ZIG ZAG PATTERN

Top and Bottom Head and Should Pattern

Exposee

This thesis investigates the identification and application of Zigzag patterns, specifically Head and Shoulders (HS) patterns, in trading strategies. The study uses real-world data from Tesla, Apple, Nestlé, and Roche stocks to test a Python-based algorithm designed to detect HS top and bottom patterns. The algorithm is evaluated for accuracy and its integration into trading strategies is ex-plored. The findings demonstrate the potential of automated pattern recognition for improving trading decisions, while also highlighting challenges in achieving consistent accuracy due to factors such as market noise and the subjective nature of pattern interpretation. The thesis concludes with a compar-ison of Python and MATLAB coding approaches for this type of analysis, favoring Python for its modularity and ease of use.

Renée Villiger & Seraina Fischer

renee.villiger@ost.ch & seraina.fischer@stud.hslu.ch

Table of Contents

1 Introduction & Project Presentation 1

2 Theoretical Background 1

2.1 HS tops 1

2.2 HS Bottom 3

3 Project planning/project process including rough division of work 4

4 Data description incl. Data source 5

5 Code Description 8

6 Trading strategies 9

7 Code Evaluation 12

8 Reflexion 17

1 Introduction & Project Presentation

This thesis explores the concept of "Zigzag Patterns," which are characterized by distinct price movements that alternate direction, forming a series of local peaks and troughs. Zigzag patterns form the basis of numerous chart formations and are crucial for understanding their predictive value. Consequently, they are regarded as one of the most significant patterns in technical analysis. Among the various zigzag patterns, six are particularly well known: head and shoulders (HS), double tops and bottoms, triple tops and bottoms, flags, pennants, and wedges. This thesis will focus specifically on the head and shoulders pattern, which indicates a trend reversal and is defined by three peaks, the central peak being the highest (or as in for HS bottom the lowest). First, we will give some theoretical inputs for the topic and will detail the criteria and conditions for identifying this pattern. In a second step we will demonstrate how the ZigZag patterns (HS top pattern) can be integrated into trading strategies. Additionally, we will provide an illustrative example using real-world data from five different stocks. The stocks used are Tesla, Apple, Nestle and Roche.

In the provided Python notebook, the code is organized as follows: Initially, all necessary libraries and modules are imported. Subsequently, the historical stock data is loaded into the environment. After the data is successfully imported, it is plotted for visualization. Following this, a Head and Shoulders pattern detection algorithm is implemented. The detector is first tested using simplified example data that includes peaks, troughs, and a combined pattern. Finally, the existing code is modified to apply the detector to the previously imported real stock data.

The outcomes of our analysis will be evaluated and enhanced through multiple iterations of the coding process.

2 Theoretical Background

The Head and Shoulders (HS) pattern is one of the most widely recognized and esteemed patterns in technical analysis. Its name is derived from its similarity to the human head and shoulders, comprising three distinct peaks. This pattern is primarily used to detect potential trend reversals, indicating a change in market sentiment from bullish to bearish.

The HS pattern can manifest in two forms: the standard (HS top) and the inverse (HS bottom).

2.1 HS tops

In its standard form (see Figure 1), the pattern features three peaks separated by two intervening troughs, positioned between the head and each shoulder. The second peak, known as the head, is higher than the first and third peaks, which represent the shoulders. The neckline connects the lowest points of each trough and can slope either upward or downward. When the price breaks below the neckline, the pattern

is confirmed, signalling a price decline roughly equal to the height of the head, defined as the vertical distance from the head to the neckline. This measurement also serves as an estimate for the price target. HS top patterns signal short positions regardless of the trend pre-existence. Both HS top and HS bottom patterns are recognized as trend reversal indicators. This suggests that a shift to an upward trend (or downward trend for the HS bottom) is anticipated prior to the formation of HS tops (or bottoms).

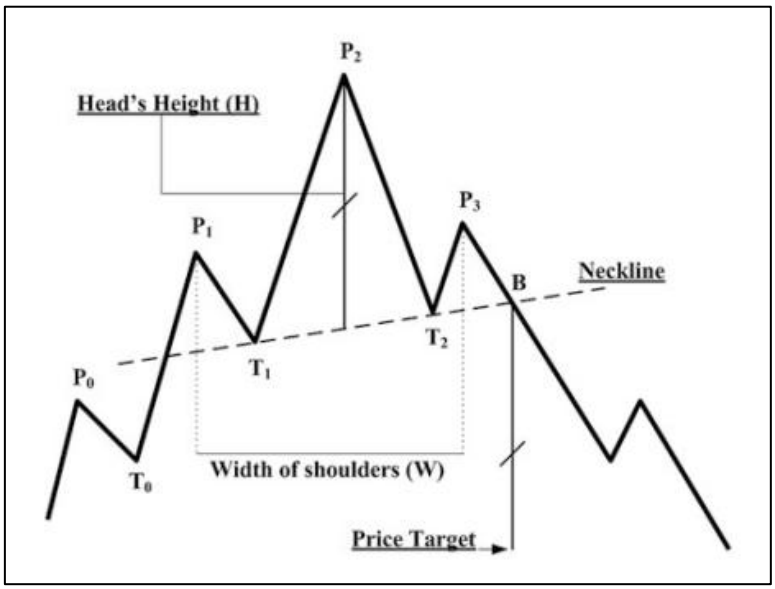

Figure 1 HS tops pattern

To accurately identify HS tops patterns, the following conditions must be met.

