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Survey on Improved Neural Network Model and Its Applications

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Abstract— Elman Neural Network has been an efficient system identification tool in many areas. However, one of the problems often associated with this type of network is the speed of learning which is too slow. The HF Elman neural network is presented for the modelling of unknown delay and high-order nonlinear system. Then chaos searching is imported to train it, make BP algorithm may skip the local minimum and find the global minimum easily. The simulation result shows that the proposed method may speed up the original ENN algorithm and get good results for the prediction tasks.

Keywords: Elman Neural Network, HF Neural Network, BP Algorithm, Simulation, Prediction.

I. INTRODUCTION

Artificial neural network contend a novel role within the field of nonlinear systems modelling, identification and management as a result of its nonlinear mapping and data processing capability, recurrent neural network have the flexibility of coping with dynamic info due to its inherent feed-back structure and represent the event manner during this space [1, 2]. So far, individuals are developed tens of continual neural network, in which, Elman network is that the most generally used kind.

Elman network is proposed by J. L. Elman in 1990 for voice processing [3], its full name is “simple recurrent neural network”, Since only partial feedback connection adopted, the accuracy has declined once it's used for prime steps system identification, Therefore, people advanced a range of modified structure [4], to enhance its dynamic mapping capabilities. Elman networks are usually adopted to spot or generate the temporal outputs of nonlinear systems. It’s documented that a recurrent network is capable of approximating a finite state machine [5] and therefore will simulate any statistic. Therefore recurrent networks area unit currently wide employed in fields involved with temporal issues. In printed literature, however, all the initial weights of recurrent networks are set arbitrarily rather than exploitation any previous information and therefore the trained networks are imprecise to human and their convergence speed is slow. Additionally, the temporal generalization capability of easy recurrent networks isn't therefore smart [6]. These two major issues build the applications of recurrent networks with temporal identification and management of systems tougher.

BP algorithm is used to train Elman network usually, that the network convergence slowly and straightforward to fall local minimum inevitably. People progress several helpful enhancements supported the standard BP algorithm, and suggest numerous training algorithm supported nonlinear optimization that improved the network’s performance effectively [7].

In order to identify high steps systems a lot of effectively, the paper proposes a brand new improved Elman neural network, Hybrid feedback Elman network, for short HF Elman, provides an adequate condition for the convergence of the new network and created the corresponding training algorithm based on chaotic mechanism. The simulation result shows that the proposed method will speed up the original ENN algorithm and obtain sensible results for the prediction tasks.

II. HF ELMAN NETWORK

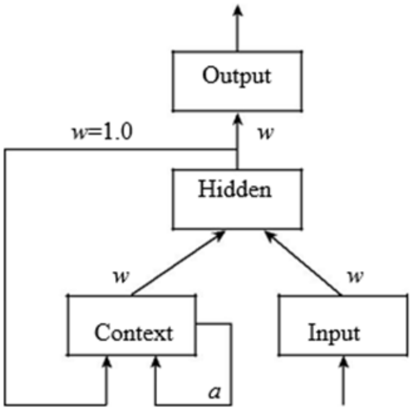

Fig. 1 The structure of the ENN

Fig. 1 shows the structure of a simple ENN. In Fig. 1, when the hidden units are calculated, their values are used to calculate the output of the network and all are stored as "extra inputs" (called context unit) to be used when the next time the network is operated. Thus, the recurrent contexts offer a weighted sum of the previous values of the hidden units as input to the hidden units. As shown in the Fig. 1, the activations are copied from hidden layer to context layer on a one for one basis, with fixed weight of 1.0 (w=1.0). The forward connection weight is trained between hidden units and context units as well as alternative weights. If self-connections are introduced to the context unit when the values of the self-connections weights (a) are fixed between 0.0 and 1.0 (usually 0.5) before the training process before the training process.

A. Internal Process Analysis of ENN

Fig. 2 is the internal learning process of ENN by the error back-propagation algorithm. From Fig. 2 we can see that training such a network isn't easy since the output of the network depends on the inputs and conjointly all previous inputs to the network. So, it ought to trace the previous values according to the recurrent connections (Fig. 3). So, the calculation of the functional derivatives isn't easy and it leads to low efficiency to handle various signal problems.

