F-055

Financial Index Prediction Based on Deep Learning Models

Kanagawa University

吴　家骏‡　　张 善俊‡

WU JIAJUN　　ZHANG SHANJUN

1. Abstract

Accurate prediction of stock price fluctuations is a critical challenge in financial markets, offering valuable information for investors and traders. Traditional statistical models and time series analysis methods have achieved certain successes but are limited by the high noise, nonlinearity, and non-stationarity of stock market data. This paper proposes a CNN-BiLSTM-ECA model to enhance stock price prediction accuracy. The model combines Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM) networks, and Efficient Channel Attention (ECA) modules. The proposed method is evaluated using Amazon stock data, demonstrating significant improvements in prediction performance.

2.Introduction

Predicting stock price fluctuations is a significant challenge in the financial market, providing valuable information for investors and traders. Accurate stock price predictions contribute to maximizing profits and managing risks effectively. Traditional statistical models and time series analysis methods have achieved certain successes in predicting stock prices. However, due to the high noise, nonlinearity, and non-stationarity of the stock market, the accuracy and reliability of these predictions are limited.

3.Research Objective

The objective of this research is to improve the prediction accuracy of stock price fluctuations using CNN-BiLSTM-ECA. Specifically, we aim to build a CNN-BiLSTM-ECA model that learns from past stock price data to predict future stock price movements and evaluate its performance.

4. Methodology

4.1 Data Collection and Preprocessing

Stock price data was sourced from Yahoo Finance, encompassing all open prices, high prices, low prices, closing prices, adjusted closing prices, and trading volumes of Amazon stock from May 16, 1997, to December 21, 2023. The data was normalized and converted into a Pandas DataFrame. A sliding window approach was employed to convert the dataset into sequences of input features. These sequences were split into training and testing sets, with 90% of the data allocated for training and 10% for testing. The data was reshaped into a format suitable for model training, creating a PyTorch dataset class named StockDataset.

4.2 Model Construction

The CNN-BiLSTM-ECA model integrates 1D convolutional layers to capture local relationships of input features. These are followed by bidirectional LSTM layers to model the temporal dependencies of the time series data. Next, the ECA modules apply channel-level attention adjustments, utilizing global average pooling, 1x1 convolutions, and Sigmoid activations. Pooling layers are used to reduce the length of the time series data, while Dropout layers are incorporated to prevent overfitting. The final fully connected layer employs Linear and Tanh activation functions to generate the prediction outputs.

5.Model Training

The model is trained to minimize loss on the validation data, with the best model saved during training. The training process is constructed as follows: a. Data loading: Stock price data is loaded using the StockDataset class, and a data loader is created. b. Model initialization: The loss function (MSELoss) and optimizer (Adam) for training are initialized. c. Training and validation: The model is trained using the training data for 100 epochs, and its performance is evaluated using the validation data. The best model is saved during training. d. Display of training progress: During training, the loss on the training and validation data is displayed at specified batch intervals. The model is saved whenever the minimum validation loss is updated.

6.Research Results

To verify the effectiveness of the proposed model, CNN-BiLSTM-ECA and CNN-BiLSTM are compared using Amazon stock data. This dataset includes all open prices, high prices, low prices, closing prices, adjusted closing prices, and trading volumes of Amazon stock from May 16, 1997, to December 21, 2023. The prediction results are the closing prices from February 2, 2022, to April 20, 2023. In the figures, the blue curve represents the predicted closing prices, and the red curve represents the actual closing prices. The x-axis represents time, and the y-axis represents the normalized stock prices. Experimental results demonstrate that the proposed

† 著者所属 Kanagawa university　著者所属英語
‡ 著者所属 Kanagawa university　著者所属英語

model has the highest prediction accuracy and the best performance. The CNN-BiLSTM-ECA model has an MSE of 0.0018066 and an MAE of 0.002043, the lowest among all methods. Compared to the CNN-BiLSTM model, the MSE and MAE are reduced by 27% and 32%, respectively. It is difficult to achieve high prediction accuracy with a single network, but the complexity of the network contributes to improving prediction accuracy. The proposed CNN-BiLSTM-ECA model effectively predicts stock prices, providing relevant reference information for investors to maximize investment returns.

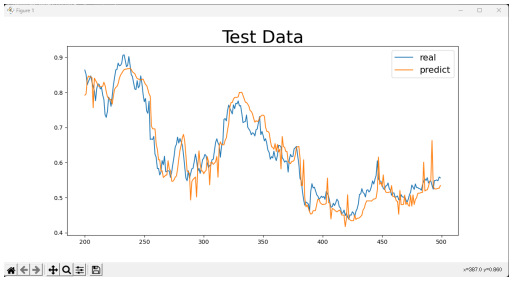

Figure 1. CNN-BiLSTM-ECA

Figure 2. CNN-BiLSTM

	MSE	MAE
CNN-BiLSTM	0.0022988	0.002696
CNN-BiLSTM-ECA	0.0018066	0.002043

Table 1.

7. Conclusion and future work

In the stock market, learning future prices is crucial for investment decisions. This paper proposes a new time series prediction network model for stock prices (CNN-BiLSTM-ECA). This model takes the opening price, closing price, high price, low price, adjusted closing price, and trading volume of stock prices as input and predicts the closing price for the next trading day. The proposed network model combines CNN and BiLSTM network models. Firstly, CNN is used to effectively extract deep features from the input data. Then, feature vectors are constructed from the time series data, which are input into the BiLSTM network for learning and prediction. Simultaneously, the ECA attention model is introduced to the model to enhance the importance of learning features. In the future, further research on the causes of these results will be conducted to improve the prediction accuracy and generalization ability of the model. The CNN-BiLSTM-ECA model proposed in this experiment demonstrates the potential to effectively predict stock prices, providing relevant reference information for investors to maximize investment returns.

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