Special Topic

1. Name

Using LSTM to predict stock price and apply Black-Litterman Model to allocate asset

2. Black-Litterman Model

Black-Litterman model is a mathematical model for portfolio allocation developed in 1990 at Goldman Sachs by Fischer Black and Robert Litterman, and published in 1992. It seeks to overcome problems that institutional investors have encountered in applying modern portfolio theory in practice. The model starts with an asset allocation based on the equilibrium assumption (assets will perform in the future as they have in the past) and then modifies that allocation by taking into account the opinion of the investor regarding future asset performance.

The formula is: $E[R] = [(\tau\Sigma)^{-1} + P'\Omega^{-1}P]^{-1} [(\tau\Sigma)^{-1}\Pi + P'\Omega^{-1}Q]$

τ: scale factor
Σ: Covariance matrix of Excess rate of return
P: Investor's view matrix
Π: Implied equilibrium rate of return vector
Q: Point of view earnings vector
Ω: Covariance matrix of opinion error, used to express the difference between the investor's opinion and the actual situation

What we will do is find the investor's view matrix and the point of view earnings vector to apply on BL model

3. Using LSTM to Predict stock price

3.1 Training Method

I use 3 years stock data to train model, and use this model to predict April, 2021. Finding the maximal stock price in the predicted data, then calculate the rate of return to apply it on BL model as a parameter matrix(Investor viewpoint matrix). Therefore, we can get the asset allocation from BL model.

3.2 Why is LSTM

I compare this model with SVR(Support Vector Regression). SVR uses SVM to do regression analysis. SVM is good to solve classification problem, but in regression, this algorithm is very sensitive to parameters and kernel function.

So the performance of SVR is worse than that of LSTM. We look at it from the perspective of root mean square error.

We used the data from March, 2018 to March, 2021 to train model. Root mean square error (RMS)formula is: sqrt(mean((real_data - predicted_data)^2))

RMS of LSTM: 1.72, RMS of SVR: 10.14. Therefore, we can find that LSTM model is more better than SVR in this view.

4. Compare with the report of the investment company

I got the target price of the stock from 4 credible investment companies. I used it to calculate the rate of return and apply it on BL model as a parameter matrix(Investor viewpoint matrix). Then, we could get a asset allocation that is different from the using LSTM to predict one. And we compare the rate of return in April, 2021.

5. BL Asset Allocation

LSTM

Stock ID	2002	2330	2603	2881
Config	-0.08	-0.49	1.5	0.07

Report

Stock ID	2002	2330	2603	2881
Config	0.74	0.015	0.195	0.05

6. The Rate of Return

We calculate the stock price on the last day of April to calculate the rate of return (assuming that it is sold on the last day of April)

The stock price on the last day of April (Open price)

Stock ID	2002	2330	2603	2881
4/01	26	598	47	57.6
4/29	39.5	609	77.8	64.9
Rate of Return(%)	51.9	1.5	65.5	12.7

Assume we have NTD20,000,000 initial funds. And we can long(Buy before Sell) or short(Sell before Buy) stock. Let's calculate the rate of return of each method.

5.1 LSTM

Stock ID	2002	2330	2603	2881
	Short	Short	Long	Long
Money(NTD)	800,000	4,900,000	15,000,000	700,000
Earn	-415,200	-73,500	9,825,000	88,900

Total profit: (-415,200) + (-73,500) + 9,825,000 + 88,900 = 9,425,200
The Rate of Return: Total profit / Initial Funds = 9,425,200 / 20,000,000 = 47.13%

6.2 Report of Investment Company

Stock ID	2002	2330	2603	2881
	Long	Long	Long	Long

Money(NTD)	14,800,000	300,000	3,900,000	1,000,000
Earn	7,681,200	4,500	2,554,500	127,000

Total profit: 7,681,200 + 4,500 + 2,554,500 + 127,000 = 10,367,200
The Rate of Return: Total profit / Initial Funds = 51.84%

7. Conclusion

We can find that the rates of return of the two are very close.

The research report of the investment company is the conclusion obtained after a series of precise analysis of the company. The target price is set by a very professional person who specializes in accounting, international situations, economic conditions, business cycles, etc. To give an evaluation.

The LSTM model is based on historical stock price trend data as training data, and the trained artificial intelligence can predict future stock trends.

The LSTM model is suitable for providing a reference basis for investment in addition to the research report of the investment company, combining with the BL model to form a sound investment portfolio, and then earning profits in the stock market.