Tamkang University
淡江大學

人工智慧投資分析

Artificial Intelligence for Investment Analysis

投資組合最佳化與程式交易

(Portfolio Optimization and Algorithmic Trading)

1071AIIA10
EMBA, IMTKU (M2399) (8540)
Thu 12,13,14 (19:20-22:10) (D503)

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Assistant Professor
專任助理教授
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淡江大學 資訊管理學系
http://mail. tku.edu.tw/myday/

2018/12/20

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2018/09/13	人工智慧投資分析課程介紹 (Course Orientation on Artificial Intelligence for Investment Analysis)
2	2018/09/20	AI 金融科技: 金融服務創新應用 (AI in FinTech: Financial Services Innovation and Application)
3	2018/09/27	機器人理財顧問與AI交談機器人 (Robo-Advisors and AI Chatbots)
4	2018/10/04	投資心理學與行為財務學 (Investing Psychology and Behavioral Finance)
5	2018/10/11	財務金融事件研究法 (Event Studies in Finance)
6	2018/10/18	人工智慧投資分析個案研究 I (Case Study on Artificial Intelligence for Investment Analysis I)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
7	2018/10/25	Python AI投資分析基礎 (Foundations of AI Investment Analysis in Python)
8	2018/11/01	Python Pandas量化投資分析 (Quantitative Investing with Pandas in Python)
9	2018/11/08	Python Scikit-Learn 機器學習 (Machine Learning with Scikit-Learn in Python)
10	2018/11/15	期中報告 (Midterm Project Report)
11	2018/11/22	TensorFlow 深度學習財務時間序列預測 I (Deep Learning for Financial Time Series Forecasting with TensorFlow I)
12	2018/11/29	TensorFlow 深度學習財務時間序列預測 II (Deep Learning for Financial Time Series Forecasting with TensorFlow II)

課程大綱 (Syllabus)

週次 (Week)　日期 (Date)　內容 (Subject/Topics)

13 2018/12/06 人工智慧投資分析個案研究 II
(Case Study on Artificial Intelligence for Investment Analysis II)

14 2018/12/13 TensorFlow 深度學習財務時間序列預測 III
(Deep Learning for Financial Time Series Forecasting with TensorFlow III)

15 2018/12/20 投資組合最佳化與程式交易
(Portfolio Optimization and Algorithmic Trading)

16 2018/12/27 自然語言處理 (Natural Language Processing)

17 2019/01/03 期末報告 I (Final Project Presentation I)

18 2019/01/10 期末報告 II (Final Project Presentation II)

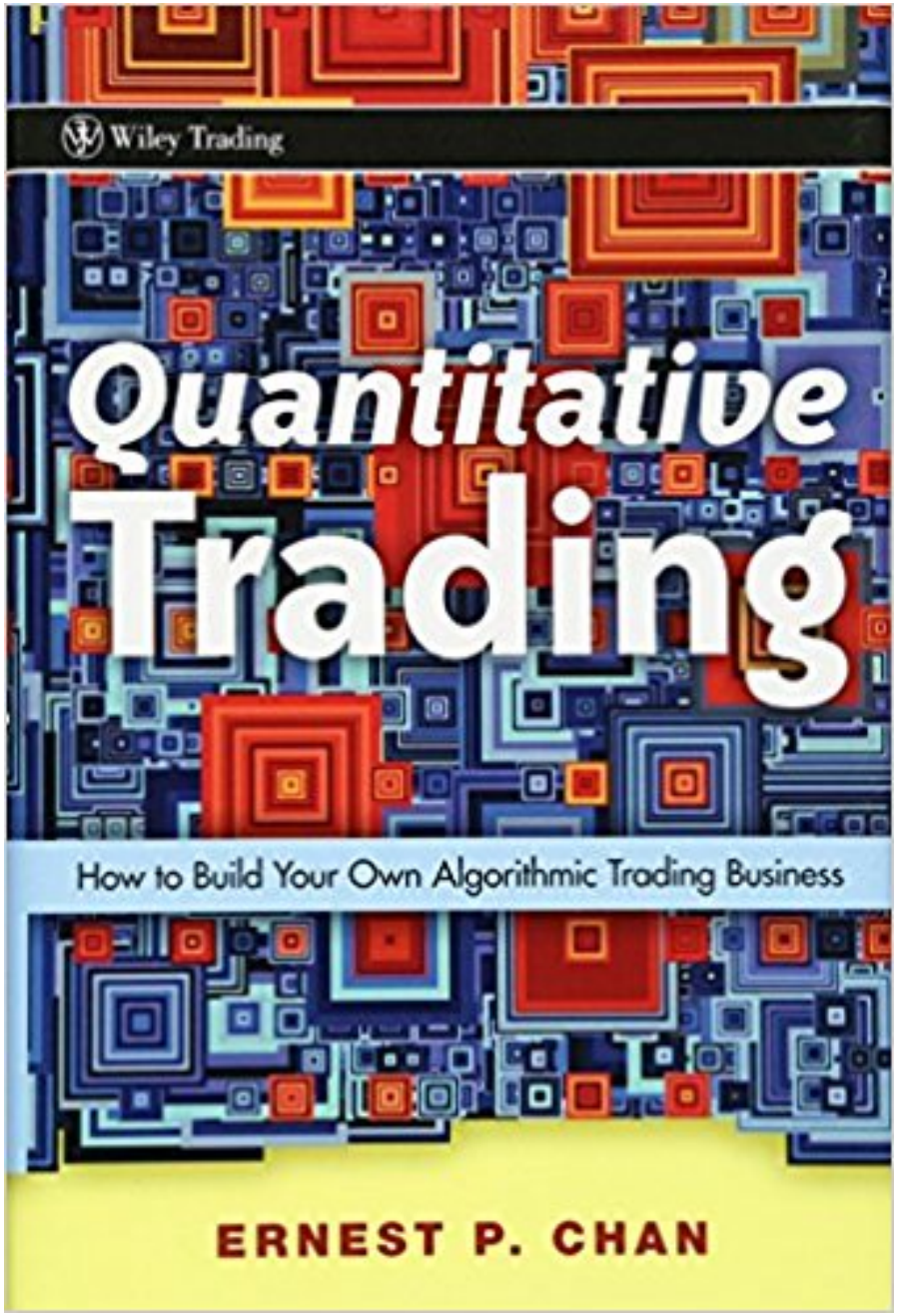
Portfolio Optimization and Algorithmic Trading

Outline

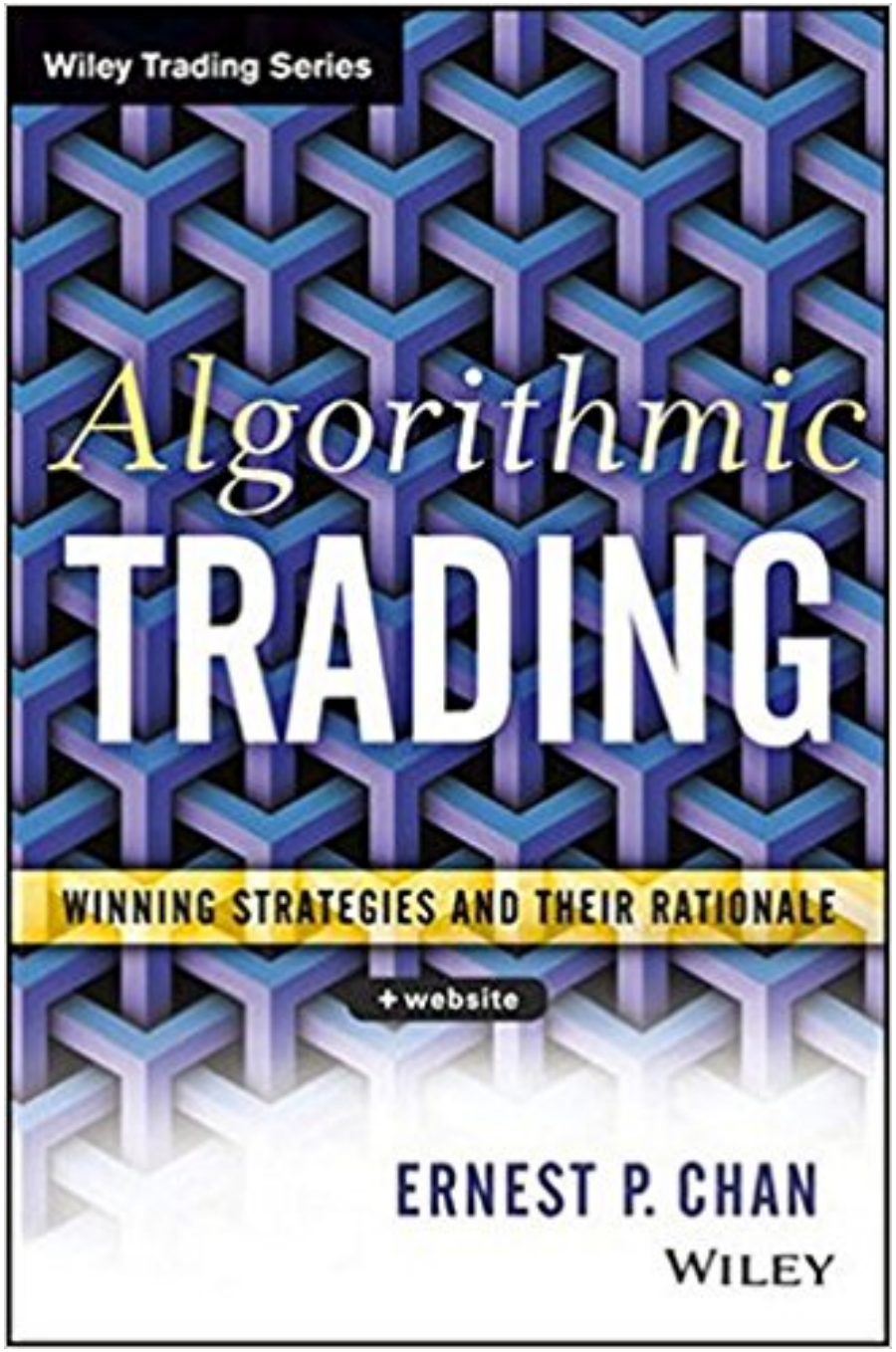
- Portfolio Optimization
- Algorithmic Trading

Portfolio Optimization

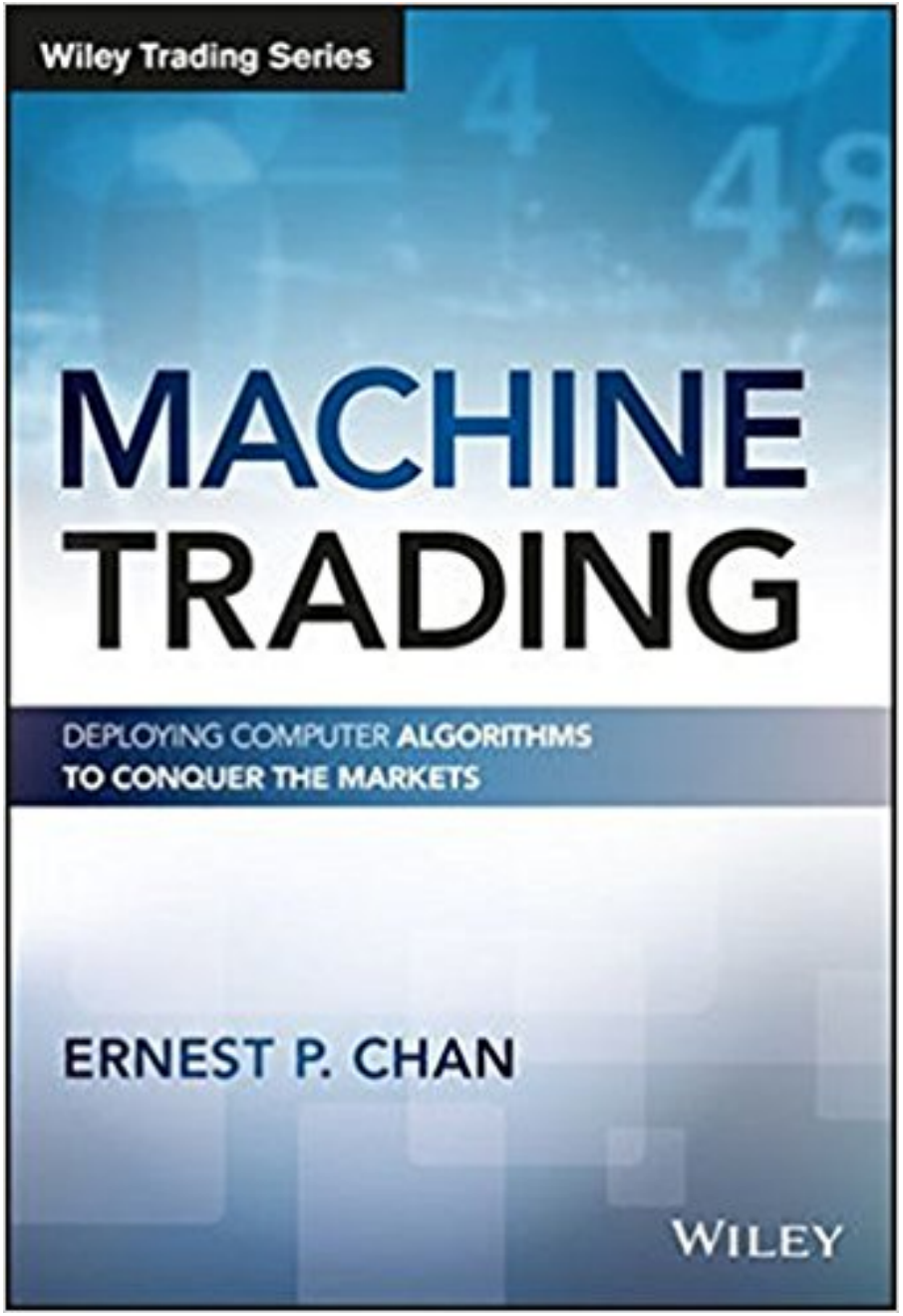
Algorithmic Trading



Source: Ernie Chan (2008), “Quantitative Trading: How to Build Your Own Algorithmic Trading Business”, Wiley

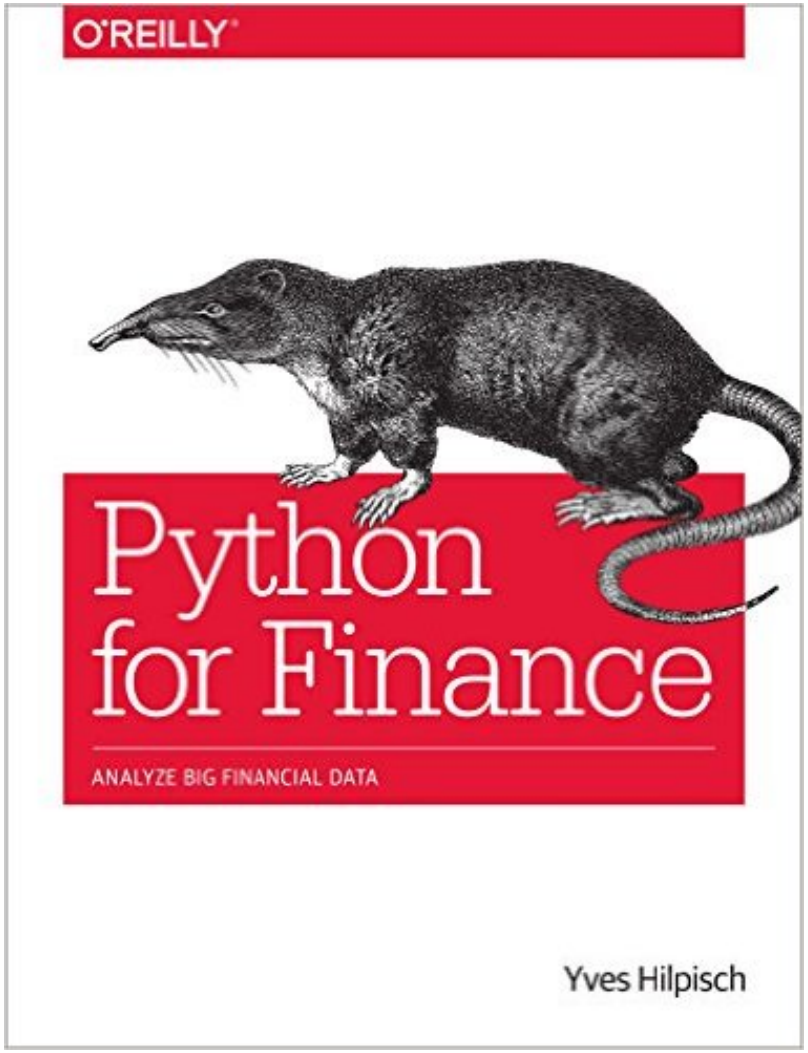


Source: Ernie Chan (2013), “Algorithmic Trading: Winning Strategies and Their Rationale”, Wiley



