TSLA Stock Prediction
Building an ML Trading Agent for Tesla Stocks
Machine Learning-Group-23
Professor: Dr.Masoud Makrehchi
Due Date: 2025-03-23

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Introduction:

This project focused on developing a machine learning system which led to the creation of an automatic trading program designed for Tesla (TSLA) stock price estimation. The simulated trading system allowed the agent to make buy, sell, or hold decisions that aimed to optimize the final account value. The trading simulation operated between March 24–28 2025 at an initial funding level of $10,000 while assessing each trade with a 1% transaction fee. We Set up 3 scripts for this project: Test_1.py uses historical and contextual data to predict Tesla stock price movements. Also, Test_2.py was created to test the agent on 5 days that have already occurred to test the agent's decision-making and ability to predict the stock price and make a sell, buy, or hold decision by 9:00 Am (EST). Finally, Test_3.py was created to test based on historical data from the day before and give the user a decision on whether they should Buy, Sell, or hold.

Data Collection and Pre-Processing:

Data Sources:

- Historical Stock Data for Tesla was retrieved via Yahoo Finance (yfinance)
- TSLA.csv provided on Canvas (did not match with the real Tesla stock data, which is why we used Yahoo Finance for real-time Tesla stock data)
- Data period: September 1, 2024, to March 23, 2025.

Feature Engineering:

- Simple Moving Average (SMA 10)
- Exponential Moving Average (EMA 10)
- Relative Strength Index (RSI)
- Moving Average Convergence Divergence (MACD)
- Average Directional Index (ADX)
- Bollinger Bands (Upper and Lower)
- Volume-Weighted Average Price (VWAP)

Machine learning Model:

Model Selection: XGBoost Regressor

XGBoost Regressor functions as an enhanced machine learning algorithm that originates from the gradient boosting paradigm. The method builds an ensemble of decision trees sequentially by adding new trees that focus on correcting errors made by preceding trees. The algorithm uses both gradient and Hessian calculations of a differentiable loss function for attaining more precise solutions at accelerated convergence rates. XGBoost includes system frameworks that balance overfitting and perform computations faster as well as maintain reliable data handling of absent data points. XGBoost applies weighted quantile sketches to operate efficiently with instance weights so it can handle large datasets very well. This model exhibits superior performance and flexibility which creates more accurate predictions for regression tasks than simpler models do.

Chosen For:

- Chosen for robust performance with time-series data and ability to handle feature interactions effectively.
- The target variable measures the stock prices at market close the following day.
- The model incorporates Open, High, and Low prices together with SMA, EMA, RSI, MACD, ADX, Bollinger Bands, and VWAP features.
- Training employed rolling historical data partitions where 80% served the training purpose while the remaining 20% validated the model by minimizing RMSE. (root mean square error)

Trading Strategy:

Buy Decisions:

- When model prediction indicated a price increase greater than 1%, the agen allocated between 20% - 80% of available capital (starting at $10,000)

Sell Decisions:

- Take profit at 3% above average buy price
- Stop loss triggered at 2% below average buy price
- Forced sell on the final day to close positions

Hold Decisions:

- Triggered when price change is ≤ 1%, indicating insufficient predicted movement to justify buying or selling.

Daily Trading Log: Test_1.py (March24-28,2025)

Date	Action	Shares Bought/Sold	Price	Account Balance	Notes/ Comments
Mar 24, 2025	Buy	8.497 shares	$236.16	$9,763.84	Predicted price increase
Mar 25, 2025	Hold	-	-	$9,763.84	No

					significant trading signal
Mar 26, 2025	Hold	-	-	$9,763.84	No actionable price prediction
Mar 27, 2025	Hold	-	-	$9,763.84	No significant trading signal
Mar 28, 2025	Sell	8.497 shares	235.09	9,959.75	Final day position closure

