

AI trading strategy_v4.pdf

by YU Rong

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Project of Artificial Intelligence in Finance

Trading Strategy for Quantopian Contest

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Strategy Overview

RSI Strategy

Turtle Trading Strategy

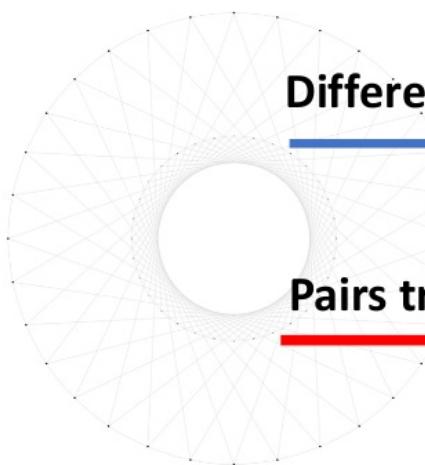
Differential Trend Motion Strategy

Pairs trading

Control Leverage Strategy

Momentum Trading Strategy

Psy Strategy

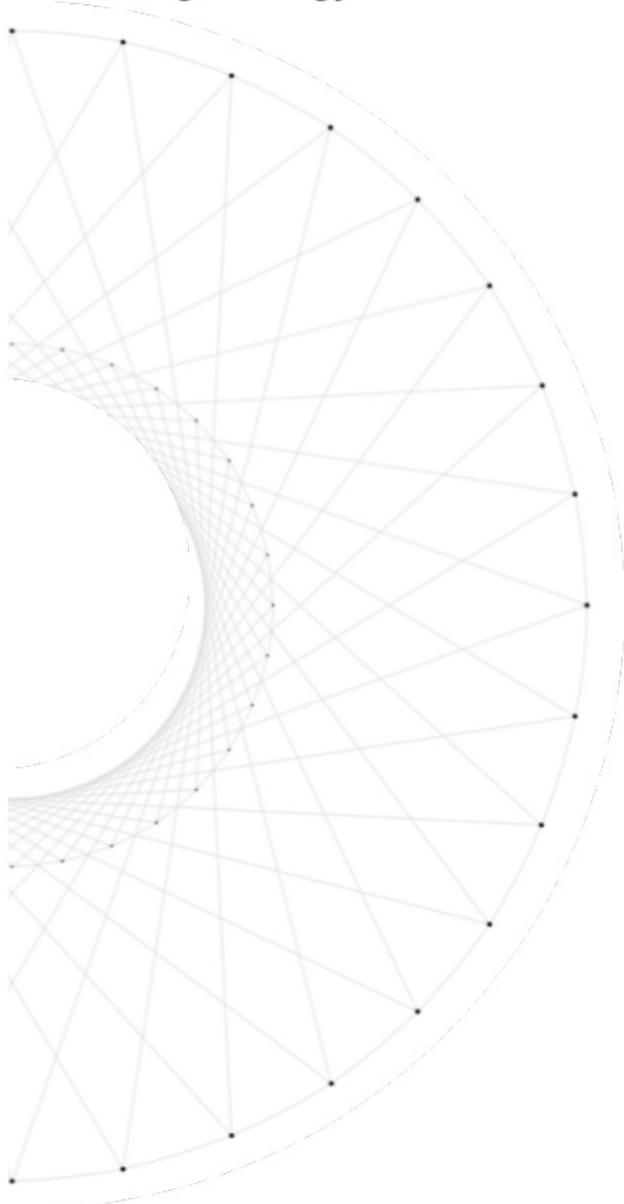


RSI Strategy

LI, Fanyi



Trading Strategy



- 1 RSI Introduction
- 2 Our strategy – RSI Trading Strategy
- 3 Performance

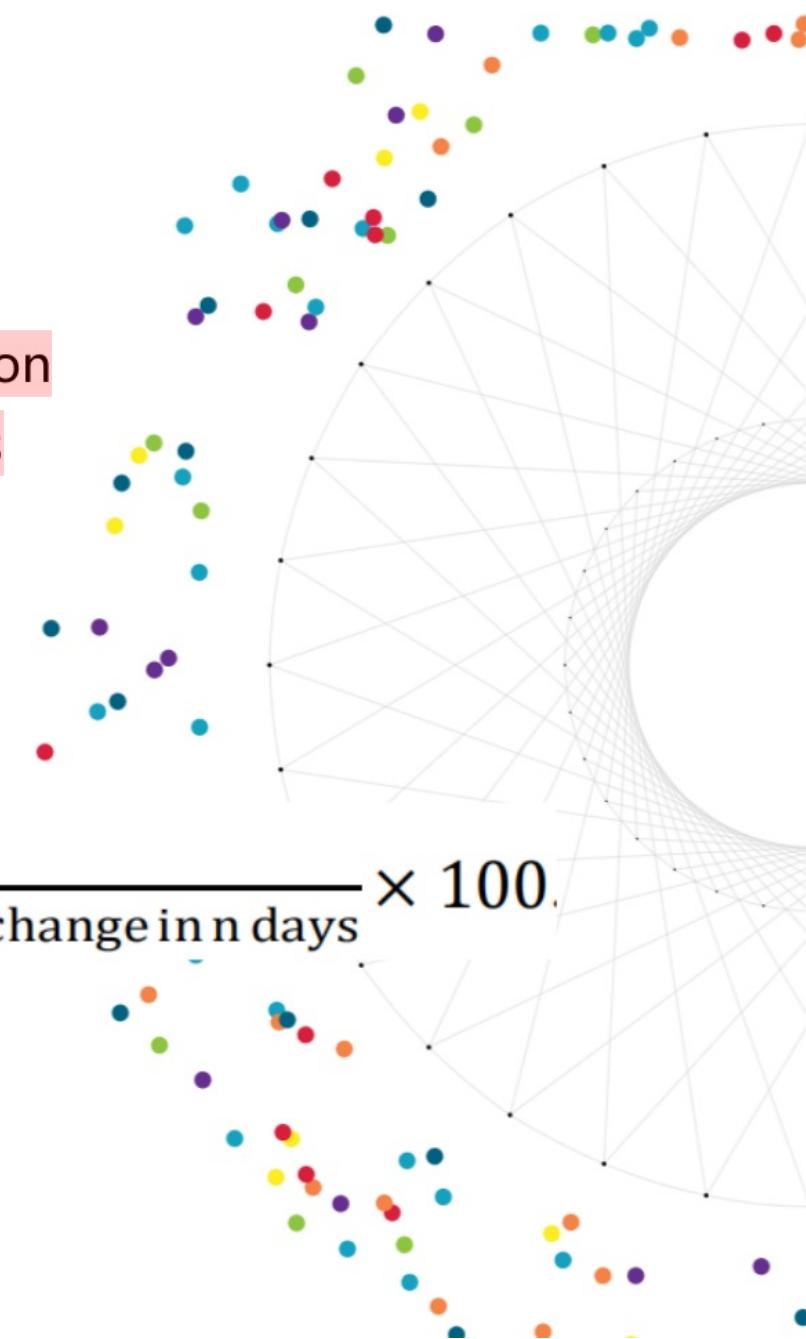
PART ONE: RSI introduction

RSI Strategy

① Relative Strength Index(RSI) is a technical indicator basing on the theory of supply- demand balance to measure stock' s or market' s intrinsic strength or weakness.

The formula for RSI:

$$\frac{\text{average of upward change in } n \text{ days}}{\text{average of upward change in } n \text{ days} + \text{average of downward change in } n \text{ days}} \times 100$$

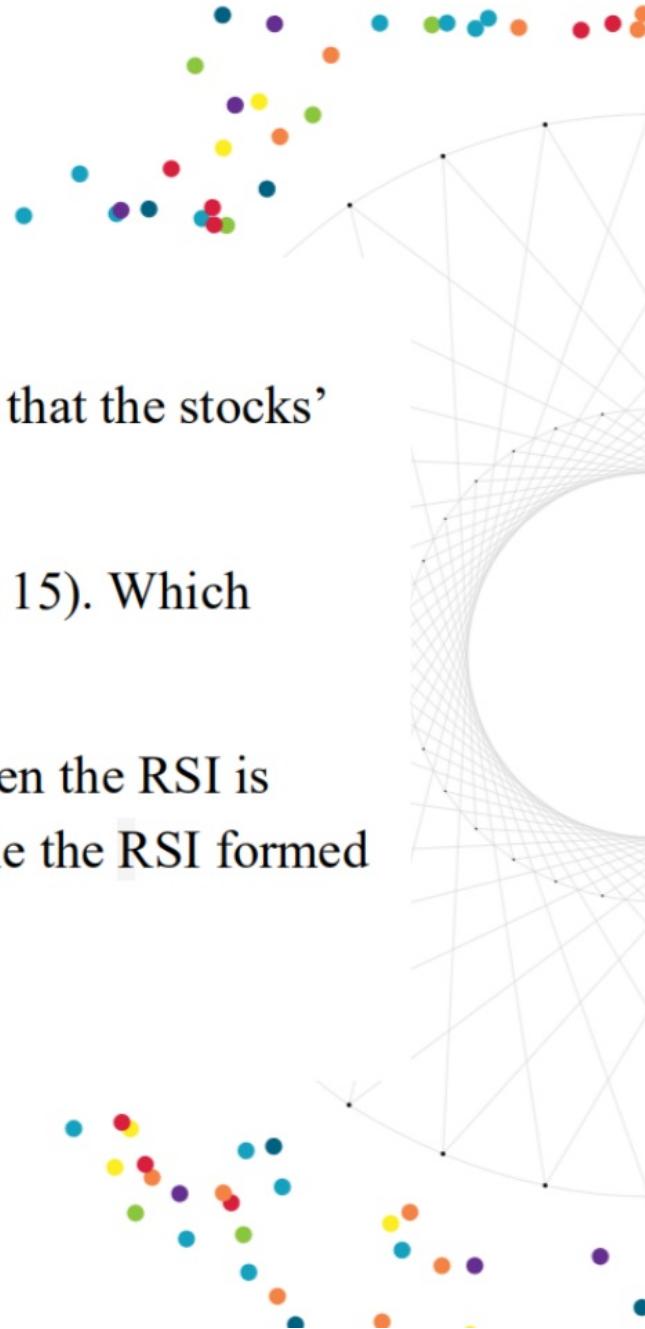


PART ONE: RSI introduction

Usually, these are the long signal:

- When the index is above 50 but not too high(about 85) , it means that the stocks' gain is greater than the loss.
- When the index drop into the extremely low region(like less than 15). Which means the stock is in oversold region.
- Bottom divergence condition: This condition always happens when the RSI is below 20. When the stock price has been falling all the way, while the RSI formed a trend of going higher.

The short signal is similar but exactly the opposite.