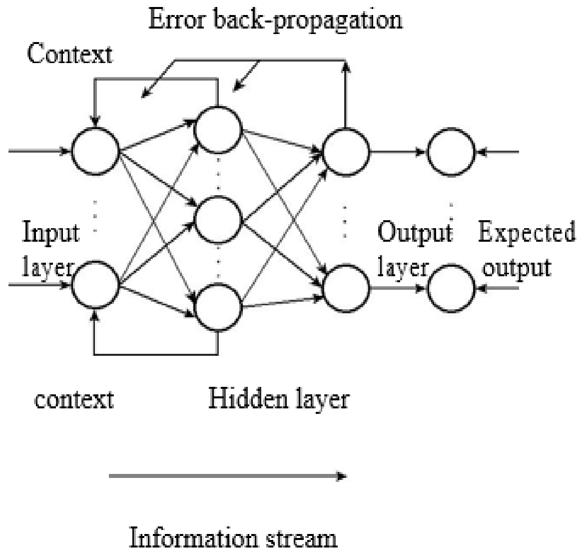

Fig. 2 Internal process analysis of ENN

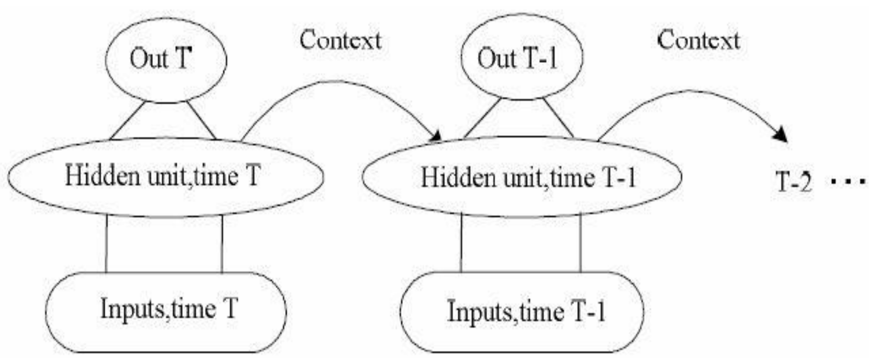

Fig. 3 Unroll the ENN through time

HF Elman network has two context layers, context 1 is analogous to the context in Fig. 1, it's used to achieve the feedback of the hidden state; context 2 may be a special party that used to achieve the feedback data of the output, and it forms two feedback loops, one of the links from the output nodes delayed when one-step time back to the hidden nodes and other from the output nodes by one-step time delays then back to its input. Additionally, the two context layers structural the self-feedback loop, and set up the self-feedback gain factor, severally. So the network can't only dynamic back a moment before the present state, but also to reflect additional information of earlier moment. From here we tend to see that the HF Elman network combine state feedback, output feedback and time delay organically.

B. Chaotic Training Algorithm

BP rule is basically for the best resolution within the direction of gradient descent, the road of gradient descent are mounted once the initial weights selected at random, if get in local minimum, we've to selected the initial weights at random again, and then reuse gradient method, so the weights which selected later could also be in the area already searched before, and therefore the algorithm can do the work meaningless. Thanks to the argotic property of chaos, chaos variables are often used to optimize the weights and escape the local optimum.

Chaotic sequence is used to optimize all weights of the HF Elman network. The Basic steps are as follows:

(1) Initialization weight vectors. Generating random number in the interval (-A, A) and assign it to the initial weight W, where A is the extreme of initial estimated weight, setting the initial weight Ebest.

(2) Let W' = W/2A+1/2, map the initial weights to the definition of chaos variables, use chaotic Algorithms to optimize the weight. Generating chaotic weight W''from W''= 4W'(1 - W'); Then map W'' to the original interval from W'''= 2AW''- A.

(3) Computing the error of network from W''' and marked it to E, if E < Ebest, then let Ebest = E, and mark the weight W''' to Wbest.

(4) Refresh the initial weigh for the next chaotic mapping. Let W = Wbest + εu, where ε is a small weight, u is a random variable in the interval (1, 1).

(5) On a given network training accuracy (or cycles), stop learning if the value of Ebest satisfies the training precision, otherwise turn to step (2).

III. QUALITY MODELLING WITH HF ELMAN NETWORK

The Elman neural network we take into account has the following architecture. It is a feed-forward network with three layers: an input, a hidden and an output layer (see Fig. 4). This type differs from conventional ones in this the input layer includes a recurrent connection with the hidden one (denoted by the dotted lines within the figure). Therefore, at every time step the output values of the hidden layer units are copied to the input ones, which store them and use them for consequent time step. This process permits the network to learn some information from the past, in such a way to better detect periodicity of the patterns.

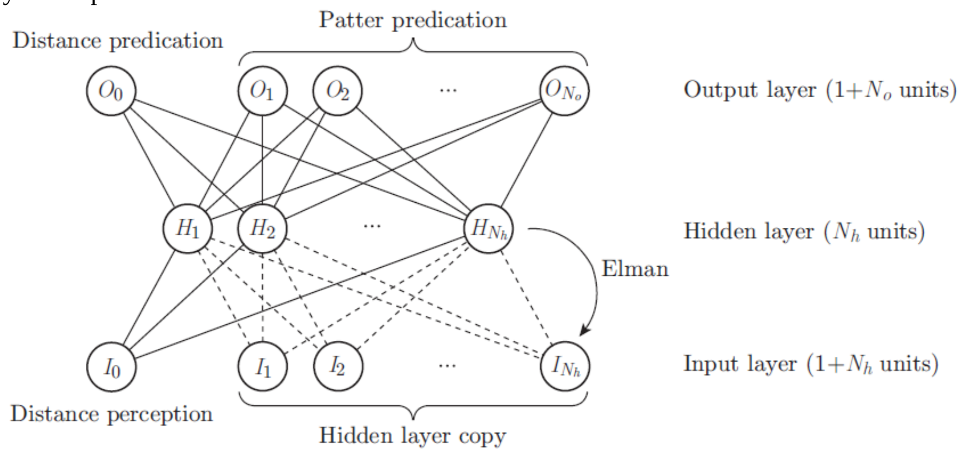

Fig. 4 The architecture of the Elman neural network

We choose the following architecture. The important characteristic is the copy of the N_h units from the Hidden to the Input Layer, which has $N_h + 1$ units, since the primary unit is given by the (normalized) distance measured by the sensor. Furthermore we observe that the Output Layer has $1+N_0$ units, where N_0 denotes the total number of patterns (to be categorized), whereas the primary unit is dedicated to the prediction of the next distance step.

IV. CONCLUSIONS

In this paper, we studied a new Elman network, the HF Elman, it combine the state feed-back, output feedback and time delay organically. And introducing chaos mechanism to train the improved network, thus the shortcomings of local extreme caused by the traditional gradient algorithm can be eliminated effectively, and either the network's learning efficiency or the fore-cast accuracy has been enhanced greatly. Results show that, the HF Elman network has super performance to the modeling of high-order, delay, nonlinear chemical dynamic system.

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