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Stock Market Analysis Using Deep Learning

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Abstract: Predicting and analysing are the two most powerful uses of deep learning. Credits go to the tremendous development in Artificial Intelligence. Analysis and prediction have been providing us with highly accurate results along with saving huge amounts of processing time and power. Tasks have become simpler and more accurate. Predicting and analysing the stock market's behaviour is one such application. By predicting the Stock market, we can help people reap benefits. This is done using historical stock data and then predicting the future value of a stock. Here the stock data refers to historical stock prices news headlines, events which affect the stock's behaviour. Stock markets are highly volatile and predicting its behaviour can only be done very experienced investors and traders. Thus, it can be difficult for an average investor to make the right decisions. Using the historical stock price data, we use the LSTM model for analysis and using the news events we implement sentiment analysis for predicting and analysis the stock market's behaviour. Our aim is to understand the deep learning and sentiment analysis methods, implement it to predict the stock market. The final goal of this project is to provide an average/inexperienced trader/investor citizen an insight into the stock exchange and to attain maximum profit with the right amount of investment.

Keywords: Stock Market, Deep Learning, Sentiment Analysis.

I. INTRODUCTION

The stock market is known for its volatility, randomness, and unpredictability. It is a chaotic place with an unbelievably huge continuously changing stream of data which makes predicting and acting on those predictions to make a profit very hard. It is actually one of the most challenging tasks in times series forecasting.

This project's main goal is to study and apply deep learning techniques and sentiment analysis to the stock market in order to predict stock behaviour and thus act on those predictions to avoid investment risk and generate profit. This project will be a helpful tool that aims to help beginner traders make better decisions.

The goal is to be able to understand the deep learning models and sentiment analysis methods and adapt it to the trading market. The importance of this project lies in the possibility of giving your average investor, an informed insight onto the stock market in order to at least make better choices than random decisions.

II. EXPERIMENTAL METHODS OR METHODOLOGY

2.1 LSTM Model

Long Short Term Memory - is a special kind of RNN (Recurrent Neural Network) capable of learning and analysing long term dependencies. Remembering information for long periods of time is their default behaviour. LSTM has feedback connections.

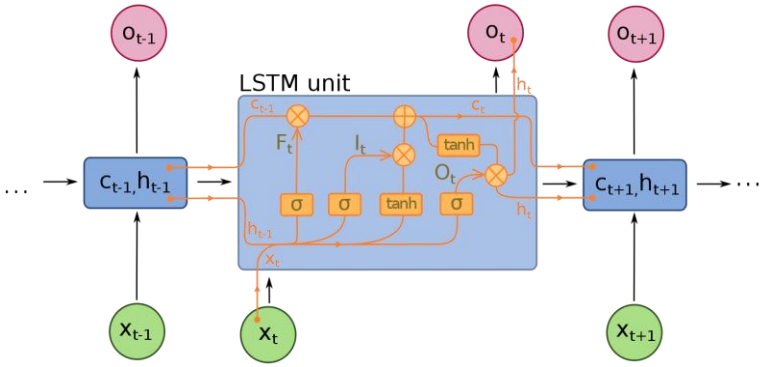

Fig. Impact of DOS Attack on Intruder and Authorized User

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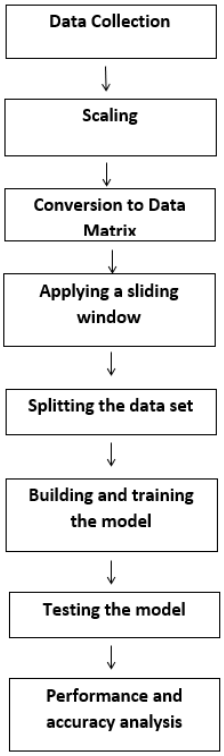
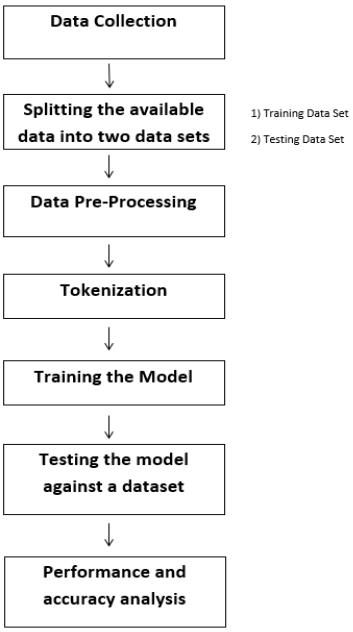
It can not only process single data points (such as images), but also entire sequences of data (such as speech or video). LSTM networks are well-suited to classifying, processing and making predictions based on time series data, since there can be lags of unknown duration between important events in a time series.

The diagram shows the overall LSTM architecture and model that will be used for analysis and prediction.