Source: Ernest P. Chan (2017), “Machine Trading: Deploying Computer Algorithms to Conquer the Markets”, Wiley

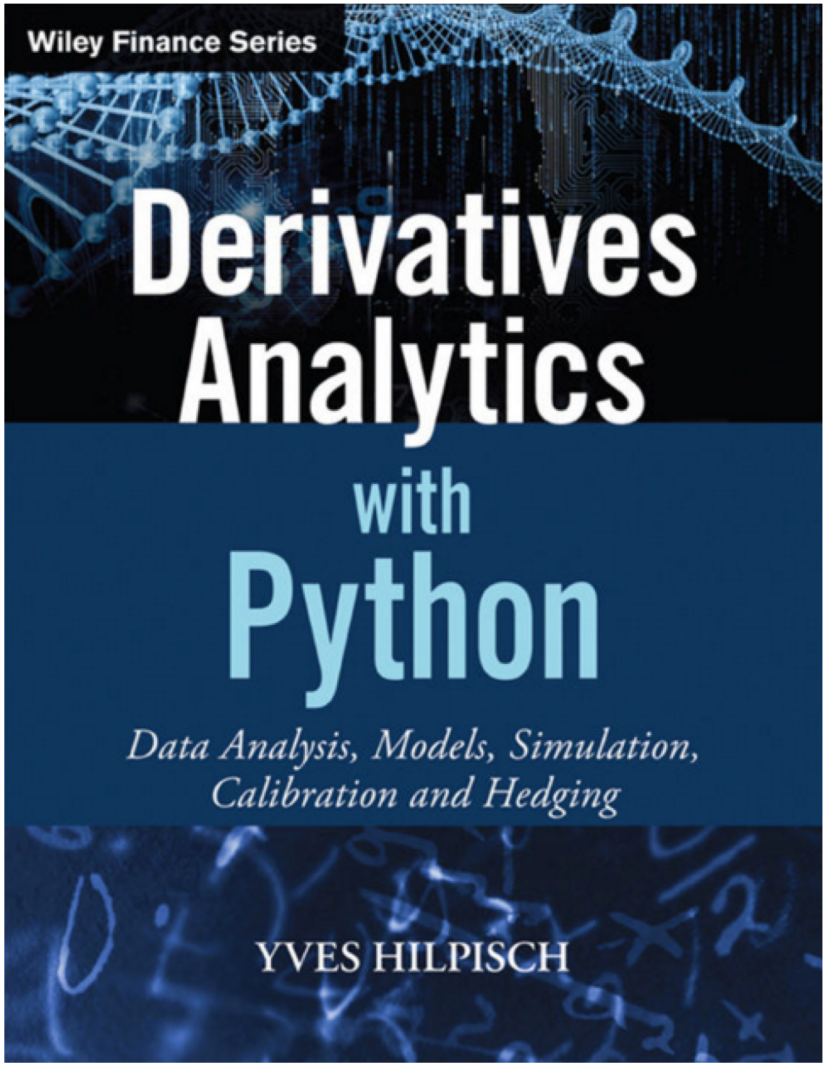
Yves Hilpisch, Python for Finance: Analyze Big Financial Data, O'Reilly, 2014



Source: http://www.amazon.com/Python-Finance-Analyze-Financial-Data/dp/1491945281

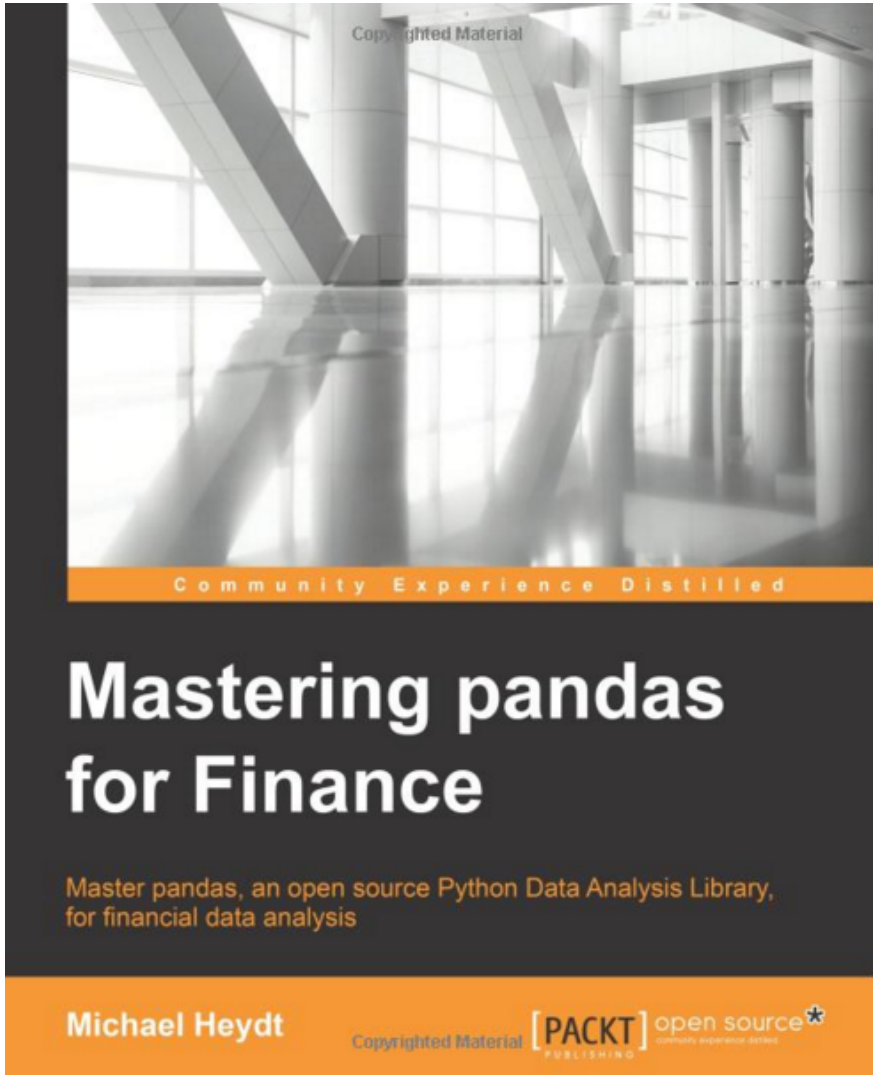
Yves Hilpisch (2015), Derivatives Analytics with Python:

Data Analysis, Models, Simulation, Calibration and Hedging, Wiley



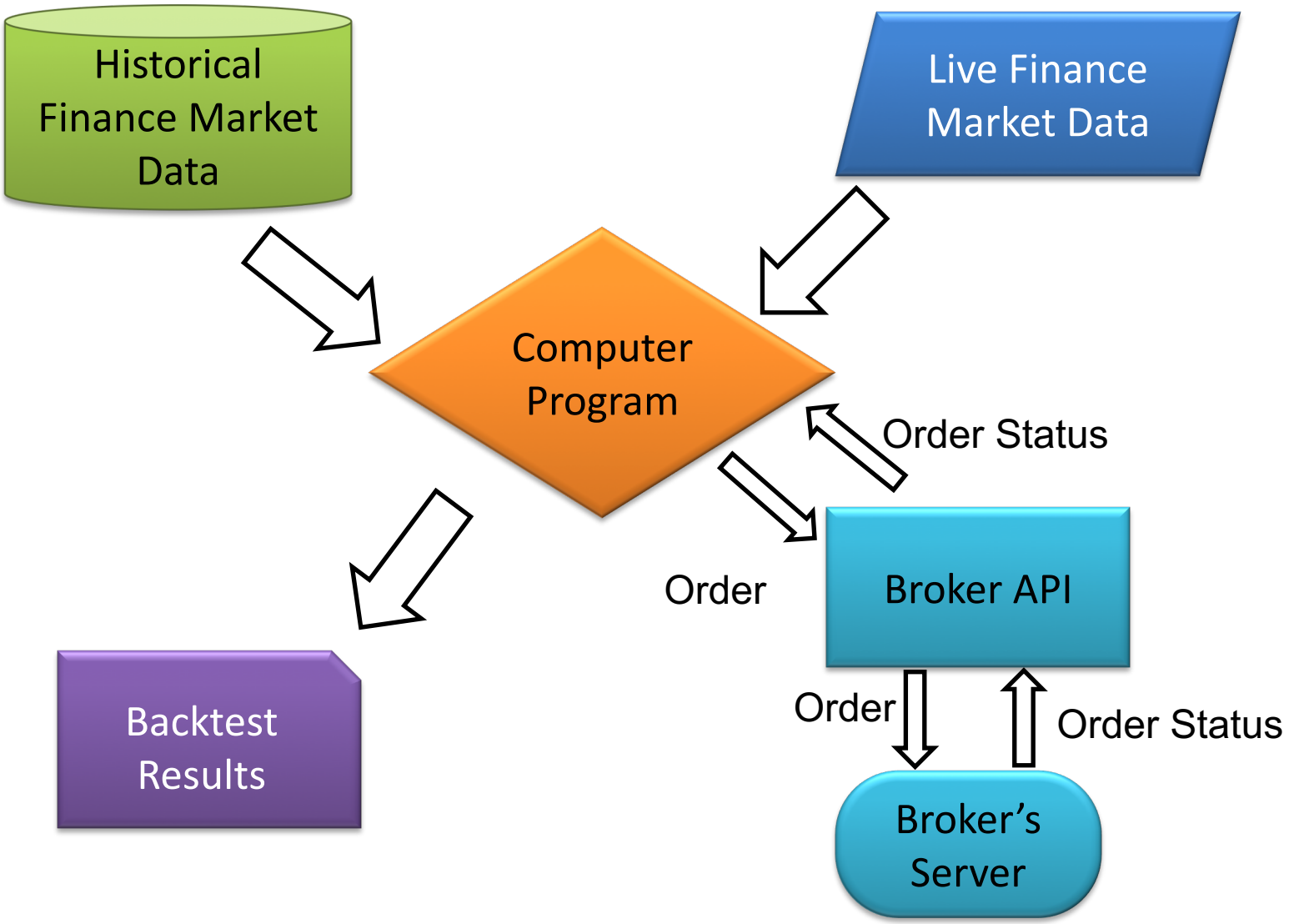
Source: http://www.amazon.com/Derivatives-Analytics-Python-Simulation-Calibration/dp/1119037999/

Michael Heydt ,
Mastering Pandas for Finance,
Packt Publishing, 2015



Source: http://www.amazon.com/Mastering-Pandas-Finance-Michael-Heydt/dp/1783985100

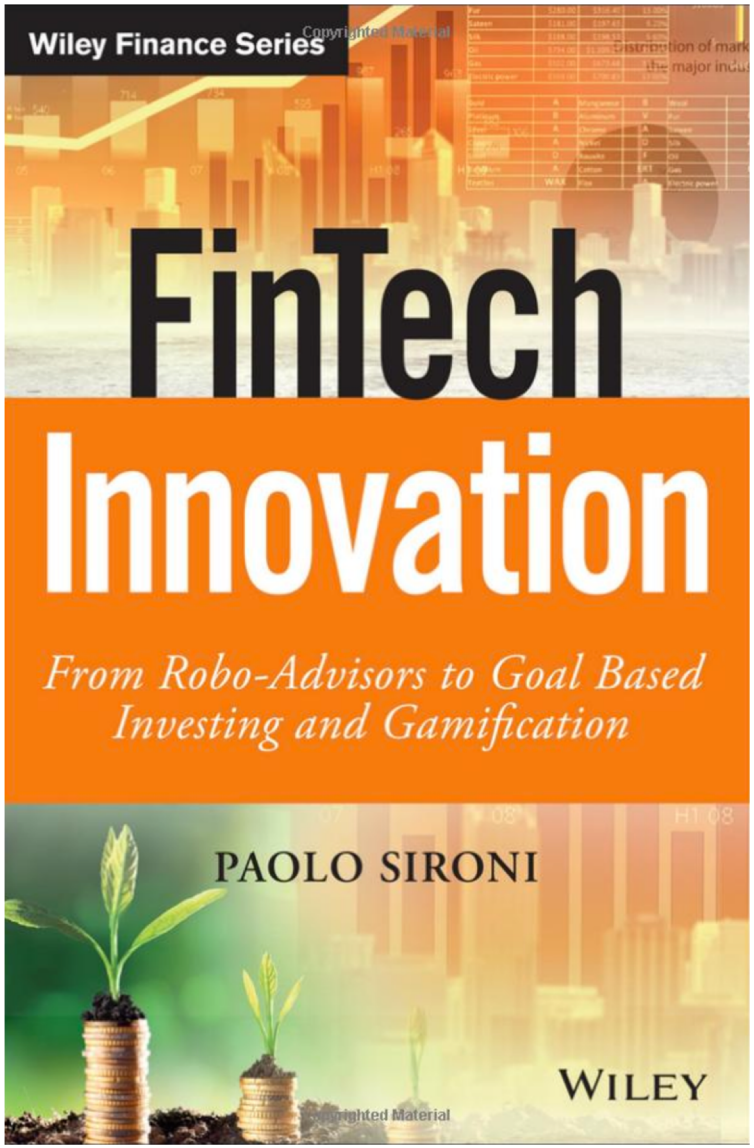
Algorithmic Trading



Source: Ernest P. Chan (2017), Machine Trading: Deploying Computer Algorithms to Conquer the Markets, Wiley

FinTech Innovation:
From Robo-Advisors to Goal Based Investing and Gamification,

Paolo Sironi, Wiley, 2016



Source: https://www.amazon.com/FinTech-Innovation-Robo-Advisors-Investing-Gamification/dp/1119226988