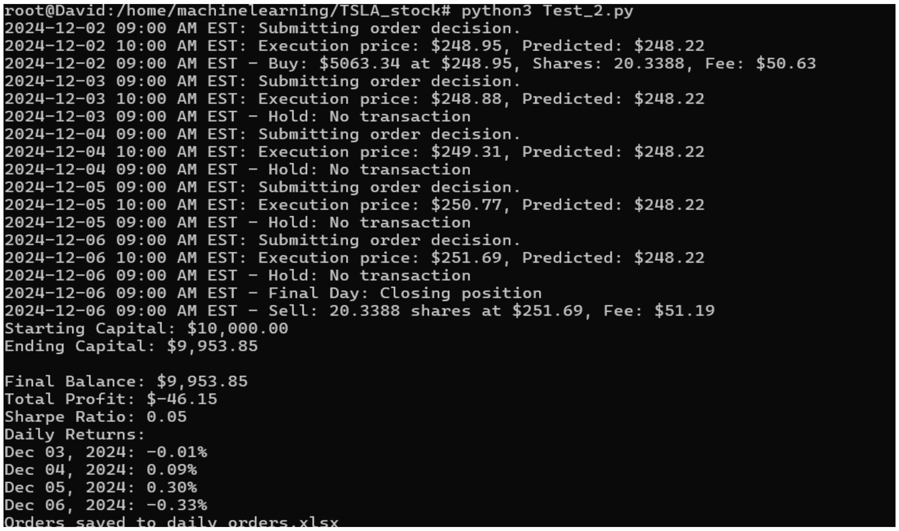
Total transactions: 1 Buy & 1 Sell = 2 transactions.

Test_2.py (testing agent on prior Dates)

NOTE: This was only done to test the efficiency of the trading agent so it is justifiable for the upcoming testing period.

Date	Action	Shares Bought/Sold	Price	Account Balance	Notes/ Comments
December 2, 2024	Buy	20.3388	248.22	9,751.78	Predicted price increase
December 3, 2024	Hold	-	-	9,751.78	No actionable price prediction
December 4, 2024	Hold	-	-	9,751.78	No actionable price prediction
December 5, 2024	Hold	-	-	9,751.78	No actionable price prediction

December 6, 2024	Sell	20.3388	251.69	9,953.85	Final day position closure

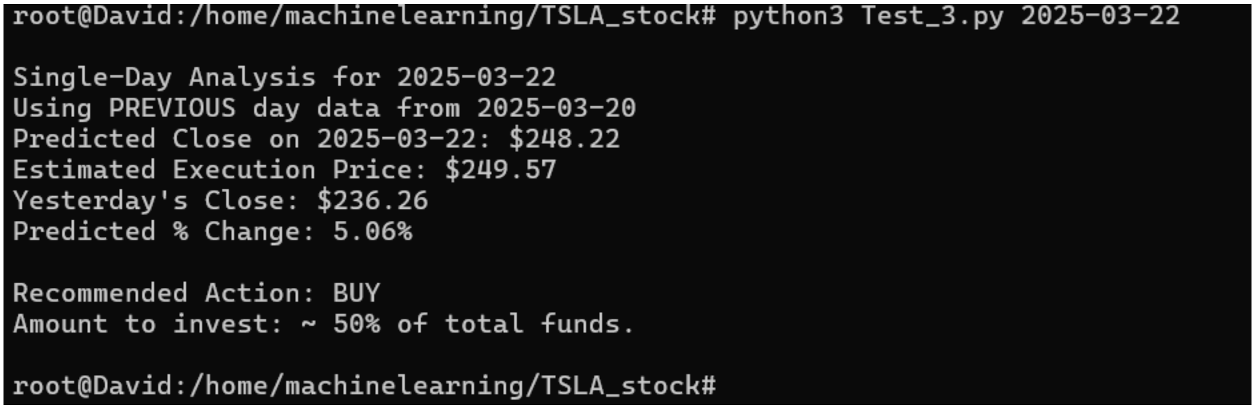


```
root@David:/home/machinelearning/TSLA_stock# python3 Test_2.py
2024-12-02 09:00 AM EST: Submitting order decision.
2024-12-02 10:00 AM EST: Execution price: $248.95, Predicted: $248.22
2024-12-02 09:00 AM EST - Buy: $5063.34 at $248.95, Shares: 20.3388, Fee: $50.63
2024-12-03 09:00 AM EST: Submitting order decision.
2024-12-03 10:00 AM EST: Execution price: $248.88, Predicted: $248.22
2024-12-03 09:00 AM EST - Hold: No transaction
2024-12-04 09:00 AM EST: Submitting order decision.
2024-12-04 10:00 AM EST: Execution price: $249.31, Predicted: $248.22
2024-12-04 09:00 AM EST - Hold: No transaction
2024-12-05 09:00 AM EST: Submitting order decision.
2024-12-05 10:00 AM EST: Execution price: $250.77, Predicted: $248.22
2024-12-05 09:00 AM EST - Hold: No transaction
2024-12-06 09:00 AM EST: Submitting order decision.
2024-12-06 10:00 AM EST: Execution price: $251.69, Predicted: $248.22
2024-12-06 09:00 AM EST - Hold: No transaction
2024-12-06 09:00 AM EST - Final Day: Closing position
2024-12-06 09:00 AM EST - Sell: 20.3388 shares at $251.69, Fee: $51.19
Starting Capital: $10,000.00
Ending Capital: $9,953.85

Final Balance: $9,953.85
Total Profit: $-46.15
Sharpe Ratio: 0.05
Daily Returns:
Dec 03, 2024: -0.01%
Dec 04, 2024: 0.09%
Dec 05, 2024: 0.30%
Dec 06, 2024: -0.33%
Orders saved to daily_orders.xlsx
```

