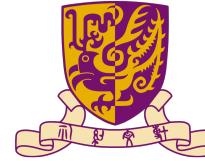




清华大学  
Tsinghua University



香港中文大學  
The Chinese University of Hong Kong



# Quant Modeling and Trading: Theory and Practice

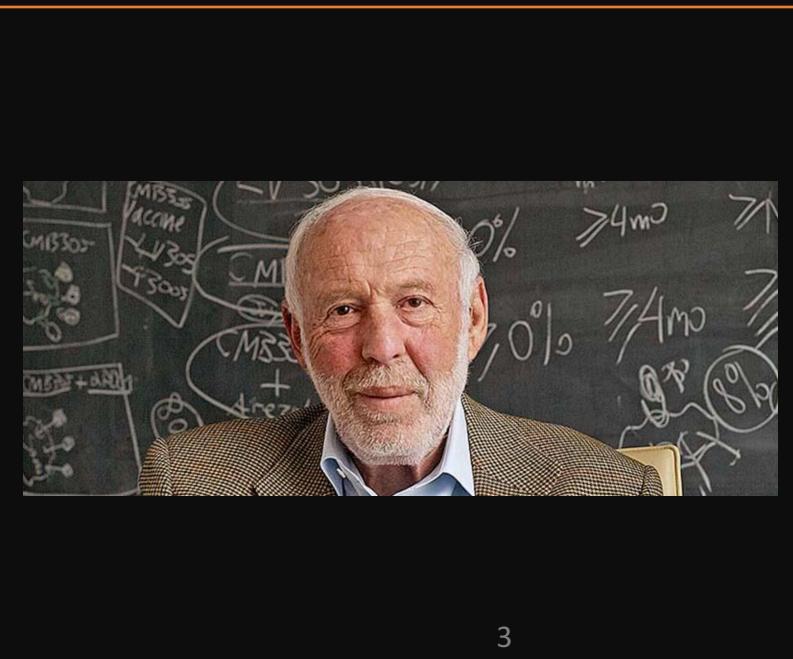
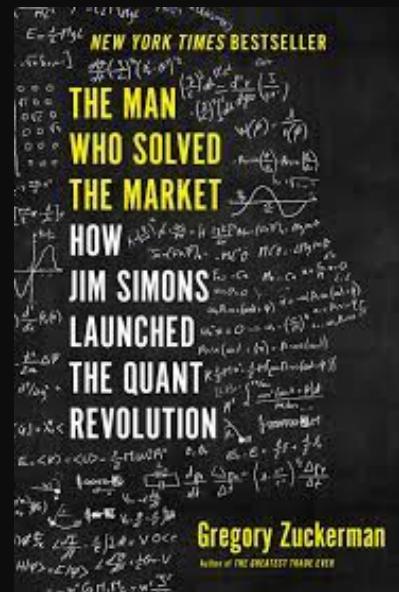
Prof. Michael Zhang

