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STOCK MARKET PREDICTION

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Abstract:
Shares are probably the most popular financial tool designed to build wealth and are the basis of any investment portfolio. Advances in commercial technology. Open markets so that today almost anyone can own shares. Over the past few decades, there has been a marked increase in the general interest in the stock market. In a financially volatile market, such as the stock market, it is important to have very accurate forecasting of future trends. Due to financial constraints and the benefit of recording, it is mandatory to have a secure forecast of stock prices. With the advent of technological wonders such as global digitization, and stock forecasting the market has entered a very technologically advanced era, reviving the old trading model. With the endless increase in market capitalization, stock trading has become a major investment hub for many financial investors. Many analysts and researchers have developed predictable tools and techniques for stock price movements and assisting investors in making informed decisions. In this paper, we propose a way to predict the stock market based on time series data and predict the risk and return of investment associated with the stock based on stock news and blogs sentiment analysis and the Beta factor. While there are many models to predict the stock market such as neural network, KNN, Data Mining techniques, Linear regression, etc. but predict the stock market by historical data with LSTM, Beta Factor and VADER which is used to fetch all the news about stocks as VADER is a legal and lexical reasoning tool that is directly related to the emotions expressed on social media, and works well in texts from other domains, the prediction of risk and return of investment of stock market increases the profit. LSTM is also a part of a neural network, but it allows multiple inputs at a time and is commonly used for Time series forecasting models so that they can predict values based on previous, sequential data. Beta factor can measure the volatility of each stock compared to the systematic risk of the whole market. Statistically, the beta represents the slope of the line with the reversal of data points. VADER is used to fetch textual news data from social media and other platforms, and it is sensitive to both polarity (positive/negative) and intensity(strength) of emotion. We test our approach to predicting daily fluctuations in the closing price. In our study, we will use the “Streamlit” framework in python language.
Keywords: Machine learning; Stock market prediction; LSTM; Sentiment analysis; Beta

I. Introduction:

The stock market is a public market where you can buy and sell shares of publicly listed companies. Stocks, also known as equities, represent ownership of a company. The stock market is a trading platform where different investors trade and buy stocks depending on stock availability. The stock market volatility affects the profitability of participants. When market prices increase with available stock participants gain profits from their purchased stock. On the other hand, if the market goes down with available stock prices, then participants should face a loss. Buyers buy stocks at lower prices and sell stocks at higher prices and try to make a bigger profit. Similarly, retailers are selling their products at higher prices for profit. Our research investigates how to use this rich online information to predict financial markets. There are a variety of forecasting methods used by stock market analysts, including statistical strategies and derecognition analysis providing quantitative predictions. There are two methods to predict the stock

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market. One method focuses on data in predicted stock, the other method focuses on data outside of predicted stock. As for the first method, there are two common methods. One is the basic analysis. This approach predicts the stock market by focusing on financial statements, interest rates, products, management, news, and more. This is used to gain insight into whether it is very important or not very important. There are some lessons to gain some insight into story matters by using the engineering method. Another technical analysis. This is the type of method that predicts the stock market by focusing on previous stock data, usually technical indicators such as movement rate, relative strength index (RSI), stochastic oscillator, and more. There are many studies to predict the stock market using such data and engineering methods, such as Neural networks, Evolutionary Algorithms, Support Vector Machine, Neuro-Fuzzy, Hidden Markov model, and decision trees. As for other alternatives, a specific study that investigates the correlation between predictable stock prices and other time-series data, such as external stock, temperature, audience level, and more. Our Model uses one of the neural network techniques called LSTM which fetches the historical data about the stock prices, a Beta factor that is used to predict the prices of the stocks. Three factors that affect beta values are the nature of the business, financial leverage, and operating leverage. And, for the textual data which have to be collected from social media and other platforms is done by VADER. VADER stands for valence aware dictionary and sentiment reasoner; it is a lexicon and rule-based emotional analysis. VADER has a combination of words whose emotions are labelled i.e., positive, or negative. And it not only gives us an idea about positivity or negativity, but it also shows the compound value either positive or negative to know how positive or negative the emotion is.

II. Literature review:

Financial services companies are developing their products to provide futures forecasts. There is a large number of world financial information sources that can be important research centers, one of these areas is stock forecasts also called stock market mines. Stock forecasts become even more important when several rules can be created to help make better investment decisions in different stock markets. [1] Many research groups are exploring stock market trend prediction using social media analytics. To detect the polarity of each tweet/news there are multiple methods.

