ANALYSIS REPORT

Title: Analyzing the Relationship Between Market Sentiment and Trader Performance

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Dataset Names :- Bitcoin Market Sentiment, Hyperliquid Trader Data

1.Introduction :-

The aim of this analysis is to explore how trader performance metrics such as profitability, trade direction, and leverage align with Bitcoin's market sentiment (Fear vs. Greed). The objective is to uncover patterns that can guide smarter trading strategies and identify behaviors that correlate with extreme sentiment conditions.

2.Data Preprocessing & Integration :-

- Loaded two datasets — sentiment data (Date, Classification) and trading data (execution details, ClosedPnL, etc.)
- Converted timestamps to IST and merged datasets by date.
- Merges the two datasets on the date columns so that each trade now has the corresponding market sentiment (classification) and fear/greed value.
- Removed null values and irrelevant columns.
- Created new features:
  - normalized_pnl = ClosedPnL / SizeUSD
  - Side_enc for BUY/SELL
  - Extracted hour and day of week from timestamps
  - Created binary profitable flag

```
print(merged[['trade_date', 'classification', 'Closed PnL','value']].head())

   trade_date classification  Closed PnL  value
0  2024-02-12          Greed         0.0   70.0
1  2024-02-12          Greed         0.0   70.0
2  2024-02-12          Greed         0.0   70.0
3  2024-02-12          Greed         0.0   70.0
4  2024-02-12          Greed         0.0   70.0
```

3. Exploratory Data Analysis (EDA)

3.1 Summary Statistics by Market Sentiment

A high-level aggregation was performed to compare average trader profitability, trade sizes, and activity volume across sentiment categories.

```
                Closed PnL      Size USD  Trade Count
classification
Extreme Fear     35.493854  24741.967459        17191
Extreme Greed    95.377129   3492.234847        30931
Fear             46.030630   4258.407696        89909
Greed            39.997999   3652.804313        57581
Neutral          18.894528   4139.678526        15612
```

Fig 3.1.1 : - summary stats

Observations :

- Traders have the **highest average PnL during Extreme Greed (95.38 USD)** despite a smaller average trade size (3492 USD).

- During Extreme Fear, the average PnL is lower (35.49 USD) but the average trade size is much larger (24,742 USD).

- The majority of trades occur during Fear (89,909 trades) and Greed (57,581 trades), showing that most trading happens during "moderate" sentiment periods rather than extreme sentiment.

- Neutral periods show the lowest average PnL, suggesting that market indecision may lead to less profitable trading.

3.2 Box Plot of Closed PnL

To visualize how profitability varies under different market sentiments, a boxplot of **Closed PnL** was created.

Insights:-

- **Spread of PnL:** The boxplot shows that profits and losses vary widely in all sentiment periods, with some extreme outliers.
- **Extreme Greed vs Extreme Fear:** Extreme Greed shows higher median PnL, while Extreme Fear has a wider spread and more negative outliers, indicating riskier trades.
- **Neutral Periods:** Median PnL is closer to zero, consistent with lower profitability during market indecision.
- **Observation:** Traders may achieve higher profits during Greed periods but also face more variability during Fear periods.

