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Fuzzy Time Series Approach for Stock Price Prediction

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Abstract: *Time is one of the most important factors in business and real-life situation. In the real world, uncertainty is a part of everyday life. Predicting the trends in stock market price is an extremely challenging task due to the uncertainty. In this work, the Fuzzy Time Series method has been used to obtain the daily stock price data of Nifty 50. Applying Fuzzy Time Series method and computing length intervals of Nifty 50 dataset. From the result, it can be observed that the Mean Absolute Percentage Error is small. In this analysis obtained by the estimates has received an only minimal error when comparing the original data. It helps to identify profit stock index trend (Nifty 50) and risk for investors in future.*

Keywords: *Nifty 50, Fuzzy Time Series, Mean Absolute Percentage Error*

I. Introduction

Time series plays a vital role in the branches of Stock prices, Global surface temperature, Economy Population growth and agricultural production. Time Series is a series of values of variable arranged in chronologically order over a period of time. The basic assumption of time series analysis is some aspects of the past pattern which will continue to remain in the future. The stock market is an unpredictable extraordinary environmental business system. The word stock means a fraction of the capital of a company and the word exchange means a place for purchasing and selling something. National Stock Exchange (NSE) is a stock exchange in India, which is set up in 1992.

Similarly, The Nifty is an indicator of the top 50 major companies on the NSE. If the Nifty goes up, it means that most of the stocks in India went up during the period. If the Nifty goes down, this tells you that the stock price of most of the major stocks on down. Through this research paper, the timing of the daily closing stock price on Nifty50 was viewed with Fuzzy Time Series Analysis. Based on the available decision, the Nifty50 Daily closing stock price appears to have a zig-zag trend in future. Through the review of the literature, it is possible to see how much of the real-life situation has been used in this regard. Song and Chissom (1993a) have initiated the study of time-invariant and time-variant forecasting models using fuzzy time series for enrollment data of the University of Alabama. Song and Chissom (1993b) have defined and studied the fuzzy time series. To apply the time-invariant fuzzy time series, a simple procedure for forecasting has been proposed. Kumar et al (2010) approach to three fuzzy time series forecast models used on wheat production. Mangale et al (2017) involve the strength of fuzzy logic to expect stock price used long-term valuation fundamental approach. In technical analysis, the highest and lowest price represents the comprehensive fighting among multi outer forces. The volume represents the market activity and popularity, and the closing price is on behalf of the balance from the multi contest, which can be seen as the opening price of the next trading day. A trading day closing price is not only associated with previous trading day closing price. The NSE (Nifty 50) data used in this paper is based on closing price (in Rs.) of the stocks in the time span of April 1, 2019, to July 31, 2019, with 83 observations. Data obtained from the financial part of nifty50.com.

1.1 Error Rates

Error rates are used to measure of prediction precision of a forecasting technique in statistics. In this paper used to three prediction measure as, Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) which are given [$E_t = A_t - P_t$]; A_t – Actual Value; P_t – Predict Value.

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n} (E_t)^2}{n}} \qquad MAE = \frac{\sum_{i=1}^{n} |E_t|}{n} \qquad MAPE = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{E_t}{A_t} \right| \times 100$$

II. Methodology

2.1 Fuzzy Time Series (FTS) Model

In the application of Fuzzy Time Series (FTS) to any practical case, there are two main steps. The first one is modelling, i.e., according to the historical data or experience knowledge setting up the fuzzy logical model. The second step is to interpret the results of the forecasting model. From the following section, we could see that human subjective experiences have a very important role in the interpretation of the result.

2.2 Universe of Discourse

All elements in a set are taken from a universe of discourse or universe set that contains all the elements that can be taken into consideration when the set is formed. In reality, there is no such thing as a set or fuzzy set because all sets are subsets of some universe set, even though the term 'set' is predominantly used. In the fuzzy case, each element in the universe set is a member of the fuzzy set to some degree, even zero. The set of elements that have a non-zero membership is referred to as the support and use the notation for the universe set.

2.3 Linguistic Variables

The concept of a fuzzy number plays a fundamental role in formulating quantitative fuzzy variables. These are variables whose states are fuzzy numbers. In addition, the fuzzy numbers represent linguistic concepts, such as very small, small, medium, and so on, the resulting constructs are usually called linguistic variables.

2.4 General Algorithm

Procedure for Fuzzy Time Series model as follows:
Step 1. Define the universes of discourse
Step 2. To divide the universe of discourse into n equal length Interval
Step 3. Universes of discourse should be marked by linguistic data
Step 4. Computing fuzzy number
Step 5. Define the linguistic term A_1, A_2, A_3 . . . A_n for each intervals U_1, U_2, U_3 . . . U_n of the universe of discourse U.
Step 6. To change the fuzzy number to fit the data
Step 7. Predicting data

III. Results And Discussion

In this section, we first see the trend of the actual closing stock price data presented. The trend in the data in Figure 1 can also see its natural fluctuations. From the data 11085.40 and 12088.55 are minimum and maximum of the daily closing stock price for N50.