1) Building own dictionary using a semi-supervised approach.
2) Domain-specific dictionary-based approach. [3]

Table 1. Research Paper with H-Index

S. No.	Research Paper	Rank with H-Index score
1	R1	207
2	R2	143
3	R3	119
4	R4	78
5	R5	76

Table.1 contains the top 5 research papers among the all research papers which were used to study the problem statement and to find the solution with a different approach. According to Table 1. The rank with H-index is given for the particular research paper where R1, R2, R3, R4, R5 are,

R1 = Applications of deep learning in stock market prediction: recent progress.
R2 = Using percentage accuracy to measure neural network predictions in Stock Market movements.
R3 = Pattern graph tracking-based stock price prediction using big data.

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Table 2. Research Paper with the Algorithm/software used in them.

S. No.	Research Paper	Algorithm / Software used
1	R1	Preprocessing Techniques, Optimization Algorithms, Linear Models, Machine Learning Models, Deep Learning Models.
2	R2	Neural Network
3	R3	Data Mining, Artificial neural network
4	R4	Support vector machine (SVM) and Artificial Neural Network (ANN)
5	R5	Neural Network (RNN) and Long Short-Term Memory (LSTM)

R4 = A systematic review of fundamental and technical analysis of stock market predictions.
R5 = Stock Market Prediction Using LSTM Recurrent Neural Network.

Table.2 contain the same research paper mentioned in Table 1 with the algorithm or software used by them to predict the stock market price. After taking references from several research papers related to stock market prediction techniques we come to point that these research papers were using data from the past or the news articles for which they were using several machine learning algorithms as mentioned in Table 2. The methodology which is used in these research papers is:

R1 = They use the concept of in-depth learning models to predict the price/movement of the stock market. First, they collect Raw data from the source and classify the data according to the type of data such as text data, image data, image representation data, etc. Considering the length of the data, they follow their next step in data processing to create. Data prediction model.

R2 = The results of two neural networks were obtained, as well as those from four different pathways of a different mathematical method, the regression of multiple lines. The test result is indicated not only by the mean square error and the root square root error but also in terms of percentage accuracy, such accuracy (98.11%) is determined by comparing the prediction of each test case with its actual result on a percentage basis.

R3 = Proposed a new integrated approach to Dynamic Time Warping, Stepwise Regression Analysis, and Artificial Neural Network. They create a large data processing framework to manage overall processes using large open data sources.

R4 = This study attempted to perform a systematic and critical review of approximately 122 relevant research activities reported in academic journals for 11 years (2007–2018) in the stock market forecast area using a study machine. The various strategies identified in these reports are grouped into three categories, namely, baseline, baseline, and integrated analysis. The collection is based on the following criteria: type of database and number of data sources used, data time, machine learning algorithms used, machine learning function, accuracy used, and error metrics and software packages used to model.

R5 = This article aims to create a model using Recurrent Neural Networks (RNN) and in particular, the Short-Term Memory (LSTM) model to predict future stock market prices. The main purpose of this paper is to determine how accurately a machine learning algorithm can predict and how periods can improve our model.

III) Problem statement:

Everyone wants to get rich in their life with low effort and great benefits. Similarly, we want to look to our future with great inner desire as we do not want to take risks or seek to reduce risk. A stock market is a place where trading and buying can provide future life goals. Now the question is how can we make a profit in the stock market? Any steps that can give us stock market predictions before we put them at risk.

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IV) Stock market prediction (SMP):

Stock market prediction is a very challenging task because the stock market is not stable, it fluctuates. However, there are various methods to predict the stock price in machine learning but to reduce an error we will use LSTM models. The LSTM model works very well with time-series analysis, and we fetch the last 5 years historical price dataset to train and test our build model.

We used VADER for the emotion analysis of textual data from social media and other platforms. VADER is a lexicon and rule-based emotional analysis model, and it only tells us about the good or bad sentiments related to news words, but it also tells us about the intensity of positive or negative sentiments. we do not need any data for training, and it also understands ambiguous words, capital words, and many more.

By analyzing the news and the blog's sentiments, we can know whether the news or the blogs of a particular company is in favor or against the company. Also, we can identify the risk associated with an investment in the company and also the return of investment by calculating the Beta factor value of the company by the linear regression method.

V) Implementation for stock prediction:

- **Stock market prediction using machine learning.**

By using machine learning concepts, we can predict the future price of company stock to gain significant profits. There are a lot of hidden factors involved in the prediction, such as emotion, sixth sense, psychological factors, physical, and so on. Therefore, predicting the stock price with high accuracy is a difficult task. However, we try to predict the stock price with historical data, news, and beta factors.