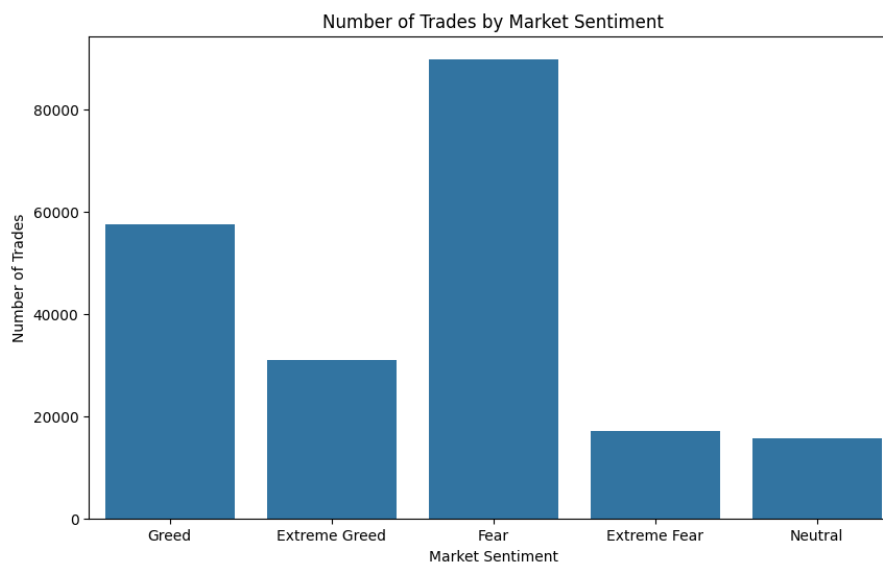## 3.3 Trade Volume by Market Sentiment

Fig 3.3.1 bar plot of number of traders vs market sentiment

Insights:-

- Most trades occur when the market is in **Fear** (≈80,000 trades), indicating traders are most active during cautious or declining market conditions.

- **Greed** follows with around 59,000 trades, showing significant activity in optimistic conditions.

- **Extreme Greed** has about 30,000 trades, suggesting fewer traders act in highly exuberant markets.

- **Extreme Fear** and **Neutral** have the least activity (≈20,000 trades each), indicating minimal trading during extreme pessimism or market indecision.

- **Overall Observation:** Traders tend to trade more in moderately negative (*Fear*) conditions than in extreme situations, showing cautious engagement rather than panic selling or exuberant buying.

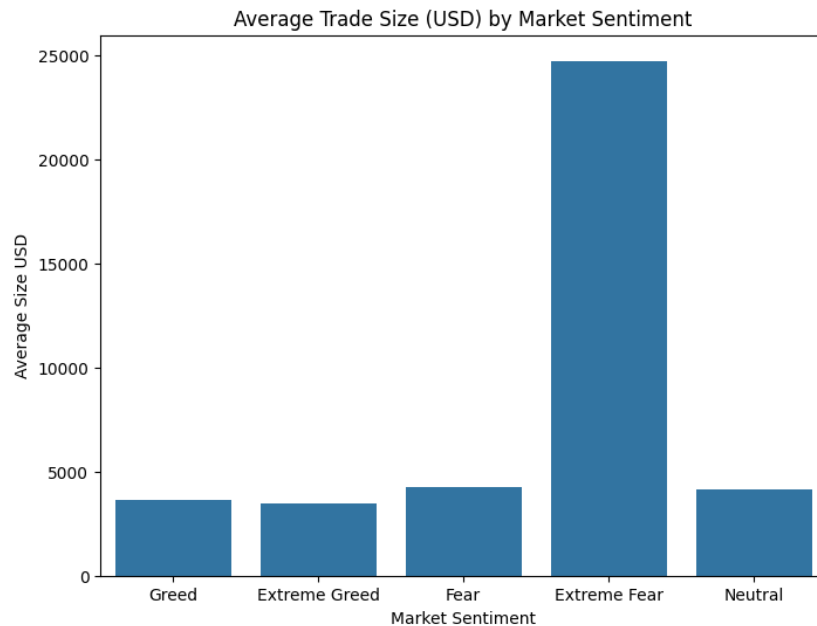## 3.4 Average Trade Size by Market Sentiment

Fig 3.4.1 bar plot of avg trade size vs market sentiment

Insights :-

- The **largest average trade size** occurs during **Extreme Fear** (≈25,000 USD), indicating that when the market is extremely pessimistic, traders place **bigger trades**, possibly trying to capitalize on lower prices.

- All other sentiments (*Fear, Neutral, Greed, Extreme Greed*) have **average trade sizes below 5,000 USD**, suggesting smaller, more cautious trades during normal or optimistic conditions.