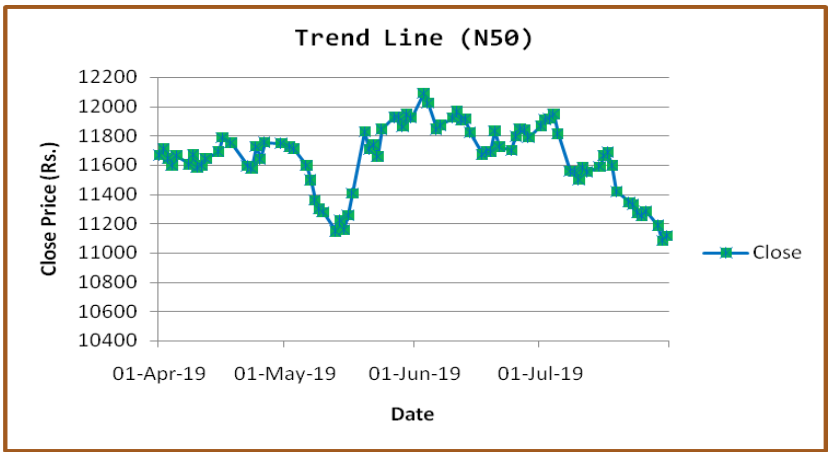

Figure 1: Trend line of actual closing stock price

Then Nifty 50 find that the Fuzzy Time Series approach for following procedures (step 1 to step 7).
Step 1: Define the universe of discourse to accommodate the time series data. It needs the minimum and maximum closing stock prices and set as D_{min} and D_{max}; MIN = 11085.40 and MAX = 12088.55 [D_1: 85.40, D_2: 11.45]; Thus the universe of discourse U is defined as $[D_{min} - D_1, D_{max} + D_2]$, here D_1 and D_2 are two positive numbers. In the present case of closing stock prices is U = [11000, 12100]

Step 2: Partition the universe of discourse into 5 equal length intervals U_1, U_2, U_3, U_4 and U_5 such that U_1 = [11000, 11220]; U_2 = [11220, 11440]; U_3 = [11440, 11660]; U_4 = [11660, 11880]; U_5 = [11880, 12100]
Step 3: Define fuzzy sets on the universes of discourse using the historical linguistic data:
A_1 - Large Decrease, A_2 - Decrease, A_3 - Medium, A_4 - Increase, A_5 - Large Increase
Step 4: Fuzzification of the time series data: U_1, U_2, U_3, U_4 and U_5 = [A_1, A_2, A_3, A_4 and A_5]
Step 5: Computation of fuzzy numbers (Using "IF-THEN RULE" condition); IF (Current Observation < Max (U_1), "1", IF (Current Observation < Max (U_2), "2", IF (Current Observation < Max (U_3), "3", IF (Current Observation < Max (U_4), "4", IF (Current Observation < Max (U_5), "5")))))
Step 6: The logical relationship associated with the fuzzy numbers.

Table 1: Logical relationship of FTS method

$A_4 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_4$	$A_4 \rightarrow A_3$
$A_3 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_3$
$A_3 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_3$
$A_3 \rightarrow A_3$	$A_3 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_1$	$A_1 \rightarrow A_2$	$A_2 \rightarrow A_1$
$A_1 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_4$
$A_4 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_4$	$A_4 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_5$
$A_5 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_4$
$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$
$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_5$	$A_5 \rightarrow A_5$	$A_5 \rightarrow A_5$
$A_5 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_3$	$A_3 \rightarrow A_3$
$A_3 \rightarrow A_4$	$A_4 \rightarrow A_4$	$A_4 \rightarrow A_3$	$A_3 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_2$
$A_2 \rightarrow A_2$	$A_2 \rightarrow A_2$	$A_2 \rightarrow A_1$	$A_1 \rightarrow A_1$	$A_1 \rightarrow A_1$		

Step 7: Identifying the fuzzy numbers, then find the count (COUNT-IF RULE) and sum (SUM-IF RULE) conditions for the fuzzy number. Compute the average of each fuzzy group A_1 to A_5 replaced by U_1 to U_5 intervals.

Table 2: Compute the prediction value of the FTS model

Fuzzy Numbers	Count	Sum	Prediction
A_1	5	55697.80	11139.56
A_2	12	135730.70	11310.89
A_3	19	220170.40	11587.91
A_4	34	399746.50	11757.25
A_5	13	155314.80	11947.29

In figure 2, the prediction line of Nifty 50 daily closing stock price for Nifty 50. It is almost equal to original data because when actual data fluctuation go to down then predict fluctuation is fall. So the predicted line at most adopted by FTS approach.

