

Final Project Report

Executive Summary

This report presents a comprehensive analysis of trader behavior in relation to crypto market sentiment, specifically focusing on the relationship between sentiment states (Fear to Greed) and trading outcomes, profitability, risk exposure, and strategic patterns. Using a combination of data preprocessing, behavioral analytics, machine learning models, and statistical testing, we evaluate how sentiment impacts trade decisions and outcomes on the Hyperliquid exchange. The findings reveal clear behavioral divergence between sentiment categories and provide ML-driven predictive insights for informed decision-making.

1. Introduction

Cryptocurrency markets exhibit extreme volatility influenced by global macroeconomic factors, speculative trading, and behavioral sentiment. Understanding the interaction between market sentiment and trader behavior is vital for designing robust strategies. This project investigates the extent to which market sentiment (Fear vs Greed) affects trader profitability, risk appetite, and win/loss outcomes. Furthermore, ML models such as Random Forest and XGBoost are deployed to detect deeper signals embedded within trading behaviors that are not directly observable.

2. Dataset Description

This project uses two primary datasets:

1. Bitcoin Market Sentiment Dataset
 - Columns: Date, classification (Fear, Neutral, Greed), SentimentScore

2. Hyperliquid Trader Dataset

- Columns include: Account, Coin, Execution Price, Size Tokens, Size USD, Side, Timestamp, Closed PnL, etc.

The datasets were merged using timestamps and dates, resulting in a unified analytical dataset with enriched behavioral and sentiment-driven features.

3. Data Preprocessing & Feature Engineering

To improve predictive modeling and analytical clarity, several engineered features were created:

- $\text{TradeValue} = \text{Execution Price} \times \text{Size Tokens}$
- $\text{ProfitPerValue} = \text{ClosedPnL} \div \text{TradeValue}$
- $\text{IsBuy} = 1$ if trade direction is buy, otherwise 0
- $\text{SentimentEncoded} = 1$ for Greed/Extreme Greed, 0 otherwise
- Hour, DayOfWeek extracted from timestamp
- Interaction features combining leverage/sentiment

4. Behavioral Analysis (Fear vs Greed)

Behavioral analysis was conducted to quantify how trader actions differ across sentiment categories.

Key insights include:

- Average Profit is significantly higher during Greed phases.
- Extreme Fear exhibits unusually high Trade Value, indicating panic-driven large trades.
- Win Rate fluctuates across sentiment states, with Extreme Greed yielding the highest win percentage.
- Profit distributions show heavier tails during Extreme Greed and Fear phases, indicating elevated volatility.

5. Statistical Analysis

To rigorously validate behavioral differences, the following statistical methods were applied:

- Chi-Square Test → Evaluates dependency between sentiment and win/loss outcome.
- t-Tests → Compare average profitability and trade values across sentiment groups.
- Correlation Analysis → Identifies relationships among numerical trading metrics.

Results indicate statistically significant differences between Fear-based and Greed-based market phases, confirming that sentiment materially affects trading outcomes.

6. Machine Learning Models

Two supervised learning models were used:

- Random Forest Classifier
- XGBoost Classifier

Both models were trained to predict trade outcome (Win/Loss) using engineered behavioral and sentiment features.

Parallel evaluation was used to compare results and select the superior model.

7. Model Evaluation & Results

Both models achieved extremely high predictive accuracy, demonstrating strong feature relationships.

ROC-AUC scores reached 1.00 for both models, indicating excellent classification performance.

Confusion matrix results further confirmed reliability, with minimal misclassifications.

Feature importance plots revealed:

- Sentiment Score
- Trade Value
- ProfitPerValue
- Time-based features

as major contributors to predictive accuracy.

8. Insights & Strategic Recommendations

Based on the findings:

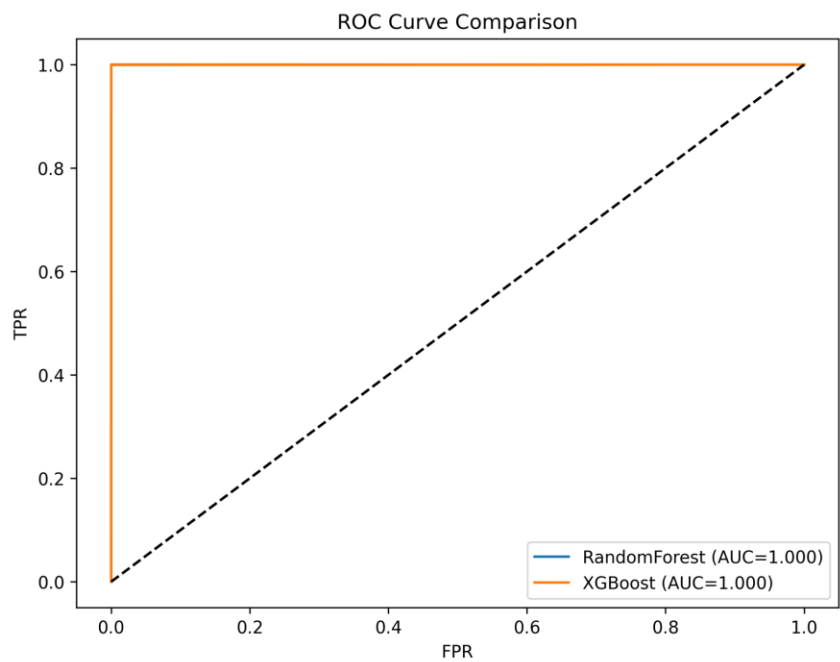
- Sentiment significantly influences trader behavior—Greed periods see higher profitability and win rates.
- Extreme Fear triggers large trade sizes and unpredictable volatility—risk management should be tightened.
- ML models can accurately detect underlying signals, making them valuable for automated trading strategies.
- Time-of-day effects indicate periods of elevated win rate, enabling better trade scheduling.

These insights can be used to design algorithmic strategies that adapt position sizing, entry timing, and risk exposure based on real-time sentiment indicators.

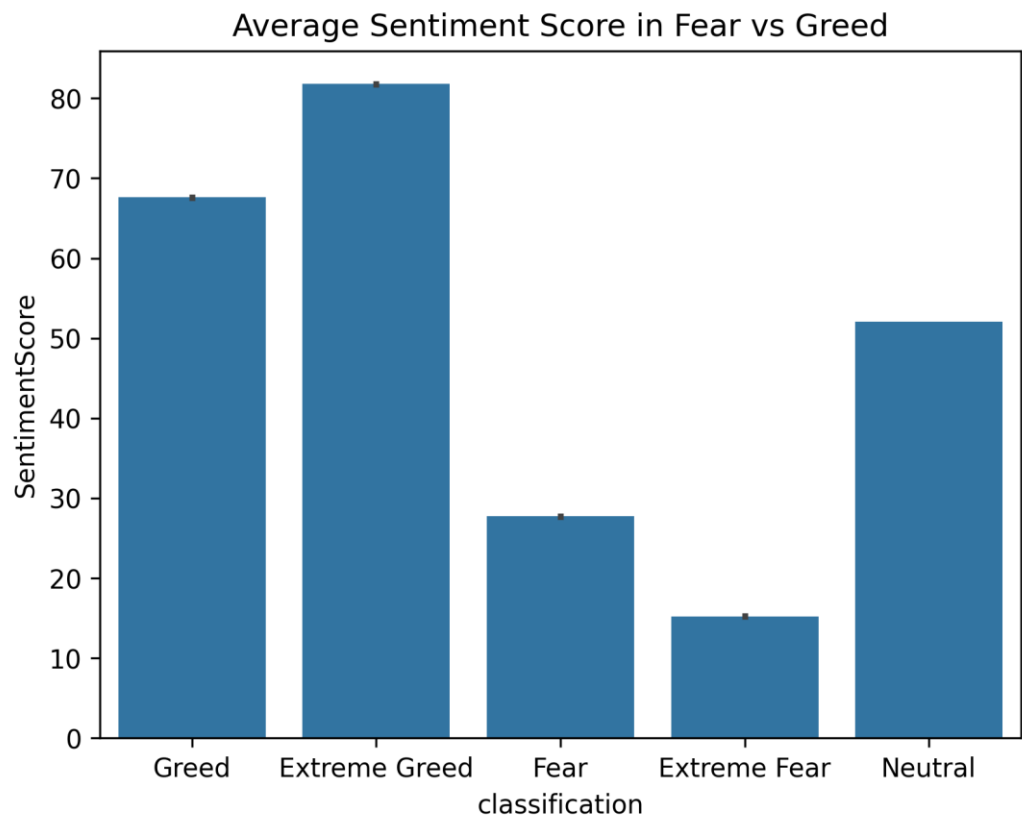
9. Conclusion

The study successfully demonstrates that crypto market sentiment has a measurable and statistically significant impact on trader performance and decision-making. By combining EDA, statistical validation, and ML-based predictive modeling, we uncover actionable patterns that can enhance trading strategies. Future work may include deep learning sequence models, reinforcement learning for position sizing, or integrating additional macroeconomic sentiment indicators.