Test_2.py output

Test_3.py

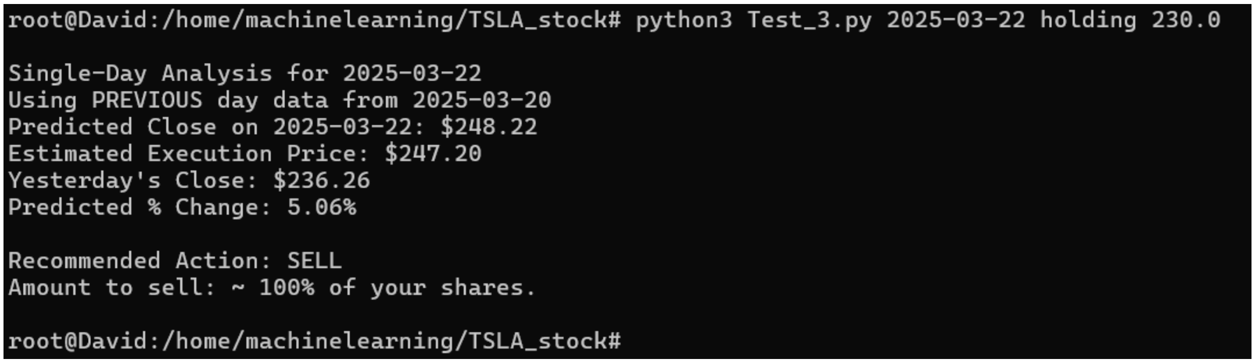
The main focus of this script was to use historical data from the day before to help the user decide whether they should Buy, Sell, or Hold their stocks. This script also used XGBoost to train the model and make an accurate decision. This script can be run with a date argument and will find the previous trading day in your dataset, Use that day's features to predict the next day's close. To run this script while holding no shares use "python Test_3.py 2025-03-24" and if the user is holding shares he must provide the average buy price ex: "*python Test_3.py 2025-03-24 holding 230.0*"



```
root@David:/home/machinelearning/TSLA_stock# python3 Test_3.py 2025-03-22

Single-Day Analysis for 2025-03-22
Using PREVIOUS day data from 2025-03-20
Predicted Close on 2025-03-22: $248.22
Estimated Execution Price: $249.57
Yesterday's Close: $236.26
Predicted % Change: 5.06%

Recommended Action: BUY
Amount to invest: ~ 50% of total funds.

root@David:/home/machinelearning/TSLA_stock#
```

Example Run For 2025-03-22 (no previous Holds)

