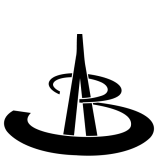
Inter IIT 13.0



Zelta Labs

Untrade Crypto Trading Challenge

~Team 53

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1.0 Introduction

Our journey into algorithmic trading begins with tackling the challenges of the BTC/USDT and ETH/USDT cryptocurrency markets. These digital arenas are characterized by their rapid pace and ever-changing dynamics, where opportunities and risks emerge in the blink of an eye. In this demanding environment, we aim to craft trading strategies that not only navigate volatility but also strive for consistent performance above market benchmarks.

With a blend of creativity and strategy, we have developed algorithms tailored to the complexities of BTC/USDT and ETH/USDT trading. While the pursuit of profit remains a key focus, managing risk is also of utmost importance, given the unpredictable nature of cryptocurrency markets. Striking this balance between risk-favouring and risk-averse methods is integral to our approach.
This report represents more than a summary of our efforts—it reflects a commitment to progress and innovation in algorithmic trading for BTC/USDT and ETH/USDT pairs. We aim to contribute to the broader conversation around algorithmic methodologies, encouraging collaboration, fostering new ideas, and setting a foundation for strategies that enhance profitability while controlling risk.

2.0 Optimal Strategy

2.1 Strategy intuition

In the realm of BTC/USDT and ETH/USDT trading, our strategy combines momentum and volatility indicators to identify favorable entry and exit points. Momentum indicators, such as EMA crossovers and MACD, highlight the direction and strength of trends, allowing us to ride strong price movements. Volatility measures, like Bollinger Bands and ATR, help adapt to varying market conditions, with ATR-based take profit (TP) and stop loss (SL) ensuring adaptive risk management. ADX confirms trend strength, enhancing signal reliability. RSI and Parabolic SAR provide complementary trend and reversal signals, while quantile regression-based TP and SL allow for dynamic exit targets based on statistical probabilities, improving precision. Together, these tools balance trend-following and risk control for robust strategy execution
.

2.2 Indicator Overview

- **RSI (Relative Strength Index):** Measures the speed and change of price movements on a scale of 0 to 100, used to identify overbought or oversold conditions.

$$RSI_i = 100 - 100 * \frac{1}{1 + \frac{MA_{U_i}}{MA_{D_i}}}$$

- **MACD (Moving Average Convergence Divergence):** Tracks the difference between short-term and long-term moving averages to identify trends and momentum.

$$MACD_i = EMA\left[fast\ period\right]_i - EMA\left[slow\ period\right]_i$$

- **Bollinger Bands:** A volatility indicator consisting of a moving average and two standard deviation bands, used to identify potential overbought or oversold levels.

$$BBands_i = SMA_i \pm STDDEV_i * d$$

- **Parabolic SAR:** A trend-following indicator that plots points above or below price to signal potential reversals.

$$SAR_{i+1} = SAR_i + \alpha\,(EP - SAR_i)$$

- **ATR (Average True Range):** Measures market volatility by calculating the average range of price movements over a given period.

$$ATR_i = ATR_{i-1} * (period - 1) + \frac{TR_i}{period}$$

- **EMA (Exponential Moving Average):** A moving average that gives more weight to recent prices, making it more responsive to new data.

$$EMA_i = EMA_{i-1} + \alpha * \left(x_i - EMA_{i-1}\right) \quad \alpha = \frac{2}{n+1}$$

- **SMA (Simple Moving Average):** A basic moving average calculated by averaging the closing prices of a security over a specific number of periods, used to identify trends and support/resistance levels.

$$SMA_i = \frac{\sum_{k=i-n}^{i} x_k}{n}$$

- **Volatility Index :** Calculated spike and then took the rolling std dev and then the moving average of it to smoothen.
- **Volume Average:** The average trading volume over a specified period, used to confirm price movements.
- **VWAP (Volume-Weighted Average Price):** A trading benchmark that shows the average price a security has traded at throughout the day based on both volume and price.

$$VWAP = \frac{\sum_{i=1}^{n} (P_i * V_i)}{\sum_{i=1}^{n} V_i}$$

- **Heiken Ashi:** A modified candlestick chart that smooths price action to identify trends more clearly.

$$HAclose = \frac{open_0 + high_0 + Low_0 + Close_0}{4} \qquad HALow = min\,(Low_0, HAOpen_0, HAClose_0)$$

$$HAOpen = \frac{HAClose_{-1} + HAOpen_{-1}}{2} \qquad HAHigh = max\,(High_0, HAOpen_0, HAClose_0)$$

- **ADX (Average Directional Index):** Measures the strength of a trend, with values above 25 indicating a strong trend.
- **Aroon:** The Aroon indicator is a technical indicator that can identify trend changes in the price of an asset, as well as that trend's strength. The Aroon indicator essentially measures the time between highs and the times between lows over various periods.

$$AroonUP = \frac{period - Days\ Since\ period\ days\ High}{period} * 100$$

$$AroonDOWN = \frac{period - Days\ Since\ period\ days\ Low}{period} * 100$$

3.0 Strategy Overview

(3.1) Strategy 1 : Volume and Volatility-Driven EMA with RSI Confirmation (*BTC-USDT-15M*)

a. Components of the Strategy

i. RSI (Relative Strength Index): 20-period RSI with 14-period EMA smoothing, confirming overbought (>60) or oversold (<25) conditions.
ii. EMA (Exponential Moving Average): 12-period (Fastest), 20-period (Fast), and 50-period (Slow) EMAs for trend identification and crossover signals.
iii. VWAP (Volume Weighted Average Price): 14-period VWAP to detect price-volume relationships and generate signals.
iv. ADX (Average Directional Index): 20-period ADX with a threshold of 25 to confirm trend strength.
v. ATR (Average True Range): 14-period ATR for calculating dynamic stop-loss levels based on market volatility.
vi. Bollinger Bands: 10-period SMA with 1.5 standard deviations for upper and lower bands to detect overbought or oversold conditions.
vii. Heikin Ashi Candlesticks: Derived from smoothed open, high, low, and close values to visualize trend direction.
viii. Volume SMA: 20-period fast and 50-period slow volume SMAs for assessing trading volume trends.
ix. Volatility Index (Custom): Standard deviation of price spikes over a 20-period window for evaluating exit signals.
x. Aroon Indicator: 20-period Aroon indicator to assess trend strength based on recent highs and lows.

b. Strategy Hypothesis

i. The development of this trading strategy emerged from a systematic approach to refining and optimizing trading signals for BTC/USDT in the 15-minute timeframe. Initially, simpler strategies, such as moving average crossovers, were tested but often led to false signals during volatile market conditions. This highlighted the need for incorporating additional filters, such as RSI and ADX, to confirm trends and reduce noise. Observing the importance of volume

and volatility, VWAP and Bollinger Bands were integrated to identify overbought and oversold zones dynamically. To further adapt the strategy to shifting market conditions, Heikin Ashi candles and volatility indexes were added for smoother trend detection and entry adjustments. Through rigorous backtesting and analysis of historical data, the indicators were carefully selected and combined to balance trend-following with mean-reversion strategies, with robust risk management mechanisms to optimize returns and minimize drawdowns.

c. Signal Generation

i. Buy Signal (Long Entry) Conditions

- RSI Smooth > 60
    a. Rationale: Ensures momentum is strong in the upward direction
- Volume SMA Fast(20) > Volume SMA Slow(50)
    a. Rationale: Confirms trend with **increasing volume momentum**
- Previous Heikin Ashi Close > Previous Bollinger Band Upper
    a. Rationale: Indicates strong **upward price momentum** breaking resistance
- EMA Fast(20) > EMA Slow(50)
    a. Rationale: Confirms **upward trend** in intermediate time frame
- EMA Fastest(5) > EMA Fast(20)
    a. Rationale: Shows **immediate momentum** is aligned with trend
- ADX > ADX Threshold(20)
    a. Rationale: Ensures market is **trending strongly enough**

ii. Long Exit Conditions

- Regular Exit
    a. RSI < 25
    b. Volume Index(14) < Volume Index MA(20)
    c. Rationale: Exit when momentum weakens and volatility decreases
- Stop Loss Hit
    a. Current HA Low < Stop Loss < Current HA High
    b. Rationale: Risk management when price moves against position

iii. Sell Signal (Short Entry) Conditions

- EMA Fast(20) < EMA Slow(50)
    a. Rationale: Confirms downward trend
- Current HA Close > Current BB Lower
    a. Rationale: Shows price hasn't moved too far down yet

- Previous RSI Smooth < 28
    a. Rationale: Shows oversold conditions
- EMA Fastest(5) crosses above VWAP(14)
    a. Previous: EMA Fastest < VWAP
    b. Current: EMA Fastest > VWAP
    c. Rationale: Indicates potential reversal point
- Current RSI Smooth < 27
    a. Rationale: Confirms oversold condition

iv. **Short Exit Conditions**

- Regular Exit
    a. VWAP(14) > EMA Fastest(5)
    b. RSI > 72
    c. Rationale: Exit when momentum shifts and overbought conditions occur
- Stop Loss Hit
    a. Current HA Low < Short Stop Loss < Current HA High
    b. Rationale: Risk management when price moves against position

d. Risk Management

i. **Stop-Loss Strategy**:

We use asymmetric stop losses: dynamic (5% below previous low) for long positions and fixed (1% above entry) for short positions, with immediate exit when stop levels are hit.

ii. **Exit Mechanisms**:

For short positions, exit occurs on VWAP/EMA relationships and RSI > 72 (overbought). Long positions exit when RSI < 25 or volatility reduces.

iii. **Reversal Trades**:

Considering BTC/USDT's high volatility, exit conditions often signal a trend reversal. After closing a trade, we use ADX > 40 to confirm a reversal and initiate a new trade with adjusted stop-loss and take-profit, but only if no opposing signal appears.