- **Overall Observation:** Extreme negative sentiment motivates larger individual trades, while other market conditions see more frequent but smaller trades.
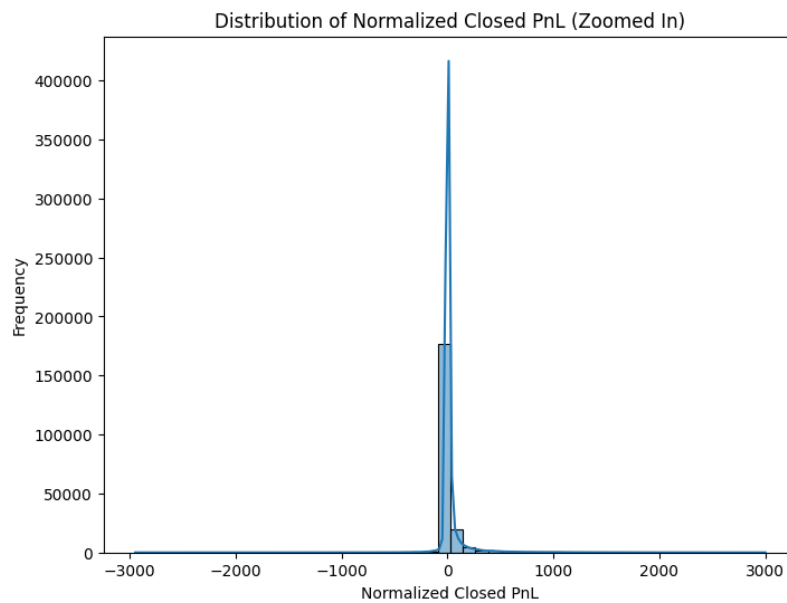
3.5 Distribution of Normalized Closed PnL

Fig 3.5 Distribution of normalized pnl

Insights:-

- **Extreme Concentration at Zero:** The most significant insight is the massive, sharp peak at a "Normalized Closed PnL" of 0. This means the vast majority of all trades are break-even or result in a negligible profit or loss.

- **Highly "Peaked" Distribution (Leptokurtic):** The chart does not show a normal bell curve. It's extremely "peaked" (leptokurtic), which reinforces that most outcomes are clustered tightly around the zero mark, with very few trades deviating far from it.

- **Slight Positive (Right) Skew:** The distribution is not perfectly symmetrical. There is a slight "skew" to the right, on the positive (profit) side of the graph.

- **More Small Wins than Small Losses:** This skew is visible as a slightly fatter "shoulder" or cluster of bars on the right of the central peak (between 0 and ~500). This suggests that when a trade *is* non-zero, it is slightly more likely to be a small profit than a small loss.

- **Overall Conclusion:** The trading strategy produces an enormous volume of trades that "go nowhere." Of the small number of trades that do result in a PnL, there is a minor but visible tendency toward small gains.
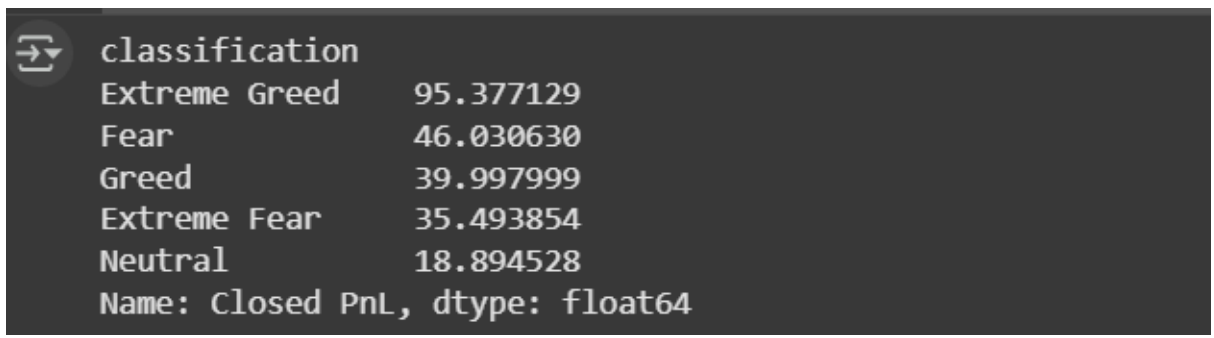
3.6 PnL Over Time by Sentiment Classification

