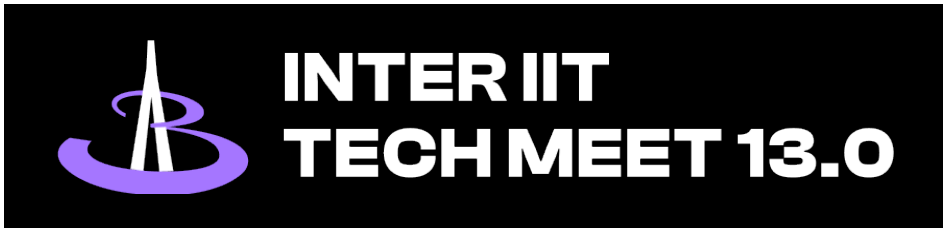
INTER-IIT TECH MEET 13.0

HP2 (Quantitative Finance)



CURATING ALPHAS ON BTC AND USDT CRYPTO MARKET

Mid-Term Evaluation Report

Team ID : 44

1 Progress Update

1.1 Current Status

The trading strategies on BTCUSDT and ETHUSDT have completed multiple buy and sell transactions over the training and testing periods, demonstrating performance for each year from 2019 to 2023.
Our strategies so far are based on using Technical Indicators, such as Moving Averages (MA), Relative Strength Index (RSI), and Moving Average Convergence Divergence (MACD), to identify entry and exit points. Each indicator was calibrated for optimal performance based on historical data.

During the training phase, parameters were fine-tuned to maximize cumulative returns and minimize risk, resulting in configurations that showed stable profitability in backtesting. In the testing phase, these strategies were evaluated on unseen data to assess their robustness and adaptability to different market conditions, including periods of high volatility and low liquidity.

Currently, we are focusing on exploring alpha-generating strategies that can deliver consistent long-term returns. These strategies involve more complex indicators and machine learning models that aim to capture subtle market inefficiencies and predict price trends over extended periods. By diversifying the strategies and incorporating a blend of technical and fundamental factors, we aim to enhance the robustness and longevity of our trading approach in both BTCUSDT and ETHUSDT markets.

Further, we analyzed risk metrics, such as maximum drawdown, Sharpe ratio, and Sortino ratio, to ensure that our strategies maintained a favorable balance between risk and reward. Preliminary results indicate that BTCUSDT strategies yielded a higher Sharpe ratio compared to ETHUSDT, reflecting relatively better risk-adjusted returns.

In summary, the current state of our trading strategies demonstrates reliable performance across BTCUSDT and ETHUSDT markets over multiple years, with risk management measures and optimization steps ready for the next development phase.

1.2 Challenges Encountered

During the testing phase, certain market conditions influenced strategy performance, especially in high volatility periods. Adjustments to the strategy parameters helped in adapting to these changes, optimizing profitability while managing drawdowns.
Some of the key challenges encountered included:

- **High Volatility and Slippage:** Unpredictable price movements and slippage affected the execution of trades, particularly during periods of major economic events or crypto market crashes. This led to potential deviations from the expected profitability and increased risk.
- **Latency and Execution Delays:** Simulating real-world trading environments introduced delays that impacted the efficiency of the strategies, as real-time trading conditions may vary from backtest assumptions.
- **Adjusting for Transaction Fees:** Transaction costs and fees gradually reduced net profits, especially for high-frequency strategies, requiring adjustments to make the strategies feasible in real trading scenarios.

1.3 Solutions Implemented

To address the challenges above, several solutions were implemented to improve strategy performance and robustness:

- **Adaptive Parameters for Volatile Periods:** Dynamic parameter adjustment mechanisms were introduced, allowing the strategy to react to changing volatility levels. For instance, stop-loss and take-profit levels were modified based on real-time volatility measures, reducing potential losses during market spikes.
- **Simulated Latency and Order Execution Adjustments:** To better approximate real-world performance, simulated latency was incorporated into backtests. Additionally, strategies were adjusted to account for partial fills and slippage, making them more resilient in live trading conditions.
- **Incorporation of Transaction Cost Analysis:** Strategies were optimized by factoring in transaction costs, reducing the frequency of trades and improving position sizing to ensure that net profits remained substantial after accounting for fees.

With these solutions in place, the strategies showed slightly improved resilience to market fluctuations and increased profitability but there was still quite a lot of improvement to be done.

2 Strategy Overview

2.1 Core Concept and Objectives of the Trading Strategy

We have tested various strategies using combinations of indicators across both BTC and ETH, including several indicator pairings such as:

1. Moving Average Convergence Divergence (MACD) with Relative Strength Index (MACD + RSI)
2. Bollinger Bands with (BB + RSI)
3. Bollinger Bands with Average True Range (BB + ATR)
4. Parabolic SAR

These combinations are crafted to generate momentum-based alpha signals that aim to exploit rare momentum opportunities rather than over-relying on frequent but potentially weaker signals.

The objective of this trading strategy is to identify strong, sustained price movements by integrating momentum indicators with volatility measures. For instance, MACD and RSI can complement each other by combining MACD's trend-following capability with RSI's ability to indicate overbought or oversold conditions, filtering out weak signals. Similarly, the use of Bollinger Bands with ATR or RSI helps capture volatility shifts that are often precursors to breakout events, while Parabolic SAR aids in trend confirmation.

This approach allows us to focus on high-probability setups where the price action aligns with multiple indicators, enhancing our confidence in the trade's direction. By prioritizing quality over quantity in signal generation, this strategy seeks to achieve consistent returns while managing downside risk through disciplined entry and exit criteria.

2.2 Key Features and Indicators: Functions and Correlations

The primary indicators applied in the strategy development include:

- **EMA (Exponential Moving Average)**
  Indicates: Trend
  Use: Similar to SMA but gives more weight to recent prices for quicker trend response.
  Formula:
  $$\text{EMA} = \text{Price}_{\text{current}} \times k + \text{EMA}_{\text{previous}} \times (1 - k)$$
  where $k = \frac{2}{N+1}$.

- **RSI (Relative Strength Index)**
  Indicates: Momentum
  Use: Measures momentum by comparing gains and losses to indicate overbought/oversold conditions.
  Formula:
  $$\text{RSI} = 100 - \frac{100}{1 + \frac{\text{Average Gain}}{\text{Average Loss}}}$$

- **MACD (Moving Average Convergence Divergence)**
  Indicates: Momentum
  Use: Shows momentum and trend direction by comparing two EMAs (typically 12-day and 26-day).
  Formula:
  $$\text{MACD} = \text{EMA}_{12} - \text{EMA}_{26}$$
  Signal Line = 9-day EMA of MACD.

- **Bollinger Bands**
  Indicates: Volatility
  Use: Shows volatility by setting bands around a moving average.
  Formula:
  $$\text{Middle Band} = \text{SMA}$$
  $$\text{Upper Band} = \text{SMA} + (2 \times \text{Standard Deviation})$$
  $$\text{Lower Band} = \text{SMA} - (2 \times \text{Standard Deviation})$$

- **ATR (Average True Range)**
  Indicates: Volatility
  Use: Measures market volatility by showing the average range between high and low prices.
  Formula:
  $$\text{ATR} = \frac{\sum \text{True Range}}{N}$$
  where True Range is calculated as max(high - low, abs(high - prev close), abs(low - prev close)).

