Automated Algorithmic Application for Exploring Trading Strategies and Methodologies

Final Report

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Outline

Introduction

This final report aims to provide an overview of a rudimentary platform designed to pull cryptocurrency price information from Gemini's API, recreate indicators in Python, develop long/short decision strategies based on predefined rules, and analyze the winrate/performance of these strategies. The platform incorporated a basic React application with a Node.js backend using Express.js for communication. Visualization was achieved using TradingView's lightweight-charts library, while data retrieval and manipulation were performed using Axios and Python, respectively.

Methodology

The platform employed various technologies and libraries to achieve its goals. Gemini’s public API was utilized to fetch cryptocurrency price data, while Python was used for data processing, indicator calculations, and strategy implementation. A NodeJS backend was created to accept requests from a frontend application and run Python scripts as needed to generate the indicators & strategies. To complete the stack, a React application was implemented with the lightweight-charts library to enable high-performance visualizations of prices, indicators, and performance metrics.

Frontend

The frontend development of the platform began with the utilization of vanilla JS, HTML, and CSS, along with the JSCharting and NoUISlider libraries. These choices were made for their simplicity, enabling rapid feature development and deployment. However, as the platform grew in complexity, the performance of the JSCharting library became a significant bottleneck. Each rendering triggered by a viewport change took over 1000ms to complete, resulting in a choppy and sluggish user experience. To address this issue and establish a more modular codebase, an extensive evaluation of charting libraries was conducted, leading to the decision to completely reformat the frontend and transition it to React.js and lightweight-charts.

The current state of the React application comprises a single-page dashboard with three main components. The chart located in the top-left area displays the price data for the target cryptocurrency, along with the long/short decisions generated by the backend. The chart below it illustrates all implemented indicators, including Heiken Ashi candles and Stochastics, along with their corresponding thresholds. The section on the right side of the dashboard presents essential information related to strategy analysis. From top to bottom, the "Active Window" section provides details about the duration for which the strategy is being analyzed. The "Active Trades" section displays the decisions made by the backend within the specified duration. The "Summary" section outlines the number of winning and losing trades, as well as the percentage gain or loss compared to the previous trade. Finally, the bottom-right graph plots the aggregate performance of the strategy throughout the specified duration, starting from 100% and indicating the final percentage value as the aggregate gain. The top-left chart's zooming, panning, or adjustment of the time window dynamically updates all other sections, as these controls manipulate the active time window.

The transition to React.js and lightweight-charts has addressed the performance bottleneck experienced with the previous charting library, ensuring smoother and more responsive user interactions. This reformatting has also facilitated the development of a modular and scalable codebase, enabling easier maintenance and future enhancements to the platform.

Backend

The backend of the platform was developed using Node.js and designed as a basic REST API utilizing Express.js. To ensure a controlled environment for performance comparison between different strategies without the need for recalculating indicators and decisions for dynamic data, a fixed dataset was utilized for this project.

The platform successfully accessed and retrieved cryptocurrency price data from Gemini's API. The obtained data encompassed historical prices for various cryptocurrencies across multiple timeframes, including 1m, 5m, 15m, 30m, 1hr, 6hr, and 1day. The data contained essential details such as opening, closing, high, and low prices, as well as trading volume. Following retrieval, the data underwent a thorough processing stage before being stored locally in a designated directory.

When a request is received from the frontend, the backend initiates a search for the corresponding data file. If the file is present, the backend retrieves the required information from it. In cases where the file is not found, the backend seamlessly pulls the necessary data from the web, ensuring data availability for further processing. Additionally, the same process is applied to indicators and analyzers, with the option to recalculate values through Python scripts

in the absence of an existing indicator file. Once the required data, indicators, and analyzers are obtained, the Express.js app returns all relevant values to be displayed on the frontend.

This backend implementation ensures a reliable and efficient data flow, allowing for seamless communication between the frontend and backend components. By utilizing a fixed dataset and providing fallback mechanisms for data retrieval and calculation, the platform ensures consistent and accurate results for performance comparison and analysis.

Indicator Calculation

The platform demonstrated consistently accurate calculation of the Heiken Ashi and Stochastic indicators using the retrieved cryptocurrency price data. The Heiken Ashi candles were generated through a meticulous smoothing technique applied to the price data, facilitating a simplified interpretation of market trends. On the other hand, the Stochastic indicator, leveraging historical price data, provided valuable insights into market momentum and strength.