This process is then repeated every day to maximize the user's stock value.



```
root@David:/home/machinelearning/TSLA_stock# python3 Test_3.py 2025-03-22 holding 230.0

Single-Day Analysis for 2025-03-22
Using PREVIOUS day data from 2025-03-20
Predicted Close on 2025-03-22: $248.22
Estimated Execution Price: $247.20
Yesterday's Close: $236.26
Predicted % Change: 5.06%

Recommended Action: SELL
Amount to sell: ~ 100% of your shares.

root@David:/home/machinelearning/TSLA_stock#
```

Example Run For 2025-03-22 (with previous Holds)

How The agent makes the Decision to buy Sell or Hold:

Not Holding Shares:

The model takes prior session trading information to forecast the target date closing value. Still, it determines the projected price shift through an assessment between forecasted closing data and actual closing numbers from yesterday. When the model predicts positive change it advises you to go with a buying strategy. One determines the amount of capital to invest through a percentage change calculation that produces a result between 20% and 80%. Announcing a 5% predicted price increase leads to a recommendation for approximately 50% investment of available funds.

Holding Shares:

The code analyzes the current execution price which combines the predicted price value with a random modifier with your provided average buy price.
The code suggests executing a SELL order (100% of shares) whenever the execution price reaches 3% above the average buy price (take profit) but also when it falls 2% below (stop loss). The system suggests retaining the existing position in case the price criteria do not reach the threshold. The logic prompts you to either increase your purchase of new shares (if you already own shares) or execute a sale of your existing holdings based on favorable or unfavorable market conditions. Otherwise, it recommends holding your current position.

Performance Analysis:

Date	Daily Return
Mar 25, 2025	0.28%
Mar 26, 2025	-0.26%
Mar 27, 2025	0.03%
Mar 28, 2025	-0.25%

During the simulation period from March 25–27 2025, the trading agent selected holding positions because it followed a cautious trading strategy that depended on certain threshold conditions for executing trades. Specifically:

- The agent entered a buying position only when next-day price predictions demonstrated significant upward appreciation exceeding 1%.
- The trading agent would execute sales only during two price conditions consisting of a take-profit opportunity at 3% higher than the average purchase price or a stop-loss point at 2% lower than the average purchase price.
- The agent deemed such price changes insufficient for trading due to the 1% transaction costs. The agent adopted a conservative strategy that required him to stay in holding positions because small price changes appeared insufficient to overcome transaction expenses.

The agent made a small financial loss amounting to $9,959.75 because of these factors:

- The executed trades lost substantial profit potential because of the 1% fees even though the number of trades remained small.
- The simulated market experienced low stock price fluctuation for Tesla thus offering limited potential for profit achievement during the trading period.

- At the conclusion of the trading period the agent executed the sell order under a forced sell mechanism which resulted in lower returns than the initial purchase price due to fees.

Agent Justification:

The agent incurred a small financial loss during the brief simulation period because volatility was low and transaction fees were high yet the system exhibited vital capabilities needed for trading operations in practice. By setting stop-loss at 2% and take-profit at 3% the agent maintains effective capital preservation as well as risk control measures. The disciplined approach to trading only executes robust prediction signals above 1% movement and protects the funds by avoiding emotional decisions while minimizing unnecessary transaction costs when market conditions become doubtful.

Through its implementation of the XGBoost Regressor framework, the agent exploits a validated machine-learning system that detects intricate market behavioral patterns. Additional time along with increased market volatility enables the agent to generate better predictions which result in enhanced profitability potential.

The agent demonstrates great transparency because it depends on easily trackable technical indicators (RSI, MACD, VWAP) which allow traders to understand and execute actions based on the decisions. Through detailed logging records, we receive both protocol visibility to facilitate trader understanding and useful data needed to optimize future improvements.

