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Evolving Neuro Structure Using Adaptive PSO and Modified TLBO for Classification

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Abstract

In this paper a method to optimize the structure of neural network named as Adaptive Particle Swarm Optimization (PSO) hasbeen proposed. In this method nested PSO has been used. Each particle in outer PSO is used for different network construction.The particles update themselves in each iteration by following the global best and personal best performances. The inner PSO isused for training the networks and evaluate the performance of the networks. The effectiveness of this method is tested on manybenchmark datasets to find out their optimum structure and the results are compared with other population based methods andfinally the optimum structure is implemented usingModified Teaching Learning Based Optimization(MTLBO)for classification using neural network in data mining.

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Keywords: Particle swarm optimization; evolutionary computation; teaching learning based optimization; classification.

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1. Introduction

Datamining is one of the interdisciplinary [1] subfield of computer science. It is the computational process of discovering patterns present in large *data* sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. Data mining includes various tasks like classification, association rule mining, clustering, regression, summarization etc. Each of these tasks can be considered as a kind of problem to be solved by a data mining algorithm. Therefore, the primary step in designing a data mining algorithm is to define which task the algorithm will address.

In this paper, we consider the problem of classification in data mining to validate our evolving neuro structure using adaptive PSO and modified TLBO for classification task. In general, a classifier partitions the feature space X intoCl_i,i=1,2…,P classes such that: i) $Cl_i \neq \varphi$,i=1,2…,P, ii) $\bigcup_{i=1}^{P} Cl_i = X$ and iii) $Cl_j \cap Cl_k = \varphi$, $j \neq k$, j=1(1)P, k=1(1)P (except for fuzzy classification domain) by constructing the hyper-planes or hyper-cubes. A hyper-plane can be written as:$d(x) = W.X^T$, where $W = [w_1,w_2,\ldots,w_N]$ and $X = [x_1,x_2,\ldots,x_{N-1},1]$are called the weight vector and augmented feature vector respectively. Now here the problem is to classify an unknown sample based on the hyper-plane.

Artificial Neural Networks (ANNs) show remarkable properties, such as adaptability, capability of learning by examples, and ability to generalize. One of the most widely used ANN models is the well-known as Multi-Layer Perceptron (MLP) [2]. Training neural networks is a complex task for supervised learning methods. The training process used in MLPs for pattern classification problems consists of two major tasks. The first one is the selection of an appropriate architecture for the selected problem, and the second is the adjustment of the connection weights of the network. Many research works has been conducted to attack this issue. Most of the available training methods for ANN's only focus on the adjustment of connection weights by taking fixed topology. Few works have considered training methods for ANNs on both topology and connection weights simultaneously. A large number of techniques have been used to train ANN's. Now a days most applications use the back propagation (BP) algorithm or other training algorithms in the feed forward ANN's. But all these training algorithms assume a fixed ANN's architecture for training. The algorithms for designing ANN's architectures automatically are based on constructive and pruning methods [3].

To efficiently apply the ANN model to various problems, the optimization of ANNs for each specific problem is critical task for problem solving. There are lots of efficient searching/optimization algorithms available for the ANN model optimization, such as evolutionary algorithms (EA) [4], simulated annealing (SA) [5], tabu search (TS) [6], ant colony optimization (ACO) [7], particle swarm optimization (PSO) [8], genetic algorithm (GA) [9], etc.. Among these searching/optimization techniques, some of them have been applied for connection weights adjustment or architecture optimization or connection weights adjustment of ANNs.Genetic algorithm (GA) [11] is a better candidate for searching near optimal neural network architecture but it can face the problem like permutation, noisy fitness evaluation, etc.. Recently, PSO has attracted extensive attention in various areas. Particle swarm optimization and some of its many variants were applied for training of MLP in [10] without generalization control with fixed topology.

This paper presents a novel method of evolution of artificial neural network using PSO that evolves the set of weights and also evolves network architecture of low complexity. PSO algorithm possesses some attractive properties, such as memory and constructive cooperation between individuals, which can avoid the permutation problem.

2. Related work

X. Yao [3] seem to have been the first researcher for evolutionary neural network structure. He used a GA algorithm to evolve the neural network architecture and weights. Compared to GA, PSO has more chance to fly into the better solution areas more quickly and discover quality solution much faster. In PSO only few parameters are to be adjusted. Unlike GA, the representations of the weights are easy and as there is no recombination and mutation operator, so there is a very less chance of facing the permutation problem. Further, since there is no selection operator in PSO, so each individual in an original population has a corresponding partner in a new generated population. This increases the diversity of population, this property is better than GA, so it can avoid the premature