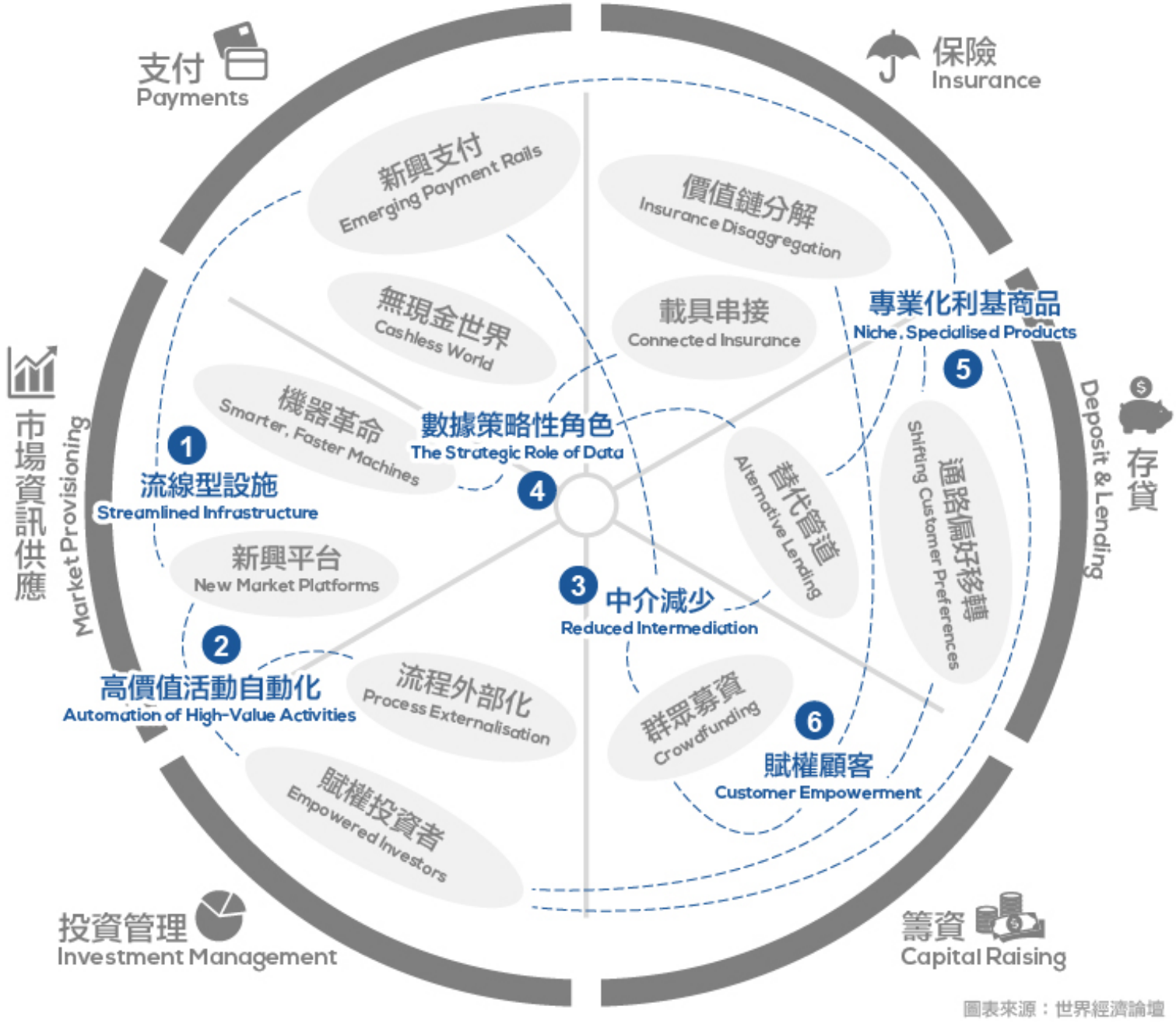
FinTech: Financial Services Innovation

Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

FinTech:
Financial Services Innovation

1. Payments
2. Insurance
3. Deposits & Lending
4. Capital Raising
5. Investment Management
6. Market Provisioning

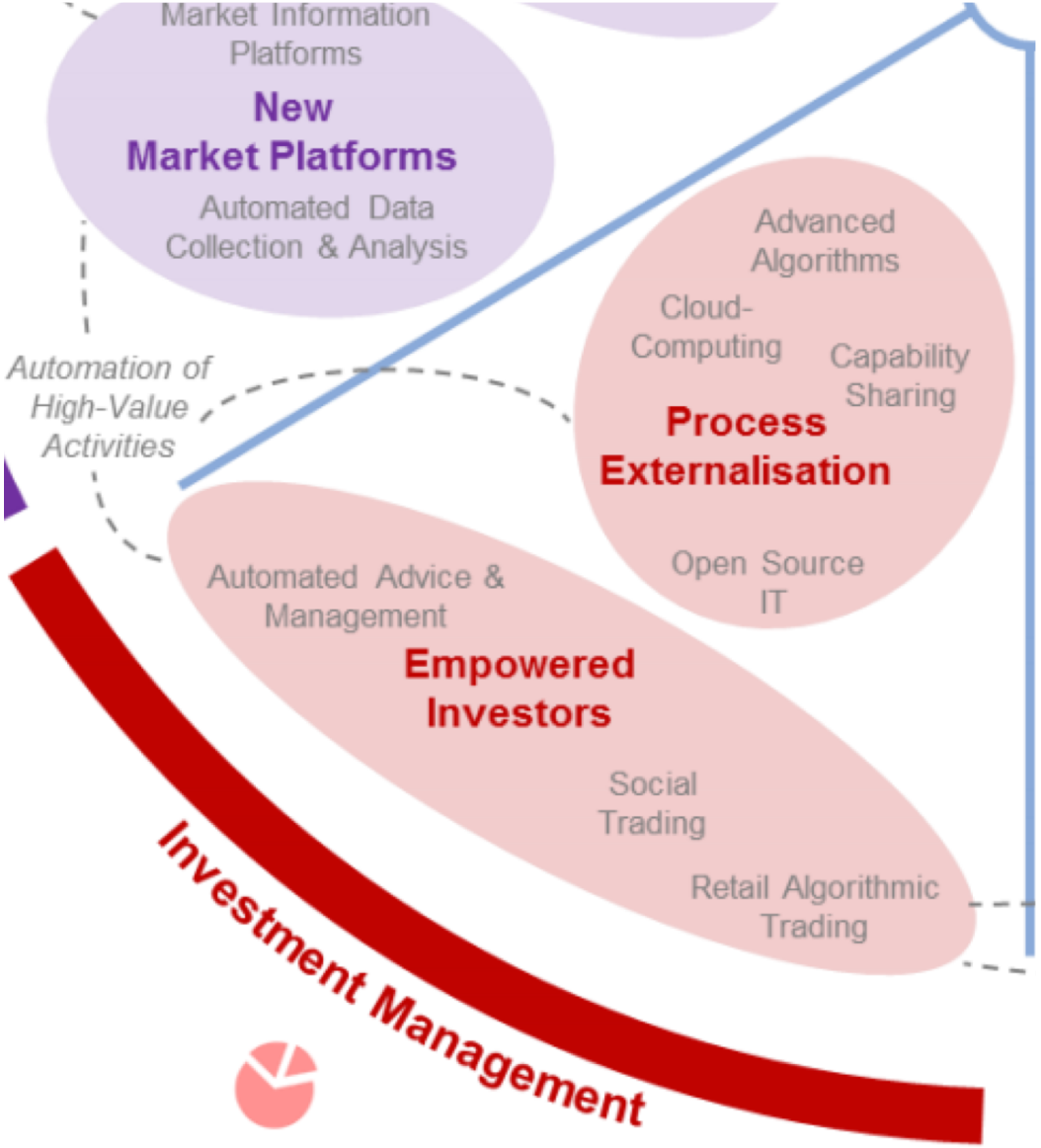
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf



圖表來源：世界經濟論壇

Source: https://www.stockfeel.com.tw/2015年世界經濟論壇－未來的金融服務/

5 FinTech: Investment Management



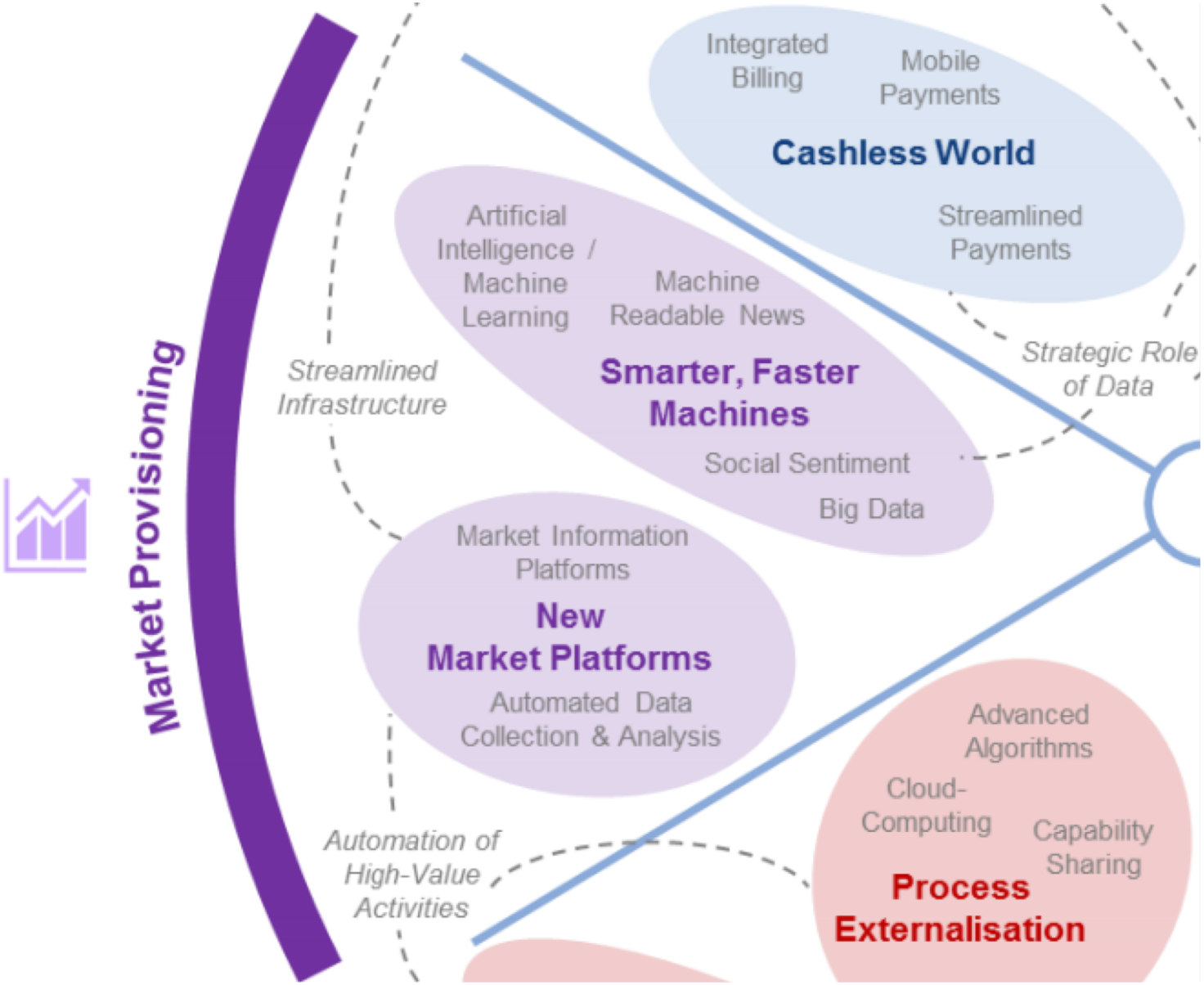
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

5 FinTech: Investment Management Empowered Investors Process Externalization

圖表來源：Fugle團隊整理

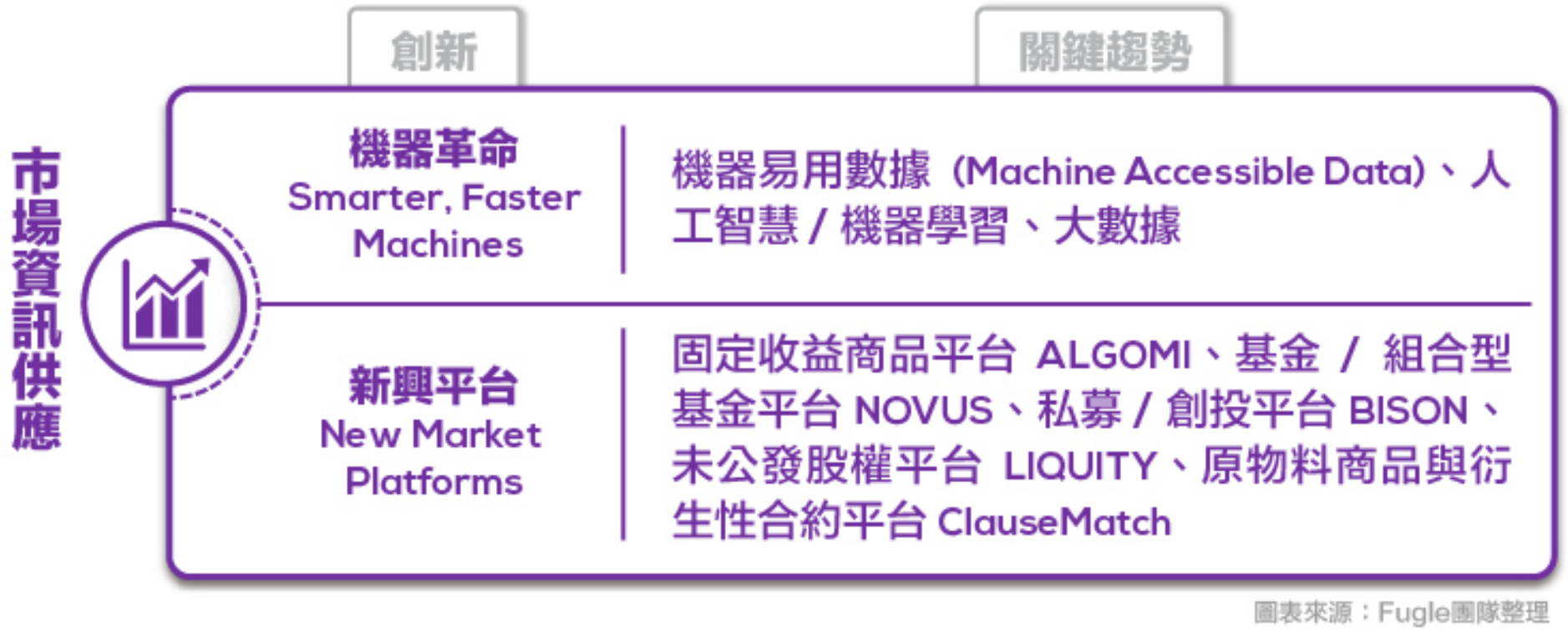
Source: https://www.stockfeel.com.tw/2015年世界經濟論壇－未來的金融服務/