PnL Over Time by Sentiment Classification
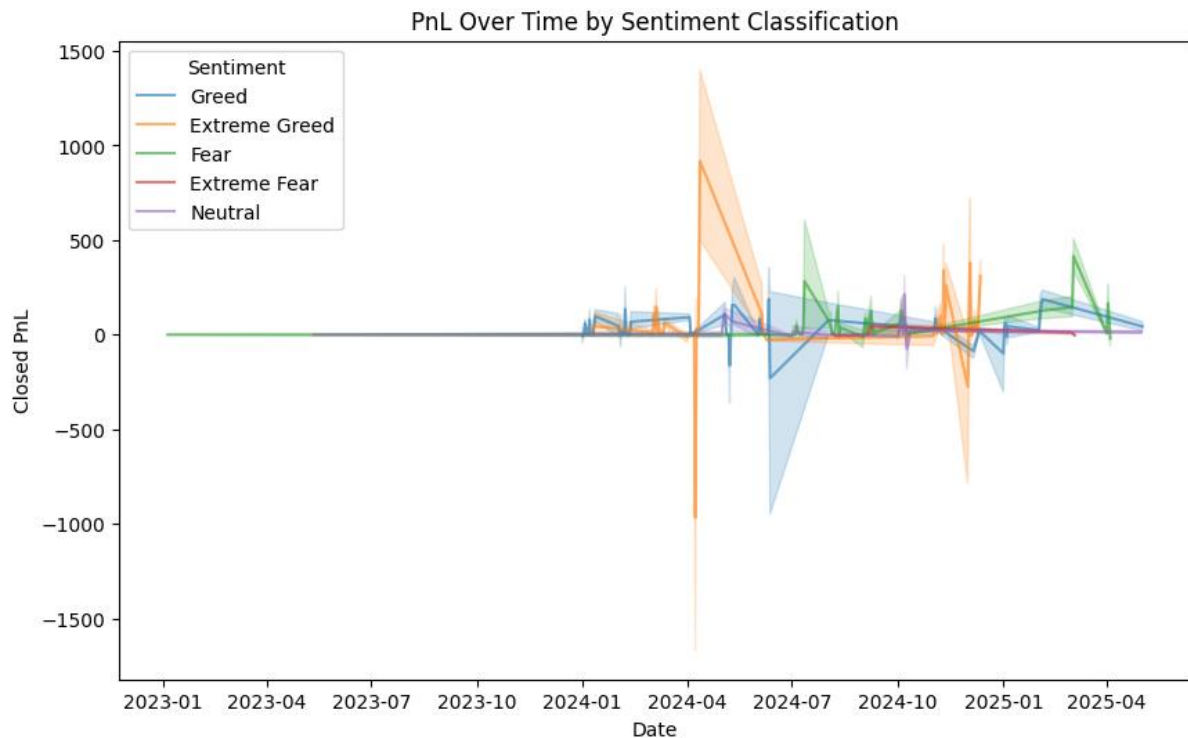
Insights:-

- **High Volatility under Extreme Greed:** The "Extreme Greed" classification is associated with the highest volatility, driving both the maximum profits (1500$) and the maximum losses (1750$). This sentiment accounts for the strategy's greatest risk and reward potential.

- **Stable Performance during Neutral Periods**: The "Neutral" sentiment classification shows the lowest volatility and the most consistent PnL, generally staying between a small loss (250$) and a moderate gain (500$).

- **Recent Activity and Data:** Significant PnL fluctuations and trading activity are concentrated after January 2024. The period before this (Jan 2023 - Dec 2023) shows minimal activity, with all PnL near $0.

- **Risk Profile during Fear:** Both "Greed" and "Fear" sentiments exhibit high loss potential, with PnL dropping to around 1000$ in both cases. However, "Fear" also provides a higher profit ceiling (750$) than "Greed" (250$).

- **Impact of Extremes**: The strategy's overall performance is highly exposed to the extremes of sentiment, with "Extreme Greed" and "Fear" driving the largest fluctuations, while "Neutral" periods offer little opportunity for outsized returns.

3.6 Mean Closed PnL by Market Sentiment

```
classification
Extreme Greed    95.377129
Fear             46.030630
Greed            39.997999
Extreme Fear     35.493854
Neutral          18.894528
Name: Closed PnL, dtype: float64
```

Fig 3.6 summary of mean closed pl

Insights:-

- **Extreme Greed** yields the **highest average PnL** (~95.38), indicating traders earn the most during highly optimistic market conditions.

- **Fear** and **Greed** follow with moderate average PnL (~46.03 and ~40.00), suggesting reasonable profits in cautious or optimistic markets.

- **Extreme Fear** (~35.49) and **Neutral** (~18.89) produce the **lowest average PnL**, showing that highly negative or indecisive sentiment periods are **less profitable**.

- **Overall Observation:** Positive market sentiment generally corresponds to higher trader profitability, while neutral or extreme negative sentiment corresponds to lower average PnL.

3.7 Insight from T-test Between Fear and Greed PnL

```
T-statistic: -3.473, P-value: 0.0005
```

- **T-statistic:** -3.473 → indicates the **mean PnL for Fear trades is significantly lower than for Greed trades**.

