Predictiong future STOCK PRICES using Deep Learning Recurrent Neural Network(RNN) with Long Short-Term Memory (LSTM)

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Abstract

The future is unknown and uncertain, but there are ways to predict future events and reap the rewards safely. One such opportunity is the application of machine learning and data science for stock market prediction. Therefore, through this medium of skill project we intend to prognosticate the next state of future prices through a **Long Short Term Memory** (LSTM) method.

Predicting stock market prices is a complex task that traditionally involves extensive human-computer interaction. Due to the correlated nature of stock prices, conventional batch processing methods cannot be utilized efficiently for stock market analysis. We propose an online learning algorithm that utilizes a kind of **Recurrent Neural Network** (RNN) called **Long Short Term Memory** (LSTM), where the weights are adjusted for individual data points using **stochastic gradient descent**. This will provide more accurate results when compared to existing stock price prediction algorithms. The network is trained and evaluated for accuracy with various sizes of data, and the results are tabulated. A comparison with respect to accuracy is then performed against an Artificial Neural Network.

KEY WORDS : stock prediction, Long Short Term Memory(LSTM), Recurrent Neural Network(RNN), online learning, stochastic gradient descent.

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1 INTRODUCTION

The stock market is a vast array of investors and traders who buy and sell stock, pushing the price up or down. The prices of stocks are governed by the principles of demand and supply, and the ultimate goal of buying shares is to make money by buying stocks in companies whose perceived value (i.e., share price) is expected to rise. Stock markets are closely linked with the world of economics —the rise and fall of share prices can be traced back to some Key Performance Indicators (KPI39;s). The five most commonly used KPI39;s are the opening stock price ('Open39;), end-of- day price ('Close39;), intraday low price ('Low39;), intra-day peak price ('High39;), and total volume of stocks traded during the day ('Volume39;). Due to the sheer volume of money involved and number of transactions that take place every minute, there comes a trade-off between the accuracy and the volume of predictions made; as such, most stock prediction systems are implemented in a distributed, parallelized fashion. These are some of the considerations and challenges faced in stock market analysis.

2 PROPOSED SYSTEM

We propose an online learning algorithm for analysing and predicting Lists are easy to create:

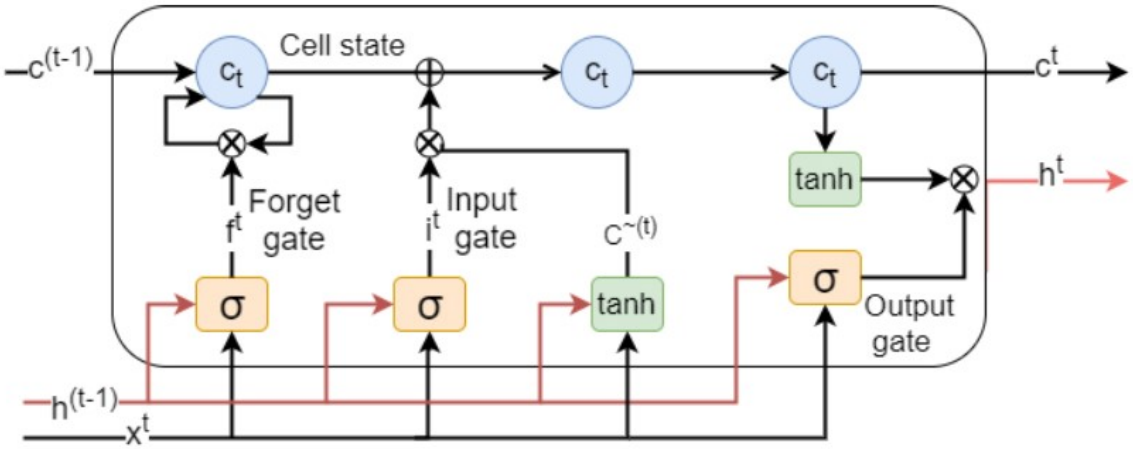
- What was the change in price of the stock overtime?
- What was the daily return of the stock on average?
- What was the moving average of the various stocks?
- What was the correlation between different stocks?
- How much value do we put at risk by investing in a particular stock?
- How can we attempt to predict future stock behaviour? (Predicting the closing price stock price of APPLE Inc. using LSTM)

3 LSTM – an overview

Long Short-Term Memory (LSTM) is one of many types of Recurrent Neural Network RNN, it's also capable of catching data from past stages and use it for future predictions.

