# Trader Behavior & Market Sentiment Analysis

## 1. Introduction

The goal of this analysis is to explore the relationship between **trader performance** (profitability, risk, volume, leverage) and **market sentiment** (Fear vs Greed). We aim to:

- Identify patterns in trader behavior under different sentiment conditions.
- Determine how profitability, risk, and trade volume vary across sentiments.
- Detect clusters of trades and interpret their significance.
- Provide actionable insights for smarter trading strategies.

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## 2. Data Overview

**Trades dataset columns:**
```
['account', 'coin', 'execution_price', 'size_tokens', 'size_usd', 'side',
'timestamp_ist', 'start_position', 'direction', 'closed_pnl',
'transaction_hash', 'order_id', 'crossed', 'fee', 'trade_id', 'timestamp',
'time', 'date']
```

**Fear/Greed dataset columns:**
```
['timestamp', 'value', 'classification', 'date']
```

Data has been **cleaned, normalized, and merged** by date to align trades with market sentiment.

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## 3. Metrics by Sentiment

Aggregated metrics include **average PnL, standard deviation of PnL, total volume, average trade size, average leverage, and win rate** for each sentiment category:

| Sentiment | Avg PnL | Std PnL | Total Volume | Avg Volume | Avg Leverage | Win Rate |
|---|---|---|---|---|---|---|
| Extreme Fear | 1.89 | 76.73 | 9.58M | 4,119 | 21,903 | 0.29 |
| Extreme Greed | 205.82 | 1,861.56 | 18.22M | 3,242 | 24,593 | 0.55 |
| Fear | 128.29 | 1,342.35 | 79.67M | 5,745 | 8,146 | 0.38 |
| Greed | 53.99 | 1,399.47 | 57.05M | 5,052 | 37,277 | 0.44 |
| Neutral | 27.09 | 142.95 | 11.94M | 4,332 | 89,200 | 0.49 |

**Observations:**

- Strong sentiment periods (Fear or Greed) have higher PnL and variability.

- Win rate is lowest during Extreme Fear and highest during Extreme Greed.
- Leverage is extremely high during Neutral periods, likely due to outliers.

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# 4. Statistical Testing

**T-test: Fear vs Greed PnL**

```
t = 4.266, p ≈ 0.000
```

**Interpretation:**

- The difference in PnL between Fear and Greed periods is **statistically significant**.
- Traders earn higher PnL on average during **Fear periods** compared to Greed.

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# 5. Clustering Trades

KMeans clustering (3 clusters) was applied using:
`['size_usd','closed_pnl','fee']`

## Cluster Overview

| Cluster | Avg Size | Avg PnL | Avg Fee | Avg Leverage | Count | Interpretation |
|---|---|---|---|---|---|---|
| 0 | ~3,237 | 29 | 0.66 | -30,480 | 208,369 | Small trades, low PnL, retail/micro traders |
| 1 | ~144,000 | 1,218 | 32 | 9,355 | 2,720 | Medium-large trades, moderate-high PnL, professional traders |
| 2 | ~926,000 | 6,836 | 150 | 1,994 | 135 | Very large trades, high PnL, whales/institutional traders |

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## Cluster Behavior Across Sentiments

| Cluster | Sentiment | Avg PnL | Avg Size | Avg Leverage | Count |
|---|---|---|---|---|---|
| 0 | All | Low | Small | High | Many |
| 1 | Extreme Greed | Very High | Medium | Moderate | Few |
| 2 | Fear / Greed | High | Large | Low | Very Few |

**Insights:**

- Retail traders (Cluster 0) dominate small trades across all sentiments.
- Medium-large traders (Cluster 1) profit most in **Extreme Greed**.
- Whales (Cluster 2) make very large profitable trades, usually during **Fear or Greed**.

# 6. Visualizations

1. **Average PnL by Sentiment**
2. **Total Trade Volume by Sentiment**
3. **Win Rate by Sentiment**
4. **Clusters of Trades (scatterplot with sentiment overlay)**

*(All visualizations use vibrant, distinguishable colors and clear axes for easy interpretation.)*

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# 7. Key Insights for Trading Strategy

1. **Profitability aligns with strong sentiment**: Fear → high-risk/high-reward trades, Greed → moderate-risk profitable trades.
2. **Risk management is critical**: retail traders with high leverage risk losses in extreme sentiment periods.
3. **Clusters reveal trader archetypes**: retail, professional, whales – each responds differently to market sentiment.
4. **Actionable strategy**:
   - Exploit Fear periods carefully with calculated risk.
   - Use Greed periods for moderate, safer trades.
   - Whale/large-trade signals can inform liquidity opportunities.