PART TWO: Our strategy – RSI Trading Strategy

Calculation of RSI indicator:

If the closing price of n minutes is higher than n-1 minutes, set:

n minute increase= closing price of n minutes-(n-1) minute closing price

otherwise we set:

n minute decrease= (n-1) minute closing price-n minute closing price Then,

we set:

$$RS = \text{n minute increase} / \text{n minute decrease}$$

$$RSI = 100 - 100 / (1 + RS)$$

Let f_1 be the number of $\text{close}(i) < \text{close}(i-1)$ for every i in this 240 minutes, g_1 be the number of $\text{RSI}(i) < \text{RSI}(i-1)$ for every i in the 240 minutes



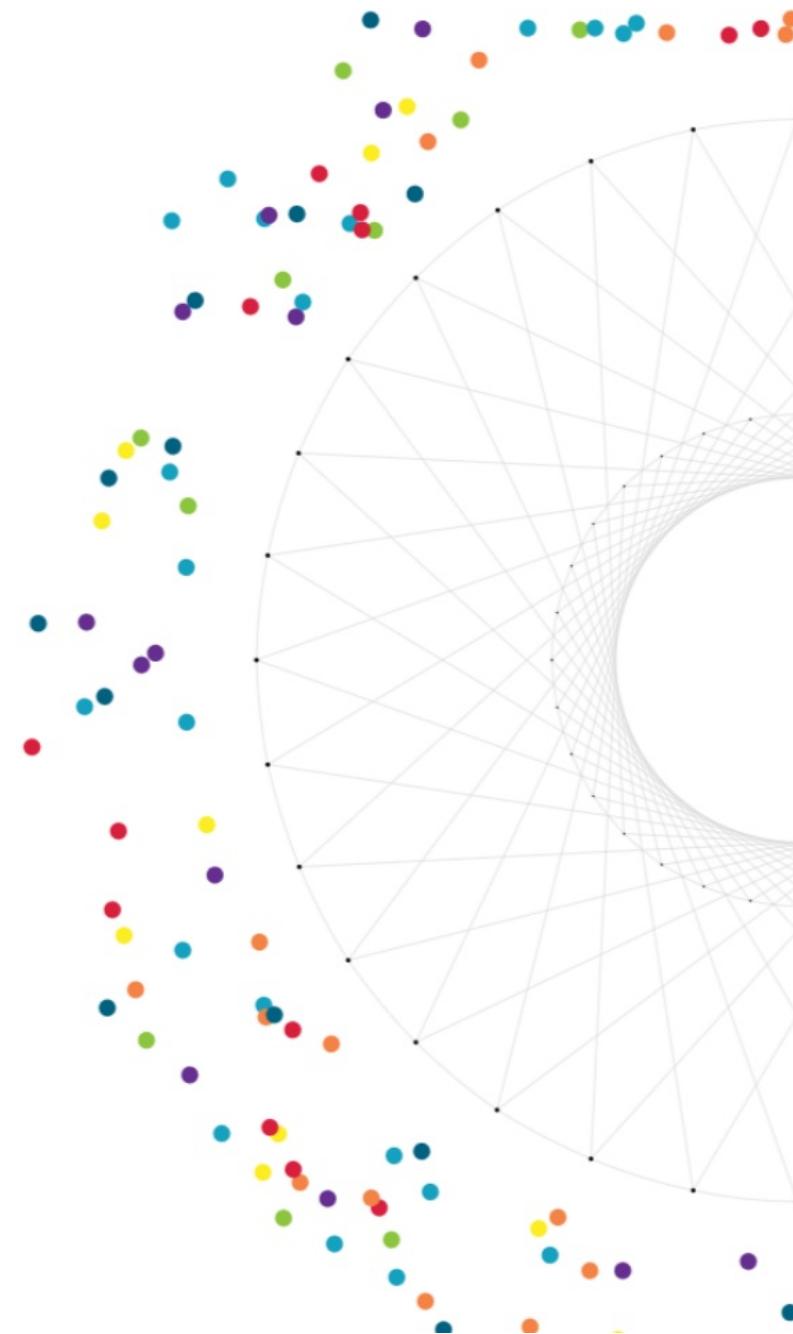
PART TWO: Our strategy – RSI Trading Strategy

Pattern for long signal:

- $50 < \text{RSI} < 80$
- $\text{RSI} < 15$
- $f1 > 35$ while $g1 < 25$.

Pattern for short signal:

- $20 < \text{RSI} < 50$
- $\text{RSI} > 85$
- $f2 > 35$ while $g2 < 25$



PART Three: Performance

Data used: stock 'AAPL'

RETURNS	ALPHA	BETA	SHARPE	DRAWDOWN
34.45%	0.10	-0.08	0.36	-38.24%

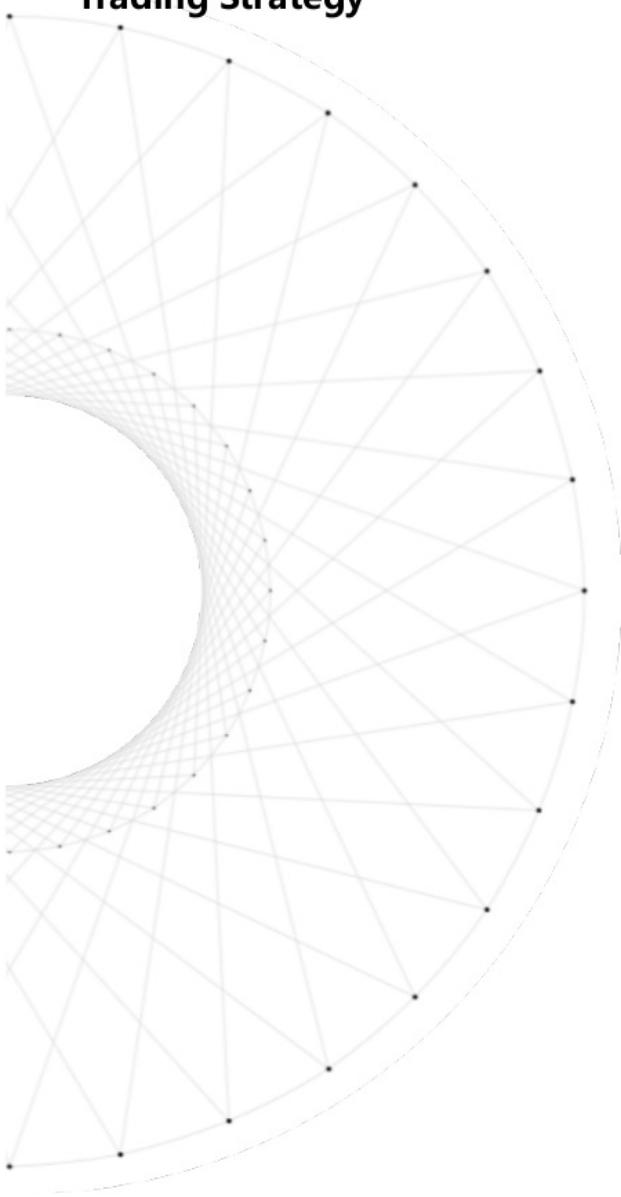


Control Leverage Strategy

LI, Fanyi&Tong Jiaqu



Trading Strategy

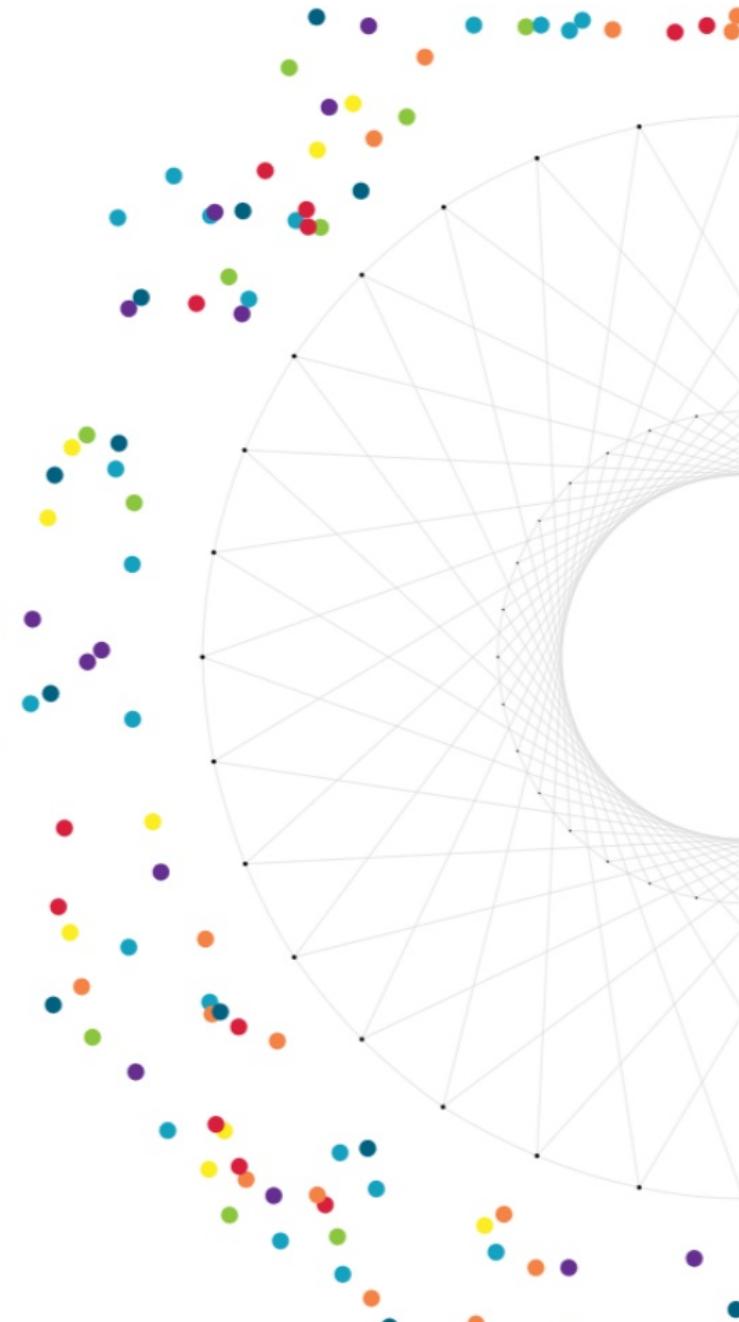


- 1 Strategy Introduction
- 2 Our strategy
- 3 Performance
- ...
- ...
- ...
- ...
- ...

PART ONE: Strategy Introduction

Control Leverage Strategy

The main idea of the strategy is doing momentum strategy while keep account leverage limited to 2.5x.



PART TWO: Our strategy

The momentum strategy:

Firstly we define two score:

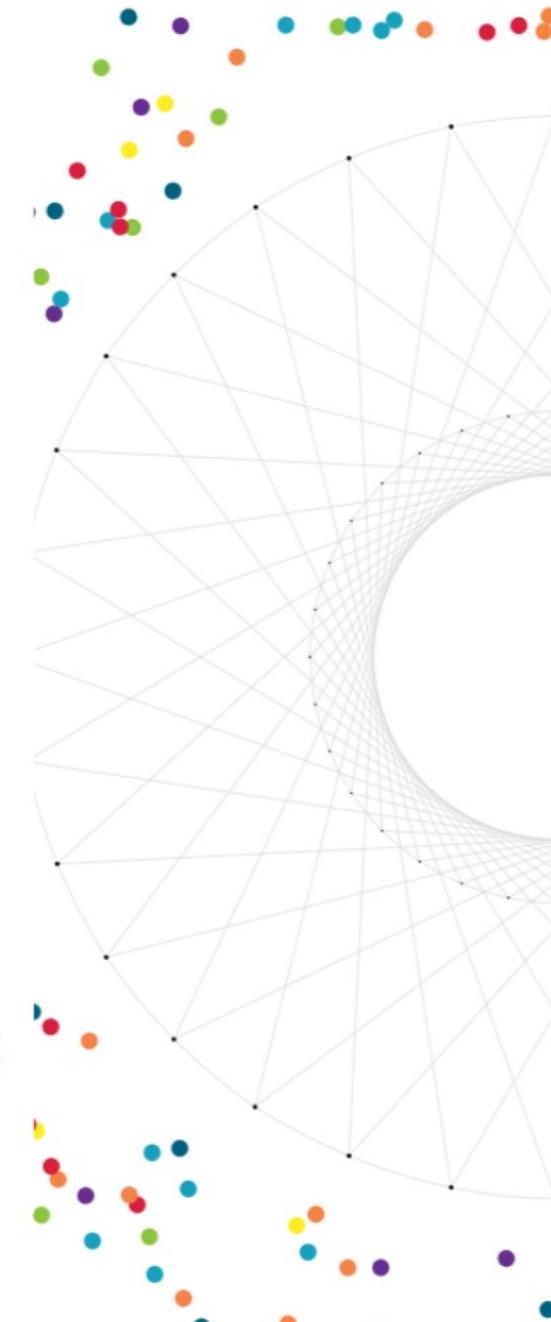
- FastMa: The average of the stock price in the past 100 days.
- SlowMa: The average of the stock price in the past 20 days

Secondly we define the long-short signal:

- Long signal of the momentum strategy:
Go long if the fast moving average is equal to or above the slow moving average.
- Short signal of the momentum strategy:
Sell short if the fast moving average is below the slow moving average.