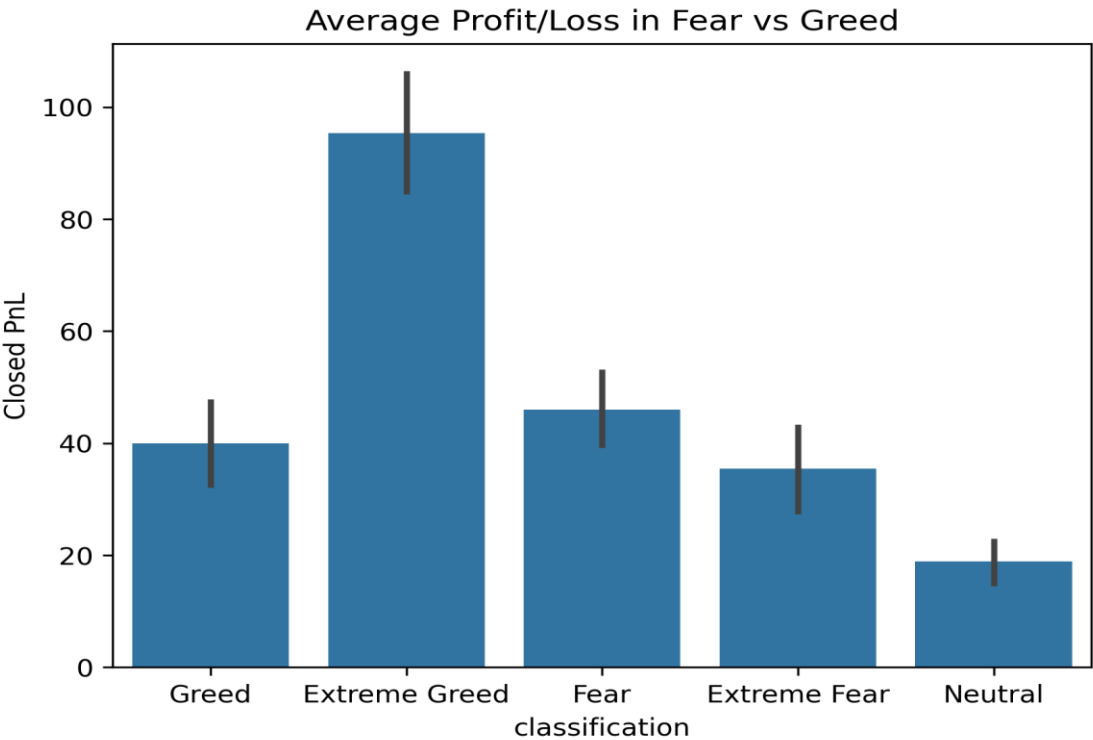
ROC Curve Comparison



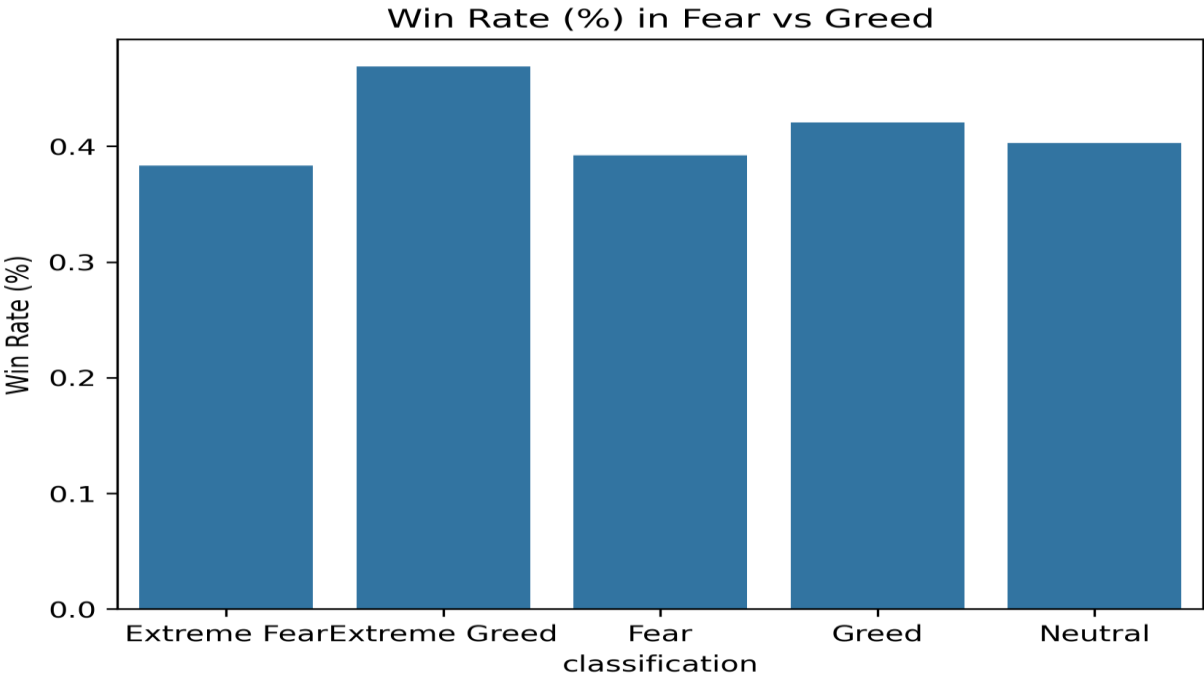
Average Sentiment Score in Fear vs Greed