6 FinTech: Market Provisioning



Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

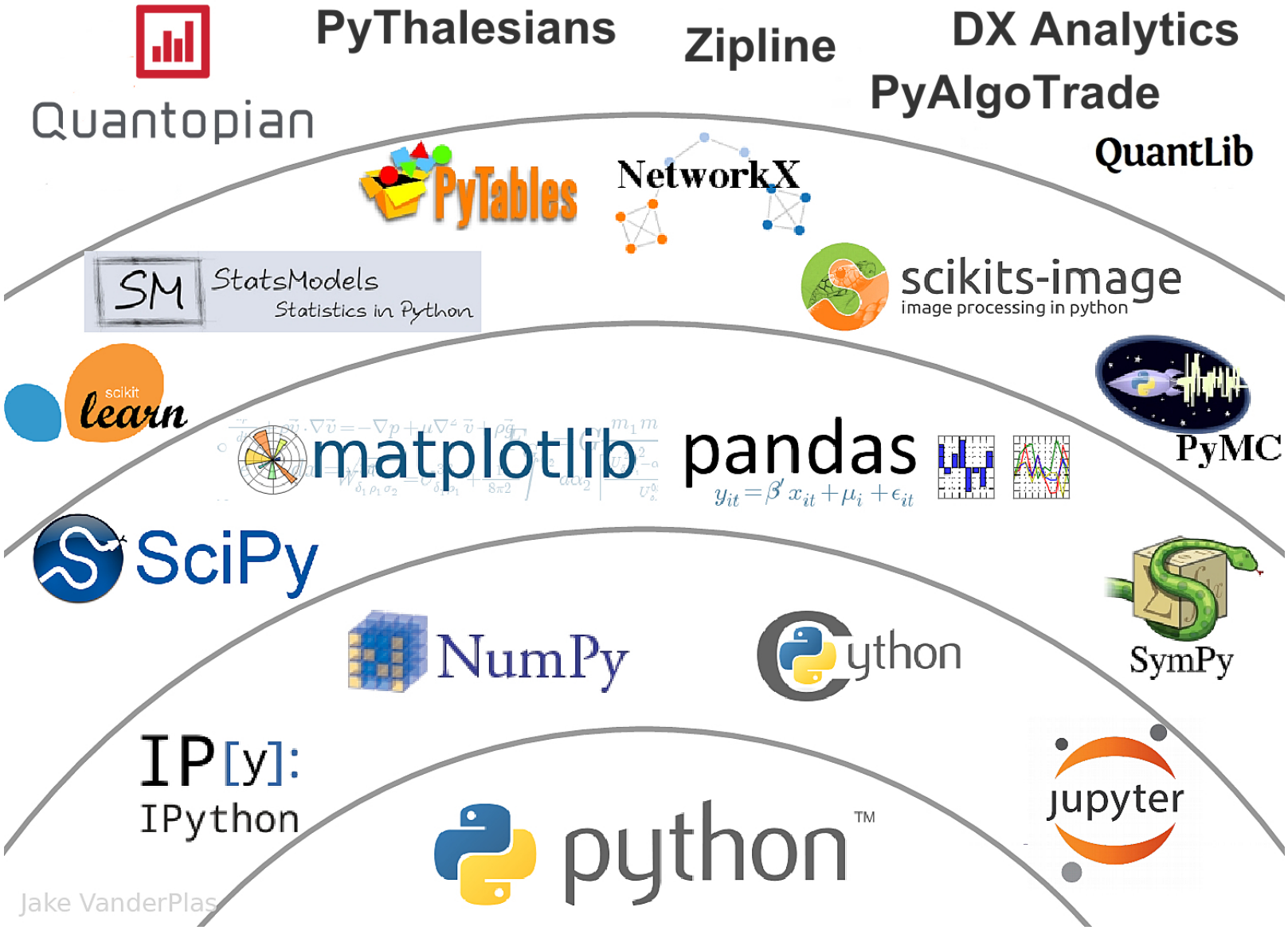
6 FinTech: Market Provisioning Smarter, Faster Machines New Market Platforms



圖表來源：Fugle團隊整理

Source: https://www.stockfeel.com.tw/2015年世界經濟論壇－未來的金融服務/

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5

Zipline

a Pythonic

Algorithmic Trading Library

http://www.zipline.io/

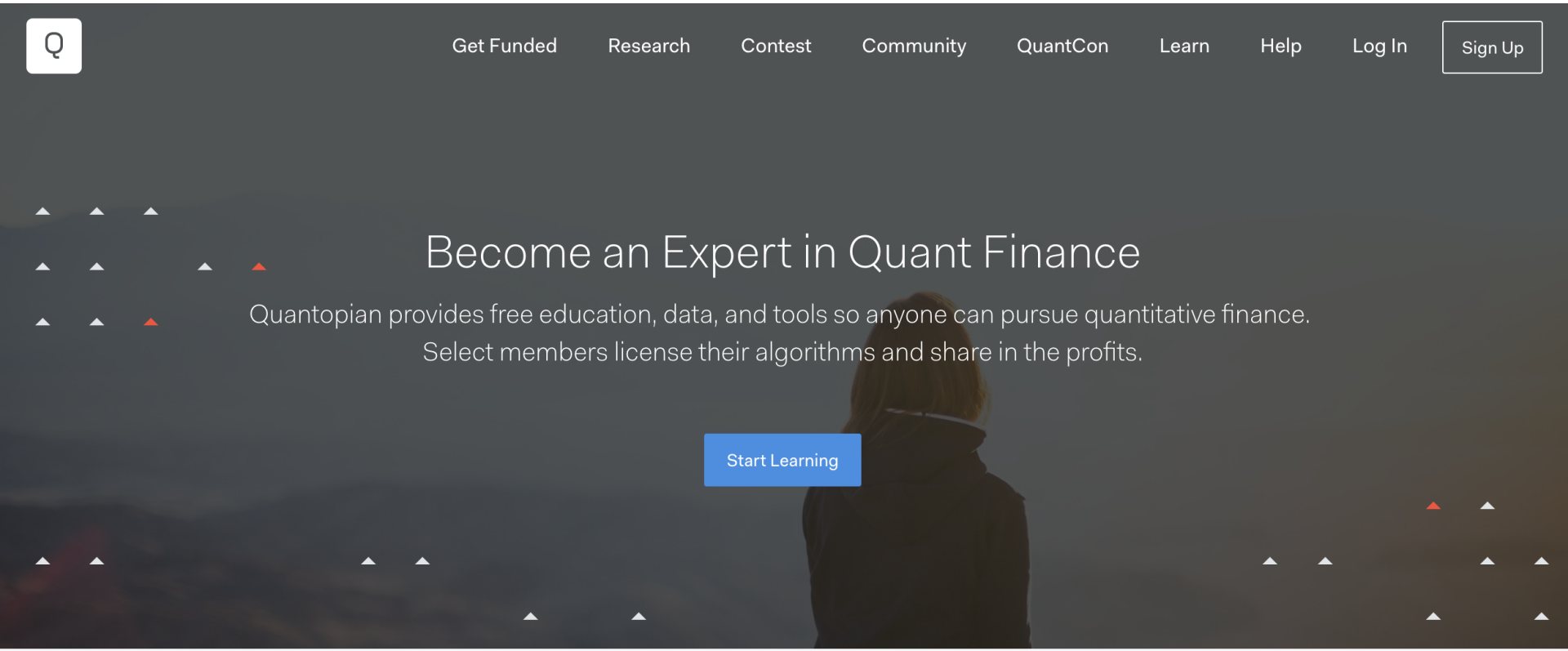
Source: https://github.com/quantopian/zipline

Zipline

- Zipline: Pythonic algorithmic trading library.
- Event-driven system
  - supports both backtesting and live-trading.
- Zipline is currently used in production as the backtesting and live-trading engine powering Quantopian
  - a free, community-centered, hosted platform for building and executing trading strategies.

Source: http://www.zipline.io/

Quantopian

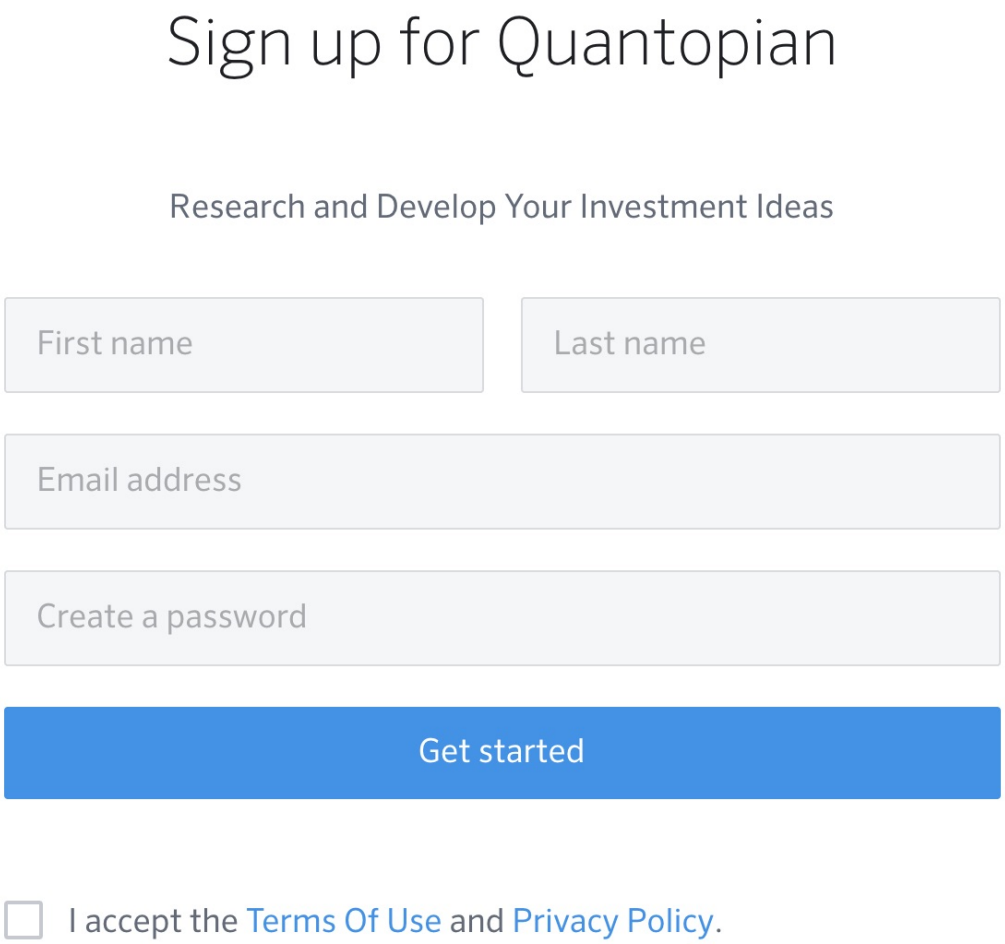


Community Achievements

All numbers are as of June 1, 2018

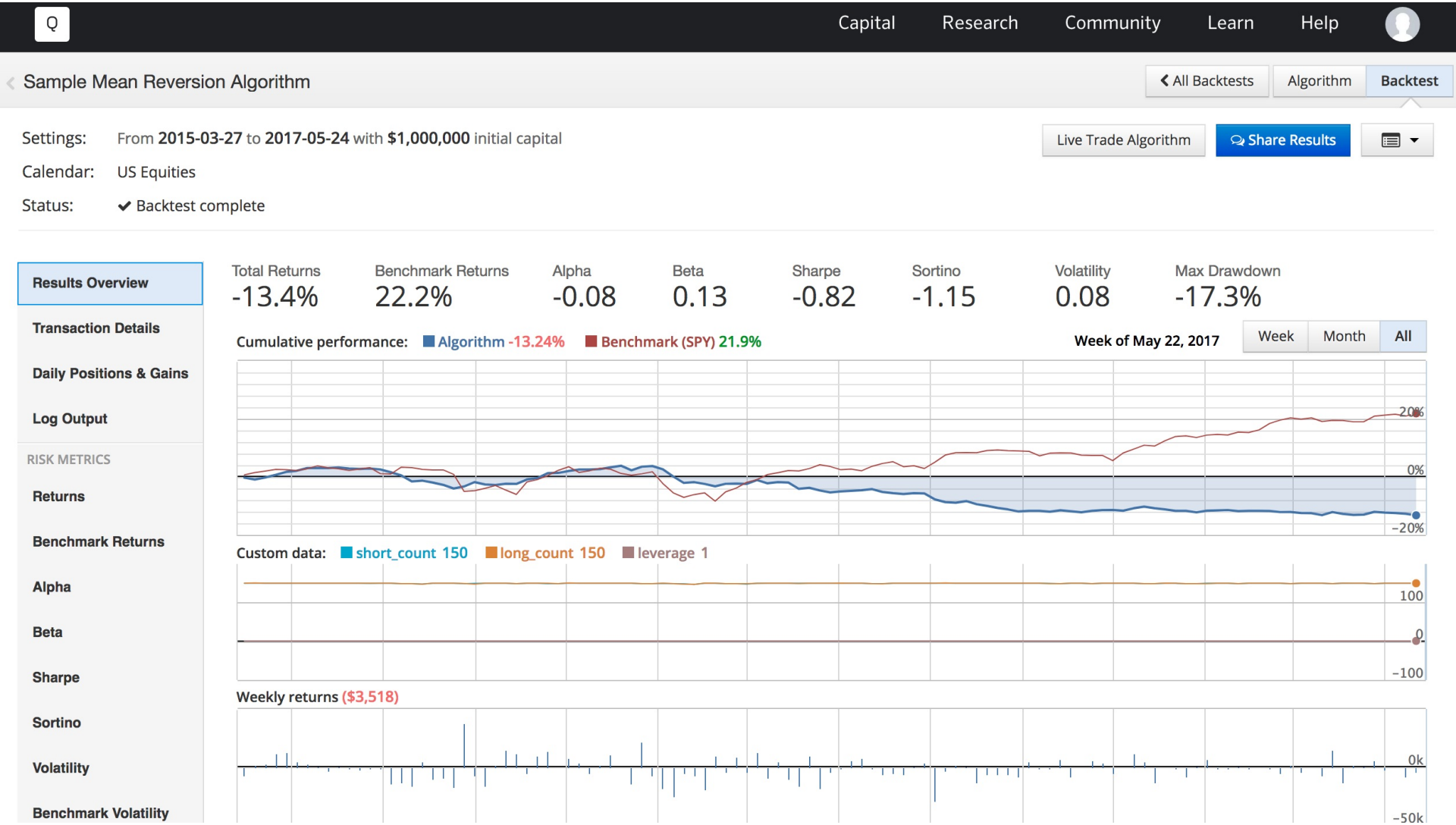
https://www.quantopian.com/

Sign up for Quantopian



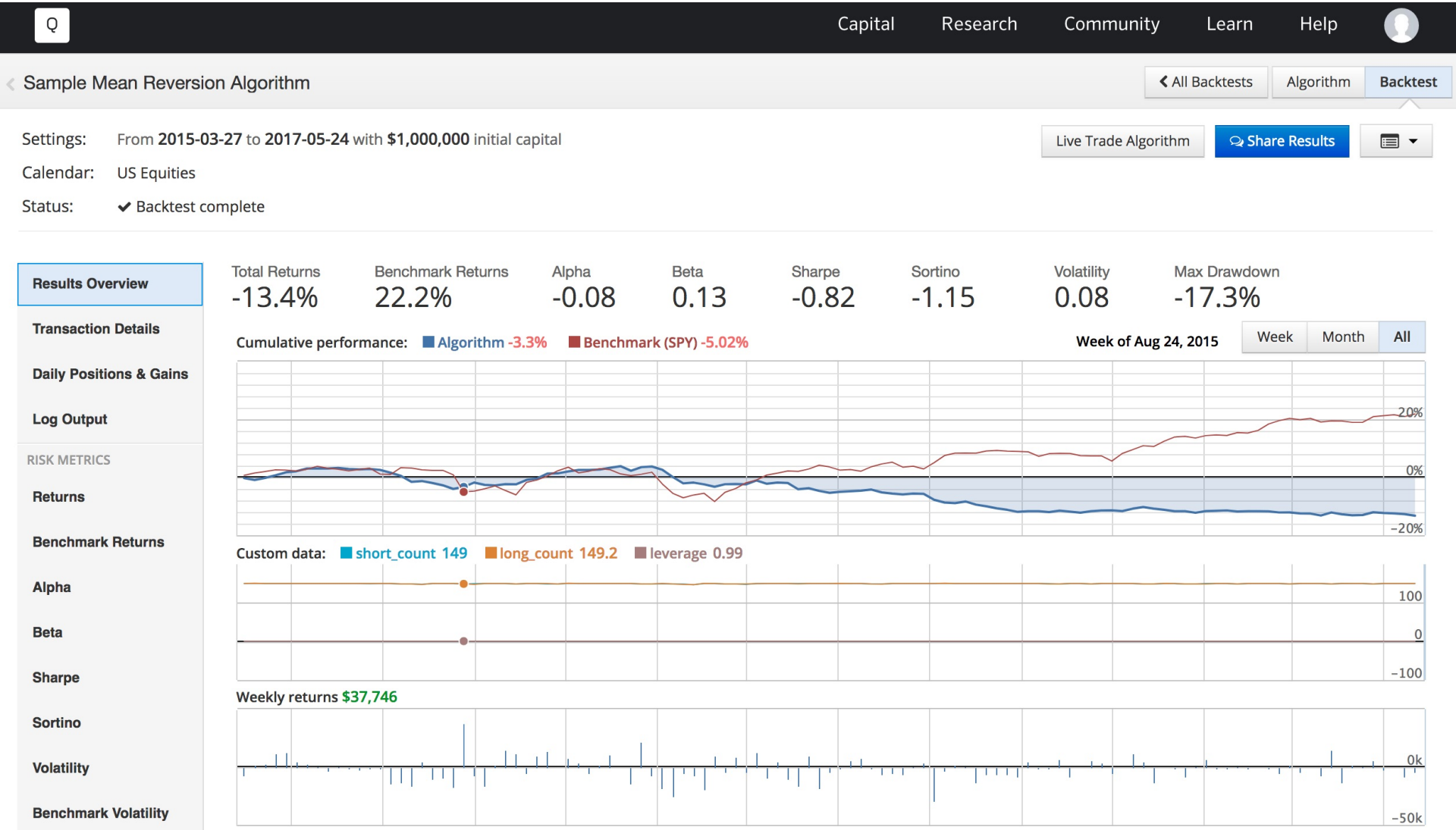
https://www.quantopian.com/users/sign_up