- **Parabolic SAR (Stop and Reverse)**
  Indicates: Trend Reversal
  Use: Places dots above or below price to indicate trend direction and potential reversals.
  Formula: Adjusted per bar based on prior dot location and acceleration factor.

3 Performance Metrics

3.1 Moving Average Convergence Divergence (MACD) with Relative Strength Index (RSI)

This strategy leverages Bollinger Bands, Average True Range (ATR), and the Relative Strength Index (RSI) to identify overbought or oversold conditions and capture potential price reversals.

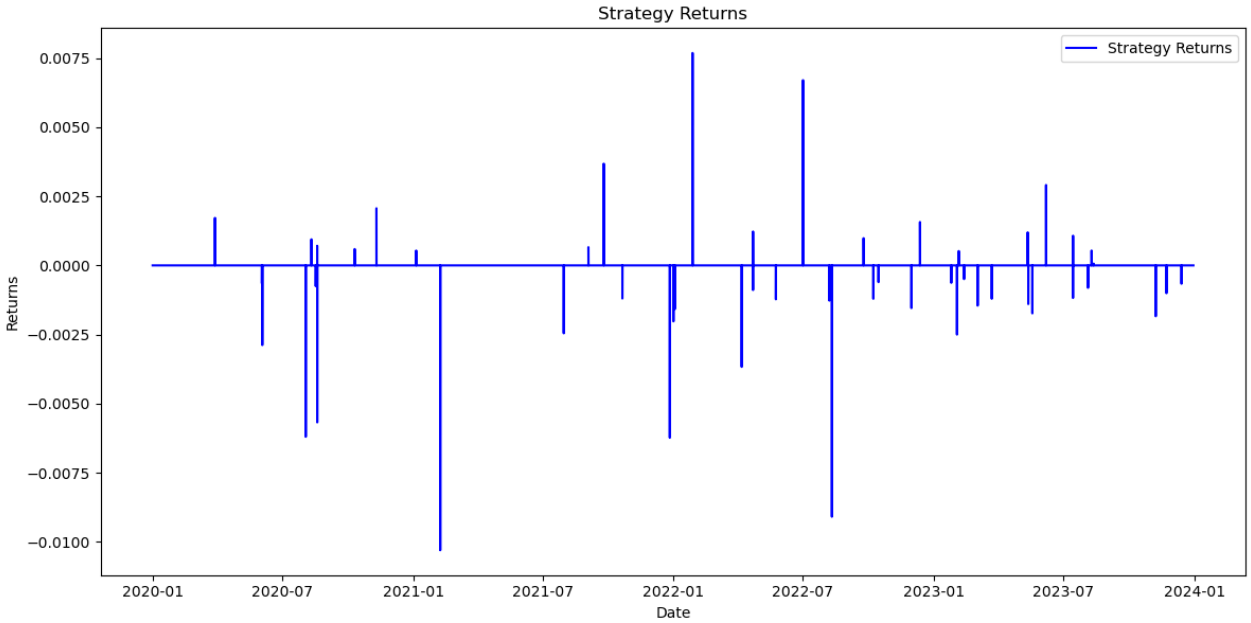
A buy signal is generated if the price closes below the lower Bollinger Band or if it moves downward more than 1.5 times the ATR from the previous close. Conversely, a sell signal occurs if the price crosses above the upper Bollinger Band or rises more than 1.5 times the ATR. This dual confirmation mechanism filters out noise and focuses on strong price movements that align with volatility and momentum trends.

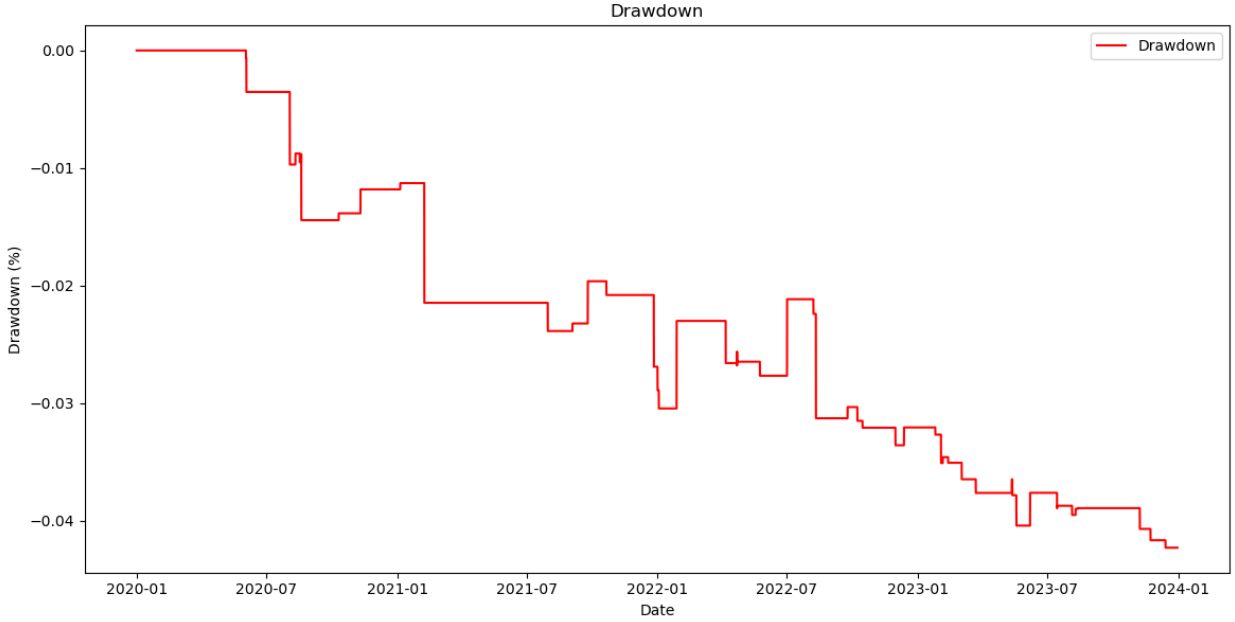
3.1.1 Performance Metrics for BTC/USDT

3.1.1.1 Summary of Performance Metrics for BTC/USDT

- **Profit Percentage**: 302.786
- **Sharpe Ratio**: 6.088
- **Maximum Drawdown**: 64.738
- **Time to Recovery**: 0