Condition 1: The head must be higher than the shoulders

$$P_2 > \max(P_1, P_3)$$

Condition 2: Trend pre-existence: If Condition 1 is fulfilled the HS top pattern is characterized as a trend reversal pattern. However when the inequalities in figure 2 hold, the pattern is considered a continuation pattern. In contrary fulfilment of figure 3 implies a continuation pattern.

$$P_1 > P_0 \,\&\, T_1 > T_0$$
$$P_1 < P_0 \,\&\, T_1 < T_0$$

Condition 3: Balance: The left (right) shoulder must be at leas as high as the midpoint between right (left) shoulder and its preceding (following= through).

$$P_1 \geq 0.5(P_3 + T_2) \,\&\, P_3 \geq 0.5(P_1 + T_1)$$

Condition 4: Symmetry: the time between left should and head must not be more than 2.5 times the time between the head and right shoulder and vice versa.

$$t_{P_2} - t_{P_1} < 2.5(t_{P_3} - t_{P_2}) \,\&\, t_{P_3} - t_{P_2} < 2.5(t_{P_2} - t_{P_1})$$

Condition 5: Penetration: The pattern is confirmed when price breaches downwards the neckline for the first time. The time required for this confirmation must be no longer than the time interval between the two shoulders.

$$B < \frac{T_2 - T_1}{t_{T_2} - t_{T_1}}(t_B - t_{T_1}) + T_1$$
$$t_B < t_{P_3} + (t_{P_3} - t_{P_1})$$

2.2 HS Bottom

HS bottom (see Figure 2) is a mirror of HS top and so is its trading recommendations as its confirmation signals a long position. When the pattern occurs in its inverse form (HS bottom) it features three bottoms whereas the middle one is the lower than the first and thirst one. As in HS top the pattern also features two intervening through which are positioned between the head and each shoulder. The highest point of each trough is connected by the neckline which can either slope upward or downward.

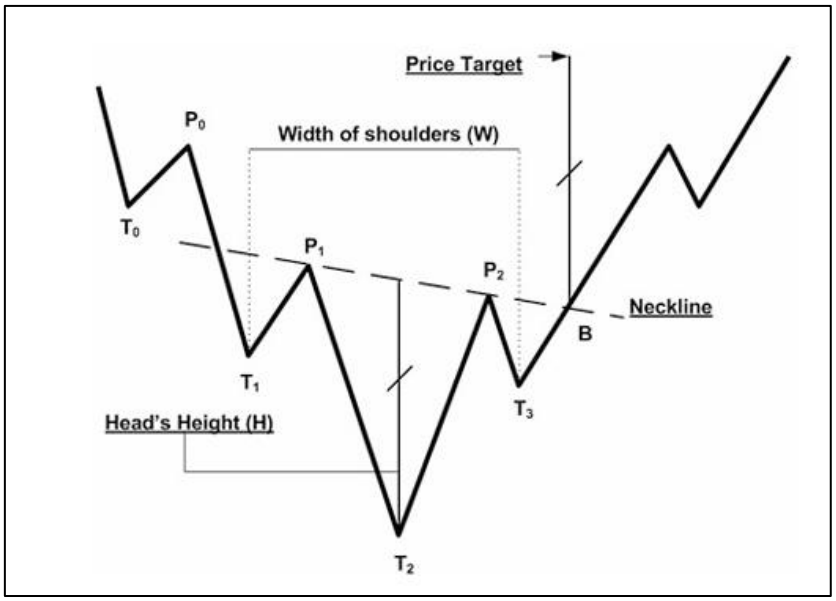

Figure 2 HS bottom pattern

To accurately identify HS top patterns, the following five conditions must be met.

Condition 1. The head must be lower than the shoulders.

$$T_2 > \min(T_1, T_3)$$

Condition 2. Trend preexistence: In this scenario, both (5.2) and (5.3) are applicable. The key difference is that if (5.2) is satisfied, the HS bottoms are identified as a trend continuation pattern. Conversely, if (5.3) applies, the pattern is classified as a trend reversal.

$$P_1 > P_0 \,\&\, T_1 > T_0$$
$$P_1 < P_0 \,\&\, T_1 < T_0$$

Condition 3. Balance:

$$T_1 \leq 0.5(T_3 + P_2) \,\&\, T_3 \leq 0.5(T_1 + P_1)$$

Condition 4. Symmetry:

$$t_{T_2} - t_{T_1} < 2.5(t_{T_3} - t_{T_2}) \,\&\, t_{T_3} - t_{T_2} < 2.5(t_{T_2} - t_{T_1})$$

Condition 5. Penetration:

$$B > \frac{P_2 - P_1}{t_{P_2} - t_{P_1}}(t_B - t_{P_1}) + P_1$$
$$t_B < t_{T_3} + (t_{T_3} - t_{T_1})$$

3 Project planning/project process including rough division of work

Initially, we ensured our theoretical understanding by reviewing the relevant literature. In the next step, we narrowed down the topic so that it could be addressed within the scope of the project. We decided to focus the work on the Head and Shoulders pattern. During the project planning phase, we agreed to divide the tasks such that one person would handle the coding while another would focus on gathering the theoretical background. The division of tasks was based on individual interests and skill sets. Throughout the project phase, regular communication took place to address any uncertainties and assess the project's progress. The project planning and task allocation are outlined in the following illustration.

DIFA Arbeit ZigZag Pattern

zeitlicher Arbeitsplan

Renée Villiger (RV) & Seraina Fischer (SF)

Quartal		Q3/2024		Q4/ 2024														
Kalenderwoche		**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**
Organisation																		
Themenfindung & -eingabe	RV & SF																	
Definition Arbeitsplan	RV & SF																	
Termine/ Besprechungen	RV & SF																	
Abgabe	RV & SF																	
Theorieteil																		
Einleitung & Projektvorstellung	SF																	
Theoretischer Hintergrund	SF																	
Datenbeschreibung	RV																	
Abstract	SF																	
Coding																		
Daten sammeln	RV																	
Datenaufbereitung	RV																	
Coding	RV																	
Abschlussphase																		
Code Evaluation	SF																	
Ableitung Investing Strategies	SF																	
Reflexion	RV																	
Korrekturlesen	RV & SF																	
Layout prüfen & anpassen	RV & SF																	

Figure 3 Project Planning

4 Data description incl. Data source

For real data examples, we utilized historical data from four stocks: Tesla, Apple, Nestlé, and Roche. The data is sourced from Nasdaq and covers historical trends from this year.

