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Prediction of Passenger Traffic for Global Airport using Holt's Winter Method in Time Series Analysis

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Abstract*—This paper presents an insight into the future usage of airport by the passenger using the method Holt's winter in time series analysis. The airport industry has a gradual development over past few years. With the time series analysis, we can predict the airport traffic through passing over the data of past ten to twelve years of previous observed values of passenger traffic. Using this method, the results predict the future airport traffic and give us a clear analysis of airport usage and to reduce traffic simultaneously solutions should be made previously. The results are based on agreement with the theoretical predictions and significant improvement over previous efforts. This work is presented has a profound implication on future prediction d this may help to solve the problem of airport.

Keywords*— Forecasting, Time series, Holt's winter method, Airplane passenger traffic.

I. INTRODUCTION

Time series techniques works on data over a considerable season, also used to generate future values of the series.

There are several methods in time series analysis. This paper tells about the forecasting Holt's winter method (Triple exponential smoothing) Smoothening.

Holt's winter method used to predict data in a series, the series is seasonal. The future value's predicted by using observed values. A time series component is seasonality, it defines a repeated movement over a trend line over periods of time. Holt's winter based on exponential smoothing. Exponential smoothing predicts the values by using additive or multiplicative methods. Smoothening is the method measured by beta and gamma parameters in Holt's winter method. If the beta parameter is set to false, the function performs exponential smoothing. The gamma parameter is for seasonal component. If the gamma is set to False, a non-seasonal model will be fitted since the usage of airport has been gradually growing over years the future passenger prediction gives an awareness of passengers over years worldwide. The financial economical and passenger luxury everything can be preprocessed and availability can be previously done.

II. LITERATURE REVIEW

A. *Passenger flow forecasting research for airport terminal based on regression:*

This report predicts the passenger flow by proposing seasonal autoregressive moving average model (SARIMA). The passenger flow is predicted on daily periodicity of sequence. The short-term prediction is used to enhance the passenger flow detection. The results produced by this SARIMA method are very accurate.

B. *Predicting Airline Passenger Load:*

This paper predicts the passenger load by using the method called as decision tree (DT). The passengers select the airlines according to some criteria. Year by year the load varies. They predict by having the values of preceding years

C. An Exploratory *Analysis* for Predicting Passenger Satisfaction at Global Hub Airports Using Logistic Model Tree*:*

This paper predicts the passenger satisfaction based using logical model tree (LMT). On time predictions are made to analyze the passenger level of satisfaction. The logical model tree is the machine learning method that predicts the satisfaction of the passenger by detecting the arrivals and departure of the flights.

D. *Model* for Forecasting Passenger of Airport:

This paper forecasts the increase in air traffic using time series method. In this the user must maintain the stationary data sets else the result will produce false regression. The stationary values can be produced by Augmented Dickey Fuller Test (ADF).

E. *Forecasting Monthly* Air Passenger Flows from Sweden:

This Paper predicts the flow of passenger from Sweden to other nations. They use seasonal autoregressive integrated moving average model (SARIMAX). The values are based on monthly or quarterly data. Thus, by reducing the oil rate they try to reduce the flow of passenger to other nations.

F. Statistical Analysis Passenger Traffic at the Chopin Airport:

This paper predicts the passenger traffic using Linear regression and time series method. They provide the explicit information for traffic prediction.

G. Future Passenger Air Traffic Modeling:

This paper is about the modeling future global air traffic on city level. This method focus lies on the initial trend analysis of global demand data as a Requirement for predicting the global demand network based on socio-economic scenarios.

H. Air transportation demand forecasts using both bagging and *Holt's* winter method:

This paper tells about the combining both bootstrap aggregation and holt's winter method for airline transportation demand in this decomposing of time series is done into three components trend, seasonal, and remainder. The new series is developed by resampling remainder and adding back the trend and seasonal ones. At last the forecast is done by Holt's method by aggregating the time series.

I. Modeling *monthly* flow of airport passengers:

In this paper, it is explained that the monthly flow of airport passenger can be predicted using a set of poison regression models the prediction is between the directly connected airport and this model gives 93 percent accuracy prediction.

J. Modeling and Forecasting Passenger traffic for a New Domestic Airport with Limited Data:

This paper tells about having a countries data with time series based and prediction of passenger traffic to the new airport by demand model.