The calculation process involved reading the collected candlestick data from a file and iteratively processing the values. By adhering to the prescribed formulas, the platform computed the indicator values. This computation process ensured that the Heiken Ashi and Stochastic indicators were derived with precision and reliability. The resulting indicator values were then written to a new file, residing in the same directory, ensuring the preservation and accessibility of these indicator outputs.

Through its calculation mechanism, the platform enabled users to leverage the power of Heiken Ashi and Stochastic indicators for enhanced market analysis. By utilizing the collected

candlestick data and applying relevant calculations, the platform facilitated a comprehensive understanding of market trends and momentum, providing a robust foundation with valuable insights for informed decision-making.

Decision Strategies

To facilitate effective decision-making, the platform implemented predefined rules that guided the development of long/short decision strategies. These rules were thoughtfully designed to identify optimal market conditions for entering long or short positions. By leveraging the signals generated by the Heiken Ashi and Stochastic indicators, such as overbought/oversold conditions and trend reversals, the platform ensured deterministic trading decisions.

The implementation process involved iterating through the indicator rows within the designated file. Through meticulous analysis and evaluation, the Python scripts utilized the calculated indicator values to identify instances where specific rules were satisfied. Based on these rule-based criteria, the platform generated decision signals that were then written to a new file, preserving the accessibility of the decision outputs within the same directory.

By effectively leveraging the calculated indicators and employing well-defined rules, the platform enabled users to make informed trading decisions. The incorporation of Heiken Ashi and Stochastic indicators, along with the systematic application of predefined rules, provided a reliable framework for identifying favorable market conditions.

Performance Analysis

The platform facilitated the analysis of the win rate and performance of the implemented strategies. Historical cryptocurrency price data was used to evaluate the effectiveness of the strategies. The win rate, representing the percentage of profitable trades, was calculated to assess strategy performance. Additionally, metrics such as average profit/loss per trade were analyzed to gain a comprehensive understanding of strategy performance.

Results

Four target trading strategies were identified and tested; two using just the stochastic indicators, and two using just the Heiken Ashi candles. All were run against seven timeframes.

Analyzers

st_analyzer

This analyzer uses the “Fast Stochastic Oscillator”, as defined in Investopedia. If the FSO goes above 80, then the asset (BTCUSD) is considered “overbought” and the algorithm outputs a “short” decision. If the FSO goes below 20, then the asset is considered “oversold” and a “long” decision is made.

st_analyzer2

This analyzer uses the “Slow Stochastic Oscillator”, as defined in Investopedia. If the SSO goes above 80, then the asset (BTCUSD) is considered “overbought” and the algorithm outputs a “short” decision. If the SSO goes below 20, then the asset is considered “oversold” and a “long” decision is made.

ha_analyzer

This analyzer uses Heiken Ashi candles, as defined in Investopedia. If for any three most recent candles, there are three bullish candles or one “doji candle”, as defined in TC2000, and two bullish candles, then an uptrend is predicted and a “long” position is made. If there are three bearish candles or one doji candle and two bearish candles, a downtrend is predicted and a “short” position is made.

ha_analyzer2

This analyzer uses Heiken Ashi candles, as defined in Investopedia. A value of 2 is assigned to each bullish candle and -2 to each bearish candle. Each “doji candle”, as defined in TC2000, is assigned a value of 1 or -1 depending on whether the closing price was higher than the open price or vice versa. If the sum of the three most recently assigned candle values is greater than 2, then an uptrend is predicted and a “long” position is made. If the sum is less than -2, a downtrend is predicted and a “short” position is made.

Timeframes

Each timeframe only has information for a specific duration. The purpose of this segment is to define these intervals for clarity.