Quantopian
Sample Mean Reversion Algorithm



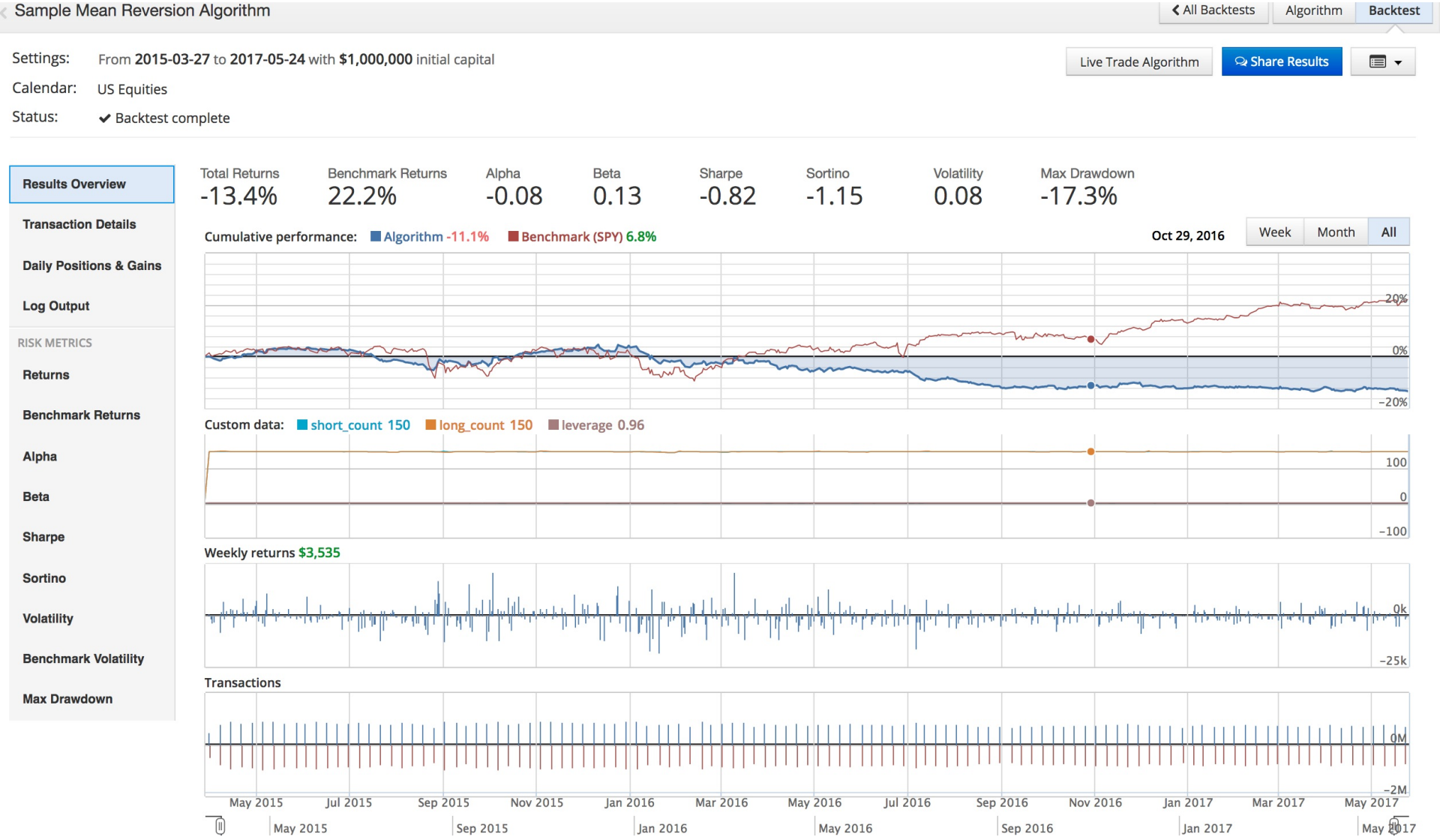
Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

Quantopian
Sample Mean Reversion Algorithm



Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

Quantopian
Sample Mean Reversion Algorithm



Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

Quantopian

Sample Mean Reversion Algorithm

Sample Mean Reversion Algorithm

All Backtests | Algorithm | Backtest

Settings: From **2015-03-27** to **2017-05-24** with **$1,000,000** initial capital

Calendar: US Equities

Status: ✔ Backtest complete

Live Trade Algorithm | Share Results

- Results Overview
- Transaction Details
- Daily Positions & Gains
- Log Output

RISK METRICS

- Returns
- Benchmark Returns
- Alpha
- Beta
- Sharpe
- Sortino
- Volatility
- Benchmark Volatility
- Max Drawdown

Transaction Details · Expand All · Collapse All

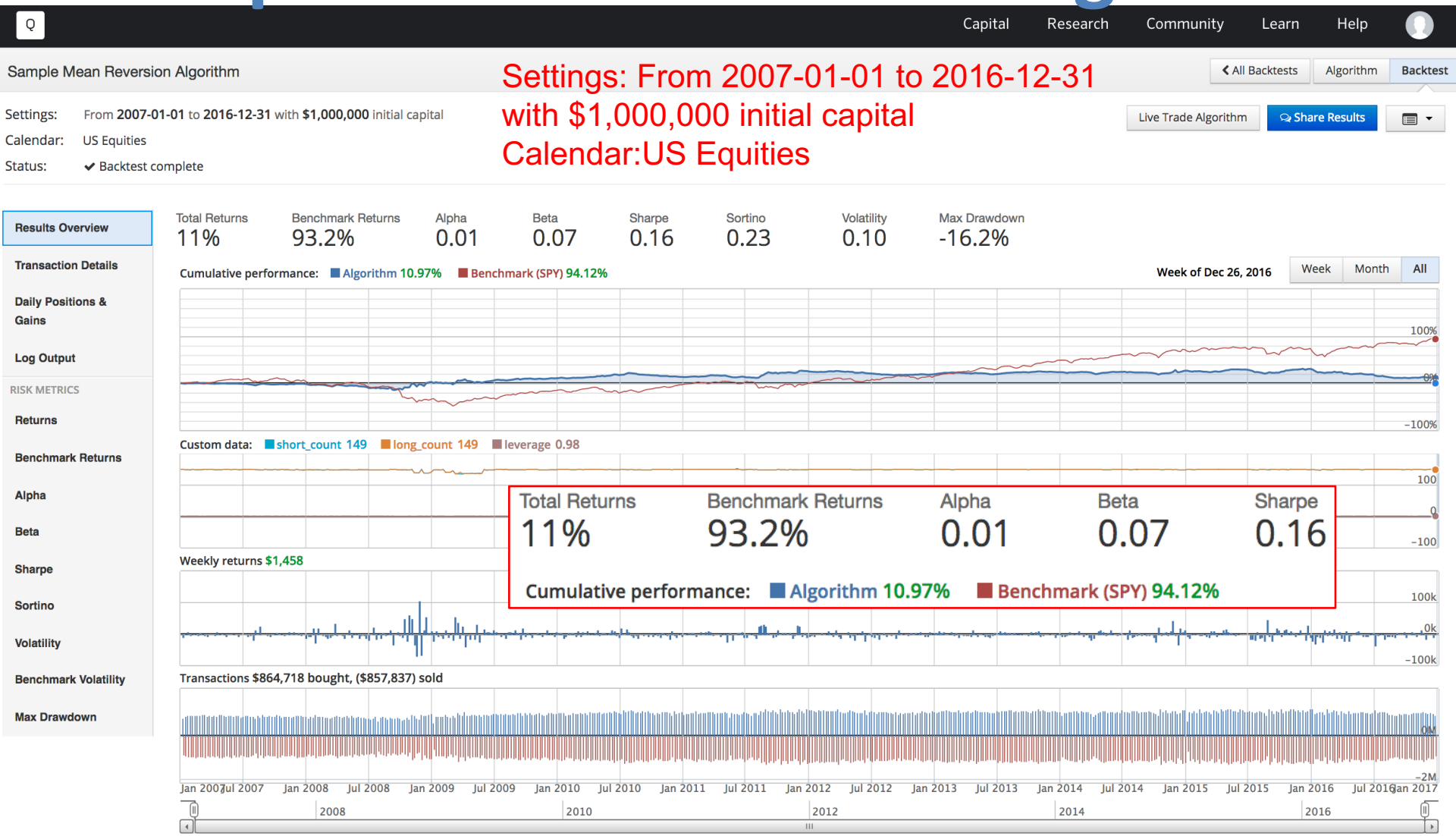
Group by day

Date	Asset	Transaction	Unit Price	Quantity	Position Value
2017-05-15 - 11:07 PM	PRAA	SELL	$37.32	-2	($74.65)
2017-05-15 - 11:07 PM	PRTA	SELL	$55.83	-31	($1,730.64)
2017-05-15 - 11:07 PM	PSTG	BUY	$11.68	44	$513.96
2017-05-15 - 11:07 PM	PTCT	SELL	$13.31	-10	($133.09)
2017-05-15 - 11:07 PM	QLYS	BUY	$43.50	10	$435.03
2017-05-15 - 11:07 PM	RGR	SELL	$64.07	-2	($128.14)
2017-05-15 - 11:07 PM	RRD	BUY	$13.30	62	$824.60
2017-05-15 - 11:07 PM	RXN	BUY	$23.45	9	$211.05
2017-05-15 - 11:07 PM	SUPN	SELL	$33.50	-12	($401.98)
2017-05-15 - 11:07 PM	TCO	SELL	$59.08	-7	($413.54)
2017-05-15 - 11:07 PM	TIVO	BUY	$17.15	2	$34.30
2017-05-15 - 11:07 PM	TLRD	BUY	$12.11	52	$629.77
2017-05-15 - 11:07 PM	TPC	SELL	$28.20	-5	($140.99)
2017-05-15 - 11:07 PM	TROX	SELL	$19.21	-60	($1,152.54)
2017-05-15 - 11:07 PM	TWNK	BUY	$15.69	17	$266.75

Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/592756885310d86a415cb0e1#backtest

Quantopian

Sample Mean Reversion Algorithm



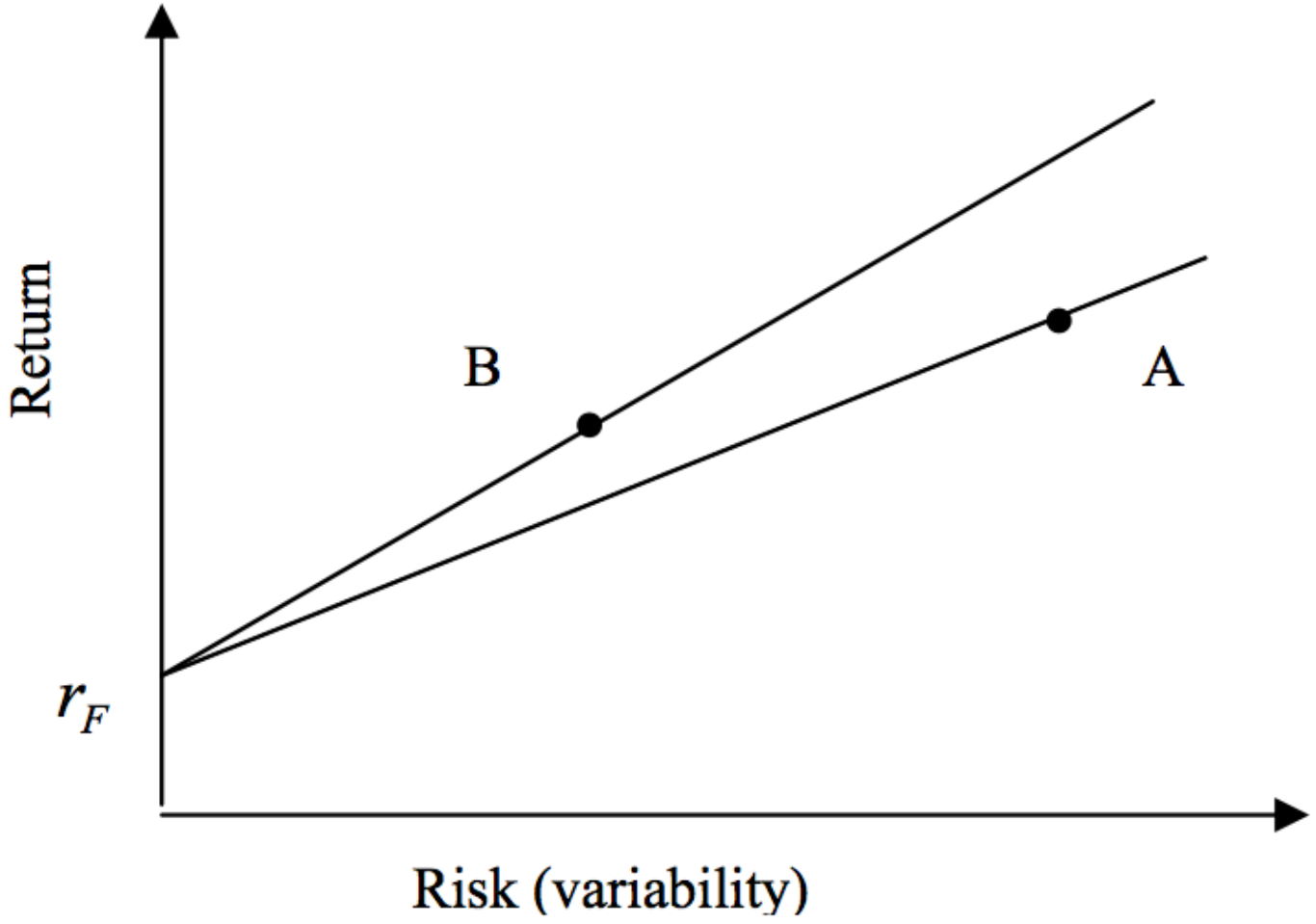
Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/592756885310d86a415cb0e1#backtest

Quantopian
Sample Mean Reversion Algorithm

Total Returns	Benchmark Returns	Alpha	Beta	Sharpe
11%	93.2%	0.01	0.07	0.16

Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/592756885310d86a415cb0e1#backtest

Risk and Return



Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

Sharpe Ratio

$$\textbf{Sharpe Ratio} = \frac{Portofolio\ Return - Risk\ Free\ Return}{Portofolio\ Risk}$$