VI) Methodology

- **Predicting stock prices with historical data:**

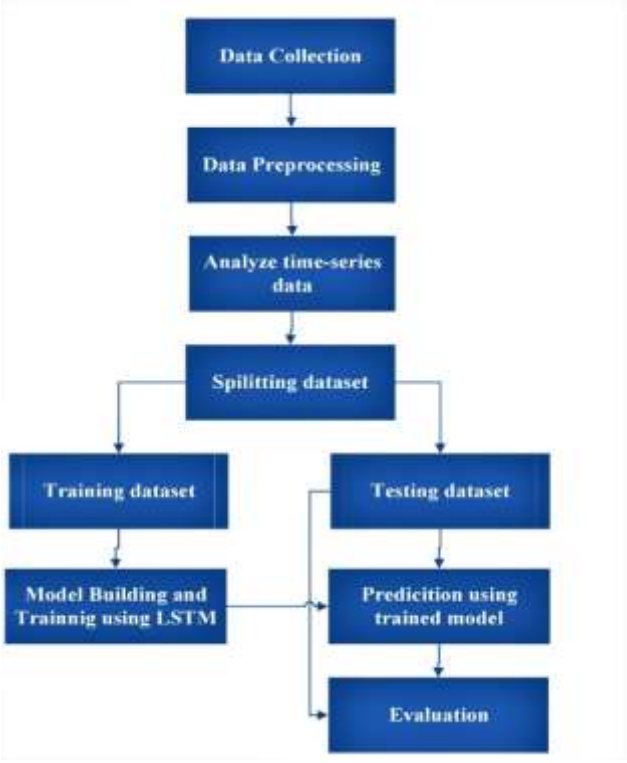

Fig. 1: LSTM Model Flow Chart

In Fig. 1: We fetch the real-time stock dataset of the desired company from the “Tiingo” API for the past 5 years. We did certain operations like pivoting, cleaning, and fetching some specific variables, so that we

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can perform our time series analysis. To train our LSTM algorithm, we split our dataset into two parts one is the training dataset which is 70% of the total dataset, and the other is the testing dataset which is 30% of the total dataset. We build our LSTM model using the training dataset by running 50 epochs. Finally, we evaluate the performance of the LSTM model using the testing dataset. Some of the historic data prediction is done in three steps as market trend identification: Pattern formations, Learning past price movement, Indicators. [2]

Long Short-Term Memory Network (LSTM)

LSTM is a type of Central Neutral Repetitive Network for learning long-term dependence. LSTM has three gates:

a) Input gateway: Add all the information to the cell state.
b) Forgetfulness: It removes information, which is not important.
c) Exit gate: Output gate to LSTM select information to display as an exit.

RNNs are a powerful type of artificial neural network that can store input memory. This enables them to solve problems that involve sequential data such as a time series. However, RNNs often suffer from a condition called vanishing gradient which results in the learning model moving too slowly or stopping altogether. LSTMs were established in the 1990s to address this issue. LSTMs have long memories and can learn from separate entries with long delays. LSTM has three gates: the input gate that determines or does not allow new inputs, the forget gate that removes non-essential information, and the exit gate that determines which information will be removed. These three analog gates are based on sigmoid activity that works in grades 0 to 1.

The data on this page contains daily opening values for all live stocks using the "Tiingo" API. To build our model we will use LSTM RNN, our model uses 70% training data and 30% data for testing. To train, we use the square error to adjust our model. Also, we used different Epochs for training data (50 times).

The architecture of LSTM:

RNNs have a single neural network layer while LSTM has four interacting layers [6].

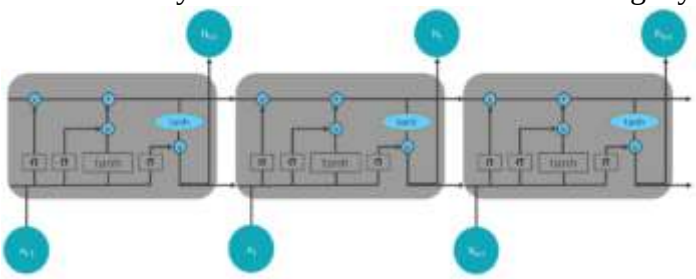

Fig. 2 Architecture of LSTM [6]

We use 50 epochs the epoch number passes in the database for training in machine learning by the algorithm. With each passing season, the parameters of the trained data set are updated. It can be thought of as a loop in planning with an epoch number and with each passing, it cuts across the entire training database.