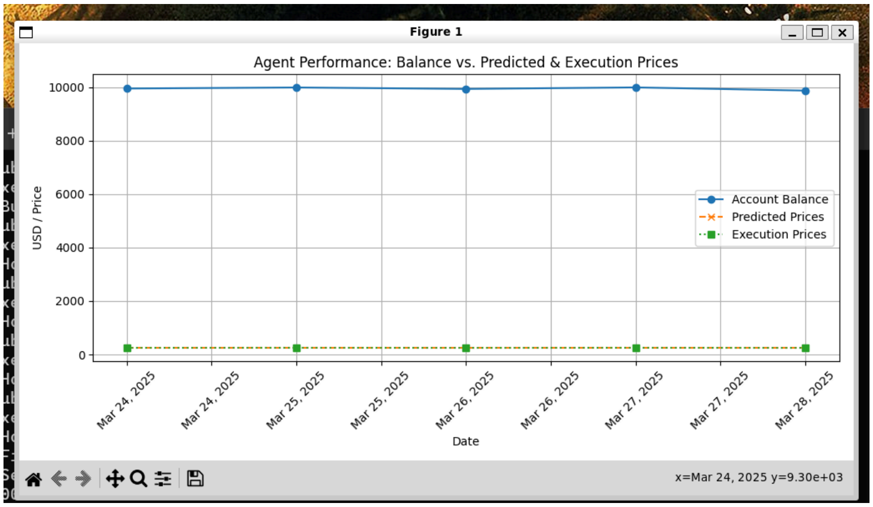
The system establishes itself as a reliable framework for practical trading applications because it combines built-in versatility with clear decision processes although it delivers limited trade performance results currently.

Future Improvements:

- **Advanced modeling:** The implementation of LSTM deep learning models with reinforcement learning techniques improves temporal pattern understanding in modeling systems.
- **Contextual Analysis**: Adding market sentiment data and economic indicators into the predictive model would boost its accuracy level.
- **Optimized Trade Execution:** A combined technique of improving trade execution performance includes trade consolidation and dynamic threshold management according to market conditions.

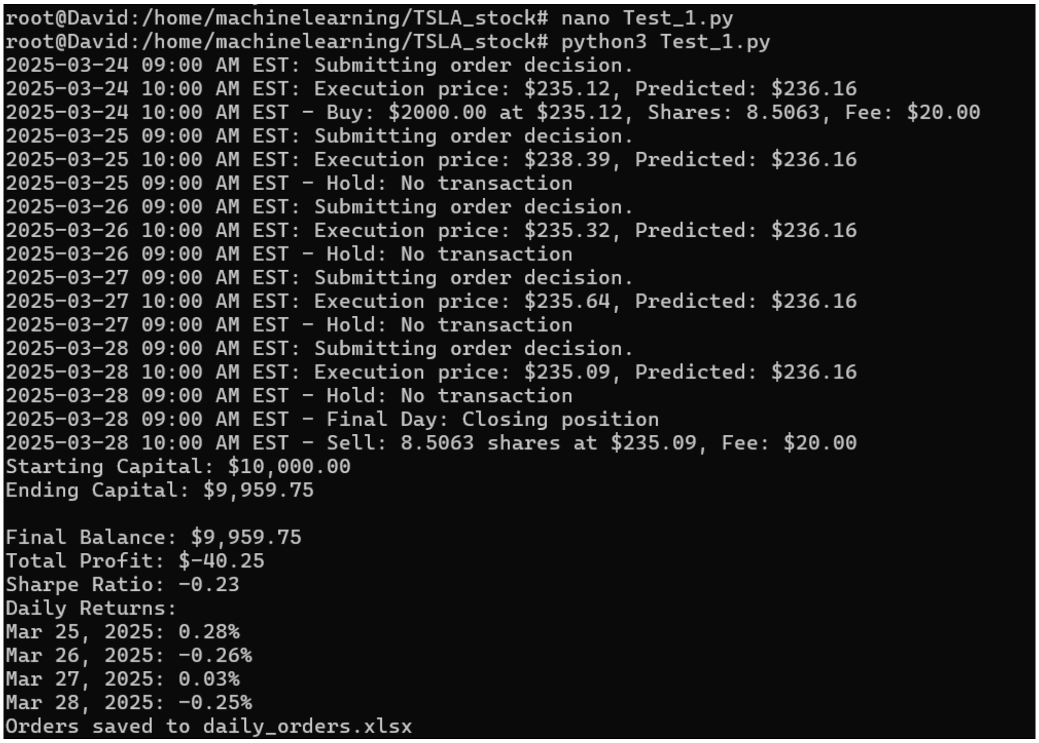
Conclusion:

The XGBoost regressor in the trading agent system proved the value of machine learning by providing accurate directions for investments. Market volatility alongside transaction costs presented obstacles that diminished the overall profits from applying this method. The simulation emphasized how accurate predictions become difficult to transform into successful trading strategies. The evaluation process needs to address three performance limitations specifically to enhance prediction accuracy, refine execution triggers and, incorporate additional data points that include market sentiment with macroeconomic indicators to deliver superior agent performance. Enduring profitability growth can be achieved through cost reductions combined with improved execution strategy implementation methods. Proper execution of machine learning for trading needs advanced modeling methods together with market condition-specific adaptive logic and a complete understanding of transaction costs for successful and lucrative outcomes.



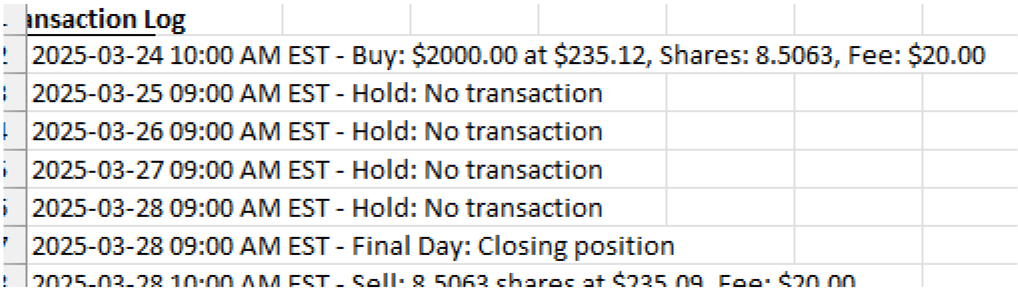
1.1Graph Generated to show Agent’s performance

As you can see it maintained the $10,000 until it sold and lost money due to the 1% interest fee



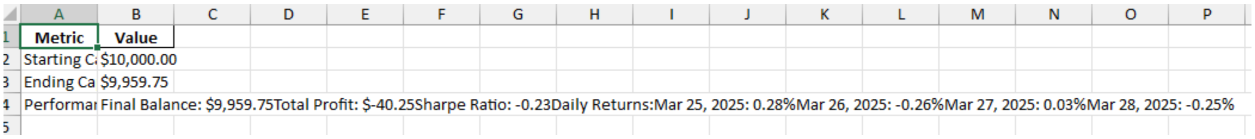
```
root@David:/home/machinelearning/TSLA_stock# nano Test_1.py
root@David:/home/machinelearning/TSLA_stock# python3 Test_1.py
2025-03-24 09:00 AM EST: Submitting order decision.
2025-03-24 10:00 AM EST: Execution price: $235.12, Predicted: $236.16
2025-03-24 10:00 AM EST - Buy: $2000.00 at $235.12, Shares: 8.5063, Fee: $20.00
2025-03-25 09:00 AM EST: Submitting order decision.
2025-03-25 10:00 AM EST: Execution price: $238.39, Predicted: $236.16
2025-03-25 09:00 AM EST - Hold: No transaction
2025-03-26 09:00 AM EST: Submitting order decision.
2025-03-26 10:00 AM EST: Execution price: $235.32, Predicted: $236.16
2025-03-26 09:00 AM EST - Hold: No transaction
2025-03-27 09:00 AM EST: Submitting order decision.
2025-03-27 10:00 AM EST: Execution price: $235.64, Predicted: $236.16
2025-03-27 09:00 AM EST - Hold: No transaction
2025-03-28 09:00 AM EST: Submitting order decision.
2025-03-28 10:00 AM EST: Execution price: $235.09, Predicted: $236.16
2025-03-28 09:00 AM EST - Hold: No transaction
2025-03-28 09:00 AM EST - Final Day: Closing position
2025-03-28 10:00 AM EST - Sell: 8.5063 shares at $235.09, Fee: $20.00
Starting Capital: $10,000.00
Ending Capital: $9,959.75

Final Balance: $9,959.75
Total Profit: $-40.25
Sharpe Ratio: -0.23
Daily Returns:
Mar 25, 2025: 0.28%
Mar 26, 2025: -0.26%
Mar 27, 2025: 0.03%
Mar 28, 2025: -0.25%
Orders saved to daily_orders.xlsx
```

