Zelta Midterm Report - Team 84

November 15, 2024

Contents

1 Progress Update

Our trading strategy has shown substantial progress, delivering strong performance in the current market environment. Successfully implemented across both BTC/USDT and ETH/USDT markets, the strategy has yielded promising returns. Backtesting results demonstrate its ability to adapt to market fluctuations, consistently outperforming benchmark metrics. Additionally, the strategy performs well on key evaluation metrics, including Sharpe ratio, Sortino ratio, and maximum drawdown, highlighting its potential for sustained and profitable trading. This single approach for both BTC and ETH has proven effective across these metrics, proving its versatility and robustness.

1.1 Current status of our strategy

- **Selection of indicators:**
  We have selected a set of key technical indicators—ATR, EMA, ADX, and Bollinger Bands—based on their strong correlation with market behavior and their ability to guide real-time trading decisions. These indicators work together to capture both trend-following and mean-reversion patterns in the market. ATR helps with volatility measurement and position sizing, EMA tracks the market trend, ADX gauges trend strength, and Bollinger Bands identify potential reversal points.

- **Rationale for same strategy for both BTC and ETH markets**
  We implemented the same strategy for both Bitcoin and Ethereum and so far, it has been performing well on both asset classes. There are several reasons for this success. First, both coins have a high correlation, which means they often respond similarly to market conditions. Secondly, the indicators in our strategy are robust and time-dependent, allowing them to adapt well across both assets. Additionally, the strategy includes tighter stop-losses, which helps in managing risk effectively, contributing to consistent performance for both coins.

1.2 Challenges

- **Indicator Selection and Tuning:**
  A key challenge was selecting effective indicators under varying market conditions. After testing multiple technical indicators, we selected ATR, EMA, ADX and Bollinger Bands for identifying trends and potential reversal points.

  Solution: We used rigorous backtesting to fine-tune indicator parameters, optimizing ATR thresholds, EMA spans, ADX thresholds, and Bollinger Band deviations. This approach enhanced the strategy's performance across both trending and sideways markets.

- **Overcoming Indicator Conflicts:**
  In some instances, different indicators signaled conflicting actions, such as when the EMA suggested an uptrend while Bollinger Band depicted a downtrend.

  Solution: To resolve this, we applied a layered approach to strategy execution, where the strategy assesses market conditions and applies multiple filters before making a trade decision. The EMA signal takes precedence during trending conditions, while Bollinger Bands dominates during range-bound conditions, ensuring more robust trade setups.

- **Data Overfitting and Model Generalization:**
  As with any algorithmic strategy, the risk of overfitting the model to historical data was a concern. Ensuring the model generalizes well to unseen data, especially considering the evolving nature of cryptocurrency markets, was crucial.

Solution: We implemented out-of-sample testing and cross-validation to assess the model's robustness. The strategy was optimized to adapt to market shifts without overfitting, ensuring that it remains effective in varying market conditions.

- **Monitoring Positions, Stop-Loss, and Target Orders**
  A key challenge was effectively tracking our current market position alongside stop-loss and target prices, which are crucial for optimal strategy performance.

  Solution: To counter this, we kept track of trade orders and stop-loss or target hits during strategy execution. This setup enables timely adjustments and informed decision-making based on market conditions.

By addressing these challenges with targeted solutions, we enhanced the strategy's effectiveness for BTC and ETH markets, achieving robust performance in both markets.

2 Strategy Overview

The core idea behind the development of our trading strategy was driven by the observation that BTC and ETH markets exhibit distinct behaviors in different volatility environments. Average True Range (ATR) is employed to gauge volatility, switching between high and low volatility modes: for high volatility, the strategy leverages trend-following indicators (EMA and ADX), while in low volatility, it utilizes Bollinger Bands for range-bound or reversal trades. This dual-mode design aims to optimize returns by adapting dynamically to changing market conditions, with volatility-based risk adjustments.

