

LSTM For Stock Price Trend Recognition

Abstract

The objective of this project is to build an LSTM model that outputs the probability of a stock being in an uptrend. The model output can be then used to identify price trend shifts and we can exploit it to make trade decisions that would yield profit. In this project we trained the model on historical price data of the S&P 500 index and back-tested our trading algorithm on Microsoft, Apple and Amazon stocks. We train the model on an index rather than the stock itself because stock market follow the trend of the index.

Method

First, we gathered past 5,274 price data of S&P500 and performed a 50-day window exponential smoothing on price and trade volume as shown below in figure 1. This was done to ensure that the model learns the general trend of the index, but not the noises.

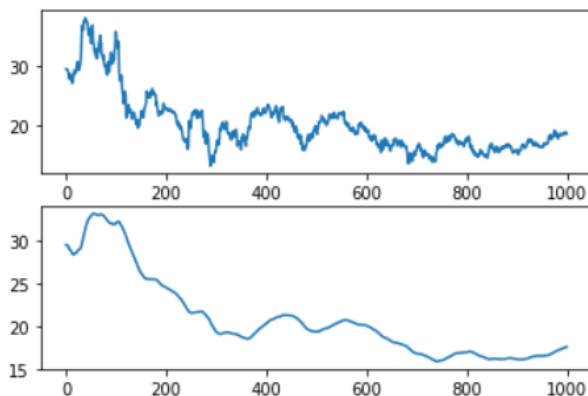


Figure 1. 50-day exponential smoothing on first 1,000 days

The LSTM model will make its prediction based on price and trade volume of the past 50 days. Thus, the training input shape for the model would look like (5,224, 50, 2) since we have 5224 samples with 50-day timestep 2 features. The training label is 1 if tomorrow's price is larger than today's price, and 0 otherwise.

The model architecture is a feed forward neural network with an LSTM layer with 50 unit and a final dense output layer with a sigmoid activation function.

Model: "sequential"

Layer (type)	Output Shape	Param #
lstm (LSTM)	(None, 50)	10800
dense (Dense)	(None, 2)	102

Total params: 10,902
Trainable params: 10,902
Non-trainable params: 0

Figure 2. Model Architecture

A single epoch of training on the first 1,000 days of inputs resulted in a training accuracy around 80% and validation accuracy 90%. Further training makes no improvement in validation accuracy.

Results

Below is the model prediction for the next 150 days (day 1,000 ~ 1,150). We plotted the Microsoft stock price and the model output as show in figure 3. When the model output is above 0.5, the point is blue and red vice versa.

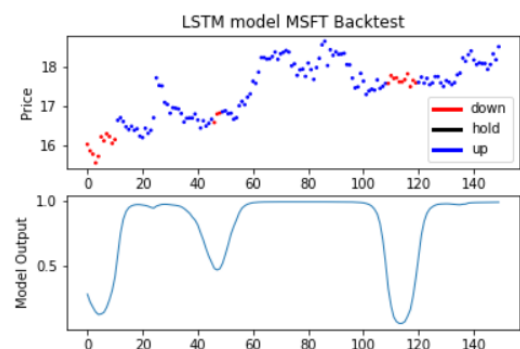


Figure 3. Model Trend Estimation

Notice that the model predicts an alternating pattern of down and up trends. We will use the model output to determine the time of entry and exit.

A strategy we have chosen is to...

- (1) enter when the trend shifts to the blue uptrend.
- (2) Hold position while the price is at blue uptrend.
- (3) Exit when the price hits the next red downtrend.

Implementing this strategy as an algorithm and executing it, the model enters at day 1,021 and exits at day 1,120, yielding 7% profit.



Figure 4. Trade Result on day 1,000 ~ 1,150

To verify if this trade strategy is valid on different time intervals, we did the same procedure for 40 intervals over the past 16 years on 3 different stocks: Microsoft, Apple, and Amazon.

For each stock, we plotted the distribution of profits yielded by the model’s trade in figure 5. The All three boxplots are heavily right skewed with an average median around 13% and an average mean around 27%. While the 1st quantile for all three distribution is near -1.6 ~ -1.7%, the 3rd quantile is above 25%. The model however does have some risk of negative outlier like minimum profit of -17.75% resulted from trading Amazon stock.

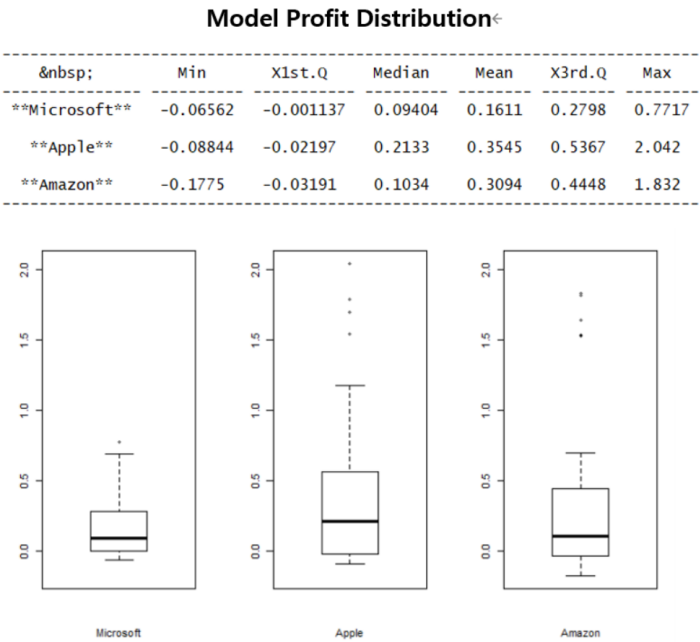


Figure 5. Model trade profit on Microsoft, Apple, Amazon stock

Conclusion

The LSTM model can correctly identify the general price trend of S&P500 index with high probability. Thus, we can come up with various strategies that can utilize the model output. A simple enter exit strategy used in this project yielded stable non-negative profits for all three stocks. Although this could be a valid trade strategy for a single short-term trade, we do not know if it would be the same for long term trades. Further work could try conducting these short trades multiple times over long term and see if it outperforms a buy and hold strategy.