e. Performance Metrics

i. Initial Capital : 1000$

ii. Leverage Applied : 1x

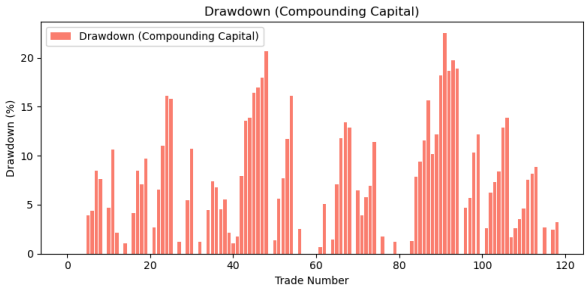
iii. Commision : 0.15%

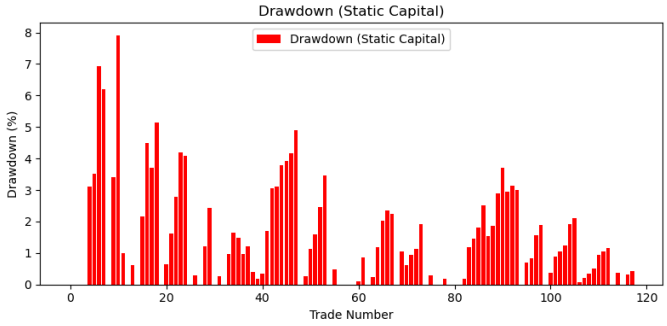
iv. Time Period : (2020-2023)

Metric	Value
Return[%]	8938
Final Balance[$]	89380.392379
Return Annualized[%]	207.14
Sharpe Ratio	4.415384
Sortino Ratio	39.205566
# Trades	118
Max Drawdown[%]	22.564325
Avg Drawdown[%]	6.012193
Win Rate[%]	37.288136
Avg Win[$]	195.937094
Avg Loss[$]	-30.081881
Profit Factor	6.54
Time to Recovery[days]	154.010417
Quarters Beaten	14/15
Static Drawdown	7.88
Static PnL	6395.17

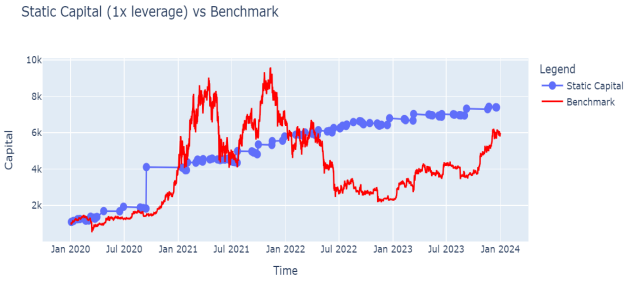
Metric	**2020**	**2021**	**2022**	**2023**
Benchmark[%]	44.4	44.0	-55.8	85.1
Initial Balance[$]	1000	1000	1000	1000
Final Balance[$]	2055.80	9588.10	2092.70	2164.7
Total Trades	19	39	36	24
Profit[%]	105.6	855.8	109.3	116.5
Benchmark Beaten	Yes	Yes	Yes	Yes

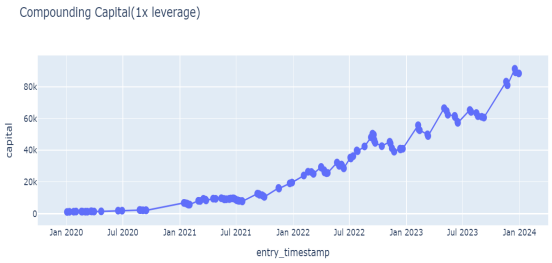
Static and Compounding Drawdown





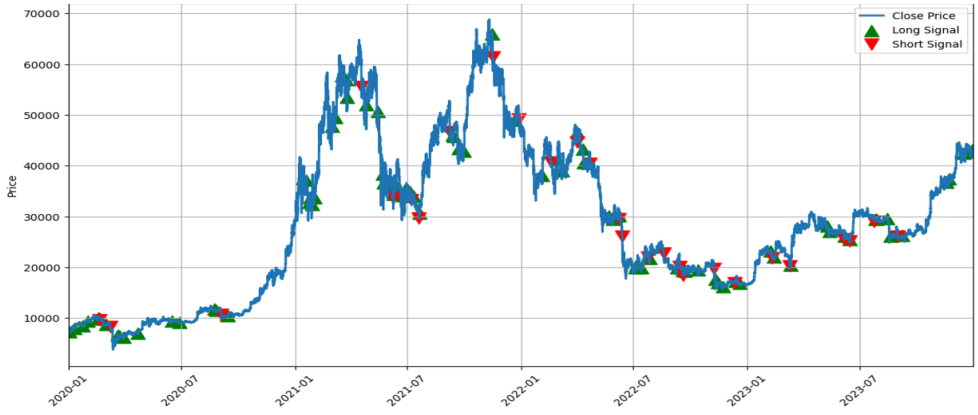
Static & Compounding Capital





Signals

long /short entries with Close



(3.2) Strategy 2 : Hawkes Process with Fibonacci exit

(*BTC-USDT-4H*)

a. Components of the Strategy

i. Hawkes Intensity Function:

1. Intensity Function 95th percentile:
    a. Length: 28 time period
2. Intensity Function 5th percentile
    a. Length: 28 time periods

ii. ADX(Average Directional Index)

1. ADX measures the trend strength ranging from 0-100 with a higher value indicating a stronger trend
2. Length - 15 time periods.

iii. Bollinger Bands:

1. Bollinger Bands consist of three components: a simple moving average line and two bands placed a few standard deviations above and below the SMA line.
2. Length: 20 time periods
3. Bands placed 2.5 standard deviations above and below the SMA line.

iv. Fibonacci Retracements

1. Fibonacci retracements can help identify potential support and resistance levels based on the Fibonacci levels.

2. We have used 38.2%, 50% and 61.8% decrement of the maximum value.

b. Strategy Hypotheses

This strategy uses the hawkes process which is a kind of self-exciting point process. In Hawkes process the occurrence of an event increases the likelihood of future events. The intensity function at any time is given by:

$$\lambda(t) = \mu + \sum_{ti < t} \phi(t - ti)$$

Where μ = Baseline intensity(constant background rate of events), $\phi(t - ti)$: kernel function quantifying the influence of past events ti on the current rate. $\sum_{ti<t}$ Summation over all past events before t. This trading strategy for ETH/USDT on the 4-hour timeframe was rooted in the need to create a robust system capable of capturing significant price movements while adapting to varying market conditions. Initial tests with simpler strategies, such as basic trend-following models, often failed in volatile environments, leading to inconsistent results. This prompted the integration of the Hawkes process to detect periods of heightened market intensity, ensuring that signals were generated only during high-impact conditions. ADX was added to confirm trend strength, reducing the likelihood of false signals during choppy or low-trend periods. Bollinger Bands were included to dynamically identify overbought and oversold zones, allowing the strategy to capture both breakout opportunities and reversal trades. To refine entry and exit accuracy, Fibonacci retracements, RSI percentiles, and ATR normalization were incorporated, enabling precise adjustments to profit-taking and stop-loss levels based on market behavior. Each indicator was carefully selected and rigorously backtested to ensure synergy, with the aim of balancing trend-following and reversal dynamics. This combination ensures the strategy not only adapts to changing market conditions but also maximizes returns while maintaining strong risk management, making it the optimal choice for achieving consistent profitability.

c. Signal Generation

i. Buy Signal (Long Entry) Conditions

1. The intensity Function crossed over the 95th percentile line, and the price has increased since the last time it crossed below the 5th percentile line.
2. ADX value is greater than 30
3. The price is above the Upper Bollinger Band.

ii. Short Entry

1. The intensity Function crossed over the 95th percentile line, and the price has decreased since the last time it crossed below the 5th percentile line.

2. ADX value is greater than 25
3. The price is lower than the Lower Bollinger Band.

iii. Exit : Long Trade

1. Fibonacci Retracements
    a. If we drop to the first Fibonacci level and the RSI is above 75 and ADX is less than 20 indicating a low chance of recovery we exit a long trade similar to the second Fibonacci level.
    b. Price drops below the third Fibonacci level, we exit the trade disregarding other indicators booking profit.

iv. Exit : Short Trade

1. Price crosses above the first Fibonacci level and ADX<20 (signaling that a recovery might not be possible.
2. Price crosses above the second Fibonacci level.

d. Risk Management

i. Exit Mechanisms:

1. The Heikin-Ashi close price crosses above a Fibonacci retracement level (23.6%, 38.2%, or 50%) after being below it in the previous period.
2. The RSI value exceeds 70, indicating overbought conditions.
3. The volatility index is below its moving average, and the RSI is greater than 60, signaling weakening downward momentum.
4. The Heikin-Ashi close price drops below a Fibonacci retracement level (23.6%, 38.2%, or 50%) after being above it in the previous period, with additional confirmation:
5. For the 23.6% level, RSI is above the 75th percentile and the Parabolic SAR value is above the Heikin-Ashi close price.
6. For the 38.2% level, RSI is above the 75th percentile.
7. The RSI value falls below 20, signaling extreme oversold conditions.
8. The volatility index exceeds its moving average, and RSI is below 30, indicating high volatility and weak momentum for continuation.

ii. **Reversal Trades**:

1. When exiting a long trade and entering a short trade, the strategy identifies a reversal by confirming a significant market shift through the Hawkes intensity crossing above the 95th percentile after previously being below the 5th percentile. A price

decrease, ADX above 25 indicating a strong trend, and the closing price below the lower Bollinger Band validate the bearish momentum for this transition.

e. Performance Metrics

i. Initial Capital : 1000$

ii. Leverage Applied : 1x & 2x

iii. Commision : 0.15%

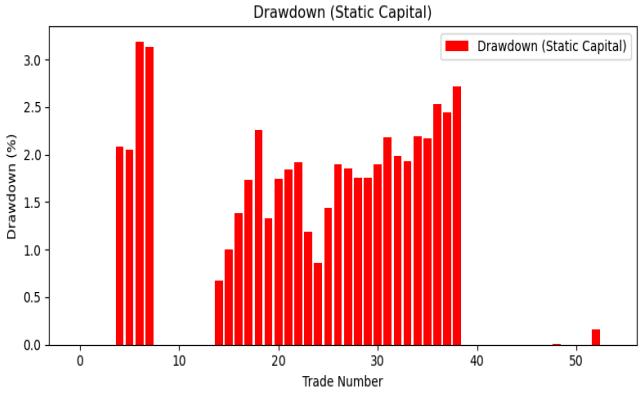
iv. Time Period : (2020-2023)