Tesla:

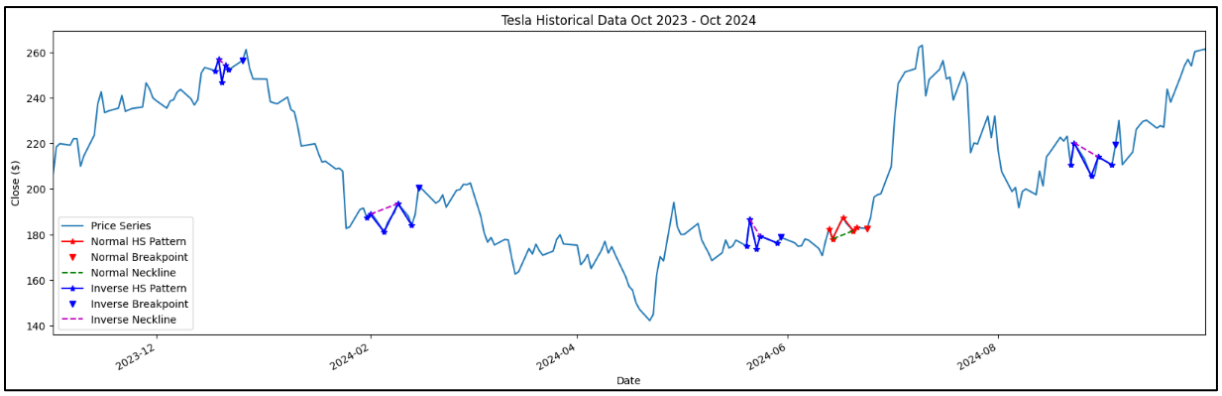

Figure 4 Tesla Stock (Own depiction)

In the beginning of the year Tesla's stock experienced a strong plunge which can be credited to demand and production concerns due to dipped electric vehicle demand as well as rising competition. However, after its low Mid-Year the stock began rising again.

One of the primary catalysts for Tesla's stock surge in September is the anticipation of better-than-expected third-quarter vehicle deliveries. Another significant factor contributing to Tesla's stock surge was the anticipation of the Robotaxi event on October 10, 2024.

Data Source Tesla:
https://www.nasdaq.com/market-activity/stocks/tsla/historical?page=1&rows_per_page=10&time-line=y1

Apple:

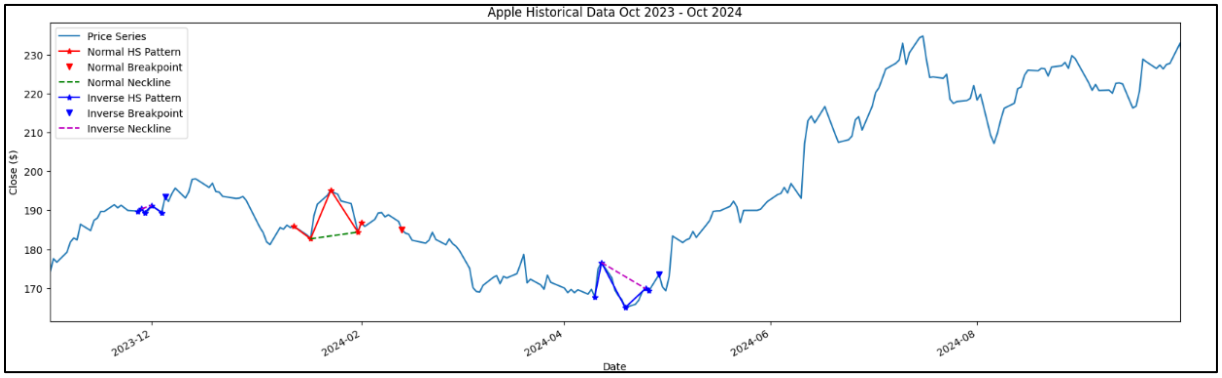

Figure 5 Apple Stock (Source: Own depiction)

Apple exhibits a strong upward trend around mid-2024. This growth was likely fuelled by the annual iPhone release in September. Investors watch these events closely, as the iPhone remains Apple's flag-ship product and a major revenue driver and generates significant investor optimism and drives revenue growth (*Apple Stock Prediction 2024-2030 | Skilling*, n.d.). Additionally, Apple's stock performance is increasingly linked to its expanding services segment and other product lines, beyond just iPhone sales (*Should You Buy Apple Stock Before or After a New iPhone Is Released?*, n.d.).

Data Source Apple:
https://www.nasdaq.com/market-activity/stocks/aapl/historical?page=1&rows_per_page=10&time-line=y1

Nestle

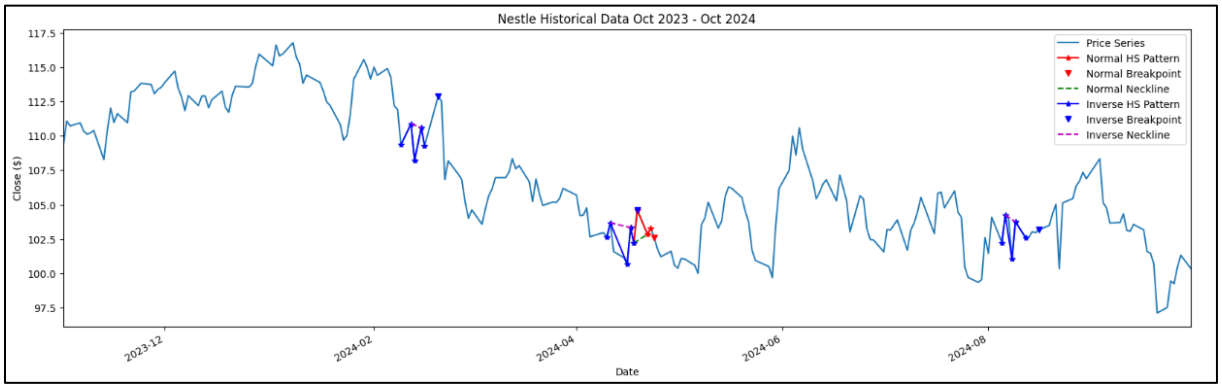

Figure 6 Nestle Stock (Own depiction)

