Research Project Report

March 11, 2025

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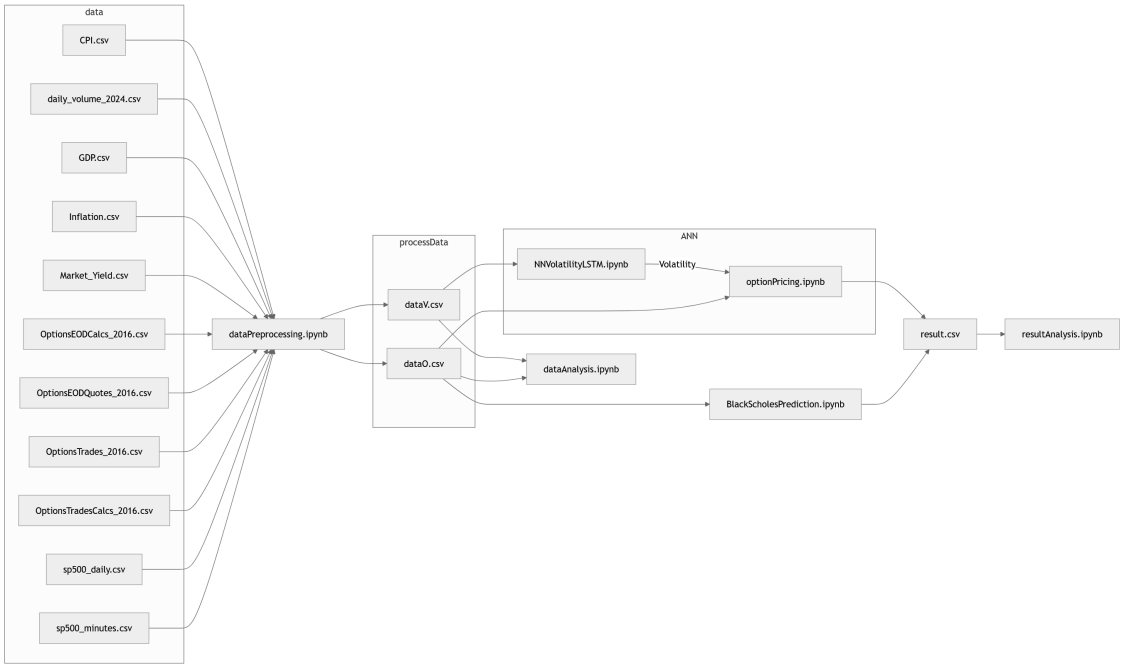
1 Introduction

This document will clearly outline the advancement of the research project. Based on the Scrum and sprint methodology, I will update the document every week, including what is new and what is next.

