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TRAINING ELMAN NEURAL NETWORK FOR DYNAMICAL SYSTEM IDENTIFICATION USING STOCHASTIC DYNAMIC BATCH LOCAL SEARCH ALGORITHM

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Abstract. *In this paper, we propose a Stochastic Dynamic Batch Local Search (SDBLS) algorithm to train Elman Neural Network (ENN) for Dynamic Systems Identification (DSI). First, we propose a new Batch Local Search (BLS) algorithm for ENN from a new angle instead of traditional Back Propagation (BP) based gradient descent technique, then add the stochastic dynamic signal into the network in order to avoid the possible local minima problem caused by the BLS method. Experimental results show that the proposed algorithm has greatly effective performances in the identification of linear and nonlinear dynamic systems in comparison with other algorithms without calculating any derivations. The results conclude that the proposed algorithm is an alternative means of training ENN when the gradient-based methods fail to find an acceptable solution. So the proposed algorithm can be regarded as a new identification approach to identify DSI for the auto-control systems.*

Keywords: Elman Neural Networks (ENN), Backpropagation Through Time (BPTT), Batch Local Search (BLS), Adaptive Local Search (ALS); Dynamical System Identification (DSI)

1. **Introduction.** Elman Neural Network is one type of the partial recurrent neural network, which consists of two-layer back propagation networks with an additional feedback connection from the output of the hidden layer to its input [1]. This feedback path represents a dynamic mapping between its outputs and inputs. So ENN is more suitable for processing temporal sequence data than multi-layer perception since it maintains state information between the input samples [2]. Recently, ENN and its modified models have been used in applications of Dynamical System Identification (DSI) problems [3-7].

Usually the Back Propagation (BP) based algorithms are employed to train ENN. Standard BP algorithm and Backpropagation Through Time (BPTT) algorithm have been detailed studied in [4]. It is certified that both BPTT-trained ENN and BP-trained modified ENN could model systems with orders higher than 1 whereas the BP-trained original ENN could not. However, since ENN usually uses BP-based algorithms to deal with the various signals, it has been proved that it suffers from a sub-optimal solution problem [2,8,9,16]. Meanwhile, due to their inherent local minimum problems, all these learning algorithms, either the error BP based algorithms or the non error BP based algorithms such as genetic algorithm [7,10] and simulated annealing algorithm [11] often converged to a local minimum solution that is far from the optimal solution. These call for the development of alternative training algorithms.

This paper explores the potential of using a SDBLS as learning algorithm by replacing the BP-based algorithm for ENN. As we know, the traditional local search methods are a