CS771A: Project Proposal

Learning Differential Equations for Stock Market Predictions

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1 Objective:

The objective of this project is to create a Neural ODE model to predict stock prices and compare the results with commonly used LSTM models. Furthermore, we plan to improve these predictions by implementation of a Neural SDE framework.

2 Rationale:

With advancement in technology, stock prediction algorithms have gained importance in the financial world as accurate predictions imply larger profit gains of investors. However, modeling a seemingly random and chaotic system like the stocks market has always been a challenge. With ever-improving machine learning tools and concepts, engineers have already devised several models for the problem. Yet the challenge remains open. The year of 2018 saw the introduction of Neural ODE[1] which bought down the space complexity of the model to constant time with the added advantages of adaptive computation and requirement of lesser parameters. In July 2020, a new concept of using Neural SDE[2] was presented which promises robust modelling of stochastic process like the stock market. Hence, we were motivated to base our project on this topic.

3 Approach:

We plan on approaching this project in several steps. First is literature review. We will begin with reading the papers [1, 2] in details, studying codes and approaches of other people, and brainstorming on how to implement stock prediction using this tool. Next, we will create a base model using LSTM, which is commonly used for stock prediction. We will compare the ODE/SDE model with the results of the LSTM model for validation. Since not much work has been reported on this framework compared to other commonly used networks, we surmise to run into issue as we move forward. These issues can help us learn and prepare better for our final goal which is applying a Neural Stochastic Differential Equation framework to predict stock prices and volatility. We will be following the paper by Gierjatowicz et. al [3] on implementing Neural SDE in Finance. We will be using data from the NSEpy library[4] for our model.

4 Timeline:

The timeline of the project is as follows:

- (30/9/2020) Basic RNN based LSTM model to be implemented
- (30/10/2020) Neural ODE model to be implementated
- (20/11/2020) Neural SDE model to be implementated
- (Till end of semester) Debugging and model improvement

5 Conflict of Interest:

We declare no conflict of interest.

References

[1] Chen, Ricky T. Q. and Rubanova, Yulia and Bettencourt, Jesse and Duvenaud, David, Neural Ordinary Differential Equations, 2018. https://arxiv.org/abs/1806.07366

[2] Liu, Xuanqing and Xiao, Tesi and Si, Si and Cao, Qin and Kumar, Sanjiv and Hsieh, Cho-Jui, Neural SDE: Stabilizing Neural ODE Networks with Stochastic Noise, 2019. https://arxiv.org/abs/1906.02355

[3] Gierjatowicz, Patryk and Sabate-Vidales, Marc and Siska, David and Szpruch, Lukasz and Zuric, Zan, Robust Pricing and Hedging via Neural SDEs (July 8, 2020). Available at SSRN: https://ssrn.com/abstract=3646241 or http://dx.doi.org/10.2139/ssrn.3646241.

[4] NSEpy library: https://nsepy.xyz/