Nestle's shares have been in a downward spiral since the beginning of the year when they were still valued at around CHF100 in January. According to swissinfo.ch (2024), the market is starting to recognise that many of the French-Swiss group's problems are self-inflicted. Competitors like Danone are likely to report significantly better results. At the end of August, Nestlé made the unexpected decision to replace its CEO.

Data Source Nestle:
https://www.nasdaq.com/market-activity/stocks/nsrgf/historical?page=1&rows_per_page=10&timeline=y1

Roche

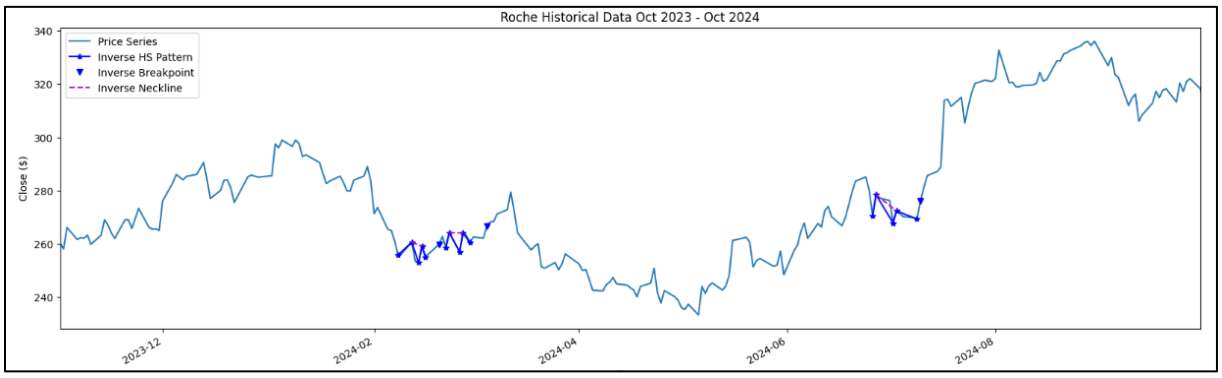

Figure 7 Roche Stock (Own depiction)

In early 2024 Roche's share fell more than 4% as the market expressed disappointed with the company's more modest than expected 2024 outlook (Fick, 2024).

Data Source Roche:
https://www.nasdaq.com/market-activity/stocks/rhhvf/historical?page=1&rows_per_page=10&timeline=y1

5 Code Description

The `rw` function identifies peaks and bottoms in a stock price series using a rolling window approach. It analyzes the price data by comparing each point to the values within a defined window both before and after it. A peak is marked when a price is higher than the values within the surrounding window, while a bottom is identified when the price is lower than the surrounding values. These peaks and bottoms are stored, and their indices are extracted for further analysis. Additionally, if plotting is enabled, the function generates a detailed plot of the price series, marking the identified peaks and bottoms. The plot is customized to show the date range from November 2023 to September 2024, with labeled axes and formatted date ticks for readability. Finally, the function returns arrays containing the prices and indices of the detected peaks and bottoms, making it useful for analyzing key turning points in stock price trends.

The `line_inter` function calculates the intersection point of two lines, each defined by two points, represented as 2x2 NumPy arrays. The function first converts the input arrays `A` and `B` into NumPy arrays, ensuring that both are 2x2 matrices. It then computes the slopes and intercepts of the two lines. For each line, the slope is determined by the difference in the y-coordinates divided by the difference in the x-coordinates, while the intercept is found by solving for the point where the line crosses the y-axis. The intersection point of the two lines is calculated by solving for the x-coordinate (`tstar`), where the two lines have the same y-value, and then using that x-value to compute the corresponding y-coordinate (`ystar`). The function returns this intersection point as a tuple `(tstar, ystar)`, representing the x and y coordinates of the intersection.

The `hs_pattern` function is designed to identify and plot potential Head and Shoulders (HS) patterns, both in their normal and inverse forms, from a stock price series. Using a rolling window approach, it first detects peaks and bottoms by calling the `rw` function. These peaks and bottoms are combined and sorted to look for sequences that match the typical structure of an HS pattern: in a normal pattern, the sequence is Peak-Bottom-Peak-Bottom-Peak, while in an inverse pattern, it is Bottom-Peak-Bottom-Peak-Bottom.

The function scans the combined series and identifies potential patterns by comparing them to predefined sequences for normal and inverse HS patterns. Once a pattern is detected, further validation is performed to ensure it meets specific conditions for heights and time symmetry. These valid patterns are then stored and analyzed for key properties such as neckline slope and intercept, pattern width, and height, as well as potential target prices based on the patterns.

A key part of this process involves the line_inter function, which is used to calculate the intersection point between the neckline of an HS pattern and the price trajectory after the pattern is formed. Once a valid HS pattern is detected, the neckline is defined by two points—typically the two shoulders (the left and right). The slope (`Beta`) and intercept (`Alpha`) of the neckline are computed based on these points, and the neckline is extended forward to determine if and where the price crosses it. The `line_inter` function is called to find this breakpoint, using two sets of points:
1. `A`: Two points on the neckline (left and right shoulders).
2. `B`: Two points on the price trajectory after the pattern, allowing for the detection of the intersection with the neckline.