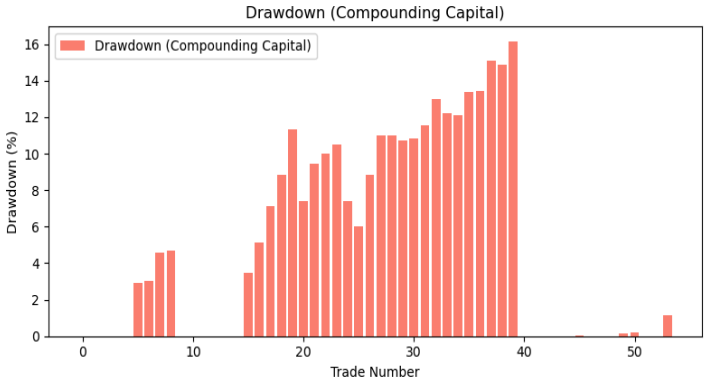
Metric	Value at 1x Leverage	Value at 2x Leverage
Return[%]	1706	8814
Final Balance[$]	17069.06	88,146
Return Annualized[%]	103.23	206.40
Sharpe Ratio	3.791912	3.791912
Sortino Ratio	176.542003	176.542003
# Trades	54	54
Max Drawdown[%]	12.973273	24.963321
Avg Drawdown[%]	4.230392	8.33014
Win Rate[%]	64.814815	64.814815
Avg Win[$]	152.165024	304.330049
Avg Loss[$]	-16.358292	-32.716584
Profit Factor	9.5	9.5
Time to Recovery[days]	182	182
Quarters Beaten	6/13	7/13
Static Drawdown	3.188	5.12
Static PnL	5094.0035	10,029.93

YoY stats at 2x leverage

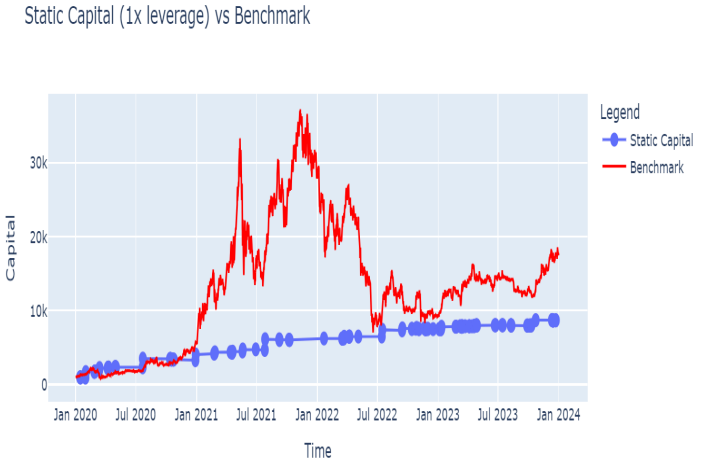
Metric	2020	2021	2022	2023
Benchmark[%]	300.9	57.7	-64.7	155.6
Initial Balance[$]	1000	1000	1000	1000
Final Balance[$]	2049.9	7224.5	2117.7	2810.5
Total Trades	11	13	18	12
Profit[%]	105.0	622.5	111.8	181.1
Benchmark Beaten	No	Yes	Yes	Yes

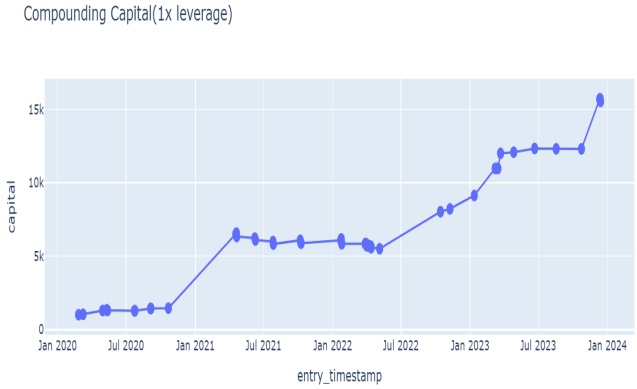
1. Static and Compounding Drawdown at 1x Leverage



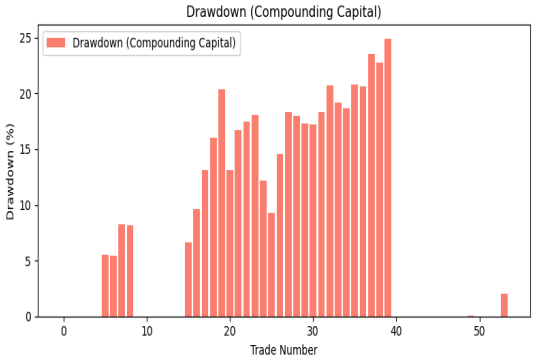


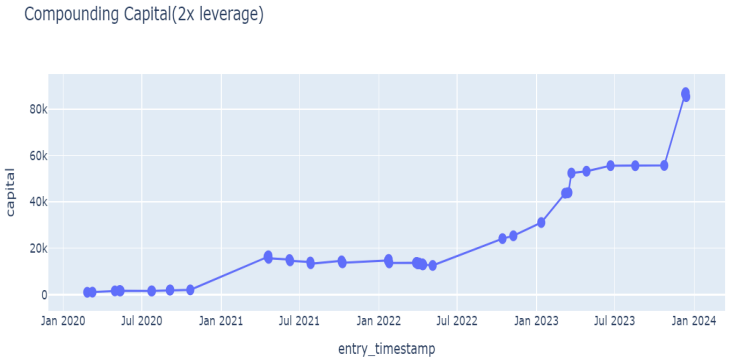
1. Static and Compounding Capital at 1x Leverage





2. Compounding Capital and Drawdown at 2x Leverage





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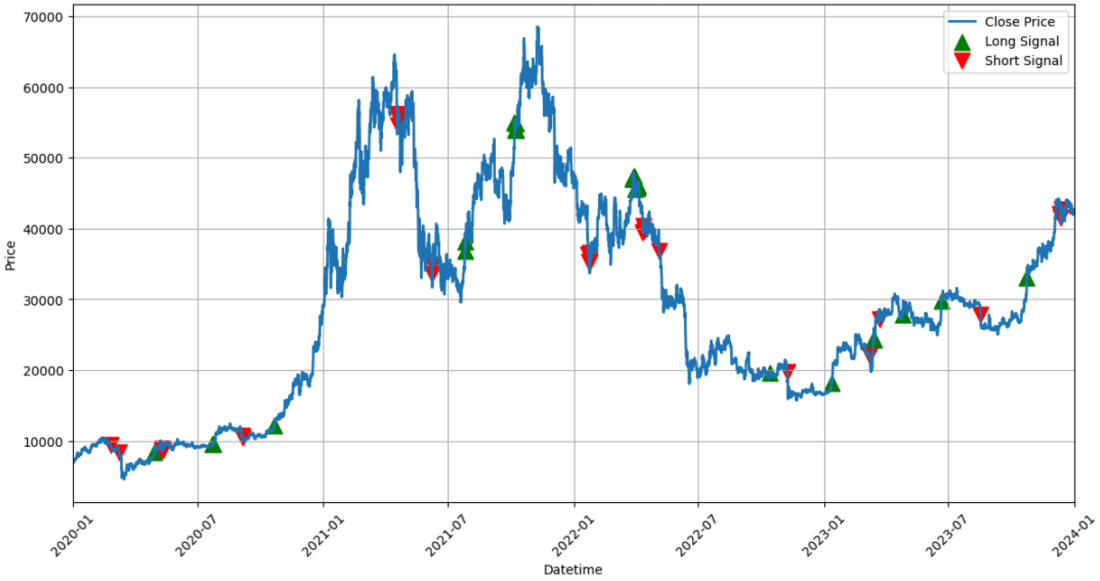


(3.3) Strategy 3 : Hawkes-Driven Multi-Indicator Strategy

(*ETH-USDT-4H***)**

a. Components of strategy:

i. **Heikin Ashi Candlesticks**: Derived from smoothed open, high, low, and close values to visualize trend direction.

ii. **ATR**:The ATR is a volatility indicator, used to determine the price range for a given time period. It's calculated based on the logarithmic of the Heikin-Ashi candlesticks.The logarithm of these prices is used for normalization.
Look back days: 28

iii. **Normalization of Range**:The strategy normalizes the range by dividing the logarithmic difference between the high and low prices by the ATR value.This helps to compare the daily price movement to the volatility level.

iv. **Hawkes process**:The hawkes_process method is applied to the normalized range (norm_range), which generates a time series representing the influence of past movements.

v. **ADX (Average Directional Index) and Directional Indicators**:The ADX and its components (+DI and -DI) help determine trend strength and direction.
time period=15

vi. **RSI (Relative Strength Index)**:The RSI measures the magnitude of recent price changes to evaluate overbought or oversold conditions.This calculates the 14-period RSI using the Heikin-Ashi close price.
time period=14

vii. **Hawkes Quantiles**:calculate the 95th and 5th percentiles (quantiles) of the Hawkes process over a rolling window.
Look back days:28

viii. **MACD (Moving Average Convergence Divergence)**: The MACD is a momentum indicator that shows the relationship between two exponential moving averages of a security's price.
Short term ema=12
Long term ema=26
Signal ema=9

ix. **Z-Score of MACD Histogram**:This normalizes the MACD histogram to assess how extreme a current reading is relative to historical data.The Z-score is calculated by

subtracting the mean of the MACD histogram from the current value and dividing by its standard deviation

x. **Bollinger Bands**:Bollinger Bands are used to measure volatility and identify overbought or oversold conditions.
Time period=20
Standard deviation addition/subtraction factor=2.5

xi. **Price Movement (Spike) and Volatility Index**:the price movement (spike) is calculated as the difference between the Heikin-Ashi close and open prices, while the volatility index (vol_index) represents the 20-period rolling standard deviation of the spike. The moving average of the volatility index (vol_index_ma) smooths out volatility signals for better trend analysis.

xii. **RSI Percentile (RSI 75 and RSI 30)**: These lines calculate specific percentile levels of the RSI to identify potential overbought or oversold conditions over longer periods.
window=252 , 512.

xiii. **Parabolic SAR (Stop and Reverse)**:The Parabolic SAR is used to identify potential price reversals in the market, acting as a trend-following indicator.The SAR is calculated using the Heikin-Ashi candles .
acceleration factor =0.02 and maximum = 0.5.

