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EVOLUTIONARY DIAGONAL RECURRENT NEURAL NETWORK WITH IMPROVED HYBRID EP-PSO ALGORITHM AND ITS IDENTIFICATION APPLICATION

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Abstract. *Conventional training methods for diagonal recurrent neural networks identifier are limited to the first and second derivative methods. In this paper, a novel training algorithm based on evolutionary programming (EP) and particle swarm optimization (PSO) for evolutionary diagonal recurrent neural network (EDRNN) is proposed. Meanwhile, a new select mode is given for improving the premature convergence for PSO. Compared with conventional methods, EDRNN has prominent advantage in identifying nonlinear dynamic systems because the structure and weight of EDRNN can be evolved simultaneously. Experimental results of identifying the classical nonlinear dynamic systems confirm that EDRNN-based method is a promising tool for identifier.*
Keywords: Nonlinear system identification, Diagonal recurrent neural network, Evolutionary programming, Particle swarm optimization

1. Introduction.

Since diagonal recurrent neural network (DRNN) was firstly proposed by Ku in [1], it has been one of the hottest topics in neural network. As DRNN is adopted as identifier or controller, one important step is to estimate a suitable parameter vector besides choose the structure of the network and the input vector. All optimization methods that can be used in the parameter learning process of neural network are recapitulated as follows: One is first derivative methods (Gradient methods), including gradient descent method and conjugate gradient method. Another is second derivative methods (Hessian methods), including steepest descent method, Newton-Raphson method, Gauss-Newton method, Pseudo-Newton method and Quasi-Newton method. The third is genetic algorithm and evolutionary computing. Most researches in the past were based on the first and second learning method, but rarely on the third method for DRNN.

At the same time, many types of recurrent neural network training algorithms have been proposed, such as back propagation through time (BPTT), real-time recurrent learning (RTRL), and time-dependent recurrent back propagation (TDRB). But all of them have several limitations: 1) a complex set of gradient equations must be derived and implemented, 2) it is easy to be trapped in local minima of the error function, 3) it is only suitable to problems which desired output values are available.

One way to overcome the above problems is to adopt evolutionary algorithms. Because they are heuristic and stochastic search procedures based on the mechanics of natural selection, genetics, and evolution, which make them find the global solution of a given problem. In addition, they only use a simple scalar performance measure that does not require or use derivative information. They can even deal with problems where no explicit or exact objective function is available.