The intersection's y-coordinate (`ystar`) is used to estimate the potential target price, which represents how far the price is expected to fall (in the case of a normal HS pattern) or rise (for an inverse HS pattern) after the pattern breaks.

If the `pflag` is set to 1, the function generates a plot of the price series along with the detected patterns. Normal HS patterns are marked with red asterisks and necklines with green dashed lines, while inverse HS patterns are marked with blue asterisks and purple dashed lines. Finally, the function returns a dictionary containing the details of the identified normal and inverse HS patterns, including their points, necklines, breakpoints, widths, heights, and target prices.

6 Trading strategies

A normal head and shoulders pattern is considered a bearish reversal, indicating a potential shift from an uptrend to a downtrend. The ideal selling point in this pattern is when the price breaks below the neckline, which is a line that connects the two troughs formed by the lows of the left and right shoulders. Confirmation of this pattern occurs when the price closes below the neckline, signaling the possible start of a downward trend. To manage risk, it's advisable to set a stop-loss order just above the right shoulder in case the price moves against the anticipated direction. As for the profit target, a typical approach is to estimate the price drop based on the distance between the head, which is the highest peak, and the neckline. Once the neckline is broken, the stock price might decline by approximately the same distance.

An inverse head and shoulders pattern serves as a bullish reversal indicator, suggesting a potential shift from a downtrend to an uptrend. The ideal buying point occurs when the price breaks above the neckline of this inverse pattern, where the neckline connects the two highs formed by the left and right shoulders. Confirmation of the pattern is achieved when the price closes above the neckline, indicating the onset of a possible upward trend. To manage risk, it's prudent to place a stop-loss order just below the right shoulder in case the trade moves unfavourably. The profit target is determined similarly to the normal

head and shoulders pattern, by measuring the distance from the head, which is the lowest low, to the neckline and projecting that distance upward from the breakout point.

To assess how these strategies can be implemented in our real data examples, we will take a systematic approach. First, we will analyse the historical price data to identify instances of both normal head and shoulders patterns and inverse head and shoulders patterns. For each identified pattern, its validity can be cross verified by checking if the subsequent price movements align with expected outcomes based on the strategies. Specifically, in a normal head and shoulders pattern, we will confirm if the price decline after breaking the neckline corresponds to the distance from the head to the neckline (Condition: Penetration). Similarly, for an inverse head and shoulders pattern, we will check whether the price rises after breaking above the neckline match the expected projected distance.

Apple

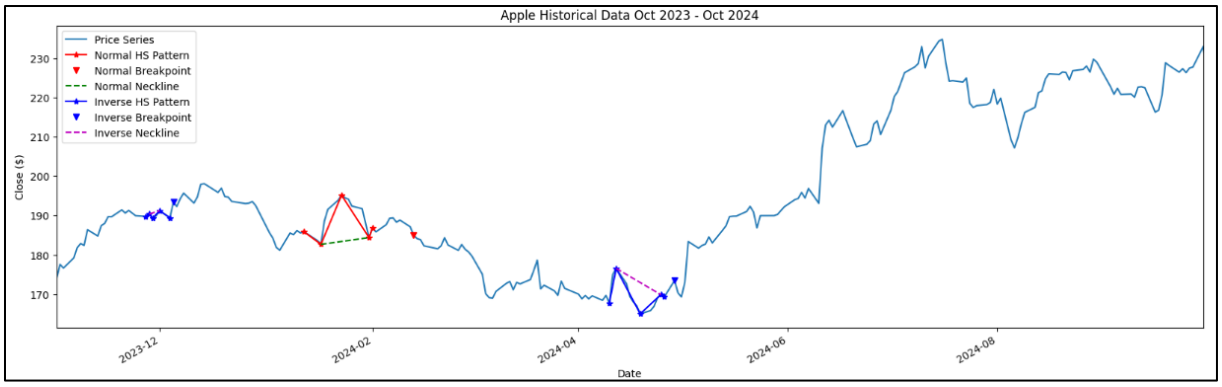

Figure 8 Apple historical data (Own depiction)

Around February 2024, a normal head and shoulders pattern was identified in the chart, presenting a selling opportunity when the price broke below the green dashed neckline as this signals a bearish reversal.

In April 2024, an inverse head and shoulders pattern was detected in the chart, providing a buying opportunity when the price broke above the purple dashed neckline signalling a bullish reversal.

Tesla

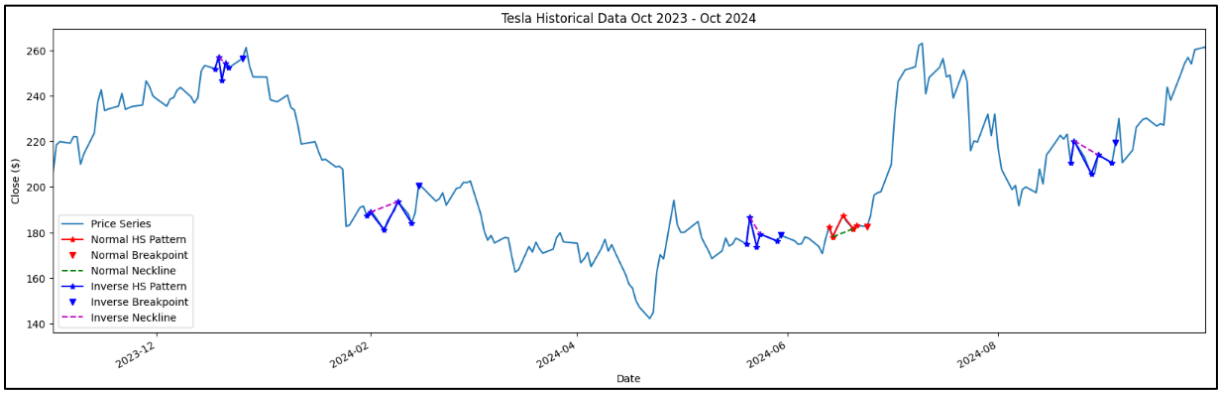

Figure 9 Tesla historical data (Own depiction)

Around February 2024 a inverse HS pattern was detected suggesting a bullish reversal which indicates that the price might start to rise. This usually follows a downtrend and signals a potential buying opportunity when the price breaks above the neckline (inverse breakpoint). Further inverse HS pattern can be identified in June and around September signalling the same strategy.
A normal HS pattern was identified in July 2024 signalling that the ideal selling point would be when the price breaks below the green marked neckline, indicating a potential bearish reversal.