b. Strategy Hypothesis :

i. This strategy we designed to trade ETH/USDT on the 4-hour timeframe by focusing on significant price movements. It combines advanced tools for identifying trends, momentum, and market volatility, aiming to take advantage of both trending and reversal conditions.Key elements of the strategy include the Hawkes process, which identifies high-impact market conditions, and Bollinger Bands, which help spot the volatility.. The ADX indicator is used to confirm the strength of trends, ensuring trades align with robust market movements. To adapt to changing market conditions, price movements are normalized using the ATR (Average True Range), while Fibonacci retracement levels and RSI percentiles provide flexible and precise exit points. Additionally, the Parabolic SAR is also used to refine trade signals, helping us minimize false entries and improve accuracy.The strategy dynamically adjusts to market conditions, entering trades during confirmed breakouts or breakdowns and exiting when signs of reversals or exhaustion are detected. Rigorous backtesting has shown promising results, demonstrating the potential to maximize returns while maintaining strong risk management practices

c. Signal Generation : When Hawkes crosses above the 95% quantile (hawkes_q95), it triggers further conditions to generate a trade signal.

a. Long signal:
    i. If the price has increased, ADX is above the threshold(20), and the price is above the upper Bollinger Band, it generates a long entry signal.
b. Short signal:
    i. If the price has decreased, ADX is above the threshold(25), and the price is below the lower Bollinger Band, it generates a short entry signal.
c. Long Exit:
    i. The long position is exited when the price crosses below key Fibonacci retracement levels (23.6%, 38.2%, or 50%) after being above them, indicating a potential reversal. Additionally, if the RSI falls below 20, signaling oversold conditions, or if the SAR indicator moves above the current price, suggesting a trend reversal, the position is exited. Other conditions, such as the volume index rising while RSI is low, also trigger an exit. When any of these conditions are met, the strategy closes the long trade
d. Short Exit:
    i. The short position is exited when the price rises above key Fibonacci retracement levels (23.6%, 38.2%, or 50%) after previously being below them, signaling a potential reversal. If the RSI rises above 70, indicating overbought conditions, or if volume conditions show declining momentum (volume index falling with a high RSI), the position is also exited.

d. Risk management:

Exit mechanism : **Heikin-Ashi Close with Fibonacci Levels**:

- **Below 23.6% Fibonacci Level with RSI > 75th Percentile**: This indicates a potential reversal after a strong rally. Exiting here ensures that profits are locked before significant pullbacks occur.
- **Below 38.2% or 50.0% Fibonacci Levels**: These levels act as critical support zones. If breached, it suggests the uptrend may be losing strength. Exiting early reduces exposure to larger losses.
- **RSI Drops Below 20**: An RSI below 20 signals oversold conditions, but for a long position, this could indicate extreme market weakness. Exiting avoids holding during extended downward pressure.

- **Volatility Index Surpasses Its Moving Average with RSI Below 30**: This signals increased market volatility and weakening momentum, making it risky to continue holding the position. Exiting prevents losses from accelerating in unstable conditions.

Reversal trade :

- **Fibonacci Levels Breached:**Breaching these levels signals that the upward trend may have reversed, creating an opportunity to switch to short positions as the market transitions into a bearish phase.
- **Volatility Index and RSI Conditions:**High volatility combined with a low RSI indicates a market shift towards bearish momentum. This presents favorable conditions for entering short trades, as the market is likely transitioning from an overbought or weakening bullish state to a downward trend.

e. Performance Metrics :

i. Initial Capital : 1000$
ii. Leverage Applied : 1x & 2x
iii. Commision : 0.15%
iv. Time Period : (2020-2023)

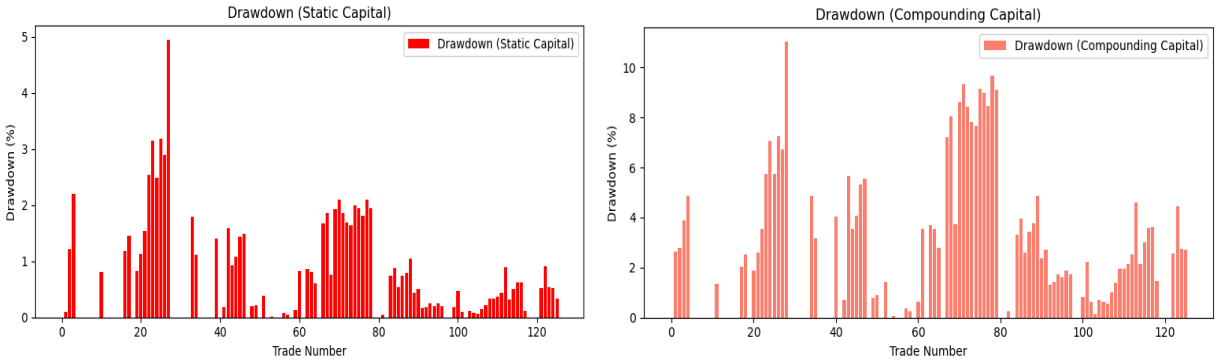
Metric	Value at 1x Leverage	Value at 2x Leverage
Return[%]	2265	22789
Final Balance[$]	22659.51	2,27,897.67
Return Annualized[%]	118.15	288.53
Sharpe Ratio	5.399	5.399
Sortino Ratio	43.477	43.477
# Trades	126	126
Max Drawdown[%]	11.05	21.21
Avg Drawdown[%]	2.515	5.051

Win Rate[%]	52.38	52.38
Avg Win[$]	69.90	139.80
Avg Loss[$]	-14.41	-28.831605
Profit Factor	4.850	4.821
Time to Recovery[days]	139.8333	139.833
Quarters Beaten	9/16	10/16
Static Drawdown	5.16	9.69
Static PnL	3937.54	7875.09

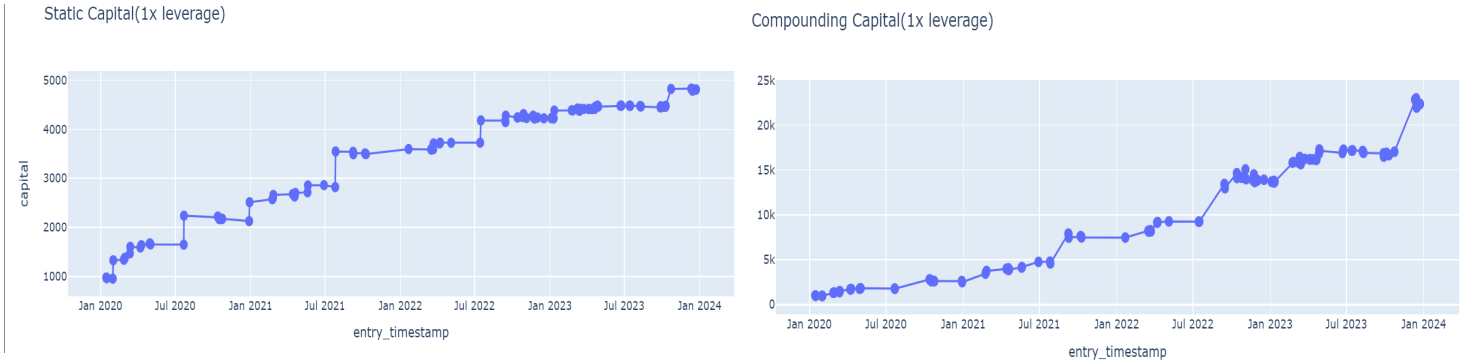
YoY stats at 2x leverage

Metric	2020	2021	2022	2023
Benchmark[%]	466.7	392.8	-67.9	92.3
Initial Balance[$]	1000	1000	1000	1000
Final Balance[$]	4831.7	6614.2	2886.6	2470.5
Total Trades	28	19	28	51
Profit[%]	383.2	561.4	188.7	147.0
Benchmark Beaten	No	Yes	Yes	Yes

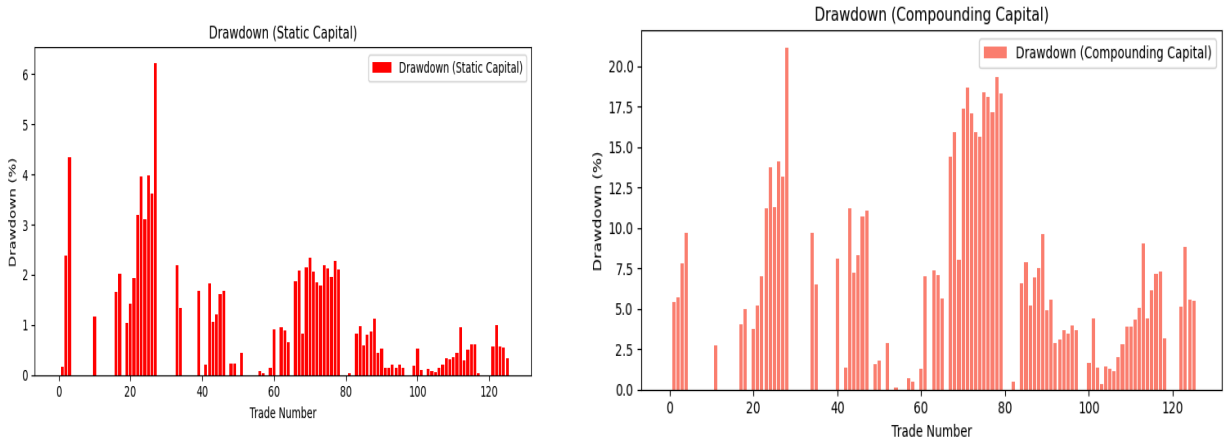
1. Static and Compounding Drawdown at 1x Leverage