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

Sharpe Ratio

$$\textbf{Sharpe Ratio } SR = \frac{r_P - r_F}{\sigma_P}$$

Where

r_P = portfolio return

r_F = risk free rate

σ_P = portfolio risk (variability, standard deviation of return)

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

Sortino Ratio

$$\textbf{Sortino Ratio} = \frac{r_P - r_T}{\sigma_D}$$

Where

r_P = portfolio return

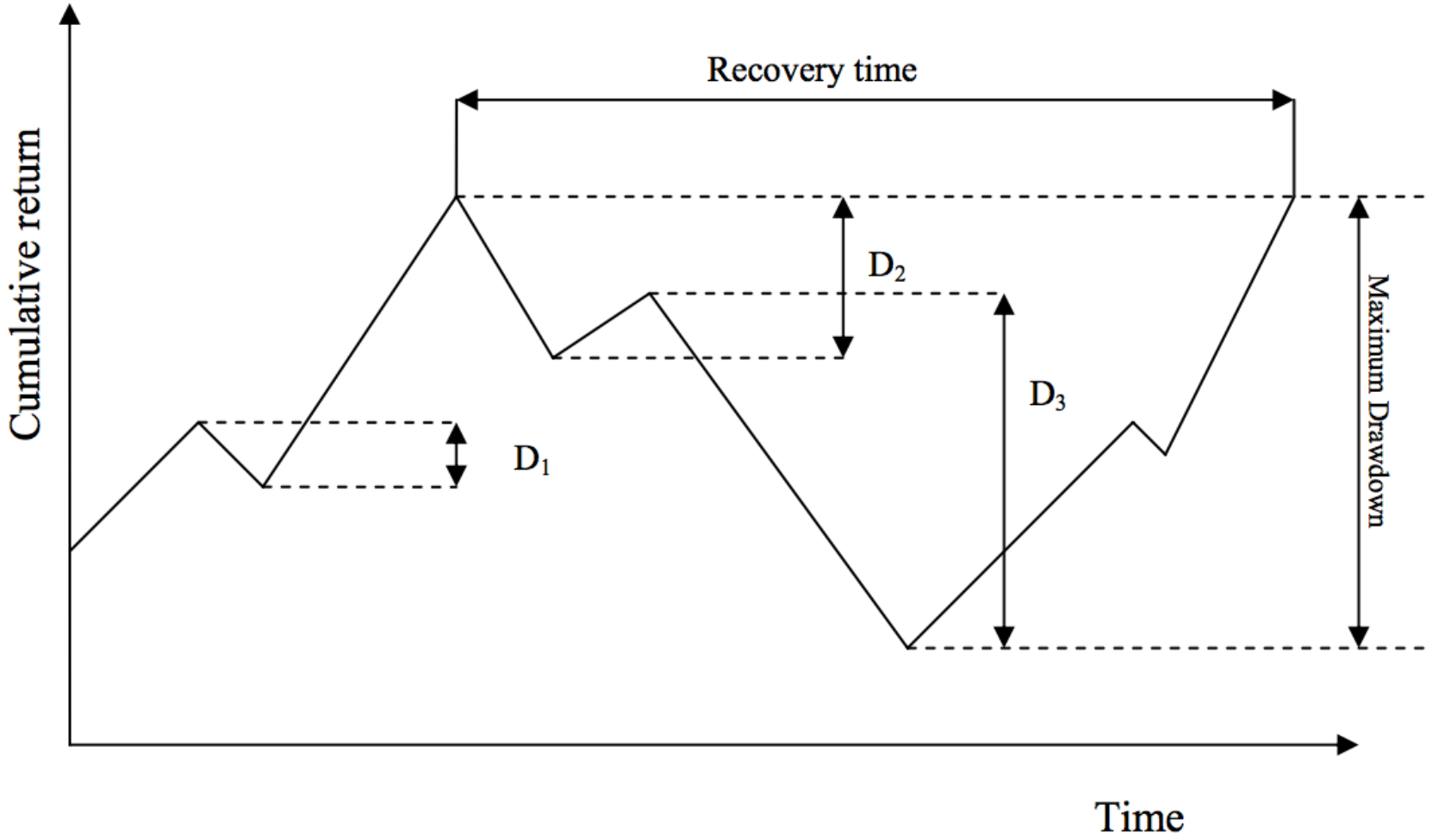
r_T = Minimum Target Return

σ_D = Downside Risk

$$\textbf{Downside Risk } \sigma_D = \sqrt{\sum_{i=1}^{n} \frac{\min[(r_i - rT), 0]^2}{n}}$$

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

Max Drawdown



Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

Quantopian

Sample Mean Reversion Algorithm

Save | Build Algorithm | Enter Contest | Collaborate | API Reference | Exit Fullscreen

```
"""
This is a sample mean-reversion algorithm on Quantopian for you to test and adapt.
This example uses a dynamic stock selector, pipeline, to select stocks to trade.
It orders stocks from the top 1% of the previous day's dollar-volume (liquid
stocks).

Algorithm investment thesis:
Top-performing stocks from last week will do worse this week, and vice-versa.

Every Monday, we rank high dollar-volume stocks based on their previous 5 day returns.
We long the bottom 10% of stocks with the WORST returns over the past 5 days.
We short the top 10% of stocks with the BEST returns over the past 5 days.

This type of algorithm may be used in live trading and in the Quantopian Open.
"""

# Import the libraries we will use here.
from quantopian.algorithm import attach_pipeline, pipeline_output
from quantopian.pipeline import Pipeline
from quantopian.pipeline.data.builtin import USEquityPricing
from quantopian.pipeline.factors import Returns
from quantopian.pipeline.filters.morningstar import Q1500US

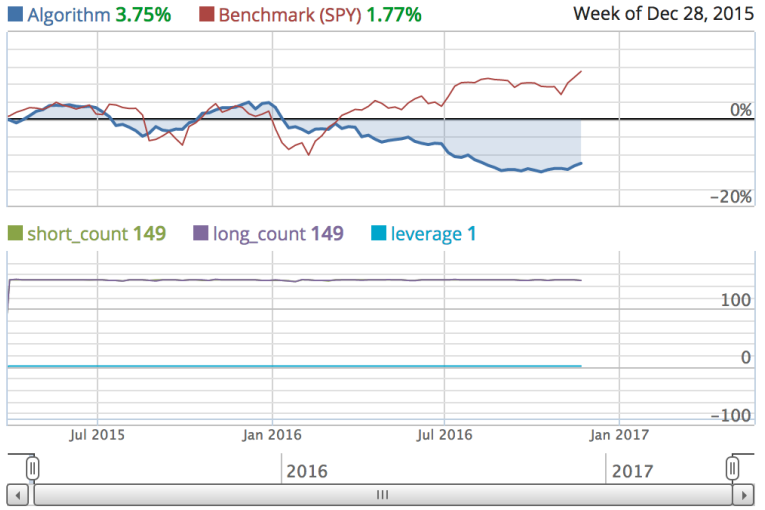

def initialize(context):
    """
    Called once at the start of the program. Any one-time
    startup logic goes here.
    """
    # Define context variables that can be accessed in other methods of
    # the algorithm.
    context.long_leverage = 0.5
    context.short_leverage = -0.5
    context.returns_lookback = 5

    # Rebalance on the first trading day of each week at 11AM.
    schedule_function(rebalance,
                      date_rules.week_start(days_offset=0),
                      time_rules.market_open(hours=1, minutes=30))

    # Record tracking variables at the end of each day.
    schedule_function(record_vars,
                      date_rules.every_day()
```

Backtesting 77.6% Cancel

RETURNS	ALPHA	BETA	SHARPE	DRAWDOWN
-10%	-0.07	0.12	-0.72	-16.4%



Logs | Runtime Errors | More

```
2015-03-30 23:00 rebalance:146 INFO This week's longs: ARCB, ACXM, ARW, AVT, AXP,
BBY, CAMP, CDE, CMCS_A, CY, ATGE, S, HL, HMSY, HPQ, IDCC, BIIB, IDTI, IMGN, IONS,
JCP, KLAC, LRCX, MAT, MBI, MGM, MTG, REGN, RGLD, SMTC, SONC, TDS, TDW, TER, TRMB,
WDC, WERN, WOR, YRCW, ZBRA, CREE, RIG, GMCR, HST, BCRX, KNX, SSYS, FOXA, VECO, MYGN,
SNDK, NVAX, SCCO, ANDE, HUBG, CRR, NBIX, GWR, OCN, CIEN, TIVO, POWI, WAC, BRCM, AMKR,
NVDA, BRCD, LPNT, JNPR, VIAV, FNSR, ON, SGMO, CYH, ARNA, KERX, MDCO, ARRY, UTIW,
EXAS, SGMS, BTU, JOY, GME, LCI, BDSI, STX, CNX, APOL, ARRS, XPER, WLL, NRG, AGO,
ACAD, GNW, ALNY, DRH, HPY, IHS, CROX, ZIOP, SFLY, LDOS, ACHN, GSAT, AFSI, TWC, SMCI,
CZZ, DFT, CATM, SEM, PEB, PPC, FNGN, TSLA, SWFT, ZG, ZLTQ, GEVA, IMPV, HLSS, NSM,
PBYI, FRGI, WAGE, BLMN, RGLS, FLTX, ENTA, CSTM, PTCT, GOGO, AGIO, COMM, NMBL, RARE,
TRUE, ANET, TMST, ECR, KITE, MIK, SYF, MBLY, KEYS, VA, LC, QRVO
```

Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

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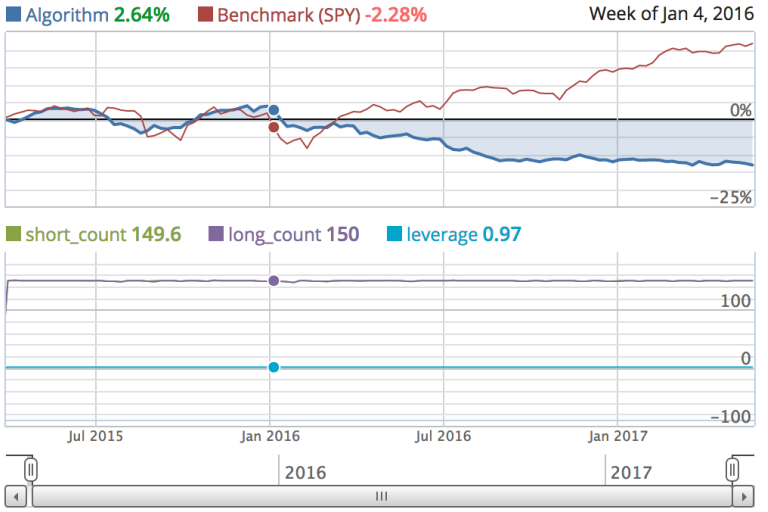
    schedule_function(record_vars,
```

03/27/2015 to 05/23/2017 | $ 1000000 | US Equities | Run Full Backtest

RETURNS	ALPHA	BETA	SHARPE	DRAWDOWN
-13.2%	-0.08	0.13	-0.81	-17.3%



Logs | Runtime Errors | More

```
2015-03-30 23:00 rebalance:146 INFO This week's longs: ARCB, ACXM, ARW, AVT, AXP,
BBY, CAMP, CDE, CMCS_A, CY, ATGE, S, HL, HMSY, HPQ, IDCC, BIIB, IDTI, IMGN, IONS,
JCP, KLAC, LRCX, MAT, MBI, MGM, MTG, REGN, RGLD, SMTC, SONC, TDS, TDW, TER, TRMB,
WDC, WERN, WOR, YRCW, ZBRA, CREE, RIG, GMCR, HST, BCRX, KNX, SSYS, FOXA, VECO, MYGN,
SNDK, NVAX, SCCO, ANDE, HUBG, CRR, NBIX, GWR, OCN, CIEN, TIVO, POWI, WAC, BRCM, AMKR,
NVDA, BRCD, LPNT, JNPR, VIAV, FNSR, ON, SGMO, CYH, ARNA, KERX, MDCO, ARRY, UTIW,
EXAS, SGMS, BTU, JOY, GME, LCI, BDSI, STX, CNX, APOL, ARRS, XPER, WLL, NRG, AGO,
ACAD, GNW, ALNY, DRH, HPY, IHS, CROX, ZIOP, SFLY, LDOS, ACHN, GSAT, AFSI, TWC, SMCI,
CZZ, DFT, CATM, SEM, PEB, PPC, FNGN, TSLA, SWFT, ZG, ZLTQ, GEVA, IMPV, HLSS, NSM,
PBYI, FRGI, WAGE, BLMN, RGLS, FLTX, ENTA, CSTM, PTCT, GOGO, AGIO, COMM, NMBL, RARE,
TRUE, ANET, TMST, ECR, KITE, MIK, SYF, MBLY, KEYS, VA, LC, QRVO
```

Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

Writing and Backtesting an Algorithm on Quantopian

Source: https://www.quantopian.com/tutorials/getting-started

What is a Trading Algorithm?

On Quantopian,
a trading algorithm
is a Python program
that defines two special functions:
initialize() and handle_data()

Source: https://www.quantopian.com/tutorials/getting-started

An example of an algorithm that allocates 100% of its portfolio in AAPL

```
def initialize(context):
    # Reference to AAPL
    context.aapl = sid(24)

def handle_data(context, data):
    # Position 100% of our portfolio to be long in AAPL
    order_target_percent(context.aapl, 1.00)
```

Source: https://www.quantopian.com/tutorials/getting-started

Moving Average

```
def initialize(context):
    context.security = symbol('AAPL')
    schedule_function(myfunc, date_rules.every_day(),  time_rules.market_open(minutes = 15))

def handle_data(context, data):
    MovingAvg1 = data[context.security].mavg(20)
    MovingAvg2 = data[context.security].mavg(60)