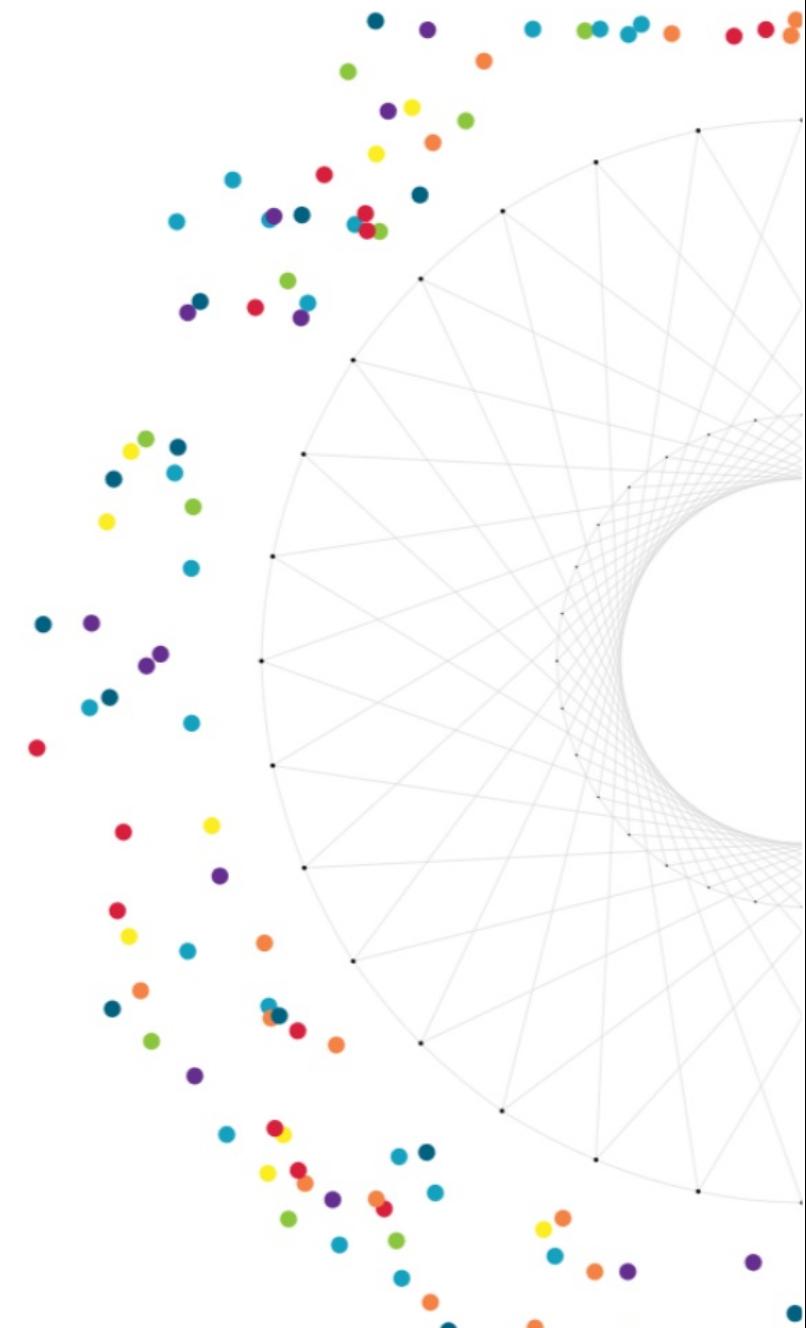
The control leverage limit:

At the beginning, we set equal weights in several volatile stocks based on their moving averages. The portfolio is firstly leveraged to 2.45x and starts to exit positions if the leverage exceeds 2.5x.



PART Three: Performance

Data used: 'FSLR', 'CREE', 'GRPN', 'NFLX', 'GMCR'



Turtle Trading Strategy

Du Yushu



Turtle Trading Strategy

³
Turtle **trading** is a well known trend following strategy that was originally taught by Richard Dennis.

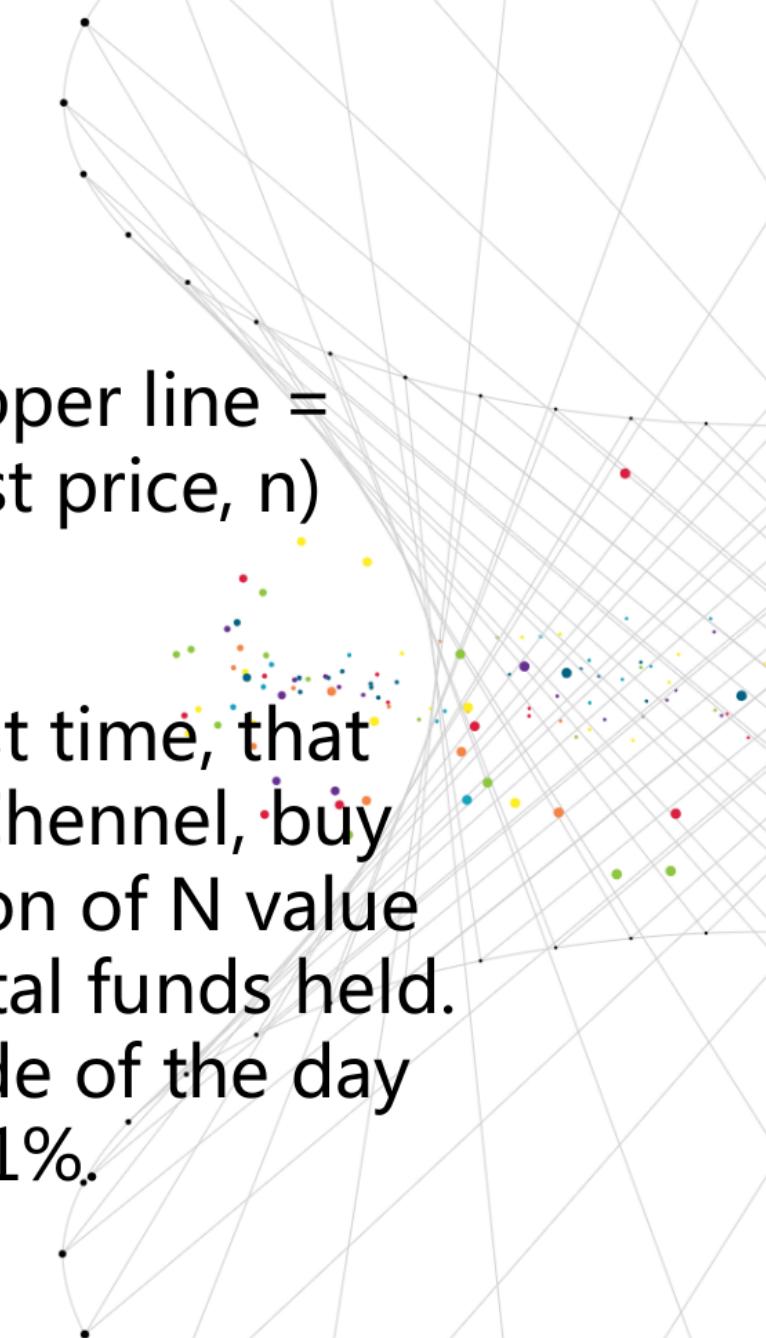
The basic strategy is to buy futures on a 20-day high (breakout) and sell on a 20-day low.

Basic method: when **the** price breaks **the** upper rail, it is **a** buy signal; conversely, when **the** price breaks **the** lower rail, it is a sell signal.

Turtle Trading Strategy

The calculation method of this indicator is: upper line = Max (highest price, n) lower line = Min (lowest price, n)
midline = (upper line + lower line) / 2

Position: When opening a position for the first time, that is, when the price breaks through Donchian Chennel, buy 1 Unit. The significance is to make a fluctuation of N value correspond to the fluctuation of 1% of the total funds held. If you buy 1 Unit (unit) of assets, the amplitude of the day makes the change of total assets not exceed 1%.



Results

01/01/2015 to 12/31/2019 \$ 1000000

Python 3.5 ▾

US Equities ▾

RETURNS
10.74%

ALPHA
-0.01

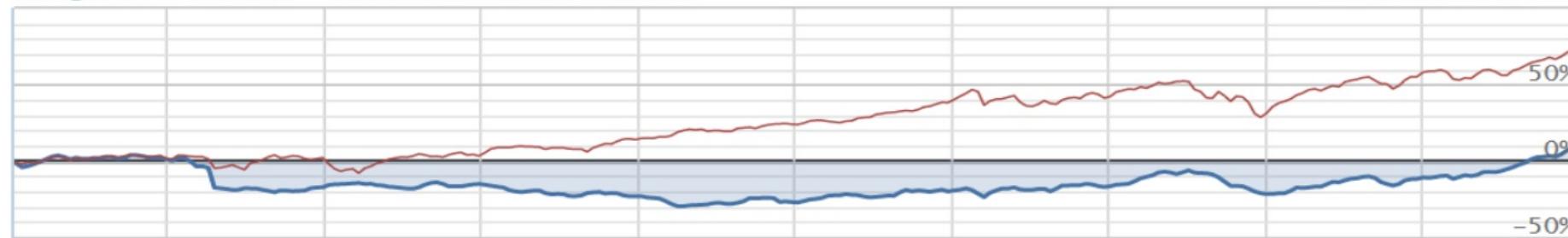
BETA
0.35

SHARPE
0.23

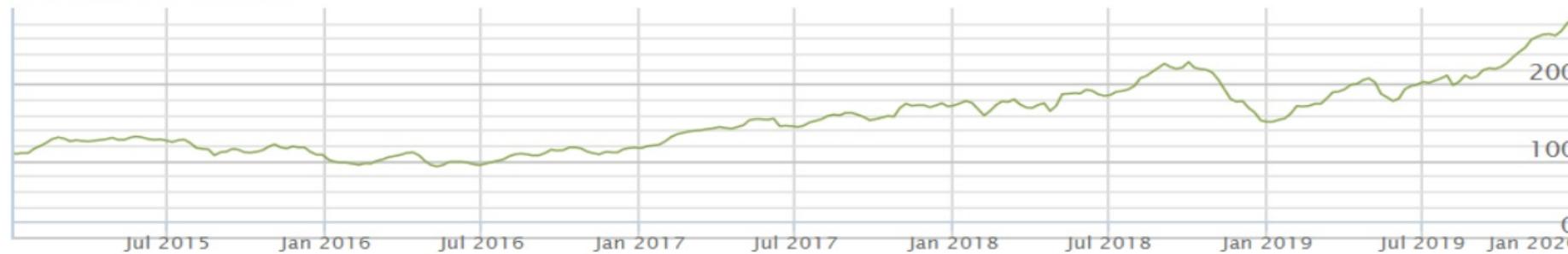
DRAWDOWN
-33.17%

Algorithm -13.51% Benchmark (SPY) 46.85%

Week of Jul 30, 2018



total_price 197.58



| 2016

| 2018

| 2020

Results

Overview Structure Risk Performance Activity Notebook

Total Returns 10.75 %

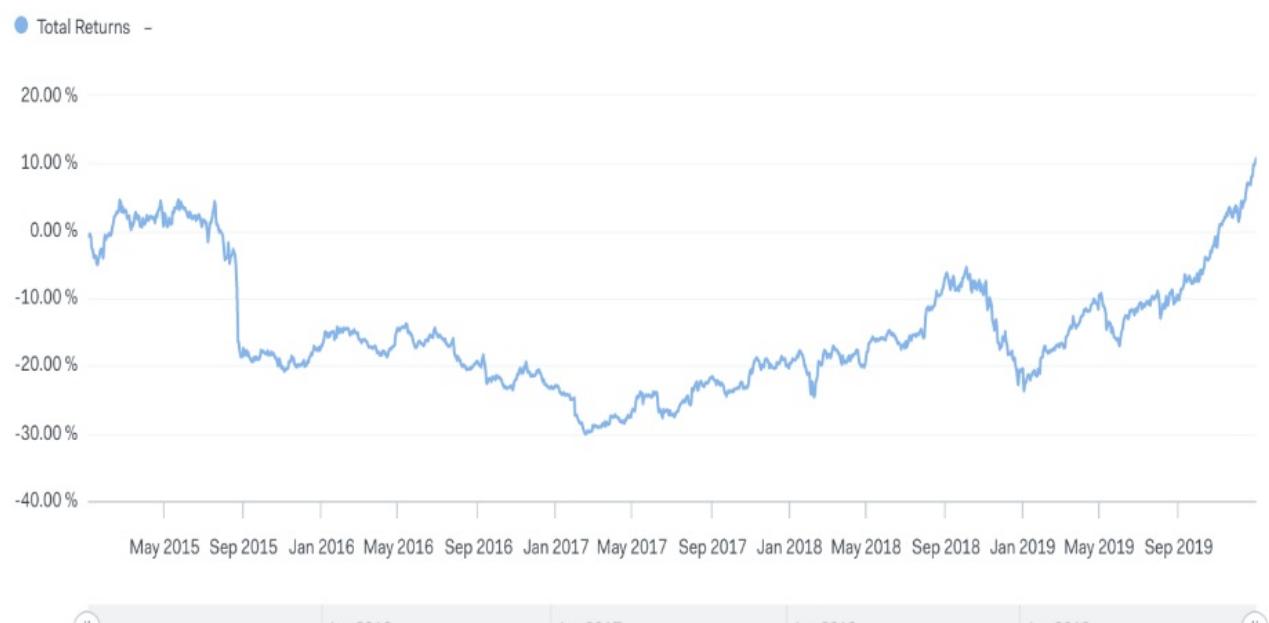
Specific Returns -18.41 %

Common Returns 34.25 %

Sharpe 0.08

Max Drawdown -33.17 %

Volatility 0.12



ⓘ The total percentage return of the portfolio from the start to the end of the backtest.

