DLWeek 2025

March 2025

Systematic Approaches to AI-Powered Trading (Finance Track)

Team Lean Large Men

Considerations

- Market-Beating AI is *Nearly* Impossible
  - Top quant firms invest billions in infrastructure, data, and TOP academic talent.
- Educational Value in Exploration
  - While true alpha is elusive, studying AI trading strategies builds valuable skills and sparks optimism for the future as AI capabilities grow exponentially.

Market Complexity

- Dynamic & Adaptive Nature
  - Strategies that work today may fail tomorrow.
  - Market participants react to and anticipate each other's moves.
- Key Challenges in Prediction
  - *Signal vs. Noise*: Finding **real** insights amid **randomness**.
  - *Self-Fulfilling Prophecies*: **Predictions** can **shape** market behavior.
  - *Market Mood Swings*: **Strategies** may **collapse** in downturns.

Key Market Factors for Adaptive Trading

Technical Indicators

Dictate trend-following vs. mean-reversion strategies

Interest Rates

Federal Interest rates greatly impact market sectors

Market Sentiment

Impacts valuations, capital flows, and sector performance.

Liquidity Conditions

Global liquidity indicators like M1, M2 money supply can influence prices

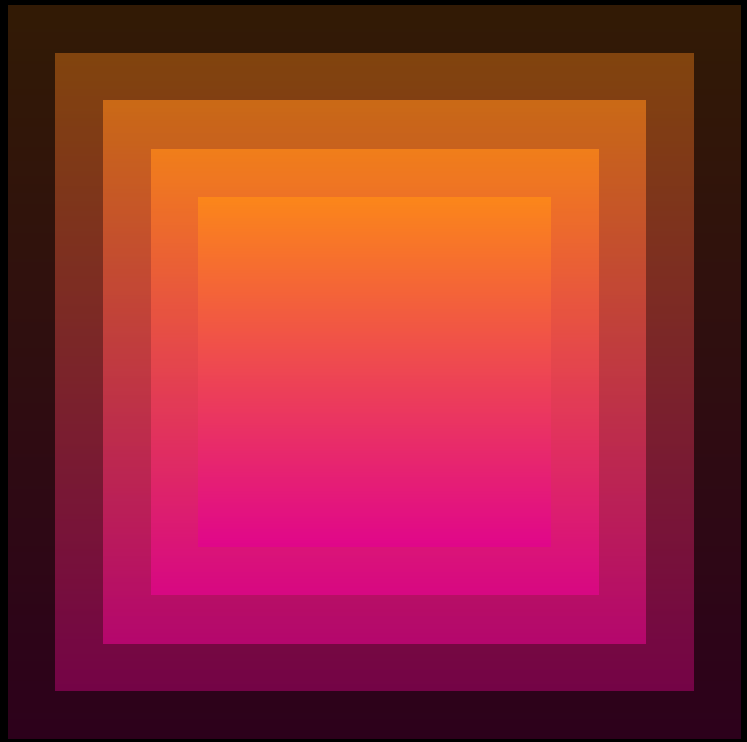
Cross-Asset Relationships

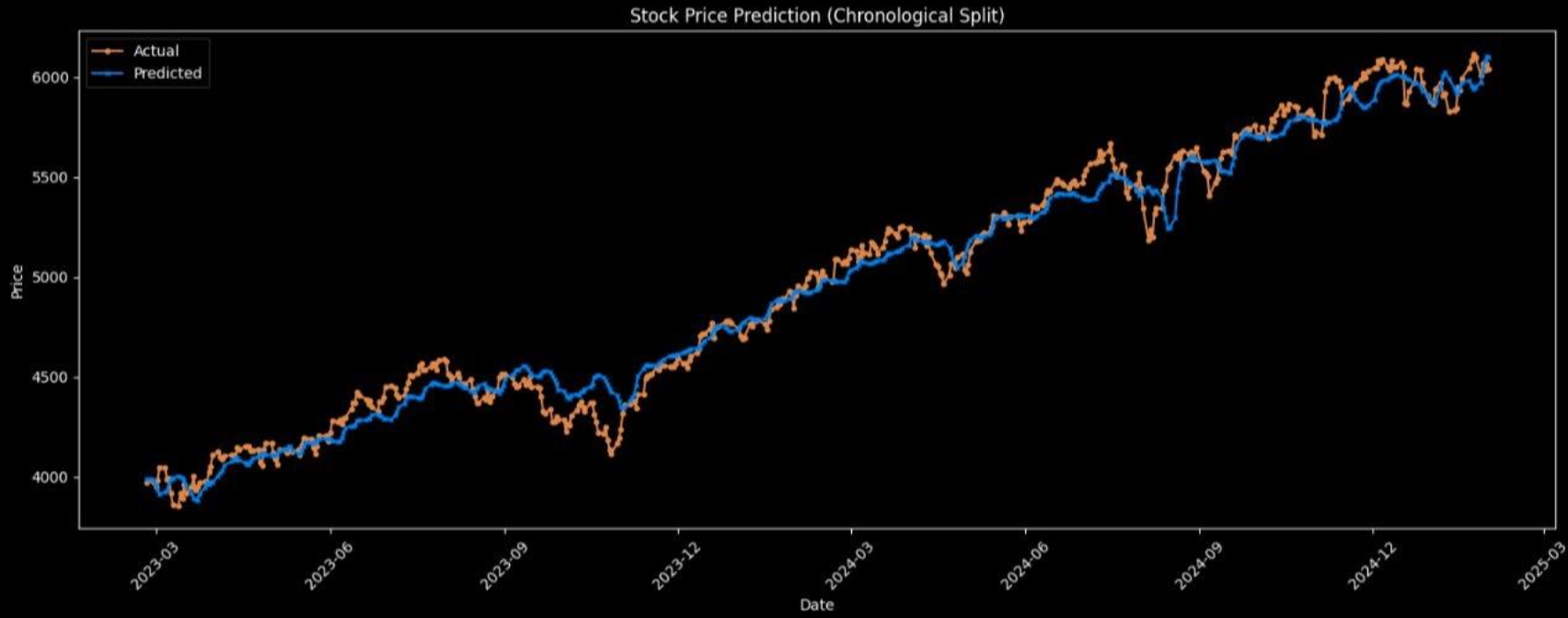
Different assets grow at different rates and economic cycles.

Our Approach

- LSTM Model (Naive Price Prediction)
- Deep Q Learning Network (Reinforcement Learning)
- Potential Hybrid Ensemble Models
- Sentiment Analysis

We chose to trade the S&P 500 for its liquidity, efficient price discovery, broad market exposure, and suitability for AI-driven trading strategies.





