Indian Institute Of Technology Bombay

CS725:Foundation of Machine learning

Stock Indices Prediction Using LSTM

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Abstract

A stock market index is a statistical measure which shows changes taking place in the stock market.To get better return, prediction is very important for any investor. Solving Stock Indices prediction problem will be key to investors in helping them to make right investment decisions. It additionally will support policy makers and financial researchers in studying Stock Indices markets behavior. A good plan for any company for growth help to "stabilize and manipulate" the Stock Indices price. Such price of stock manipulations cannot be forecasted. This makes Stock Indices prediction problem very challenging.

The report presents Long short-term memory(LSTM) artificial recurrent neural network (RNN) architecture. This is a popular architecture used for time-series data like that of stock index. We train the model for Nifty 50 index. We have chosen Nifty 50 index as it is the most heavily traded derivative commodity. It represents how the top 50 NSE stocks behave. This gives us the ability to understand and 'time' the market. Moreover, this gives us a deeper understanding into the world of algorithmic trading. Today almost all major financial powerhouses use machine learning to increase the profits for their clients. In the report both single and multiple hidden layers of LSTM are modelled and their performance is compared.

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1. Introduction

1.1 Nifty Indices

An index is a method to track the performance of a group of assets in a standardized way. Indexes typically measure the performance of a basket of securities intended to replicate a certain area of the market.An index measures the price performance of a basket of securities using a standardized metric and methodology.Indexes in financial markets are often used as benchmarks to evaluate an investment's performance against.Passive index investing has become a popular low-cost way to replicate the returns of popular indices such as the SP 500 Index or Dow Jones Industrial Average.Indexes are also created to measure other financial or economic data such as interest rates, inflation, or manufacturing output.Indexes often serve as benchmarks against which to evaluate the performance of a portfolio's returns.

NIFTY is a market index introduced by the National Stock Exchange. It is a blended word – National Stock Exchange and Fifty coined by NSE on 21st April 1996. NIFTY 50 is a benchmark based index and also the flagship of NSE, which showcases the top 50 equity stocks traded in the stock exchange out of a total of 1600 stocks. These stocks span across 12 sectors of the Indian economy which include – information technology, financial services, consumer goods, entertainment and media, financial services, metals, pharmaceuticals, telecommunications, cement and its products, automobiles, pesticides and fertilizers, energy, and other services. The NIFTY index is most heavily traded derivative commodity, even though the prediction of future NIFTY index depends on many factors.

2. Data description.

In this project we use 2727 days of the data of Nifty Indices of previous 10 year starting from 2011 to 2021 . which is taken from NSE website. For prediction we used the closing value column for Nifty Index . i.e closing value of Nifty index for each of the day . using the data of previous 5 day we tried to predict the value for next day .

