Time Series Forecasting Models: A Comprehensive Review

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Abstract: This comprehensive review provides an extensive overview of the existing Time Series Forecasting technique. This survey is not restricted to any single time series analysis; it provides forecasting of time series in different areas like marketing prediction, weather forecasting, technology prediction, financial forecasting etc. In this paper, we have analyzed forecasting in some areas namely, load forecasting, wind speed forecasting, prediction of energy consumption and short-term traffic flow prediction. Various models are available for prediction among them Autoregressive Integrated Moving Average model (ARIMA) is seen as a universal mechanism, these discussed forecasting areas utilizes different models that are combined with ARIMA. Hybrid models are the combination of classical models and modern methods, like ARIMA (classical method) combines with Artificial Neural Network (ANN) as well as with Support Vector Machine (SVM) (modern models). Hybrid model’s performance is depending on the variety of data that are taken for forecasting.

Keywords: ARIMA, ANN, SVM, Time series, ARMA.

I. INTRODUCTION

The forecasting of time series is an essential field of predicting the future data by observing the relationship among past data. The use of time series analysis extracts useful data information along with other important data features. This approach is beneficial when a very small knowledge is available and the data is available in the form of non-stationary data for an example the data of weather, retail, electricity consumption, stock price and many more. A number of researchers have contributed in this field to design a time series forecasting model in different area [1].

The conducted survey in this paper covers the existing work that used different techniques such as machine learning to forecast the data in different fields. The major aim of this paper is to analyze the opportunities or the best approach for future work. The basic steps that are required to design a time series forecasting model are shown in Figure 1

II. TECHNIQUE USED

This section deals with the most commonly used approaches to forecasting time series. The ARIMA model is among the most frequently used techniques. This technique gain popularity due to its statistical characteristics along with the Box-Jenkins mechanism used for the designing of forecasting model [2]. The ARIMA model has been used to develop a number of time series modeling models such as exchange rate data forecasting, energy consumption forecasting and carbon price forecasting [3].

Besides, ARIMA models may implement different exponential smoothing models. Although the model is capable of representing several different time series, namely Autoregressive (AR), Moving averages (MA), and combined AR and MA (ARMA) series, their main limitation is the linear form of the previously thought-out model. In other words, a linear correlation structure is assumed between the time series values and therefore, the ARIMA model cannot catch any nonlinear patterns. To approximate the linear models into complex real-world problem is sometimes not satisfactory [4].

Jenkins developed the ARIMA model by integrating two time series approaches for instance; AR and MA and ARIMA. Mathematically can be defined as

$$ \phi_t = K + \phi_1 \phi_{t-1} + \phi_2 \phi_{t-2} + \cdots + \phi_m \phi_{t-m} + \psi_0 - \psi_1 \psi_{t-1} + \psi_2 \psi_{t-2} - \cdots - \psi_q \psi_{t-q} $$

Where,

$\phi_1, \phi_2, \ldots, \phi_m$ are the model parameters,

$K \rightarrow$ Constant.

$\psi_1, \psi_2, \ldots, \psi_q$ are the white Gaussian noise.

The values obtained from equation (1) represent the ARIMA predicted values. If the value of $n=0$, then ARIMA model becomes an AR model with order of m and if the value of m=0 is an MA model or an order n [5].

A. ANN in time series modeling

ANN is an effective and competitive alternative to ARIMA models for predicting the link between time series and distinctive features. This approach helps to make the designed model more consistent as well greatly accurate. A single hidden layer ANN with single output is used in this research [6].
The output of ANN can be defined as

\[ Z_t = \phi_0 + \sum_{j=1}^{m} \phi_{0j} h(\sum_{i=1}^{n} \varphi_{ij} Z_{t-i}) + \varepsilon_t \]

Where,
- \( \varphi_{ij} \) \( (j=0,1,2,3,4,\ldots,n) \)
- \( \varphi_{0j} \) \( (i=0,1,2,3,4,\ldots,m) \), both are the weight,
- \( \phi_0 \) and \( \phi_{0j} \) Bias value
- \( \varepsilon_t \) White Noise
- \( h \) hidden layer activation function of hidden layer [7]

### SVM

SVM works based on the concept of decision planes, which defines the boundaries of the available problem. In Figure 3
categorized data is separated by the decision plane. This figure composed of two data form groups identified by colors
green and red. The data type is separated by the hyperplane. From the figure 3, the red and green color nodes are located
in the separating plane’s right and left side. If any new data enters into the system and it is towards the green side then
it comes under green data category otherwise come under red color category.
The obtained MAPE for ARIMA (Model I), ARIMA-SVM (Model II) and proposed work is 26.45%, 30.79% and 23.06% by which it has to be concluded that the error value is reduced for proposed model by which accuracy is improved.

In figure 5, the previous work has been evaluated on the basis of mean absolute percent error (MAPE) Karthika et al. (2017) and Xuemei et al. (2010) used hybrid technique ARIMA along with SVM, Wang et al. (2012) have done own work by utilizing ARIMA and SVR (Support vector regression) and obtained enhanced result as per the graph plotted. In which distinct work has been represented through different colors such as green, blue and red line in the form of column graph. The name of authors with published year and obtained MAPE value in percentage has been plotted corresponds to x-axis and y-axis respectively.

III. CONCLUSION

Time series analysis consists of methods to examine the specific data to derive meaningful stats and other features of the data. The forecasting of time is the use of a model to predict future values on the basis of previously observed values. In this review work, different time series forecasting models has been discussed and it has also analyzed that sometimes it’s not good to compare the models to analyze the performance. Because it always depends on the types of data i.e. the patterns and features of data, the hybrid model ARIMA-ANN or, ARIMA with SVM provides better accuracy. The increase of accuracy in hybrid models is due to the combination of linear and nonlinear models. The parameter for time series forecast is taken as MAPE, RMSE, MARE etc are used in the previous work.

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