Chapter 12
Designing a Neural Network Model for Time Series Forecasting

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ABSTRACT

Artificial neural networks are highly flexible and efficient tools in the approximation of time series patterns. In recent years, more than 5,000 studies oriented to the use of neural networks in time series forecasting have been evidenced in the extant literature. However, the methodology used for its specification and construction still involves a lot of trial and error or is inherited from econometric and statistical procedures that do not fit perfectly to the characteristics of the time series. This is especially true when they present non-linear behavior; moreover, it is not designed for working with neural networks. The objective of this chapter is to present a five-step guide for the specification, design, and validation of a neural network model for forecasting time series.

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INTRODUCTION

The general objective of the time series forecast is to explain the evolution of the phenomenon in time and, based on this, infer behavior in the future. Although this definition sounds simple, its execution is not since it is closely related to factors such as the structure of the series, the purpose of the prediction, the period of time to be forecasted, among many other aspects. Prediction is an essential input in decision making in the evaluation of future scenarios and, even more, in the very understanding of the series which requires a well-constituted methodological process.

Neural networks have been widely used in the forecast of time series, but also strongly criticized due to the difficulty in the specification and construction of a model, given by the number of parameters that the modeler must select to generate a good forecast. The cost of this flexibility lies in the fact that the modeler must select the correct combination of structural and functional parameters, which involves trial and error since there is no adequate methodology to perform it. The main objective of this chapter is to present a systematic methodological strategy that allows one to specify and build a convergent and replicable neuronal network model for the forecasting time series.

PREVIOUS WORKS

The forecast of time series has been an area of growing interest for many disciplines, and in which many efforts have been devoted to the development of new methods and techniques. Its objective is to provide the modeler with a mathematical representation of a time series, which allows capturing, totally or partially, the most relevant characteristics of the real phenomenon, based on the information contained in the data. Although in the extant literature various models oriented to the representation of time series have been proposed, their usefulness depends on the degree of similarity between the dynamics of the generating process of the series and the mathematical formulation of the model with which it is represented.

In the traditional approaches, the most widespread methodology for the construction of time series models, and therefore the most widely used, is that of Box and Jenkins (1970) which has proved to be useful in the representation of numerous real series and is based on a solid mathematical foundation. However, this methodology is not applicable when the data exhibit non-linear characteristics. For time series with non-linear relationships, there are models that have been developed that attempt to reflect the type of non-linearity present in the data with different functional forms; however, the methodology used for the construction of such models remains Box and Jenkins (Tong, 1990; Granger & Teräsvirta, 1993; Harvey, 1989).

Likewise, models of neural networks have been used motivated by the versatility offered in the recognition of different patterns. In this sense, in the incipient work of Kaastra and Boyd (1996), a guide to build a neural network model for financial time series is presented, but still with the dependence of linear characteristics. A similar work for the case of tourism series is carried out by Palmer, Montaño, and Sesé (2006); in this, the theory that there is no systematic procedure to guide the construction of neural network models for the prediction of time series is supported. Anders and Korn (1999) make an effort that goes beyond representing a single model by presenting a series of procedures oriented to the construction of constructive models, and focusing on the task of selecting the best one.