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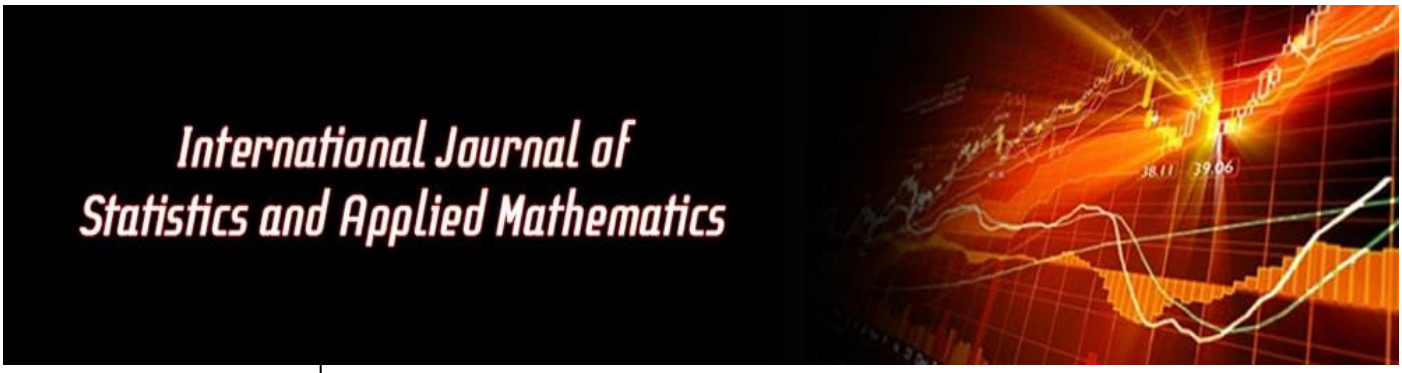

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Stock market prediction using time series analysis

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Abstract
Stock market is a market that enables seamless exchange of buying and selling of company stocks. Every Stock Exchange has their own Stock Index value. Index is the average value that is calculated by combining several stocks. This helps in representing the entire stock market and predicting the market's movement over time. The Equity market can have a profound impact on people and the country's economy as a whole. Therefore, predicting the stock trends in an effective manner can minimize the risk of investing and maximize profit. In our paper, we are using the Time Series Forecasting methodology for predicting and visualizing the predictions. Our focus for prediction will be based on the technical analysis using historic data and ARIMA Model. Autoregressive Integrated Moving Average (ARIMA) model has been used extensively in the field of finance and economics as it is known to be robust, efficient and has a strong potential for short-term share market prediction.

Keywords: Stock market, prediction using, time series analysis

1. Introduction
The stock market is a general term which refers to the collection of markets where the issuing and trading of equities, bonds and other sorts of securities takes place through various physical and electronic exchanges and over the counter market. The stock market is one of the most important components of a market economy, because it provides companies with access to capital by allowing investors to buy shares of ownership in a company. The arena of stock market is constantly developing under the process of refinements. Considering the variations it brings every day, investors need to plan intensively to make profit.

Forecasting the stock exchange data includes an assumption that the information publicly available at present has some predictive relationships to the future stock returns. Stock trend forecasting is one of the most difficult tasks to achieve in finance market because of the difficulty in the highly intricate world of stock market. The investors in the stock market always find a technique that can guarantee easy profiting by forecasting the stock trends and minimize the risk of investing. This motivates the researchers in the domain field to develop new forecasting models.

Stock prices are not randomly generated values rather they can be treated as a discrete time series model which is based on a set of well-defined numerical data items collected at successive points at regular intervals of time. Since, it is essential to identify a model to analyze trends of stock prices with adequate information for decision making, it recommends that transforming the time series using ARIMA is a better algorithmic approach than forecasting directly, as it gives more authentic results. Autoregressive Integrated Moving Average (ARIMA) Model converts a non-stationary data to a stationary data before working on it. It is one of the most popular model to predict linear time series data.

