Exponential Smoothing Methods for Detection of the Movement of Stock Prices

Shaik Shahid, SK. Althaf Rahaman

Abstract: Business Intelligence is a set of processes, architecture and technologies that convert raw data into meaningful information. BI has a direct impact on an organization's strategic statistical and operational business decisions. In BI one of the most interesting areas is time series data analysis to predict are stock prices. Prediction and analysis of stock market data has got an important role in today's economy. The aim of this paper is to predict the daily previous closing stock prices of the major tech giants of NSE (i.e. HCLTECH and TCS), using information from the historical data with the help Exponential Smoothing Methods. The historical stock prices of the stated companies for three years will be used for the training and testing of the methods. It is found that Holt-Winter's method of exponential smoothing the given the best results out of the other exponential smoothing methods.

Keywords : Exponential Smoothing, Holt's Exponential Smoothing, Time Series Data Analysis, Winter's Exponential Smoothing s.

I. INTRODUCTION

A lot research work has been done in the area of analyzing price patterns and predicting stock prices and index changes with the help of various Machine Learning Algorithms. Most of the stock traders and brokers are using various Advanced Trading Systems which help them in predicting prices and help them in making dynamic investment decisions. Stock Prices are considered to be very volatile and susceptible to quick changes because of known parameters and unknown factors that might affect movement of stock prices. In this paper, we discuss the exponential smoothing techniques which will be used to predict the movement of stock prices in the near future. In this paper we apply these algorithms on the two major companies of IT Sector of India.

II. EXPONENTIAL SMOOTHING METHODS

Exponential smoothing is a used set of methods for smoothing time series in order to forecast the immediate future. The main idea behind exponential smoothing is to forecast future values using a weighted average of all the previous values in our time series data. Exponential smoothing can used for forecasting the time series data based on the three aspects: the level, the trend and the seasonal component. Based on these three aspects we have three types of exponential smoothing. Exponential smoothing is very popular because it is simple, it's adaptive and it's inexpensive to compute.

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A. Simple Exponential Smoothing (SES)

SES method can be used for the forecasting of the future values of the time series data that doesn't have trend and seasonality. The key concept to remember here is the something called smoothing constant. In SES we make an assumption that our series contains only the level, no trend or seasonality and it does include error. So, if we only level the assumption of the exponential smoother is that this level will stay but not move.

Therefore, forecast equation for SES is:

Forecast = Estimate level at most recent time point

$$F_{t+k} = L_t$$

the k^{th} step ahead of SES forecast is simply the most recent Estimate of level (L), at time (t) for which we need to estimate the level using the level updating equation:

$$L_t = \alpha Y_t + (1-\alpha)L_{t-1}$$

The above equation states that the algorithm is learning the new level from the newest data it is seeing. At first we have to initialize it with L1 at some point. Here we simply set the L1 to the first record in the data-set Y.

Smoothing constant (α) determines how much smoothing is being done i.e., (how much weight is given to the values in the past). If α = 1, then the past values have no effect on the algorithm, whereas, if α = 0, then all the values in the series have equal weight in our average. We typically choose something between 1 and 0. Usually closer to 0 than to 1.

B. Holt's Exponential Smoothing (HES)

Holt's Exponential Smoothing also sometimes called Double Exponential Smoothing. The main aim of this method is to take SES set up and to extend it to capture trend component. Halt's Exponential Smoothing can be employed when the time series data contains trend, but have no seasonality. Here we make an assumption that the time series data has a level, it has trend and noise but not seasonality.

Therefore, forecast equation for Holt's Exponential Smoothing is:

Forecast = Estimated level + Trend at most recent time point

$$F_{t+k} = L_t + KT_t$$

Here, we have two update equations. One for level and one for trend.

Level updating equation,

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$

The above equation states that we are adjusting previous level by adding trend to it.

Trend updating equation,

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$

The above equation states that we are updating previous trend by using the difference between the most recent level values. It can be noticed that this method allows the trend to vary and change in shape over time.

Smoothing constant (β) is controlling the speed of adjusting the trend.

C. Holt Winter's Exponential Smoothing (HWES)

Any Winter's Exponential Smoothing also called Holt-Winter's Exponential Smoothing and even sometimes called Triple Exponential Smoothing. This method takes the idea of Holt's method and adds a seasonal component to create the even more complex system. We assume here, that the series has a level, trend, seasonality with M seasons and noise.

