

Time Series Forecasting using Artificial Neural Networks

*Rajasekhar Nannapaneni, Raghavendra V. Kulkarni

Faculty of Engineering and Technology, M.S. Ramaiah University of Applied Sciences, Bengaluru-560024

*Contact Author Email: raja.nannapa.neni@gmail.com

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 proposed 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. Time-series 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 this paper [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 that 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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forecasting methods including smoothing algorithms regression models and neural networks A practical approach to evaluating the performance of forecasting solutions A business analytics exposition focused on linking time series forecasting to business goals Guided cases for integrating the acquired knowledge using real data End of chapter problems to facilitate active learning A companion site with data sets R code learning resources and instructor materials solutions to exercises case studies Globally available textbook available in both softcover and Kindle formats Practical Time Series Forecasting with R A Hands On Guide Second Edition is the perfect textbook for upper undergraduate graduate and MBA level courses as well as professional programs in data science and business analytics The book is also designed for practitioners in the fields of operations research supply chain management marketing economics finance and management For more information visit forecastingbook.com [Practical Time Series Analysis](#) Dr. Avishek Pal, Dr. PKS Prakash, 2017-09-28 Step by Step guide filled with real world practical examples About This Book Get your first experience with data analysis with one of the most powerful types of analysis time series Find patterns in your data and predict the future pattern based on historical data Learn the statistics theory and implementation of Time series methods using this example rich guide Who This Book Is For This book is for anyone who wants to analyze data over time and or frequency A statistical background is necessary to quickly learn the analysis methods What You Will Learn Understand the basic concepts of Time Series Analysis and appreciate its importance for the success of a data science project Develop an understanding of loading exploring and visualizing time series data Explore auto correlation and gain knowledge of statistical techniques to deal with non stationarity time series Take advantage of exponential smoothing to tackle noise in time series data Learn how to use auto regressive models to make predictions using time series data Build predictive models on time series using techniques based on auto regressive moving averages Discover recent advancements in deep learning to build accurate forecasting models for time series Gain familiarity with the basics of Python as a powerful yet simple to write programming language In Detail Time Series Analysis allows us to analyze data which is generated over a period of time and has sequential interdependencies between the observations This book describes special mathematical tricks and techniques which are geared towards exploring the internal structures of time series data and generating powerful descriptive and predictive insights Also the book is full of real life examples of time series and their analyses using cutting edge solutions developed in Python The book starts with descriptive analysis to create insightful visualizations of internal structures such as trend seasonality and autocorrelation Next the statistical methods of dealing with autocorrelation and non stationary time series are described This is followed by exponential smoothing to produce meaningful insights from noisy time series data At this point we shift focus towards predictive analysis and introduce autoregressive models such as ARMA and ARIMA for time series forecasting Later powerful deep learning methods are presented to develop accurate forecasting models for complex time series and under the availability of little domain knowledge All the topics are illustrated with real life problem scenarios and their solutions by

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 *Neural Networks for Time Series Forecasting* Melinda Francine Thielbar,2011

Data Science Fundamentals and Practical Approaches Dr. Gypsy Nandi,Dr. Rupam Kumar Sharma,2026-03-07 DESCRIPTION Data science is one of the fastest growing fields in technology today powering decisions across industries through data driven insights machine learning and advanced analytics The book journeys from the fundamentals of data science to the advanced concepts and applications in the present day computer vision techniques and data analysis It covers the full data science pipeline beginning with core fundamentals ethics and the analytics lifecycle moving through data preprocessing visualization and a strong statistical foundation covering probability theory Bayesian inference and Monte Carlo simulation This second edition expands on the first with two dedicated machine learning and deep learning chapters adding AutoML reinforcement learning graph neural networks transformer networks and hybrid big data processing architectures By the end of this book readers will emerge as competent data practitioners equipped with a thorough understanding of data science concepts They will have gained the technical proficiency to use modern tools such as Python PyTorch TensorFlow and data visualization tools along with the analytical skills required for business problem solving and data driven decision making across diverse real world domains WHAT YOU WILL LEARN Comprehensive understanding of the data science lifecycle and core tools Building supervised unsupervised and semi supervised learning models in Python Performing time series analysis using ANN SVM and stochastic models Developing deep learning models using CNN RNN and encoder decoder networks In this 2nd edition explore AutoML Transformers and expanded deep learning Conducting social media analytics through text mining and trend detection Applying business analytics financial modelling and fraud detection strategies Working with Hadoop ecosystem tools for scalable big data analytics WHO THIS BOOK IS FOR This book is designed for students researchers data analysts and professionals such as software engineers business analysts and aspiring data scientists who seek a strong foundation in data science It also serves educators and industry practitioners aiming to apply analytical and machine learning techniques to real world challenges TABLE OF CONTENTS 1 Fundamentals of Data Science 2 Data Preprocessing 3 Data Plotting and Visualization 4 Statistical Data Analysis 5 Advanced and Computational Statistical Analysis Techniques 6 Machine Learning for Data Science 7 Advanced Machine Learning for Data Science 8 Time series Analysis 9 Deep Learning for Data Science 10 Advanced Architectures in Deep Learning for Data Science 11 Social Media Analytics 12 Business Analytics 13 Big Data Analytics