R is a programming language and environment for statistical processing and graphics. The R dialect is generally utilized by data analysts for statistical programming and data analysis. R language was created by Ross Ihaka and Robert Gentleman at the University of Auckland, New Zealand and is presently maintained by the R development core team. R-Studio is a free and powerful integrated development environment for R language which allows the user to implement ARIMA model.

In this paper, we have mainly focused on the amount of accuracy of forecasting stock values for various sectors which will aid new investors understand the market and make a wise decision to invest in the stock market.

2. Literature Survey

The author [Banerjee D] [1] has tried to develop a model that helps forecast the future Indian stock market values, based on the past information collected on the monthly closing stock indices. Using ARIMA model he has predicted the future stock indices which have strong performance on the economy of India.

The authors [Ayodele A] [Adebiyi] [2] have used the ARIMA model to develop a process of building stock price predictive model by taking data from NYSE and NSE. Artificial Neural Networks (ANNs) model is popular for its ability to make patterns from data and deduce solution from unknown data. The obtained results from real-life data reveals the potential strength of ARIMA models in short-term prediction that can aid investor's decsion making process.

The authors [Devi, B. Uma] [D. Sundar] [P. Alli.] [3] has applied ARIMA to solve the real world problems of the stock market by forecasting the stock prices with the top four companies in Nifty Midcap-50 using MATLAB along with performance measure.

The authors [Jarrett] [E. Jeffrey] [Eric Kyper] [4] have used ARIMA as both analytical and forecasting models in the PACAP-CCER China Database, developed by the Pacific.

The authors [J. Contreras][R. Espinola][F. J. Nogales][A.J. Conejo] [5] have provided a method of using ARIMA model for predicting or forecasting electricity price more specifically of the next day.

The authors [Prapanna Mondal] [Labani Shit] [Saptarsi Goswami] [6] have conducted a study to predict amount of accuracy for various sectors of Indian stocks using ARIMA model. As a result it has been found that accuracy of in predicting stock prices using ARIMA model is above 85%.

The authors [M. Angadi] [A. Kulkarni] [7] have attempted to develop a model for predicting the trends of stock market based on the technical analysis using historical time series stock market data and ARIMA model. The experimental results reveal that the potential of ARIMA model to predict future indices of stock price is strong. This provide guidance for the investors in the to make a decision of profitable investment in stock market.

3. Implementation

For in-depth understanding and visualization of results, we have used two different techniques for stock prediction.

3.1 QuantMod package

In this approach we have collected data from Google Finance and Yahoo Finance using R script. The appropriate ticker symbol needs to be specified to load data from the above sources. The OHLC data cannot be downloaded directly from Google Finance, we need to call the getSymbols method. By default it uses Yahoo for data retrieval.

3.1.1 First step is to install the Quant Mod package

install. packages (quantmod') Next, we need to select a secure CRAN Mirror CRAN Mirror allows us to select a download site close to us for better bandwidth/latency.

Add the QuantMod library

library ("quantmod")

3.1.2 To retrieve data set from Quant Mod

get Symbols ("AAPL") AAPL For retrieving data of a particular period Get Symbols ("AAPL", from=2016-01-01", to="2017-01-01") We can obtain the first several rows of a data set using the head function head (AAPL)

3.1.4 Plot Visualization using charts

chart Series (MSFT) chart Series (MSFT, subset="2017-01: 2017-06") By default it shows the OHLC data and the volume data For detailed analysis we can use add MACD and add B Bands Moving Average Convergence Divergence (MACD) is a centred oscillator that fluctuates above and below the zero line. It helps us analyse the strength, weakness or direction of momentum of a security's move. BBands allows us to compare the volatility and price levels of a stock over a period of time.

3.1.5 View and analyse results

To get the short-term predictions, correlations can be found out once we plot the results.

The default MACD formula used in almost all charting packages is - MACD 12,26,9 The MACD line is plotted by taking the difference between the value of 12 day and 26 day Exponential Moving Average (EMA). The difference between the 26 day EMA and 12 day EMA gives the MACD line. Then a 9 day EMA of the MACD line is superimposed over the MACD as a 'signal line'.

