Time Series Forecasting using Artificial Neural Networks

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Abstract

Time series datasets contain a collection of observations in time and this additional temporal component differentiates time series with normal datasets. Studies of forecasting time series datasets are particularly popular as they improve financial planning, sales prediction, average rainfall forecast, internet traffic rates, business trend forecasting, weather forecast, contagious disease spread, etc. Time series forecasting facilitates the decision process in various domains such as business by predicting timely sales information thereby improving management of product manufacturing output. In medical domain, predicting patient health improves medical treatment. The environmental and physical time series forecasting such as rainfall, disaster prediction would improve the contingency plans. On an overall basis time series prediction improves the way humans live. Artificial neural networks are increasingly becoming successful in predicting the time series data through regression-based models. In this article, a benchmark time series model called Mackey-Glass chaotic time series is predicted using feedforward multi-layer neural network trained using the error backpropagation algorithm. The architecture and algorithm proposal in this article can easily be extended to any real-world time series prediction requirements.

Key Words: Artificial Neural Networks, Mackey-Glass, Time Series, Forecasting

1. INTRODUCTION

Time series analysis is a crucial research area that is attracting researchers' attention in the recent past. Timebound data is being generated continuously in numerous fields including businesses, natural phenomena, medical devices or industrial production output. Data collected sequentially or in an orderly fashion over time is known as time series data and analyzing a time series data helps in improving decision making in the concerned sector [1]. Improved decision making in a process can be achieved by improving the forecasting of future values of relevant parameters based on their current values [2].

Time series data that cannot be modelled using a mathematical equation or a function is known as a chaotic time series. Most natural phenomena, like disease spread, annual rainfall and industrial sensor data, which are often corrupted by noise, fall into the category of chaotic time series. A chaotic time series is non-stationary, and it appears to be random due to noise and other external influences.

Mackey-glass chaotic time series is a benchmark chaotic time series that has 1201 data points in time [3]. The objective is to model this dynamic process or time series and forecast future values.

Artificial neural networks (ANNs) are increasingly becoming popular in forecasting or predicting time-series data. An ANN model has been proposed in this paper to predict the future values of Mackey-glass chaotic time series. This paper is an abridged version of [4]. The ANN model and the training method used in the paper performs better than some traditional statistical methods.

2. BACKGROUND AND RELATED WORK

An ANN is biologically inspired as its building block – artificial neuron – derived from McCulloch Pitts model aims to emulate a biological neuron. Though ANNs are unable to emulate perfect behavior of a human brain, they can perform a few other tasks than humans do better than the traditional programming or rule-based systems [5]. ANNs can be designed with various combinations of interconnections of neurons resulting in various topologies or structures with varying computations and connection weights that can perform powerful human-like tasks.

ANNs are naturally good in pattern (image or speech) recognition and association tasks where they almost behave like or sometimes even better than humans. Their importance can be understood as they tend to classify/categorize unseen data and are also able to predict unknown future trends. They learn by examples and map inputs to output patterns. They are also fault tolerant and are robust in executing the tasks [6].

Traditionally, several methods have been developed for the prediction of future values, and to model a given time series [7]. These include auto regressive integrated moving average and other statistical methods. However, the performance of statistical and moving average methods are not always encouraging, especially with higher order complexities and when the given dynamic processes are non-stationary. The nature of any given dynamic process is usually non-stationary due to noise and other environmental conditions.

Neural networks have been extensively used for time series prediction [8]. Forecasting a time series has also been addressed using regression models, such as auto regressive integrated moving average (ARIMA) model.

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