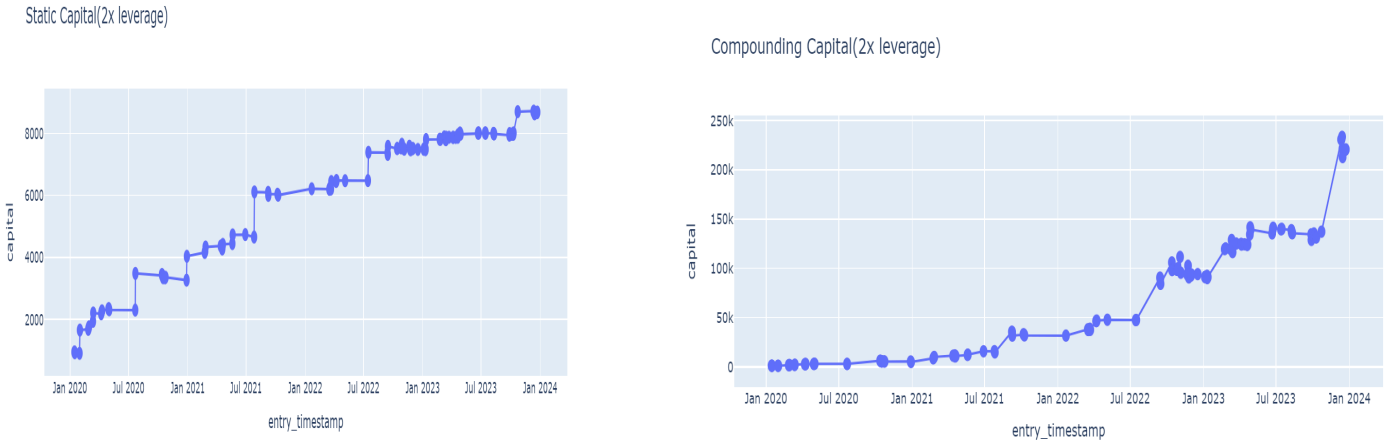
2. Static and Compounding Capital at 1x leverage



3. Static and Compounding Drawdown at 2x Leverage



4. Static and Compounding Capital at 2x leverage



5. Signals {Long v/s Short Close}

(3.4) Strategy 4 : MACD with EMA Crossover

(*ETH-USDT-30M***)**

a. Components of the Strategy

i. **Heikin Ashi Candlesticks (HA_Close)**: Heikin Ashi candles smooth out price movements, making trend direction clearer. The strategy uses the Heikin Ashi close price (`HA_Close`) to determine whether the price is above or below key moving averages and trend indicators.

ii. **Exponential Moving Averages (EMA_50 and EMA_200)**: The 50-period and 200-period EMAs are used to identify the long-term and short-term trend directions.

iii. **MACD (Moving Average Convergence Divergence)**: The MACD is used to identify momentum shifts.

1. Short term ema=12
2. Long term ema=26
3. Signal ema=9

iv. **Parabolic SAR (Stop and Reverse):**The Parabolic SAR is used to identify potential price reversals in the market, acting as a trend-following indicator.The SAR is calculated using the Heikin-Ashi candles .

1. acceleration factor =0.02
2. maximum = 0.5.

v. **Average True Range (ATR)**: The ATR is used to gauge volatility and set the stop-loss (SL) levels.

1. Look back days = 14

vi. **RSI (Relative Strength Index)**: The RSI is used to identify overbought or oversold conditions.

1. RSI > 80 : For exiting short positions
2. RSI < 20 : For exiting long positions

vii. **Volume Indicators**: The strategy incorporates volume index and volume moving averages to confirm the strength of a trend.

viii. **VWAP (Volume-Weighted Average Price)**: VWAP is used in conjunction with other indicators to confirm entry and exit points.

b. Strategy Hypothesis

i. The development of this trading strategy for Ethereum on the 30-minute timeframe arose from an iterative approach aimed at balancing precise trend identification with effective risk management. Initial efforts focused on trend-following indicators like moving average crossovers but revealed vulnerabilities to false signals, particularly in noisy market conditions. To address this, we layered multiple filters for confirmation, starting with the Heikin Ashi close and the relationship between EMA_50 and EMA_200 to strengthen trend validation. The MACD was integrated to detect momentum shifts and refine entry points, ensuring signals were generated only during strong directional moves. Recognizing the importance of minimizing noise, the strategy incorporates a standard deviation check against rolling averages to filter out erratic price movements. To enhance exits, the RSI was employed to identify overbought and oversold conditions, providing timely reversals. Additionally, volatility metrics such as ATR were used to dynamically adjust stop-loss levels, ensuring the strategy adapts to changing market environments. By combining trend, momentum, and volatility indicators with dynamic risk controls, the strategy aims to capture significant price movements while safeguarding against excessive drawdowns, creating a robust framework for short-term BTC trading.

c. Signal Generation

i. Buy Signal (Long Entry) Condition:
    1. Trend Confirmation:
        a. HA_Close is above EMA_200 (uptrend).
        b. EMA_50 is above EMA_200, consistently across the current and previous rows.
    2. Momentum Indicators:
        a. A MACD crossover (MACD > Signal Line) shows positive momentum.
    3. Volatility Check:
        a. close_std is below rolling_mean_std, indicating low market noise.

ii. Sell Signal (Short Entry) Condition:
    1. Trend Confirmation:
        a. HA_Close is below EMA_200 (downtrend).
        b. EMA_50 is below EMA_200, consistently across the current and previous rows.
    2. Momentum Indicators:
        a. A MACD crossover (MACD < Signal Line) signals downward momentum.
    3. Volatility Check:

a. close_std is below rolling_mean_std, indicating low market noise.

iii. Long Exit Condition:

1. RSI Breach: RSI falls below 20 (oversold).
2. Stop-Loss Hit: The stop-loss (sl) is within the candle's high-low range.
3. Volatility & Momentum:
   - vol_index exceeds its moving average (vol_index_ma).
   - RSI drops below 25, indicating fading momentum.

iv. Short Exit Condition:

1. RSI Breach: RSI exceeds 80 (overbought).
2. Stop-Loss Hit: The stop-loss (sl) falls within the candle's high-low range.
3. VWAP & Momentum:
   - VWAP crosses above the fastest EMA.
   - RSI rises above 70, signaling a potential reversal.

d. Risk Management

i. Stop-Loss (SL): Dynamically calculated for both long and short positions based on recent price extrema:

1. Long: Stop-loss = Lowest low - 8% buffer.
2. Short: Stop-loss = Highest high + 8% buffer.

ii. Volatility Zones: The logic avoids initiating trades during high market volatility by ensuring that close_std < rolling_mean_std**.**

e. Performance Metrics

i. Initial Capital : 1000 $

ii. Leverage Applied : 1x

iii. Commision : 0.15%

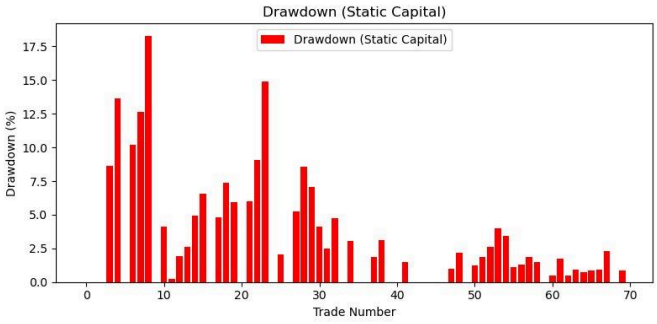
iv. Time Frame : [2020-2023]

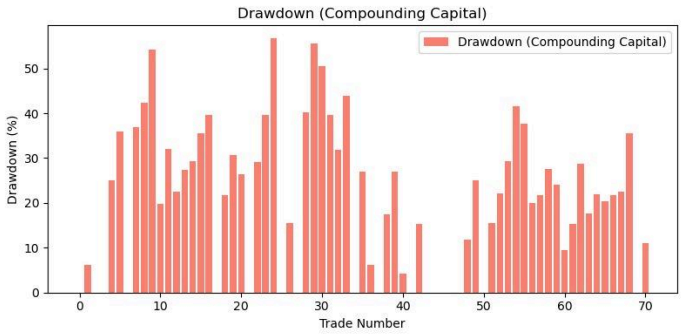
.. .

Metric	Value
Return[%]	4204

Final Balance[$]	42049.175538
Return Annualized[%]	172.25
Sharpe Ratio	5.646047
Sortino Ratio	25.142051
# Trades	68
Max Drawdown[%]	32.204875
Avg Drawdown[%]	9.923923
Win Rate[%]	44.117647
Avg Win[$]	284.191815
Avg Loss[$]	-74.684029
Profit Factor	3.83
Time to Recovery[days]	283.020833
Quarters Beaten	10/16
Static Drawdown	15.198293
Static PnL	5687.761436

Metric	**2020**	**2021**	**2022**	**2023**
Benchmark[%]	441.7	401.9	-67.6	96.0
Initial Balance[$]	1000	1000	1000	1000
Final Balance[$]	2252.3	3783.2	4140.5	1191.7
Total Trades	22	12	12	22
Profit[%]	125.3	278.3	314.0	19.2
Benchmark Beaten	No	No	Yes	No





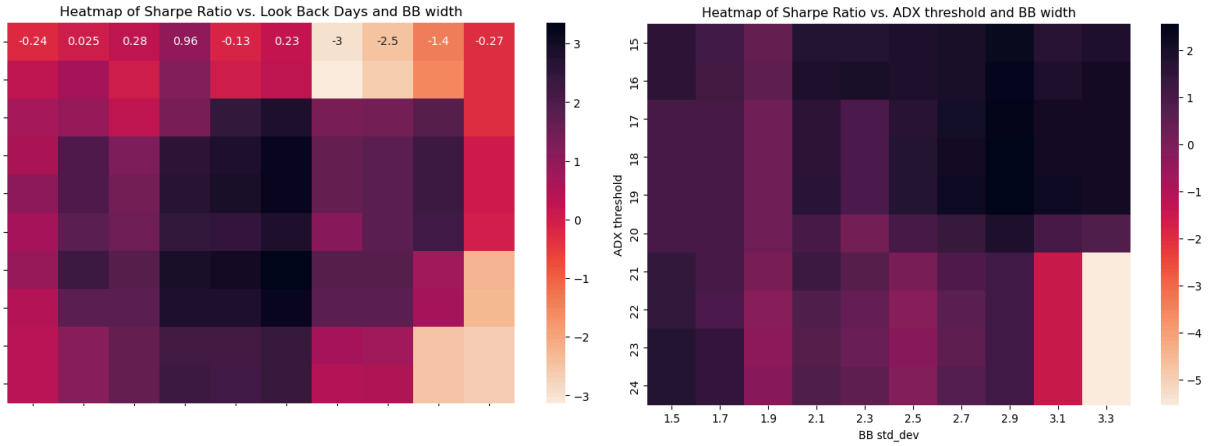
Drawdown Static and Compounding

Compounding and Static Capital

Robustness and Consistency

A robust strategy should not depend too much on the parameters used for indicators.Otherwise the parameters can give great results for the back tested data but can fail for the future data as the market is uncertain.