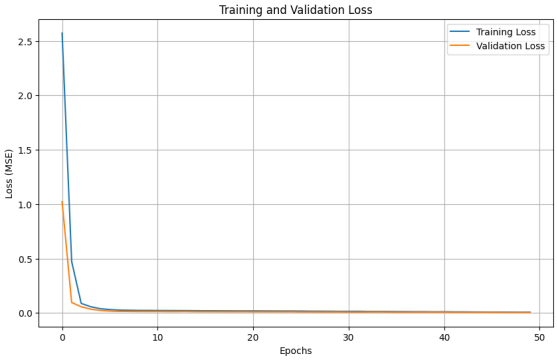


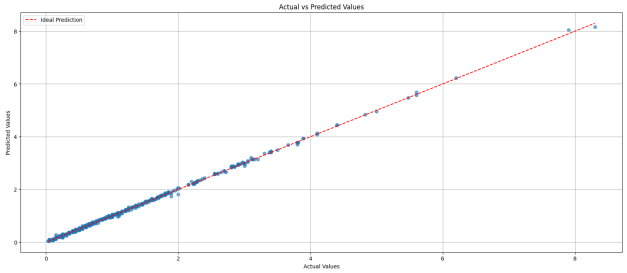
Iteration 1

February 3, 2025

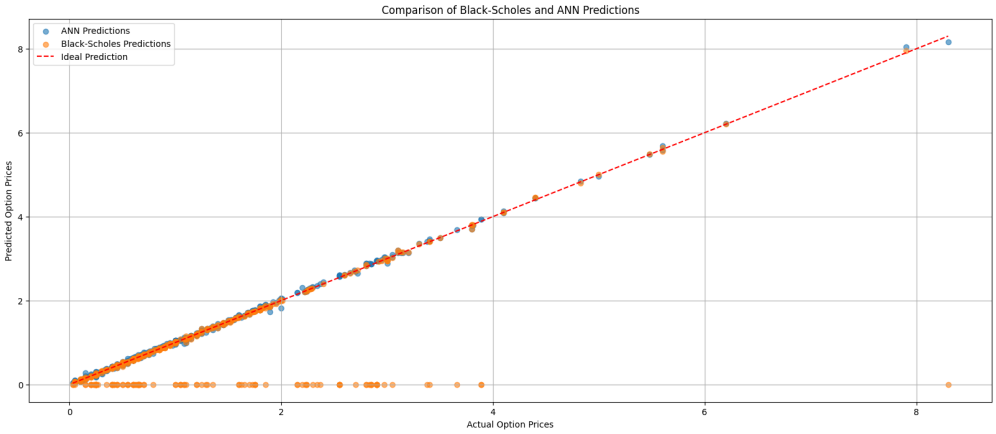
What Is New?

- Created and trained a ANN MLP model for option pricing, using Black-Scholes parameters to target option prices.





- Compared the model's performance against Black-Scholes models:



- Started to build a custom LSTM model with NumPy. For now, I think Python allows better flexibility and development time than C++, while still maintaining decent performance using only NumPy. I want the model to be compatible with TensorFlow formatting for easier use.

What Is Next?

- Finish the custom MLP model.
- Outliers suppression

Iteration 2

February 10, 2025

What Is New?

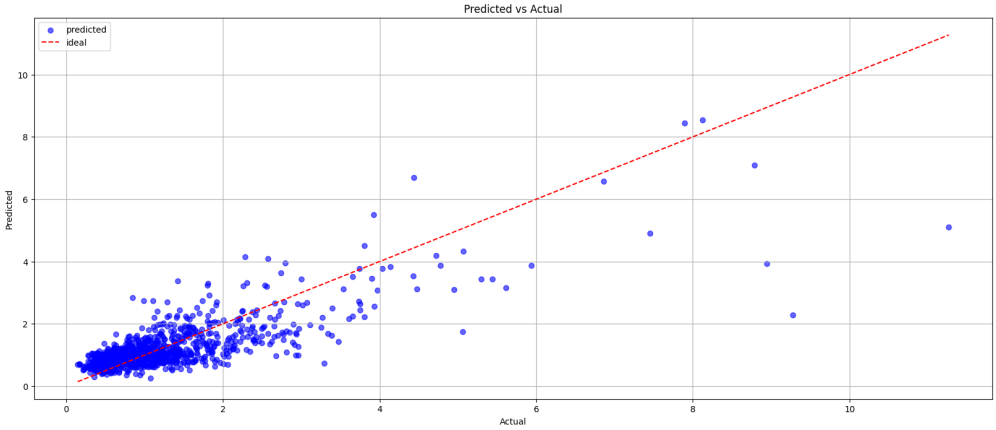
- First principle implementation of artificail neural network **multilayer perceptron**. Can be found here : /code_/models/annModels.py

- ```
  mlp = am.MLP(n_input=22, n_hidden1=64, n_hidden2=32, n_output=1)
  epochs = 5000
  learning_rate = 0.001

  #Training
  history = mlp.train(X_train_normalized, y_train, epochs, learning_rate)

  # Predict
  train_preds = mlp.forward(X_train_normalized)
  y_pred = mlp.forward(X_test_normalized)

  #---
  Final Training Loss: 0.41194406219492513
  Final Test Loss: 0.41460153925356924
  ```



What Is Next?

