Optimizing Stock Market Predictions with Hybrid Deep Learning Architectures

Catherine Zhang (yz5609) Tianyu Wu (tw1802) Xintong Xie (xx964) Zhiyu Guo (zg915)

March 28, 2024

1 Research Question & Importance

Our research delves into the application of advanced machine learning models in finance, specifically investigating, "How can integrating multiple deep neural networks enhance performance and accuracy in predicting time-series stock data?"

The complexity and adaptability of neural networks offer a significant advantage in addressing stock data's non-linearity compared to traditional auto-correlated regression models. Recent studies highlight deep neural networks' potential to improve prediction performance significantly. Our project aims to explore how the synergistic use of various DNNs can further enhance stock prediction accuracy. This investigation will contribute to our understanding of DNN interrelations, feature learning across different layers, and the underlying dynamics of stock returns.

2 Previous Work & Literature

Huang et al. have extensively reviewed machine learning models, particularly deep learning (DL) and deep neural networks (DNN), in finance, noting the increasing trend of applying Recurrent Neural Networks (RNNs) for time-series financial data. Among RNNs, Long Short-Term Memory (LSTM) networks are preferred for their ability to incorporate historical data. While standard LSTMs have demonstrated strong predictive capabilities, recent literature has explored their variants. Sunny et al. showed that Bi-Directional LSTM (BI-LSTM) could surpass traditional machine learning models, including simple LSTMs, in predicting Google's stock price. Lu et al. introduced a CNN-LSTM model that combines Convolutional Neural Networks (CNNs) for feature extraction with LSTMs for prediction, achieving superior performance over conventional LSTM models. Motivated by these findings, we aim to examine the effects of CNN and LSTM integration on model performance and explore whether further enhancements can be achieved by incorporating BI-LSTM.

3 Data Source

Our primary data source will be U.S. stock price data, specifically daily returns from the S&P 500 index and select high-profile stocks, to capture both general market trends and individual stock performance. This data will likely be sourced from Yahoo Finance.

4 Research Plan & Evaluation

1. Conduct a comprehensive review one proposed models (CNN, LSTM, & BI-LSTM) and related literature.
2. Collect and preprocess the stock data.
3. Replicate the CNN-LSTM model proposed by Lu et al., analyzing the learned features.
4. Experiment with integrating BI-LSTM to create a CNN-BI-LSTM model and assess its performance.

Evaluation metrics will include RMSE, R-squared, and accuracy, as commonly used in existing literature, to ensure a robust comparison of model performance.

References

Huang, J., Chai, J., & Cho, S. (2020). Deep learning in finance and banking: A literature review and classification. *Front. Bus. Res. China, 14*, 13. https://doi.org/10.1186/s11782-020-00082-6

Lu, W., Li, J., Li, Y., Sun, A., & Wang, J. (2020). A CNN-LSTM-Based Model to Forecast Stock Prices. *Artificial Intelligence for Smart System Simulation, Volume 2020*. https://doi.org/10.1155/2020/6622927

Sunny, M. A. I., Maswood, M. M. S., & Alharbi, A. G. (2020). Deep Learning-Based Stock Price Prediction Using LSTM and Bi-Directional LSTM Model. In *2020 2nd Novel Intelligent and Leading Emerging Sciences Conference (NILES)*, Giza, Egypt (pp. 87-92). https://doi.org/10.1109/NILES50944.2020.9257950