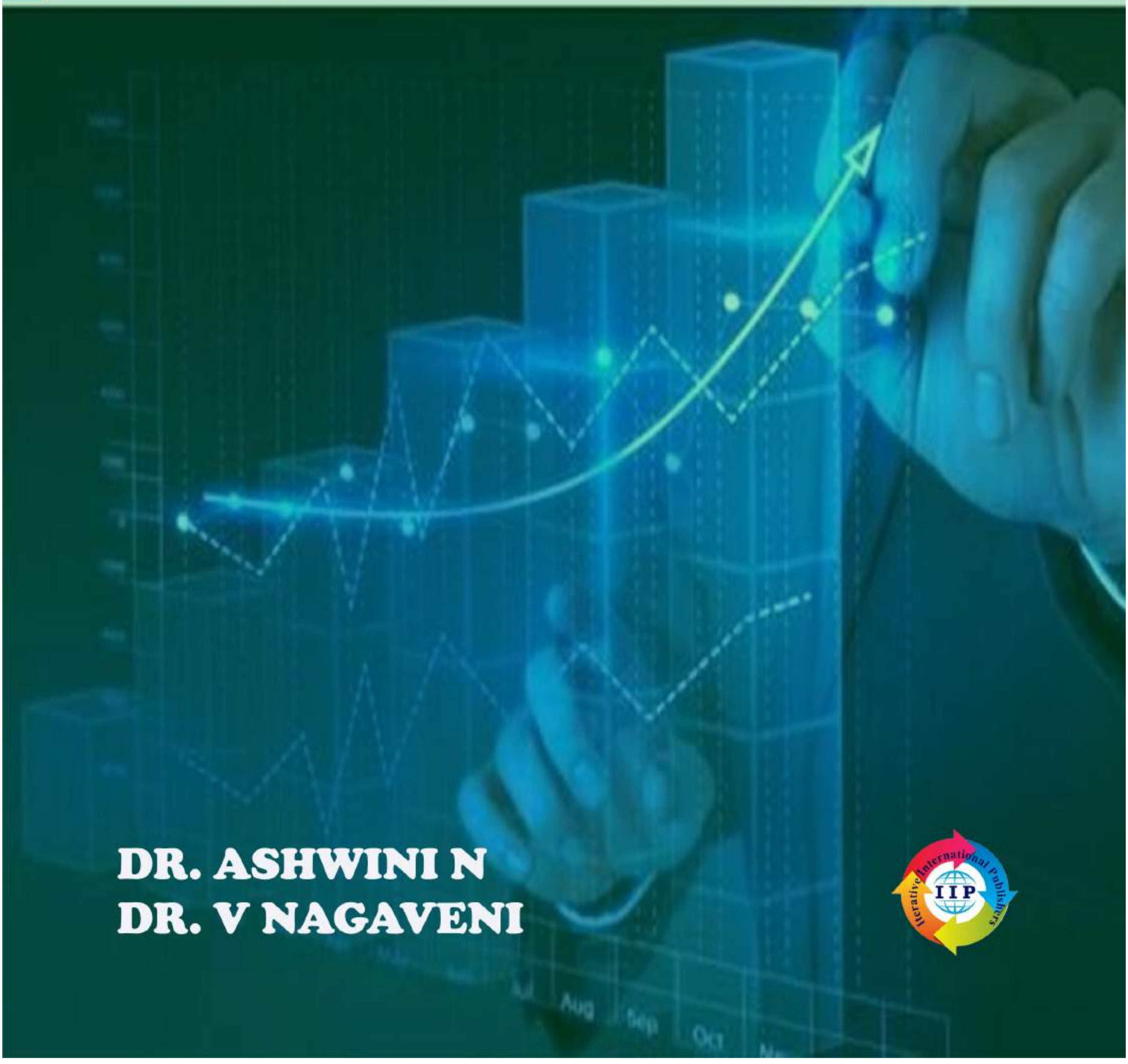
# AUTOMATED FORECASTING OF TIME SERIES USING COMPUTATIONAL INTELLIGENT APPROACH





DR. ASHWINI N
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# Automated Forecasting of Time Series Using Computational Intelligent Approach

First Edition

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# Abstract

Making predictions is called extrapolation in the classical statistical handling of time series data. Forecasting involves taking models to fit historical data and using them to predict future observations. Successful research in automated forecasting incorporates advances in data science, computer science, applied mathematics or a related field. The approach involves years of experience, building Time Series Forecasting (TSF) models, expertise in data collection, cleaning, preprocessing, and wrangling. The objective of the current dissertation is to evolve a novel algorithm for automated forecasting of time series using a computational intelligence approach.