2.1 Key Features and Indicators

- **Average True Range (ATR)** - *Volatility Filter*
  ATR determines the market's volatility, enabling the strategy to alternate between trend-following and mean-reversion approaches. High ATR values indicate volatile conditions suited to trend-following strategies, while lower values suggest calm periods where reversal or range-bound strategies are more effective. In our strategy, we have set the value of ATR to 1200 to monitor the volatility, but we will further fine-tune it in our final strategy to capture the trends.

- **High Volatility Mode: EMA and ADX**
  When ATR signals high volatility, the strategy employs trend-following indicators to capture extended price movements:

  – **Exponential Moving Average (EMA)**
    The EMA signal identifies trend direction by comparing short-term and long-term EMAs. An uptrend is signaled when the short-term EMA is above the long-term EMA, while a downtrend is indicated when it falls below. This allows the strategy to align with current market momentum in dynamic conditions. We specifically used the 2-day and 4-day EMAs (Exponential Moving Averages) because Bitcoin is a volatile asset, making it important to capture early momentum in trades. Shorter periods, like 2 and 4 days, allow us to react quickly to price changes and take advantage of emerging trends in the market.

  – **Average Directional Index (ADX)**
    ADX confirms trend strength, filtering out weak trends to improve trade reliability. In high-volatility conditions, an ADX above a set threshold validates EMA-based trend signals, ensuring trades align with strong, sustained price movements. ADX greater than 25 depicts a strong trend and ADX less than 25 depicts a weak trend, so we are trading only when both of our indicators are depicting to either buy or sell the asset.

- **Low Volatility Mode: Bollinger Bands**
  In low volatility, the strategy pivots to a mean-reversion approach, identifying short-term entry and exit points in range-bound markets, so we can implement Bollinger bands in these types of market conditions:

  – **Bollinger Bands (BB)**
    Bollinger Bands identifies overbought or oversold conditions by indicating how far the price deviates from its moving average. When the price approaches the upper or lower band, it signals potential reversal points, suggesting the price may revert toward the average.

- **Position Management and Targets**
  Stop-loss (SL) and target-price (TP) levels are set based on the identified volatility mode:

  – **High Volatility:** TP at 5% with SL at 2% for larger price swings. We know in trendy markets we can capture long candles so that's why we have increased our stop-loss and target levels.

- **Low Volatility:** TP at 2% with SL at 1%, adjusting to range-bound price action. We know in range-bound conditions there is not much to capture more than 2 percent of the asset as the price will be approaching towards mean and will be having a consolidating range. so it's better to have tighter stop-loss and target.

3 Performance Metrics

- **Profitability**: Both assets showed significant profitability over the past 4 years. Ethereum achieved a far higher return, with a benchmark return of 1,462.97% compared to Bitcoin's 315.73%. The strategy yielded a net profit of $8,779.30 for Ethereum, with a remarkable profit percentage of 443,560.19%, significantly outpacing Bitcoin's $2,484.31 net profit and 897.08% profit percentage.
- **Risk Management**: Bitcoin's strategy exhibited lower drawdown compared to Ethereum, with a maximum drawdown of 8.99% versus Ethereum's 15.86%. However, Ethereum showed a quicker time to recovery (67 days versus 267 days for Bitcoin).
- **Sharpe and Sortino Ratios**: Ethereum achieved a Sharpe Ratio of 9.24 and a Sortino Ratio of 20.98, highlighting superior performance per unit of risk. Bitcoin, on the other hand, had a Sharpe Ratio of 8.08 and a Sortino Ratio of 18.36, indicating slightly lower risk-adjusted returns compared to Ethereum.
- **Trade Statistics**: Ethereum executed significantly more trades (783 trades) than Bitcoin (139 trades), reflecting a higher level of activity and perhaps more aggressive trading strategies.

Overall, our strategy is performing well for both Bitcoin and Ethereum. Here are the results for each asset.