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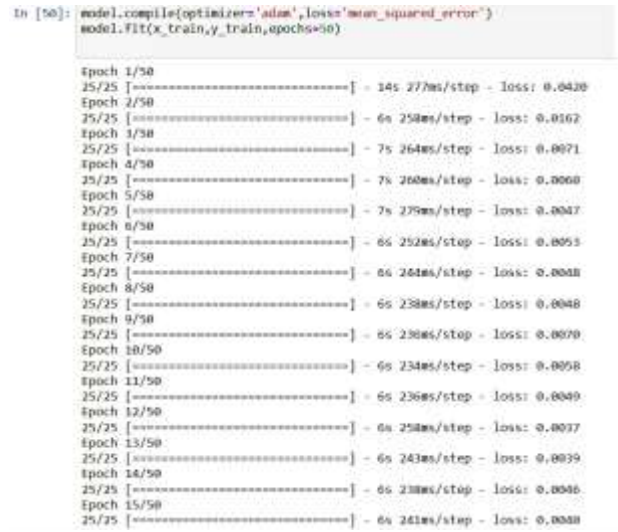

Fig. 3: Running epoch with loss

Fig. 4: Running epoch with loss

There is one parameter called the loss function, it is a measure of the model's predicted stock price variation from the actual stock price. If the value of the loss function is high, this means the prediction is not accurate and if the value of the loss function is less, the model accuracy is good, and the predicted price is accurate. We use Mean squared error (MSE) to calculate the loss function. In this error method, we calculate the difference between the actual price and the predicted price of the stock market and square the result because while calculating the difference only may we get a negative value to avoid it we square the difference. Repeat the calculation for the whole dataset and then take an average of the whole dataset.

To minimize the loss function, we use the “Adam” optimizer algorithm for gradient descent in the loss function curve. It is a combination of two algorithms: the first is gradient descent and the second is RMSprop. There are two moments in the “Adam” optimizer one is the mean and the second is the uncentered variance which doesn't subtract the mean.

- **Stock news sentiment analysis:**

Sentiment Analysis is knowing whether a sentence is positive, negative, or intermediate.
Also, known as mining ideas, determine the viewer's point of view. It can be used to predict stock news by analyzing news or blog posts. If it is positive, there is a chance that the stock price will rise and vice versa.

VADER (Valence Aware Dictionary and sentiment Reasoner)

It is a lexical database and a legal-based emotional analysis tool designed for the emotions of the social media platform. VADER stands for Valence Aware Dictionary and Sentiment Reasoner; it is a lexicon and rule-based emotional analysis. VADER has a combination of words whose emotions are labelled i.e., positive, or negative. And it not only gives us an idea about positivity or negativity, but it also shows the compound value either positive or negative to know how positive or negative the emotion is. The compound value is between +1(very positive) to -1(very negative).

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Fig.5: Sentiment Analysis Flow chart

In Fig.5: We fetch news and blogs via the web scraping method using the Beautiful Soup package. We have done certain operations like pivoting, cleaning, and fetching some specific variables, so that we can perform our time series analysis. We build a model to evaluate whether news and the blogs we have collected are negative or positive.

- **Predicting the risk and returns of stocks with a Beta factor**

Beta Factor

How should investors evaluate the risks in the stocks they buy or sell? Although the concept of risk is difficult to incorporate into stock analysis and measurement, one of the most popular indicators is the mathematical measure called beta. Analysts often use it when determining the risk profile of a stock. However, while the beta says something about price risk, it has its limitations for investors who want to determine the basic risk factors.

What is Beta?

Beta is a measure of volatility — or systemic risk — of a security or portfolio compared to the overall market. Beta is used in the capital asset price index (CAPM), which describes the relationship between fixed risk and expected return on assets (usually stocks). CAPM is widely used as a way to set prices for risky stocks and to estimate the expected return on assets, considering both the risks of those assets and the cost of capital. Estimating Beta with linear regression.

Beta is the capital percentage change in a security's return given a 1% change in the market index. Beta is used in the capital asset price index (CAPM), which describes the correlation between risk and expected return on assets, considering both the risks of those investments and the cost of capital.

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Estimating Beta with linear regression.

Beta is the slope of the line when you pot a security's excess returns against the market's excess returns.

$R_e = \beta * [R_m - R_f] + R_f$ or $R_e - R_f = b * [R_m - R_f]$

R_e = Stock Return

β= Beta Coefficient

R_m= Market Return

R_f= Risk-Free Rate

We can compare this from the line slope-intercept formula.

Where, Re=y, B=slope, (Rm-Rf) =x, and Rf=y-intercept.