Therefore, forecast equation for Winter's Exponential Smoothing is:

Forecast = Estimated level + Trend + Seasonality at most recent time point

$$F_{t+k} = L_t + KT_t + S_{t+k-M}$$

In Winter's Exponential Smoothing method, we have three smoothing constants and there are three updating equation.
Level updating equation,

$$L_t = \alpha \frac{Y_t}{S_{t-M}} + (1-\alpha)(L_{t-1} + T_{t-1})$$

Here, when we divide *Y* by *S* it means, we are de-seasonalizing the value of *Y*. In this level equation we are therefore updating the previous level, else of *t-1* by adding the previous trend estimate, $T_{t-1}$and then combining with the de-seasonalized value of Y_t.
Trend updating equation,

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$

The above equation is similar to the one in Holt's Exponential Smoothing method.
Seasonality updating equation,

$$S_t = \gamma \frac{Y_t}{L_t} + (1-\gamma)S_{t-M}$$

Here, we can see the Y_t is divided by the level component L_t. This gives the de-trended value of *Y*. So, the seasonal component S_{t-M} with the de-trended value of Y_t.

Smoothing constant (γ) is controlling the speed of adjusting the seasonality.

III. DATA SET AND ATTRIBUTES

In this time-series data analyses problem in which stock price data-sets is used which contain information about the historical stock prices of two IT companies of India namely Tata Consultancy Services Limited (TCS) and Hindustan Computers Limited **(**HCL) downloaded from Kaggle.com The data-set contains various attributes such as Date, Symbol, Series, Prev_Close, Open, High, Low, Last, Close VWAP, Volume, Turnover, Trades, Deliverable Volume, %Deliverable.The data set is divided trained data and test data. Preparation of the data-set for applying it to the model includes: Data Cleaning, Data Transformation and Data Splitting (train dataset, test dataset). The data-set was already cleaned and transformed. The data-set of the past three years is taken and split into two years of data as training set and one year data as testing set.

IV. RESULTS AND ANALYSIS

The results generated by Exponential Smoothing Techniques on TCS data-set which is as follows:

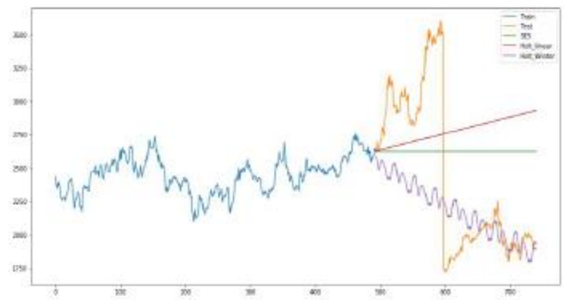

Fig. 1.Graph Generated by TCS Data-Set

The results generated by Exponential Smoothing Techniques on HCL data-set which is as follows:

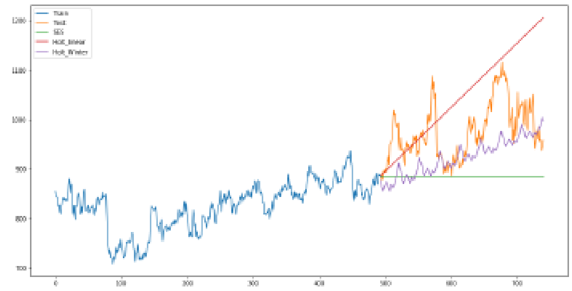

Fig. 2.Graph Generated by HCL Data-Set

The data-set results are with the comparison with different techniques of the Exponential Smoothing Methods. The root mean square error (RMSE), mean absolute percentage error (MAPE) and mean absolute error (MAE) metrics are used to evaluate the effectiveness of the methods. Lower the value, the better the prediction.

Table- I: Results Comparison of different Methods of TCS and HCL dataset

Algorithms	Tata Consultancy Services Limited (TCS)			Hindustan Computers Limited (HCL)		
	RMSE	MAPE	MAE	RMSE	MAPE	MAE
SES	625.56	22.30%	586.08	106.81	10.34%	91.53
HES	747.80	24.34%	684.31	108.07	7.94%	86.70
HWES	532.73	16.74%	381.94	72.84	6.26%	57.64

V. CONCLUSION

From the results it can be said that Holt's method of exponential smoothing has performed worst on TCS data-set whereas simple exponential smoothing method has performed worst on HCL data-set. On the other hand, Holt-Winter's method of exponential smoothing has performed best on the data-sets of both the companies and outperformed the other two methods.

FUTURE SCOPE

There can be chances of using many other algorithms on these stock price datasets to forecast and use in the real time environment by the stock brokers and traders to predict the price of stocks in the near future and to take necessary trading decisions before getting losses in their businesses.

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