Momentum Trading Strategy

Du Yushu



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Momentum Trading Strategy

Momentum effect refers to assets with higher returns in the past, which will still obtain higher returns in the future, and assets with lower returns in the past will still receive lower returns in the future.

Momentum effect was proposed by Jegadeesh and Titman (1993). They believe that the return of stocks has a tendency to continue the original direction of movement, that is, stocks with higher returns in the past period will still achieve higher than average returns in the future. Momentum effect is to study the past historical market and predict that the past market will continue.

Results



Differential Trend Motion Strategy

HUANG, Jian



Data Selection and introduction

Two stocks { AINV (Apollo Investment Corporation)
 ANF. (Abercrombie & Fitch Co.)

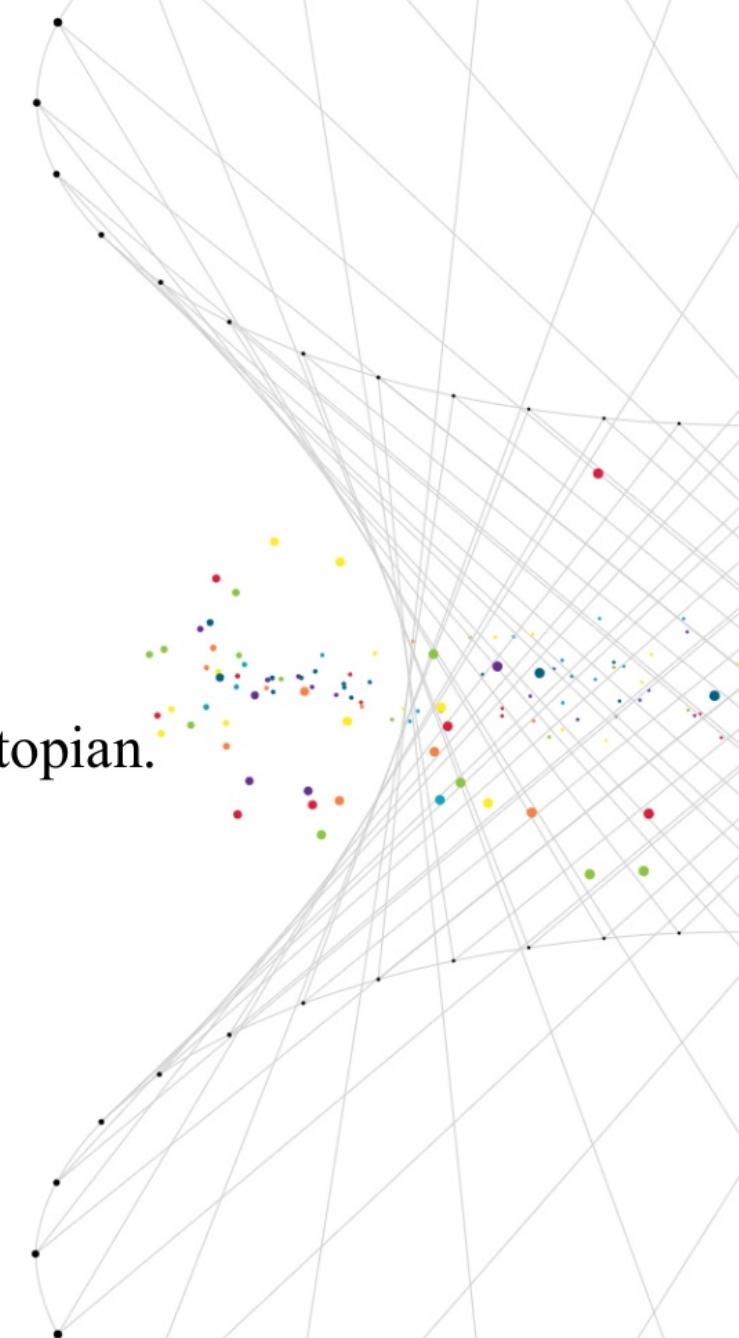
Back-testing system: at the Jupyter-notebook platform of Quantopian.



Training set

80%

Time line: Jan. 2nd, 2004 to May. 22th, 2020



Least square regression

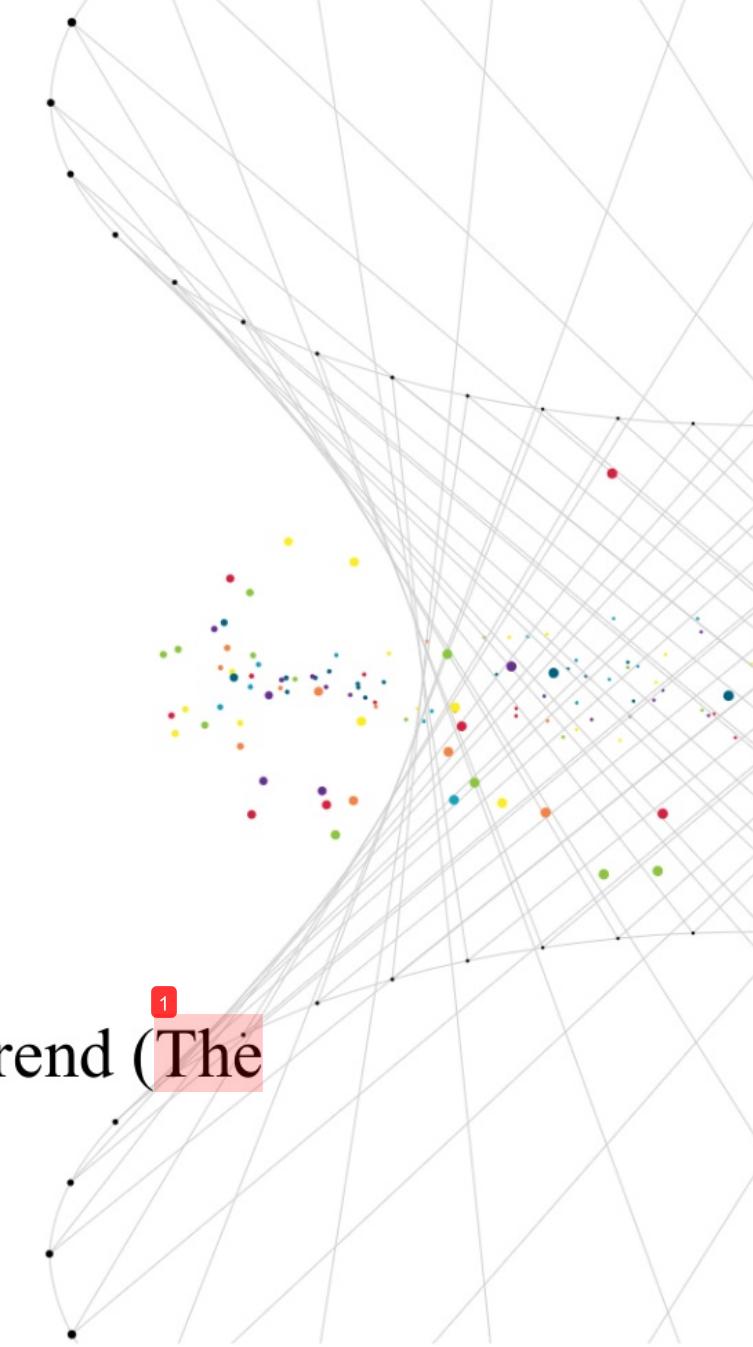
The **objective function** is:

$$\min_w \|Xw - y\|_2^2$$

The **unique solution** of it is:

$$w^* = (X^T X)^{-1} X^T y$$

This research we apply it to estimation of differential trend (The
moving average of first order differential price)



Differential trend motion model

$MV_{(n)}(P_t^* - P_{t-1}^*)$ ¹ is the differential trend of price and it is estimated by OLS model.

$MV_{(n)}(P_t - P_{t-1})$ ¹ is the real value of differential trend.

$MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2})$ ¹ represents the change (or called motion) of differential trend. ¹³

$$MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$$

$\Downarrow p_1$

$$MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$$

$\Downarrow p_2$

$$MV_{(n)}(P_t - P_{t-1}) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$$

$$MV_{(n)}(P_t - P_{t-1}) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$$

$$(P_t - P_{t-n}) - (P_{t-1} - P_{t-n-1}) > 0$$

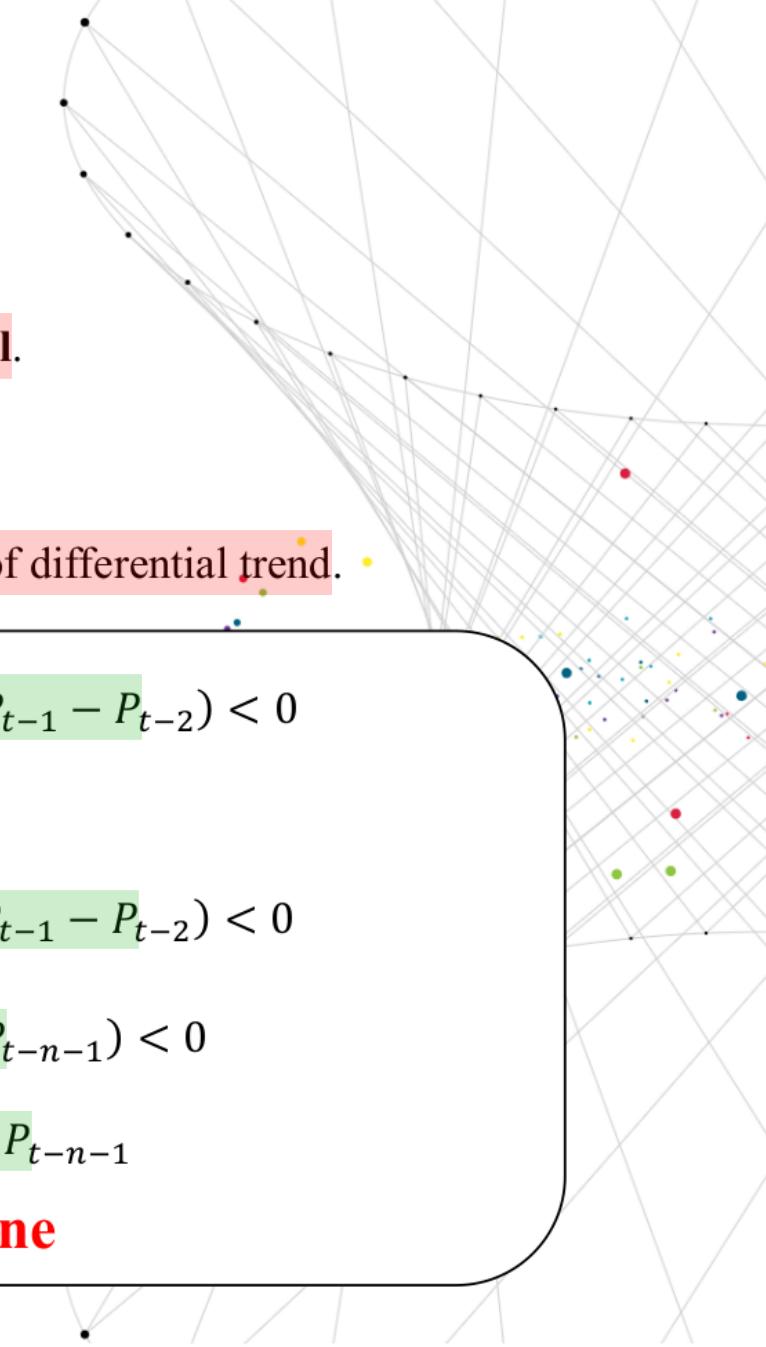
$$(P_t - P_{t-n}) - (P_{t-1} - P_{t-n-1}) < 0$$

$$P_t > P_{t-n} + P_{t-1} - P_{t-n-1}$$

$$P_t < P_{t-n} + P_{t-1} - P_{t-n-1}$$

Supported line

Restricted line



Factors that affect the trading strategies

Judgement of trading

$$P_t > P_{t-n} + P_{t-1} - P_{t-n-1}$$

(1) when Open price $< P_{t-n} + P_{t-1} - P_{t-n-1}$

① LONG at Open price

① SHORT at Close price

(2) if (1) cannot be satisfied, however, Low price $< P_{t-n} + P_{t-1} - P_{t-n-1} <$ High price,

① which means that the market price crosses the Supported line,

LONG at Suppted line

SHORT at Close price

$$P_t < P_{t-n} + P_{t-1} - P_{t-n-1}$$

(1) when Open price $> P_{t-n} + P_{t-1} - P_{t-n-1}$

SHORT at Open price

LONG at Close price

(2) if (1) cannot be satisfied, however, Low price $< P_{t-n} + P_{t-1} - P_{t-n-1} <$ High price,

① which means that the market price crosses the Restricted line,

① SHORT at Restricted line

LONG at Close price

Factors that affect the trading strategies

		Judgement	
		Right	Wrong
Have transaction	Profit	Loss	
	No profit	No profit	1

If $|Profit| > |Loss|$, keep the original trading strategy.

