

IEDA4500: Final Project

Robo Advising for Retail Investor

Kwok Ho Kai, Kyro 2024/05

Agenda



1 Introduction

- Characteristics of robo advising and retail investors
- Project objective



2 Methodology

- Implementation steps
- Data processing workflow



3 Result

- Evaluation of the performance and stability of the robo advising



4 Summary

- Limitation
- Further Improvement
- Conclusion

Background

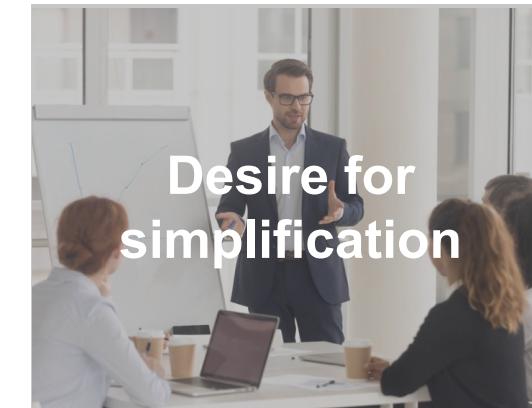
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3, Result 4, Summary

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Benefit of Robo-Advisors

	Robo-Advisors	Traditional Advisors
Expertise	✓	
Accessibility	✓	
Wealth Requirement	✓	
Efficiency	✓	

Characteristic of Retail Investors



Objective

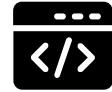
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Data-Driven Strategy Development



Daily Trading Signals



Automated Diversification Investment on ETFs (SPY)