3.1.1.2 Visualizations



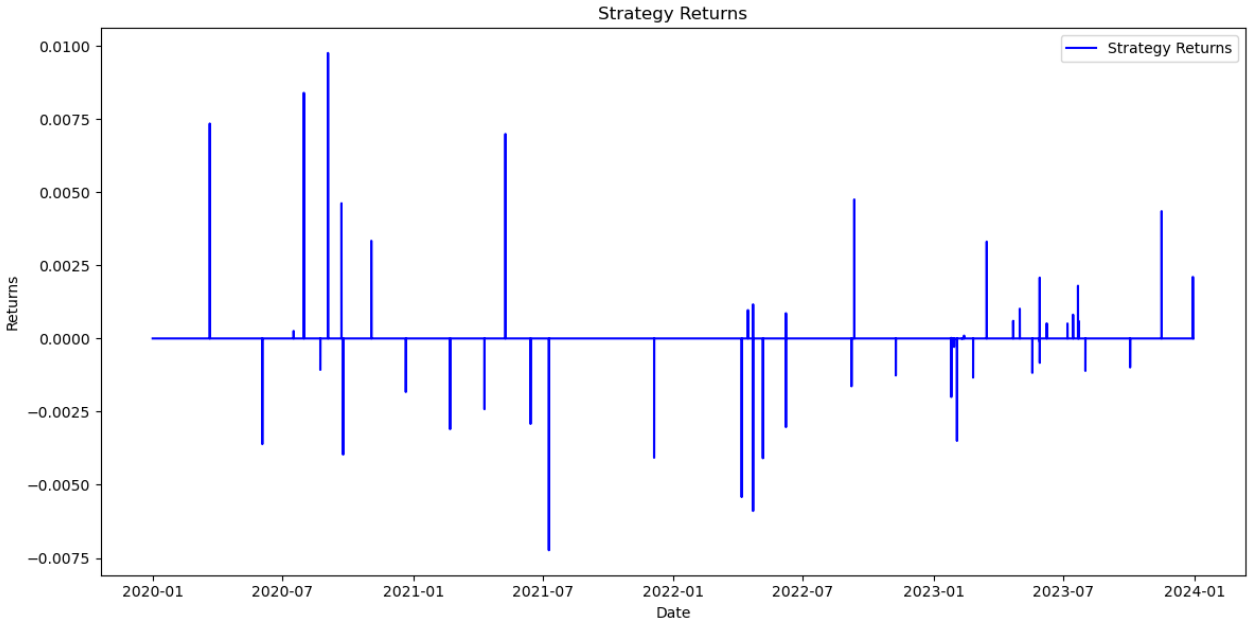


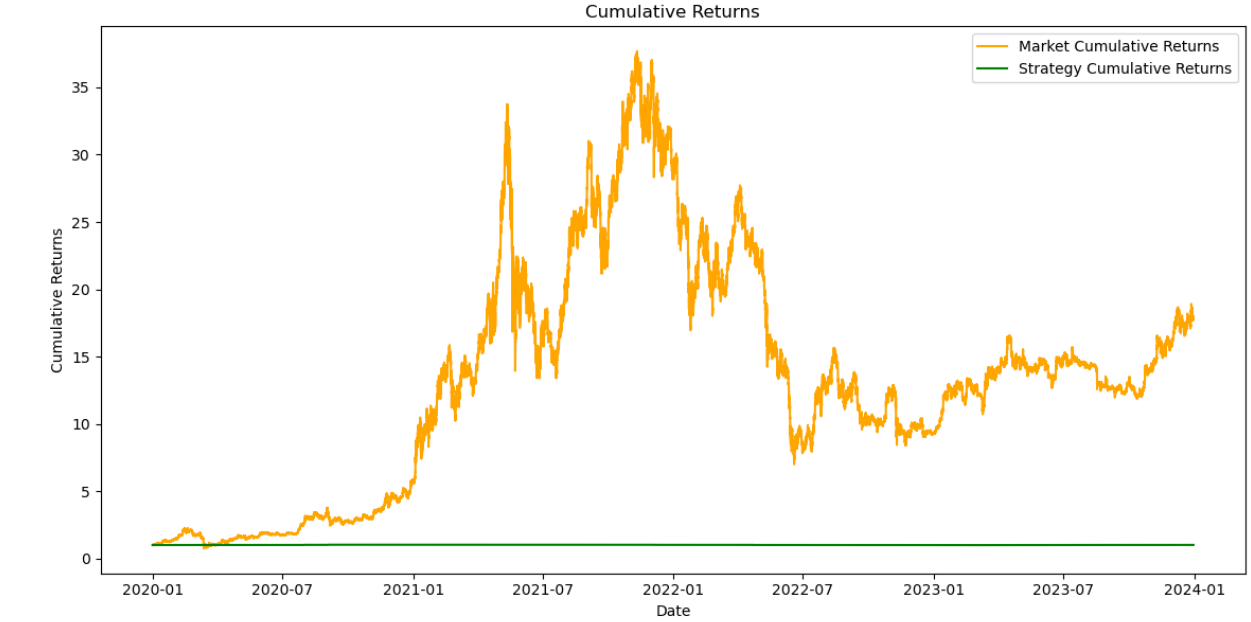
3.1.2 Performance Metrics for ETH/USDT

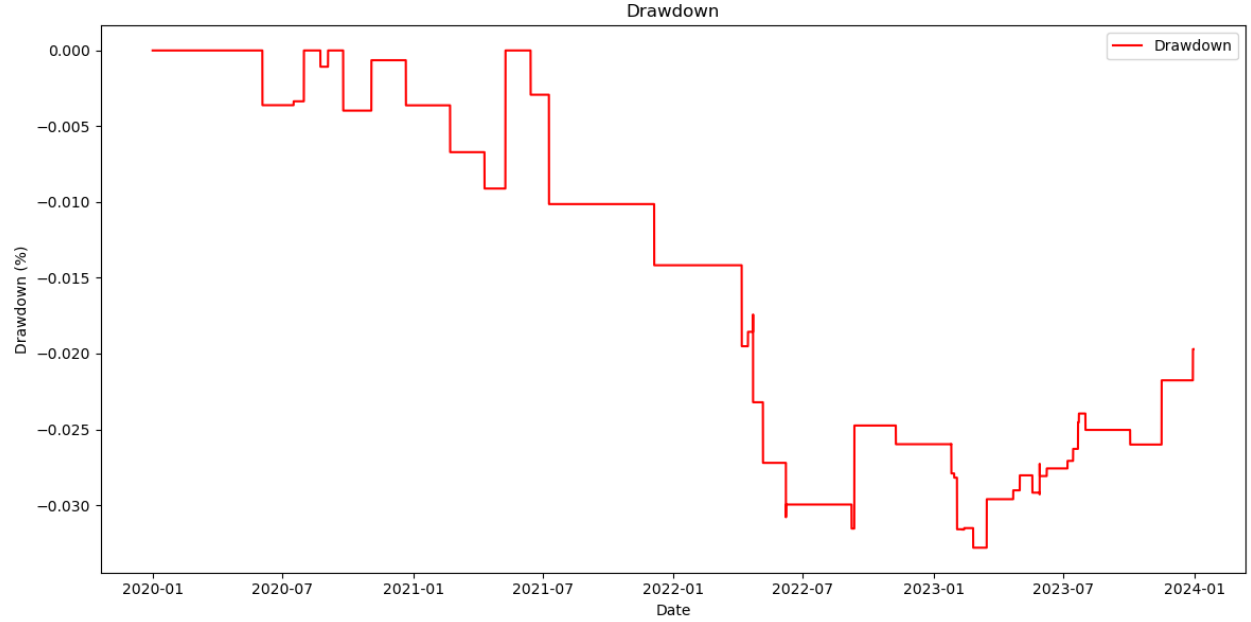
3.1.2.1 Summary of Performance Metrics for ETH/USDT

- **Profit Percentage**: 5.308
- **Sharpe Ratio**: 5.239
- **Maximum Drawdown**: 94.361
- **Time to Recovery**: 219.50

3.1.2.2 Visualizations







3.2 Bollinger Bands (BB) with RSI

In this strategy, signals are generated based on both Relative Strength Index (RSI) and Bollinger Bands. The approach is designed to identify overbought and oversold conditions to trigger potential buy and sell signals.

A buy signal is generated if either of the following conditions is met:

- The RSI falls below 30, indicating that the asset is oversold.
- The price closes below the lower Bollinger Band, suggesting a potential reversal from oversold levels.