In order to Verify that the strategy was not too reliable on the parameters a heat map was prepared between sharpe ratio and adx_threshold/bb width and sharpe ratio vs lookback days/bbwidth.

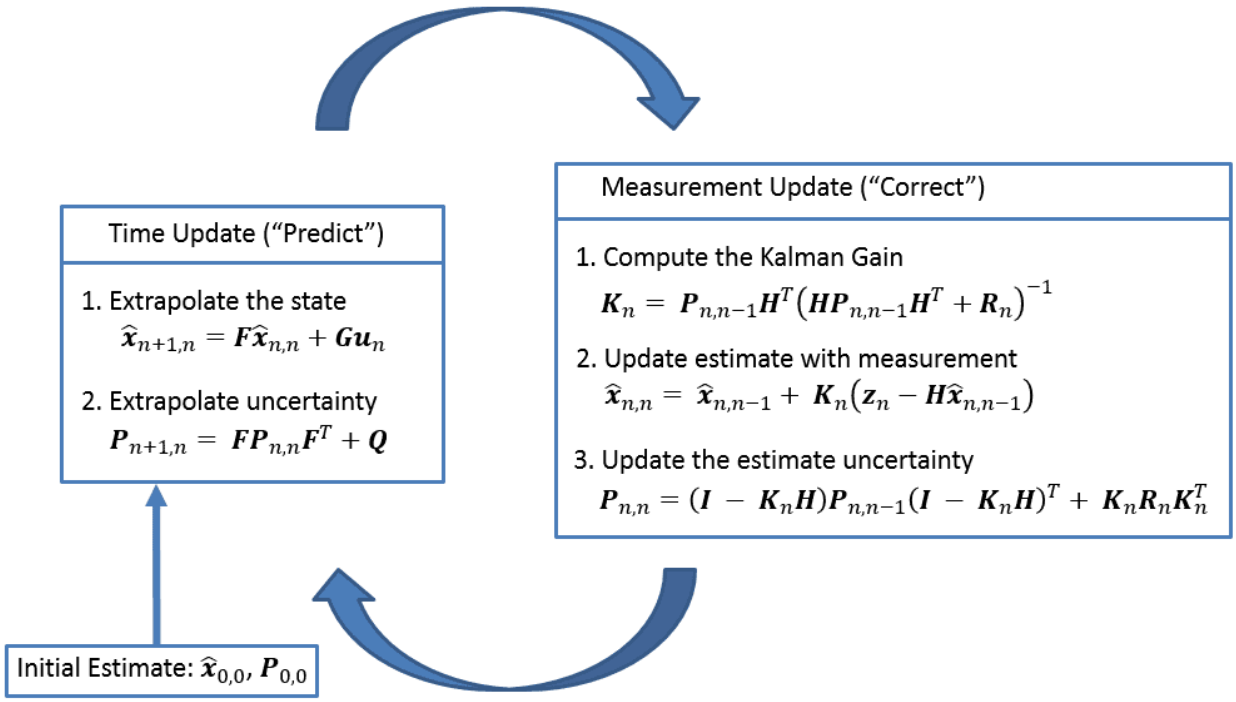


4.0 Filters :

1. Kalman Filter

a. The Kalman filter has two basic steps :

1. Prediction step: Based on the system model the filer predicts where the step should be at the current time step taking into account the previous state estimate.
2. Update step: The filter compares the predicted state with the actual state and makes corrections and decides how much to adjust the predicted step.



2. Fourier Low Pass Filter:

a. The fourier lowpass filter is a filtration technique which removes the high frequency data using fast fourier transformation. The Fourier Transformation decomposes a signal into sines and cosines of different Frequencies and Amplitude. Then frequencies above a cutoff frequency are set to zero retaining only low frequency components. The signal is then reconstructed using only low frequency components given by:

b. $$F[k]= \sum_{n=0}^{N-1} f[n].\, e^{-i2\pi kn/N}$$

F[k] = Fourier Transform of the signal

f[k] = Input Signal

N = Number of data points

3. Gaussian Smoothing

a. This smoothing technique averages nearby data by weights determined using Gaussian distribution. The weights are highest at the center,i.e., the current data point, and decrease exponentially as we move away from the center. This filter generally looks to both sides of

the center which could introduce look-ahead bias, to tackle this issue we create a window initially of size zero and append the current value to its end, and then use the filter.

b. The weights are given by:

c. $w[i] = \frac{1}{\sqrt{2\pi}} e^{\frac{-i^2}{2}}$ (where i is the distance from the centre.)

4. Savitzky-Golay Filter

a. Savitzky-Golay filter works by fitting a low degree (2 in our case) polynomial to a rolling window of the data using least squares regression, normally this filter considers data on both sides of center but since this will introduce look-ahead bias we worked our way around this by only passing it data till the current point in each iteration. This filter preserves the peaks and troughs while removing noise.

5.0 Optimizers:

Random Search Optimization:

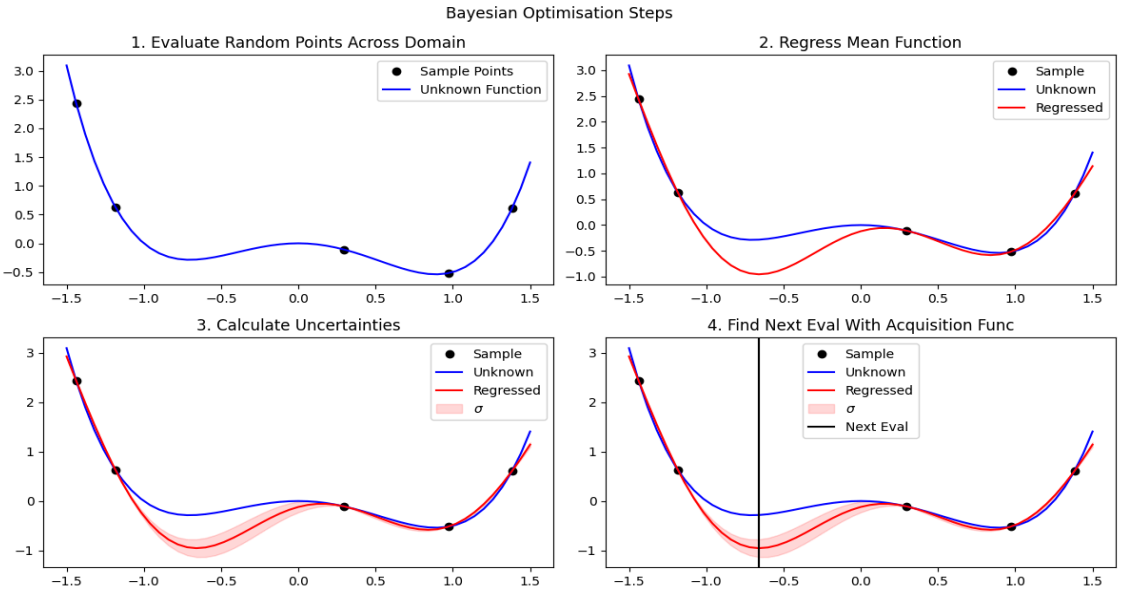
1. In this, we take different combinations of hyperparameters and it returns the combination which gave the best results.
2. It is much faster and more resource-efficient than grid search.
3. We tried to find a meaningful condition that would reduce the maximum drawdown to desired levels (under 25%) while maximizing returns.

Bayesian Optimization

1. Bayesian optimization is more efficient than random search, it minimizes the number of objective functions to improve efficiency.
2. It builds a probability model of the objective function to find the most suitable set of parameters.

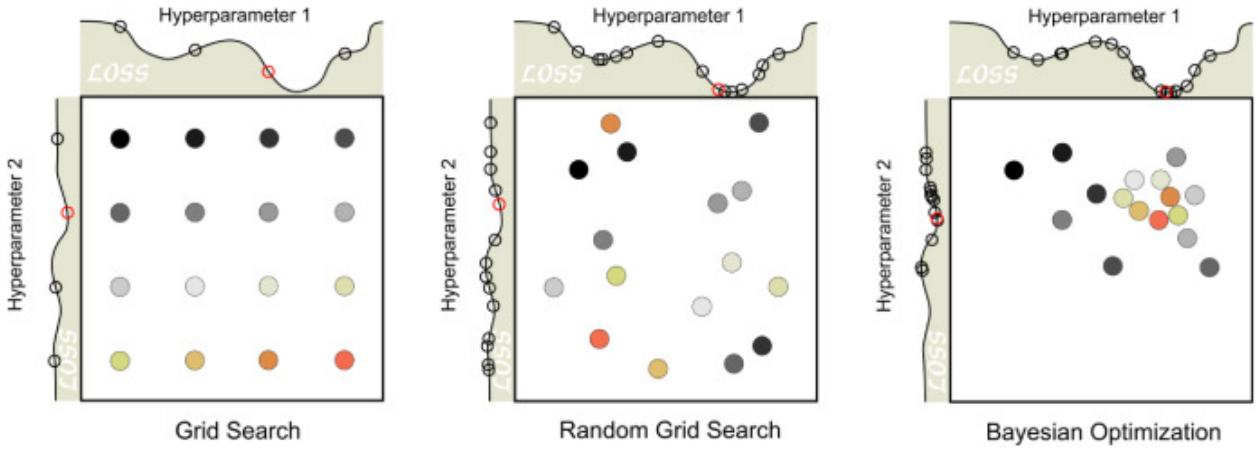
We tried to find a meaningful condition that would reduce the maximum drawdown to desired levels (under 25%) while maximizing returns.

1. **Surrogate Model (Gaussian Process):**
   $$f(x) \sim GP(m(x), k(x, x'))$$
2. **Posterior Prediction:**
   $$p(f_*|X, y, X_*) = \mathcal{N}(\mu_*, \Sigma_*)$$
3. **Acquisition Function (Expected Improvement):**
   $$\text{EI}(x_*) = (\mu(x_*) - f(x_{\text{best}}))\Phi\left(\frac{\mu(x_*) - f(x_{\text{best}})}{\sigma(x_*)}\right) + \sigma(x_*)\phi\left(\frac{\mu(x_*) - f(x_{\text{best}})}{\sigma(x_*)}\right)$$
4. **Maximize Acquisition:**
   $$x_* = \arg\max_x \text{EI}(x)$$



Grid Search

Grid search finds the best set of parameters by exhaustively iterating through every possible combination of parameters. It aims to achive best performance on a chosen evaluation metric. But grid search can get computationally expensive on a large set of parameters.