III. METHOD USED

A. Holt's winter method:

The time series has three components

1. Trend
2. Seasonal.
3. Cyclic.

Our airplane traffic prediction based on seasonal pattern in time series. Time series is also dependent on series. When a series influenced by seasonal factors (e.g., the quarter of the year, the month, or day of the week) seasonal pattern occurs. Seasonality is always over fixed and known period. Seasonal time series is known by periodic time series.

Series:

A series is merely an order of numbers or the data's a series can be of two coordinates X and Y where

X is order (always going up by 1)

Y is value. Forecasting is the estimation of values we don't know by having the values we know. The values we know is said to be observed values and the values forecasted are said to be the expected values. The expected value is denoted by y^.

Holt's winter method comes under triple exponential smoothing techniques. There are three exponential smoothing such as

1. Single exponential smoothing.
2. Double exponential smoothing.
3. Triple exponential smoothing.

- Holt's winter method has different methods naive method, simple average, moving average, weighted moving average.
- In the prediction of airplane passenger, we used a method called FORECAST.ETS.STAT()
- FORECAST.ETS.STAT() is a function that returns a statistical value. The statistical given as a result value of time series forecasting.

FORECAST.ETS.STAT (values, timeline, statistic type, [seasonality], [data completion], [aggregation])

A. Values**:**

Values are said to be observed values.

B. Timeline**:**

The array which is independent or a range of numeric data the timeline data cannot be zero. FORECAST.ETS.STAT() supports to 30 percent of missing data, in which it will automatically adjust for it. The timeline data don't have a condition that it should be sorted, as FORECAST.ETS.STAT () function will sort automatically for calculations. Timeline is a compulsory one to be forecasted.

C. Statistic type**:**

Statistic type is a numeric value. The default value is 1 which detects seasonality automatically for the prediction and the value should be positive, the value zero indicates no seasonality and the method will be linear prediction. The positive seasonality value has a maximum length of 8,706.

D. Data completion**:**

The FORECAST.ETS.STAT() function automatically fills the missing values for the data completion. The value of one will complete the missing points automatically on the average of neighboring points. The value zero will indicate algorithm to take missing points as zeros.

E. Aggregation**:**

The timeline is based on the series of data. The aggregate parameter has multiple points which aggregate a function for time stamp. If the default value of zero is given the aggregate value will be average. If we provide other than zero the following options will be SUM, COUNT, COUNTA, MIN, MAX, and MEDIAN.

FORECAST.ETS.STAT() function uses advanced machine learning algorithms.

- In a provided timeline, if any constant step cannot be identified then the FORECAST.ETS.STAT() returns the number error.

- If the timeline has duplicate values, then the function returns a value error.
- The ranges of the timeline and values are not equal then, the FORECAST.ETS.STAT () returns the #N/A error.
- If the Seasonality should be in positive and it has a maximum length and the value given to seasonality should be between 0< and >8706, if it exceeds or any wrong values are given FORECAST.ETS.STAT() returns the #NUM!

ETS algorithms are said to be enhanced transmission algorithms.

ETS algorithm has many seasonal parameters such as alpha, beta, Gamma. Alpha parameter returns the base value parameter. The base value parameter is higher value which gives more weight to recent data points. Beta parameter returns the value of trend parameter. The value of trend parameter is a higher value which gives more weight to recent trend points. Gamma parameter returns the value of seasonality parameter. There are four different metrics in ETS function. Such as MASE, SMAPE, RMSE, MAE

- MASE metric returns the mean absolute scale error metric.
- The mean absolute scale error metric is the measure of accuracy of forecasts.
- SMAPE metric returns symmetric mean absolute percentage error metric. The symmetric mean absolute percentage error metric is the measure of percentage error with accuracy measure.
- MAE metric is which returns the value of symmetric percentage error metric. The symmetric mean absolute percentage error metric is the measure of percentage errors.
- RMSE metric returns root mean squared error metric root mean squared error metric is the measure of the differences between predicted and observed values.4

Two types of methods in Holt's winter method

1. Additive
2. Multiplicative

Since the airplane prediction is based seasonality and the future airplane passenger is predicted based on Holt's winter multiplicative method, Holt's winter is based on seasonality. There are three smoothening equations one for the level Lt, one for the seasonal component St, and the seasonal component St with the parameters alpha, beta, gamma. M is used to denote seasonality or period of time.

In multiplicative method, season variations are changing proportional to the level of the series. The seasonal component is expressed in terms of percentage by dividing the series by seasonal component, the seasonal adjustments of the series is done. The seasonal component will approximate up to each year.