Conversely, a sell signal is triggered if:

- The RSI rises above 70, indicating that the asset is overbought.
- The price closes above the upper Bollinger Band, signaling a potential reversal from overbought levels.

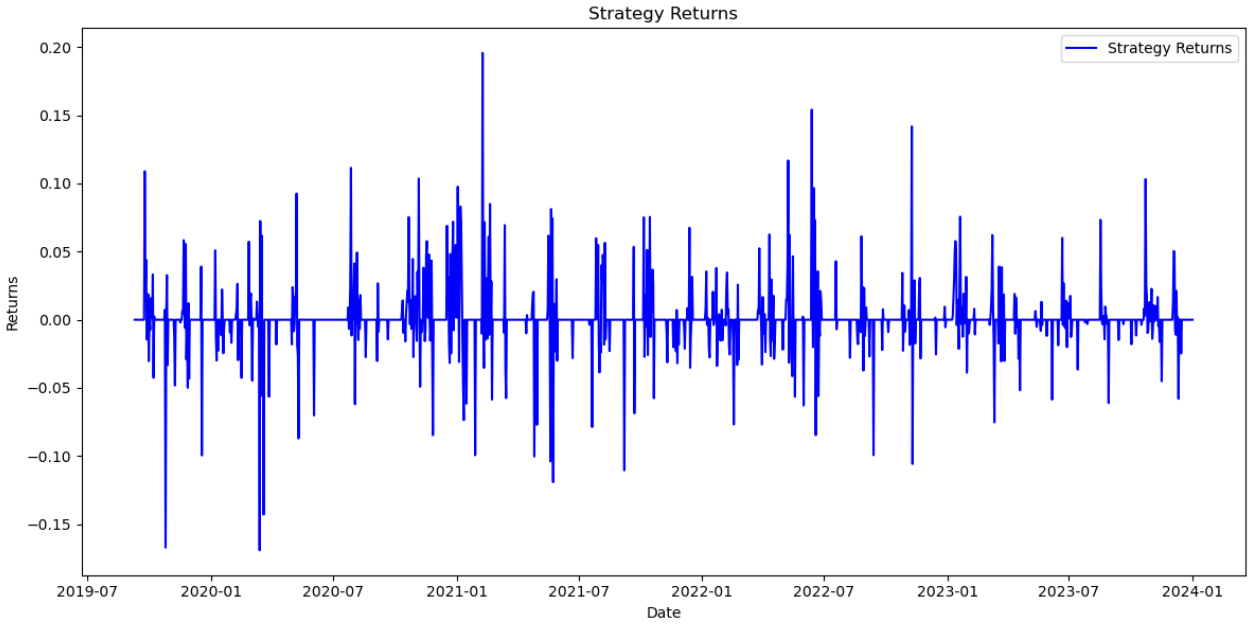
This dual-criteria approach helps to increase signal accuracy by confirming overbought or oversold conditions with both a price-based indicator (Bollinger Bands) and a momentum oscillator (RSI). By requiring one of these criteria to shift from the previous signal state, this strategy also avoids consecutive signals from minor price fluctuations.

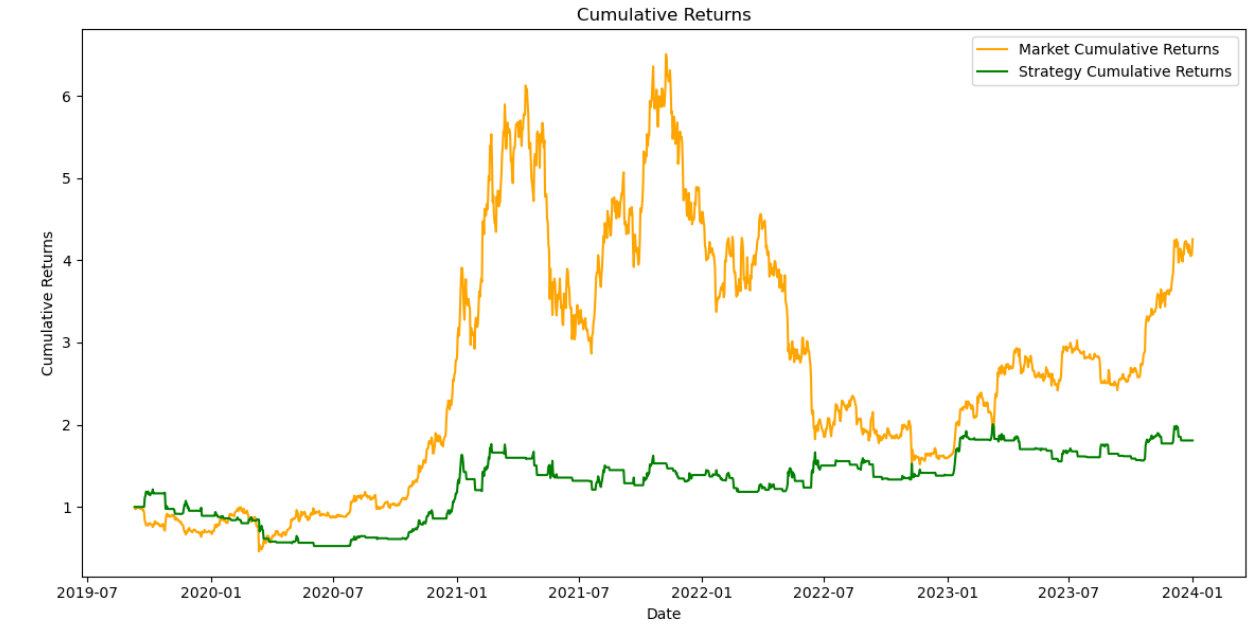
3.2.1 Performance Metrics for BTC/USDT

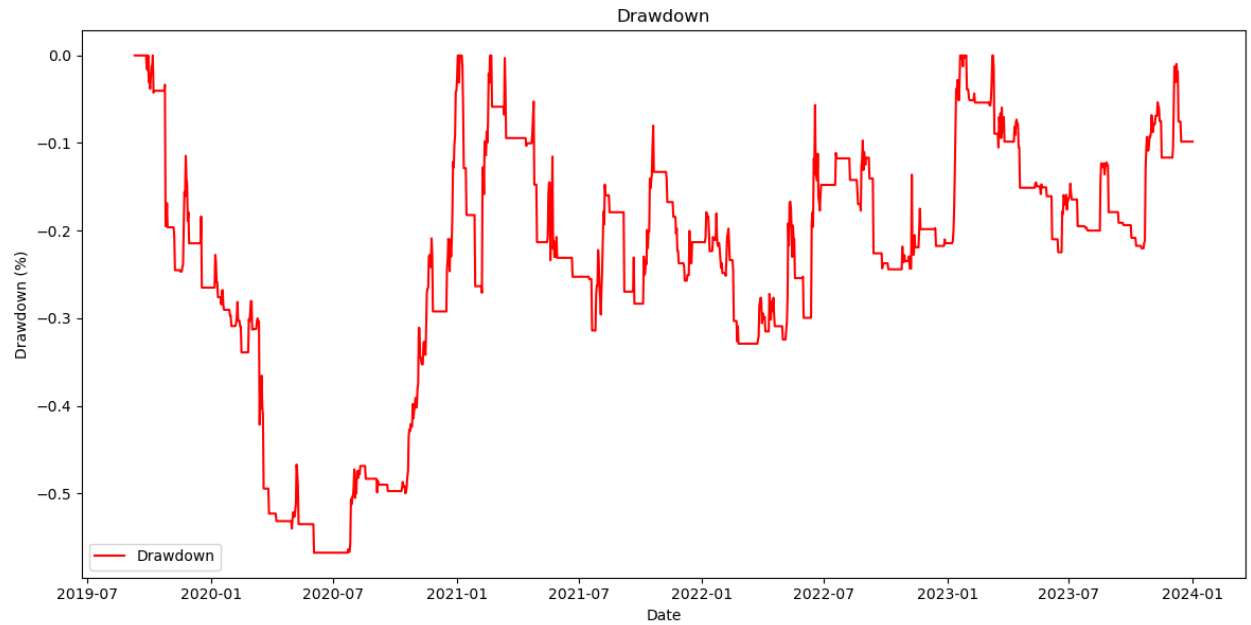
3.2.1.1 Summary of Performance Metrics for BTC/USDT