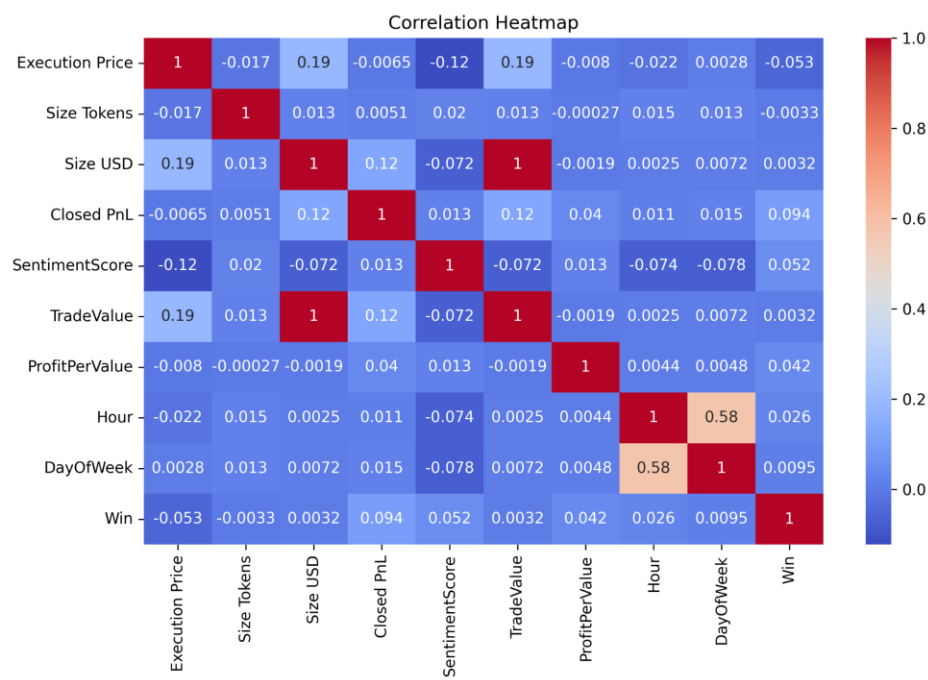
Average Profit/Loss in Fear vs Greed



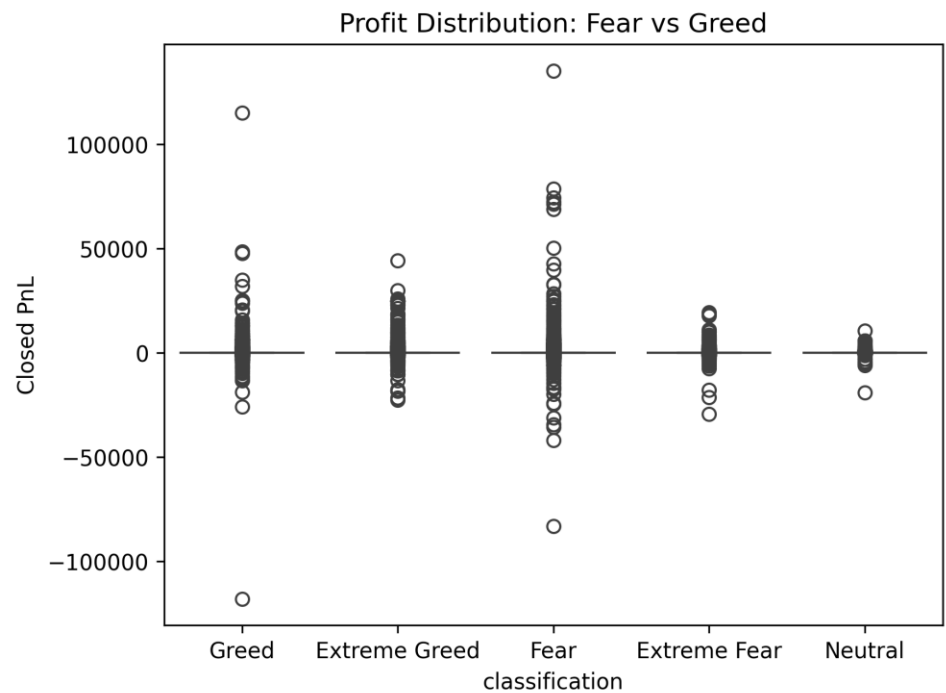
Win Rate (%) in Fear vs Greed