Static Statistics	**BTC/USDT**	**ETH/USDT**
Timeframe	3 days	1 day
Total Trades	139	783
Leverage Applied	2.0	2.0
Winning Trades	83	451
Losing Trades	56	332
No. of Long Trades	70	82
No. of Short Trades	69	701
Win Rate (%)	59.71	57.60
Winning Streak	11	15
Losing Streak	6	9
Gross Profit	2901.31	11128.30
Net Profit	2484.31	8779.30
Average Profit	17.87	11.21
Maximum Drawdown (%)	8.99	15.86
Average Drawdown (%)	1.66	0.88
Largest Win	97.0	37.0
Average Win	54.12	36.22
Largest Loss	-43.0	-23.0
Average Loss	-35.86	-22.76
Maximum Holding Time	6 days 0:0:0	2 days 0:0:0
Average Holding Time	3 days 3:6:28	1 days 1:9:53
Maximum Adverse Excursion	27.33	31.93
Average Adverse Excursion	4.72	3.23
Sharpe Ratio	8.08	9.24
Sortino Ratio	18.36	20.98
Benchmark Return (%)	315.73	1462.97
Benchmark Return (on $1000)	3157.32	14629.74

Table 1: Static Performance Metrics for Bitcoin (BTC) and Ethereum (ETH) from 2019 to 2023

Compound Statistics	**BTC/USDT**	**ETH/USDT**
Profit Percentage	897.08	443560.19
Maximum Drawdown (%)	28.78	28.77
Average Drawdown (%)	5.57	4.74
Time to Recovery (TTR)	267 days	67 days
Average TTR	36.1 days	4.31 days
Maximum PNL	957.75	162023.82
Minimum PNL	-465.75	-104444.06
Max Portfolio Balance	10831.48	4541045.91
Min Portfolio Balance	1000.0	1000.0
Final Balance	9970.78	4436601.85
Total Fee	2329.60	3318417.97

Table 2: Compound Performance Metrics for Bitcoin (BTC) and Ethereum (ETH) from 2019 to 2023