Implementation Steps

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Evaluation

- Verify the strategy with performance metrics



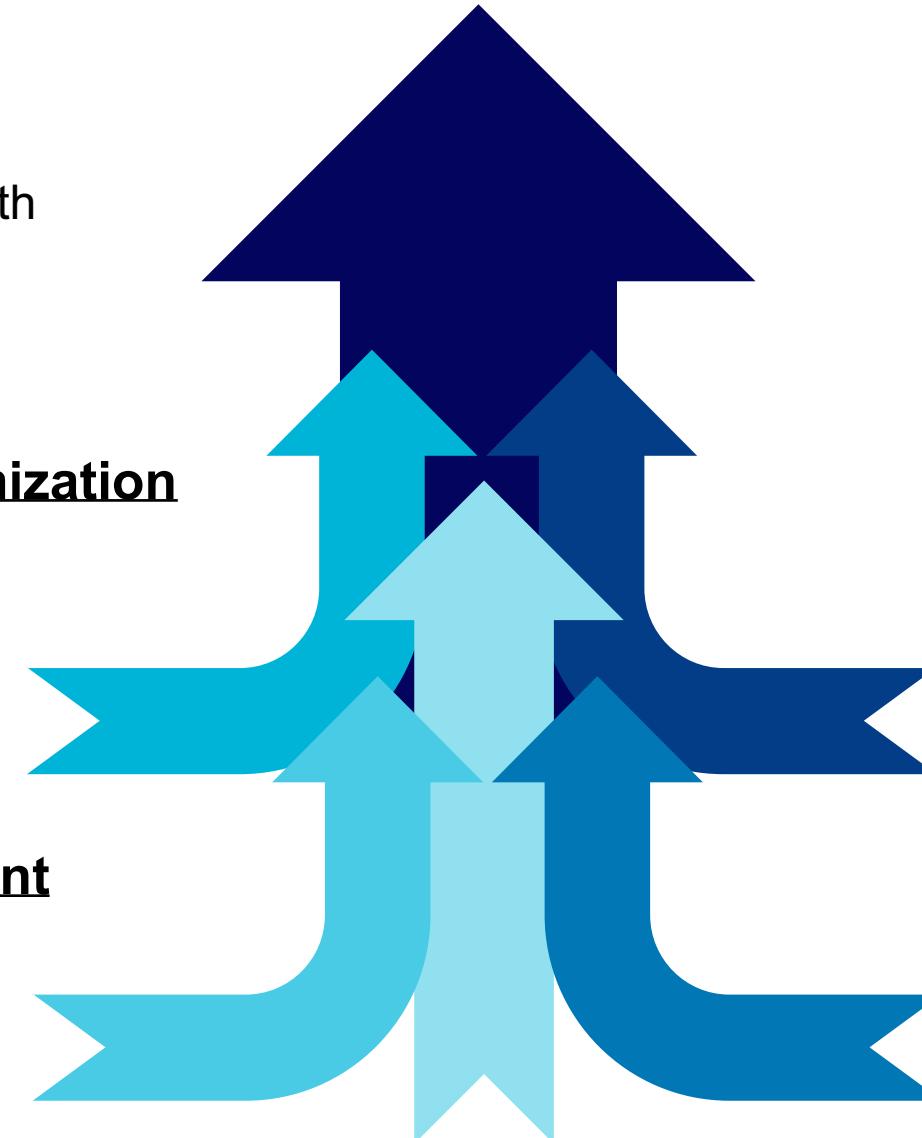
Backtesting & Optimization

- Run simulation
- Tune the hyperparameter



Strategy Development

- Quantify the strategy base on mean reversion



Robo Advising

- Data Driven
- All net worth customers
- Low human biases



Automation

- Discord Bot API
- Google Cloud Function
- Function Scheduler



Script

- Data scraping from internet
- Transforming data to signals



Strategy Development

1, Introduction

2, Methodology

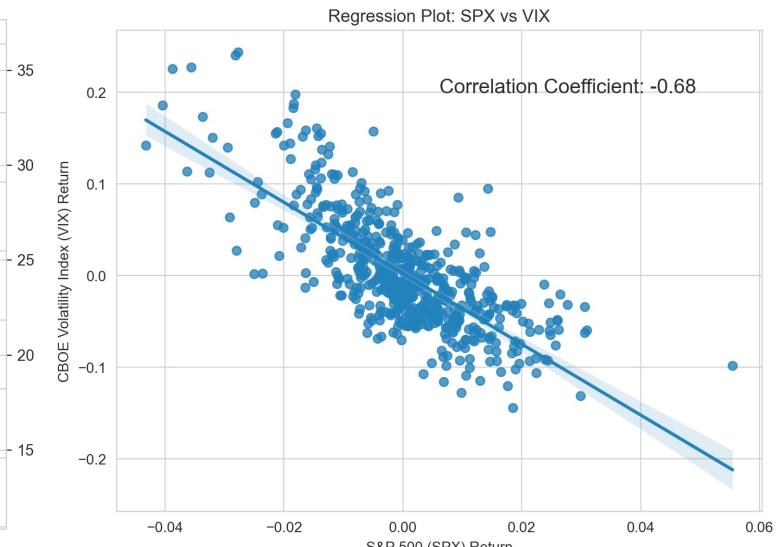
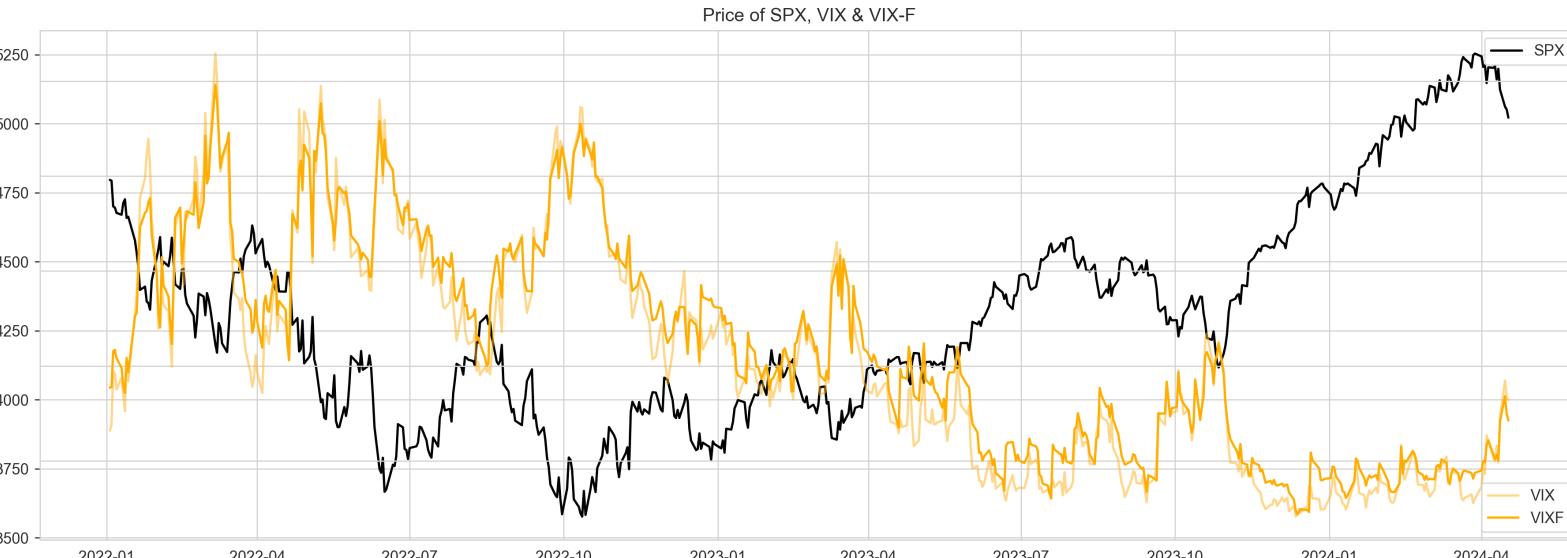
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VIX - CBOE Volatility Index

- ❖ **Volatility** expectation of S&P 500 index option, which is not tradable for index but for future
- ❖ Indicator of market **sentiment**
- ❖ **Negative correlation** with S&P 500



Mean Reversion

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Indicator Introduction – Spread

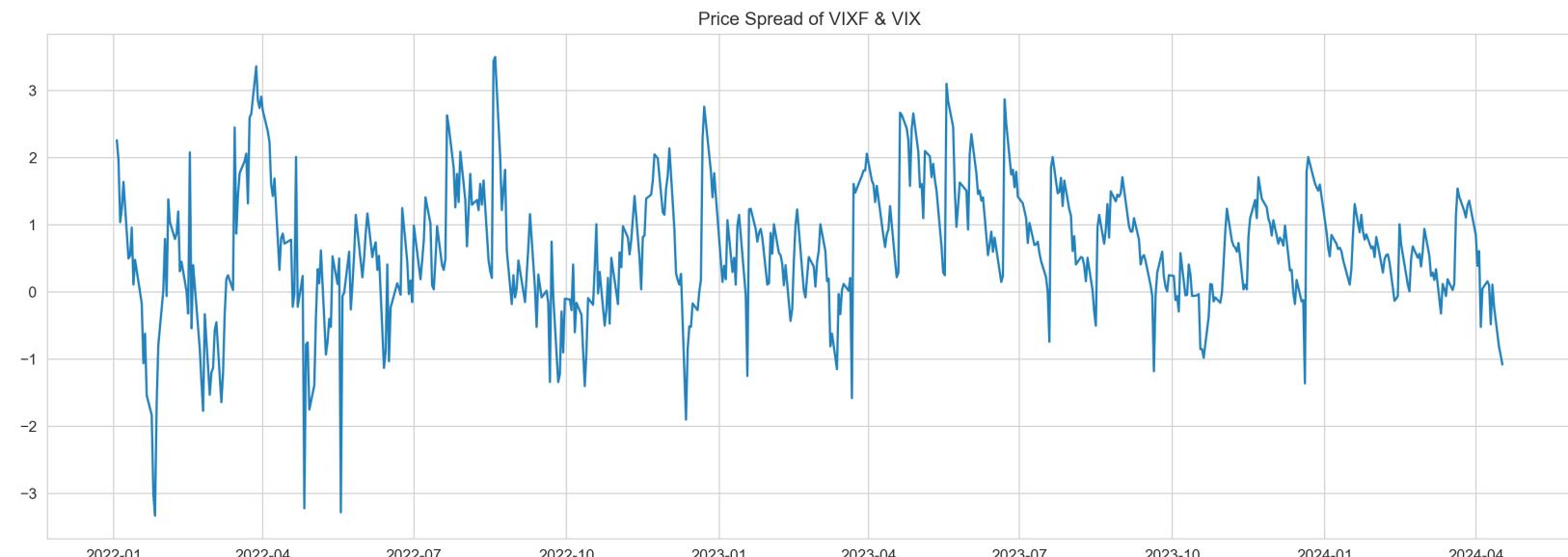
- VIXF – VIX



Stationarity of the Spread

- Cointegration Test: determines if the spread between the two time series data are constant over time
- Null Hypothesis: spread between two time series are non-stationary
- P-value is **0.0001**: indicates the spread is **stationary**

