Stock Prediction with LSTM in Bear v.s. Bull Markets in U.S. and China

Shiqi Pan

I. Introduction

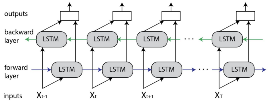
LSTM models have been shown as effective in stock prediction. In this project, we experiment with 3 variations of LSTM models to predict the stock opening prices. And we apply the models to bear v.s. bull markets with S&P500 and China SSE Composite Index aiming to provide insight in models' performance during times of increased market voltality.

II. Models & Setup

Evaluation Metric: We use RMSE,... for models' proformance evaluation.

Models: We experiment with the following LSTM variations.

1.Simple LSTM
2.Bidirectional LSTM
3.BiLSTM with Attention (Bi-LSTM-Att)



Bidirectional LSTM

Package: We implement keras for model development.

III. Datasets

We evaluate the models with U.S. and Chinese stock indices, S&P500 and SSE Exchange Index respectively. For each, the data is splited into periods of bear v.s. bull markets, and for each period, we take the data 4-times-length before it for training, i.e., 80% training and 20% testing data.

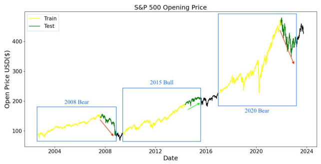
All data are fetched from Yahoo Finance, and they include the daily stock data: open, high, low, close, adjusted close and volume, This research focuses on the daily Open price.

S&P500

Period	Prediction/Test Period	Train Period	Test Len	Train Len	Market
Recent	2019/07 - 2023/09	2002/09 - 2019/07	1061	4245	General
2008 Bear	2007/08 - 2008/11	2002/09 - 2007/08	312	1252	Bear
2015 Bull	2014/05 - 2015/08	2009/05 - 2014/05	312	1252	Bull
2022 Bear	2021/12 - 2023/03	2016/12 - 2021/12	312	1252	Bear

S&P500 Datasets

We consider the stock opening price from 2002/09/01 to 2023/10/01. We take the data in equal-lengt periods of 2002/09-2008/11, 2009/05-2015/08, and 2016/12-2023/03. Each is splited into training(80%) and testing(20%) sets and the testings sets cover the bear market in 2008(2007/08-2008/11), bull market in 2015(2014/05-2015-08), and bear market in 2022(2021/12-2023/03). In addition, we also use the whole dataset to predict a longer period of 2019/07-2023/09.



China SSE Composite Index

We use SSE Composite Index(000001.SS) for Chinese market.

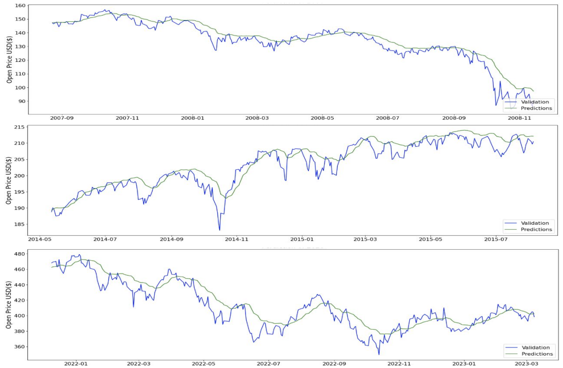
Period	Prediction/Test Period	Train Period	Test Len	Train Len	Market
Recent	2019/07 - 2023/09	2002/09 - 2019/07	1023	4093	General
2008 Bear	2007/11 - 2009/02	2002/09 - 2007/08	312	1192	Bear
2014 Bull	2014/02 - 2015/06	2008/12 - 2014/02	312	1192	Bull

IV. Results

We observe the following results:

1. **Bi-LSTM-Att** outperforms other models on average.
2. Models performs better with less **volatility** on market, e.g. during 2015 in S&P500 where the market follows the upward trend in the previous years.
3. **S&P 500** stock prediction obtains better results than SSE Index prediction. The average adjusted RMSE of the former(0.0095) is 52.4% of the later(0.0181), both with Bi-LSTM-Att).
4. The graph of the predicted prices tend to be **smoother** with more centered values, esepcailly during times with high volatility.

Market Period	Train Loss	Adj. RMSE	MAE	MSE	RMSE
Stock Predictions of S&P 500 - LSTM					
Recent	3.7932e-05	0.0206	6.8939	72.1741	8.4955
2008 Bear	1.7465e-05	0.0092	2.7812	14.3773	3.7917
2015 Bull	3.4139e-05	0.0064	2.0230	6.9338	2.6332
2022 Bear	3.0585e-04	0.0355	11.5238	212.6314	14.5819
Stock Predictions of S&P 500 - BiLSTM					
Recent	3.9144e-05	0.0156	4.6921	41.2269	6.4208
2008 Bear	1.7623e-05	0.0098	2.8805	16.2450	4.0305
2015 Bull	3.7808e-05	0.0072	2.2288	8.8610	2.9767
2022 Bear	4.4654e-04	0.0311	10.1425	164.6050	12.8298
Stock Predictions of S&P 500 - Attention Bi-LSTM					
Recent	2.3939e-05	**0.0127**	3.8314	27.7046	5.2635
2008 Bear	6.5319e-06	**0.0061**	1.7868	6.3241	2.5148
2015 Bull	1.5134e-05	**0.0042**	1.2975	2.9949	1.7306
2020 Bear	8.8309e-05	**0.0151**	4.8593	38.6152	6.2141
Stock Predictions of SSE Composite Index - Attention Bi-LSTM					
Recent	2.3442e-04	**0.0110**	45.4443	3105.7441	55.7292
2008 Bear	1.7565e-04	**0.0266**	105.4714	18061.4677	134.3930
2014 Bull	1.8547e-04	**0.0167**	56.4101	7140.6798	84.5025



V. Future Work

- To apply the models on stock prediction tasks in other markets.
- To incorporate additional technical indicators such as investor sentiments(with the implementation of NLP), OBV, KDJ, and RS
- To extend to trading decision and portfolio optimization with "Buy High Sell Low" strategy and see returned annual interests.