1m

Each candle is one minute long, and all candles reside in a 24-hour window (From 3/17/2023 01:13 GMT-0400 to 3/18/2023 01:12 GMT-0400)

5m

Each candle is five minutes long, and all candles reside in a 6-day & 23-hour & 55-minute window (From 3/11/2023 00:10 GMT-0500 to 3/18/2023 01:05 GMT-0400)

15m

Each candle is fifteen minutes long, and all candles reside in a 13-day & 23-hour & 45-minute window (From 3/04/2023 00:00 GMT-0500 to 3/18/2023 00:45 GMT-0400)

30m

Each candle is thirty minutes long, and all candles reside in a 29-day & 23-hour & 30-minute window (From 2/16/2023 00:00 GMT-0500 to 3/18/2023 00:30 GMT-0400)

1hr

Each candle is one hour long, and all candles reside in a 58-day & 23-hour window (From 12/18/2023 00:00 GMT-0500 to 3/18/2023 00:00 GMT-0400)

6hr

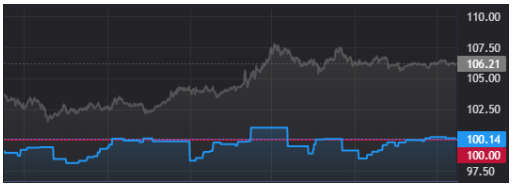
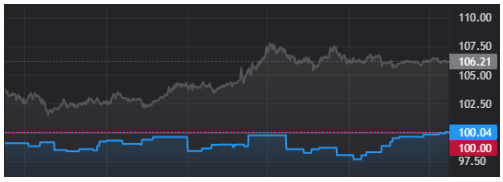
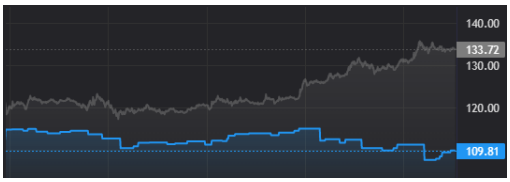
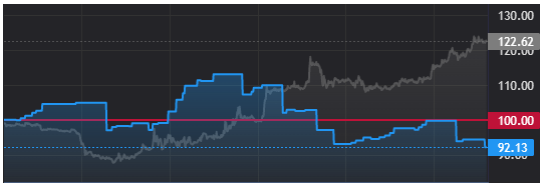
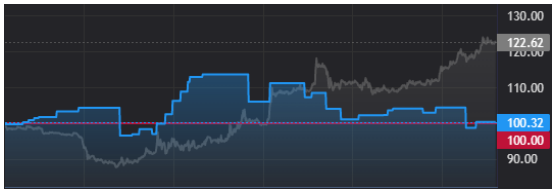
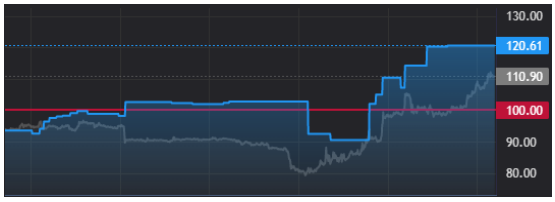
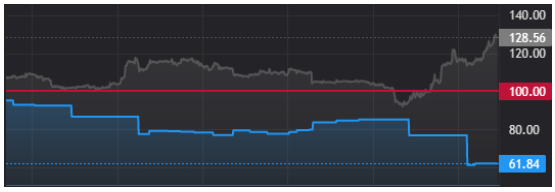
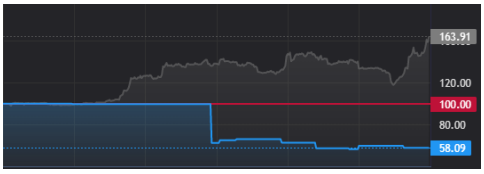
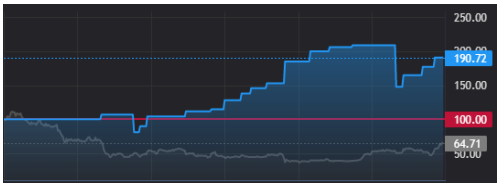
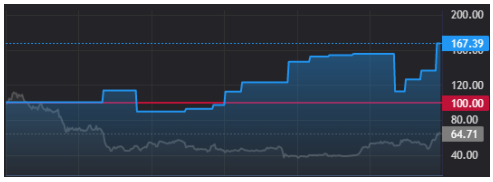
Each candle is six hours long, and all candles reside in a 89-day & 18-hour window (From 12/17/2022 19:00 GMT-0500 to 3/17/2023 14:00 GMT-0400)

