and PSO for training the neural network. The experiments and contents in this chapter are from the study by Nuzly (2006) in her thesis entitled “Particle Swarm Optimization for Neural Network Learning Enhancement”.*

### 1 INTRODUCTION

Neural network has been widely used in solving the problems of the world and has developed their applications in many areas. One of the most important applications of the NN is in prediction. It means that we give the data and then NN will be trained to be used for predicting the future event. ANN has the ability to learn and adapt and these make it suitable for tasks such as classification, pattern recognition, memory recall, prediction, optimization, and noise filtering (Luger, 2002).

As it is mentioned, ANN has the significance ability to learn from the environment. The primary significance for a NN is the ability of the network to learn from

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its environment and improve its performance using learning (Haykin, 1999). The objective of learning is to classify certain input data patterns to certain outputs before testing with another group of related data. There are optimization algorithms for increasing the performance and speed of training. Some algorithms that usually are used for optimization are Genetic Algorithm (GA) and Swarm Intelligence (SI).

## **2 PROBLEM BACKGROUND**

In the past parts we explained the BP and MLP networks. However, the major disadvantages of BP are their slow rate of convergence (Zweiri, Whidborne, & Sceviratne, 2003) and being trapped at the local minima. This is because of the hill climbing technique in the BP learning which cause to trapping in local minima where every small change in synaptic weight increases the cost function. But somewhere else in the weight space there exist another set of synaptic weight for which the cost function is smaller than the local minimum in which the network is stuck. Terminating the learning process because of trapping in the local minima is not desirable. Many researchers in the field of NN have worked on solving the problem of slow convergence rate. Many powerful optimization algorithms have been devised, most of which have been based on simple gradient descent algorithm as explain by Bishop (1995) such as conjugate gradient decent, scaled conjugate gradient descent, quasi-Newton BFGS and Levenberg-Marquardt methods. The classical solutions are by improving the program codes and upgrading the machine's hardware. Lately, latest solutions proposed by NN researcher try to guide the learning so that the converge speed become faster. The guidelines to select better functions, learning rate, momentum rate and activation functions. Genetic Algorithm (GA) is one of the algorithms proposed to determine the learning rate and momentum rate and will produce a set of weight that can be used for testing related data. Table 1 briefly described the finding from several researchers in order to increase learning speed (Fnaiech et al., 2002), avoid from trapped into local minima (Wyeth, Buskey, & Roberts, 2000) and better classification result.

The task of optimization is that of determining the values of a set of parameters so that some measures of optimality is satisfied, subject to certain constraints. This task is of great importance to many professions, for example, physicists, chemists and engineers are interested in design optimization when designing a chemical plant to maximize production, subject to certain constraints, e.g. cost and pollution. Scientists require optimization techniques when performing non-linear curve or model fitting. Economists and operation researchers have to consider the optimal allocation of resources in industrial and social settings. Some of these problems involve only linear models, resulting in linear optimization problems, for which an

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