If $|Profit| < |Loss|$, change the LONG&SHORT direction of trading strategy.

In summary, the total profit gained from strategy depends on judgement, successful transaction rate, and the profit gain whenever transaction.

Differential trend motion Strategy for two stocks (AINV and ANF)

AINV

line = $P_{t-n} + P_{t-1} - P_{t-n-1}$ (optimal n for AINV is 677)

(1) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$ and line - open < 0:

SHORT at open price and LONG at close price

(2) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$, line - open > 0 and low price < line < high price (when price cross the standard line):

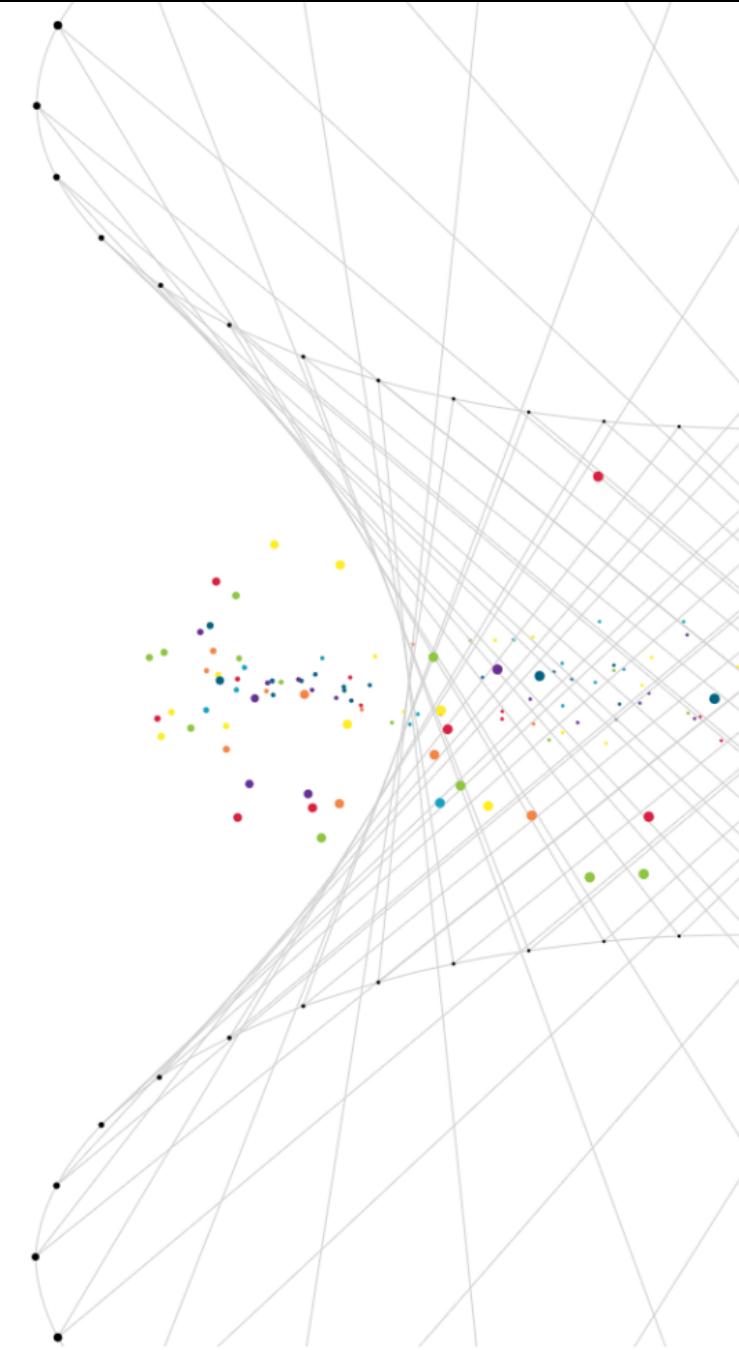
SHORT at standard line and LONG at close price

(3) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$ and open - line > 0:

SHORT at open price and LONG at close price

(4) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$, open - line < 0 and low price < line < high price

SHORT at standard line and LONG at close price



Differential trend motion Strategy for two stocks (AINV and ANF)

ANF

line = $P_{t-n} + P_{t-1} - P_{t-n-1}$ (optimal n for ANF is 1635)

(1) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$ and open - line < 0:

SHORT at open price and LONG at close price

(2) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) > 0$, open - line > 0 and low price <

line < high price (when price cross the standard line):

SHORT at standard line and LONG at close price

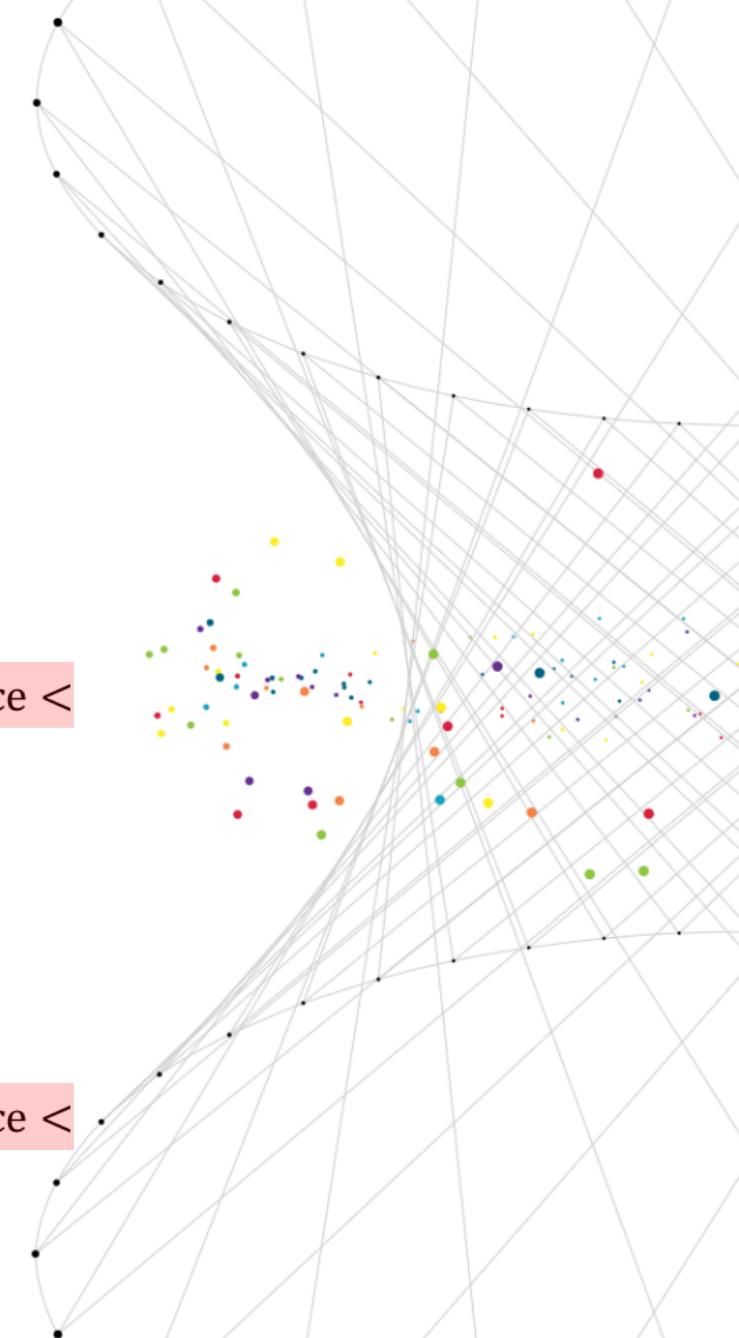
(3) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$ and line - open > 0:

SHORT at open price and LONG at close price

(4) If $MV_{(n)}(P_t^* - P_{t-1}^*) - MV_{(n)}(P_{t-1} - P_{t-2}) < 0$, line - open < 0 and low price <