- **Profit Percentage**: 325.303
- **Sharpe Ratio**: 4.810
- **Maximum Drawdown**: 67.256
- **Time to Recovery**: 102

3.2.1.2 Visualizations





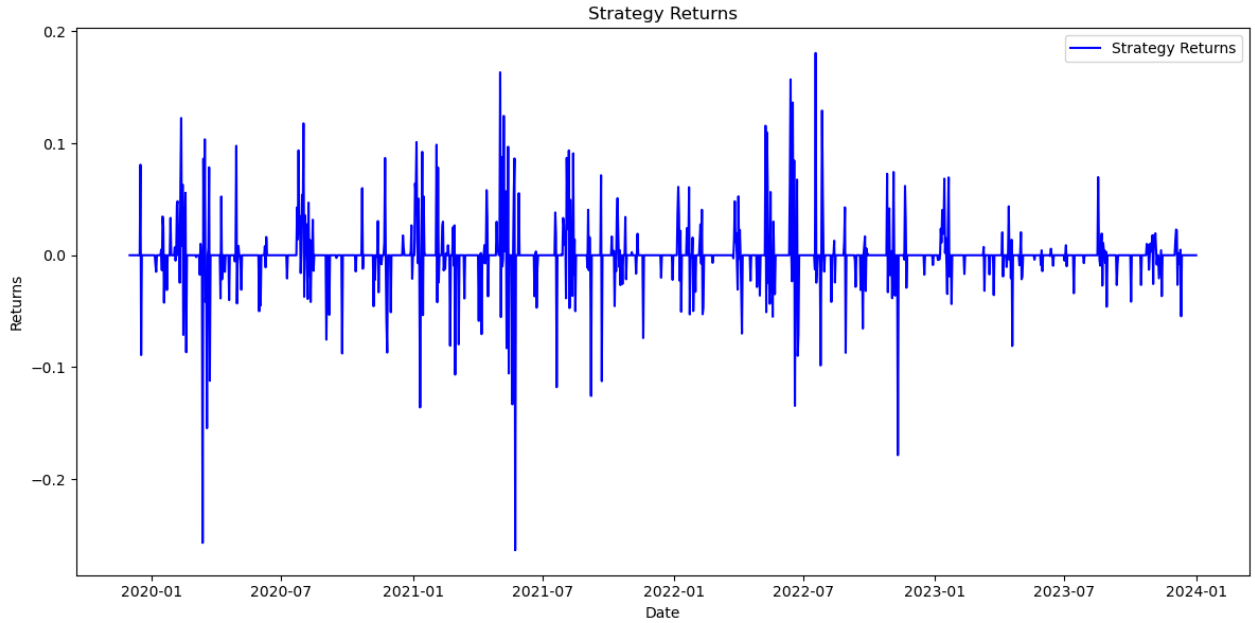


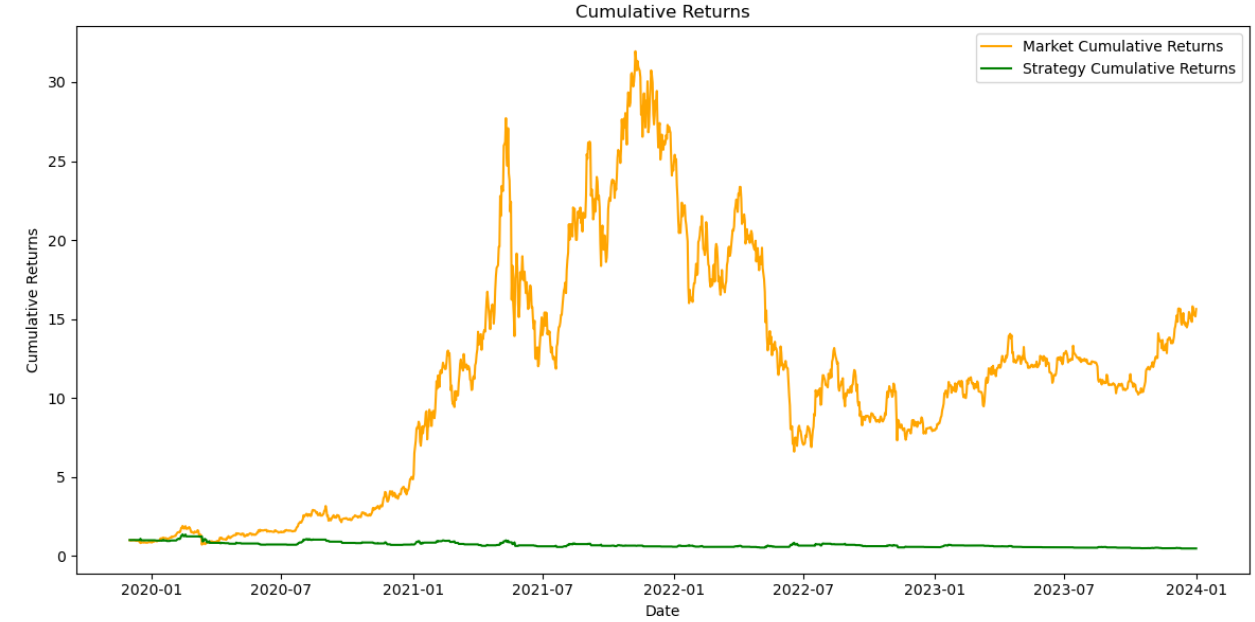
3.2.2 Performance Metrics for ETH/USDT

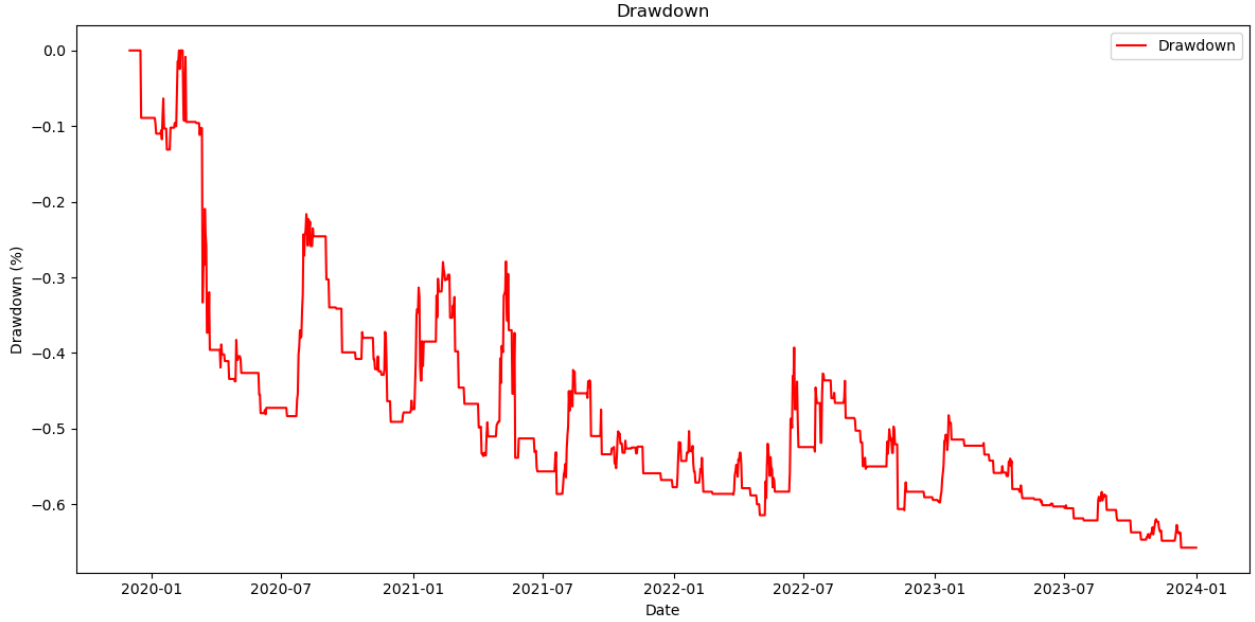
3.2.2.1 Summary of Performance Metrics for ETH/USDT

- **Profit Percentage**: 451.685
- **Sharpe Ratio**: 4.850
- **Maximum Drawdown**: 71.690
- **Time to Recovery**: 191

3.2.2.2 Visualizations







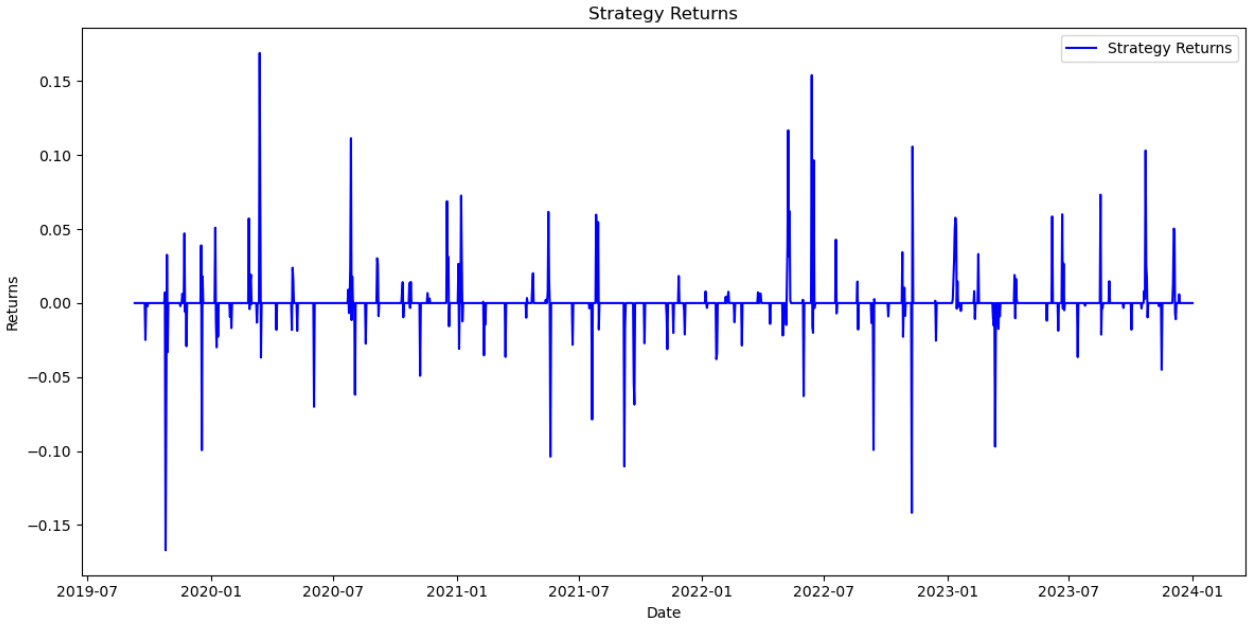
3.3 Bollinger Bands with Average True Range (ATR)