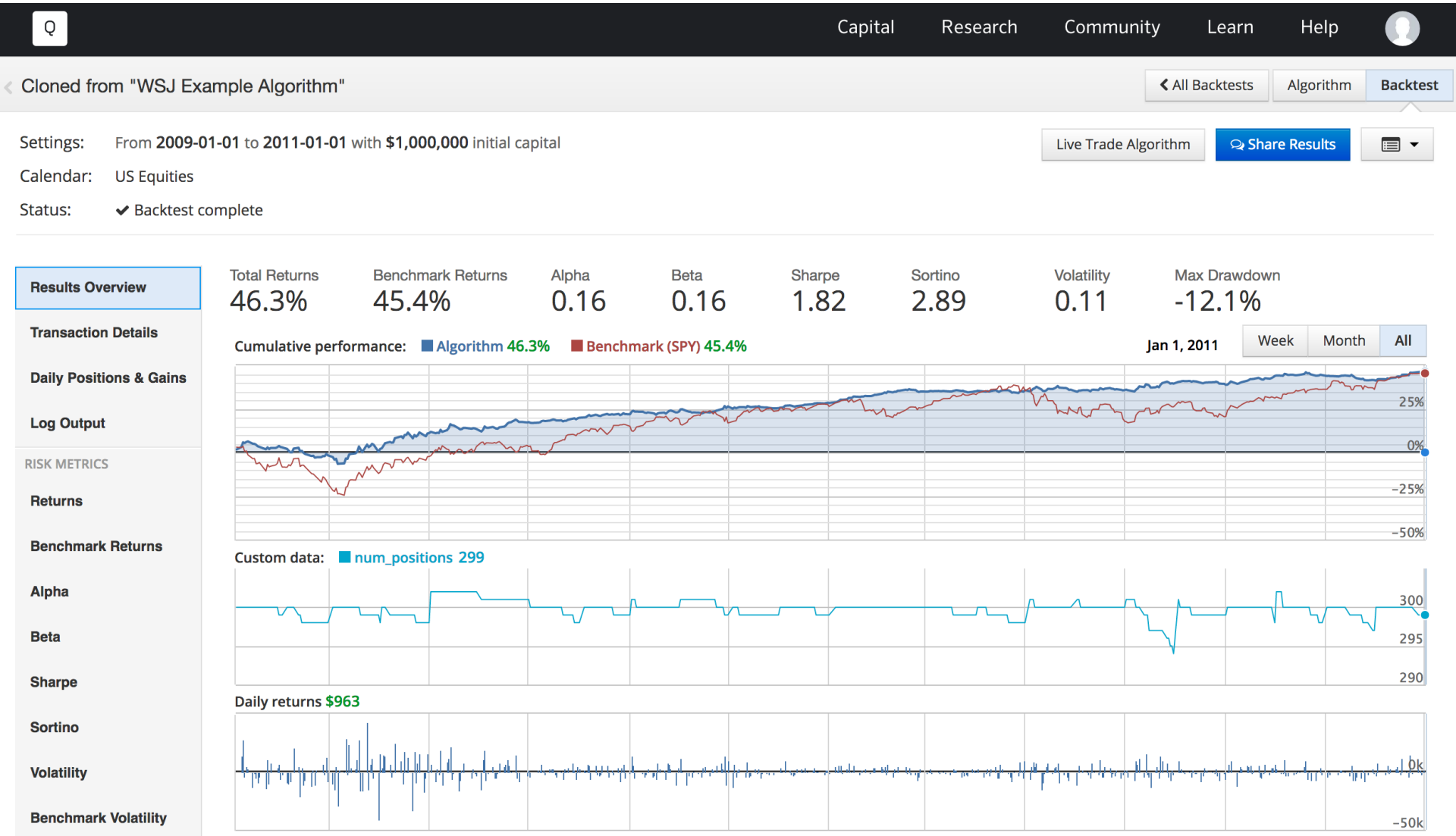
    current_positions = context.portfolio.positions[symbol('AAPL')].amount

    if (MovingAvg1 > MovingAvg2) and current_positions == 0:
        order_target_percent(context.security, 0.25)

    elif (MovingAvg1 < MovingAvg2) and current_positions != 0:
        order_target(context.security, 0)
```

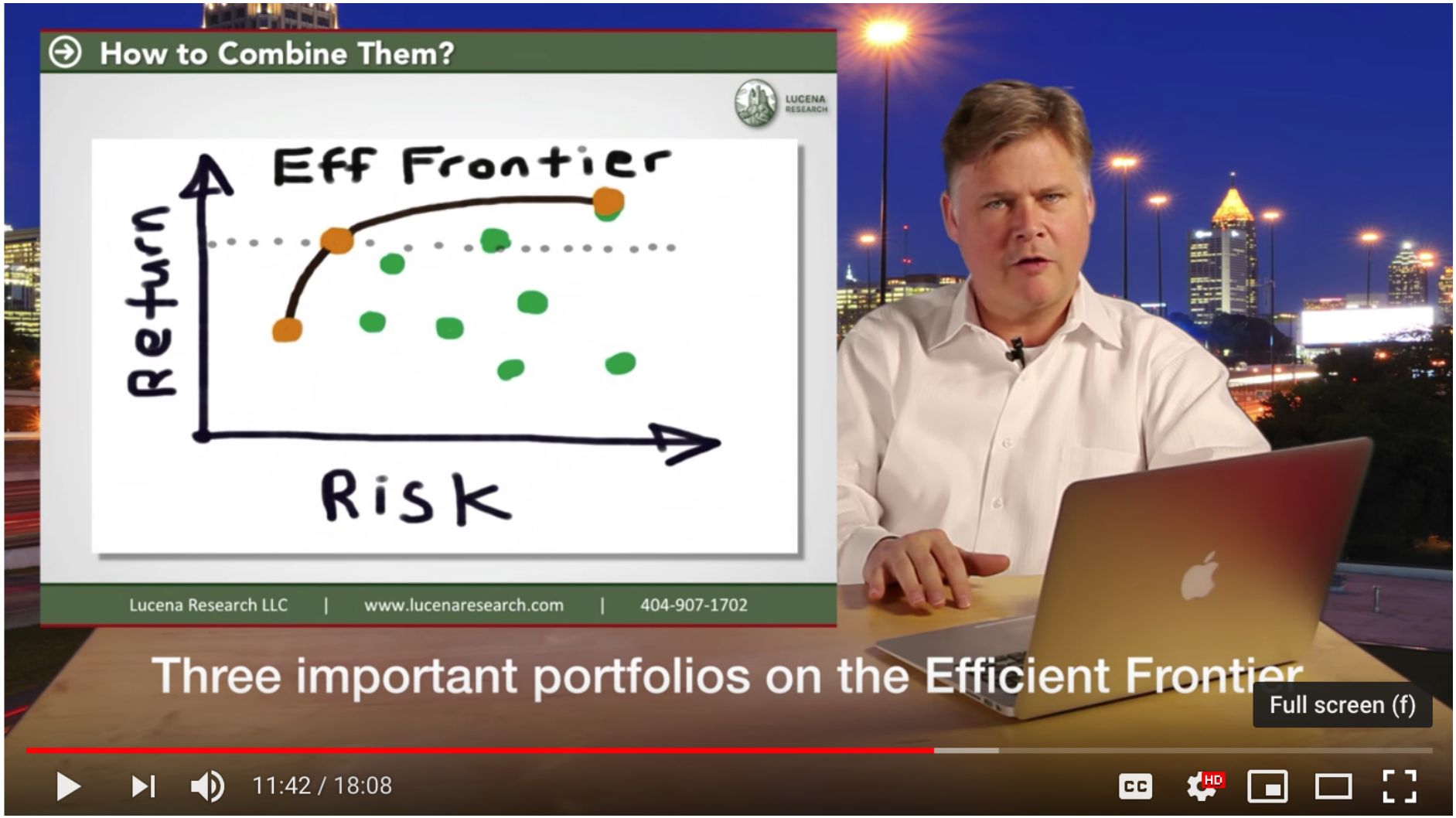
Source: https://www.quantopian.com/tutorials/getting-started

Quantopian
WSJ Example Algorithm



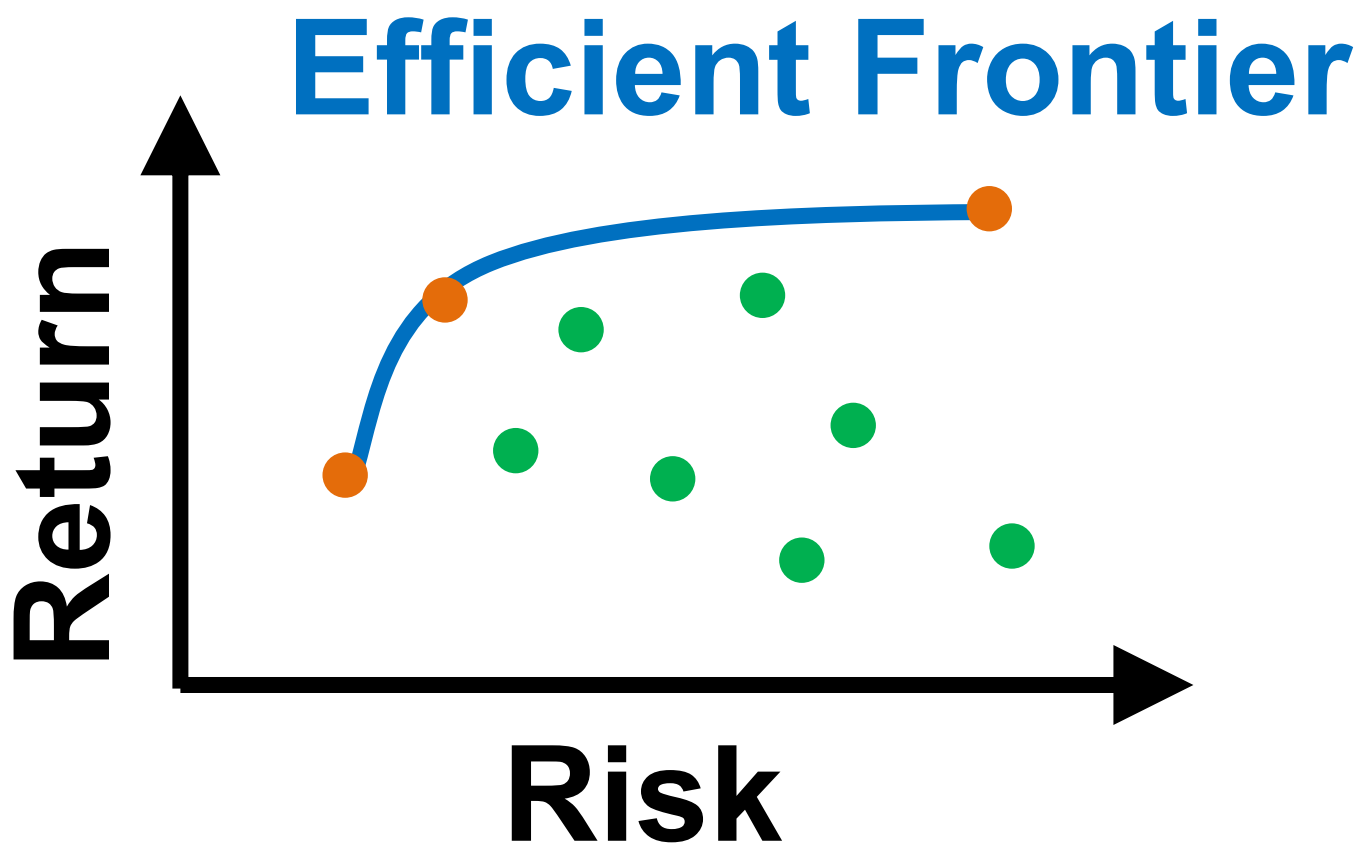
Source: https://www.quantopian.com/algorithms/59274d707875d1000d41937d/5927506f3cf7da6fec5951b6#backtest

Investment Science: Portfolio Optimization



Source: Tucker Balch (2012), Investment Science: Portfolio Optimization, https://www.youtube.com/watch?v=5qbMhXXq0vI

Portfolio Optimization
Efficient Frontier



Source: Tucker Balch (2012), Investment Science: Portfolio Optimization, https://www.youtube.com/watch?v=5qbMhXXq0vI

Portfolio Optimization and Algorithmic Trading

Portfolio_Optimization_Algo_Trading.ipynb

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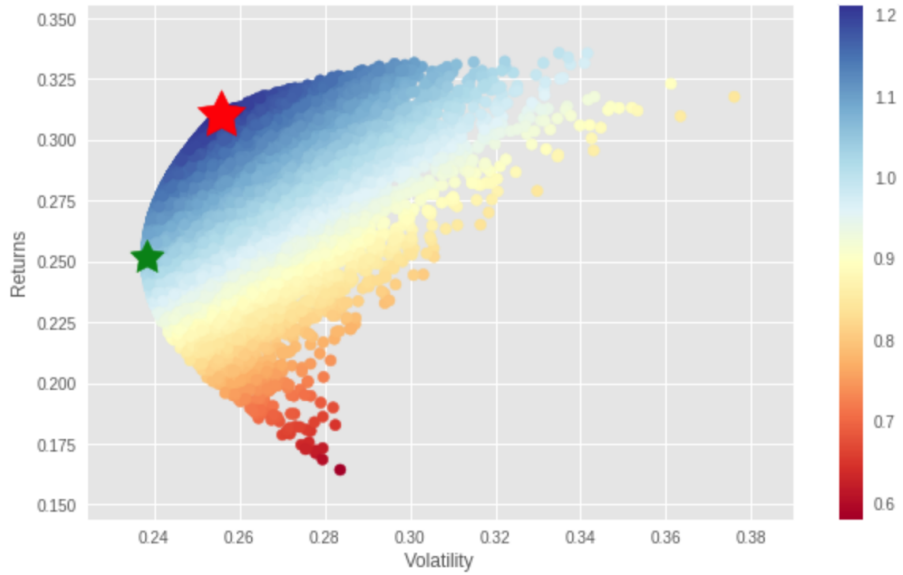
```
#locate position of portfolio with highest Sharpe Ratio
max_sharpe_port = results_frame.iloc[results_frame['sharpe'].idxmax()]
#locate positon of portfolio with minimum standard deviation
min_vol_port = results_frame.iloc[results_frame['stdev'].idxmin()]

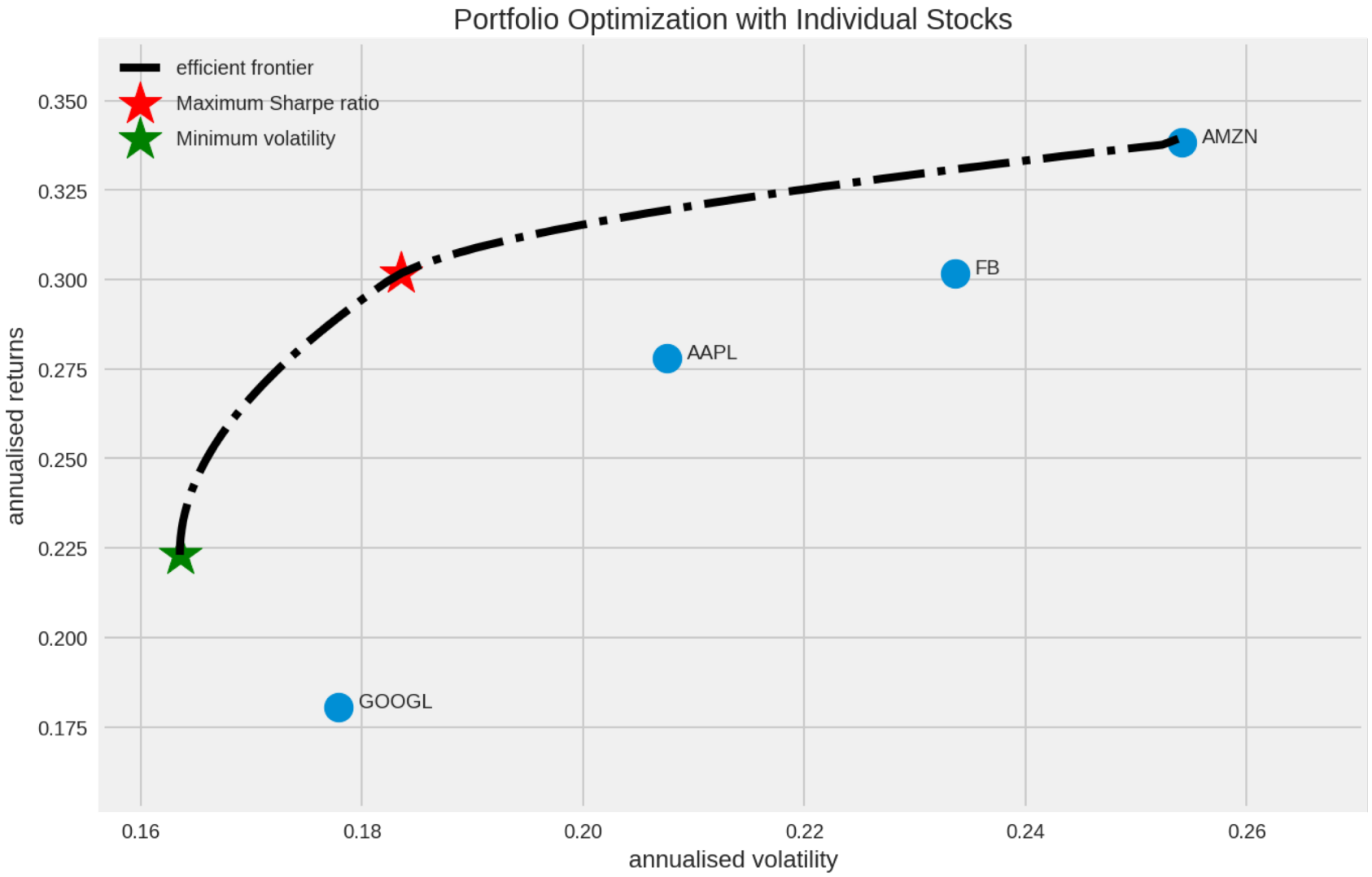
#create scatter plot coloured by Sharpe Ratio
plt.figure(figsize=(10,6))
plt.scatter(results_frame.stdev,results_frame.ret,c=results_frame.sharpe,cmap='RdYlBu')
plt.xlabel('Volatility')
plt.ylabel('Returns')
plt.colorbar()
#plot red star to highlight position of portfolio with highest Sharpe Ratio
plt.scatter(max_sharpe_port[1],max_sharpe_port[0],marker=(5,1,0),color='r',s=1000)
#plot green star to highlight position of minimum variance portfolio
plt.scatter(min_vol_port[1],min_vol_port[0],marker=(5,1,0),color='g',s=500)
```