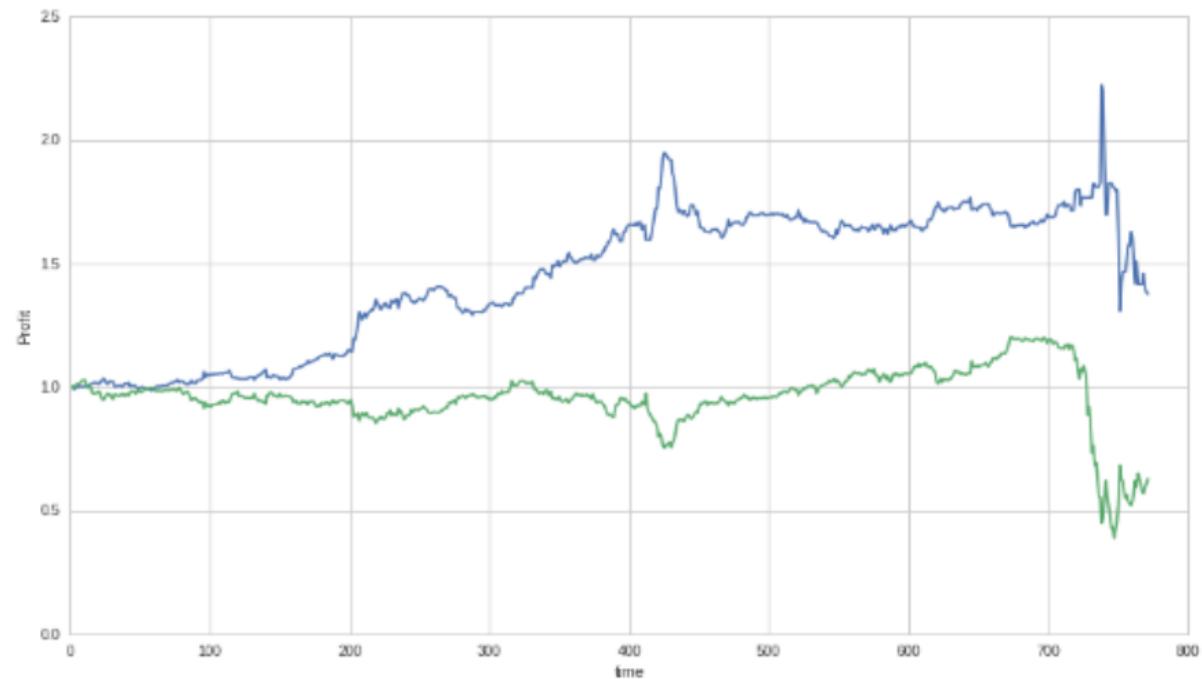
line < high price

LONG at standard line and SHORT at close price



Result of back-testing

AINV

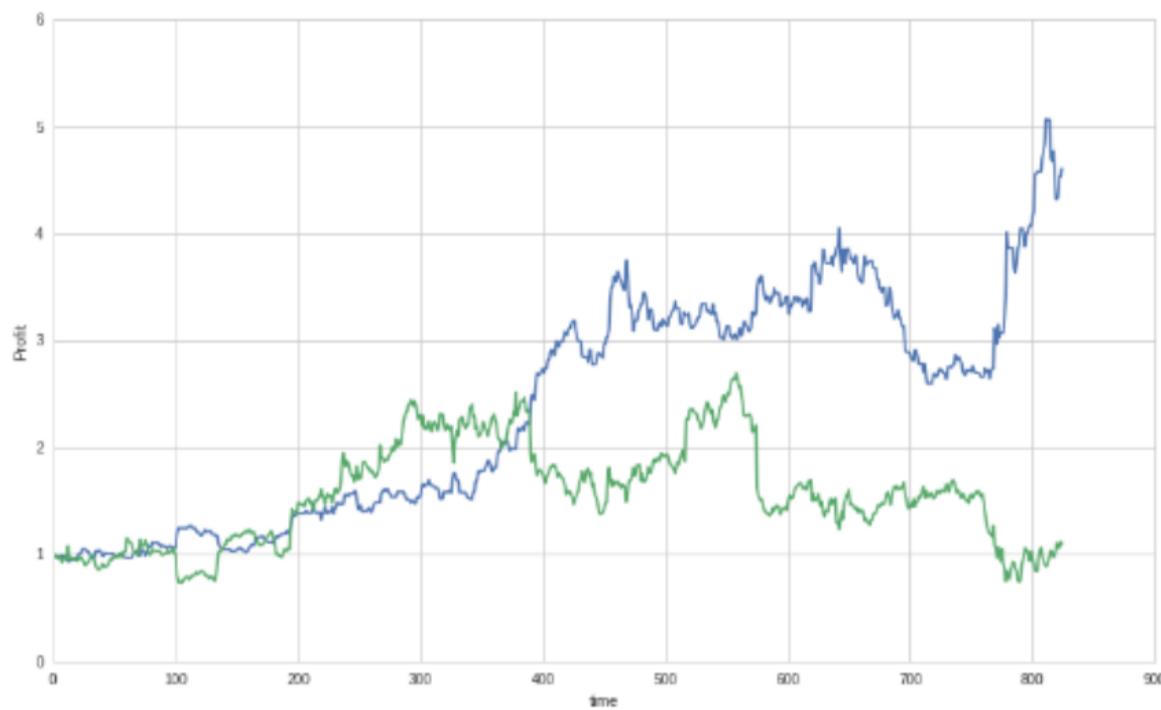


blue line is the strategy performance and green line is
benchmark which is buying and holding strategy

Optimal order	677
Annual return of strategy	0.12205754
Annual return of benchmark	-0.12091812
Sharp ratio of strategy	0.18268332
Sharp ratio of benchmark	-0.59718986
Daily maximum drawdown	-0.31120463
Daily 5% VAR of strategy	-0.04851153

Result of back-testing

ANF



blue line is the strategy performance and green line is
benchmark which is buying and holding strategy

Optimal order	1635
Annual return of strategy	1.09299462
Annual return of benchmark	0.03012813
Sharp ratio of strategy	1.02593541
Sharp ratio of benchmark	-0.01028494
Daily maximum drawdown	-0.36371073
Daily 5% VAR of strategy	-0.11235758



Psy Strategy

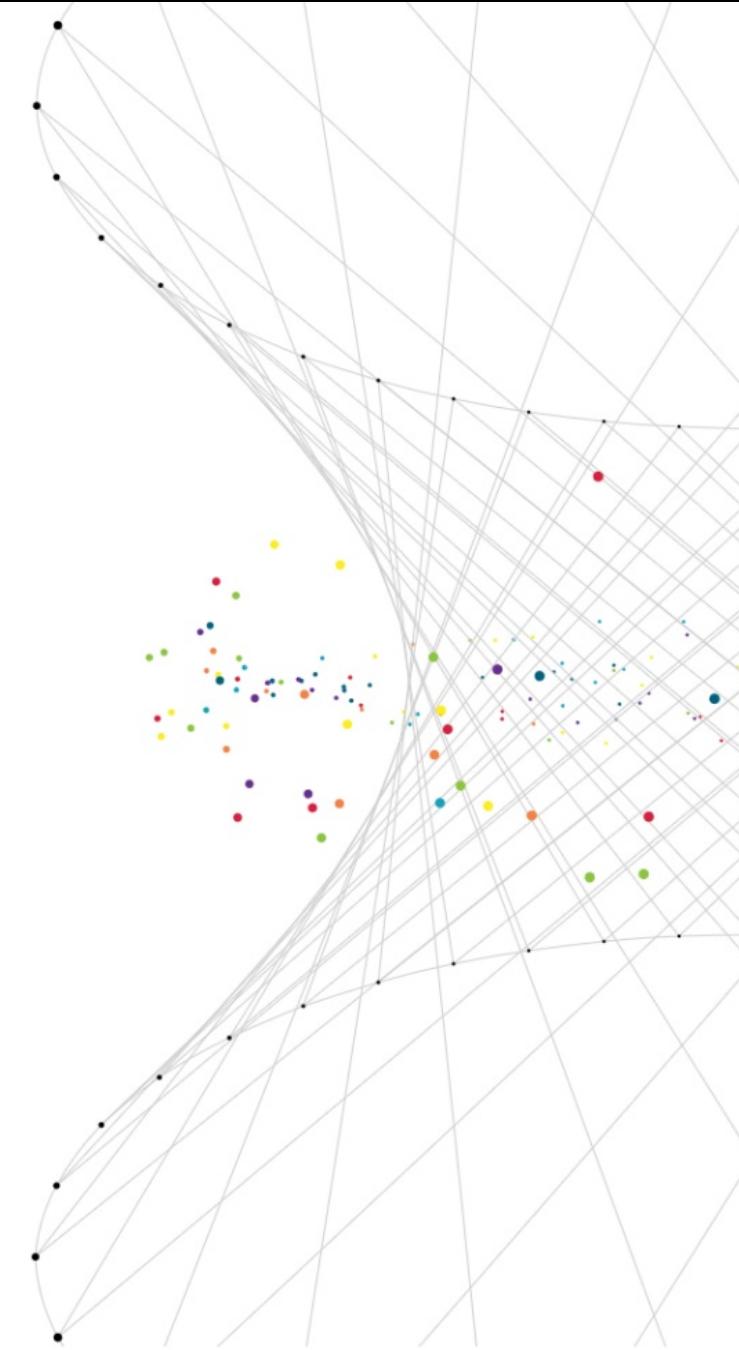
Tong Jiaqu

Office**PLUS**.cn

PART ONE Pipeline API



- select assets by the method of filtering
- set a function to determine the value of assets
- assign weights to each asset in the portfolio



PART TWO Psy Strategy

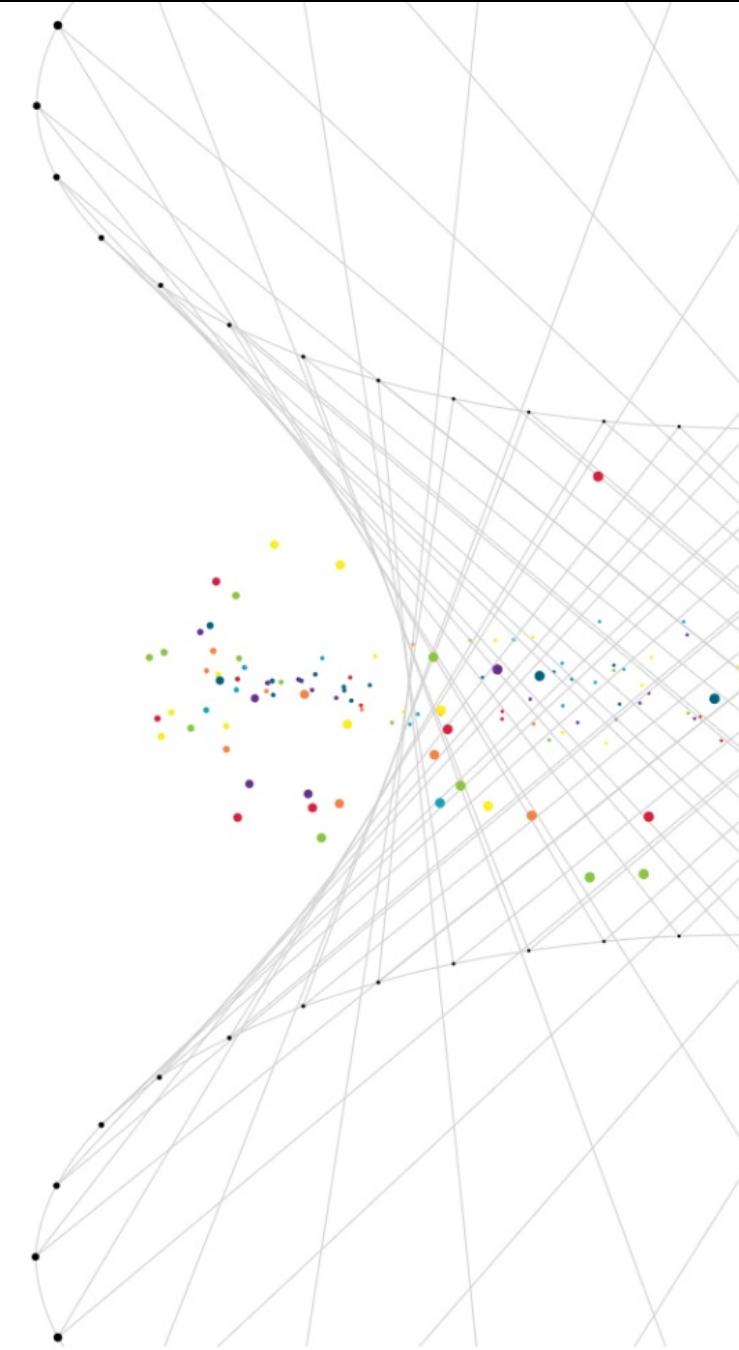
Psy Strategy

Use the simple moving average and bull_minus_bear index in the stockwits module to define a moving average curve.
The object gotten is named psy.

The strategy:

Assets with high psy values are considered high-value assets and vice versa.

Then, based on the psy value of the asset and accepting some restrictions, find a target portfolio with the highest profit.



PART TWO Psy Strategy

Psy Strategy

Rebalance: once a week

Three constraints:

- The ratio of each asset to all assets held (size)

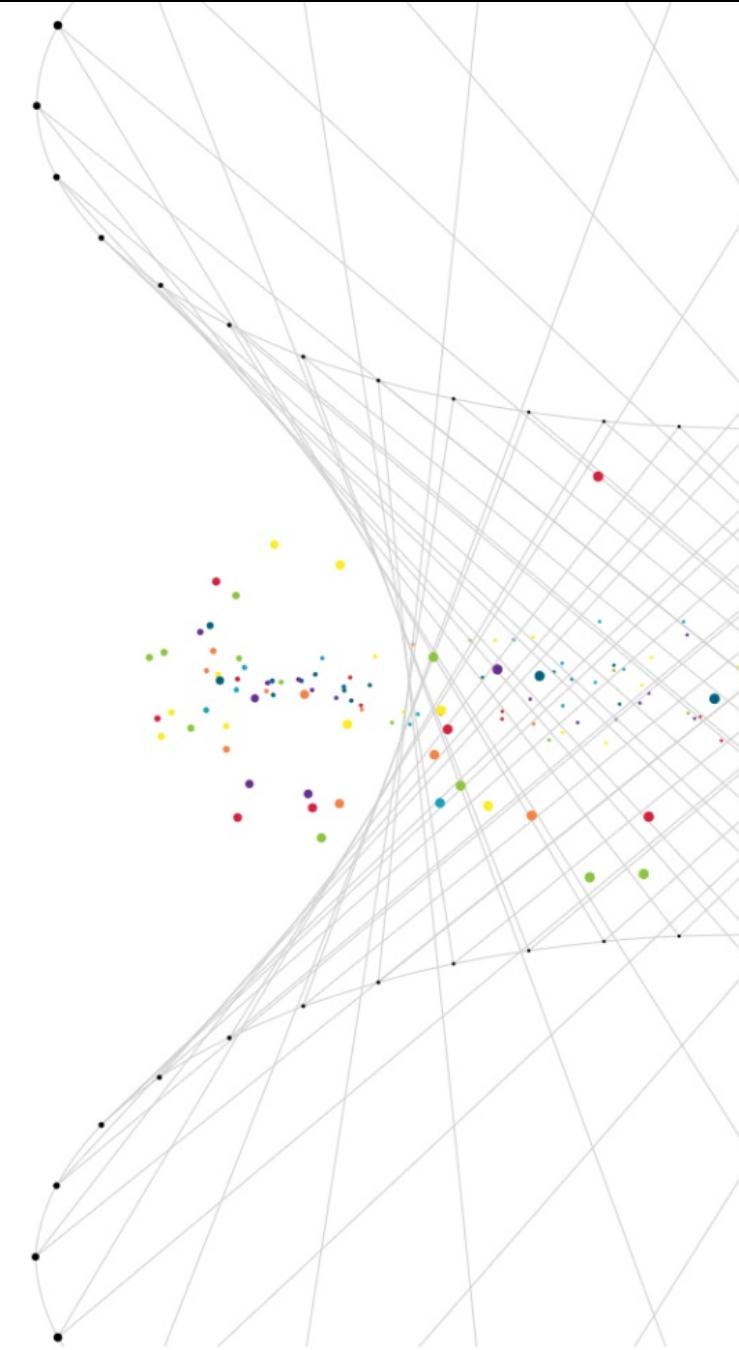
The ratio set in the strategy is 0.05, which means that the maximum share of an asset in all assets cannot exceed 5%.