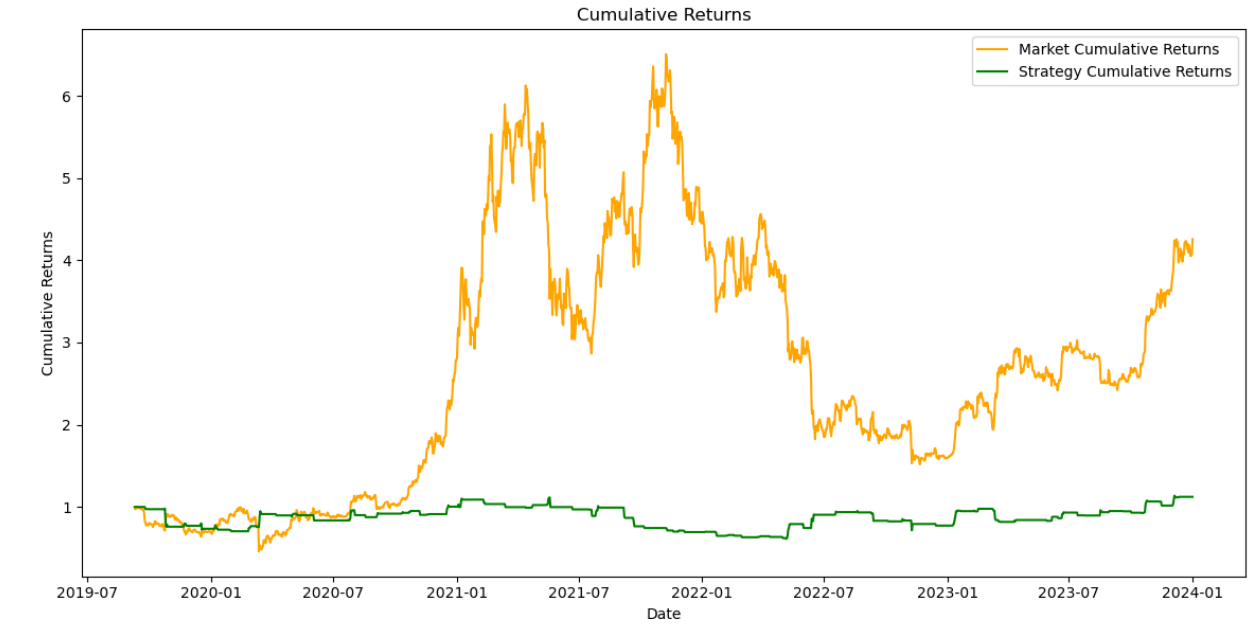
3.3.1 Performance Metrics for BTC/USDT

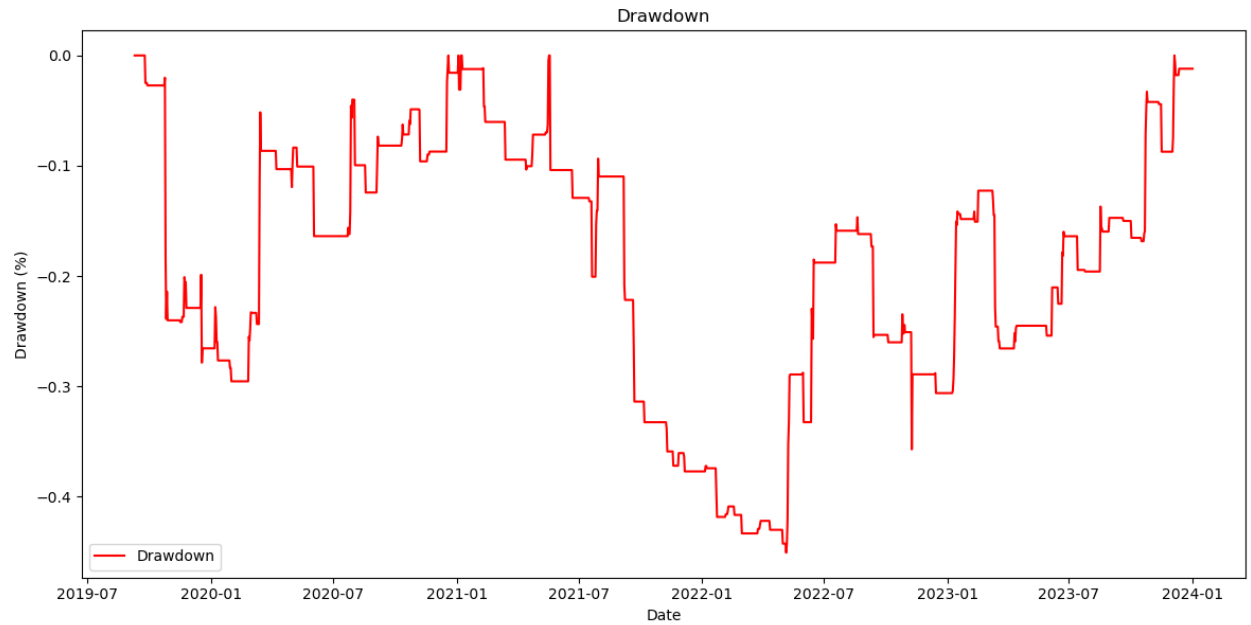
3.3.1.1 Summary of Performance Metrics for BTC/USDT

- **Profit Percentage**: 101.377
- **Sharpe Ratio**: 3.074
- **Maximum Drawdown**: 52
- **Time to Recovery**: 405