IV. PROPOSED METHODOLOGY

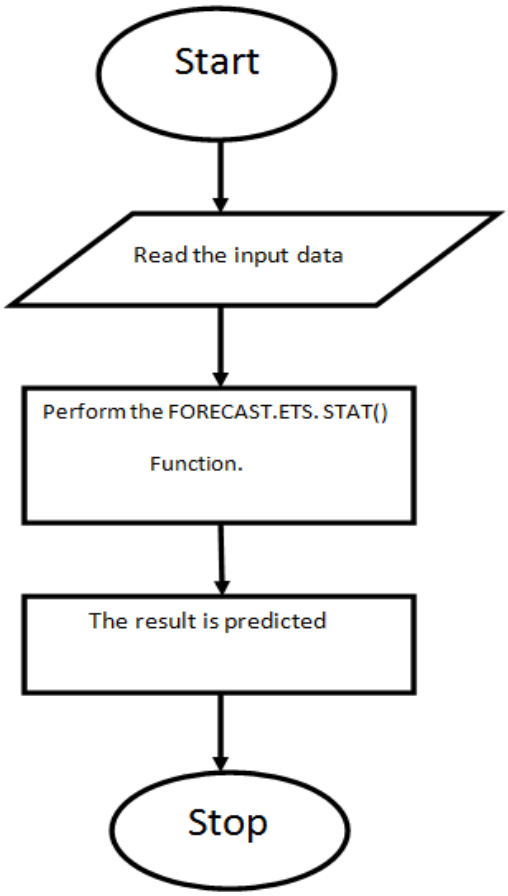


Fig.1. Proposed methodology

Here the user first gives a seasonality period, the user who wants to predict the airport passenger on their preset date or month or on which date they want to predict the airline traffic. Based on that date month and year the FORECAST.ETS.STAT() Function by applying the multiplicative method the previous observed values and based on their seasonality the method will predict the value approximately. And gives us an alpha parameter value that is it returns the data predicted value. And since it is a smoothening method it can be represented in graphs in a clear format. And the output will be obtained. And the process stops. And recursively if he wants to predict for another year he can also predict it by re login by using the same observed data.

A. Equation:

Holt-Winters multiplicative method

The component form for the multiplicative method is:

$$\hat{y}_{t+h|t} = (\ell_t + hb_t)s_{t-m+h_m^+}.$$
$$\ell_t = \alpha\frac{y_t}{s_{t-m}} + (1-\alpha)(\ell_{t-1} + b_{t-1})$$
$$b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1}$$
$$s_t = \gamma\frac{y_t}{(\ell_{t-1} + b_{t-1})} + (1-\gamma)s_{t-m}$$

and the error correction representation is:

$$\ell_t = \ell_{t-1} + b_{t-1} + \alpha\frac{e_t}{s_{t-m}}$$
$$b_t = b_{t-1} + \alpha\beta^*\frac{e_t}{s_{t-m}}$$
$$s_t = s_t + \gamma\frac{e_t}{(\ell_{t-1} + b_{t-1})}$$

where $e_t = y_t - (\ell_{t-1} + b_{t-1})s_{t-m}$.

Fig. 2. The general component form of holt's winter multiplicative method

B. Reference:

Here the alpha determines about the performance using statistical measures. The beta is used to determine the volatility of an asset or portfolio in relation to the overall performance. The gamma is used to determine the complex numbers expect the non positive numbers.

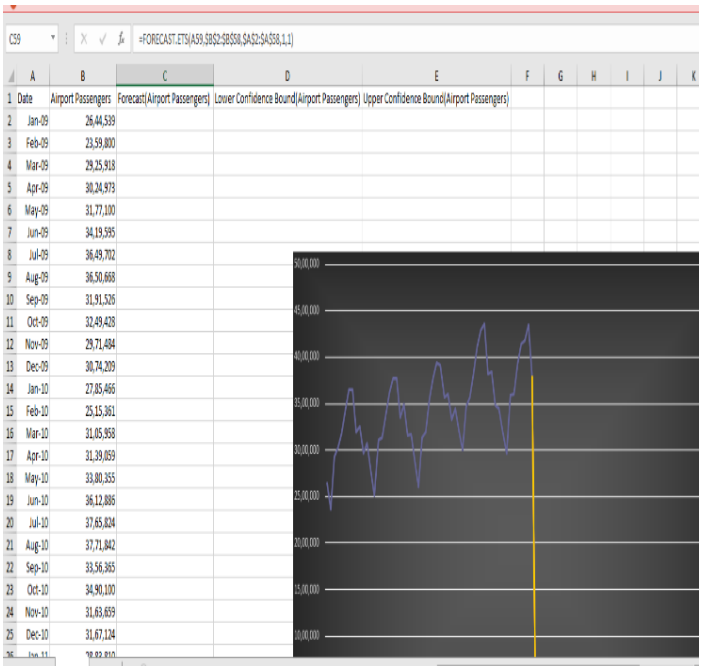
ALPHA: The alpha parameter used in the Holt winters filter specifies how to smoothen the level component, it must be within the half open unit interval (0, 1).