- Leverage ratio

In the strategy, the leverage ratio is set to 1, that is, short selling is not allowed.

- Turnover rate

The turnover rate is set to 0.60, which means that all assets cannot be changed at the same time in one rebalance.



PART TWO Psy Strategy

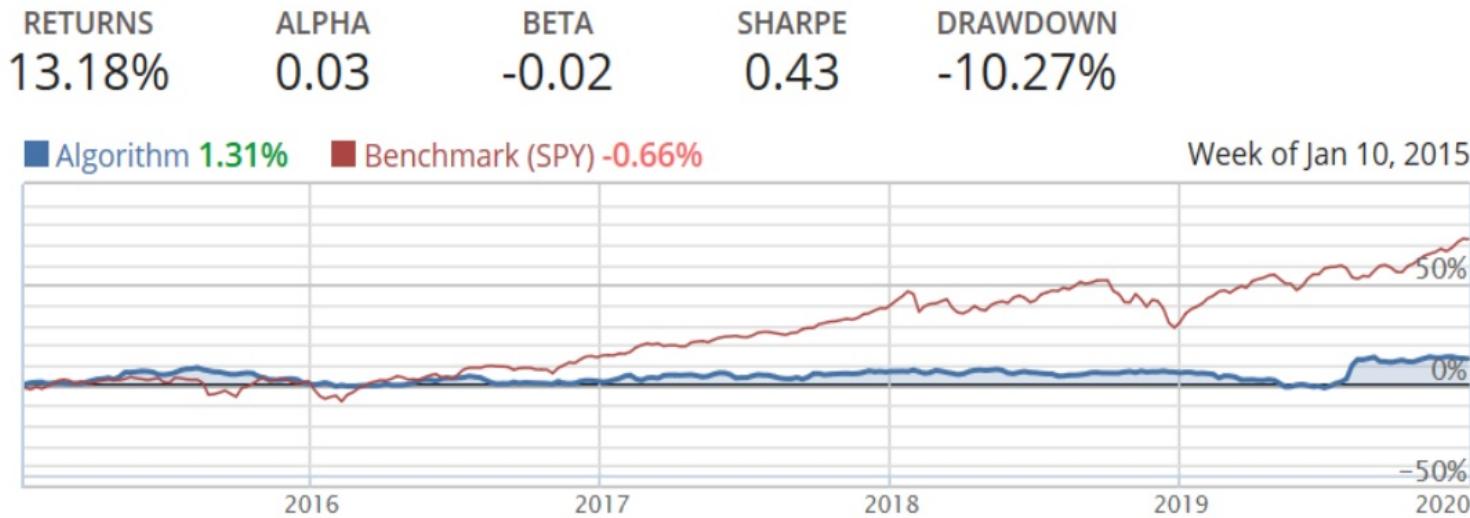


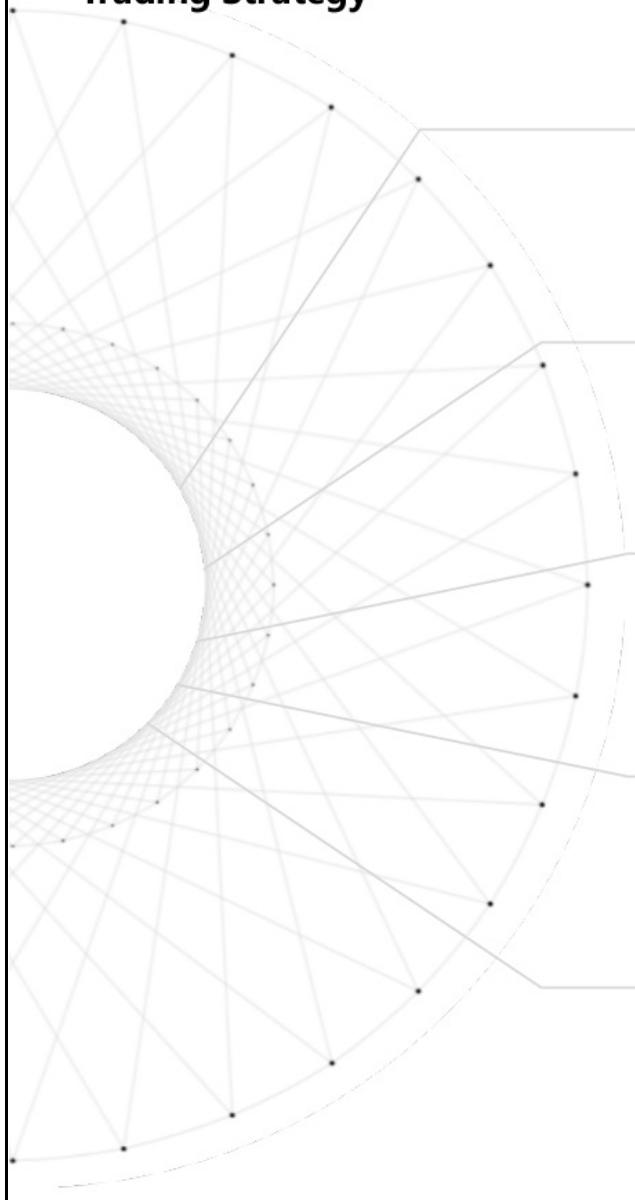
Figure: Algorithm and benchmark performance from
2015-01-01 to 2019-12-31



Pairs Trading

Yu Rong

Trading Strategy



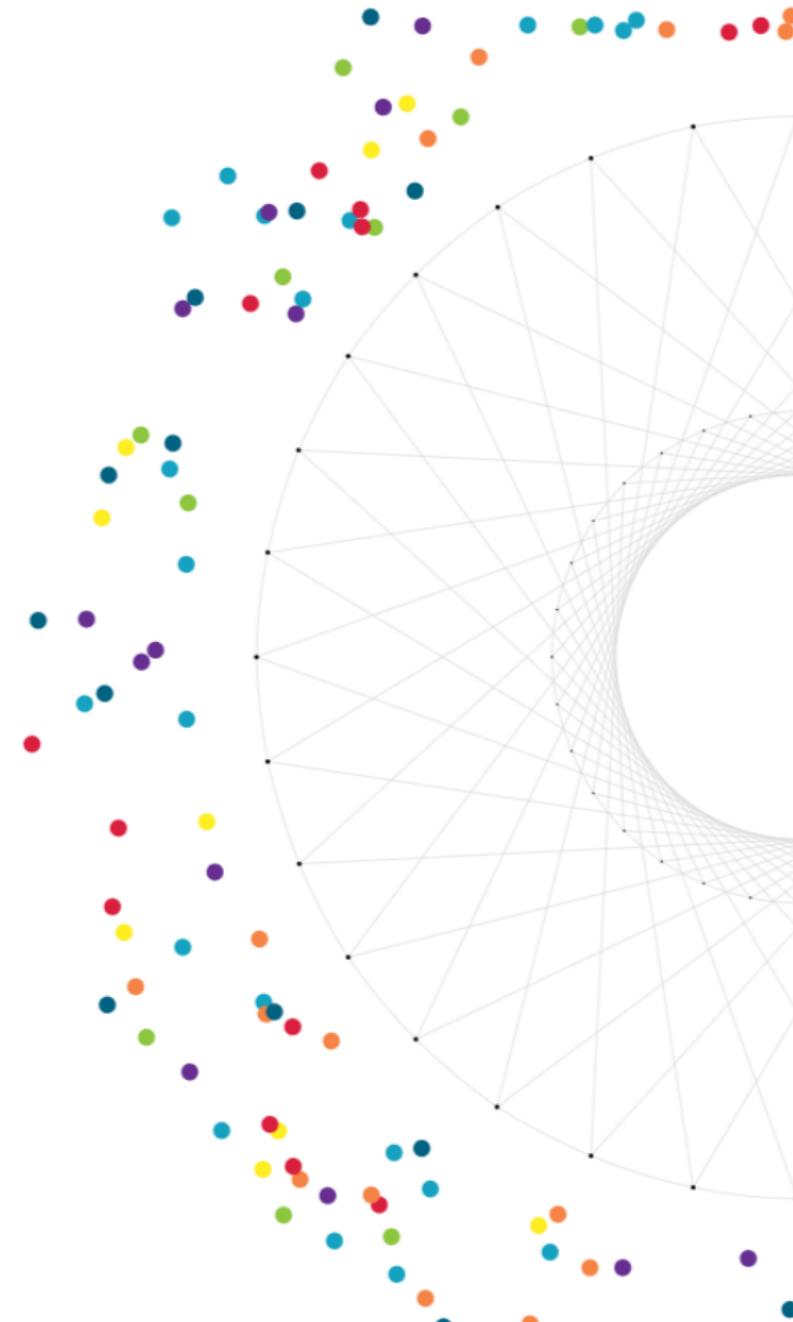
- 1 ● Pairs Trading Introduction
- 2 ● Our strategy – Multiple Pairs Trading
- 3 ● Stock Selection
- 4 ● Parameter Setting
- 5 ● Performance

PART ONE: Pairs trading introduction

7

Pairs Trading

- attempts to resolve this using ⁶ the idea of relative pricing; that is, if two stocks whose prices showed similar behavior over a long period of time, then the prices of both securities must be more or less the same
- involves a long-short position when the spread is substantially away from its mean value, betting that the mispricing is likely to correct itself ⁹
- The greater the spread, the higher the magnitude of mispricing and greater the profit potential ⁶



PART TWO: Multiple pairs trading (all possible pairs among 10 stocks)

Step 1

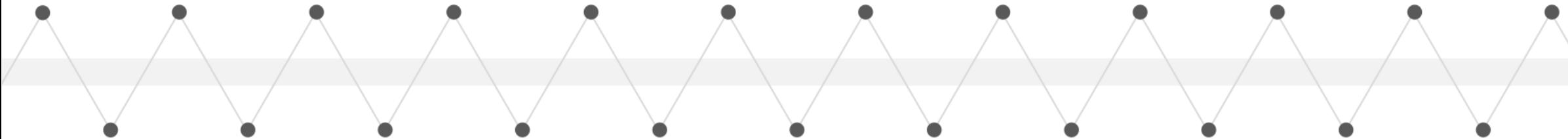
Define hedged spread :
 $\text{Spread} = \text{Stock1Price} - \text{HedgeRatio} \times \text{Stock2Price}$

Step 2

Define Z-score:
 $\text{Z-score} = (\text{SMA30(Spread)} - \text{Spread}) / \text{STD30(Spread)}$

Step 3

short spread when its value rises above 2 standard deviations ($\text{Z-score} > \text{EnterThreshold}$); long the Spread when its value rises above 2 standard deviations ($\text{Z-score} < -\text{EnterThreshold}$).



Step 4

Exist any spread position when its value is within 0.2 standard deviation of its mean (Exit the short position if $\text{Z-score} < \text{ExitThreshold}$; exit the long position if $\text{Z-score} > -\text{ExitThreshold}$)

Step 5

Trade all possible pairs among selected securities.