3.3.1.2 Visualizations





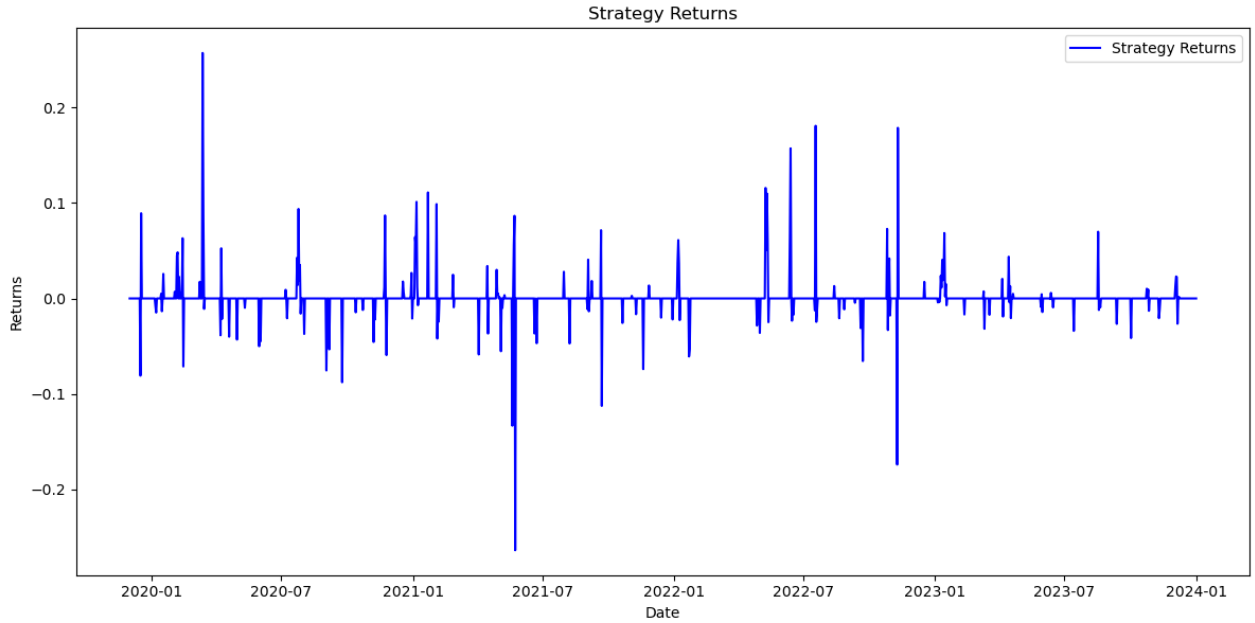


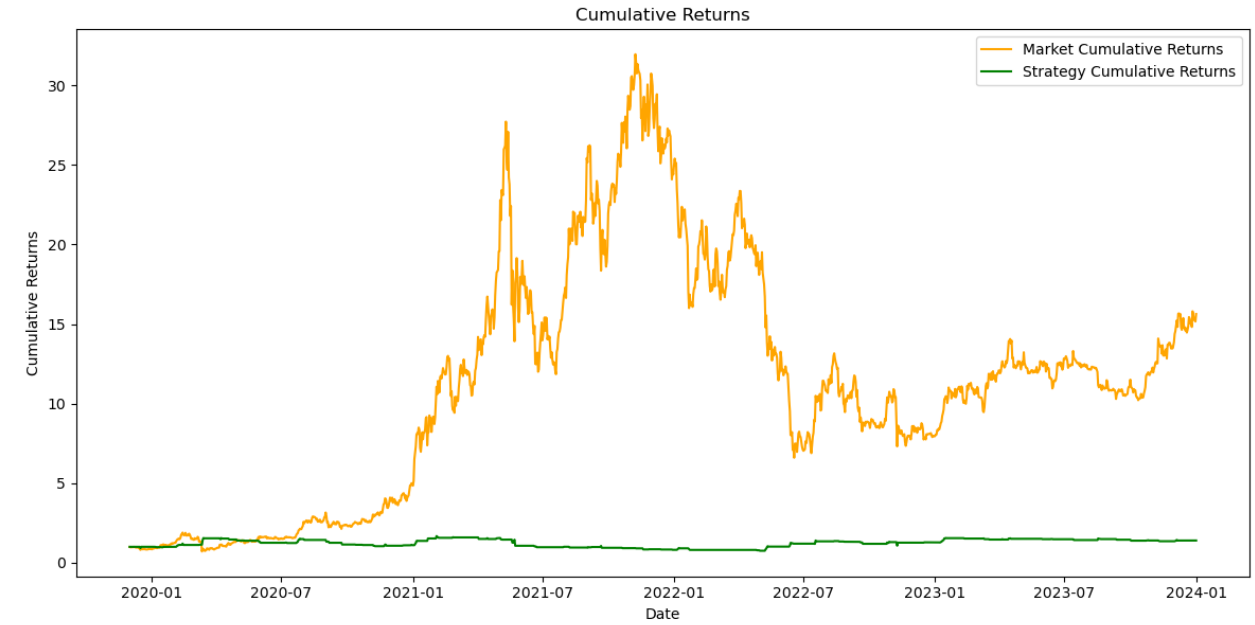
3.3.2 Performance Metrics for ETH/USDT

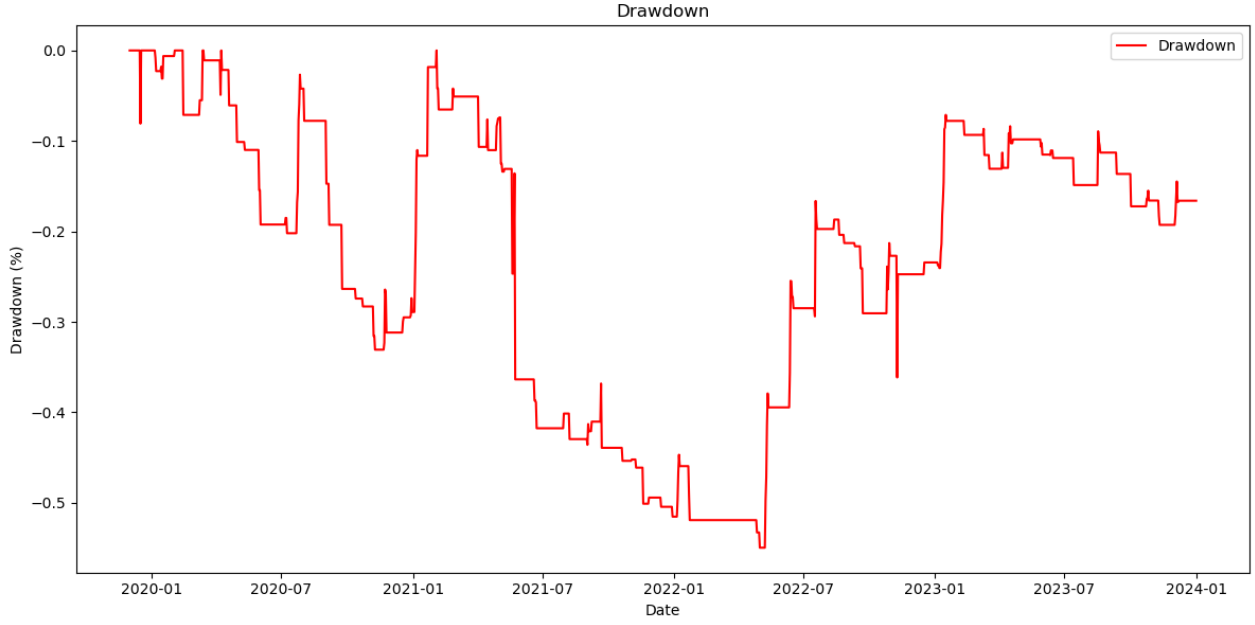
3.3.2.1 Summary of Performance Metrics for ETH/USDT

- **Profit Percentage**: 184.772
- **Sharpe Ratio**: 4.276
- **Maximum Drawdown**: 69.244
- **Time to Recovery**: 159

3.3.2.2 Visualizations







4 Unique Approaches and Innovations

4.1 Unique Aspects of the Strategy and Associated Market Inefficiencies

Unique Aspect of the Strategy
The strategy combines multiple technical indicators—Bollinger Bands (BB), Relative Strength Index (RSI), and Average True Range (ATR)—to capture different market conditions, such as trend reversals, overbought/oversold states, and volatility shifts. This multi-indicator approach enhances the robustness of the strategy across varying market regimes by providing a more comprehensive view of market behavior.

Adaptive parameters are employed to adjust thresholds based on shifting volatility, utilizing ATR to dynamically fine-tune signal generation. This allows the strategy to adapt to the prevailing market conditions, helping manage risks during periods of high volatility and reducing potential losses during market downturns.

Market Inefficiencies
The strategy targets specific market inefficiencies, particularly in highly volatile assets like Bitcoin, where a combination of trend-following and mean-reversion signals can be highly effective. The entry and exit points are refined through unique criteria derived from the interplay of the following indicators:

- **Bollinger Bands (BB)** identify abnormal price volatility, triggering buy/sell signals when prices deviate significantly from the 20-period moving average. This suggests potential mean-reversion points, capitalizing on price extremes.
- **RSI** provides confirmation of overbought and oversold conditions, helping to align entries with momentum shifts, signaling either profit-taking opportunities or renewed buying interest at key levels.
- **BB + ATR** utilizes the ATR to adjust the threshold for the Bollinger Bands, incorporating volatility into the decision-making process. This reduces false signals in low volatility periods and enhances trade accuracy during high volatility.
- **MACD + RSI** combines the momentum indicator (MACD) with RSI to identify trend-following signals and overbought/oversold conditions simultaneously. This dual confirmation strategy enhances the likelihood of profitable trades by filtering out noisy signals.