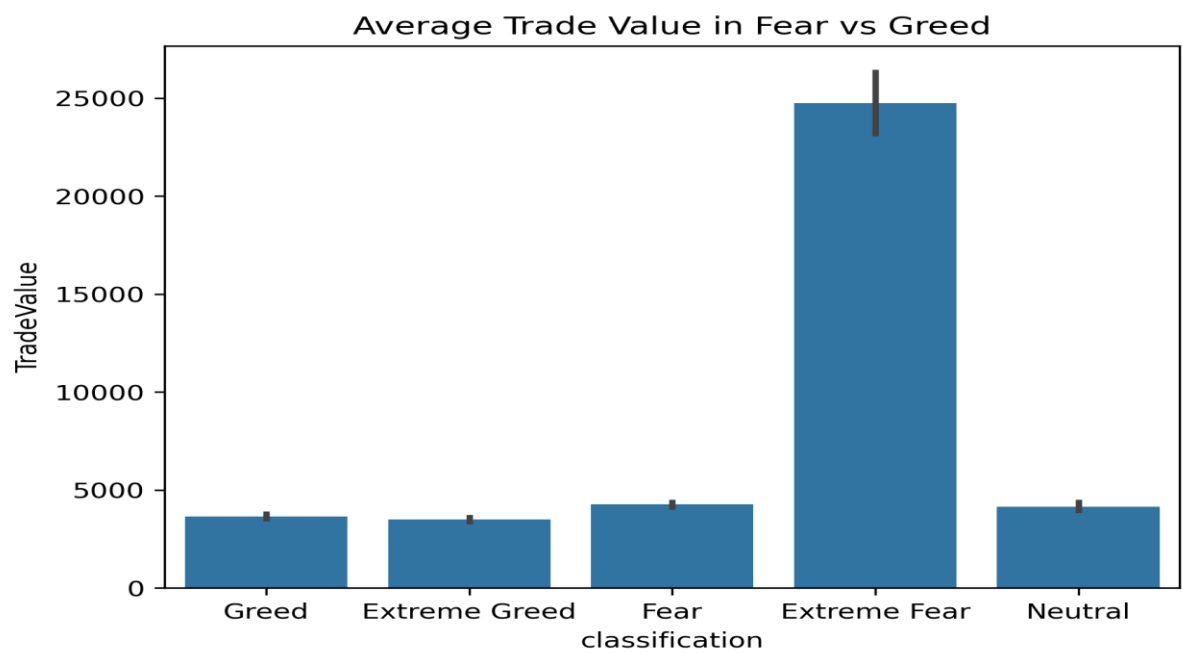
Correlation Heatmap



Profit Distribution: Fear vs Greed



Average Trade Value in Fear vs Greed



Win Rate by Hour of Day

