Food enterprises' profit growth rate prediction based on LSTM from the perspective of the supply chain

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Introduction

The profit growth rate is crucial in providing a decision-making reference for enterprises in planning business objectives in the next stage. Therefore, in this paper, we propose an LSTM-based model to predict the profit growth rate of 41 food enterprises by using the operational data of four seasons ahead. Moreover, considering that the COVID-19 epidemic has a significant impact on the food supply chain and affects enterprises' profits, we introduce the factor of the supply chain into the prediction of profit growth rate.The experiment results show that the LSTM prediction model exhibits high accuracy in predicting the profit growth rate.

Methodology

The financial data of listed food enterprises is served quarterly, mainly from March 2016 to March 2021. We choose 24 secondary indexes from the financial dataset, which can be classified into three dimensions, income, costs, and administration.The calculation formula of profit growth rate is constructed as follows:

$$R = (V_{n+1} - V_n)/|V_n| \times 100\%$$

The LSTM model consists of a chain of repetitive memory units. Each unit contains three gates: input gate, forget gate, and output gate (Figure 1).
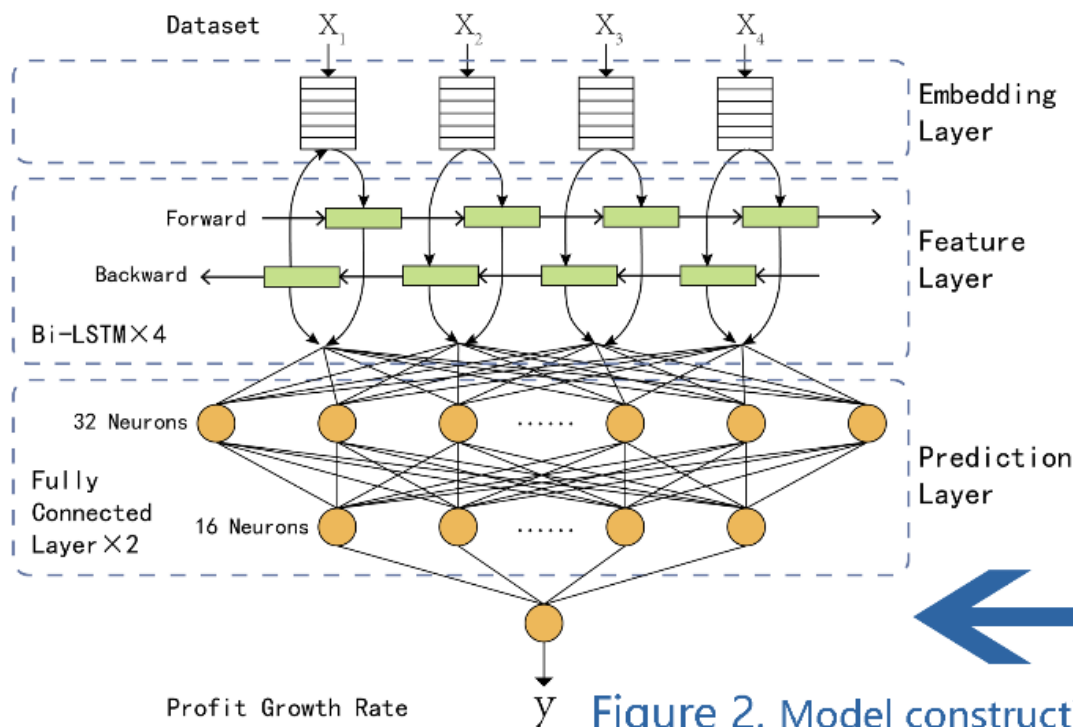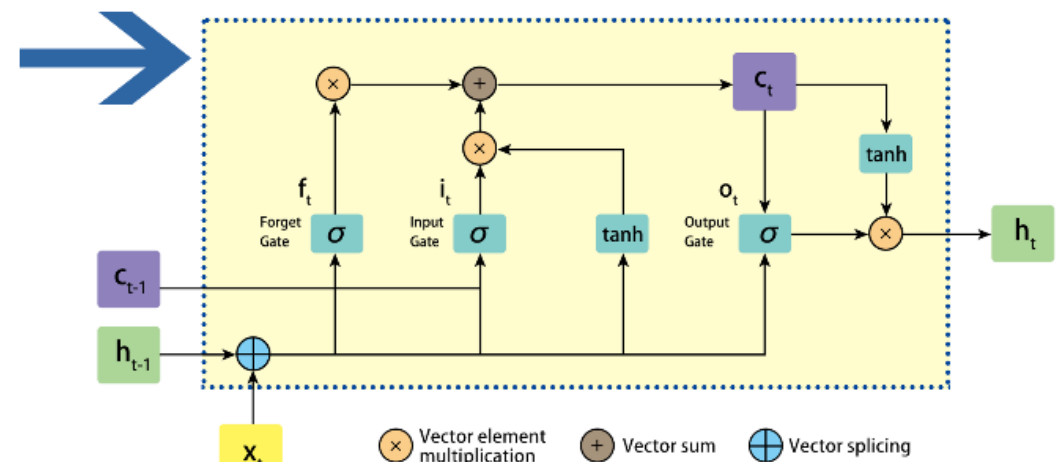

Figure 1. A memory unit of LSTM

We apply an LSTM model with 4 layers of Bi-LSTM , and each one contains 32 units and a ReLU activation function. Each input contains a 4-time step. Add 2 fully connected layers after the Bi-LSTM layers.

Figure 2. Model construction

Training Process

We collect 192 samples in total for this experiment. Each data sample includes the enterprise's financial data for four quarters; each input contains a 4-time step.The input shape is (4,25), and then the model is trained.

Table 3. Training hyperparameters setting

Model	Construction and output shape	Training Hyperparameters
Bi-LSTM	**Input** **Bi-LSTM layer × 4** **Fully connected layer×2** **RELU**	Batch size 6, **8**,12 Learning rate 0.01,**0. 001**, 0.0001 Epochs 500, 800, **1000** Loss function: **Mean Absolute Error** Update strategy: **Adam**

*The BOLD labels indicate the final chosen parameters.

Conclusion

This paper introduces the Bi-LSTM model to train the financial data of listed food enterprises. Considering the type of supply chain owned by enterprises under the background of the COVID-19 pandemic, we divide enterprises into 2 types. We select 41 food enterprises and collect 192 samples including 25 features for this study. The result of our study indicates that the Bi-LSTM model performs better than the traditional prediction methods and enhances the guiding role for enterprise management.

Results

The result of 4-fold absolute error and relative error shows in Table 4.We can see that the difference between the predicted and actual value is very small, as the model's output is the profit growth rate. It indicates that the LSTM prediction model achieves high accuracy in predicting profit growth rate.

Table 4. LSTM training and test error

Fold Number	Training error		Test error	
	Absolute error	Relative error	Absolute error	Relative error
1-fold	0.059	9.62%	0.173	14.56%
2-fold	0.078	6.50%	0.117	13.21%
3-fold	0.053	8.79%	0.138	10.99%
4-fold	0.067	6.16%	0.091	10.67%
Average	0.065	7.77%	0.130	12.36%

The change of the loss value as the epoch increases during the training process shows in Figure3. It indicates that the training of this study is effective.