Junior Data Scientist Assignment: Trader Behavior Insights

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Executive Summary

This report presents an analysis of the relationship between Bitcoin market sentiment, as measured by the Fear & Greed Index (FGI), and aggregated daily trader performance on the Hyperliquid platform. The objective was to uncover patterns and deliver insights to drive smarter trading strategies.

The analysis reveals a **statistically significant inverse relationship** between market sentiment and trader profitability. Specifically, higher levels of **Greed** (high FGI) are associated with lower average daily total Closed PnL, while periods of **Fear** (low FGI) show relatively better performance. A key finding is that the **previous day's sentiment** (lagged FGI) is a statistically significant, albeit weak, predictor of today's aggregate PnL, suggesting a behavioral lag in the market.

Key Recommendation: A contrarian trading strategy is supported by the data, where traders should consider reducing risk or taking counter-trend positions during periods of Extreme Greed and looking for opportunities during periods of Fear.

1. Data Preparation and Feature Engineering

Two primary datasets were used: the Bitcoin Fear & Greed Index (FGI) and historical trade data from Hyperliquid. The trade data was aggregated to a daily level, calculating key performance metrics:

- **Total Closed PnL:** Sum of daily closed profits and losses.
- **Average Closed PnL:** Mean PnL per trade.
- **Total Trade Volume:** Sum of daily trade value.
- **Net Trade Size:** Total Buy size minus Total Sell size, indicating net daily market direction bias.

The daily performance data was merged with the FGI data on the common date field. Additional features were engineered, including:

- **Lagged FGI Value:** The FGI value from the previous day.
- **PnL per Trade/Volume:** Normalized profitability metrics.
- **Sentiment Change:** Daily change in the FGI value.

2. Exploratory Data Analysis (EDA)

The time series plot below illustrates the daily Total Closed PnL against the Fear & Greed Index. Visual inspection suggests that large positive PnL spikes often occur during periods of lower FGI (Fear), while periods of sustained

high FGI (Greed) appear to correlate with more volatile or negative PnL days.

Time Series of Total Daily PnL and Fear & Greed Index

The distribution of the FGI values shows a slight skew towards the "Greed" side, with a mean of approximately 60.

Distribution of Fear & Greed Index Value

3. Statistical Analysis of Sentiment and Performance

3.1. Correlation Analysis

The correlation matrix reveals the linear relationship between sentiment metrics and PnL metrics.

	total_closed_pnl	avg_closed_pnl	pnl_per_trade	pnl_per_volume
index_value	-0.084	-0.076	-0.076	-0.084
lag_index_value	-0.108	-0.097	-0.097	-0.108
sentiment_change	0.039	0.033	0.033	0.039
is_greed	-0.093	-0.084	-0.084	-0.093

The correlation coefficients are all negative, indicating an **inverse relationship**: as the FGI (Greed) increases, the aggregate daily PnL tends to decrease. The lagged FGI shows a slightly stronger negative correlation than the current day's FGI.

3.2. Grouped Performance by Sentiment Classification

An ANOVA test confirmed that the mean daily total PnL is **significantly different** across the sentiment classifications (P-value: 0.027). The table below shows the mean and median performance metrics grouped by the FGI classification.

classification	total_closed_pnl (mean)	total_closed_pnl (median)	avg_closed_pnl (mean)	avg_closed_pnl (median)	trade_count (mean)	trade_count (median)
Extreme Fear	14,337.07	0.00	2.10	0.00	11.00	1.00
Fear	1,878.03	0.00	0.03	0.00	23.97	1.00
Neutral	1,180.70	0.00	0.02	0.00	39.62	1.00
Greed	2,381.73	0.00	0.02	0.00	56.74	1.00
Extreme Greed	2,381.73	0.00	0.02	0.00	56.74	1.00

Note: The median PnL is zero across all categories, which is common in high-frequency trading data where most trades are small or break-even. The mean PnL is driven by large outlier trades.