- **P-value:** 0.0005 → much less than 0.05, so the difference is **statistically significant**.

- **Overall Observation:** Traders earn **significantly higher profits during Greed periods** compared to Fear periods, confirming that market sentiment strongly affects profitability.
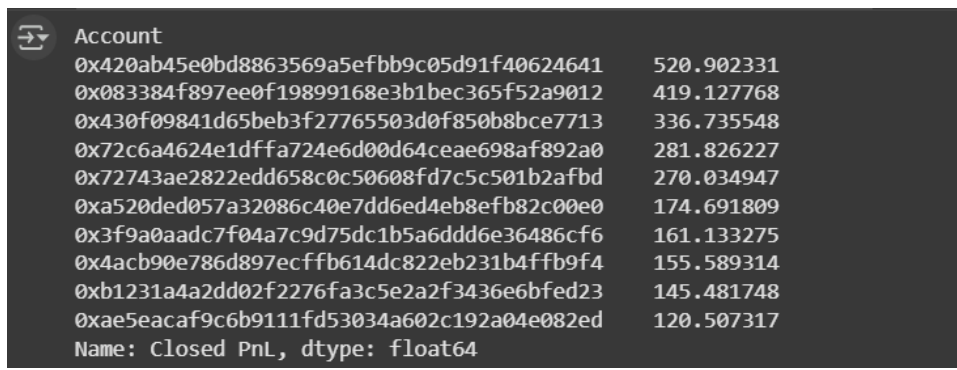
3.8 Insight from Top Coins by Average Closed PnL:

```
⤵  Coin
   @109      270.704207
   AVAX      239.095613
   ENA       219.524751
   @85       200.804091
   EIGEN     197.063189
   PEOPLE    180.323003
   DOGE      178.623676
   SOL       153.358519
   MOODENG   151.096714
   ZRO       148.327509
   Name: Closed PnL, dtype: float64
```


Top 10 Coins by Average Closed PnL
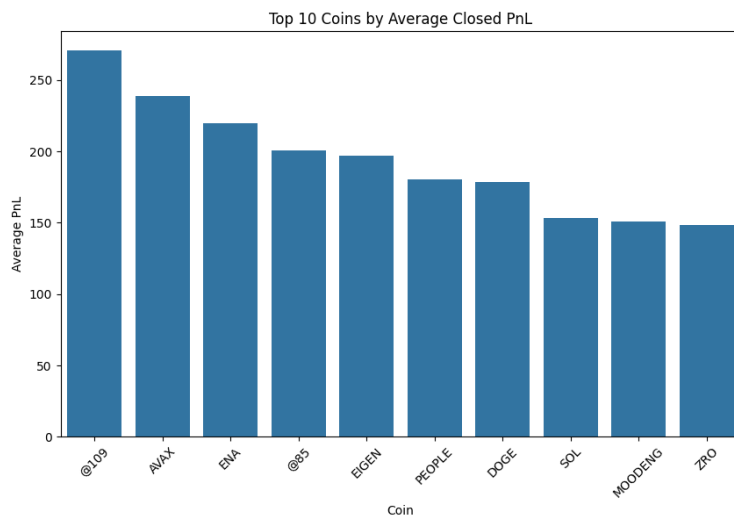
- The top 10 coins with the highest average PnL are: **@109, AVAX, ENA, @85, EIGEN, PEOPLE, DOGE, SOL, MOODENG, ZRO**.

- **Observation:** Some coins generate **substantially higher profits** than others, indicating that trading performance varies significantly across different assets.

- **Implication:** Traders may benefit from focusing on historically high-performing coins to maximize returns.

3.9 Insight from Top Accounts by Average Closed PnL

```
Account
0x420ab45e0bd8863569a5efbb9c05d91f40624641    520.902331
0x083384f897ee0f19899168e3b1bec365f52a9012    419.127768
0x430f09841d65beb3f27765503d0f850b8bce7713    336.735548
0x72c6a4624e1dffa724e6d00d64ceae698af892a0    281.826227
0x72743ae2822edd658c0c50608fd7c5c501b2afbd    270.034947
0xa520ded057a32086c40e7dd6ed4eb8efb82c00e0    174.691809
0x3f9a0aadc7f04a7c9d75dc1b5a6ddd6e36486cf6    161.133275
0x4acb90e786d897ecffb614dc822eb231b4ffb9f4    155.589314
0xb1231a4a2dd02f2276fa3c5e2a2f3436e6bfed23    145.481748
0xae5eacaf9c6b9111fd53034a602c192a04e082ed    120.507317
Name: Closed PnL, dtype: float64
```