Pair	P-Value
SPX&VIX	0.965
SPX&VIXF	0.945
VIX&VIXF	0.0001



Rationale Behind

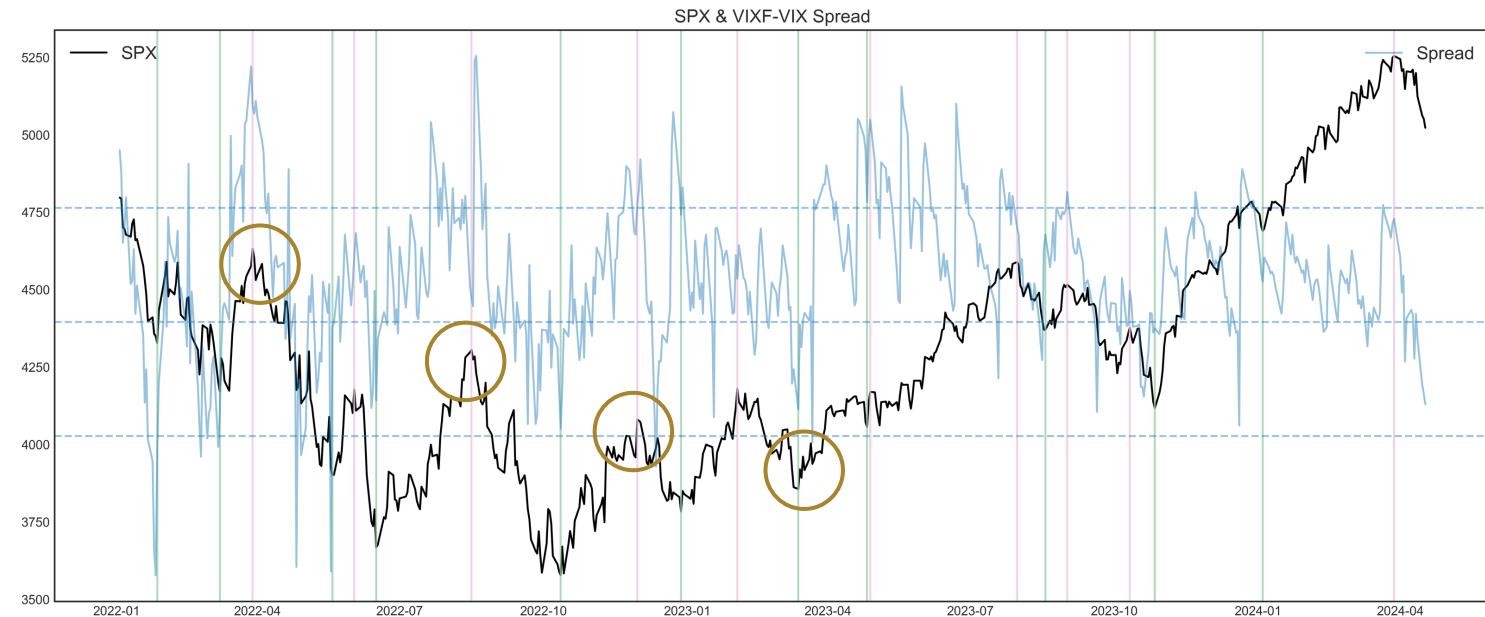
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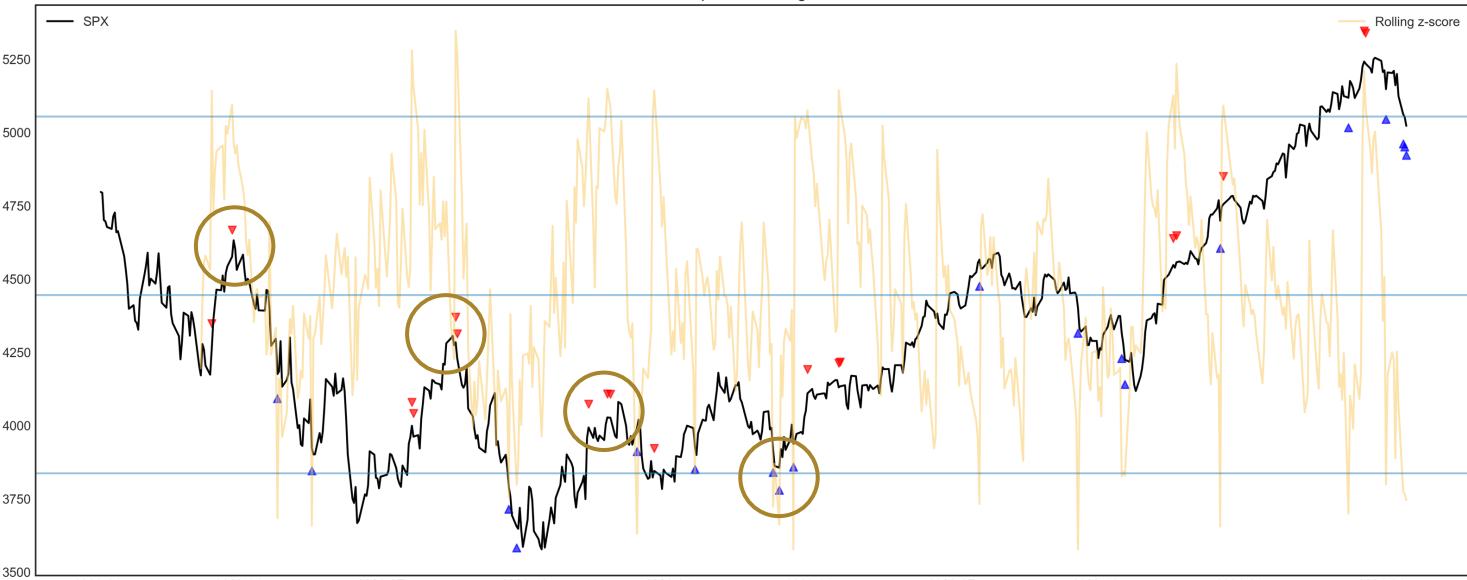
- ◀ Institutional Influence
- ◀ Following Institutional Flow
- ◀ Mean Reversion Mechanism

$$\text{Spread} = \text{VIXF} - \text{VIX}$$

If spread rise, it tends to reverse:
 $\text{Spread} \downarrow \leftarrow \text{VIX} \uparrow \leftarrow \text{SPX} \downarrow$



SPX & Spread Rolling Z-Score



Simple Moving Average (SMA)

- Filter out some daily 'noise,' while retaining information



Rolling Z-Score

- Capture the concept of relative highs and lows
- Without the use of future data

Strategy Explanation

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1) Reverse

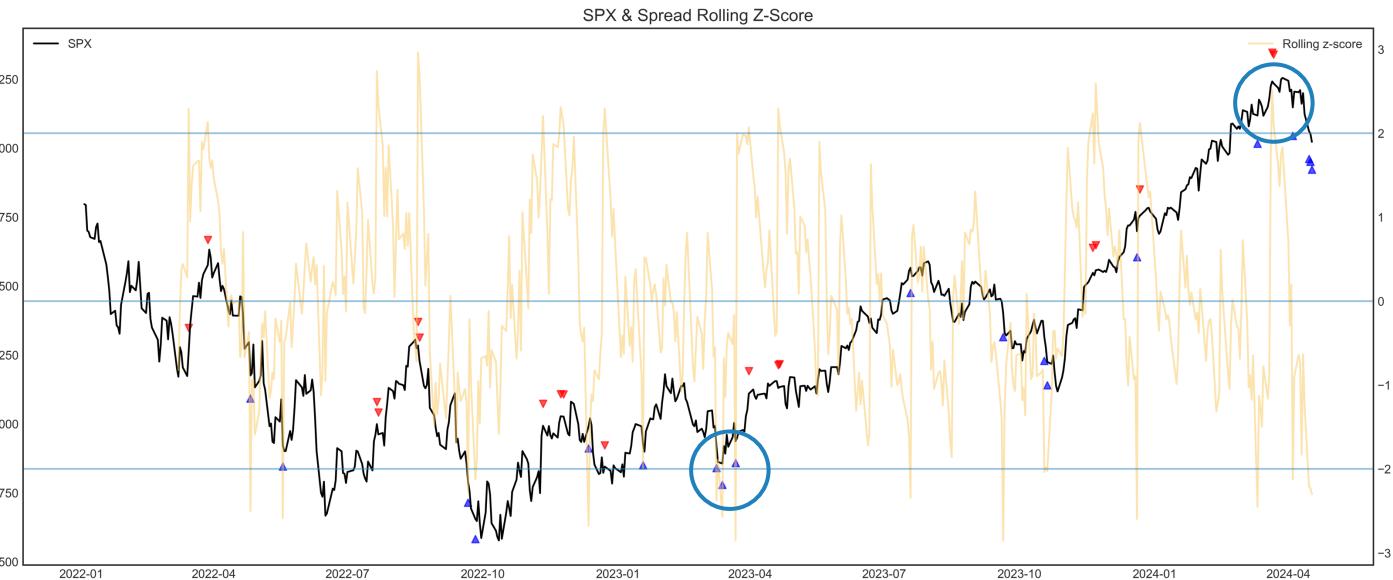
When the rolling z breaks upper threshold