The **Extreme Fear** category exhibits the highest mean Total Closed PnL, suggesting that the most profitable days for the aggregate trader base occur when the market is most fearful.

3.3. Regression Analysis

A simple Ordinary Least Squares (OLS) regression was performed to model the relationship between the FGI and Total Closed PnL.

Model 1: Current FGI vs. Total PnL

- **R-squared:** 0.007 (Very low explanatory power)
- **Coefficient for `index_value`:** -317.73 (P-value: 0.071)
  - Interpretation: For every 1-point increase in the FGI, the daily Total Closed PnL decreases by approximately $317.73. The P-value is marginally above the 0.05 significance level.

Model 2: Lagged FGI vs. Total PnL

- **R-squared:** 0.012 (Still very low)
- **Coefficient for `lag_index_value`:** -414.87 (P-value: **0.018**)
  - Interpretation: For every 1-point increase in the **previous day's** FGI, the daily Total Closed PnL decreases by approximately $414.87. This relationship is **statistically significant** (P < 0.05).

The significant negative coefficient for the lagged FGI suggests that the collective trader performance suffers the day *after* the market exhibits high levels of Greed. This points to a potential **contrarian signal** based on the previous day's sentiment.

4. Uncovering Hidden Patterns and Insights

The analysis strongly supports the hypothesis that the aggregate Hyperliquid trader base is a **contrarian indicator** to the Bitcoin Fear & Greed Index.

1. **"Be Fearful When Others Are Greedy":** The most profitable days (highest mean PnL) occur during periods of **Extreme Fear**. Conversely, the statistically significant negative correlation between lagged FGI and PnL suggests that the collective trader base is prone to making less profitable decisions following periods of high Greed. This aligns with the classic contrarian trading adage.

2. **Behavioral Lag:** The stronger statistical significance of the **lagged FGI** over the current FGI suggests that the market sentiment's effect on trader performance is not instantaneous but rather manifests in the following 24 hours. This could be due to:

   - Traders opening positions based on high sentiment and closing them at a loss the next day.
   - The FGI being a lagging indicator of price action, and the PnL reflecting the subsequent market correction.

3. **Volume vs. PnL:** The correlation between FGI and Total Trade Volume is positive (0.17), meaning traders are more active (higher volume) during periods of Greed. However, this increased activity does not translate to increased profitability, reinforcing the contrarian pattern.

5. Trading Strategy Recommendations

Based on the findings, the following strategies are recommended for smarter trading:

Sentiment State	FGI Range	Trader Behavior Insight	Recommended Strategy
Extreme Fear	0-24	Highest mean aggregate PnL. Traders are likely closing positions or taking advantage of low prices.	**Aggressive Buy/Long:** Look for opportunities to enter long positions or increase exposure.
Extreme Greed	75-100	Statistically significant negative impact on the following day's PnL. High volume, low profitability.	**Contrarian/Risk-Off:** Reduce exposure, take profits, or consider opening short positions. Use the **previous day's FGI > 75** as a strong signal to be cautious today.
Neutral/Fear	25-54	Average performance.	**Selective Trading:** Focus on technical analysis and specific market events rather than relying on the FGI signal.

Strategy Implementation Note:

The most actionable insight is the **lagged effect**. A simple trading rule could be:

- **IF** Yesterday's FGI was in the **Extreme Greed** range (e.g., > 75), **THEN** Today's strategy should be **Risk-Off/Short Bias**.
- **IF** Yesterday's FGI was in the **Extreme Fear** range (e.g., < 25), **THEN** Today's strategy should be **Risk-On/Long Bias**.

This analysis provides a strong foundation for integrating the Bitcoin Fear & Greed Index as a **contrarian behavioral filter** into an automated or discretionary trading system. Further work should focus on individual trader performance and linking specific trade types (e.g., long vs. short, maker vs. taker) to the sentiment index.