Information Sciences 280 (2014) 188–204

Contents lists available at ScienceDirect

Information Sciences

journal homepage: www.elsevier.com/locate/ins

Particle swarm optimization of ensemble neural networks with fuzzy aggregation for time series prediction of the Mexican Stock Exchange

Martha Pulido, Patricia Melin *, Oscar Castillo

Tijuana Institute of Technology, Division of Graduate Studies and Research, Calzada Tecnologico, s/n, Fracc. Tomas Aquino, 22379 Tijuana, BC, Mexico

ARTICLE INFO

Article history:
Received 23 October 2013
Received in revised form 27 March 2014
Accepted 3 May 2014
Available online 13 May 2014

Keywords:
Ensemble neural network
Particle swarm optimization
Time series prediction

ABSTRACT

This paper describes a hybrid method based on particle swarm optimization for designing ensemble neural networks with fuzzy aggregation of responses to forecast complex time series. The time series that was considered in this paper, to compare the hybrid approach with traditional methods, is the Mexican Stock Exchange, and the results shown are for the optimization of the structure of the ensemble neural network with type-1 and type-2 fuzzy logic integration. Simulation results show that the optimized ensemble neural network approach produces good prediction of the Mexican Stock Exchange.

© 2014 Elsevier Inc. All rights reserved.

1. Introduction

A time series is a sequence of data points, measured typically at successive points in time and spaced at uniform time intervals [2,10]. Examples of time series are the daily closing value of the Mexican Stock Exchange. Time series are very frequently plotted via line charts. Time series are used in statistics, signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, earthquake prediction, electroencephalography, control engineering, astronomy and communications engineering.

Stock fund managers and financial analysts attempt to predict price activity in the stock market on the basis of either their professional knowledge or stock analyzing tools, in order to obtain gains in prices in the stock market.

For more than one decade, time series models have also been applied to solve various domain problems, such as financial forecasting.

In this paper the design of a neural network ensemble with the Particle Swarm Optimization algorithm (PSO) and its integration with type-1 and type-2 fuzzy systems, along with simulation results for the prediction of the Mexican Stock Exchange are presented. In the literature there has been a lot of recent work in time series prediction [3,4,6–9,17,19,23–25,34,37,40], which indicate the recent importance of the topic.

Time series prediction with hybrid models has also been a hot topic in recent years [35,36,38]. This paper shows the results of an optimized ensemble neural network and its fuzzy response aggregation for predicting the time series of the Mexican Stock Exchange [1]. The PSO technique is used to optimize the neural network ensemble, as this can help in finding a good solution to a complex problem, which in this case is to find the best ensemble neural network architecture to obtain

* Corresponding author. Tel.: +52 6646236318.
E-mail address: pmelin@tectijuana.mx (P. Melin).

http://dx.doi.org/10.1016/j.ins.2014.05.006
0020-0255/© 2014 Elsevier Inc. All rights reserved.

the minimum forecast error for the time series mentioned above and to integrate the results with type-1 and type-2 fuzzy systems.

The main contribution of the paper is the proposed model of a neural network ensemble with type-2 fuzzy logic for response integration. In addition the particle swarm optimization method determines the number of modules of the neural network ensemble, number of layers and number of neurons per layer, and thus obtains the best architecture of the ensemble neural network. After obtaining this architecture the results from the modules are aggregated with type-1 and type-2 fuzzy systems, the inputs to the fuzzy system are the responses according to the number of network modules and this are the number of inputs of the fuzzy system. In this case, the maximum number of inputs is of 5 inputs and one output with two Gaussian membership functions and these are be granulated in two linguistic variables that are low and high forecast, and the forecast output will also be low or high and thereby obtain the forecast error for this series of the Mexican Stock Exchange. The proposed hybrid ensemble of neural networks with fuzzy response aggregation and its optimization with PSO is main contribution of the paper, as this hybrid approach has not been proposed previously in the literature for this kind of time series prediction problems. This paper considers the times series of the Mexican Stock Exchange because the problem is quite complex and the time series is chaotic in some periods of time and for this reason an ensemble model is justified. To consider different possible behaviors we have also previously worked with other time series, such as the Mackey–Glass $\tau = 17,\ 34$ and 68 and this series has chaotic behavior and as the value of τ increases it will be more chaotic. Also the US/Dollar/MX Peso and the Dow Jones time series, which are quite complex, have been considered with ensembles and have produced good results in these cases [27].

We can find that there are similar ensemble approaches in the literature, but the main difference is that in the proposed approach in this paper we use type-2 fuzzy aggregation of responses in the ensemble, which is not found into other similar works. The idea of using type-2 fuzzy logic is the better manage the uncertainty in prediction. In addition, we also use PSO to optimize ensemble neural network, which is not so commonly used in ensembles.

We consider this as the new contribution, since the results obtained are better than other methods proposed in the literature.

The rest of the paper is organized as follows: Section 2 describes the architecture of the ensemble neural network, basic concepts of the proposed method, Section 3 describes the concepts particle swarm optimization, In Section 4 Optimization Ensemble Neural Network with Particle Swarm Optimization. Section 5 describes the concepts of fuzzy systems as methods of integration. In Section 6 the methodology for solving it are represented, Section 7 describes the simulation results of the proposed method, in Section 8 the comparison and the *t* student test are presented, and Section 9 shows the conclusions.

2. Time series and prediction

Time series are analyzed to understand the past and to predict the future, enabling managers or policy makers to make properly informed decisions. A time series analysis quantifies the main features in data and the random variation. These facts, combined with improved computing power, have made time series methods widely applicable in government, industry, and commerce.

Time series models often form the basis of computer simulations. Some examples are assessing different strategies for control of inventory using a simulated time series of demand; comparing designs of wave power devices using a simulated series of sea states; and simulating daily rainfall to investigate the long-term environmental effects of proposed water management policies

A time-series is defined as a sequence of observations on a set of values that takes a variable (quantitative) at different points in time. Time series are widely used today because organizations need to know the future behavior of certain relevant phenomena in order to plan, prevent, and so on, their actions. That is, to predict what will happen with a variable in the future from the behavior of that variable in the past [1]. The data can behave in different ways over time, this may be a trend, which is the component that represents a long-term growth or decline over a period of time. A cycle is also possible, which refers to the wave motion that occurs around the trend, or may not have a defined or random manner; there are seasonal variations (annual, biannual, etc.), which are a behavior patterns that are repeated year after year at a particular time [2–4].

The word "prediction" comes from the Latin prognosticum, which means I know in advance. Prediction is to issue a statement about what is likely to happen in the future, based on analysis and considerations of experiments. Making a forecast is to obtain knowledge about uncertain events that are important in decision-making [5]. Time series prediction tries to predict the future based on past data, it take a series of real data $x_t - n, \ldots x_t - 2.0\, x_t - 1, x_t$ and then obtains the prediction of the data $x_t + 1, x_t + 2 \ldots x_n + n$. The goal of time series prediction or its model is to observe the series of real data, so that future data may be accurately predicted [26].

3. Ensemble neural network

Artificial neural networks are inspired by the biological nervous system architecture, which consists of a large number of relatively simple neurons that work in parallel to facilitate rapid decision making [29].

A neural network is a system of parallel processors interconnected as a directed graph. Schematically each processing element (neurons) in the network is represented as a node. Its most important advantage is to solve problems that are too

Download English Version:

https://daneshyari.com/en/article/391638

Download Persian Version:

https://daneshyari.com/article/391638

Daneshyari.com