MACD produces signals from 3 sources for prediction

1. MACD/signal line crossovers - They are the most common signals sent out but are not very reliable as most of the times it sends a false signal. When the MACD line crosses above the signal line it is considered as bullish moving average and when the MACD is below the signal line it is considered as bearish moving average crossover.
2. MACD central line crossover - MACD line below the centre line crossing over the centre line indicates bullish crossover and vice versa.
3. Divergence with price - It is the least frequent signal that MACD generates but it the most powerful and reliable signal. In an uptrend, when price makes a higher high, but the MACD line makes a lower high diverging with the actual price. In a downtrend, divergence occurs when price makes a lower low but the MACD line makes a higher low. Whenever a divergence is spotted, there is a higher chance of price retracement.

	AAPL.Open	AAPL.High	AAPL.Low	AAPL.Close	AAPL.Volume	AAPL.Adjusted
2015-01-02	111.39	111.44	107.35	109.33	53204600	103.86647
2015-01-05	108.29	108.65	105.41	106.25	64285500	100.94039
2015-01-06	106.54	107.43	104.63	106.26	65797100	100.94989
2015-01-07	107.20	108.20	106.70	107.75	40105900	102.36544
2015-01-08	109.23	112.15	108.70	111.89	59364500	106.29853
2015-01-09	112.67	113.25	110.21	112.01	53645500	106.41255
2015-01-12	112.60	112.63	108.80	109.25	49650800	103.79047
2015-01-13	111.43	112.80	108.91	110.22	67091900	104.71200
2015-01-14	109.04	110.49	108.50	109.80	48956600	104.31299
2015-01-15	110.00	110.06	106.66	106.82	60014000	101.48190
2015-01-16	107.03	107.58	105.20	105.99	78513300	100.69338
2015-01-20	107.84	108.97	106.50	108.72	49012100	103.28696
2015-01-21	108.95	111.06	108.27	109.55	48575900	104.07549
2015-01-22	110.26	112.47	109.72	112.40	53796400	106.78306
2015-01-23	112.30	113.75	111.53	112.98	46051200	107.33408
2015-01-26	113.74	114.36	112.80	113.10	55615000	107.44807
2015-01-27	112.42	112.48	109.03	109.14	95568700	103.68597
2015-01-28	117.63	118.12	115.31	115.31	146477100	109.54764
2015-01-29	116.32	119.19	115.56	118.90	84436400	112.95824
2015-01-30	118.40	120.00	116.85	117.16	83745500	111.30518
2015-02-02	118.05	119.17	116.08	118.63	62739100	112.70172
2015-02-03	118.50	119.09	117.61	118.65	51640300	112.72072
2015-02-04	118.50	120.51	118.31	119.56	70149700	113.58526
2015-02-05	120.02	120.23	119.25	119.94	42246200	114.39597
2015-02-06	120.02	120.25	118.45	118.93	43372000	113.43264
2015-02-09	118.55	119.84	118.43	119.72	38889800	114.18613
2015-02-10	120.17	122.15	120.16	122.02	62008500	116.37981
2015-02-11	122.77	124.92	122.50	124.88	73561800	119.10761
2015-02-12	126.06	127.48	125.57	126.46	74474500	120.61459
2015-02-13	127.28	127.28	125.65	127.08	54272200	121.20593
2015-02-17	127.49	128.88	126.92	127.83	63152400	121.92125
2015-02-18	127.63	128.78	127.45	128.72	44082300	122.77013
2015-02-19	128.48	129.03	128.33	128.45	37362400	122.51260
2015-02-20	128.62	129.50	128.05	129.50	48948400	123.51408
2015-02-23	130.02	133.00	129.66	133.00	70974100	126.85228

3.2 By importing data set in R

We have downloaded the historical data of APPLE from Yahoo Finance. The historical data of any company can be downloaded. A csv file is generated which we will import in R studio for our analysis.

3.2.1 Importing the data

```
aapl=read.csv("C:\\Users\\Laptop\\Downloads\\AAPL.csv",header=T)
head (aapl)
```

3.2.2 Creating a time series function

In our data the closing prices are listed in the 5th column, we use the ts() function to create time series. We have taken data from October 2015 to October 2017.

aapl.ts=ts(rev(aapl) [5], start=c (2015, 10), end=c (2017, 10), freq=12)

aapl. ts

In addition, we also take the log of values and place them both in an accessible data frame. We have saved the closing values and the log values in a separate file.