Machine Learning and Principles and Practice of Knowledge Discovery in Databases Rosa Meo,Fabrizio Silvestri,2025-01-01 The five volume set CCIS 2133 2137 constitutes the refereed proceedings of the workshops held in conjunction with the Joint European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2023 which took place in Turin Italy during

September 18 22 2023 The 200 full papers presented in these proceedings were carefully reviewed and selected from 515 submissions The papers have been organized in the following tracks Part I Advances in Interpretable Machine Learning and Artificial Intelligence Joint Workshop and Tutorial BIAS 2023 3rd Workshop on Bias and Fairness in AI Biased Data in Conversational Agents Explainable Artificial Intelligence From Static to Dynamic ML Law and Society Part II RKDE 2023 1st International Tutorial and Workshop on Responsible Knowledge Discovery in Education SoGood 2023 8th Workshop on Data Science for Social Good Towards Hybrid Human Machine Learning and Decision Making HLDM Uncertainty meets explainability in machine learning Workshop Deep Learning and Multimedia Forensics Combating fake media and misinformation Part III XAI TS Explainable AI for Time Series Advances and Applications XKDD 2023 5th International Workshop on eXplainable Knowledge Discovery in Data Mining Deep Learning for Sustainable Precision Agriculture Knowledge Guided Machine Learning MACLEAN MACHine Learning for EArth ObservatioN MLG Mining and Learning with Graphs Neuro Explicit AI and Expert Informed ML for Engineering and Physical Sciences New Frontiers in Mining Complex Patterns Part IV PharML Machine Learning for Pharma and Healthcare Applications Simplification Compression Efficiency and Frugality for Artificial intelligence Workshop on Uplift Modeling and Causal Machine Learning for Operational Decision Making 6th Workshop on AI in Aging Rehabilitation and Intelligent Assisted Living ARIAL Adapting to Change Reliable Multimodal Learning Across Domains AI4M AI for Manufacturing Part V Challenges and Opportunities of Large Language Models in Real World Machine Learning Applications Deep learning meets Neuromorphic Hardware Discovery challenge ITEM IoT Edge and Mobile for Embedded Machine Learning LIMBO LearnIng and Mining for BLOckchains Machine Learning for Cybersecurity MLCS 2023 MIDAS The 8th Workshop on MIning DAta for financial applicationS Workshop on Advancements in Federated Learning 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 build deep time series forecasting models in the minimum amount of time using Python Once you have mastered the process it will be easy for you to translate your knowledge into your own powerful business applications

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Time Series Forecasting using Deep Learning Ivan Gridin,2021-10-15 Explore the infinite possibilities offered by Artificial Intelligence and Neural Networks

KEY FEATURES Covers numerous concepts techniques best practices and troubleshooting tips by community experts Includes practical demonstration of robust deep learning prediction models with exciting use cases Covers the use of the most powerful research toolkit such as Python PyTorch and Neural Network Intelligence