```
<matplotlib.collections.PathCollection at 0x7ff864d33c18>
```



https://colab.research.google.com/drive/1nN5yOB3ZFXKxq4y9WwzCVTV1i_BVpfAD

Portfolio Optimization Efficient Frontier



UQER

Source: https://uqer.io/home/

UQER

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UQER

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年化收益	最大回撤	初始资金
305.71%	13.31%	¥ 50000

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走得很慢的海龟

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年化收益	最大回撤	初始资金
10.05%	20.49%	¥ 1000000

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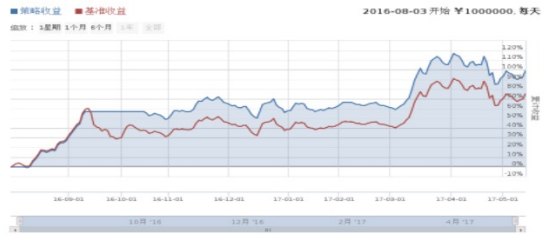
策略收益 基准收益



年化收益	最大回撤	初始资金
142.52%	15.88%	¥ 1000000

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模拟实盘


囚徒之爱

策略收益 基准收益

年化收益	最大回撤	初始资金
78.64%	4.51%	¥ 30000

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策略收益 基准收益

年化收益	最大回撤	初始资金
56.11%	17.13%	¥ 1000000

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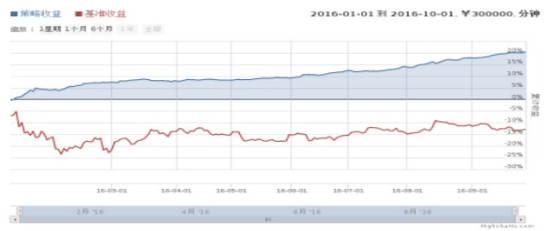
策略回测


囚徒

策略收益 基准收益



年化收益	最大回撤	初始资金
18.58%	1.08%	¥ 300000

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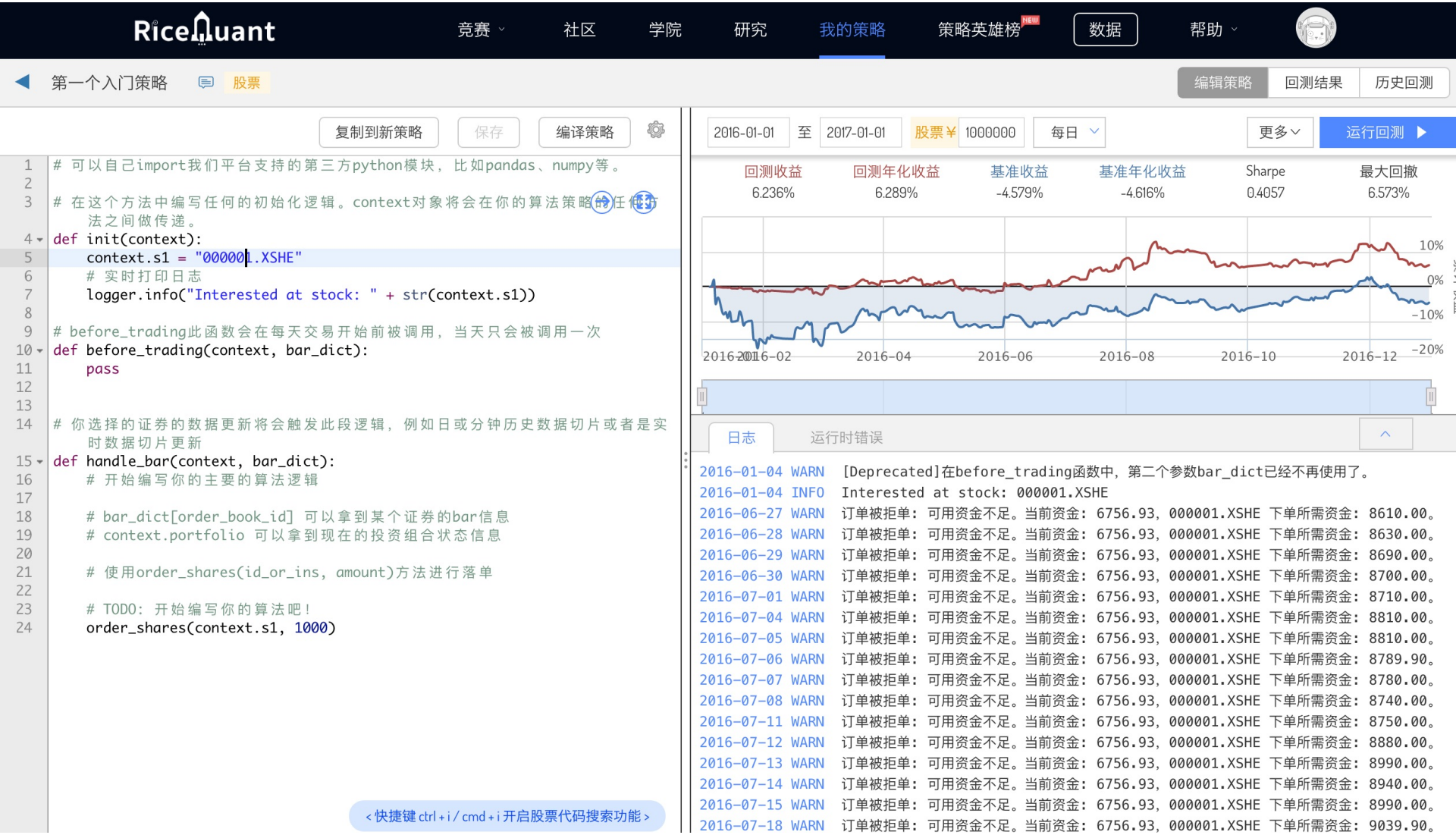


```
# 可以自己import我们平台支持的第三方python模块，比如pandas、numpy等。

# 在这个方法中编写任何的初始化逻辑。context对象将会在你的算法策略的任何方法之间做传递。
def init(context):
    context.s1 = "000001.XSHE"
    # 实时打印日志
    logger.info("Interested at stock: " + str(context.s1))

# before_trading此函数会在每天交易开始前被调用，当天只会被调用一次
def before_trading(context, bar_dict):
    pass


# 你选择的证券的数据更新将会触发此段逻辑，例如日或分钟历史数据切片或者是实时数据切片更新
def handle_bar(context, bar_dict):
    # 开始编写你的主要的算法逻辑

    # bar_dict[order_book_id] 可以拿到某个证券的bar信息
    # context.portfolio 可以拿到现在的投资组合状态信息

    # 使用order_shares(id_or_ins, amount)方法进行落单

    # TODO: 开始编写你的算法吧！
    order_shares(context.s1, 1000)
```

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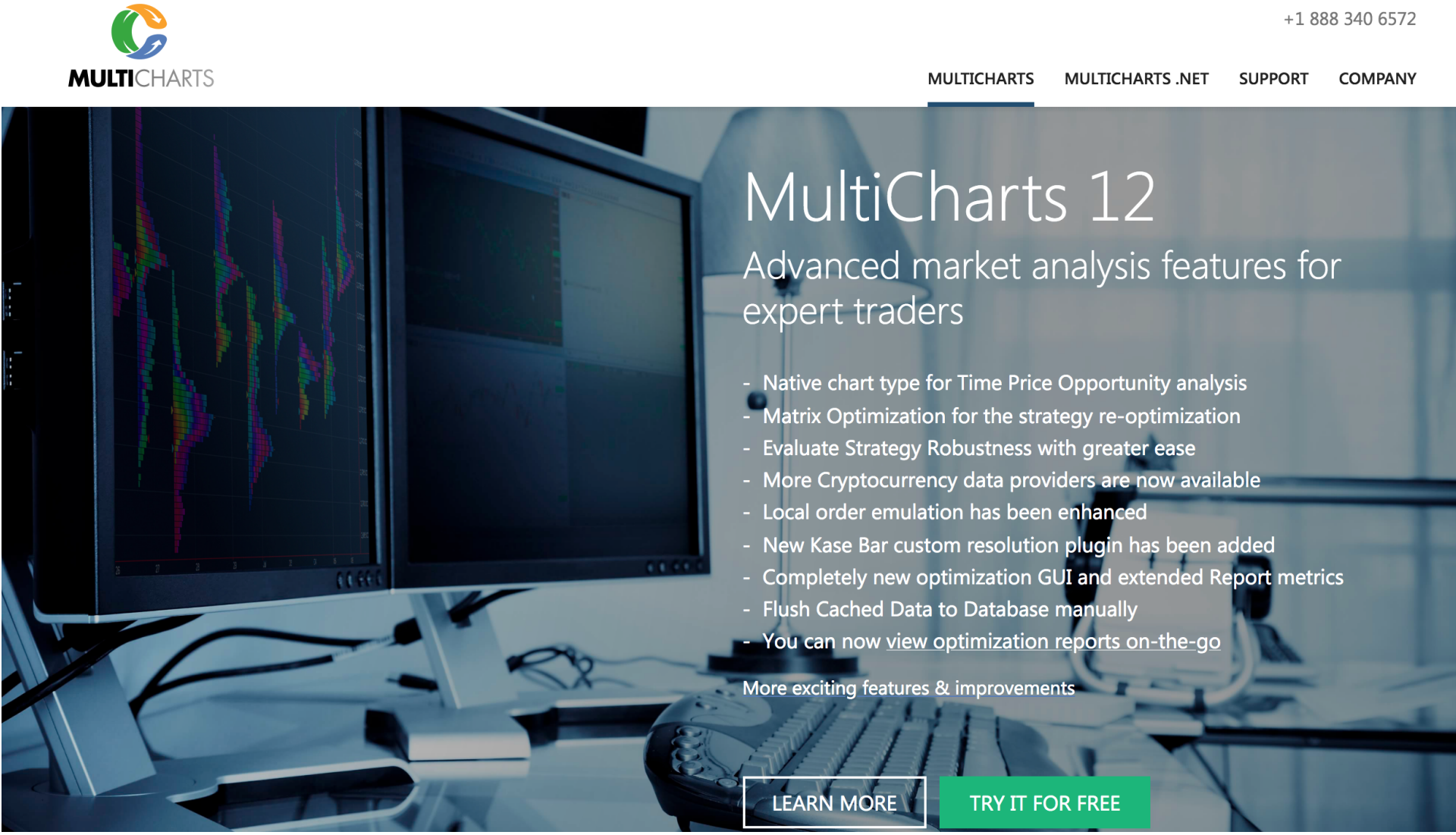
```
# 在这个方法中编写任何的初始化逻辑。context对象将会在你的算法策略的任何方法之间做传递。
def init(context):
    #沪深300指数、中证500指数和国债指数
    context.stocks = ["000300.XSHG","000905.XSHG","000012.XSHG"]
# before_trading此函数会在每天交易开始前被调用，当天只会被调用一次
# 你选择的证券的数据更新将会触发此段逻辑，例如日或分钟历史数据切片或者是实时数据切片更新
def handle_bar(context, bar_dict):
    # 开始编写你的主要的算法逻辑
    hs300 = history_bars(context.stocks[0],20,"1d","close")
    zz500 = history_bars(context.stocks[1],20,"1d","close")
    hsIncrease = hs300[19] - hs300[0]
    zzIncrease = zz500[19] - zz500[0]
    p = context.portfolio.positions
    hsQuality = p[context.stocks[0]].quantity
    zzQuality = p[context.stocks[1]].quantity
    gzQuality = p[context.stocks[2]].quantity
    if hsIncrease < 0 and zzIncrease < 0:
        if hsQuality > 0:
            order_target_percent(context.stocks[0],0)
            logger.info("卖出沪深300")
        if zzQuality > 0:
            order_target_percent(context.stocks[1],0)
            logger.info("卖出中证500")
        if gzQuality <= 0.001:
            order_target_percent(context.stocks[2],1)
            logger.info("买入国债")
    elif hsIncrease < zzIncrease:
        if hsQuality > 0:
            order_target_percent(context.stocks[0],0)
            logger.info("卖出沪深300")
        if gzQuality > 0:
            order_target_percent(context.stocks[2],0)
            logger.info("卖出国债")
        if zzQuality <= 0.001:
```

Source: https://www.ricequant.com/algorithm/523092

MultiCharts



https://www.multicharts.com/

Python Pandas in Google Colab

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

python101.ipynb

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```
# !pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()

df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0), rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0), rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'], color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])

# set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
```


AAPL
Adj Close
MA05
MA20
MA60
220
200
180
160
140
120
100
80
2016-02
2016-06
2016-10
2017-02
2017-06
2017-10
2018-02
2018-06
2018-10
Date

Deep Learning for Financial Time Series Forecasting

https://colab.research.google.com/drive/1aEK0eSev8Q-Y0nNY32geFk7CB8pVgSQM

Deep_Learning_for_Financial_Time_Series_Forecasting.ipynb

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LSTM for Time Series Forecasting

```
# univariate lstm example
from numpy import array
from keras.models import Sequential
from keras.layers import LSTM
from keras.layers import Dense
import matplotlib.pyplot as plt
%matplotlib inline

# define dataset
X = array([[100, 110, 120], [110, 120, 130], [120, 130, 140], [130, 140, 150], [140, 150, 160]])
y = array([130, 140, 150, 160, 170])
# reshape from [samples, timesteps] into [samples, timesteps, features]
X = X.reshape((X.shape[0], X.shape[1], 1))
# define model
model = Sequential()
model.add(LSTM(50, activation='relu', input_shape=(3, 1)))
model.add(Dense(1))
model.compile(optimizer='adam', loss='mse')
# fit model
history = model.fit(X, y, epochs=2000, verbose=0)
# demonstrate prediction
x_input = array([150, 160, 170])
x_input = x_input.reshape((1, 3, 1))
yhat = model.predict(x_input, verbose=0)
print('yhat', yhat)
print(model.summary())
# list all data in history
print(history.history.keys())
# summarize history for loss
print('loss:', '%f'%history.history['loss'][-1])
print('loss:', history.history['loss'][-1])
plt.plot(history.history['loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.show()
```

```
yhat [[181.34615]]
```

Source: https://machinelearningmastery.com/how-to-develop-lstm-models-for-time-series-forecasting/

Summary

- Portfolio Optimization
- Algorithmic Trading

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- Pyfolio, https://github.com/quantopian/pyfolio
- UQER, https://uqer.io/
- Joinquant, https://www.joinquant.com/
- Ricequant, https://www.ricequant.com/
- MultiCharts, https://www.multicharts.com/