PART THREE: Stock Selection

JD.COM ('JD'), Alibaba ('BABA'), Apple Inc. (AAPL), Microsoft Corporation ('MSFT'), Concho Resources Inc. ('CZO'), Pioneer Natural Resources Compa ('PXD'), Analog Devices Inc. ('ADI'), Texas Instruments Incorporated ('TXN'), McDonald's Corporation ('MCD'), Coca-Cola Company('KO').



PART FOUR: Parameter Setting



Hedge Ratio

- the numbers of shares of the second security versus one share of the first security
- perform a regression analysis to determine the hedge ratio



EnterThreshold

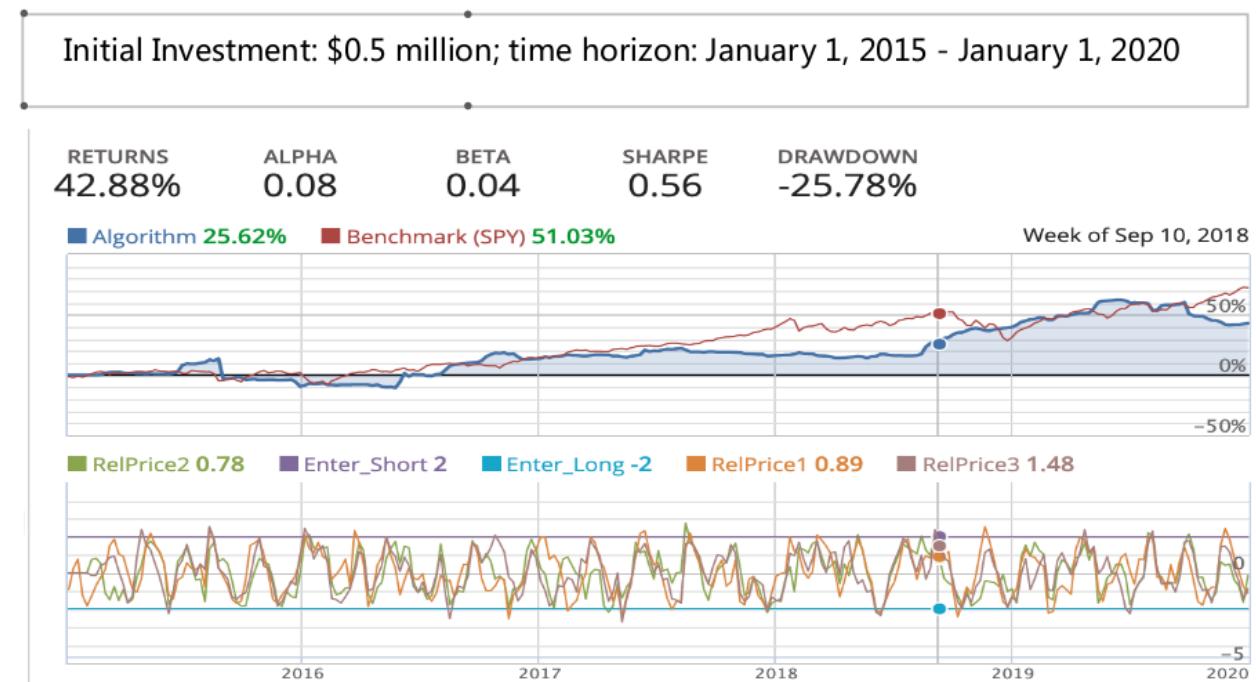
2 standard deviations



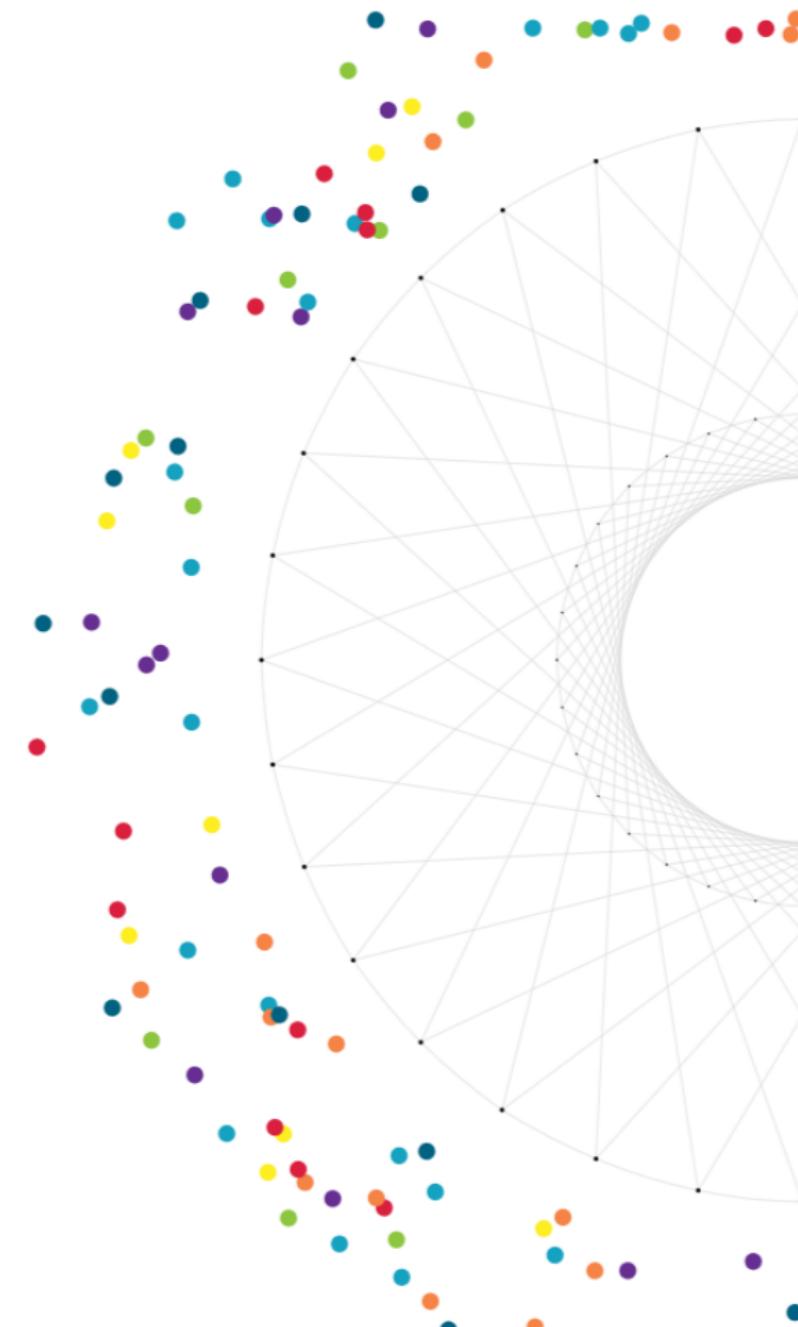
ExitThreshold

0.2 standard deviation

PART FIVE: Performance

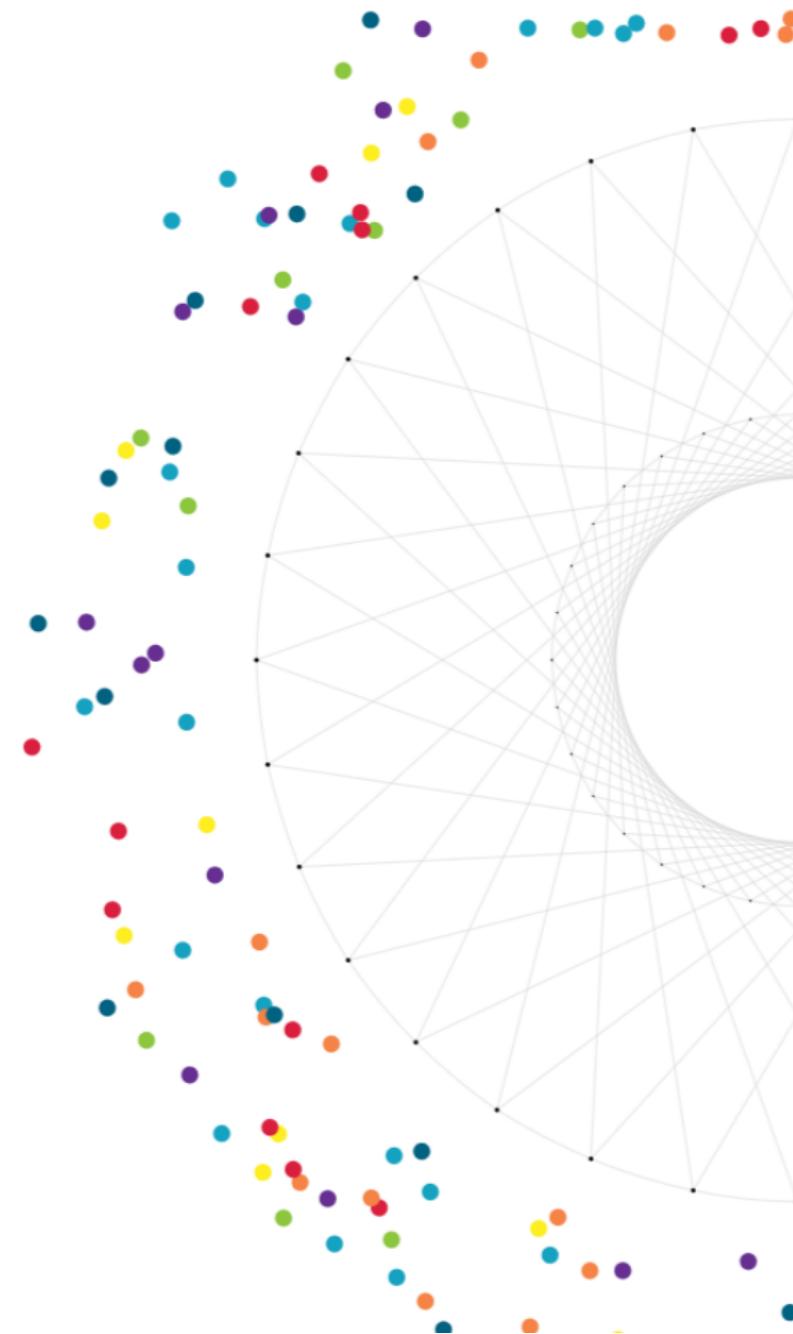


```
2019-12-27 04:59 PRINT -----N-E-X-T---D-A-Y-----
2019-12-27 22:31 PRINT Ex Long : 10-th pair ; 0.000000 @ BABA and 0.000000 @ AAPL
2019-12-27 22:31 PRINT Ex Short : 21-th pair ; 0.000000 @ AAPL and 0.000000 @ ADI
2019-12-27 22:31 PRINT Ex Short : 29-th pair ; 0.000000 @ MSFT and 0.000000 @ MCD
2019-12-27 22:31 PRINT Ex Short : 30-th pair ; 0.000000 @ MSFT and 0.000000 @ KO
2019-12-28 04:59 PRINT -----N-E-X-T---D-A-Y-----
2019-12-30 22:31 PRINT Ex Long : 11-th pair ; 0.000000 @ BABA and 0.000000 @ MSFT
2019-12-31 04:59 PRINT -----N-E-X-T---D-A-Y-----
2019-12-31 22:31 PRINT Ex Long : 2-th pair ; 0.000000 @ JD and 0.000000 @ AAPL
2019-12-31 22:31 PRINT Go Long : 18-th pair ; -0.012454 @ AAPL and 0.022222 @ MSFT
2019-12-31 22:31 PRINT Ex Short : 19-th pair ; 0.000000 @ AAPL and 0.000000 @ CXO
2019-12-31 22:31 PRINT Ex Short : 22-th pair ; 0.000000 @ AAPL and 0.000000 @ TXN
2020-01-01 04:59 PRINT -----N-E-X-T---D-A-Y-----
```



Conclusion

- Control leverage strategy performs very well, especially after 2018, since it can make take advantage of the momentum strategy as well as limit the leverage.
- The returns of these turtle and momentum strategies are no more than 20%, which not good enough. In the future, we can optimize the strategies.
- Differential trend motion strategy has been successfully applied to two stocks--ANF and AINV. Their annual return and sharp ratio can outperform the benchmark. Especially, ANF can gain 109% of annual return.
- The reason why psy strategy does not outperform the benchmark is that for complex financial markets, simple models cannot work well, and the factor used is too subjective and worth improving.
- For being a successful pairs trading strategy, it is of great importance to know when to initiate the pairs trade and when to close all positions.
12





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