BETA: The beta parameter in Holts winter filter specifies how to smooth the trend component. If numeric, it must be within the unit interval (0, 1). The trend component is omitted if beta is false.

GAMMA: The gamma parameter is used to specify to smooth the seasonal component. If numeric, it must be within the unit interval (0, 1).

This formula FORECAST.ETS.STAT () is used in the excel sheet to predict the future values. Here it contains date, month, year as a first column and the passenger traffic particular month's data is present. FORECAST.ETS(A59,$B$2:$B$58,$A$2:$A$58,1,1) this specifies the columns data and their seasonality and it works on holt's winter multiplicative method .Here is proposed methodology of FORECAST.ETS.STAT() function in the prediction of airplane passengers at oct 13.

C. Figures and Representation:



Date	Airport Passengers	Forecast(Airport Passengers)	Lower Confidence Bound(Airport Passengers)	Upper Confidence Bound(Airport Passengers)
Jan-09	26,44,539			
Feb-09	23,59,800			
Mar-09	29,25,918			
Apr-09	30,24,973			
May-09	31,77,100			
Jun-09	34,19,595			
Jul-09	36,49,702			
Aug-09	36,50,668			
Sep-09	31,91,526			
Oct-09	32,49,428			
Nov-09	29,71,484			
Dec-09	30,74,209			
Jan-10	27,85,466			
Feb-10	25,15,361			
Mar-10	31,05,958			
Apr-10	31,39,059			
May-10	33,80,355			
Jun-10	36,12,886			
Jul-10	37,65,824			
Aug-10	37,71,842			
Sep-10	33,56,365			
Oct-10	34,90,100			
Nov-10	31,63,659			
Dec-10	31,67,124			

Fig. 3. Represents the previous recorded data set

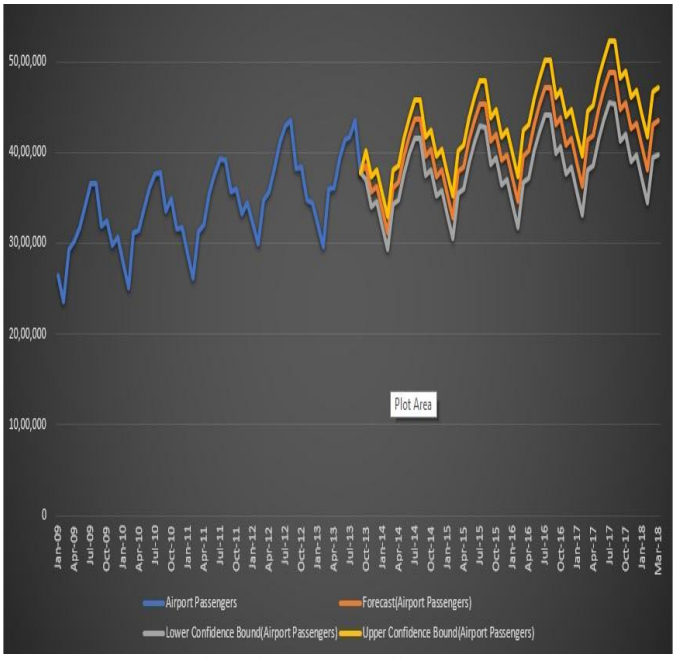


Fig. 4. Represents the flow of passengers traffic increasing over year by year and shows the no of passengers travelled in Oct 13

V. Conclusion

The paper is about how to predict the future values on a basis on seasonality a method is being applied and that function is detailed in it. In our project prediction of airport traffic on a particular future date is found. By having separate countries data, we can also predict that particular countries travelling. Prediction may helps us for the availability to be Increased and security to be maintained and gives us a wide knowledge about the traffic of passengers in future persons and can alert that country to preprocess

everything and giving information of availability of flights to Travel.

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