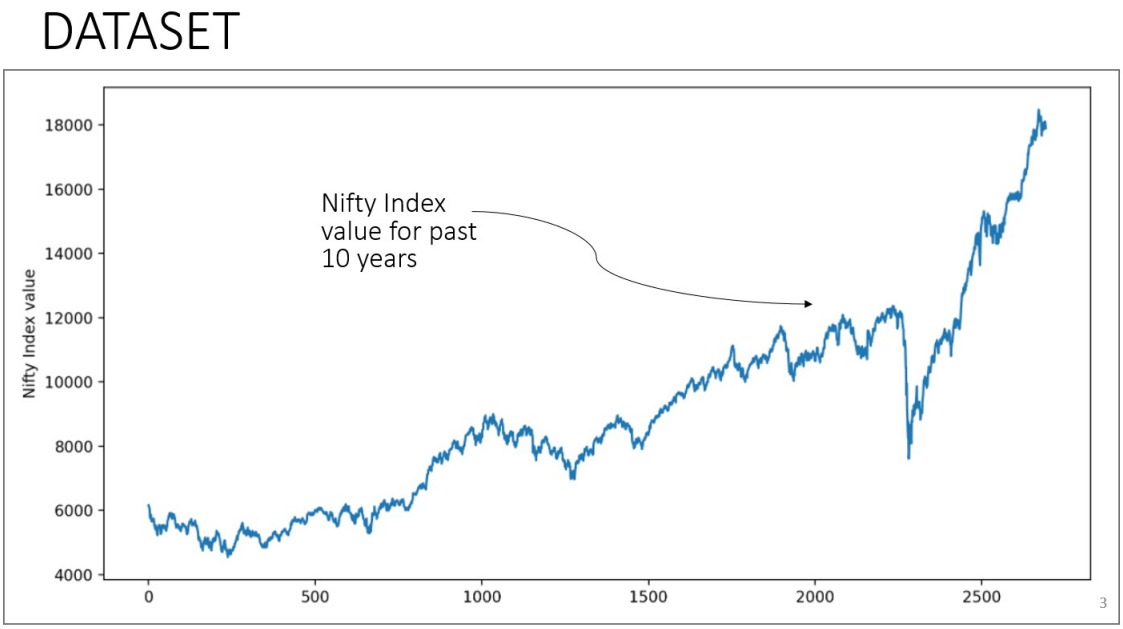


Figure 1: Nifty Index (Market Capitalization)

To train the LSTM model, the Nifty closing values are processed in the following manner :

- Scaling of Data : The index values are scaled between 0 and 1 using the MinMaxScaler function.
- The scaled values are then converted to matrix form of data using the function dataset new
- Creating training and testing data by splitting in 80% and 20%

3. Long Short term memory (LSTM)

Long short-term memory (LSTM) is an artificial recurrent neural network(RNN) architecture used in the field of deep learning. An auto-regressive integrated moving average, or ARIMA, is a statistical analysis model that uses time series data to either better understand the data set or to predict future trends. A statistical model is auto-regressive if it predicts future values based on past values. For example, an ARIMA model might seek to predict a stock's future prices based on its past performance or forecast a company's earnings based on past periods.But it used for a short time of period and for a long time memory we use LSTM. Because it is able to store information over a period of time .

Long Short-Term Memory (LSTM) networks are a type of recurrent neural network capable of learning order dependence in sequence prediction problems.This is a behavior required in complex problem domains like machine translation, speech recognition, and more.LSTMs are a complex area of deep learning. In this project we use the previous five days data of Nifty indices to predict the prices for sixth day .There are few that are better at clearly and precisely articulating both the promise of LSTMs and how they work than the experts that developed them. This characteristic is extremely useful when we deal with Time-Series or Sequential Data .

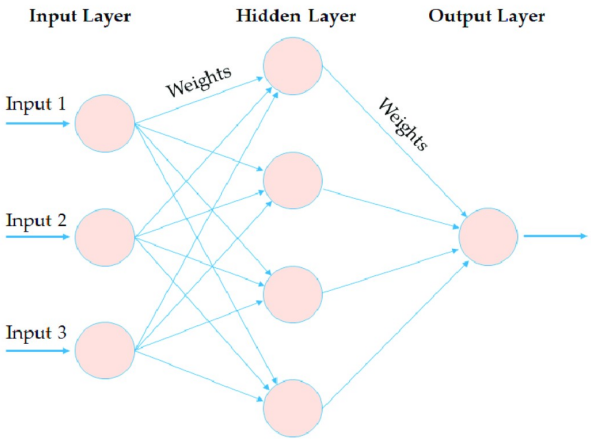


Figure 2: LSTM Model Summary

3.1 Single hidden layer LSTM

A single layer network is a simple structure consisting of m neurons each having n inputs. The system performs a mapping from the n -dimensional input space to the m -dimensional output space. To train the network the same learning algorithms as for a single neuron can be used. The Single Layer LSTM model can be seen in 3.