Nestle

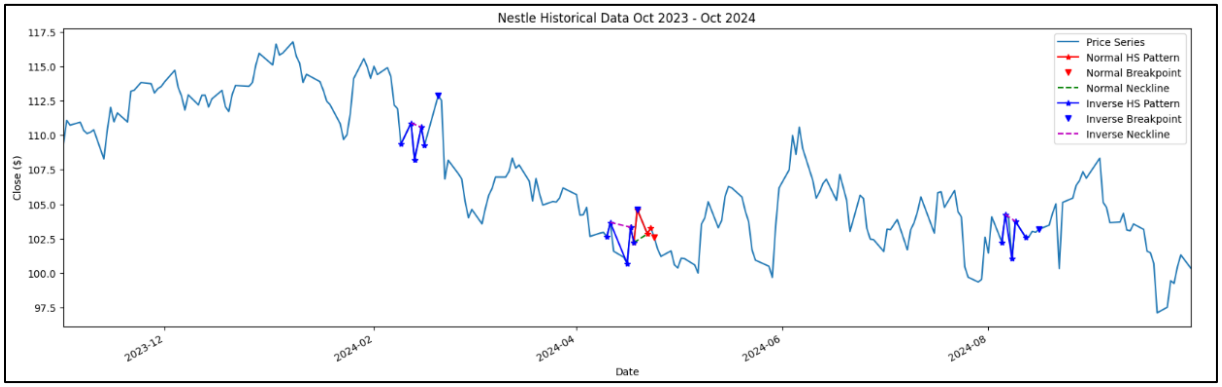

Figure 10 Nestle historical data (Own depiction)

In the chart above, the inverse head and shoulders pattern is observed around early 2024. The blue markers indicate where the price breaks above the neckline, suggesting a potential bullish reversal.
Another inverse head and shoulders pattern is observed around the middle of 2024 directly followed by a normal head and shoulders pattern where the red markers indicate the break below the neckline, suggesting a potential bearish reversal.

Roche

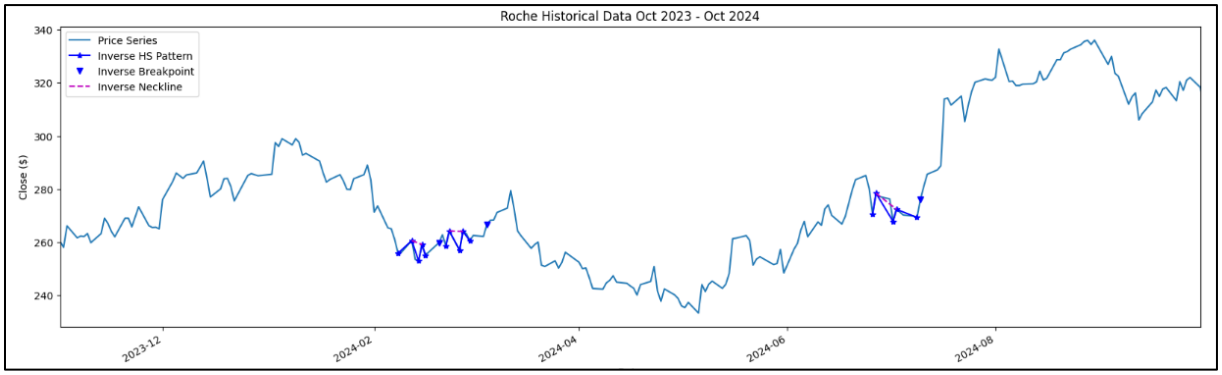

Figure 11 Roche historical data (Own depiction)

In chart, the inverse head and shoulders pattern is observed February 2024 where three throughs can be identified: the middle one being the lowest. The buying opportunity arises when the price breaks above the purple dashed line, confirmed by the blue markers in the chart. It suggest the start of an upward trend.

7 Code Evaluation

In this chapter we will evaluate if the code has correctly identified HS top and bottom patterns in our real world data. For each plot we are going to check if the defined criteria for either the inverse or normal HS pattern are met.

Apple

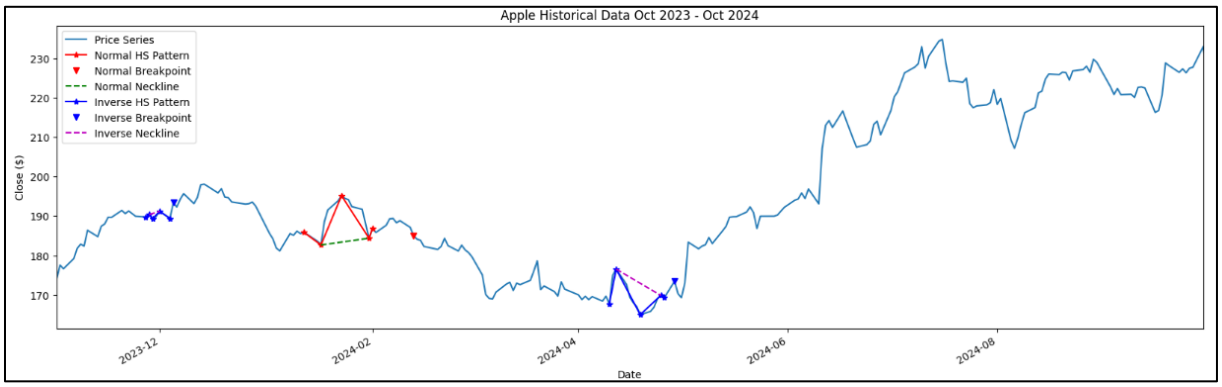

Figure 12 Apple historical data (Own depiction)