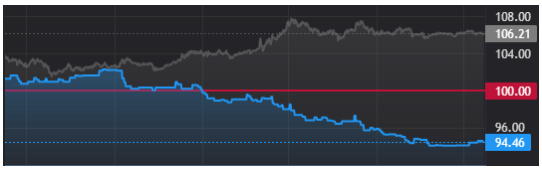
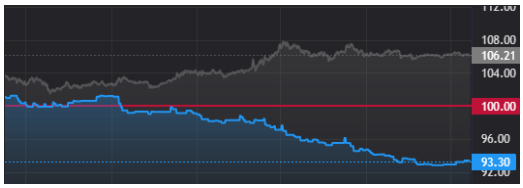
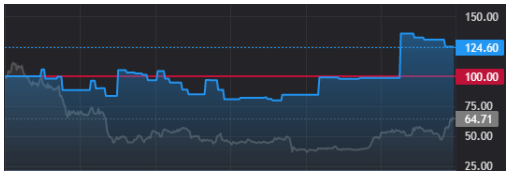
1day

Each candle is one day long, and all candles reside in a 363-day & 11-hour window (From 3/21/2022 09:00 GMT-0400 to 3/19/2023 20:00 GMT-0400)

Performance Charts

The graphs plotting each individual strategy performance for each individual timeframe can be found in the next two pages.

	BTCUSD st_analyzer	BTCUSD st_analyzer2
1m		
5m		
15m		
30m		
1hr		
6hr		
1day		

	BTCUSD ha_analyzer	BTCUSD ha_analyzer2
1m		
5m		
15m		
30m		
1hr		
6hr		
1day		

Takeaways

During the analysis of the implemented strategies, it became evident that each strategy category possessed its own strengths and weaknesses. Individual strategies within each category demonstrated similar performance outcomes. Overall, the outlined strategies showcased a positive trend, with the blue lines consistently positioned above the red line, indicating profitability. However, notable instances, such as the stochastic analyzers for the 1 and 5-minute timeframes, revealed that a simple "buy at the beginning and hold until the end" strategy outperformed our target strategies. It is crucial to validate and substantiate this behavior through additional data.

In the broader context, both strategy categories exhibited promising potential in the 1-day timeframe. Despite BTCUSD experiencing a significant 40% drop within the one-year window, the Heiken-Ashi-based strategies generated a gain of over 25%, while the Stochastic-based strategies achieved a gain of over 60%. Although long-term gains were not the primary focus of this project, as it primarily focused on high-frequency trading, this avenue warrants further exploration, especially if the outperforming behavior can be replicated with other cryptocurrencies beyond BTCUSD.

Several patterns emerged during the analysis of these strategies. With stochastic-based decisions, shorter durations between entry and exit points tended to yield profits. While the aggregate value generally increased in such scenarios, holding the asset for an extended period increased the likelihood of incurring substantial losses. While the stochastic strategies faced challenges in performing well within the 6-hour timeframe, the Heiken-Ashi strategies flourished.

However, both strategy categories exhibited suboptimal performance under the 1-hour timeframe.

These findings provide valuable insights for further development of this project. One potential course of action is the incorporation of a stop-loss mechanism, a common practice in day trading. Implementing a stop-loss feature would establish a maximum acceptable loss per trade, hypothetically improving overall performance by minimizing potential losses. Additionally, future development efforts can explore the integration of additional indicators and the combination of their strengths to create more effective trading strategies, both in the short and long term.

By leveraging these insights and pursuing further enhancements, the platform has the potential to evolve into a more robust and sophisticated trading tool. Continued exploration of new strategies, risk management techniques, and the integration of additional indicators will contribute to the continuous improvement of the platform's performance and overall value proposition.

Conclusion

In conclusion, the developed platform successfully pulled cryptocurrency price information from Gemini's API, recreated Heiken Ashi and Stochastic indicators, implemented long/short decision strategies based on predefined rules, and analyzed the win rate and performance of these strategies.

While the platform's performance was promising, it should be noted that the strategies implemented were rudimentary and based on predefined rules. To enhance the platform's

capabilities, more sophisticated trading algorithms, risk management techniques, and additional indicators could be incorporated. Furthermore, incorporating real-time data and exploring machine learning algorithms could improve the accuracy and timeliness of decision-making.

Overall, this platform is a starting point for traders and researchers interested in cryptocurrency price analysis and strategy development. It provides a solid foundation for future enhancements and customization based on specific requirements and market conditions.