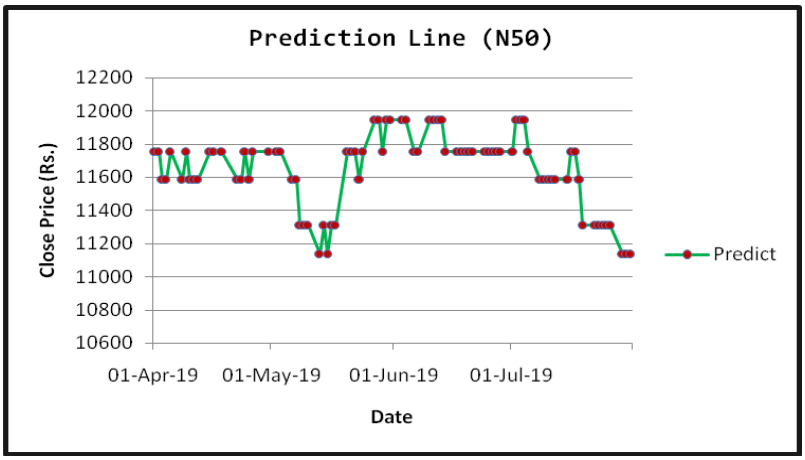

Figure 2: Predict line of closing stock price

3.1 Comparison

In this section evaluated by actual and prediction daily closing stock of Nifty 50. In figure 3, the trend line of actual and prediction of N50 data. It is showing that very closed lines of two function. There are computed three error rates of N50 dataset (such as MSE, RMSE and MAPE) in table 3.

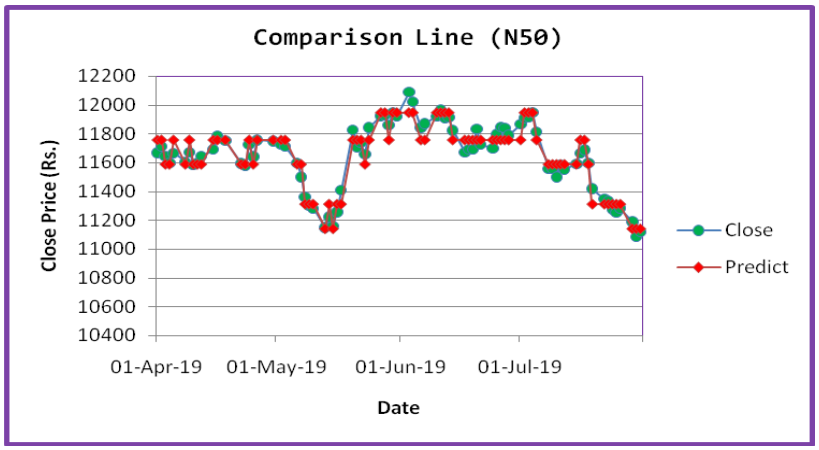

Figure 3: Comparison line of actual and predict closing stock price

From table 3, Mean Absolute Percentage Error (MAPE) of the daily closing stock price is very tiny. The two lines are positively associated (same direction) because the actual value goes to up then predict value also up and the actual value is fall then predict value is also falling. There is no high difference between these two lines. So that FTS approach is more appropriate for N50 data. In figure 4, scale of error rates (RMSE & MAPE) for daily closing stock price data.

Table 3: Error Rates of N50 closing stock price

Error Rates	**Occurred**
Mean Square Error (MSE)	3295.42
Root Mean Square Error (RMSE)	57.40
Mean Absolute Percentage Error (MAPE)	**0.40**

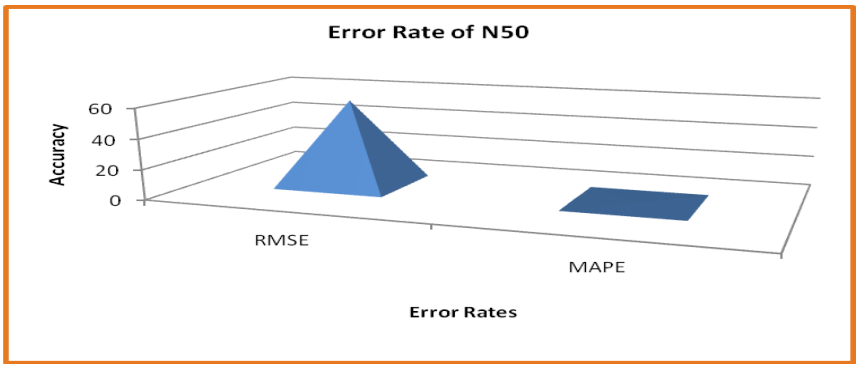

Figure 4: Error Rate of Nifty 50 closing stock price

IV. Conclusion

In this work, the Fuzzy Time Series method has been used to obtain the daily stock price data of Nifty 50. Applying Fuzzy Time Series method and computing length intervals of Nifty 50 dataset. From the result, it can be observed that the Mean Absolute Percentage Error is (0.40) small. Then MSE and RMSE rates are convenience result for Nifty 50 data. In this analysis obtained by the estimates has received an only minimal error when comparing the original data. It helps to identify profit stock index trend (Nifty 50) and risk for investors in future.

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