Useful things we can gain from this:

i) An asset is expected to generate a low risk.

ii) A beta coefficient value is 1, and the profit return is equal to the average market profit return.

iii) The beta coefficient represents the slope of the line.

The stock that is more volatile than the market over time has more than 1.0 beta. If the stock goes below market, the stock beta is below 1.0. High beta stocks should be very risky but offer high recovery power; stocks with lower beta risk have less risk but also have lower returns.

Beta is part of the capital asset pricing (CAPM) model, which is used to calculate equity funding costs. The CAPM formula uses the total market return and stock beta value to determine the level of return that shareholders can reasonably expect based on projected investment risk. In this way, the beta can affect the expected return on stock and share value.

Key Takeaways –

i) Beta is a concept that measures the expected movement in a stock-related stock throughout the market.

ii) A beta larger than 1.0 suggests that stocks are more volatile than the broader market, and a beta below 1.0 indicates stocks with lower volatility.

iii) Beta is part of the Capital Asset Pricing Model, which calculates equity funding costs and can assist in determining the expected rate of return concerning the perceived risk.

iv) Critics argue that the beta does not provide enough information about the company's foundations and has a limited value when choosing a stock.

v) Beta is probably a better indicator of short-term risk than long-term risk.

Calculating Beta:

The beta coefficient can measure each stock volatility compared to the systematic risk of the entire market. Statistically, the beta represents the slope of the line with the reversal of data points. In finance, each of these data points represents the return on each stock compared to those in the market as a whole.

Beta is calculated using retrospective analysis. Numerically, it represents the tendency for collateral to respond to market fluctuations. The beta calculation formula is a combination of asset return and bank restitution that is separated by a benchmark return period over some time.

β= Covariance (R_e, R_m) / Variance (R_m)

Covariance (R_e, R_m) = $\Sigma(((R_{e,\,n} - R_{e,\,average}) * (R_{m,\,n} - R_{m,\,average})) / (n-1))$

Variance (R_m) = $\Sigma((R_{m,\,n} - R_{m,\,average})^2 / n)$

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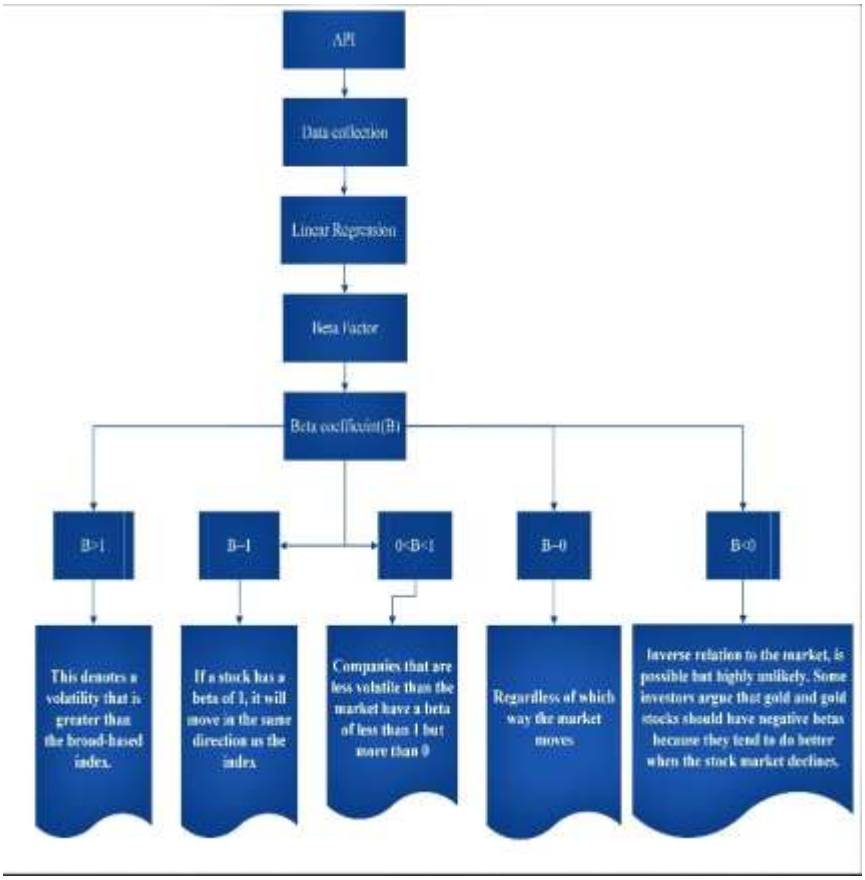