- the spread is relatively high
- shorting SPX, vice versa

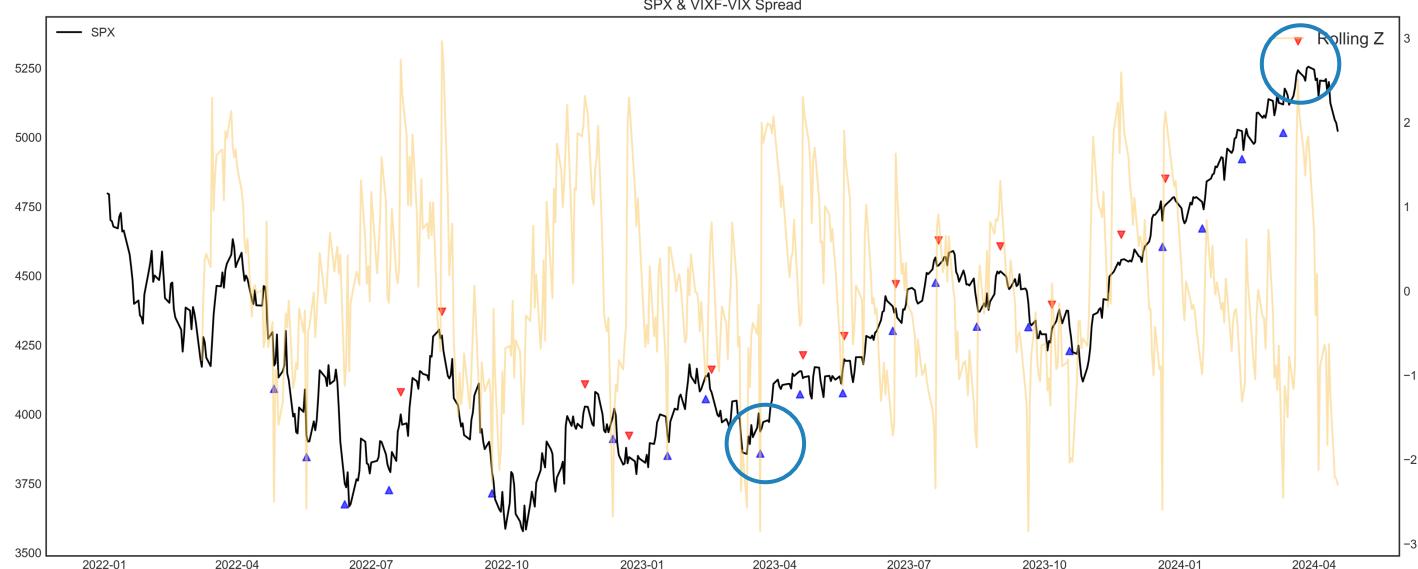


Hyperparameter

- Upper, lower threshold
- Holding dates (n)



SPX & VIXF-VIX Spread



2) Local Minima

When the local maxima is confirmed

- The spread is relatively high
- The spread is under downtrend
- shorting SPX, vice versa



Hyperparameter

- Order (period to confirm the minima)
- Holding dates (n)

Backtesting & Optimization

1, Introduction

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3, Result

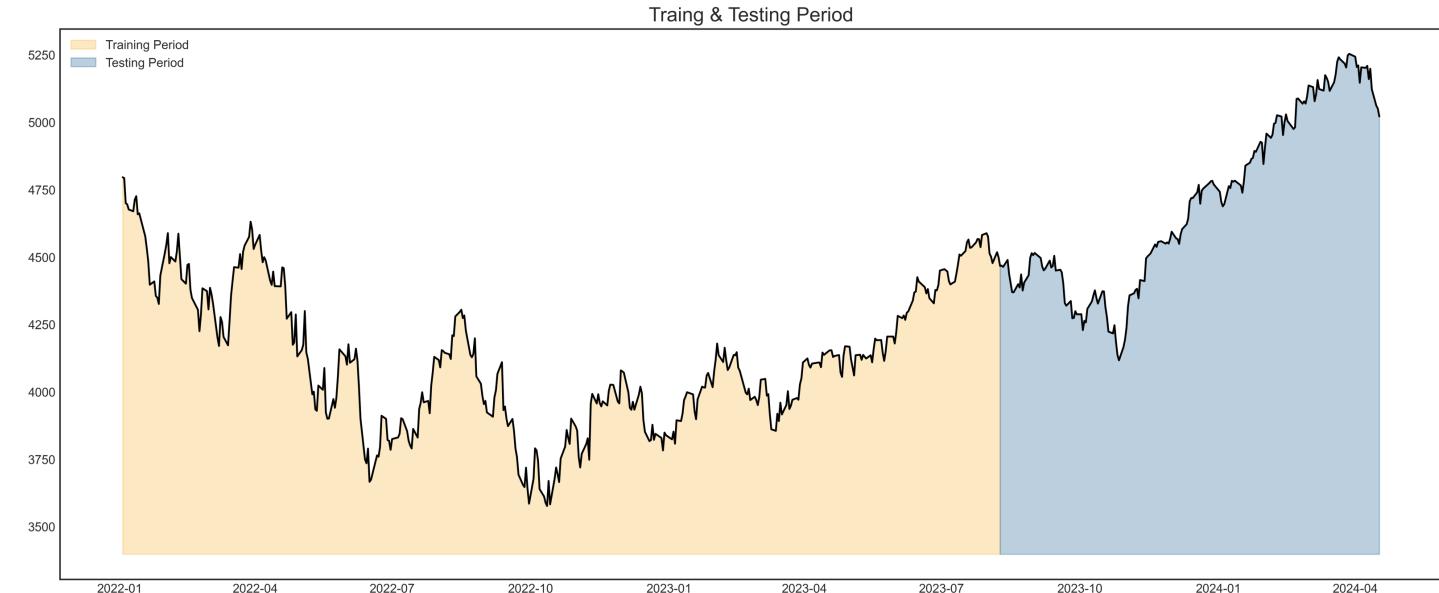
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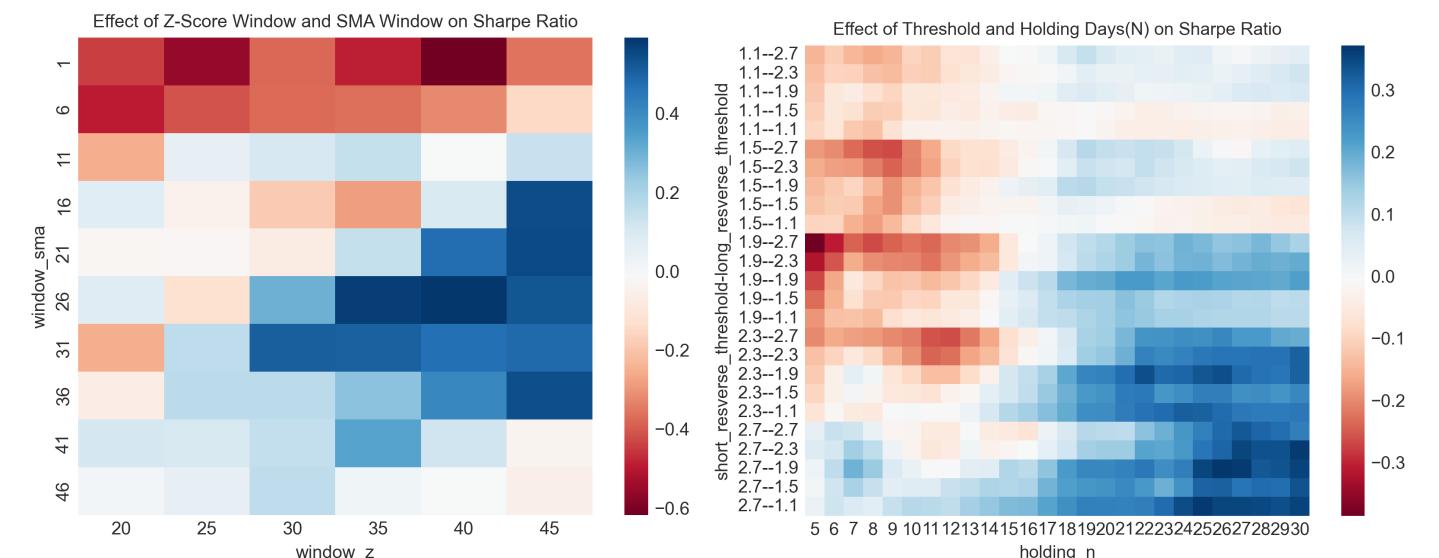
Data splitting