Code Evaluation

Inverse HS pattern (2023-12):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	no
Trend preexistence	yes
Balance	yes
Symmetry	no
Penetration	yes

Normal HS pattern (2024-02)

Condition for HS tops	**Criteria met?**
The head must be higher than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

Inverse HS pattern (2023-12):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	no
Penetration	no

Tesla

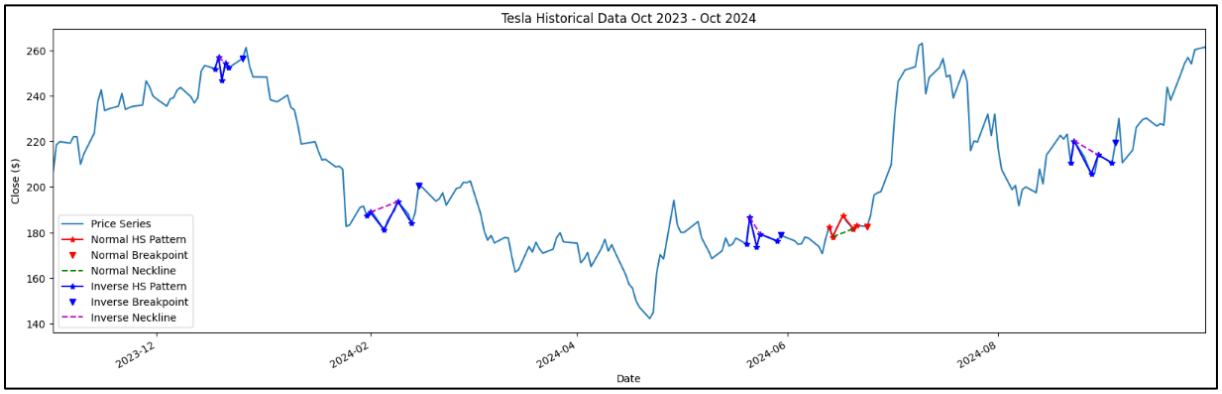

Figure 13 Tesla historical data (Own depiction)

Code Evaluation

Inverse HS pattern (2023-12):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes

Trend preexistence	yes
Balance	no
Symmetry	no
Penetration	no

Inverse HS pattern (2024-02):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	no
Symmetry	no
Penetration	yes

Inverse HS pattern (2024-06):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	no
Symmetry	no
Penetration	no

Normal HS pattern (2024-06)

Condition for HS tops	**Criteria met?**
The head must be higher than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	no
Penetration	yes

Inverse HS pattern (2024-08):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

Nestle

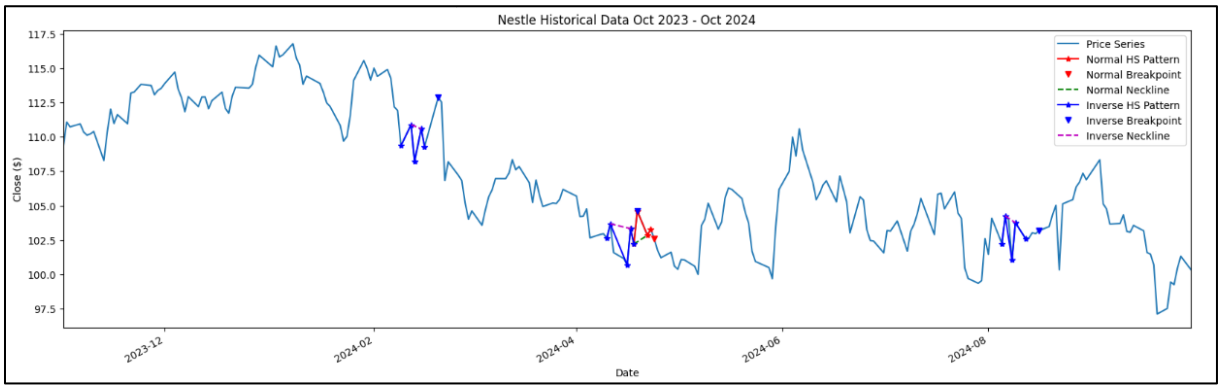

Figure 14 Nestle historical data (Own depiction)

Code Evaluation

Inverse HS pattern (2024-02):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

Inverse HS pattern (2024-04):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

HS top pattern 2024-04

Condition for HS tops	**Criteria met?**
The head must be higher than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

Inverse HS pattern (2024-08):

Conditions for HS bottom	**Criteria met?**
The head must be lower than the shoulders	yes

Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

We assessed whether the patterns identified in the charts fulfill all the conditions for HS tops and HS bottoms as defined by Prodromos and Achilleas. The evaluation indicated that the code successfully recognized all patterns in the data for Nestlé's stock.

