International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Water Demand Forecasting

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ABSTRACT

Whenever an engineer given a task of designing a treatment unit for water, the first step will be what the water demand is by total number of population? Now it's very difficult job to find that exact quantity of water demand so exact quantity cannot be estimated because its changes from time to time, seasonal variations are there, early variations are there, and different types of variations are there. But still there are certain formulas, techniques such machine learning and deep learning and the models such as Auto Regressive Integrated Moving Average (ARIMA), Seasonal Auto Regressive Integrated Moving Average with Exogenous Factors (SARIMAX), and Long Short Term Memory (LSTM) model through which these kind of forecasting can be done.

Key Words: Demand Forecasting, Exploratory Data Analysis, Statistical Modelling, Auto Regressive Integrated Moving Average, Recurrent Neural Network and Long Short Term Memory (LSTM).

INTRODUCTION

Demand Forecasting basically is the predicting the future demand for the firm's product and why it is important to predict the future demand of a firm's product it's just because it will give an idea for the firm to plan and schedule the production of the product demanded in the market, the next importance is that it also helps in acquiring inputs that is if we know that what will be the future demand in the product so will be know the quantity of inputs we have to order to get the product made, the next importance is that it also helps in making advanced provisions for the finances if we have to go into the production process we know that what will be the demand of the product in the future, so we will also know that what finances we need and

accordingly we can arrange for the finances. The next importance is that formulating pricing strategy that is what price of the product should be charged in the market, then planning the advertisement strategy if we know that the demand of this particular product is low in the market and so will plan better advertisement strategy that will increase the frequency of the advertisements on various media in order to create more demand about the product.

Now check what are steps involved in demand forecasting:

1. The first step is to specify the objective means we need to aim that for what purpose we are forecasting the demand, is it for short run demand or long run demand, is it for the demand of a firm's product or we want to forecast the demand for the industries product as a whole, is it for firm's market share so what is the objective of demand forecasting in the long run.

2. Next is determining the time perspective this after specifying the objective we need to determine that for what time period we are going to focus the demand for the product that is for short run or long run if it's for short run that is 2 to 3 years down the line so for that particular time period we can assume various determinants of demand to be constant. For example we can assume that okay the income of the consumer will be constant the traced and preference of the consumer will be constant for the short time period but if the perspective the time perspective is for long run that is beyond 2 to 3 years then we have to assume that all the determinants of demand will change significantly and accordingly we have to forecast a demand.

3. The third step after determining the time perspective we have to make choice of the method of demand forecasting there are various methods we are going to study about all the methods of demand forecasting and amongst them we have to make a considerable choice that which method will suit the requirement of a particular problem statement, so the third method is to make the choice of the method of demand forecasting.

OBJECTIVE OF THEWORK

The objective of this project work is to Now if we want to check which of these and

many other models will be the best one for your forecasting use case depends on a multitude of different factors including on how much historic data is available and what your business constraints are for example does the method need to be interpretable so there is no real way to actually forecast which of these forecasting techniques is the best and so one actually needs to compare multiple different approaches so how does one do that note here that we have to do chronological testing the ordering in time series is extremely important so you cannot take out chunk out in the middle of the time series and train on the before and after data of that and test in the middle that would be cheating and what we need to do is we have to train on a time series of events up to a certain point and then tests subsequently so there are two major approaches the sliding-window approach as well as the expanding window approach and the name really says it all. In the sliding window approach you take a fixed window of training data here shown in black that you have forward at every single pass and then you test on the orange data now for the expanding window approach which is particularly useful if you have very little data available you actually expand the training data from pass to passes and as indicated here in black you don't drop any of the data points and you again test on unseen data that is fixed now.

Now in terms of the evaluation metrics of comparing various different time series methodologies there is quite a few out there both absolute as well as percentage ones, the one I want to call it in particular that I think is very useful is to compare with regression forecast. So, what's a regression forecast that basically means that you assume that today's value will hold for tomorrow.

Result:-After building the model successfully, we have to evaluate the model. Which will help us to understand how our model is working means to understand the performance of our model. It states how good our model is predicting for future. To do this we are going to use multiple Accuracy metrics which will help us to measure the performance of our time series forecasting model. These metrics are as follows: -

(i) Mean Absolute Percentage Error [MAPE] - Mathematical Formula for MAPE is.

$$\textbf{MAPE} = (1/n) * \Sigma(|\text{actual} - \text{forecast}| / |\text{actual}|) * 100$$

Here:

• Σ = symbol which means summation

• n = Size of Sample

• actual = original values of data

• forecast = forecasted values of data

MAPE is frequently used metric as it is easy to interpret. It signifies, lower the value for MAPE the model build is better to forecast values.

(ii) Mean Absolute Error [MAE] - Error basically defines as absolute difference between the actual or true values and the predicted values. Absolute error here states that if the result has negative sign then it is to be ignored.

Mathematical formula for MAE looks like: -

MAE = True Values – Predicted Values

We can understand MAE as it considered average of the error from each individual sample from a dataset and hence produces output.

MAE metric is not very sensitive towards outliers. MAE often used when we have to measure the performance of our model for a continuous data variable. Because of which it will produce a linear value, which can be averaged the individual weight differences equally.

(iii) Mean Squared Error [MSE] - MSE is derived from taking average value of difference among the actual and the predicted values of data.

Mathematical Formula for MSE looks like: -

$$MSE = \frac{1}{N} \sum_{i=1}^{n} (\text{actual values} - \text{predicted values})^2$$

In above formula

N = total Number of rows present in dataset

Σ = Difference between Actual and Predicted Values taken for every row values n and ranging between t to k.

Types of Autocorrelation: -

(i) Positive Autocorrelation - Positive Autocorrelation occurs when there given error of given sign among the values of series which is lagged by using n followed by some error of that same sign.

Mathematical formula can be derived as: -

$$Corr\,(X_{t+k}, X_t) > 0\; for\; k > 0$$

(ii) Negative Autocorrelation – In Negative Autocorrelation error of any sign among the series which is lagged by n value and followed by an error using different sign.

Mathematically we can derive as: -

$$Corr\,(X_{t+k}, X_t) < 0\; for\; k > 0$$

Conclusions are carried out:

After Performing this model building steps and evaluation, we are going to finalize the best model which has the best performance values which were derived using the different evaluation metrics. We have performed this conduct with the help of multiple model such ARIMA, SARIMA, LSTM. Out of which we have concluded that LSTM works or fit well with the given dataset. It has the best RMSE value by which we have concluded this model as the best performing model for our research.

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