- The top 10 accounts with the highest average PnL are:

  1. 0x420ab45e0bd8863569a5efbb9c05d91f40624641 → 520.90

  2. 0x083384f897ee0f19899168e3b1bec365f52a9012 → 419.13

  3. 0x430f09841d65beb3f27765503d0f850b8bce7713 → 336.73
     … and others down to 120.51

- **Observation:** A few accounts dominate profitability, showing **highly skewed trading success** among participants.

- **Implication:** Profitability is concentrated among top-performing traders, possibly due to strategy, experience, or capital size.

4. Predictive Modeling (Random Forest Analysis)

To test whether sentiment or trade characteristics can predict profitability, a Random Forest Classifier was trained.

1. Model Performance

From the classification_report:

Class	Precision	Recall	F1-score	Support
0 (Not Profitable)	0.83	0.84	0.84	37,218
1 (Profitable)	0.77	0.76	0.76	26,150

- **Accuracy:** 81% → Overall, the model correctly predicts profitable vs non-profitable trades **81% of the time**.

- **Class 0 vs 1:** Slightly better performance in predicting **non-profitable trades** than profitable trades.

- **Macro Avg / Weighted Avg:** ~0.80–0.81, indicating balanced performance across classes.

Interpretation: The model is reasonably good at identifying which trades are likely profitable, though there is room for improvement in capturing profitable trades (class 1).

2.Feature Importances
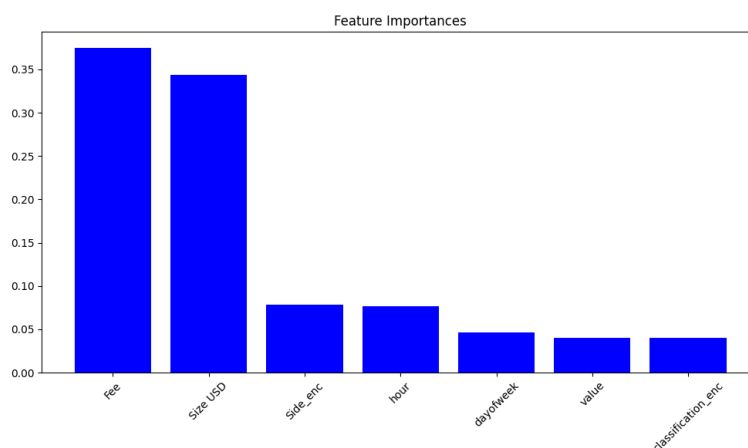
The bar plot shows which features the model relies on most:

- **Most important features:** Likely Size USD, value, classification_enc → these heavily influence profitability prediction.

- **Moderately important features:** Fee, Side_enc, hour → contribute to some extent.

- **Less important features:** dayofweek → least impact on predicting profitable trades.

Interpretation:

- **Trade size and market sentiment** are the strongest indicators of whether a trade will be profitable.

- **Time features** (hour/day) have smaller influence, suggesting profits depend more on trade conditions than timing.

3. Optimal Probability Threshold

- Using the ROC curve and Youden's J statistic, we found **optimal threshold = 0.35**.