Genetic Optimization algorithm

Genetic Algorithm attempts to imitate Darwin's theory of survival of the fittest. Initially, multiple models are generated based on different hyperparameters then the best parameters among these are determined using some predetermined evaluation metric. In the next generation, we select a ratio of the best-performing models from the last generation and a new set of models generated by slightly tuning the parameters of selected models from the last generation. This process is repeated until the desired result is obtained.

1. For each generation fitness score of a model is calculated.

$$f(\mathbf{C}) \rightarrow \text{fitness score of } \mathbf{C}$$

2. The probability of selection of a parent for mutation/crossover is given by:

$$P(i) = \frac{f(\mathbf{C_i})}{\sum_{j=1}^{M} f(\mathbf{C_j})}$$

3. New offspring are generated using recombination of two parents :

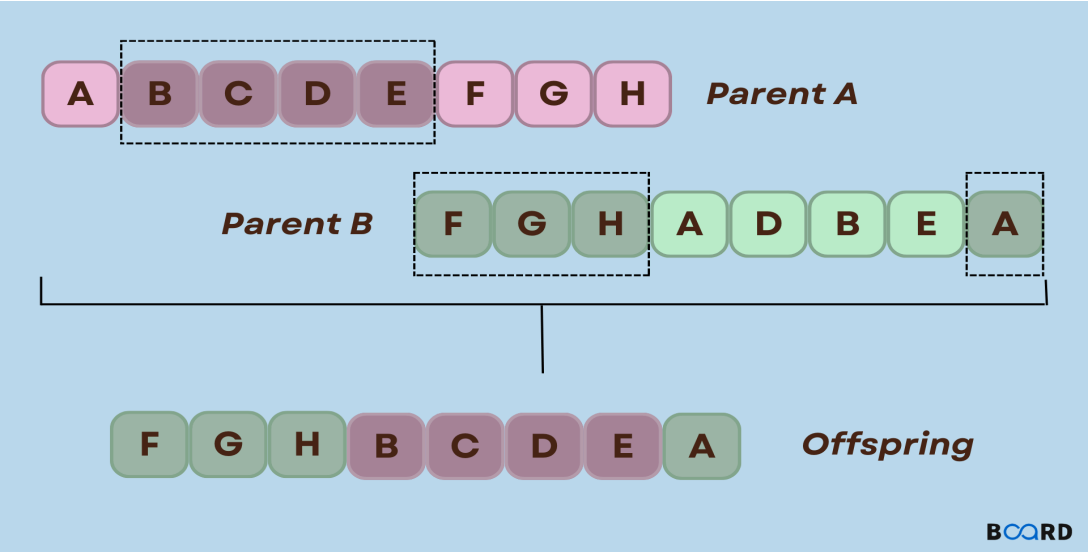
$$O_1 = (P_1[1:k], P_2[k+1:n])$$

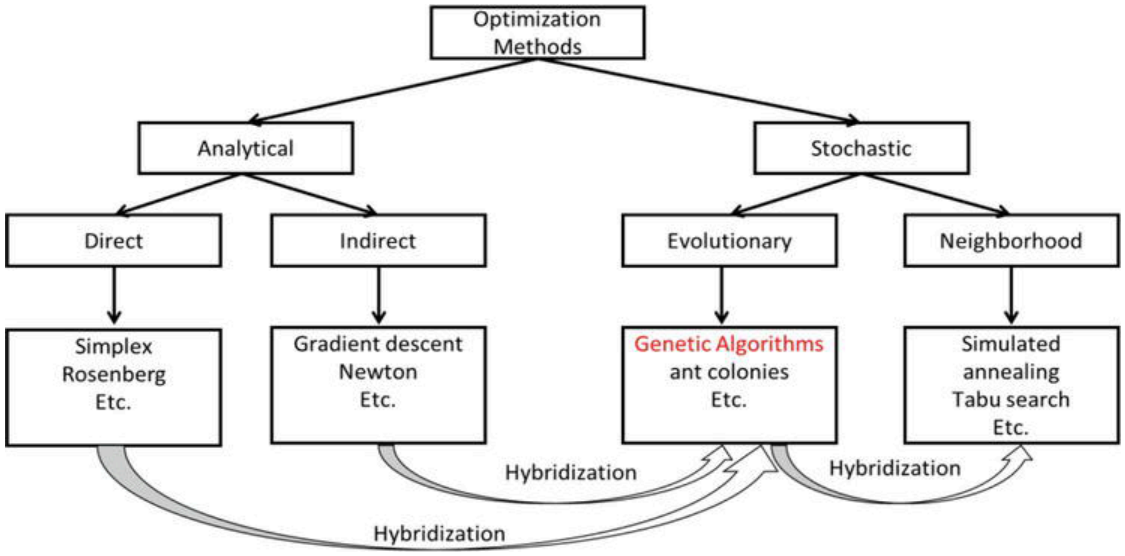
$$O_2 = (P_2[1:k], P_1[k+1:n])$$

where k is the crossover point, and $P_1[1:k]$ refers to the first part of parent 1's chromosome, and $P_2[k+1:n]$ refers to the second part of parent 2's chromosome.

4. Mutation is introduced in the offspring through introducing random noise in the offspring

$$\mathbf{C_i} \leftarrow \mathbf{C_i} + \delta$$





6.0 ML APPROACHES

[6.0.1]PATCH TST (Patch Time Series Transformer) :

This script predicts the future prices, Simple Moving Averages (SMA), and Exponential Moving Averages (EMA) for BTC and ETH using a powerful AI model called PatchTST, which is based on transformers. The model is designed to analyze time-series data by breaking it into smaller pieces (called patches) to better understand patterns over time. The data is prepared by normalizing it and splitting it into sequences for training and testing.

How It Works:

1. **Training Process**:
    - **Gradient Accumulation**: Helps manage memory by spreading out calculations across multiple steps, so it can handle large datasets even with limited computing power.
    - **Gradient Clipping**: Stops the training from making overly large adjustments, keeping the learning process stable.
    - **Weight Decay**: Prevents the model from getting too complicated, reducing the chance of overfitting (when the model works too well on training data but fails on new data).

- **Learning Rate Scheduling**: Gradually adjusts the learning speed to help the model learn efficiently without making sudden jumps.

2. **Evaluating the Model**:
    - The script checks how accurate its predictions are using metrics like:
        - **MSE (Mean Squared Error)**: Measures how far off the predictions are from actual values.
        - **RMSE (Root Mean Squared Error)**: Like MSE but easier to understand because it's in the same unit as the data.
        - **MAPE (Mean Absolute Percentage Error)**: Shows the percentage error between predictions and actual values.
        - **MPE (Mean Percentage Error)**: Highlights whether predictions are mostly too high or too low.
3. **Why It's Effective**:
    - The model can handle different tasks, like predicting prices or calculating SMAs and EMAs, all with high accuracy. Its advanced techniques ensure it learns patterns in the data without making mistakes due to overfitting or unstable training.

Key Takeaway:

This script is a practical and smart way to predict BTC and ETH trends. By combining cutting-edge AI techniques and thoughtful training methods, it produces reliable forecasts that can help in making better trading decisions.

	MSE	RMSE	MAPE [%]	MPE [%]
Close	5249.45	72.45	6.93%	5.399%
SMA	57874.077	240.57	10.016%	-9.95%
EMA	7664.43	87.54	6.633	-0.115

[6.0.2]XGBOOST:

This innovative strategy leverages the advanced predictive capabilities of one of the most widely acclaimed boosted tree ensemble models, the XGBoost Classifier. By utilizing a diverse range of oscillator-based technical indicators that capture trend, momentum, and volatility characteristics, the model delivers precise

predictions for optimal trade decisions. Oscillator-based indicators are specifically chosen due to their minimal autocorrelation with price and volume, effectively mitigating the risk of overfitting.
XGBoost is an ideal choice for this machine learning framework due to its numerous advantages:

- Optimized Performance: XGBoost is designed for speed and efficiency, offering highly optimized implementations for tree construction and gradient boosting.
- Regularization: Incorporates L1 (Lasso) and L2 (Ridge) regularization techniques, reducing overfitting and enhancing generalization.
- Scalability: Efficiently handles large-scale datasets through distributed and parallel processing capabilities.
- Missing Data Handling: Automatically manages missing values by learning the optimal pathways during training.
- Feature Importance: Provides detailed insights into feature importance, facilitating effective feature selection and model interpretability.
- Cross-validation: Includes built-in support for K-fold cross-validation, enabling robust model evaluation and hyperparameter tuning.

The trade signals predicted by the XGBoost model are further refined by integrating a Moving Average crossover signal for entry points, while the exit strategy employs an ATR (Average True Range)-based trailing stop-loss mechanism. This combination ensures a systematic and balanced approach to trade execution, aligning predictive accuracy with risk management.

b. Signal Generation :

1) **Long Signal** :
    a) If the model's predicted trade call is long and MA_Short > MA_Long i.e the moving average crossover complements the trade signal thus eliminating the possibility of any arbitrarily noisy decision , a long entry signal is generated.
    b) Length of MA_Short = 9 periods , Length of MA_Long = 26 periods.

2) **Short Signal:**
    a) Similarly if the model's predicted trade call is short and MA_Short < MA_Long , it generates a short entry signal.

3) **Long Exit:**
    a) An ATR-based trailing stop-loss mechanism governs exit decisions for long trades::
        i) Stop-loss = current_price - ATR_Multiplier * ATR_value, when the price moves favourably.

ii) Remains unchanged if the price moves unfavourably i.e downwards.

b) When the trailing stop-loss is attained , it generates a long exit signal.

c) Length of ATR= 14 periods , ATR_Multiplier =14

4) Short Exit:

a) For short trades, the trailing stop-loss is defined as::

i) Stop-loss = current_price + ATR_Multiplier * ATR_value, when the price moves favourably.

ii) Remains unchanged if the price moves unfavourably i.e upwards.

b) When the trailing stop-loss is attained , it generates a short exit signal.

c. Avoiding Overfitting and Look-Ahead Bias:

Given the machine learning-based nature of this strategy, addressing overfitting and look-ahead bias is paramount. The following measures are implemented to ensure robustness:

1) **K-fold cross-validation:** The model employs K-fold cross-validation to curb overfitting by ensuring the model was trained and validated on diverse subsets of data, enhancing its generalization capability.