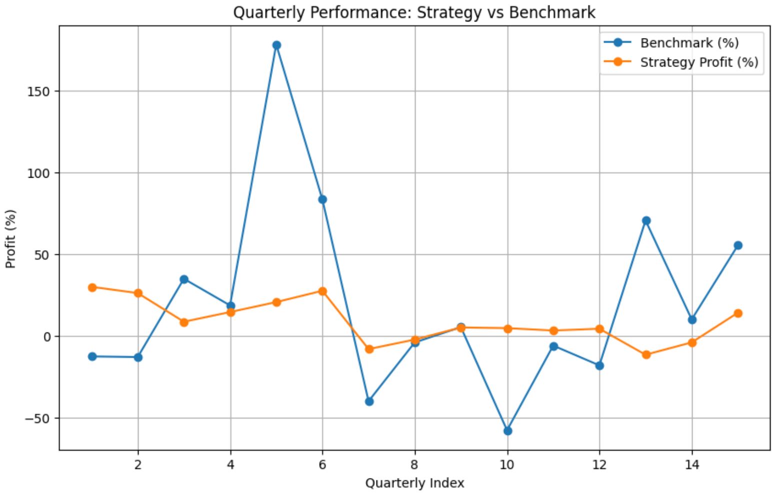


Figure 1: Quarterly Results for BTC/USDT Strategy

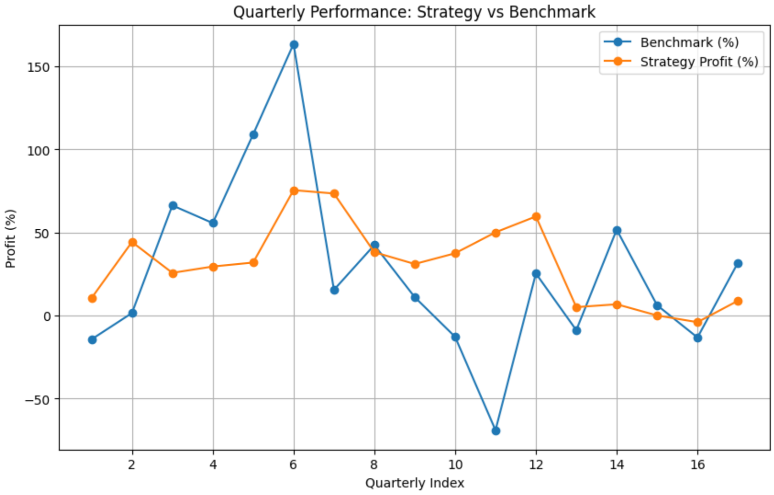


Figure 2: Quarterly Results for ETH/USDT Strategy

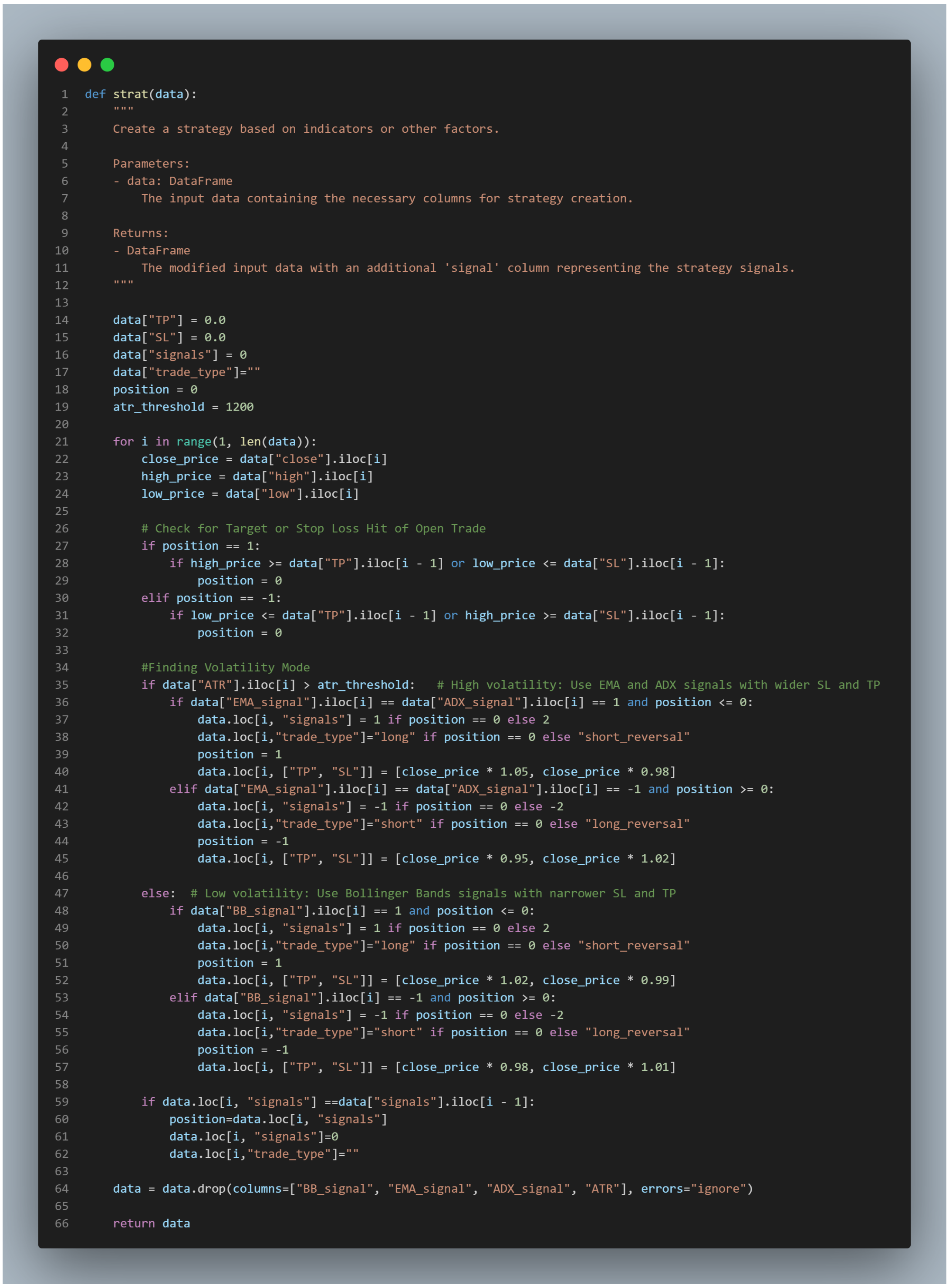
4 Unique Approaches and Innovations

Our strategy leverages a dual-mode approach that adapts to high and low-volatility markets. It captures trend-based opportunities in volatile conditions while utilizing momentum-reversal signals in quieter markets. This flexibility addresses market inefficiencies and enhances profit potential by dynamically adjusting to changing market environments. Here are the innovative aspects and the rationale behind this adaptive approach.

- **Adaptive Dual-Mode Approach**
  The strategy uniquely combines trend-following and mean-reversion techniques, allowing it to adapt to different market conditions. In contrast to traditional models, which typically rely on a single mode, this dual approach enhances flexibility and effectiveness across varying volatility levels.
- **Exploiting Market Inefficiencies**
  - **High-Volatility Mode:** In periods of high volatility, markets often move in alignment with broader trends. The use of EMA and ADX in our strategy enables it to capture these significant directional movements, leveraging trend strength to optimize entries and exits.
  - **Low-Volatility Mode:** During low-volatility or sideways markets, traditional trend-following methods can generate false signals. By incorporating Bollinger Bands, our approach identifies and capitalizes on smaller, range-bound opportunities that arise when markets lack a clear directional bias.
- **Smooth Transitions Between Volatility Regimes**
  Unlike many strategies that struggle in changing conditions, our model smoothly transitions between high and low volatility modes. This adaptability minimizes exposure to risks associated with single-mode strategies, making it resilient to sudden shifts in market sentiment.
- **Enhanced Responsiveness**
  By using volatility-sensitive indicators, the strategy automatically adjusts stop-loss and take-profit levels, ensuring proportional risk and reward according to market conditions. This enhances trade accuracy and helps avoid false entries, especially in less predictable environments.
- **Mathematical Rationale**
  - **High Volatility:** EMA and ADX serve as robust indicators of trend strength, ideal for capturing substantial moves.
  - **Low Volatility:** Bollinger Bands pinpoint overbought/oversold levels, facilitating trades that exploit price reversals in a controlled range.