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm (LSTM)                  (None, 5, 80)             26240
_________________________________________________________________
lstm_1 (LSTM)                (None, 80)                51520
_________________________________________________________________
dense (Dense)                (None, 1)                 81
=================================================================
Total params: 77,841
Trainable params: 77,841
Non-trainable params: 0
_________________________________________________________________
```

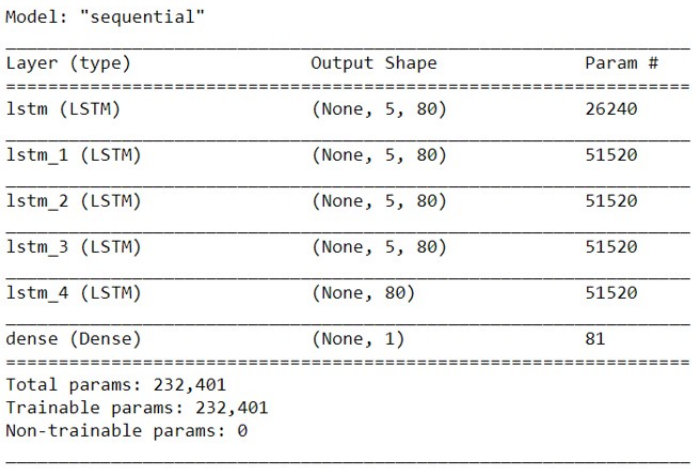
Figure 3: Single LSTM Model Summary

3.2 Multiple hidden layer LSTM.

The Stacked LSTM is an extension to this model that has multiple hidden LSTM layers where each layer contains multiple memory cells.Additional hidden layers can be added to a Multilayer Perceptron neural network to make it deeper. The additional hidden layers are understood to recombine the learned representa-

tion from prior layers and create new representations at high levels of abstraction. For example, from lines to shapes to objects.

A sufficiently large single hidden layer Multilayer Perceptron can be used to approximate most functions. Increasing the depth of the network provides an alternate solution that requires fewer neurons and trains faster. Ultimately, adding depth it is a type of representational optimization.



