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 outputs. 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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best practice implementations in Python The book concludes with the Appendix with a brief discussion of programming and solving data science problems using Python Style and approach This book takes the readers from the basic to advance level of Time series analysis in a very practical and real world use cases <u>Time Series Analysis - Frontiers in Research and Practice</u> Jorge Rocha,Cláudia Viana,Inês Boavida-Portugal,Eduardo Gomes,2025-12-24 Time Series Analysis Frontiers in Research and Practice offers a concise overview of cutting edge methods for understanding forecasting and applying models to temporal data The volume combines Markov Chain Monte Carlo Bayesian ARIMA and Posterior Predictive Distribution to enable uncertainty aware time series forecasting It reinterprets temporal data through co evolving time series causal dependencies shift visibility graph representations graph representation learning multiplex networks and temporal metagraphs tools suited for dependency regime forecasting and critical fields such as cybersecurity Bridging theory and application it advances data driven prediction using Takens embedding theorem dynamic models neural network algorithms and demonstrates deployment ready efficient pipelines via neuro symbolic techniques for edge computing integrating spectral signal processing pattern recognition signal symbolization and convolutional neural networks Additionally it features compression based prediction with universal coding and decision trees providing transparent and robust baselines The book s strengths include a unified cross disciplinary view focus on interpretability and uncertainty guidance for real time resource limited environments and practical examples such as numerical and dislocation modeling in geoscience that turn techniques into actionable insights Geared toward researchers practitioners and postgraduate students this edited volume provides a modern interoperable toolkit linking rigorous modeling with real world applications and decision making **Deep Time Series Forecasting with Python** N. Lewis,2016-12-11 Master Deep Time Series Forecasting with Python Deep Time Series Forecasting with Python takes you on a gentle fun and unhurried practical journey to creating deep neural network models for time series forecasting with Python It uses plain language rather than mathematics And is designed for working professionals office workers economists business analysts and computer users who want to try deep learning on their own time series data using Python QUICK AND EASY Using plain language this book offers a simple intuitive practical non mathematical easy to follow guide to the most successful ideas outstanding techniques and usable solutions available using Python Examples are clearly described and can be typed directly into Python as printed on the page NO EXPERIENCE I m assuming you never did like linear algebra don t want to see things derived dislike complicated computer code and you re here because you want to see how to use deep learning for time series forecasting explained in plain language and try it out for yourself THIS BOOK IS FOR YOU IF YOU WANT Explanations rather than mathematical derivation Real world applications that make sense Illustrations to deepen your understanding Worked examples you can easily follow and immediately implement Ideas you can actually use and try on your own data CUT LEARNING TIME IN HALF This guide was written for people who want to get up to speed as soon as possible Through a simple to follow process you will learn how to

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Table of Contents Neural Networks For Time Series Forecasting Practical

1. Understanding the eBook Neural Networks For Time Series Forecasting Practical
    - The Rise of Digital Reading Neural Networks For Time Series Forecasting Practical
    - Advantages of eBooks Over Traditional Books
2. Identifying Neural Networks For Time Series Forecasting Practical
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Neural Networks For Time Series Forecasting Practical
    - User-Friendly Interface
4. Exploring eBook Recommendations from Neural Networks For Time Series Forecasting Practical
    - Personalized Recommendations
    - Neural Networks For Time Series Forecasting Practical User Reviews and Ratings

- Neural Networks For Time Series Forecasting Practical and Bestseller Lists
5. Accessing Neural Networks For Time Series Forecasting Practical Free and Paid eBooks
   - Neural Networks For Time Series Forecasting Practical Public Domain eBooks
   - Neural Networks For Time Series Forecasting Practical eBook Subscription Services
   - Neural Networks For Time Series Forecasting Practical Budget-Friendly Options
6. Navigating Neural Networks For Time Series Forecasting Practical eBook Formats
   - ePub, PDF, MOBI, and More
   - Neural Networks For Time Series Forecasting Practical Compatibility with Devices
   - Neural Networks For Time Series Forecasting Practical Enhanced eBook Features
7. Enhancing Your Reading Experience
   - Adjustable Fonts and Text Sizes of Neural Networks For Time Series Forecasting Practical
   - Highlighting and Note-Taking Neural Networks For Time Series Forecasting Practical
   - Interactive Elements Neural Networks For Time Series Forecasting Practical
8. Staying Engaged with Neural Networks For Time Series Forecasting Practical
   - Joining Online Reading Communities
   - Participating in Virtual Book Clubs
   - Following Authors and Publishers Neural Networks For Time Series Forecasting Practical
9. Balancing eBooks and Physical Books Neural Networks For Time Series Forecasting Practical
   - Benefits of a Digital Library
   - Creating a Diverse Reading Collection Neural Networks For Time Series Forecasting Practical
10. Overcoming Reading Challenges
    - Dealing with Digital Eye Strain
    - Minimizing Distractions
    - Managing Screen Time
11. Cultivating a Reading Routine Neural Networks For Time Series Forecasting Practical
    - Setting Reading Goals Neural Networks For Time Series Forecasting Practical
    - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Neural Networks For Time Series Forecasting Practical
    - Fact-Checking eBook Content of Neural Networks For Time Series Forecasting Practical
    - Distinguishing Credible Sources

13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
14. Embracing eBook Trends
    - Integration of Multimedia Elements
    - Interactive and Gamified eBooks

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