>aapl=data. frame (closing=aapl. ts, lclosing=log(aapl. ts))

> save (aapl, file="aapl. df. RData")

> load ("aapl. df. RData")

3.2.3 Plotting the stock values

Plot the data frame x-axis year and y-axis closing price

plot (aapl$closing, main="AAPLE Stock Prices(APPLE)", lwd=2,sub="October 2015 to October 2017",ylab="Closing Price")

3.3 Decomposition

The function stl() removes the seasonal component from the data set and the trend is found after smoothening the remainder.

aapl. stl=stl (aapl $closing, s. window="periodic")

plot (aapl. stl, main="APPLE Stock decomposition")

3.4 Forecasting using stl()

We use the forecast package to predict the stock price over the next 2 years.

Prediction method=ARIMA Model

h=24 (Predict 2 years into the future)

level =95 (95% confidence level)

install. packages ('forecast')

library (forecast)

aapl. f=forecast (aapl. stl, method="arima", h=24, level=95)

plot (aapl. f, ylab="Stock Price", xlab="Year", sub="Forecast from October 2017 to October 2019")

	AAPL.Open	AAPL.High	AAPL.Low	AAPL.Close	AAPL.Volume	AAPL.Adjusted
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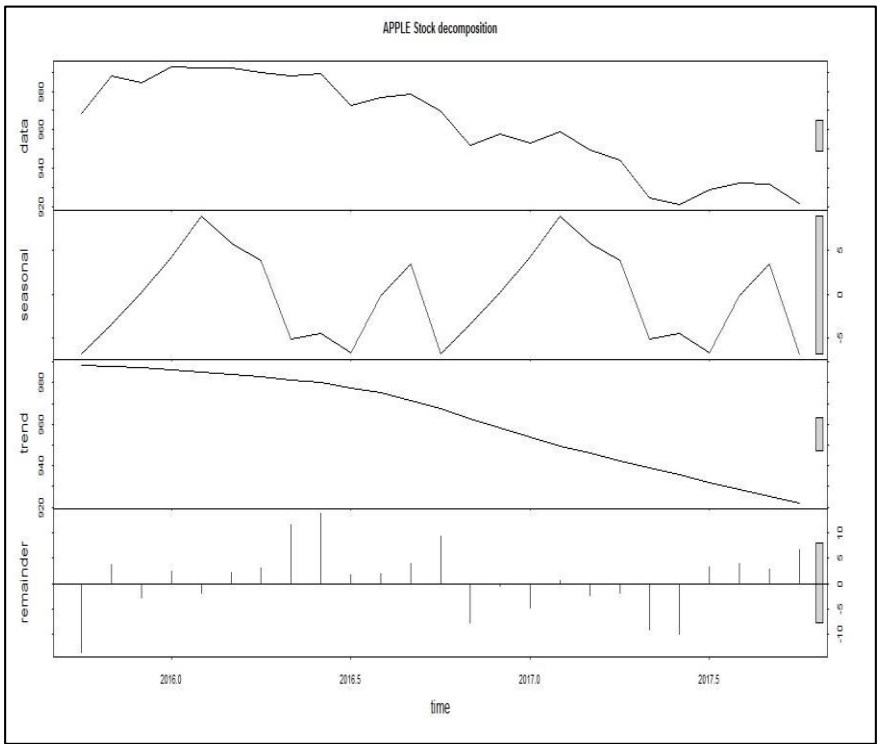