```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm (LSTM)                  (None, 5, 80)             26240
_________________________________________________________________
lstm_1 (LSTM)                (None, 5, 80)             51520
_________________________________________________________________
lstm_2 (LSTM)                (None, 5, 80)             51520
_________________________________________________________________
lstm_3 (LSTM)                (None, 5, 80)             51520
_________________________________________________________________
lstm_4 (LSTM)                (None, 80)                51520
_________________________________________________________________
dense (Dense)                (None, 1)                 81
=================================================================
Total params: 232,401
Trainable params: 232,401
Non-trainable params: 0
_________________________________________________________________
```

Figure 4: Multiple hidden layer Lstm summary

3.3 Selecting Number of Neurons The model is run for different number of neurons ranging from 1 to 100, with an interval of 10.The Mean absolute precentage error is plotted for various selection of neurons in Fig 5. The maximum error was found at 30 Neurons with MAPE at 30 Neurons being 38.03%. The minimum error was found at 80 Neurons. The MAPE at 80 Neurons was – 1.91

3.4 Selecting Optimal Epochs It is important to select correctly the number of times the model is run while training. Built in function of early stopping is implemented to prevent overfitting and underfitting. The optimal number of epochs was around 200. This was done by monitoring validation loss for patience level of 50.

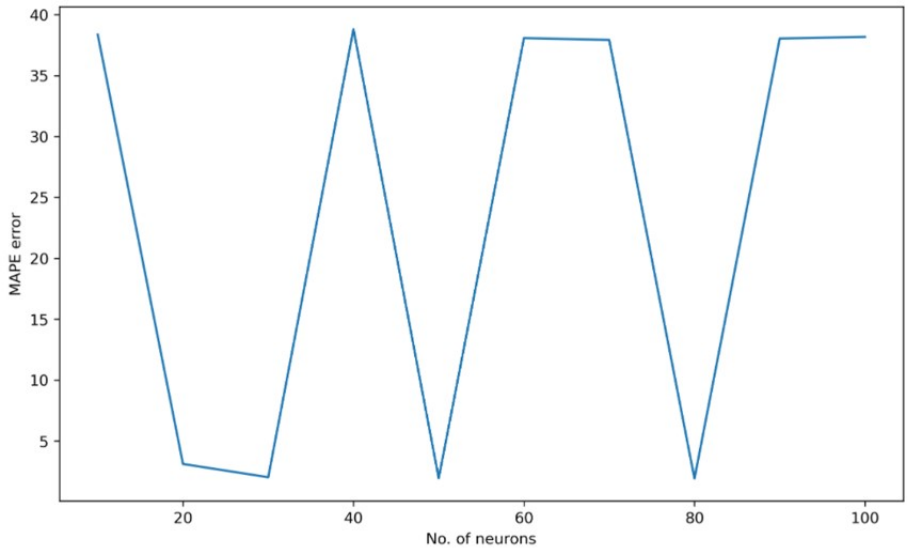


Figure 5: MAPE Error vs. Number of Neurons

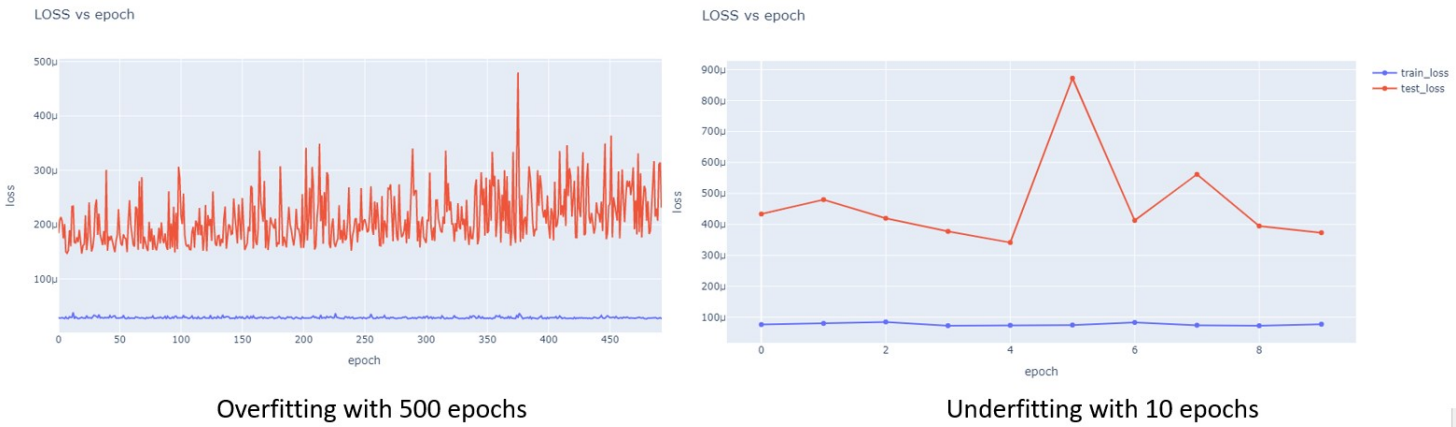


Figure 6: Loss vs. epoch over-fitting the model

4.Result

We can see in Fig 7, increase number of hidden layer increase the error . Also single hidden layer **LSTM** model will give the best result .

The optimal number of epochs was around 200

Using Single layer model gave the best prediction.

Optimal number of Neurons was 80.

Metric	Value
RMSE_training	77.8553
RMSE_test	175.159
MAE_train	60.5599
MAE_test	127.618
MAPE_train(%)	0.800251
MAPE_test(%)	1.04112

Single hidden layer LSTM

Metric	Value
RMSE_training	97.5791
RMSE_test	348.824
MAE_train	76.331
MAE_test	290.033
MAPE_train%	0.972116
MAPE_test%	2.12338

Multiple hidden layer LSTM

Figure 7: Multiple hidden layer LSTM

5. Conclusion

In this project, we have predicted market value of Nifty Indices using Deep Learning Model like LSTM. We have used Single hidden layer and also multiples hidden layer LSTM to predict market value of Nifty Indices . Multiple hidden layer model predictions are not so much helpful since there prediction error is more then the single hidden layer . We have tried to predict Market Value by the single hidden layer and we get the better result. That's why we can say that single hidden layer is better option then multiple hidden layer . The predicted value of the Nifty index does predict the trend of the actual index value.

References

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