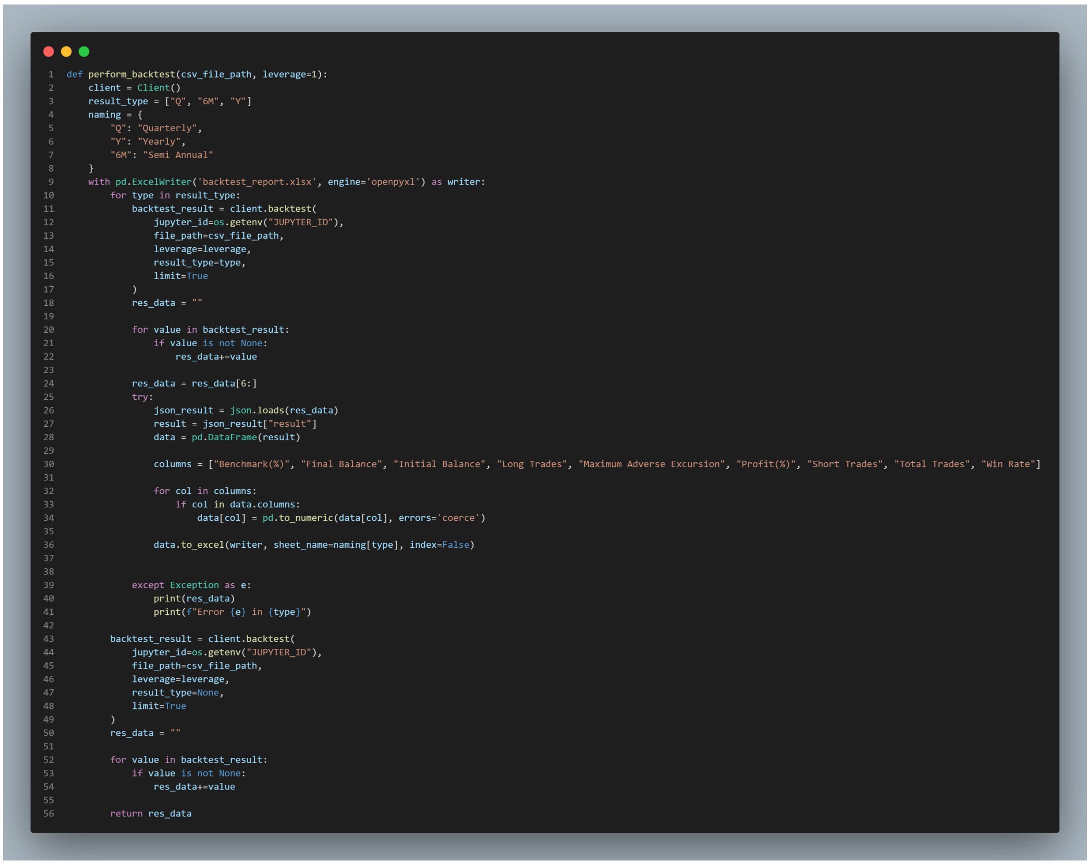
Appendix

Source Code



```python
def strat(data):
    """
    Create a strategy based on indicators or other factors.

    Parameters:
    - data: DataFrame
        The input data containing the necessary columns for strategy creation.

    Returns:
    - DataFrame
        The modified input data with an additional 'signal' column representing the strategy signals.
    """

    data["TP"] = 0.0
    data["SL"] = 0.0
    data["signals"] = 0
    data["trade_type"]=""
    position = 0
    atr_threshold = 1200

    for i in range(1, len(data)):
        close_price = data["close"].iloc[i]
        high_price = data["high"].iloc[i]
        low_price = data["low"].iloc[i]

        # Check for Target or Stop Loss Hit of Open Trade
        if position == 1:
            if high_price >= data["TP"].iloc[i - 1] or low_price <= data["SL"].iloc[i - 1]:
                position = 0
        elif position == -1:
            if low_price <= data["TP"].iloc[i - 1] or high_price >= data["SL"].iloc[i - 1]:
                position = 0

        #Finding Volatility Mode
        if data["ATR"].iloc[i] > atr_threshold:   # High volatility: Use EMA and ADX signals with wider SL and TP
            if data["EMA_signal"].iloc[i] == data["ADX_signal"].iloc[i] == 1 and position <= 0:
                data.loc[i, "signals"] = 1 if position == 0 else 2
                data.loc[i,"trade_type"]="long" if position == 0 else "short_reversal"
                position = 1
                data.loc[i, ["TP", "SL"]] = [close_price * 1.05, close_price * 0.98]
            elif data["EMA_signal"].iloc[i] == data["ADX_signal"].iloc[i] == -1 and position >= 0:
                data.loc[i, "signals"] = -1 if position == 0 else -2
                data.loc[i,"trade_type"]="short" if position == 0 else "long_reversal"
                position = -1
                data.loc[i, ["TP", "SL"]] = [close_price * 0.95, close_price * 1.02]

        else:  # Low volatility: Use Bollinger Bands signals with narrower SL and TP
            if data["BB_signal"].iloc[i] == 1 and position <= 0:
                data.loc[i, "signals"] = 1 if position == 0 else 2
                data.loc[i,"trade_type"]="long" if position == 0 else "short_reversal"
                position = 1
                data.loc[i, ["TP", "SL"]] = [close_price * 1.02, close_price * 0.99]
            elif data["BB_signal"].iloc[i] == -1 and position >= 0:
                data.loc[i, "signals"] = -1 if position == 0 else -2
                data.loc[i,"trade_type"]="short" if position == 0 else "long_reversal"
                position = -1
                data.loc[i, ["TP", "SL"]] = [close_price * 0.98, close_price * 1.01]

        if data.loc[i, "signals"] ==data["signals"].iloc[i - 1]:
            position=data.loc[i, "signals"]
            data.loc[i, "signals"]=0
            data.loc[i,"trade_type"]=""

    data = data.drop(columns=["BB_signal", "EMA_signal", "ADX_signal", "ATR"], errors="ignore")

    return data
```