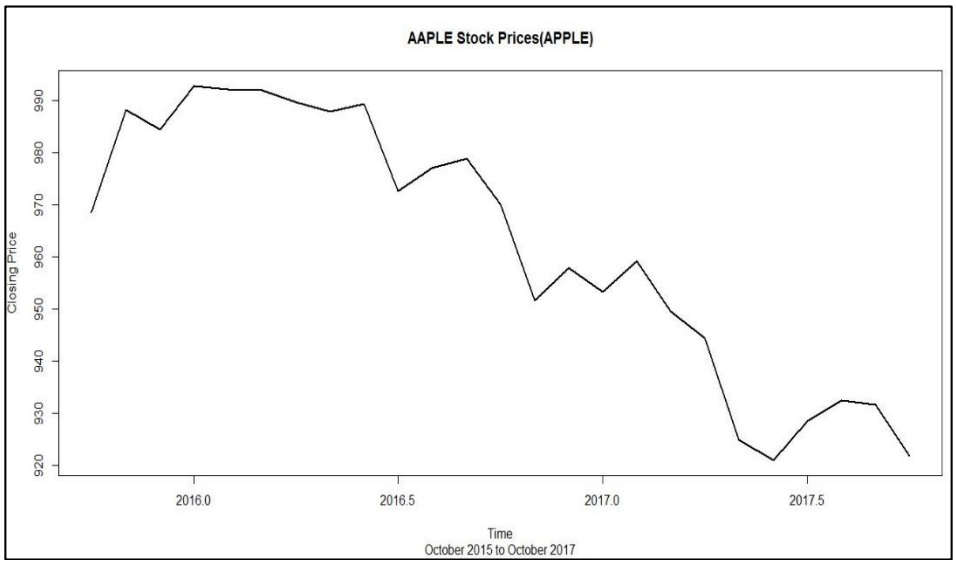

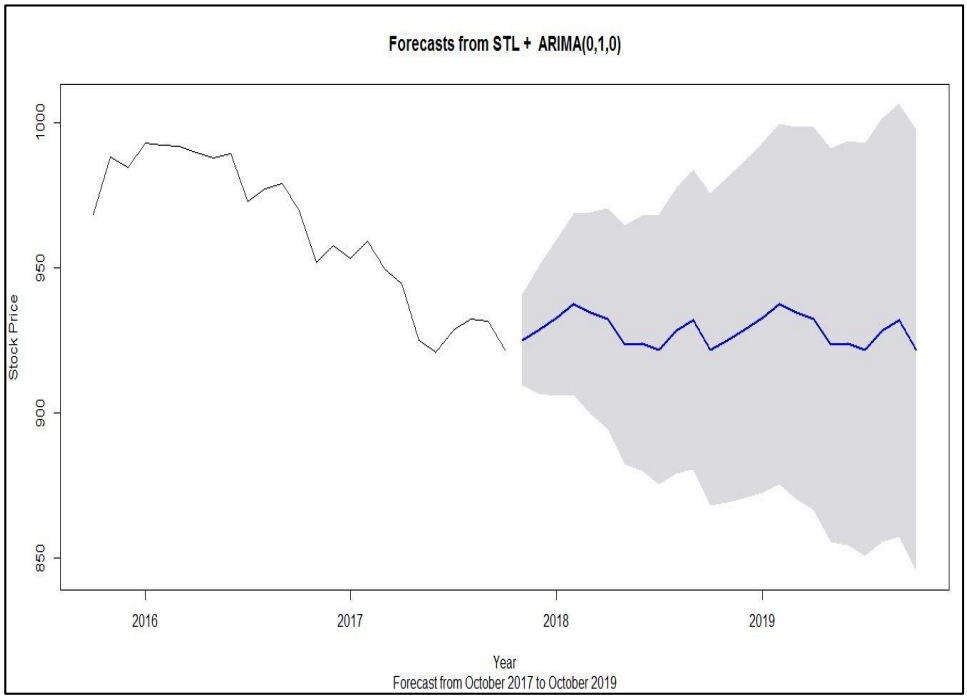

Conclusion

In this paper we have predicted the share market trends by considering a company's historical time series data. The ARIMA Model played a key role in predicting the short-term trends of a stock market. The investors can do a thorough analysis of the share market by visualizing the graphical plots. There are various technical ways in which the plots can be visualized. For accurate prediction the MACD line should be compared with the signal line indicator. The divergence with price signal is generated very rarely but is the most effective technique for precise analysis. This can help the investors make a profitable decision on whether to buy/sell/hold a stock.

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