- 70%:30% for training and testing
- Employ **grid search** to tune the hyperparameter in training period
- Evaluate the strategy in testing period



Reverse Strategy Backtesting

- Performance of upper threshold value is not balanced with lower threshold with following preference:
- Long when z-score below **-1.9**
- Short when z-score above **2.7**
- Successfully eliminate the small SMA windows and Rolling Z-Score window



Backtesting & Optimization

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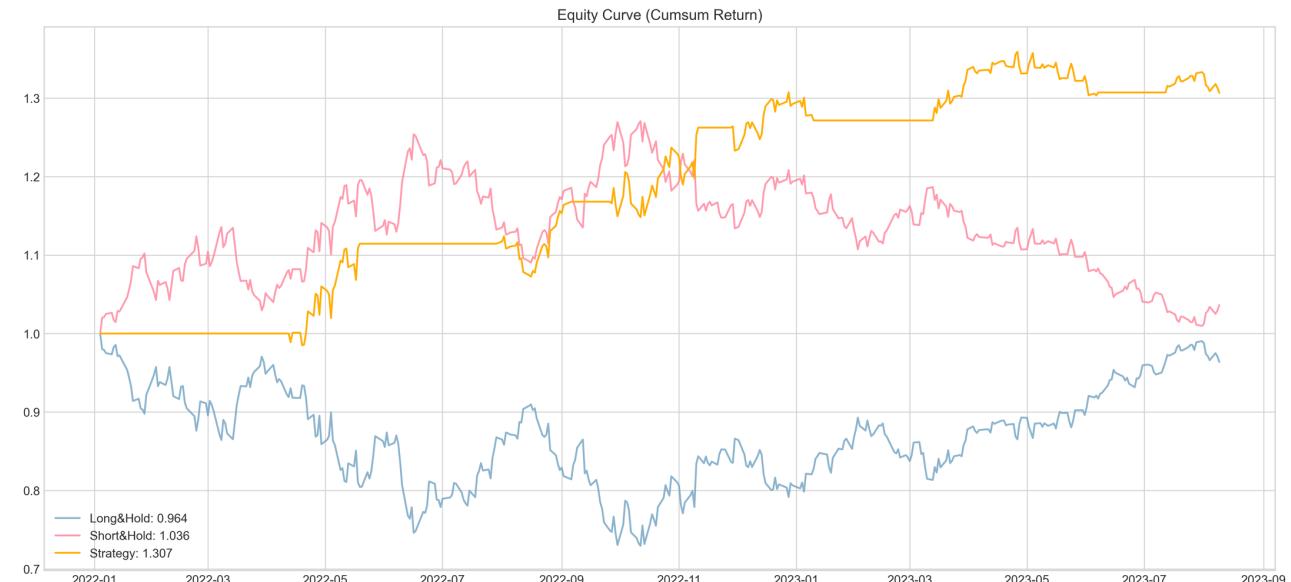
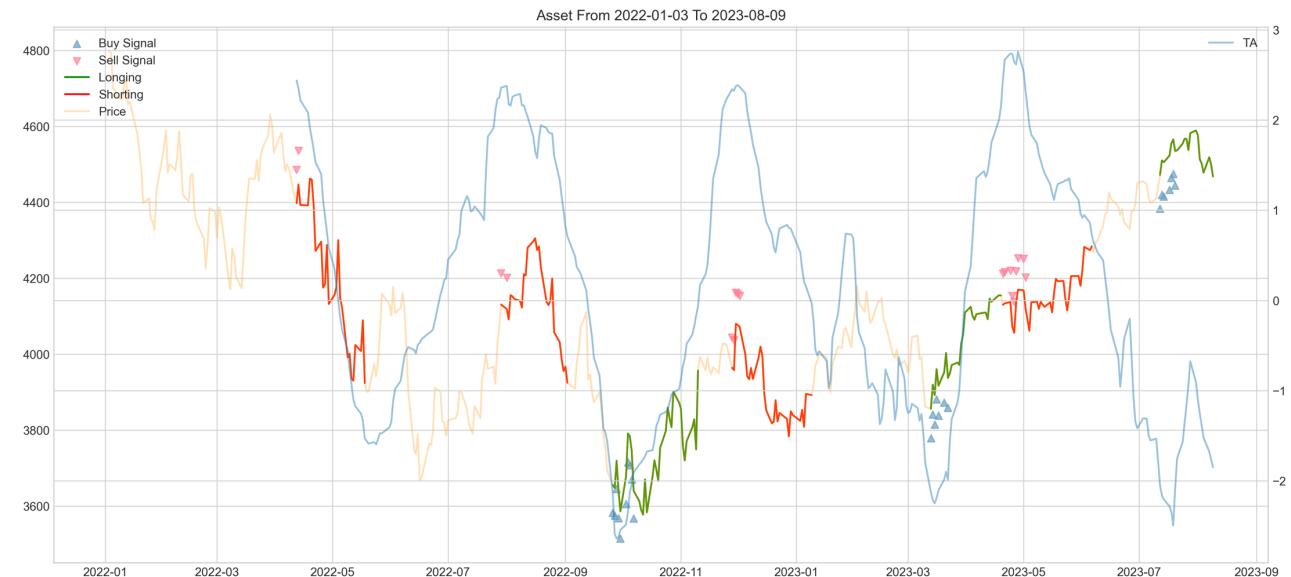
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Able to capture the reversal timing