By leveraging these complementary indicators, the strategy adapts dynamically to various market phases and reduces dependence on any single signal. It seeks to exploit market inefficiencies where price movement and sentiment diverge from historical patterns, enhancing the potential for capturing profitable trades.

4.2 Comparison with Traditional Trading Methods and Application of Novel Mathematical Models

Novelty Compared to Traditional Methods: Unlike traditional methods that rely on fixed parameters and static indicators, this strategy incorporates dynamic models that adapt to changing market conditions. By utilizing volatility-adjusted signals (such as ATR for price volatility and adaptive parameters in the Parabolic SAR), the strategy adjusts trade sizes and frequencies based on current market behavior, offering greater flexibility and responsiveness to market shifts. This approach aims to optimize performance during both trending and volatile periods.

5 Future Directions

5.1 AI-Driven Predictive Trading Models

Develop and fine-tune machine learning models, such as reinforcement learning, deep neural networks, and ensemble methods, to predict market movements and optimize trading decisions. These models can incorporate historical price data, sentiment analysis, and macroeconomic indicators to enhance the predictive power.

5.2 Advanced Visualization of Trading Metrics and Network Behavior

Leverage interactive data visualization tools to present complex market data, including transaction flows and Bitcoin network behavior. Create visualizations that provide insights into correlations, price movements, and network topologies, aiding in better decision-making for trading and risk management.

5.3 Natural Language Processing for Financial News and Social Media Sentiment

Use advanced NLP techniques like transformers and deep learning models to analyze financial news articles, social media posts, and market reports. Extract insights about market sentiment, public opinion, and potential impacts on asset prices, and integrate this data into trading algorithms.

5.4 Celestial Cycle Integration in Financial Forecasting

Explore the potential influence of celestial cycles, such as lunar phases or planetary alignments, on financial markets. Investigate how periodic astronomical events could correlate with market trends and enhance time series forecasting models, particularly for predicting long-term market behaviors.

5.5 Network Graph Analysis for Cryptocurrency Transactions

Investigate the topology of Bitcoin's transaction network using graph theory. Focus on detecting anomalies, identifying influential nodes, and analyzing transaction patterns. This approach can offer insights into the flow of transactions, which can be used to predict price movements and detect market manipulation or fraud.