Fig. 6: Beta Methodology Flow Chart

In Fig.6: We fetch the real-time stock dataset of the desired company from the "Tiingo" API for the past 5 years. We build CAPM (Capital Asset Pricing) Model Using Linear Regression to get the Beta Coefficient. From the Beta Coefficient, we can conclude the risk and return of the stock market.
Types of Beta Values: -

i) Beta =1: If a stock has a beta value equal to 1, the company will move the same as the index.
ii) 0<Beta<1: Companies are less volatile than the index. For example, if a company has Beta=0.35 it will return 35%.
iii) Beta>1: The company has a higher risk and higher return on investment. The company is more volatile than the market. For example, a company has Beta=1.67, which means the return is 167% of the market return.
iv) Beta Value equal to zero: Regardless of which way the market moves, nothing to relate to the market.
v) Negative Beta Value: Inverse relation to the returns of the market. Mostly, observed in the gold companies. For example, A company with Beta= -0.3 will return -3% when the market is high by 10%.

Advantages of Beta:

For CAPM fans, beta is useful. Stock price volatility is important to consider when risk aversion. If you consider risk as the stock is likely to lose value, beta is popular as a risk representative. Intuitively, it makes a lot of sense. Think of a pre-existing stock market with a higher jump price than the market. It is hard not to imagine that stocks would be more dangerous than stocks in the low-beta industry.

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Besides, beta offers a clear, measurable scale that is easy to operate. Of course, there are variations in beta depending on factors such as the market index used and the estimated time. But overall, the beta view is straightforward. An accurate measurement that can be used to calculate the equity costs used in the measurement method.

Disadvantages of Beta:

When you invest based on the basics of stock, the beta has many shortcomings. First, beta does not include new information. Consider a helpful company, let's call it Company X. Company X is considered a protective stock with low beta. When it came to the broker-dealer business and took on more debt, the beta of X's history no longer took the greater risk the company took. At the same time, many tech stocks are new to the market and thus have an insufficient price history to establish a reliable beta. Another worrying factor is that the price movement in the past is a poor predictor of the future. Beta is just rear-view mirrors, showing very little of what is to come. In addition, the beta rate in a single stock often changes over time, making it unreliable. Admittedly, for traders who want to buy and sell stocks in the short term, beta is a good risk metric. For long-term investors, however, it is less effective.

VII) Technical Analysis:

To gain profit, one should perform a technical analysis of the market by focusing on historical data to know the trend of stock price. It helps in predicting the price and reducing the loss.

- **Method:**

a) Moving average is a technical indicator that helps to identify the trend by removing the dynamic fluctuation from the short-term price data. The Moving average is calculated over a certain period, and it will be helpful for both long-term investors and short-term traders.

Fig.7: 200 Day Moving Average

In Fig.7: The red line in the chart represents the average price over the last 200 days and if the actual stock price line is above the 200 Day Moving Average, it will be considered the uptrend.

b) Machine learning is a new technique used in technical analysis:

i) LSTM: to predict the stock price based on historical data LSTM is used, it uses linear regression with neural network concept together to work perfectly with time-series data analysis.

ii) Sentiment analysis: As time is changing, most things are digital mainly on social media, blogs, and news. So, analyzing the sentiments that are emotions in people's posts on Twitter, blogs, and the news related to the company helps the user identify whether the company will perform better in the people's posts on Twitter, blogs, and the news related to the company helps the user to identify whether the company will perform better in future or not.

iii) Beta Factor: Everyone wants to get higher returns and low risk while investing in them to get a higher return and low risk while investing in the stock market. To achieve this, we can analyze the

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Beta factor of the company by using a regression method. This method finds the relationship between the stock company and the standard market index like the S&P 500.

VIII) Result Analysis:

- **LSTM predicted price results**

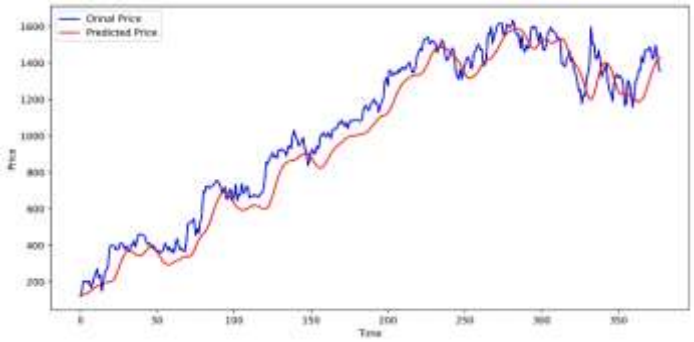

Fig. 8: Original price vs Predicted Price

In Fig.8: There are two lines indicating the original price and Predicated Price with the time of Google company "GOOGL". Almost, predicted is nearly equal to the original price.