In general, an Artificial Neural Network (ANN) consists of three layers :

1. Input layer
2. Hidden layers
3. Output layer



An LSTM memory cell, as depicted in Figure, has the following three components, or gates:

- **Forget gate:** the forget gate decides when specific portions of the cell state are to be replaced with more recent information. It outputs values close to 1 for parts of the cell state that should be retained, and zero for values that should be neglected.
- **Input gate:** based on the input (i.e., previous output o(t-1), input x(t), and previous cell state c(t-1)), this section of the network learns the conditions under which any information should be stored (or updated) in the cell state.
- **Output gate:** depending on the input and cell state, this portion decides what information is propagated forward (i.e., output o(t) and cell state c(t)) to the next node in the network.

4 Architecture System Design

Data flow control :

1. Data is initially collected from online sources or the stock exchange.
2. Data is then used to train the system.
3. Trained model is saved.
4. User views the trade exchange and stock of a company.
5. Using the model, closing prices are predicted.

Obtained Data has five features:

1. **Date:** of the Observations.
2. **Opening price:** of the stock.
3. **High:** Highest intra-day price reached by the stock.
4. **Low:** Lowest intra-day price reached by the stock.
5. **Volume:** Number of shares or contracts brought and sold in the market during the day.

5 Stock prediction algorithm

Algorithm 1: LSTM stock prediction algorithm
Input: Historical stock price data
Output: Prediction for stock prices based on stock price variation

1. Start
2. Stock data is taken and stored in a NumPy array of 3 dimensions (N,W,F) where:
   - N is number of training sequences
   - W is sequence length
   - F is the number of features of each sequence
3. A network structure is built with [1,a,b,1] dimensions, where there is 1 input layer, a neuron in the next layer, b neurons in the subsequent layer, and a single layer with a linear activation function.
4. Train the constructed network on the data.
5. Use the output of the last layer as prediction of the next time step.
6. Repeat steps 4 and 5 until optimal convergence is reached.
7. Obtain predictions by providing test data as input to the network.
8. Evaluate accuracy by comparing predictions made with actual data.
9. End

6 Terminologies used

1. **Training set:** subsection of the original data that is used to train the neural network model for predicting the output values.
2. **Test set:** part of the original data that is used to make predictions of the output value, which are then compared with the actual values to evaluate the performance of the model.
3. **Validation set:** portion of the original data that is used to tune the parameters of the neural network model.
4. **Activation function:** in a neural network, the activation function of a node defines the output of that node as a weighted sum of inputs.

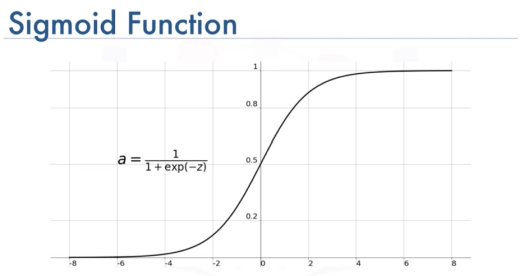
   Activation Function = $\sum(Input * weights) + Bias$

Here, the sigmoid and ReLU (Rectified Linear Unit) activation functions were tested to optimize the prediction model.