Work started with a literature survey throughout the available relevant research work to identify opportunities for leveraging published data to drive possible identification of problems area and solutions. Mine and analyze available data from data sources to drive optimization and improvement of development and implement strategies. Assess the effectiveness and accuracy of new data sources and data gathering techniques. Develop custom data models and algorithms as needed and appropriate to address identified problems. Use predictive modeling and time series forecasting to increase and optimize targeted outcomes. Develop testing mechanisms and test model quality and value, validate hypothesis accordingly and publish the result. Current work involves the implementation of multiple case studies.

The first case study is related to a survey on the forecaster model using time series data. This work describes the brief introduction to the forecaster model using time series data and the outcome of the current survey. The ability to forecast the future is on only past data, which leads to strategic advantages and will be the key to success in organizations. TSF allows the modeling of complex systems in several research areas. There are verity of methods for time series data, which mainly depends on whether the data is linear or non-linear. This survey concentrated on neural network, evolutionary computation.

Further work is on computational intelligence-based Chaotic TSF prediction using Evolved Neural Network (ENN) and its outcome. A non-linear behavior existing intrinsically with a deterministic dynamic system showing high sensitivity with initial condition is chaotic behavior. A time-delay neural network is applied to predict the various chaotic time series by selecting optimal set of weights using adaptive social behavior optimization. Comparison of learning performance has given with popularly gradient-descent based learning. Performance evaluation is the coefficient of determination with root-mean-

square (RMS) error in prediction under the learning and test phase of chaotic time series. Three benchmarks of chaotic time series (Logistic differential equation, Micky-glass and Lorenz system) are used for predicting. Experimental results show that the proposed new method of ENN learning is very efficient and has delivered a better prediction for various chaotic time series.

Further the research is continued with forecasting the trend-cycle of TSF using a hybrid model of Linear Regression (LR) & Adaptive RBF Neural Network (ARBFNN). An individual neural model generally performs well over mapping function-based forecasting, but the complexity arises when there is a mixture of a different pattern in time series data and the need to predict the distant time samples arises. The current work resolves the complexity of forecasting the trend-cycle in time series data by using decomposition approach of time series data into fundamental data patterns of trend and cyclic. A hybrid model is developed combining linear regression model and adaptive radial basis function neural network for predicting the trend patterns and cyclic pattern respectively. The Gaussian function is used as a basic function for its efficient applicability in spreading the centre of function's control with weights values, thus improving the learning performance. Performances compared against a static version of radial basis function neural network and multilayer perceptron-based model with a mapping-based forecast of power demand by a house and monthly basis year-wise power generation prediction.

The adaptive radial basis functions neural network has appeared as a better predictor model for function mapping-based forecasting to others. In trend-cyclic time-series, the adaptive radial basis function neural network has shown excellent performance over training data while poor performances occurred over the test data. The proposed decomposition approach has given significant improvement in predicting the time series having trend-cycle patterns.

The last case study is on parameter estimation of linear & non-linear multiple regression models using Differential Evolution (DE). Forecasting the regression model has been considered widely because of its satisfactory performances with simplicity in the design. Regression model-based prediction quality heavily decided by the involved coefficient parameters. Even though for the linear model, up to the high accuracy, the algebraic method-based approach provides the optimal solution but the difficulties appeared when there is higher-order complexity involved among the independent parameters. This work has proposed the use of natural computation based computational intelligence approach. Primarily to explore the solution domain for obtaining the optimal values of parameters. The different forms of computing paradigm like DE and swarm intelligence are there over parameter estimation for non-linear and linear regression models for applications. The performance evolution has been examined and compared with the index quality coefficient of determination. With extensive experimental work, DE based estimation has delivered the optimal coefficient values.

To summarize, forecasting methods analyzed for all the case studies mentioned above. This analysis involves prior periods to expose improvement opportunities in areas such as increases, parameter changes (historical versus current), fluctuation impacts and exposures, rationalizations, parameter alignments, etc. The statistical requirements associated with the case studies like regression type can be beneficial. The operating statistics, variance analysis forecasts, and key ratios were some of the parameters. Experiment with an ad hoc analysis and variance data, making extensive use of MATLAB tools. The objective was to strive for the continuous improvement, development, modification, and implementation of models, as necessary. In most case studies, analyzing large amounts of data to summarize it into meaningful and relevant information. This approach led to improving the efficiency of the models in providing insightful, timely, and accurate process improvements with quantifiable results to measure effectiveness. The overall objective of the dissertation accomplished.

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# Contents

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