1.Introduction

This report examines how trader behavior on Hyperliquid aligns or diverges from the aggregate market sentiment of Bitcoin, as measured by the Fear & Greed Index.

The goal is to find the relations between:

- Profitability
- Risk: Volatility of PnL plus loss frequency
- Trade volume & side (BUY/SELL)
- Sentiment conditions (Extreme Fear → Extreme Greed)
- Uncover hidden behavioral trends and drive smarter trading strategies

We used two datasets:

1. Fear & Greed Sentiment Dataset
2. Hyperliquid Historical Trader Data

The datasets were cleaned, combined by date, analyzed through EDA, statistical models (OLS), nonlinear models (Random Forest), and risk metrics.

2. Data Processing & Integration

Key pre-processing steps:

- Converted UNIX timestamps to readable dates.
- Normalized sentiment classifications.
- Cleaned numerical fields: Closed PnL, Size USD, Execution Price.
- Standardized BUY/SELL trade sides.
- Extracted trade_date from timestamps.
- Datasets were merged on trade_date using a left join.
- Removed 6 corrupted rows labeled as "nan" in the sentiment classification.

The notebook_1.ipynb contains all cleaning, merging, and transformations.

3. Exploratory Data Analysis

3.1. Profitability Across Sentiment States

Average PnL by sentiment:

- High fear level → High profitability
- Extreme Greed → High sell-side profitability
- Fear → Medium returns
- Neutral and Greed → Lowest profitability

This indicates that traders tend to do the best during high-volatility emotional extremes and poorly during stable/neutral or mildly greedy markets.

3.2 BUY vs SELL Performance

A clear divergence and alignment with market psychology.

- **Extreme Fear**

  BUY trades significantly outperform → "buy the dip" effect.

- **Excessive Greed**

  SELL trades significantly outperform: overheated markets get shorted effectively.

This Indicates :

Profitability is lowest despite heavy trading activity → overconfidence bias.

3.3 Trade Volume Distribution

Sentiment vs trade counts:

- Greed → highest volume
- Extreme Fear → lowest volume but highest PnL

This means that:

- Traders become more active when markets feel euphoric - FOMO.
- Traders are cautious during fear, yet the trades made during fear are more profitable.

4. Risk Analysis

- Risk was measured by:
- PNL Standard Deviation (volatility)
- Negative PnL percentage - loss frequency
- Worst loss
- Best win

Findings:

Sentiment	Risk (Std Dev)	Loss Frequency	Insight
Extreme Fear	Highest	Moderate	High-risk, high-reward zone
Extreme Greed	Mid	Lowest	Best for SELL trades
Fear	High	Mid	Volatile period
Greed	High	Highest	Worst performer
Neutral	Lowest	Low	Stable but low returns

Interpretation

- Not all sentiment states bear the same risk.
- Extreme emotional conditions create large PnL swings.
- Neutral markets are safe but yield poor returns.

This is essential for position sizing and risk management.

5. Regression Analysis

5.1 Linear Regression: Sentiment Value → PnL

Model: Closed PnL ~ Sentiment Value (0–100)

- $R^2 \approx 0$
- P-value ~ 0.57 → no significant relationship
- Sentiment value (numeric score) does not predict PnL

Conclusion:

On its own, the numerical Fear–Greed index is not a good predictor of profitability.

5.2 Regression with Categorical Sentiment

Model: Closed PnL ~ sentiment categories (dummy variables)

Significant findings:

- Greed → large negative coefficient
- Neutral → significant negative coefficient
- Extreme categories not statistically significant (high variance)

Interpretation:

Traders tend to perform poorly in the Greed and Neutral states, even after controlling for categories.

This reinforces earlier EDA findings.

6. Model Diagnostics

Predicted vs Actual Plot

- No clustering around diagonal → poor linear predictability
- Confirms PnL is influenced by other variables outside sentiment: volatility, timing, leverage among others.

Residual Plot

- Random scatter → linear model valid
- Large variance → model cannot explain PnL well
- Reinforces the noisy nature of trading data

7. Non-linear Modeling: Random Forest

Non-linear relationships were captured by training a Random Forest Regressor.

Feature Importance (most influential first):

- Excessive Avarice
- Greed
- Neutral
- Fear

This model displays the non-linear effect of sentiment on PnL, showing that extreme sentiments influence it the most.

8. Alignment & Divergence Analysis

Where trader behavior matches sentiment

- Extreme Fear → BUY trades profitable
- Extreme Greed → SELL trades profitable
- The outcomes reflect sentiment-driven psychology.

Where trader behavior diverges

- Greed → highest trading volume but lowest PnL

  Traders overtrade and underperform.

- Neutral → stable sentiment but poor profitability

  Indicates lack of conviction, low-quality trade.

9. Strategy Recommendations

Based on all analyses:

1. Trade Long in Extreme Fear

Best average PnL + strongest dip-buying opportunities.

2. Trade Short in Extreme Greed

Markets overextend → profitable short entries.

3. Reduce activity during Greed periods

Greed → highest trade frequency + lowest PnL → avoid overtrading.

4. Avoid large positions in Neutral periods

Low returns plus unclear direction.

5. Use sentiment categories, not sentiment scores

Numeric value doesn't have predictive power; categories capture behavior better.

6. Merge sentiment with volatility + trade-level metrics

Sentiment alone cannot predict PnL; integrate:

- trade size
- timing
- coin volatility
- Execution price movements

10. Conclusion

This analysis shows that market sentiment has a significant-but non-linear-role in trader performance. Extreme sentiment states strongly influence profitability, while Greed and Neutral states show consistent underperformance along with increased risk. The insights from this report can help build:

- More adaptive position sizing
- Sentiment-aware trading strategies
- Stronger risk management frameworks

The complete implementation is in notebook_1.ipynb and all the charts are in the outputs/ directory.