Figure 3: Code Snippet of the Strategy Function



```python
def perform_backtest(csv_file_path, leverage=1):
    client = Client()
    result_type = ["Q", "6M", "Y"]
    naming = {
        "Q": "Quarterly",
        "Y": "Yearly",
        "6M": "Semi Annual"
    }
    with pd.ExcelWriter('backtest_report.xlsx', engine='openpyxl') as writer:
        for type in result_type:
            backtest_result = client.backtest(
                jupyter_id=os.getenv("JUPYTER_ID"),
                file_path=csv_file_path,
                leverage=leverage,
                result_type=type,
                limit=True
            )
            res_data = ""

            for value in backtest_result:
                if value is not None:
                    res_data+=value

            res_data = res_data[6:]
            try:
                json_result = json.loads(res_data)
                result = json_result["result"]
                data = pd.DataFrame(result)

                columns = ["Benchmark(%)", "Final Balance", "Initial Balance", "Long Trades", "Maximum Adverse Excursion", "Profit(%)", "Short Trades", "Total Trades", "Win Rate"]

                for col in columns:
                    if col in data.columns:
                        data[col] = pd.to_numeric(data[col], errors='coerce')

                data.to_excel(writer, sheet_name=naming[type], index=False)


            except Exception as e:
                print(res_data)
                print(f"Error {e} in {type}")

        backtest_result = client.backtest(
            jupyter_id=os.getenv("JUPYTER_ID"),
            file_path=csv_file_path,
            leverage=leverage,
            result_type=None,
            limit=True
        )
        res_data = ""

        for value in backtest_result:
            if value is not None:
                res_data+=value

        return res_data
```

Figure 4: Code Snippet of the Backtesting Function

Future Plans

The current strategy has shown promising results, and moving forward, we aim to enhance its performance and adaptability through the integration of machine learning and advanced mathematical models. Key areas for future development include:

- **Machine Learning Integration:** We plan to incorporate machine learning algorithms, to further optimize indicator selection and improve prediction accuracy for market conditions. This will enable the strategy to learn from historical data and adjust dynamically to changing market environments.
- **Advanced Mathematical Models:** By incorporating advanced techniques, such as stochastic calculus, non-linear optimization methods, and machine learning algorithms, we aim to enhance the decision-making process, particularly in complex market scenarios. These models will enable us to capture more intricate patterns and trends. For instance, we plan to apply algorithms like NSGA (Non-dominated Sorting Genetic Algorithm), Bio-objective evolutionary algorithms, Markov decision processes (MDPs), etc.
- **Changing of position sizing based on volatility:** We will adjust our position sizing based on the volatility of the asset. In highly volatile conditions, we will trade less Bitcoin, while in low volatility conditions, we can trade with more Bitcoin/Ethereum. However, we will ensure that this adjustment does not negatively impact our overall performance metrics.
- **Enhanced Risk Management:** We also plan to incorporate advanced risk management techniques, utilizing machine learning models to predict and mitigate potential drawdowns, thus ensuring more consistent performance.