**Reference: Forecasting the S&P 500 Index Using Mathematical-Based Sentiment Analysis and Deep Learning Models: A FinBERT Transformer Model and LSTM**

Stock price prediction has been a subject of significant interest in the financial mathematics field. Recently, interest in natural language processing models has increased, and among them, transformer models, such as BERT and FinBERT, are attracting attention. This study uses a mathematical framework to investigate the effects of human sentiment on stock movements, especially in text data. In particular, FinBERT, a domain-specific language model based on BERT tailored for financial language, was employed for the sentiment analysis on the financial texts to extract sentiment information. In this study, we use “summary” text data extracted from *The New York Times*, representing concise summaries of news articles. Accordingly, we apply FinBERT to the summary text data to calculate sentiment scores. In addition, we employ the LSTM (Long short-term memory) methodology, one of the machine learning models, for stock price prediction using sentiment scores. Furthermore, the LSTM model was trained by stock price data and the estimated sentiment scores. We compared the predictive power of LSTM models with and without sentiment analysis based on error measures such as MSE, RMSE, and MAE. The empirical results demonstrated that including sentiment scores through the LSTM model led to improved prediction accuracy for all three measures. These findings indicate the significance of incorporating news sentiment into stock price predictions, shedding light on the potential impact of psychological factors on financial markets. By using the FinBERT transformer model, this study aimed to investigate the interplay between sentiment and stock price predictions, contributing to a deeper understanding of mathematical-based sentiment analysis in finance and its role in enhancing forecasting in financial mathematics. Furthermore, we show that using summary data instead of entire news articles is a useful strategy for mathematical-based sentiment analysis.

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