Roche

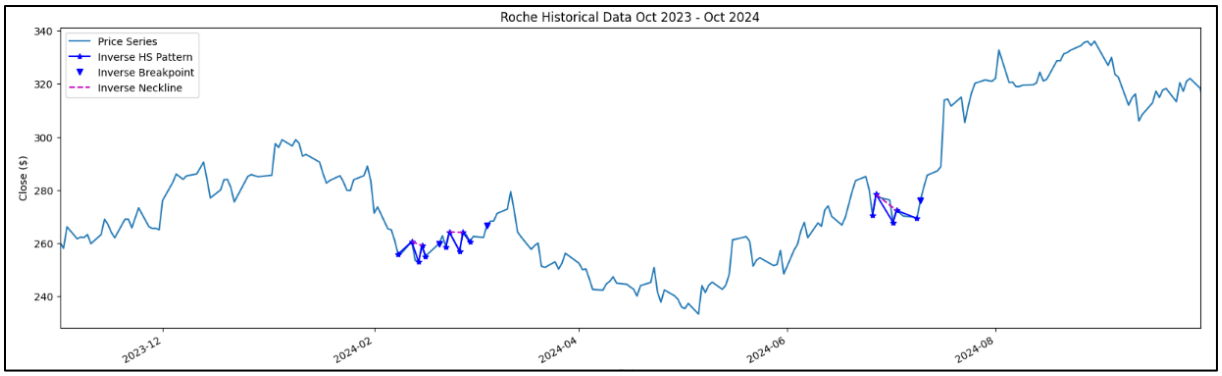

Figure 15 Roche historical data (Own depiction)

Code Evaluation

Inverse HS pattern (2024-02):

Conditions for HS bottom/ inverse	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	yes
Penetration	yes

Inverse HS pattern (2024-02):

Conditions for HS bottom/ inverse	**Criteria met?**
The head must be lower than the shoulders	yes
Trend preexistence	yes
Balance	yes
Symmetry	no
Penetration	no

It seems like the code was able to correctly detect almost all of the pattern. However, there were some challenges such the condition of symmetry which was not often achieved in the charts with real world data. However, most of the other conditions were met in almost all of the patterns.

8 Reflexion

Added Value

The differences between the MATLAB and Python code are evident in how each handles structure, logic, and data processing. The Python code is much more modular, separating key tasks like peak detection (`rw()`), line intersection (`line_inter()`), and pattern recognition (`hs_pattern()`) into distinct, reusable functions. In MATLAB, these tasks are often intertwined within larger functions, making the code harder to maintain and debug. Data handling in Python, particularly through NumPy, is more concise and intuitive. Operations like combining and sorting peaks and bottoms are handled efficiently, while MATLAB relies on more manual matrix manipulation, which is both verbose and prone to errors.

Pattern detection logic in Python is clearer and more declarative, using array-based comparisons like `np.array_equal()` to identify head and shoulders patterns. MATLAB's logic is more spread out, with nested loops and conditions that make tracking the detection process harder. Additionally, Python's use of dictionaries to store patterns provides a flexible way to manage and access data, compared to MATLAB's reliance on structured arrays with more complex indexing.

When it comes to plotting, Python's Matplotlib offers more flexibility and cleaner code, separating visualization from the main logic. In contrast, MATLAB embeds plotting within functions, making customization more cumbersome. Python also excels in geometric calculations, isolating tasks like line intersection into standalone functions, whereas MATLAB integrates them directly into the main code flow. Overall, Python's modular design and streamlined data handling make it easier to read, maintain, and extend than MATLAB's more manual approach.

Future Extensions

The Python code can be extended in several ways to enhance its functionality and usability. One potential extension is integrating real-time stock data by using APIs like `yfinance` or `Alpha Vantage`, allowing for dynamic pattern detection on live market data. Another enhancement could involve adding machine learning models to predict the likelihood of a detected pattern leading to a significant price movement, using libraries like `scikit-learn` or `TensorFlow`. Additionally, the code could be modified to detect other technical patterns, such as double tops, triangles, or flags, broadening its application in technical analysis. More advanced plotting options could be integrated using interactive libraries like `Plotly` to provide users with zoomable, interactive visualizations. Finally, incorporating a backtesting module would allow traders to evaluate the effectiveness of the detected patterns on historical data, providing valuable insights into trading strategies.

Challenges and Difficulties

One of the main challenges we faced was understanding the head and shoulders pattern itself, as neither of us had much prior knowledge of technical analysis in the stock market. This made it difficult to grasp how the pattern should be detected and incorporated into the code. Writing the code in a way that wasn't too bulky, while still being easily understandable and able to perform all the necessary functions, was also quite challenging. We had to ensure the code was modular and efficient, which required careful planning. Analyzing the output was tricky as well, as it wasn't always immediately clear if the detected patterns were correct or aligned with real-world data Balancing functionality with clarity and ensuring that the code performed as expected required significant effort and iteration.

Conclusion

In conclusion, this project was both interesting and challenging, providing a valuable learning experience for both participants. Each of us brought different strengths to the table, allowing us to collaborate effectively and overcome the hurdles we encountered. It was an eye-opening journey into the world of technical analysis, expanding our understanding of stock market patterns and the complexities involved in coding such analyses. Despite the difficulties in writing efficient, understandable code and analyzing the outputs, the project ultimately deepened our knowledge and appreciation of technical analysis.

References

Apple stock prediction 2024-2030 | Skilling. (n.d.). Skilling.Com. Retrieved October 13, 2024, from https://skilling.com/row/en/blog/stocks-trading/apple-stock-forecast/

Fick, M. (2024, February 1). Roche shares fall on modest 2024 outlook. *Reuters*. https://www.reuters.com/business/healthcare-pharmaceuticals/roche-forecasts-return-growth-2024-it-overcomes-drop-covid-sales-2024-02-01/

Should You Buy Apple Stock Before or After a New iPhone is Released? (n.d.). Investopedia. Retrieved October 13, 2024, from https://www.investopedia.com/apple-stock-and-new-iphone-release-8722477

swissinfo.ch, S. W. I. (2024, September 21). Swiss food giant Nestlé's shares drop to lowest level since early 2019. *SWI Swissinfo.Ch*. https://www.swissinfo.ch/eng/multinational-companies/swiss-food-giant-nestlés-shares-drop-to-lowest-level-since-early-2019/87590509