LSTM Model

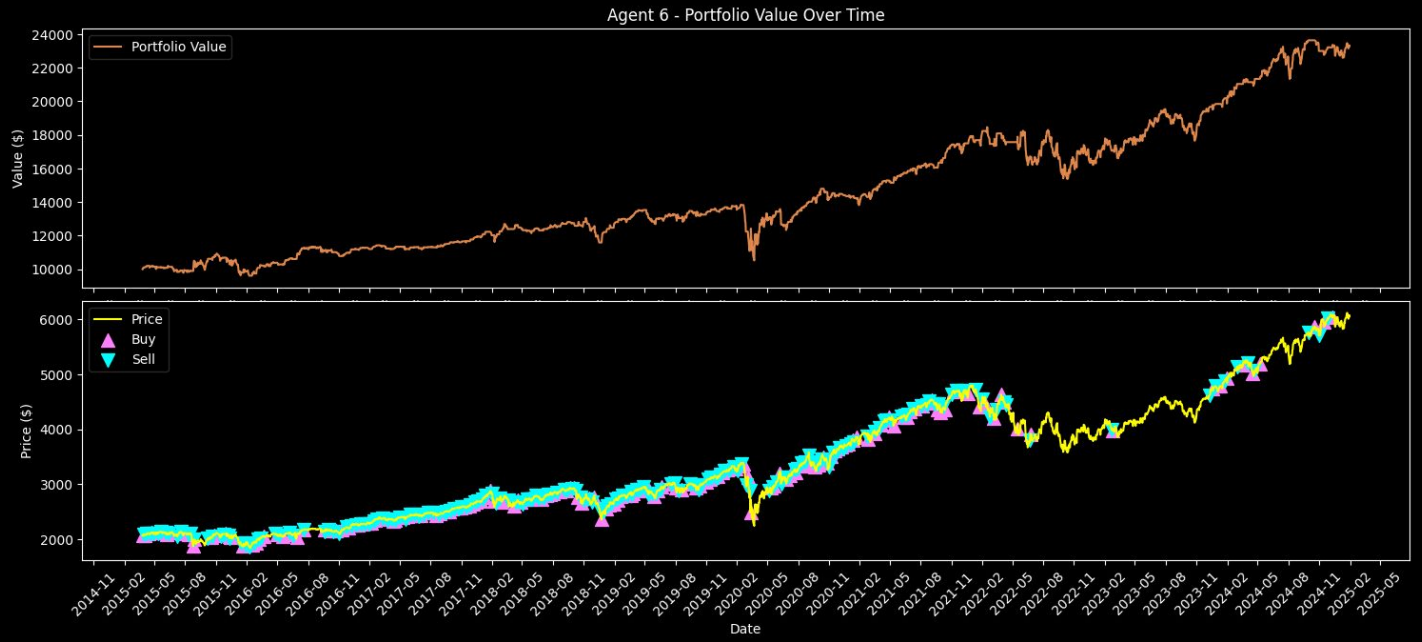
- Chosen for its ability to *capture sequential patterns* and *long-term dependencies* in time-series data
- LSTMs *mitigate problematic effects* of ML like gradient-vanishing issues

Evaluation of LSTM Model

Initial Capital: $10000
Final Portfolio Value: $14023.52
Profit/Loss: $4023.52

Sharpe Ratio: -0.6437
Max Drawdown: 120.84%

- Sub-optimal performance compared to just buying and holding
- Nevertheless, a step forward in the right direction



Deep Q-Network (DQN) Model

- Selected for its *reinforcement learning* approach, enabling the agent to *learn optimal strategies* through interaction with the *market environment*
- DQN allows the agent to *adapt* its decision-making model based on *rewards and punishments*, aligning with the goal of developing an *adaptive trading strategy*

Evaluation of DQN Model

- The DQN agent achieved a total return of 161.14%, outperforming traditional buy-and-hold strategies.
- With a Sharpe Ratio of 0.7025, the model demonstrated a favorable risk-adjusted return profile.
- While promising, further validation across diverse market conditions is necessary to confirm the model's robustness and adaptability.

Total Return (%)	161.14
Sharpe Ratio	0.7025
Max Drawdown (%)	59.31
Final Portfolio Value (USD)	23312.60

Comparison of Models

- The DQN model outperformed the LSTM both arithmetically and across key financial metrics, including Sharpe Ratio and Max Drawdown.
- With a significantly higher Sharpe Ratio, the DQN model demonstrated stronger risk-adjusted returns compared to the LSTM approach.
- Improved risk management was evident, as the DQN model's max drawdown was limited to 59.31%, far lower than the LSTM's steep 120.84% decline.
- Overall, the DQN model proved more effective by minimizing risk and making more strategic, data-driven trading decisions, ultimately maximizing profitability.

Potential future approaches

Given more time, we would have gone on to explore:

- Explore even more hybridised deep learning models combining LSTM, Transformer, and reinforcement learning
- Incorporate financial sentiment analysis using NLP (BERT) to augment input features (currently limited to using AlphaVantage's market sentiment API)
- Expand our financial dataset to include more diverse financial instruments and markets
- Conduct more extensive backtesting and forward testing to validate adaptability and robustness

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Thank you to all the judges, organisers, and sponsors!

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