ECS 170 Project Proposal [Submission]

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Proposal: Our project for ECS 170 this Spring will seek to reimplement and build upon existing research into the usage of GARCH-style Hybrid Neural Networks for forecasting the volatility of U.S. large cap equities. As part of this project, our team seeks to evaluate the performance of different Hybrid Neural Networks in forecasting the volatility of large cap U.S. equities. For each of these neural networks, the activation functions will be based on GARCH (Generalized Autoregressive Conditionally Heteroskedastic) time series models, as these models serve as the foundation for modern techniques used to forecast the volatility of financial assets. Upon identifying the best performing GARCH-style Hybrid Neural Network, we will also use the model to design and test a trading strategy for U.S. large cap equities. This strategy will either involve betting on large shifts in volatility, and/or betting on deviations in the volatility of individual equities relative to the volatility of major indices for whom they are components (in the case of U.S. large cap equities, the index would likely be the S&P 500).

This project will make use of Artificial Intelligence to forecast the volatility of financial assets (in this case, large cap U.S. equities). The primary Artificial Intelligence technique that will be utilized by our group will be neural networks, which will be implemented in Python using modern computing tools and hardware. Per our current plan, no hardware apart from standard computer systems (i.e. GPUs, et al) will be needed as part of our project. However, in the event that training and execution time is unreasonably high, this may change. The data required for this project (price data on U.S. large cap equities) will be obtained via the Tiingo Stock Price API (since volatility data can be calculated off of price data to use in our training process, our project is therefore a form of supervised learning via neural networks). The results of our project (performance of the model & the associated trading strategy) will be summarized via a paper and presentation w/accompanying slide deck. There will be no front-end for this project for users to interact with, as our model does not require interaction with users to function properly.

The primary value that our project has is that it can help to improve existing volatility forecasting models used in modern financial markets, which could confer enormous benefits to institutional participants in the financial markets (investors, liquidity providers, etc) in the form of higher profitability, better management of volatility-related risk, & better employment of leverage. Additionally, if our trading strategy is effective, our project may also be able to help retail investors (including students in this class) generate returns for themselves using similar strategies.

Scaffolding: Our project will reimplement some of the research performed in the following studies, while adding some of the knowledge that we gain through this course about Neural Networks:

- Volatility Forecast Based on the Hybrid Artificial Neural Network and GARCH-type Models (Lu, Que, Cao, 2016)
- Volatility Forecasting using Hybrid GARCH Neural Network Models: The Case of the Italian Stock Market (Mademlis, Dritsakis, 2021)
- Volatility Forecasting Using a Hybrid GJR-GARCH Neural Network Model

ECS 170 Project Proposal [Outline – For team use Only]

Background: This project will seek to reimplement and build upon existing research into the usage of GARCH-style Hybrid Neural Networks for forecasting the volatility of U.S. large cap equities. As part of this project, our team seeks to do the following:

- Evaluate the performance of different Hybrid Neural Networks whose activation functions are based on GARCH (Generalized Autoregressive Conditionally Heteroskedastic) time series models in forecasting the volatility of large cap U.S. equities

- Design and test a trading strategy based on our best performing model. Such a strategy would either bet on large shifts in volatility for U.S. large cap equities, and/or bet on deviation in the volatility of U.S. large cap equities in relation to major indices for whom they are components.

Methods & Implementation: This project will make use of Artificial Intelligence by implementing variations of Hybrid Neural Networks to forecast the volatility of U.S. large cap equities.

- Our implementation will be conducted via Python using standard modern computing tools and hardware. Per our initial plan, we do not plan to use accelerated computing hardware (GPUs, et al) for the training and implementation of our Neural Network models or for the test of the associated trading strategy. However, this is subject to change based on training times and execution speed.

- Data will be obtained via the Tiingo Stock Price API, which provides price data for U.S. large cap equities at various timeframes for a period of 3+ years in the past.

Value-Add: The major value add of our project will be to shed light on which types of Neural Networks are best for forecasting U.S. stock volatility, which could help investors in the financial markets improve existing models.

- Improvement on existing volatility forecasting models would likely confer enormous benefits to institutional participants in the financial markets (investors, liquidity providers, etc), resulting in higher profitability, better management of volatility-related risk, & better employment of leverage.

- Additionally, if our trading strategy is profitable and generates risk adjusted returns, it could also help retail investors generate returns for themselves in trading U.S. large cap equities and/or help them build their own such strategies for the same purpose.

- As this project will be a reimplementation and improvement of existing research, there will not be a front-end interface for users to interact with. Rather, the benefits conferred in terms of knowledge would be displayed via a paper & presentation.

Scaffolding and References:

- Our evaluation of Hybrid Neural Networks will be reimplementing some of the research techniques used in the following papers
    - Volatility Forecast Based on the Hybrid Artificial Neural Network and GARCH-type Models (Lu, Que, Cao)
    - Volatility Forecasting using Hybrid GARCH Neural Network Models: The Case of the Italian Stock Market
    - Volatility Forecasting Using a Hybrid GJR-GARCH Neural Network Model
- Stock price data (used for training the Neural Networks, evaluating their performance, and for backtesting the associated trading strategy) will be obtained from the Tiingo API.