Strategy beats the index

Unbiased to the long short preference

Sharpe Ratio	1.286
Maximum Drawdown	4.8%
Long Short Ratio	0.72



Verification & Evaluation

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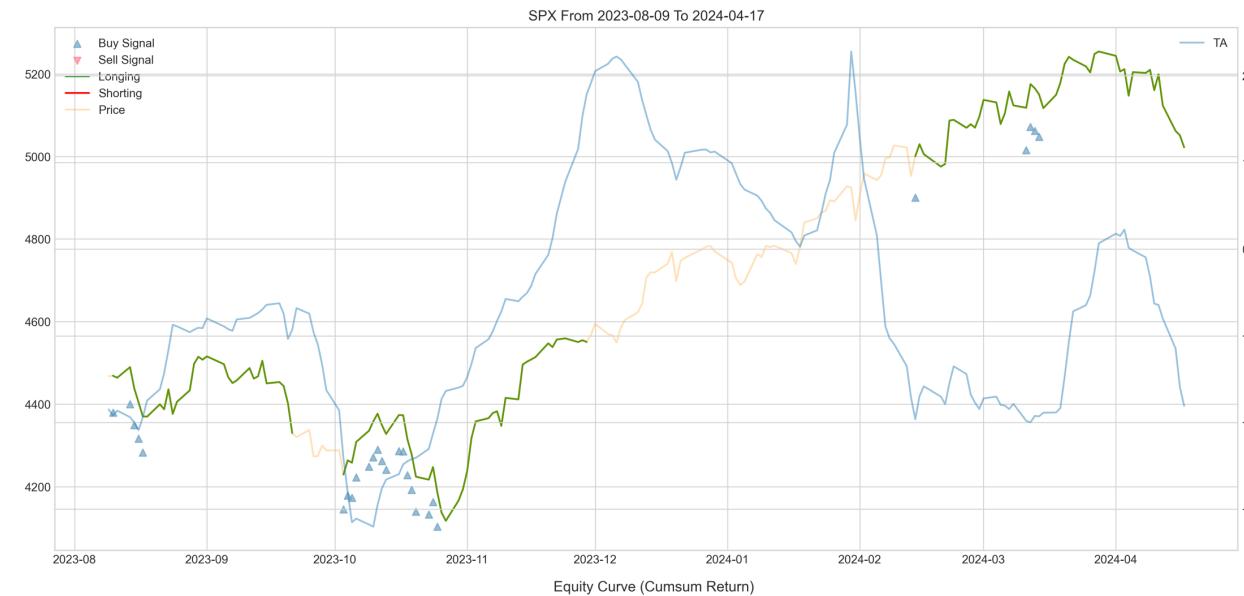
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1) Reverse Strategy

- Not losing money but not as **promising** in training set
- **Cannot** beat the index
- Long short biased which **unable** to capture the downtrend

Sharpe Ratio	0.743
Maximum Drawdown	6.94%
Long Short Ratio	inf



Verification & Evaluation

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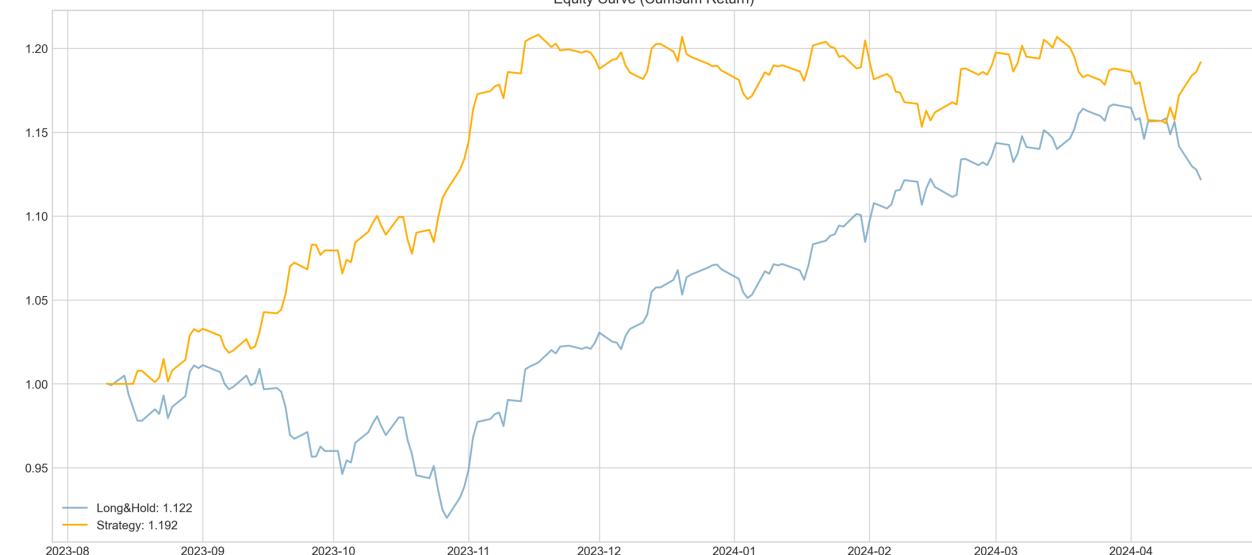
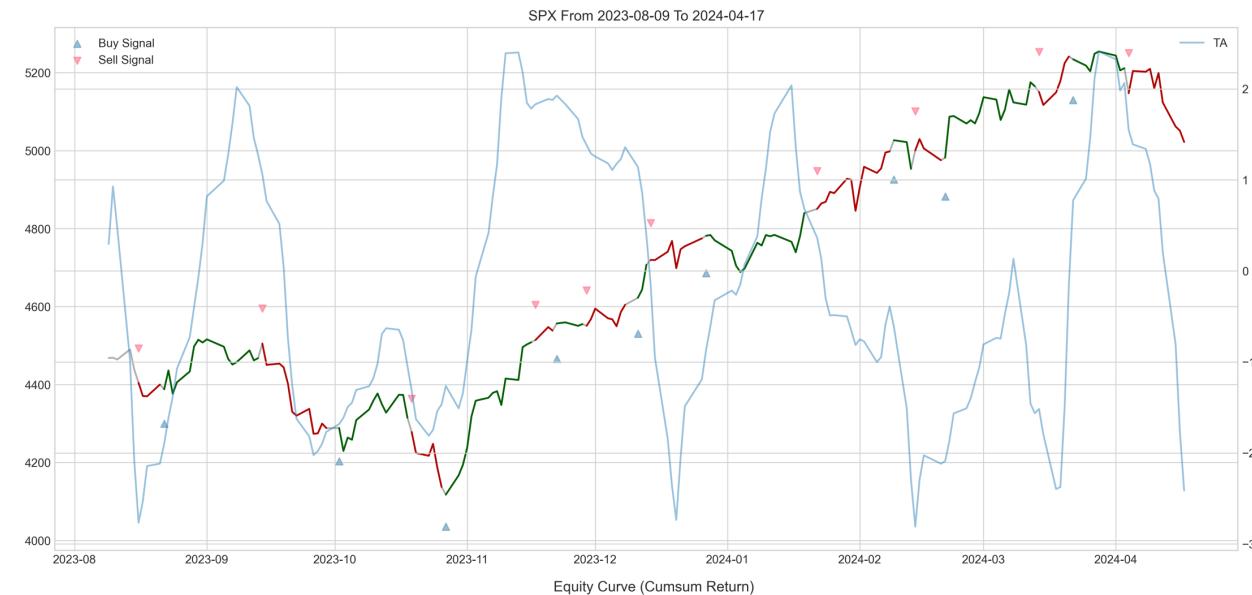
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2) Local Minima Strategy

- Archive relatively **good** performance than the index
- Balanced long short ratio, indicated the **reliability** to both bull or bear market