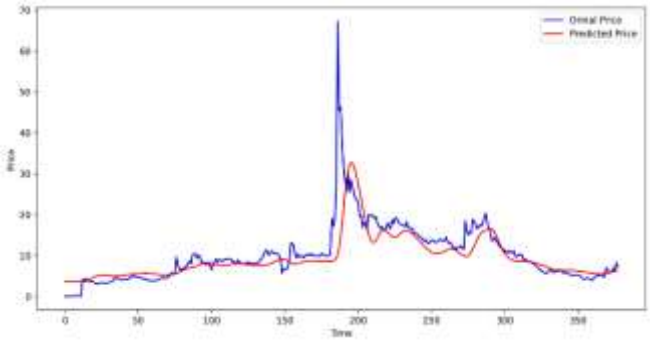

Fig.9: Original Price vs Predicted price

In Fig.9: Shows a time-series graph where the red line indicates the predicted value, and the blue line indicates the original price of Newegg Commerce Inc company “NEGG”. We find that the predicted price and original price almost lie over each other, which shows the higher accuracy of our model.

- **News sentiment analysis results**

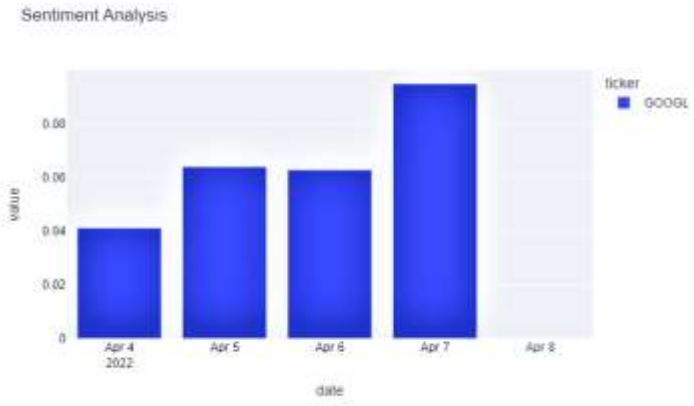

Fig. 10: Sentiment value over the period

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In Fig.10: Shows the stock news sentiment of "Google" company using VADER and represents the compound value on different dates of news or blogs. Most of the day, news sentiment is positive which indicates that stock prices will go up in the future.

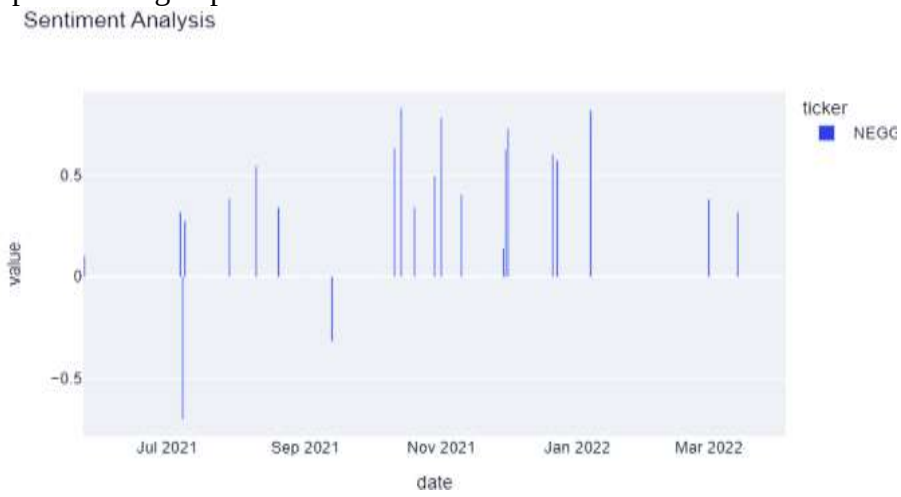

Fig. 11: Sentiment value over the period

In Fig.11: Shows the stock news sentiment of "Newegg Commerce Inc company", which represents that news sentiment is positive as well as negative. The news having a positive compound value is not high enough to categorize as strong positive sentiment. So, the news is not strongly in favor of this stock company.