- Sigmoid – has the following formula

  y = 1/(1+e*-x)

  and graphical representation:

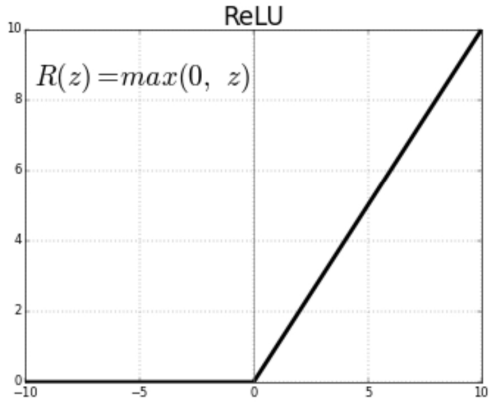


- ReLU – has the following formula

  y=max (0, x)

  and graphical representation

$$g(z) = \max\{0, z\}$$



ReLU Activation Function

5. **Batch size:** number of samples that must be processed by the model before updating the weights of the parameters
6. **Epoch:** a complete pass through the given dataset by the training algorithm.
7. **Dropout:** a technique where randomly selected neurons are ignored during training i.e., they are "dropped out" randomly. Thus, their contribution to the activation of downstream neurons is temporally removed on the forward pass, and any weight updates are not applied to the neuron on the backward pass.
8. **Loss function:** a function, defined on a data point, prediction and label, that measures a penalty such as square loss which is mathematically explained as follows –
   l(f(xi), yi) = (f(xi)-yi
9. **Cost function:** a sum of loss functions over the training set. An example is the Mean Squared Error (MSE), which is mathematically explained as follows:
   MSE () = $\sum Ni = l(f(xi) - y)/N$

10. **Root Mean Square Error (RMSE):** measure of the difference between values predicted by a model and the values actually observed. It is calculated by taking the summation of the squares of the differences between the predicted value and actual value, and dividing it by the number of samples. It is mathematically expressed as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} \|y(i) - \hat{y}(i)\|^2}{N}},$$

In general, smaller the RMSE value, greater the accuracy of the predictions made

7 Implementation of Algorithm

Algorithm:StockPrediction
Input: COMP, `D_RANGE`, `N_PRED` [company, date range,`n-day` predictions]
Output : A vector of predicted prices and graph, RESULT

1. data-fetch stock for COMP in date range `D_RANGE`
2. plot(data)
3. traindata + sliding Window(data) //perform sliding window operation ondata
4. RESULTS-0 //set accuracy vector to zeroes
5. for each day in `N_PRED`:
   (a) model-LSTM(`train_data`) //pass the training data to LSTM
   (b) pred predict(model,day) //predict the price given model and day
   (c) remove first item from `train_data` //removing last item
   (d) `train_data`-add pred to `train_data` //Last In, First Out.
   (e) RESULTS add pred to RESULTS
6. end for
7. print (RESULTS)
8. plot(RESULTS)
9. return

8 Results and Discussion

1. **Change in price of Stock Overtime**

   First of all we find out the change in price of the stock overtime by visualizing theclosing price of each stock

2. **Daily Return of Stock on average**

   To analyse the risk of the stock , we'll need to take a closer look at the daily changes of the stock, and not just its absolute value. Let's go ahead and use pandas to retrieve the daily returns for the Apple stock.

3. **Correlation between different stocks closing prices**

   Now we can compare the daily percentage return of two stocks to check how correlated. Finally, we could also do a correlation plot, to get actual numerical values for the correlation between the stocks' daily return values. By comparing the closing prices, we see an interesting relationship between Microsoft and Apple.

4. **How much value do we put at risk by investing in a particular stock?**

   There are many ways we can quantify risk, one of the most basic ways using the information we've gathered on daily percentage returns is by comparing the expected return with the standard deviation of the daily returns.

Predicting the closing stock price of APPLE Inc.

Out[34]:

	Close	Predictions
Date		
2021-08-18	146.360001	156.496674
2021-08-19	146.699997	156.400574
2021-08-20	148.190002	156.024658
2021-08-23	149.710007	155.831879
2021-08-24	149.619995	156.002792
...	...	...
2022-02-10	172.119995	182.100449
2022-02-11	168.639999	182.034378
2022-02-14	168.880005	181.115479
2022-02-15	172.789993	180.050308
2022-02-16	172.408493	179.768295

127 rows × 2 columns

9 Conclusion

Determining the stock market forecasts is always been a challenging work.

Thus, Project applies the data mining technology of neural network to stock price forecast and receives a preferable result, which will provide the research of the stock market development a new thought We attempted to make use of huge textual data to predict the stock market indices.

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