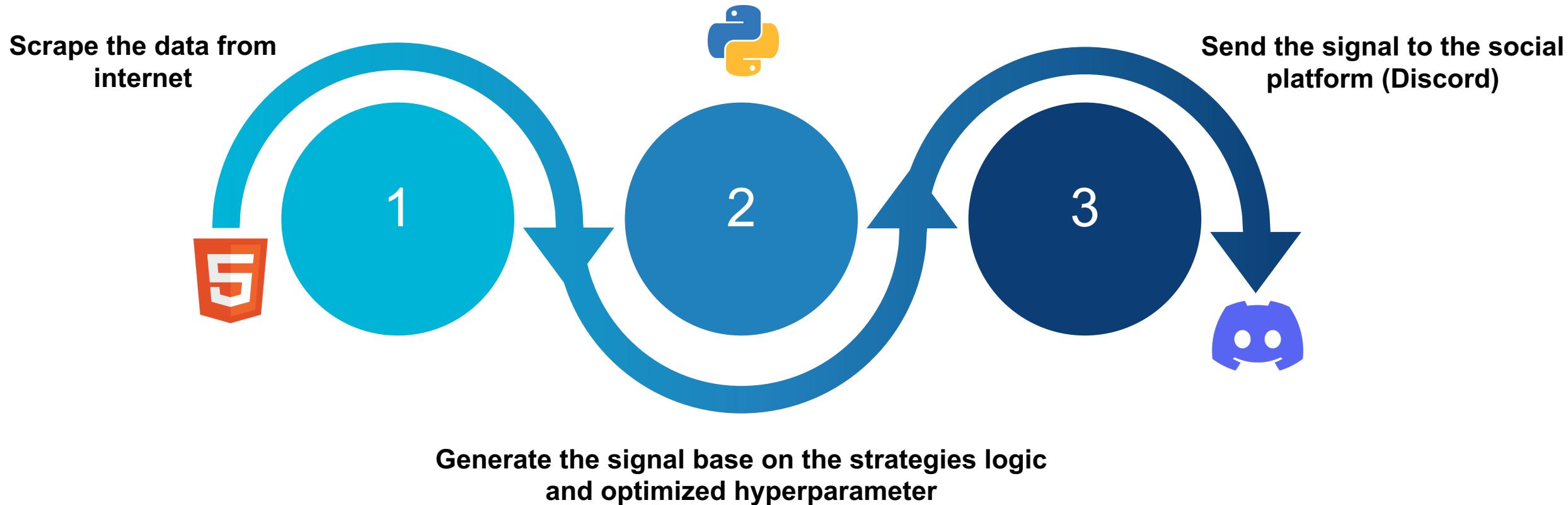
Sharpe Ratio	2.40
Maximum Drawdown	4.55%
Long Short Ratio	2.35



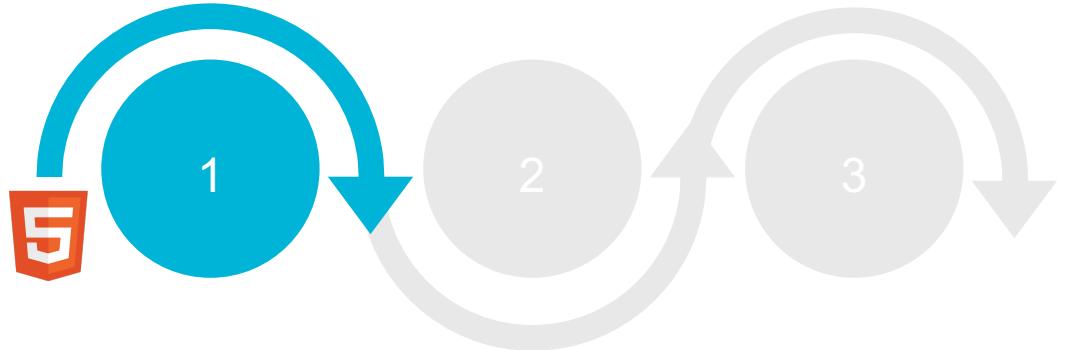
Automate Data Processing

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Automate Data Processing



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Data Scraping

- Use Beautiful Soap to **scrape** the **html** data from internet and load it to **python** in DataFrame format

標普500 VIX期貨歷史數據

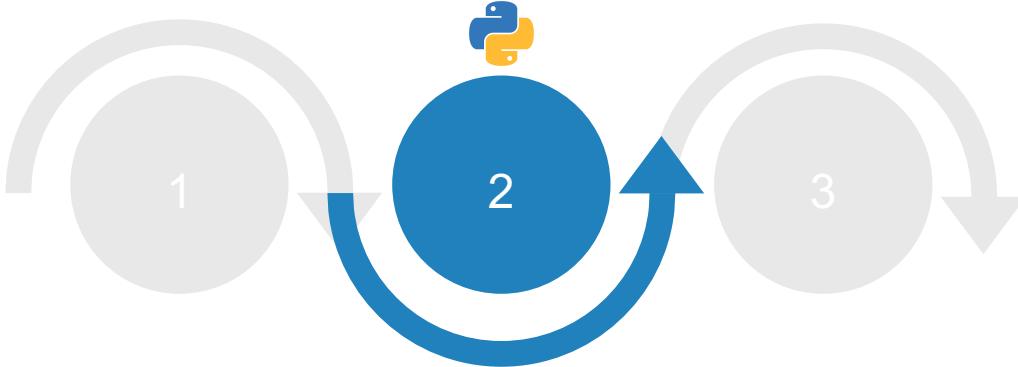
時間範圍: Daily | 下載數據 | 2024-03-21 ~ 2024-04-21

日期	收市	開市	高	低	成交量	升跌 (%)
2024-4-19	17.78	17.50	19.73	17.13	99.12K	+2.28%
2024-4-18	17.38	17.20	17.65	16.75	99.12K	-3.59%
2024-4-17	18.03	18.00	18.65	17.80	1.15K	-1.19%
2024-4-16	18.25	18.50	19.70	17.50	104.27K	-0.87%
2024-4-15	18.41	17.05	18.70	15.95	150.98K	+7.72%
2024-4-12	17.09	15.00	18.10	15.00	200.30K	+13.74%
2024-4-11	15.02	15.50	16.30	14.95	116.86K	-1.91%
2024-4-10	15.32	15.00	16.20	14.75	153.09K	+1.60%
2024-4-9	15.08	15.30	16.00	14.95	126.61K	-1.77%
2024-4-8	15.35	16.00	16.02	15.15	110.61K	-4.54%
2024-4-5	16.08	15.96	16.35	15.43	141.00K	+1.56%
2024-4-4	15.83	14.90	16.35	14.45	164.60K	+5.93%
2024-4-3	14.94	15.00	15.40	14.70	92.57K	-0.37%
2024-4-2	15.00	14.65	15.65	14.45	129.00K	+3.43%
2024-4-1	14.50	14.35	14.80	14.15	65.36K	+0.93%
2024-3-28	14.37	14.05	14.40	14.05	67.83K	+2.15%
2024-3-27	14.07	14.35	14.45	14.04	58.79K	-1.95%
2024-3-26	14.35	14.40	14.40	14.10	51.35K	-0.38%
2024-3-25	14.40	14.50	14.75	14.25	58.08K	-0.56%
2024-3-22	14.48	14.45	14.65	14.25	58.27K	+0.17%
2024-3-21	14.46	14.50	14.65	14.30	79.78K	+2.02%
最高: 19.73		最低: 14.04		基價: 5.69		升跌 (%) : 25.48

pd.DataFrame(data_scraped)