- **Beta Factor Results**

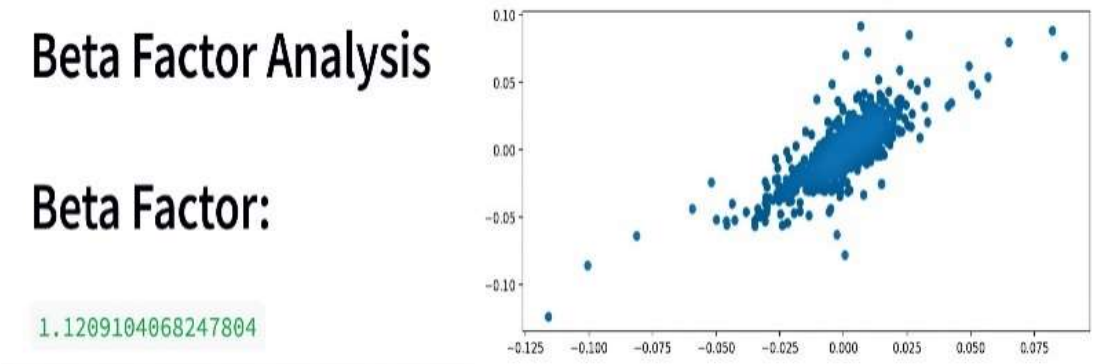

Fig.12: Linear regression concerning index

In Fig.12: It is a linear regression chart between covariance and variance of Google "GOOGL" company stock concerning standard market index of USA which is a collection of top 500 companies named "S&P 500" to represent the beta value of Google company "GOOGL", which is near about 1.12 means that this stock should give return by 22.4% if the standard market index S&P 500 will give return 20%. This result suggests to the user that risk and return of investment are moderate.

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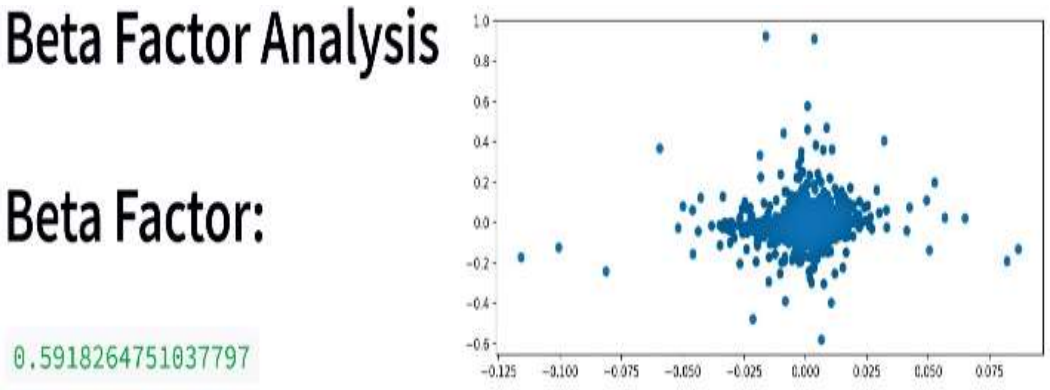

Fig.13: Linear regression concerning index

In Fig.13: Representing of "Newegg Commerce Inc company" having a beta value less than 1, which clearly states that this company is less than 1 and one can invest who doesn't want to take a risk.

IX) Conclusion:

Stock market predictions are a real need for a profitable business. Forecasts are always helpful in reducing loss and prices get predicated on historical data of the stock market. Before investing in any company, not only predicted stock prices make a good return on investment, the modern technique of prediction like news sentiment analysis and beta Factor analysis predicts the risk associated with the stock company and the return of investment concerning the standard market index. The risk factor and return can be analyzed based on the Beta Factor and news sentiment analysis. We have done a technical analysis of two companies in our research paper using our three methods:

- **Google company "GOOGL"**

LSTM: Predicted price suggests that it may go up or down.
News sentiment: The news sentiment is a strongly positive sentiment with a high compound value, which means that stock prices will go high in the future.
Beta Factor: Beta value is near about 1.12, which represents moderate risk and moderate return.
All the above three analyses of Google company support each other and suggest to the users that investing in Google stock is a good choice for gaining profit.

- **Newegg Commerce Inc company "NEGG"**

LSTM: Predicted price suggests that it will go high.
News sentiment: The news sentiment is both positive and negative and even positive news doesn't have a high compound value, So, the news is not strongly in favor of this stock company.
Beta Factor: Beta value is near about 0.6, which represents low risk and low return.
All above three analyses of Newegg Commerce Inc company are not strongly in favor of investing in this company.

X) Future Growth:

We would like to add a fundamental analysis of the stock market in our software to check our prediction more accurately and for those companies, whose news and blogs are not available over the internet, we would fetch Twitter data to do Twitter sentiment analysis for those companies.

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