

# Data Science Assignment Report

## Analyzing Trader Behavior vs Market Sentiment (Fear & Greed)

**Candidate:** Anirudh Rao

**Role:** Data Scientist / ML Engineer

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### 1. Introduction

Financial markets are heavily influenced by trader psychology and overall market sentiment. In crypto markets, sentiment indicators such as the **Fear & Greed Index** are often used to gauge emotional extremes that may impact trading behavior.

This project aims to analyze how **trader behavior aligns or diverges from market sentiment** by combining:

- Bitcoin Market Sentiment data (Fear vs Greed)
- Historical trader activity data from Hyperliquid

The ultimate objective is to uncover **hidden behavioral patterns** and evaluate whether **trader activity can be used to predict market sentiment** using machine learning.

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### 2. Datasets Overview

#### 2.1 Bitcoin Market Sentiment Dataset

- Date – Trading day
- Classification – Market sentiment (**Fear / Greed**)

This dataset provides a daily psychological snapshot of the crypto market.

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## 2.2 Historical Trader Data (Hyperliquid)

Key fields used:

- `account`
- `execution price`
- `size`
- `side` (BUY / SELL)
- `closedPnL`
- `leverage`
- `time`

This dataset captures **real trader actions**, including risk exposure, profitability, and trading volume.

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## 3. Data Preprocessing & Feature Engineering

### 3.1 Data Cleaning

- Converted timestamps into daily granularity
  - Handled missing values by applying neutral defaults
  - Removed inconsistencies across numerical fields
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### 3.2 Feature Engineering (Daily Aggregation)

Trader-level data was aggregated **per day** to align with sentiment data.  
The following behavioral features were created:

Feature	Description
<code>total_volum</code>	Total traded size per day
<code>e</code>	
<code>avg_leverag</code>	Average leverage used
<code>e</code>	
<code>avg_price</code>	Mean execution price
<code>net_pnl</code>	Total realized PnL
<code>trade_count</code>	Number of trades
<code>buy_sell_ra</code>	BUY trades ÷ SELL trades
<code>tio</code>	

These features represent **risk appetite, confidence, and aggression** in trading behavior.

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## 4. Exploratory Data Analysis (EDA)

Key behavioral observations:

- **Greed periods** show:

- Higher trade volume

- Increased leverage usage
  - Strong positive net PnL
  - Aggressive buy-side behavior
- **Fear periods show:**
    - Reduced trading activity
    - Conservative leverage
    - Lower trade frequency
    - More defensive positioning

This indicates a **clear behavioral shift** based on market sentiment.

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## 5. Machine Learning Approach

### 5.1 Problem Formulation

- **Type:** Binary Classification
- **Target Variable:** Market Sentiment
  - $0 \rightarrow$  Fear
  - $1 \rightarrow$  Greed

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### 5.2 Model Selection

A **Random Forest Classifier** was chosen due to:

- Ability to capture non-linear relationships
- Robustness to noisy financial data

- Built-in feature importance analysis
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### 5.3 Model Pipeline

1. Train–test split (75% / 25%)
  2. Feature scaling using StandardScaler
  3. Random Forest training
  4. Performance evaluation using classification metrics
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## 6. Model Evaluation

The model achieved strong predictive performance in distinguishing between **Fear and Greed** market conditions.

### Evaluation Metrics Used:

- Precision
- Recall
- F1-score
- Confusion Matrix

The results confirm that **aggregated trader behavior contains predictive signals** about overall market sentiment.

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## 7. Feature Importance Analysis

The most influential features were:

1. **Net PnL**
2. **Average Leverage**
3. **Total Trade Volume**
4. **Buy/Sell Ratio**

#### **Interpretation:**

- High leverage + positive PnL strongly correlates with **Greed**
- Lower volume and cautious positioning align with **Fear**

This suggests that **traders collectively front-run sentiment shifts** before they are reflected in public indicators.

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## **8. Key Insights & Findings**

- Trader behavior significantly correlates with market sentiment
  - Greed markets encourage higher risk-taking and leverage
  - Fear markets trigger conservative trading strategies
  - Machine learning models can **anticipate sentiment using trader activity alone**
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## **9. Business & Trading Implications**

This analysis can be leveraged to:

- Build **early-warning sentiment indicators**
- Improve **risk management systems**
- Enhance **algorithmic trading strategies**

- Detect **crowd psychology shifts** before price reversals
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## 10. Conclusion

This project demonstrates that **trader behavior is a powerful proxy for market sentiment**. By combining behavioral analytics with machine learning, trading platforms can gain actionable insights that go beyond traditional sentiment indicators.

The results highlight the value of **data-driven decision-making in Web3 trading environments**.