DESCRIPTION This book is amid at teaching the readers how to apply the deep learning techniques to the time series forecasting challenges and how to build prediction models using PyTorch The readers will learn the fundamentals of PyTorch in the early stages of the book Next the time series forecasting is covered in greater depth after the programme has been developed You will try to use machine learning to identify the patterns that can help us forecast the future results It covers methodologies such as Recurrent Neural Network Encoder decoder model and Temporal Convolutional Network all of which are state of the art neural network architectures Furthermore for good measure we have also introduced the neural architecture search which automates searching for an ideal neural network design for a certain task Finally by the end of the book readers would be able to solve complex real world prediction issues by applying the models and strategies learnt throughout the course of the book This book also offers another great way of mastering deep learning and its various techniques

WHAT YOU WILL LEARN Work with the Encoder Decoder concept and Temporal Convolutional Network mechanics Learn the basics of neural architecture search with Neural Network Intelligence Combine standard statistical analysis methods with deep learning approaches Automate the search for optimal predictive architecture Design your custom neural network architecture for specific tasks Apply predictive models to real world problems of forecasting stock quotes weather and natural processes

WHO THIS BOOK IS FOR This book is written for engineers data scientists and stock traders who want to build time series forecasting programs using deep learning Possessing some familiarity of Python is sufficient while a basic understanding of machine learning is desirable but not needed

TABLE OF CONTENTS 1 Time Series Problems and Challenges 2 Deep Learning with PyTorch 3 Time Series as Deep Learning Problem 4 Recurrent Neural Networks 5 Advanced Forecasting Models 6 PyTorch Model Tuning with Neural

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Using Artificial Neural Networks for Timeseries Smoothing and Forecasting Jaromír Vrbka,2021-09-04 The aim of this publication is to identify and apply suitable methods for analysing and predicting the time series of gold prices together with acquainting the reader with the history and characteristics of the methods and with the time series issues in general Both statistical and econometric methods and especially artificial intelligence methods are used in the case studies The publication presents both traditional and innovative methods on the theoretical level always accompanied by a case study i e their specific use in practice Furthermore a comprehensive comparative analysis of the individual methods is provided The book is intended for readers from the ranks of academic staff students of universities of economics but also the scientists and practitioners dealing with the time series prediction From the point of view of practical application it could provide useful information for speculators and traders on financial markets especially the commodity markets

Practical Time Series Forecasting with R Galit Shmueli,Julia Polak,2024-02-24 Practical Time Series Forecasting with R A Hands On Guide Third Edition provides an applied approach to time series forecasting Forecasting is an essential component of predictive analytics The book introduces popular forecasting methods and approaches used in a variety of business applications The book offers clear explanations practical examples and end of chapter exercises and cases Readers will learn to use forecasting methods using the free open source R software to develop effective forecasting solutions that extract business value from time series data This edition features the R fable package full color enhanced organization and new material It includes Popular forecasting methods including smoothing algorithms regression models ARIMA neural networks deep learning and ensembles A practical approach to evaluating the performance of forecasting solutions A business analytics exposition focused on linking time series forecasting to business goals Guided cases for integrating the acquired knowledge using real data End of chapter problems to facilitate active learning Data R code and instructor materials on companion website Affordable and globally available textbook available in hardcover paperback and Kindle formats Practical Time Series Forecasting with R A Hands On Guide Third Edition is the perfect textbook for upper undergraduate graduate and MBA level courses as well as professional programs in data science and business analytics The book is also designed for practitioners in the fields of operations research supply chain management marketing economics information systems finance and management

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Treleaven,1995 Intelligent Systems for Finance and Business Edited by Suran Goonatilake and Philip Treleaven A new generation of computing methods commonly known as intelligent systems are now beginning to be successfully applied in a variety of business and financial modelling tasks and in many cases are outperforming traditional statistical techniques Intelligent Systems for Finance and Business provides comprehensive coverage of the latest intelligent systems including genetic algorithms neural networks fuzzy logic expert systems rule induction genetic programming case based reasoning and intelligent hybrid systems The authors clearly illustrate theories with practical case studies drawn from a wide variety of business sectors such as credit evaluation direct marketing insider dealing detection insurance fraud detection insurance claims processing financial trading portfolio management economic modelling Written by leading professionals from the US Europe and Asia who have developed intelligent systems to tackle some of the most challenging problems in finance and business this book will be a valuable source of information for traders analysts researchers and computing personnel in investment banking retailing marketing financial services insurance and regulation

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