1.2 Code Output



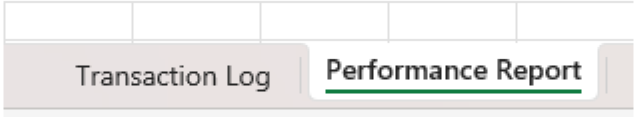
ansaction Log
2025-03-24 10:00 AM EST - Buy: $2000.00 at $235.12, Shares: 8.5063, Fee: $20.00
2025-03-25 09:00 AM EST - Hold: No transaction
2025-03-26 09:00 AM EST - Hold: No transaction
2025-03-27 09:00 AM EST - Hold: No transaction
2025-03-28 09:00 AM EST - Hold: No transaction
2025-03-28 09:00 AM EST - Final Day: Closing position
2025-03-28 10:00 AM EST - Sell: 8.5063 shares at $235.09, Fee: $20.00

1.3Transaction Log daily_orders.xlsx



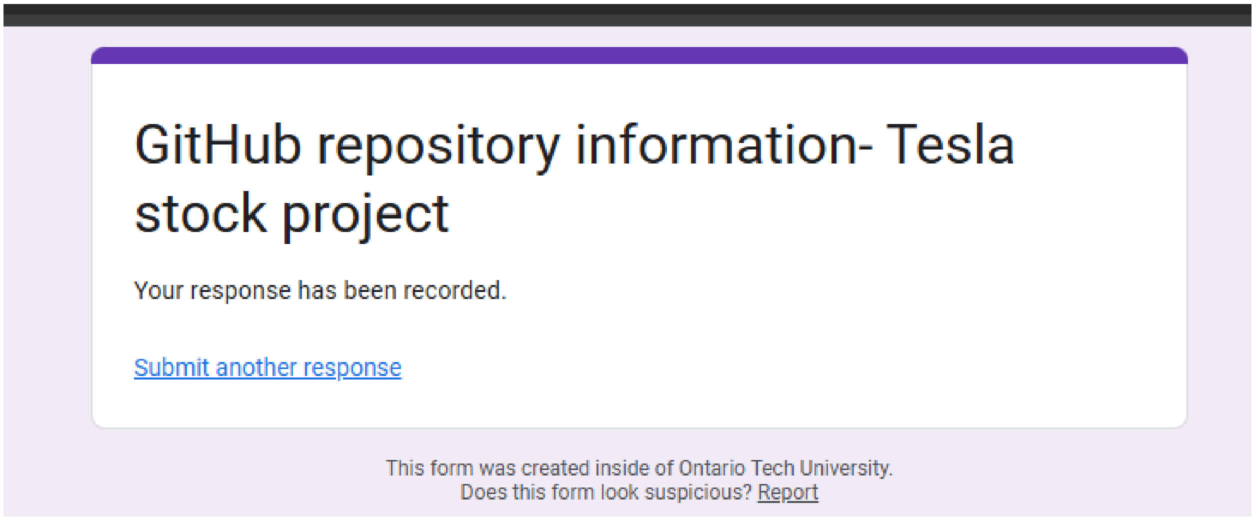
Metric	Value
Starting C:	$10,000.00
Ending Ca	$9,959.75
Performar	Final Balance: $9,959.75Total Profit: $-40.25Sharpe Ratio: -0.23Daily Returns:Mar 25, 2025: 0.28%Mar 26, 2025: -0.26%Mar 27, 2025: 0.03%Mar 28, 2025: -0.25%

1.4 Performance Report



1.5 Excel sheet layout

GitHub Link: https://github.com/DavidHanna03/TSLA_Stock-prediction



GitHub repository information- Tesla stock project

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