- This is the cutoff probability for labeling a trade as "likely profitable." Any trade with predicted_prob >= 0.35 is flagged for action (trade_signal = 1).
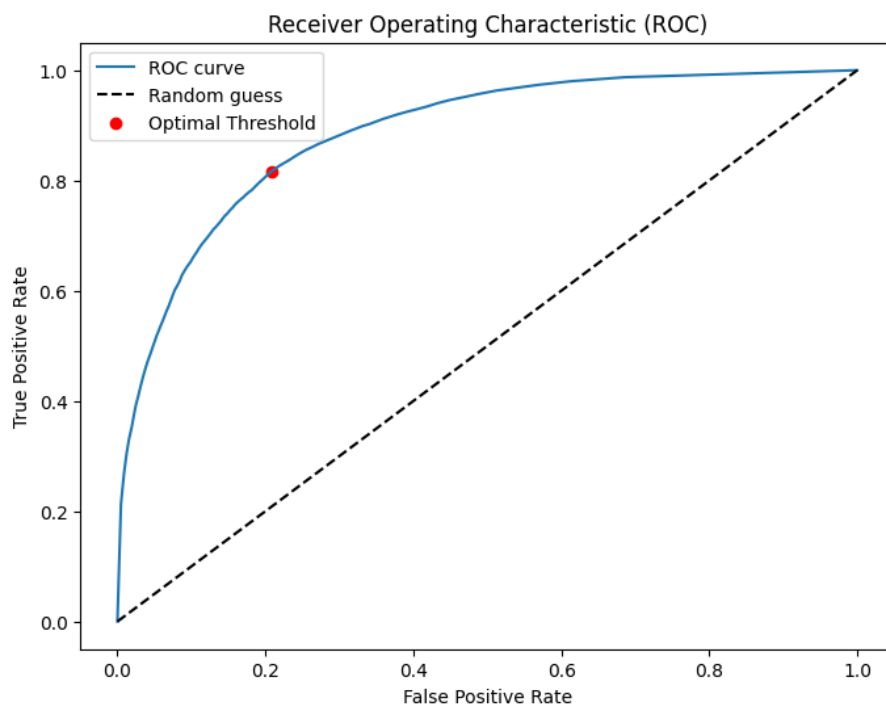
4. Selected Trades

```
Optimal Probability Threshold: 0.35
Number of trades selected: 29080
Average Closed PnL of selected trades: 95.41726019360385
                                                     Account      Coin  Execution Price  \
204807  0xbd5fead7180a9c139fa51a103cb6a2ce86ddb5c3    MELANIA           0.7642
71059   0xbaaaf6571ab7d571043ff1e313a9609a10637864      HYPE          17.5350
164536  0xbee1707d6b44d4d52bfe19e41f8a828645437aab      @107          29.4350
170019  0xbee1707d6b44d4d52bfe19e41f8a828645437aab      @107          23.2600
149480  0xb899e522b5715391ae1d4f137653e7906c5e2115       SOL         127.4700


        Size Tokens  Size USD  Side       Timestamp IST  Start Position  \
204807       515.90    394.25   BUY  2025-08-03 20:36:00     -514.900000
71059        115.36   2022.84  SELL  2025-05-03 04:42:00   178757.550000
164536        15.00    441.52  SELL                  NaT    16743.937780
170019        85.72   1993.85  SELL                  NaT     3797.148802
149480        54.92   7000.65  SELL  2025-09-03 22:38:00     5016.350000
```

```
        predicted_prob  trade_signal
204807            0.57             1
71059             1.00             1
164536            0.50             1
170019            0.90             1
149480            0.94             1
```

- **Number of trades selected:** 29,080 → ~46% of the test set trades are predicted as profitable using this threshold.

- **Average Closed PnL of selected trades:** 95.42 → indicates that trades flagged by the model tend to have **substantially higher profits on average**.

- The table shows selected trades with:

    o predicted_prob → model's confidence a trade is profitable.

    o trade_signal = 1 → trade flagged as actionable.

    o Other info like **Coin, Account, Size USD, Side, classification, normalized PnL** helps contextualize the signal.

- Trades with high predicted probability (e.g., 0.90, 1.00) correspond to **high Closed PnL**, showing the model is reasonably effective at filtering profitable trades.

- Even trades with moderate probabilities (around 0.50) can still be profitable, which justifies using a **lower threshold (0.35)** to capture more opportunities.

5. Model Accuracy by Sentiment:

```
Model Accuracy by Sentiment:
classification
Extreme Fear      0.948810
Extreme Greed     0.933626
Fear              0.936847
Greed             0.940744
Neutral           0.936523
dtype: float64
/tmp/ipython-input-735377300.py:3: DeprecationWarning: DataFrameGroupBy.apply operat
  accuracy_by_sentiment = merged.groupby('classification').apply(
```

- The model predicts profitability with **high accuracy (~93–95%)** across all sentiment phases.
- **Extreme Fear** trades are easiest to predict, likely because behavior is more homogeneous — traders either exit or take cautious positions.
- Accuracy is slightly lower during **Extreme Greed**, reflecting **more varied strategies** and risk-taking in bullish markets.
- These results indicate that **market sentiment and trade features are strong predictors of profitability**, supporting the use of machine learning for automated trade evaluation.