2) **Evaluating train-test errors:** Errors on the train and test sets are evaluated to detect signs of overfitting. The win ratios indicate minimal or no overfitting:

a) Win ratio on train set : 0.54

b) Win ratio on test set : 0.53

3) **Hyperparameter optimization:** RandomizedSearchCV, combined with validation set evaluation, was used for hyperparameter optimization. This approach efficiently explores a wide range of parameter configurations and identifies the optimal setup, reducing overfitting

4) **Moving Average Crossover Confirmation:** The strategy avoids relying solely on the XGBoost model for trade signal generation, as this could result in arbitrarily noisy and potentially loss-inducing signals. Instead, the trade signal is validated through a moving average crossover, ensuring greater accuracy and reliability.

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Metric	Value
Return[%]	9.5

Final Balance[$]	1095
Return Annualized[%]	16.83
Sharpe Ratio	2.653279
Sortino Ratio	7.546044
# Trades	10
Max Drawdown[%]	13.329
Avg Drawdown[%]	6.64
Win Rate[%]	40
Avg Win[$]	111.100
Avg Loss[$]	-48.085
Profit Factor	2.31
Time to Recovery[days]	52.45
Static Drawdown	13.35
Static PnL	155.5

[6.0.3]Arima LSTM:

This script predicts BTC/ETH prices and generates trading signals using two models: **LSTM** (a deep learning model) and **Auto ARIMA** (a statistical model). It combines these predictions with a 20-period EMA (Exponential Moving Average) to decide when to enter or exit trades.

How It Works:

1. Preparing the Data

- The price data is normalized (scaled between 0 and 1) to make it easier for the models to process.
- A 60-period look-back window is used, meaning the models look at the last 60 prices to predict the next one.

- The dataset is split into training (80%) and testing (20%) so the models can be trained and tested separately.

2. LSTM Model

- The LSTM is a type of deep learning model designed to work with sequences, like price data over time.
- It uses three layers of LSTM cells to capture patterns in price movements.
- Dropout layers prevent overfitting, ensuring the model works well with new data.
- The model is trained to minimize errors, and an **early stopping mechanism** stops training if it doesn't improve further.
- The LSTM predicts prices for the testing set, and predictions are scaled back to the original price range.

3. Auto ARIMA Model

- Auto ARIMA is a statistical model that predicts price changes based on past data.
- For each point in the test set, it looks at the last 60 prices, makes a prediction, and moves forward.
- These predictions complement the LSTM by providing a statistical perspective.

4. Evaluating the Models

- Both models are evaluated using **Mean Squared Error (MSE)**, which measures how close their predictions are to actual prices.

5. Generating Trading Signals

Signals are created based on predictions from LSTM and ARIMA combined with the 20-period EMA:

- **Long Entry (Buy)**:
    - Both models predict higher prices, and the current price is above the EMA.
- **Short Entry (Sell)**:
    - Both models predict lower prices, and the current price is below the EMA.
- **Long Exit (Sell to close long)**:
    - If the price moves significantly (±2%) away from the predictions, indicating a reversal.
- **Short Exit (Buy to close short)**:
    - If the price moves significantly (±2%) away from the predictions, signaling the trend has ended.
- **No Signal**:
    - When none of the conditions above are met.

6. Results

- The script outputs:

- Actual prices, LSTM predictions, ARIMA predictions, and the generated signals (Buy, Sell, Exit, or No Action).

Why It's Useful

This script combines two powerful approaches:

1. **LSTM** for identifying complex price patterns.
2. **Auto ARIMA** for reliable statistical forecasting.

By combining these models with the EMA and creating rules for entries and exits, the strategy adapts to price changes and manages risks effectively. It's a practical tool for predicting trends and making smarter trading decisions.

On 20% of test data we received the..following result:

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Metric	Value
Return[%]	59.3
Final Balance[$]	1593.44
Return Annualized[%]	83.93
Sharpe Ratio	2.475
Sortino Ratio	5.737
# Trades	146
Max Drawdown[%]	24.45
Avg Drawdown[%]	10.89
Win Rate[%]	32.191
Avg Win[$]	41.511
Avg Loss[$]	-13.73
Profit Factor	3.023

Time to Recovery[days]	151.83
Static Drawdown	25.105
Static PnL	591.287

7.0 Challenges faced

Developing algorithmic trading strategies for highly volatile markets like BTC/USDT and ETH/USDT posed several significant challenges it was tough to proceed in the beginning as our direction was not clear slowly we started dividing the work among our team to try out different methodologies which helped us effectively in managing our time during exams. The feedback of the mid evaluation also helped us as it located all the mistakes we did so far still the major challenges we faced are as follows-

1. **Market Complexity**:
    - The cryptocurrency markets are inherently volatile and influenced by a variety of factors such as macroeconomic news, regulatory changes, and market sentiment. This complexity made it difficult to identify stable patterns or trends.
    - Unlike traditional assets, cryptocurrencies lack long-term historical data, adding uncertainty to the strategy development process.
2. **Timeframe Optimization**:
    - Each time frame, such as 15 minutes, 30 minutes, or 4 hours, required unique parameter tuning to identify optimal values for indicators like ADX, RSI, and Bollinger Bands.
    - A strategy effective on a 15-minute chart often failed on a 30-minute chart, requiring extensive backtesting and recalibration to maintain reliability across multiple timeframes.
3. **Signal Deviation and Lookahead Bias**:
    - Managing signal deviation was particularly challenging, as entries and exits sometimes lagged behind actual market movements, reducing profitability.

- Avoiding lookahead bias required meticulous testing to ensure that decisions were based solely on past and present data, and not on future information inadvertently included in the calculations.

4. **Overfitting Risks**:
    - Overfitting was a constant concern, especially when strategies performed exceptionally well during backtests but failed to replicate the same success in live markets.
    - The balancing act of creating robust strategies without tailoring them excessively to past data required careful use of validation datasets and out-of-sample testing.
5. **Learning Curve for Advanced Concepts**:
    - Incorporating advanced techniques like the Hawkes process was challenging, as it required diving into academic literature and understanding mathematical models unfamiliar to the team at the start.
    - Gaining proficiency in such concepts and integrating them into the strategy demanded considerable time and effort.
6. **Literature Review and Experimentation**:
    - The absence of a one-size-fits-all solution meant extensive reading of academic papers, articles, and expert discussions to explore innovative methods.
    - Practical experimentation with these ideas in live or simulated markets was necessary to determine their effectiveness, which added to the development timeline.

Further Improvements

1. BTC-ETH Pairs Trading Strategy:

There is a positive correlation between btc-usdt and eth-usdt of 0.89 (89%) considering direct prices and a correlation of 94% considering the logarithm of their prices(for stabilizing variance). However, running a cointegration test between the two price series doesn't show that the two prices are co-integrated at the 5% significance level or even at the 1% significance level. This means that the BTC-ETH pair is not suitable for a pairs trading strategy as their spread does not mean revert if they are not co-integrated.

However, we still tried developing a pairs trading strategy between the two to check if there's any empirical way in which we can tweak the strategy parameters and get a positive result.

There were two pairs-trading approaches that we tried:

1. Long-Only Bollinger-Band based strategy:

   A simple strategy where we buy BTC when the price ratio of BTC/ETH (RATIO) falls below the lower BB and we exit the long position when RATIO rises above the upper BB.

   BTC_ETH SPREAD = BTC_PRICE/ETH_PRICE

   BTC_ETH_LOG_SPREAD = LOG(BTC_PRICE)/LOG(ETH_PRICE)

   UPPER_BB = BTC_ETH_SPREAD_MEAN(window=30) +
   2*BTC_ETH_SPREAD_STD(window=30)

   LOWER_BB = BTC_ETH_SPREAD_MEAN(window=30) -
   2*BTC_ETH_SPREAD_STD(window=30)

   BUY CONDITION: If RATIO < LOWER_BB : SELL ETH and BUY BTC.

   EXIT CONDITION: If RATIO > UPPER_BB: SELL BTC and BUY ETH.

   This particular strategy was giving negative returns with large drawdowns even with optimization of the various strategy parameters and using different timeframes.

2. Long-Short pairs trading strategy using z score values:

   We first obtain the hedge ratio from the co-integration test and define the spread as:

   BTC_ETH_SPREAD = LOG (BTC_PRICE)0−β×LOG(ETH); β is the hedge ratio obtained from the cointegration test.

   Post that, we calculate the zscore values and define the trading conditions following that:

   BTC_ETH_SPREAD_ZSCORE = (BTC_ETH_SPREAD -
   MEAN(BTC_ETH_SPREAD)) / STD(BTC_ETH_SPREAD)

We also define two thresholds: ENTRY_THRESHOLD and EXIT_THRESHOLD, which are the z score values corresponding to taking a long or short position or exiting from them.

LONG CONDITION: BTC_ETH_SPREAD_ZSCORE < -ENTRY_THRESHOLD

SHORT CONDITION: BTC_ETH_SPREAD_ZSCORE > ENTRY_THRESHOLD

EXIT CONDITION: BTC_ETH_SPREAD_ZSCORE > -EXIT_THRESHOLD or BTC_ETH_SPREAD_ZSCORE < EXIT_THRESHOLD

This strategy too, has a maximum drawdown of 40% and a Sharpe Ratio equal to 0.05 and a dismal return of just 1%. Also, while implementing this strategy we found that the two price series were not co-integrated, pointing to the fact that pairs-trading strategies are not viable for the BTC-ETH pair.

However, we do hope on finding optimal strategy parameters as well as using indicators along with pairs trading to find a decent strategy on the BTC-ETH pair.

2. Sentimental Analysis(Incorporating Fear and Greed Index)

a. We also wanted to include sentiment analysis with our signals . Instead of performing the original sentimental analysis by gathering data from different sources we thought of using the Fear and Greed Index to strengthen our signals. We incorporated a basic strategy in the beginning but it did not perform as per the benchmarks..

3. Using Onchain Data

a. There are papers citing the fact that on-chain data can be used to create trading strategies in the crypto space one such data we tried was the hash ribbon index which tells us the miner activity and sentiments by analyzing the 30 day and 60 day moving average of Bitcoin's hash rate.When the 30 day moving average crosses above the 60 day,it suggests a positive shift often interpreted as miner capitulation coming to end. Which could give us a bearish sentiment as the miner can shut the mining and sell the coin.