RBF Neural Network Based on Particle Swarm Optimization

Yuxiang Shao¹, Qing Chen²,³, and Hong Jiang²,³

¹ School of Computer Sciences, China University of Geosciences, Wuhan, Hubei, 430074, China
   syxcq@163.com
² Hubei Province Key Laboratory of Intelligent Robot, Wuhan Institute of Technology, Wuhan, Hubei, 430073, China
³ School of Computer Science & Engineering, Wuhan Institute of Technology, Wuhan, Hubei, 430073, China

Abstract. This paper develops a RBF neural network based on particle swarm optimization (PSO) algorithm. It is composed of a RBF neural network, whose parameters including clustering centers, variances of Radial Basis Function and weights are optimized by PSO algorithm. Therefore it has not only simplified the structure of RBF neural network, but also enhanced training speed and mapping accurate. The performance and effectiveness of the proposed method are evaluated by using function simulation and compared with RBF neural network. The result shows that the optimized RBF neural network has significant advantages inspect of fast convergence speed, good generalization ability and not easy to yield minimal local results.

Keywords: RBF neural network, Particle swarm optimization algorithm, Optimize.

1 Introduction

Radial basis function (RBF), emerged as a variant of artificial neural network, have been successfully applied to a large diversity of applications including interpolation, chaotic time-series modeling, control engineering, image restoration, data fusion, etc[1~3].

In RBF network, parameters of basis functions (such as width, the position and number of centers) in the nonlinear hidden layer have great influence on the performance of the network[4][5]. Common RBF training algorithms cannot possibly find the global optima of nonlinear parameters in the hidden layer, and often have too many hidden units to reach certain approximation abilities, which will lead to too large a scale for the network and decline of generalization ability.

Particle Swarm Optimization (PSO) algorithm is a global optimization technology based on the group intelligence, it carries on the intelligent search for the solution space through mutual effect in order to discover the optimal solution[6][7].

In this paper, a hybrid RBF training method combining Particle Swarm Optimization (PSO) algorithm is proposed. In this method, PSO algorithm is used to determine
the structure and parameters in RBF hidden layer, and RBF linear output weights as well. The experiments showed that this method improved effectively the convergence speed of the algorithm and overcomes the problem of immature convergence, and the proposed method integrating RBF network and PSO algorithm are effective and feasible.

This paper is divided into four sections. In Sect. 2, the integration of RBF network and PSO algorithm is described. In Sect. 3, simulation experiment through two functions is done and the results are presented. The conclusions are given in Sect. 4.

2 Integration of RBF Network and PSO Algorithm

2.1 Radial Basis Function Neural Network

Radial basis function (RBF) neural network was proposed by Broomhead and Lowe, and this neural network differs from neural networks with sigmoidal activation functions in that it utilizes basic functions in the hidden layer that are locally responsive to input stimulus. RBF are embedded in a two-layer neural network, where each hidden unit implements a radial activated function. The output units implement a weighted sum of hidden unit outputs. While the input into a RBF network is nonlinear, the output is often linear. Their excellent approximation capabilities have been studied by Park and Sandberg. Owing to their nonlinear approximation properties, RBF networks are able to model complex mappings, indicating that neural networks can only model by means of multiple intermediary layers.

2.2 Radial Basis Function Network Model

The RBF network topological structure is shown in Fig.1. The network consists of three layers, namely the input layer, radial basic function hidden layer and output layer. The input part does not transform the signals but only dispatches the input vector to the radial basic layer. The function in a hidden layer node (also called nucleus function) responds partly to the input signals, i.e. when the input function is close to the center range of the nucleus function, the hidden layer will produce a larger output. The output layer makes output values through a linear combination of outputs from the hidden layer.

Fig. 1. Structure of RBF neural network