Capstone Proposal
Stock price prediction using GAN

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Description of the Problem

Deep learning nowadays is a new and exciting topic in the Machine Learning, it has been utilized in many areas owing to its “strong potential”, for example, it has been widely used in the financial area which is vital in the society, such as high-frequency trading, portfolio optimization, fraud detection and risk management. “Stock market prediction is one of the most popular and valuable areas in finance." In this project, we will compare two algorithms for stock prediction. First, we will utilize the Long Short Term Memory(LSTM) network to do the Stock Market Prediction. LSTM is a powerful method that is capable of learning order dependence in sequence prediction problems. Furthermore, we will utilize Generative Adversarial Network(GAN) to make the prediction. LSTM will be used as a generator, and CNN as a discriminator. In addition, Natural Language Processing(NLP) will also be used in this project to analyze the influence of News on stock prices.

Data Source

The stock price of Apple.Inc will be used in training and testing the model. The movement of stock price is influenced by many factors, such as the stock index of NASDAQ, NYSE, FTSE100, Nikkei225, BSE Sensex and Hang Seng. In addition, economic indices (Unemployment Rate, Personal Consumption Expenditures, Industry Production Index), exchange rate and inflation rate will also be used in the analysis. A very important feature indicating the stock movement is News. Daily news for Apple.Inc will be classified into positive, neutral or negative.

The time series data are from 2010 to 2020 and are downloaded from Yahoo finance, FRED.

Framework to Implement the Network

Long short-term memory (LSTM) is a specific recurrent neural network (RNN)

architecture, it can not only be utilized on single-point data but also on sequence of data. The basic components of LSTM are an input gate, an output gate and a forget gate, and the LSTM network was developed to resolve the vanishing gradient problem while training the traditional RNNs. LSTM is a cell memory unit which means that LSTM has the ability to remove or add information to the cell state.

GAN has two key components, generator and discriminator, and both are neural networks. The generator trains the input sequence data and generates the predicted value. Discriminator, which performs as a classifier, learns to evaluate the output data of the generator and assign high scores to the data it defines as real value and low scores it defines as generated value. Generator always wants to improve the performance to "fool" the discriminator. When the generator improves, there must be a loss increase in discriminator. And the goal is to find the lowest aggregate loss of generator and discriminator.

Deep Network Selection

LSTM is able to maintain an internal memory state based on its cell state, and be used for dealing with sequence and time-series related problems. This project will utilize multi-step LSTM with multivariable as the first model to predict the stock price.

A generative adversarial network (GAN), is an architecture for training deep learning-based generative models. The architecture of GAN consists of a generator and a discriminator model. The second model of this project will be GAN with the LSTM as the generator and convolution neural network (CNN) as the discriminator. Based on the original GAN, the original GAN can be improved by changing the loss function. The Wasserstein GAN (WGAN), was introduced by Martin Arjovsky, et al., which is an extension of the original GAN that both improves the stability when training the model and proposes a new loss function that correlates with the quality of generated images. Extended from the original WGAN, a paper "Improved Training of Wasserstein GANs" written by Ishaan Gulrajani, et al. proposed to expose penalty on the norm of weights from the critical network, which is the WGAN with gradient penalty(WGAN-GP) in this project.

Reference Materials and Background Support

Stock price predictions commonly use traditional time series models such as LSTM, ARIMA. Since GAN became more and more popular, some research began to use GAN to make the time series prediction. For example, Romero (2019) compared the LSTM model with the GAN model and had the result that the two models do not have significant differences. And Bi *et al.* (2020) also used GAN to make the stock price prediction and made an improvement than the benchmark. We found inspiration from their research to explore the use of an improved GAN model to make the prediction of a stock price movement.

Evaluation

Daily data from 2010 to 2018 will be trained in the algorithms and data from 2019 to 2020 will be used as test data. During the training, the result of different epochs will be compared, and the generator will be trained more times than the discriminator. In order to find the best model, different optimizers will be evaluated. Finally, the evaluation of the LSTM model and GAN model will be analyzed by comparing their prediction result.

Working Schedule

Check Point Date	**Milestone**
09/14/2020 - 09/20/2020	Project Proposal, Search Data
09/21/2020 - 09/26/2020	Data Preprocessing
09/27/2020 - 10/03/2020	Data Preprocessing
10/04//2020 - 10/10/2020	LSTM model
10/11/2020 - 10/17/2020	LSTM model
10/18/2020 - 10/25/2020	GAN model
10/26/2020 - 10/31/2020	GAN model
11/1/2020 - 11/7/2020	GAN model
11/8/2020 - 11/14/2020	Final prediction

11/15/2020 - 11/21/2020	Final prediction
11/22/2020 - 11/29/2020	Final report
11/30/2020	Mock Presentation
12/07/2020	Final Presentation

Reference:

Bi Q., Yan H., Chen C., Su Q. (2020) ,An Integrated Machine Learning Framework for Stock Price Prediction. In: Dou Z., Miao Q., Lu W., Mao J., Jia G. (eds) Information Retrieval. CCIR 2020. Lecture Notes in Computer Science, vol 12285. Springer, Cham. https://doi.org/10.1007/978-3-030-56725-5_8

R.A.C. Romero (2019), “Generative Adversarial Network for Stock Market price Prediction” . https://cs230.stanford.edu/projects_fall_2019/reports/26259829.pdf,

K. Zhang, G. Zhong, J. Dong, S. Wang, and Y. Wang (2019), “Stock Market Prediction Based on Generative Adversarial Network,” Procedia Computer Science, vol. 147, pp. 400–406, 2019.