

Chapter X

Generalized Correlation Higher Order Neural Networks for Financial Time Series Prediction

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ABSTRACT

Generalized correlation higher order neural network designs are developed. Their performance is compared with that of first order networks, conventional higher order neural network designs, and higher order linear regression networks for financial time series prediction. The correlation higher order neural network design is shown to give the highest accuracy for prediction of stock market share prices and share indices. The simulations compare the performance for three different training algorithms, stationary versus non-stationary input data, different numbers of neurons in the hidden layer and several generalized correlation higher order neural network designs. Generalized correlation higher order linear regression networks are also introduced and two designs are shown by simulation to give good correct direction prediction and higher prediction accuracies, particularly for long-term predictions, than other linear regression networks for the prediction of inter-bank lending risk Libor and Swap interest rate yield curves. The simulations compare the performance for different input data sample lag lengths.

INTRODUCTION

Neural networks are usually trained by means of a training algorithm, which calculates the values of the interconnection weights and threshold biases.

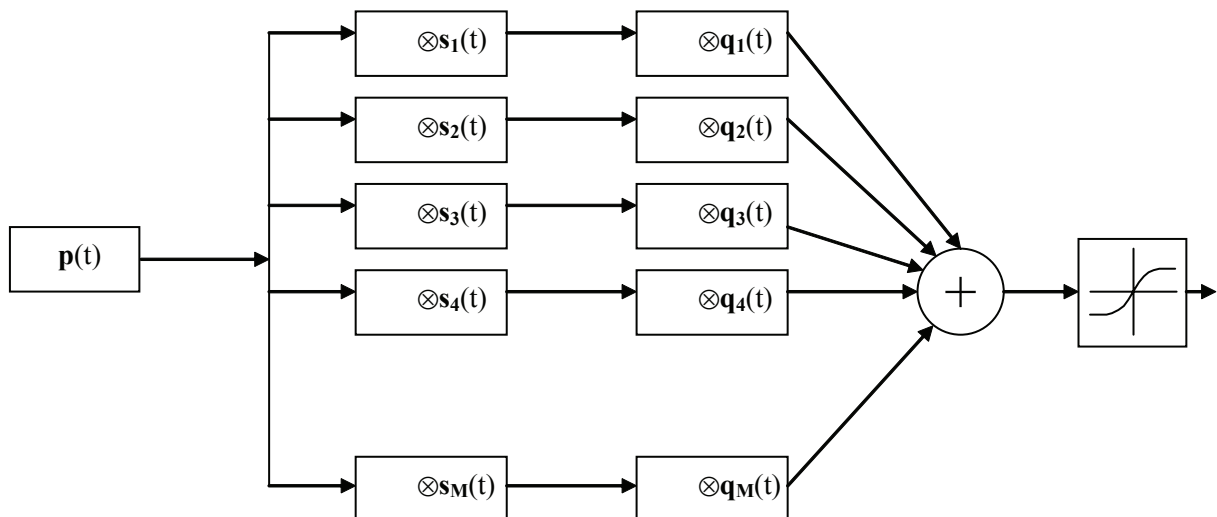
After training, it is difficult to understand how the final weights encapsulate the trends and patterns in the training data. If the network does not perform sufficiently well, it is difficult to understand how to modify or redesign the network or the training

algorithm to give better performance. The correlation model (Selviah, 1989; Midwinter, 1989; Midwinter, 2003; Twaij, 1992) of first order neural networks provides a conceptual framework, which gives an insight into the behavior of neural networks (Selviah, 1989) and has enabled improved network structures (Selviah, 1989; Selviah, 1989) and training algorithms to be developed (Selviah, 1996; Stamos, 1998; Selviah, 2002). Instead of dealing with individual weights, the model considers the network to store two sets of vectors or patterns, each formed by various combinations of the weights. One layer in a first order neural network is equivalent to two cascaded arrays of inner product correlators, each array storing one set of vectors, as in Figure 1. The inner product correlation, or dot product, of the input vector and each of the first set of stored vectors yields a number of correlation magnitudes. The inner product correlation operation is particularly useful for comparing patterns and for recognizing any similarities between them, provided the patterns are in alignment with each other. The inner product correlation magnitudes are passed to the second set of vectors with which they multiply. This weighted second set of vectors is then summed

and thresholded. By expanding the neurons non-linear threshold function as a power series, (Selviah, 1989) weighted higher order products of the second set of stored vectors are formed generating high order terms in an otherwise “first order” neural network.

Higher order neural networks offer improved performance over first order networks as the higher order cross products between elements of the input vector highlight inter-element relationships. Apart from the use of the non-linear threshold, the higher order cross products may be formed in additional pre-processing layers or by multiplier unit neurons. However, the number of such cross products increases exponentially as the input vector lengthens, resulting in many interconnection weights, long training times, insufficient simulating computer memory and convergence to one of the many shallow local minima (Leshno, 1993) in the neural networks energy surface instead of one of the few deep global minima, which give high accuracy. The challenge is to find new higher order neural network designs having fewer network variables, but which still give the same high accuracy.

Figure 1. Correlator model of one neural network layer



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