	Date	Close	Open	High	Low	Volume	Change
0	2024-4-23	16.38	16.28	16.43	16.23		+0.31%
1	2024-4-22	16.33	17.43	17.58	16.23		-6.04%
2	2024-4-21	17.38	17.58	17.68	17.38		-2.55%
3	2024-4-19	17.84	17.35	19.70	17.10	152.82K	+2.60%
4	2024-4-18	17.38	17.20	17.65	16.75	99.12K	-3.59%
5	2024-4-17	18.03	18.00	18.65	17.80	1.15K	-1.19%
6	2024-4-16	18.25	18.50	19.70	17.50	104.27K	-0.87%
7	2024-4-15	18.41	17.05	18.70	15.95	150.98K	+7.72%
8	2024-4-12	17.09	15.00	18.10	15.00	200.30K	+13.74%
9	2024-4-11	15.02	15.50	16.30	14.95	116.86K	-1.91%
10	2024-4-10	15.32	15.00	16.20	14.75	153.09K	+1.60%
11	2024-4-9	15.08	15.30	16.00	14.95	126.61K	-1.77%
12	2024-4-8	15.35	16.00	16.02	15.15	110.61K	-4.54%
13	2024-4-5	16.08	15.96	16.35	15.43	141.00K	+1.56%
14	2024-4-4	15.83	14.90	16.35	14.45	164.60K	+5.93%
15	2024-4-3	14.94	15.00	15.40	14.70	92.57K	-0.37%
16	2024-4-2	15.00	14.65	15.65	14.45	129.00K	+3.43%
17	2024-4-1	14.50	14.35	14.80	14.15	65.36K	+0.93%
18	2024-3-28	14.37	14.05	14.40	14.05	78.83K	+2.15%
19	2024-3-27	14.07	14.35	14.45	14.04	58.79K	-1.95%
20	2024-3-26	14.35	14.40	14.40	14.10	51.35K	-0.38%
21	2024-3-25	14.40	14.50	14.75	14.25	58.08K	-0.56%

Automate Data Processing



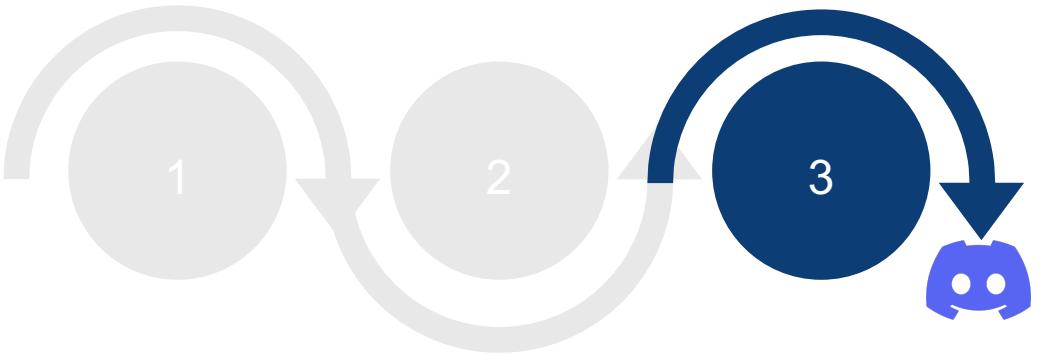
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- ## Data Transformation
- Generate the signal base on the strategies logic and optimized hyperparameter
1. Calculate the **spread**
 2. Smoothed the spread with **optimized SMA** and rolling z-score window
 3. Transformed the indicator into **signals** base on the strategy logics and hyperparameter

Date	SPX	VIX	VIXF	Minima Rolling Z	Position
2024-03-20	5224.620117	13.04	14.17	-1.493432	-1.0
2024-03-21	5241.529785	12.92	14.46	-0.137427	-1.0
2024-03-22	5234.180176	13.06	14.48	0.777961	1.0
2024-03-25	5218.189941	13.19	14.40	1.014005	1.0
2024-03-26	5203.580078	13.24	14.35	1.469125	1.0
2024-03-27	5248.490234	12.78	14.07	2.113826	1.0
2024-03-28	5254.350098	13.01	14.37	2.411164	1.0
2024-04-01	5243.770020	13.65	14.50	2.324336	1.0
2024-04-02	5205.810059	14.61	15.00	1.981209	1.0
2024-04-03	5211.490234	14.33	14.94	2.064735	1.0

Automate Data Processing



Robo Advising

- The scripts are linked with **discord bots** by its token
- Information of the strategy would be sent out to the discord channel by the bot **each day before the market open.**
- Data Including the market data, strategies' positions could **advise** retail investors on their investment decisions

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April 24, 2024	
VIXF (COBE) APP	04/24/2024 8:51 PM
2024-04-23 00:00:00	
SPX: 5070.55	
VIXF: 15.8	
VIX: 15.69	
Spread: 0.11	
Rolling Z Reverse: -2.46	
Signal Reverse: Long	
Rolling Z Minima: -1.92	
Signal Minima: Long	
April 25, 2024	
VIXF (COBE) APP	04/25/2024 10:34 PM
2024-04-24 00:00:00	
SPX: 5071.63	
VIXF: 15.96	
VIX: 15.97	
Spread: -0.01	
Rolling Z Reverse: -2.42	
Signal Reverse: Long	
Rolling Z Minima: -1.75	
Signal Minima: Long	
April 26, 2024	
VIXF (COBE) APP	04/26/2024 9:09 PM
2024-04-25 00:00:00	
SPX: 5048.42	
VIXF: 15.6	
VIX: 15.37	
Spread: 0.23	
Rolling Z Reverse: -2.37	
Signal Reverse: Long	
Rolling Z Minima: -1.62	
Signal Minima: Long	

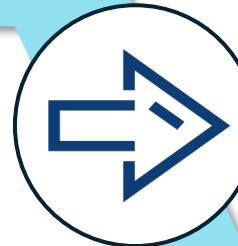
Limitation & Improvement

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Insufficient Backtesting

Only one sample for backtesting and hyperparameter optimization has been carried out. There is a potential risk of overfitting, even the result is promising



Additional backtesting using rolling-walk sampling or multiple randomized sampling to enhance model robustness and reduce the risk of overfitting.

Apply the trading strategy to **other underlying assets** such as commodities, interest rates, forex, and cryptocurrencies

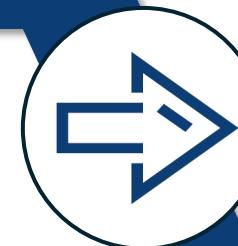


Limited Underlying Asset

The strategy has been applied **only** to the S&P 500 Index (SPX) which may not sufficiently capture broader market dynamics.

Lack of Full Automation

It requires **manual force** to initiate the run, even the script successfully automates data scraping, signal generation, and robo-advising process.



Implement full automation using **job scheduler in cloud services** to run the job automatically every day.

Conclusion

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1

Importance of Professional Institution Sentiment

- The sentiment of professional institutions **matters** in market movement, at least in trading level and the short term of the market

2

Insight of Featuring Engineering on VIX Future

- Reflection of implied volatility and futures products **offer** valuable insights
- Use of SMA and Rolling Z-Score technique highlights the ability of **explaining** trend

3

Successful of Robo Advising

- Technology **transforms** the investment market by **utilizing** data-driven approach instead of human.

**Thank You
For Your Attention**