2.2 Sentiment Analysis Model

Sentiment analysis is the process of detecting positive or negative sentiment in text. It's often used by businesses to detect sentiment in social data, gauge brand reputation, and understand customers. Since customers express their thoughts and feelings more openly than ever before, sentiment analysis is becoming an essential tool to monitor and understand that sentiment.



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III. RESULTS AND DISCUSSION

The project implementation for both the models involves pre-processing methods respective to its own type of dataset. Next step is to train the model, both the LSTM model and various variation under the sentiment analysis model. After training, the models are tested with the data set to check their performance. The LSTM model trains and performs with a low RMSE value and when compared with the original data set values.

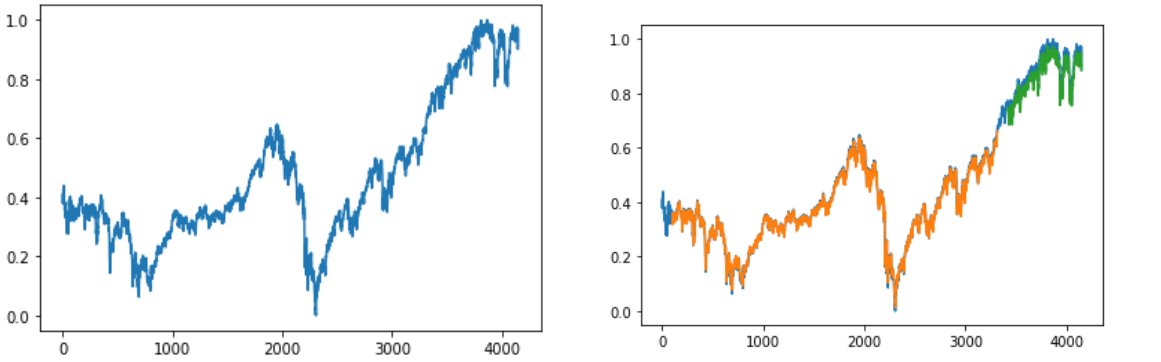

Figure . (a) Original dataset plot (b) LSTM trained and tested model plotted against the original values.

```
In [81]: import math
         from sklearn.metrics import mean_squared_error
         math.sqrt(mean_squared_error(y_train,train_predict))

Out[81]: 0.011355054725502705

In [82]: math.sqrt(mean_squared_error(ytest,test_predict))

Out[82]: 0.02704859523129325
```

Figure . shows the RMSE performnance metric of the model.

The Sentiment analysis also involves pre-processing steps on the dataset and then training and testing the model. Different variation of classifiers and vectorizers are used to get to the best result possible. The vectorizers used were Count Vectorizer and TFI-DF Vectorizer. The classifiers used were Random Forest Classifier and Multinomial Naïve Bayes Classifier. A total of 4 variations were tried out and the results are shown below with the best result of 85.44%.

```
[[141  45]
 [ 10 182]]
0.8544973544973545
              precision    recall  f1-score   support

           0       0.93      0.76      0.84       186
           1       0.80      0.95      0.87       192

    accuracy                           0.85       378
   macro avg       0.87      0.85      0.85       378
weighted avg       0.87      0.85      0.85       378

[[130  56]
 [  0 192]]
0.8518518518518519
              precision    recall  f1-score   support

           0       1.00      0.70      0.82       186
           1       0.77      1.00      0.87       192

    accuracy                           0.85       378
   macro avg       0.89      0.85      0.85       378
weighted avg       0.89      0.85      0.85       378

[[141  45]
 [ 18 174]]
0.8333333333333334
              precision    recall  f1-score   support

           0       0.89      0.76      0.82       186
           1       0.79      0.91      0.85       192

    accuracy                           0.83       378
   macro avg       0.84      0.83      0.83       378
weighted avg       0.84      0.83      0.83       378

[[138  48]
 [ 10 182]]
0.8465608465608465
              precision    recall  f1-score   support

           0       0.93      0.74      0.83       186
           1       0.79      0.95      0.86       192

    accuracy                           0.85       378
   macro avg       0.86      0.84      0.84       378
weighted avg       0.86      0.85      0.84       378
```

Figure . shows the Sentiment analysis model result using different varioations

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IV. CONCLUSION

The LSTM model uses closing prices of stocks and the sentiment analysis model uses top news headlines. Both the models use data of the Dow Jones Industrial Average from the year 2000 to 2016. The highest accuracy achieved by the Sentiment analysis model is 85.44\% where, a combination of Random Forest Classifier and Count Vectorizer was used. The LSTM model's RMSE score is 0.027. On comparing both the models, we concluded that the LSTM model performs better since it gives a more accurate prediction. The RMSE score of the LSTM model is close to 0, which indicates the model has performed well and can be used to predict a stock's price for a given period of 30 days.

This LSTM model can be implemented in the SaaS form for investors, where they can use it for efficiently buying and trading stocks. Also to further explore and extend the working of LSTM model, we can test it on newer entities in the market such as crypto currency. In addition to this, using parameters other than closing prices and news headlines, we can implement a different model and compare it against the currently tested models.

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