- Paramater optimization for custom model implementation ?
- Would a Transformer work better ? - Wiki Transformer
  - Very likely, However, to get a working transformer model, the data volume is much more advanced than we currently use.
  ```

Iteration 3

February 17, 2025

What Is New?

- Finnish data gathering with scipt :/code_/tools/getData.ipynb, all the assets data are gather in /data/stocks (around 200 symbols)
- Transformer implementation in progress
- Benchmark against LSTM model
- Paramater optimization for custom model implementation ?

What Is Next?

- Document on maths behind models (models.pdf)

Iteration 4

February 24, 2025

What Is New?

- LSTM implementaiton in progress
- FFNN MLP and LSTM mathematics models

What Is Next?

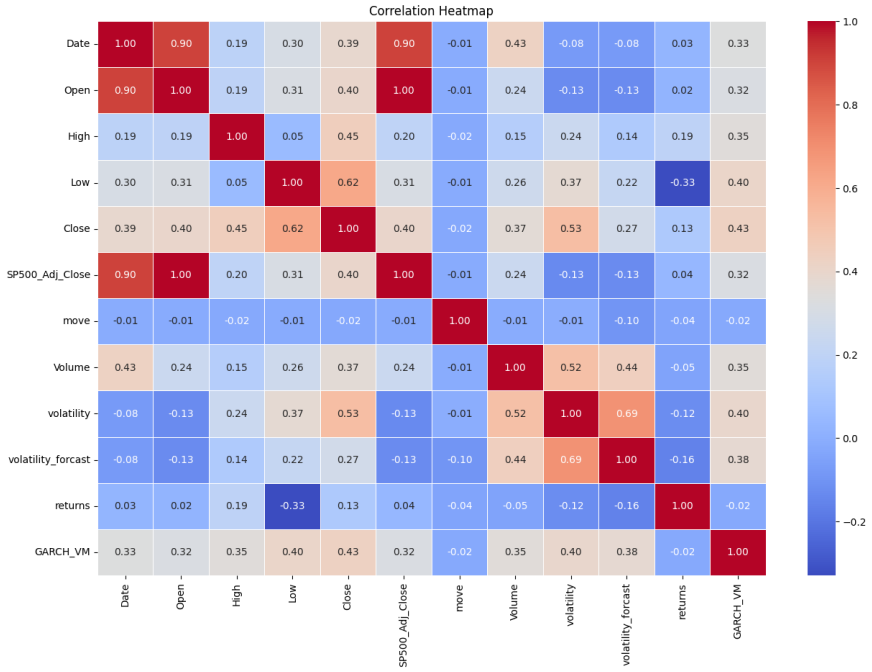
- Identifies specific aspect of volatility time series (mean reversion, volatility clustering, heavy tail)
- identifies drawback in LSTM architecture for specific financial time series
- Optimize model for financial time series
- identify best loss function for volatility time series

Iteration 5

March 3, 2025

What Is New?

- Data Work
  - Compare to litterature
  - Normalize data to improve models performances
  - Select relevant feature to work with the model (clean confusion matrix)
- Litterature about new/modify LSTM model for financial time series prediction
- Document on volatility model updated



What Is Next?

- Improve mathematical relationship of LSTM models with litterature and financial time series properties.

Iteration 6

March 10, 2025

What Is New?

- The volatility time series have some properties as for exemple **volatility clustering**. It implied that huge amplitude volatility periode are follow by small volatility changes and back to huge periode. The default LSTM network isn't aware of that so we can try to implement this in the forget get to keep this informaiton inside the network. For instance we can propose a solution like this

$$F_t = \sigma\left(W_f \cdot [H_{t-1}, X_t] + b_f - \mathbf{k}\sigma_\mathbf{t}\right)$$

  Where the new term $k\sigma_t$ represente the a contante k that is a leanring parameter to scale the impact on the network and σ_t that is the volatility estimation value.

What Is Next?

- Implementaiton
- Benchmark against default LSTM and Black-Scholes