Data Science Assignment Report: Trader Behavior and Market Sentiment

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Executive Summary

This analysis investigates the relationship between Bitcoin (BTC) trader performance (profitability, risk, and volume) and market sentiment, as defined by the Fear & Greed Index (FGI).

The primary finding is that the **FGI is not a statistically significant predictor of next-day trader profitability** ($\rho = -0.0816$, P-Value 0.9184). However, market sentiment is a powerful indicator of **trader risk appetite** and **market participation**. The vast majority of trades and the highest PnL volatility (risk) occur during periods of **Fear**. The median trader is consistently break-even ($\$0.00$) across all sentiment categories.

1. Methodology

1.1 Data Preprocessing

1. **Data Sources:** Historical Trader Data and the Bitcoin Fear & Greed Index (FGI) were loaded via public URLs.
2. **Cleaning:** Columns were standardized to ensure clean merging (e.g., renaming the 'coin' column to 'symbol' and standardizing 'closed_pnl'). The leverage column was confirmed to be missing from the source data and was excluded from the final metrics.
3. **Filtering & Merging:** All trades were filtered to **BTC only**. Trades were merged with the daily FGI classification on the transaction date.

1.2 Quantitative Metrics

Metric Category	Metric Used	Purpose
Profitability	Median Closed PnL	Measures the typical trader's return, robust against outliers.
Risk	Standard Deviation of Closed PnL	Measures the volatility or risk associated with PnL distribution.
Trade Volume	Total Trades (Count)	Measures the level of trading activity under each sentiment.
Hidden Trend	Pearson Correlation (ρ)	Tests the linear relationship between Today's FGI and Tomorrow's Average PnL.

2. Quantitative Findings

2.1 Performance Metrics by Sentiment

Classification	Median PnL	Risk (Std Dev of PnL)	Total Trades
Extreme Greed	0.0000	126.2042	1451
Fear	0.0000	526.8727	16168
Greed	0.0000	185.9849	2299
Neutral	0.0000	235.3373	217

Key Insights:

- **Risk Concentration:** Traders exhibit the highest risk-taking behavior (highest Standard Deviation of PnL: **$526.87**) during periods of **Fear**. The lowest risk $(\$126.20)$ occurs during Extreme Greed.
- **Activity Volume:** Approximately 80% of all analyzed BTC trades occurred when the market sentiment was classified as **Fear** (16,168 trades), indicating high panic and activity in volatile market conditions.

2.2 Correlation Analysis (The Hidden Trend)

The Pearson Correlation test was run on the FGI (today) against the Average PnL (tomorrow).

Metric	Result
Pearson Correlation	-0.0816
P-Value	0.9184

Conclusion on Trend:

The correlation of -0.0816 is negligible, and the P-Value is far from statistically significant. The **FGI cannot be used as a standalone linear predictor** for the average profitability of traders on the subsequent day.

3. Visualizations

The two required visualizations (trader_pnl_by_sentiment.png and final_trend_plot.png) are included in the **outputs/** folder of the repository.

1. **Boxplot:** Confirms the near-zero median PnL across all categories and visually highlights the extreme PnL spread (volatility) during **Fear**.
2. **Time Series:** Visually confirms the lack of a clear, consistent lead-lag pattern between the Daily Average PnL and the FGI Value.

4. Conclusion and Recommendations

The analysis highlights that while market sentiment does not predict profitability, it is a crucial driver of **trade risk and volume**. The greatest market noise and speculation occur when traders are fearful.

Recommendations for Future Analysis:

1. **Directional Analysis:** Investigate the PnL distribution of **Long vs. Short** positions specifically during periods of high **Fear** to determine which directional trade (if any) is more successful during high volatility.
2. **Outlier Study:** Isolate and analyze the characteristics of the most successful traders (e.g., top 5% PnL) to understand if their behavior (size, frequency, leverage) differs under varying sentiment conditions.