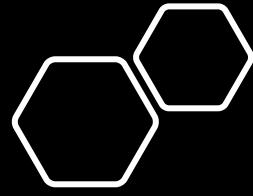


Associate Dean and Chair Professor  
Chinese University of Hong Kong

# Theory

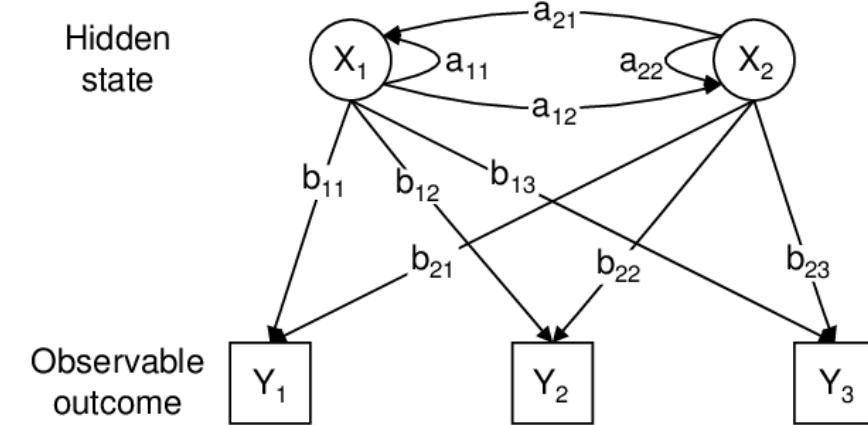
# Jim Simons





HMM

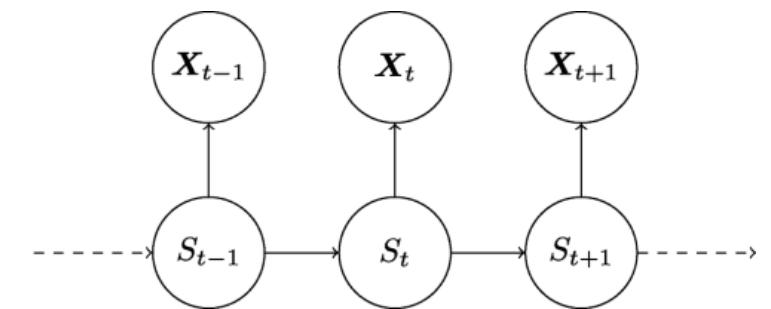
Hidden state



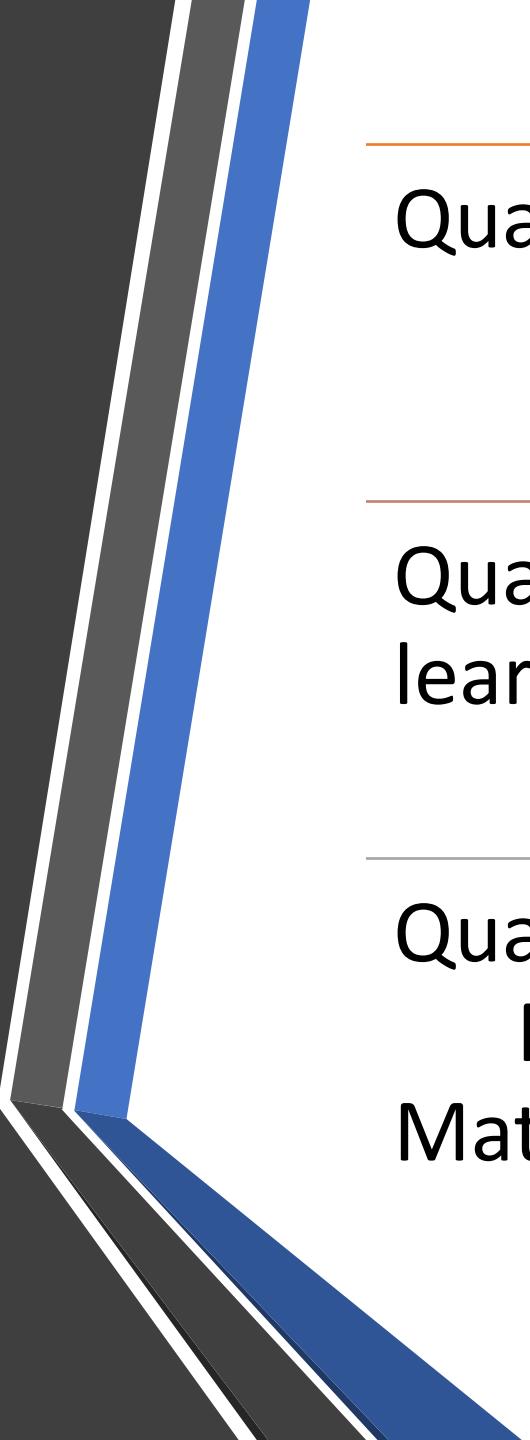
Observable outcome

observations

state process  
(hidden)



# 3 Generations of Quant Models



---

Quant 1.0: Linear factor models

---

Quant 2.0: Non-linear machine  
learning models

---

Quant 3.0:  
Machine learning + Financial  
Mathematics + Stats

# $\alpha$ vs. $\beta$

$$R_p = R_f + \beta * (R_m - R_f) + \alpha$$

Diagram illustrating the components of the Capital Asset Pricing Model (CAPM) formula:

- Risk Free Rate**: Labeled above  $R_f$ .
- Beta of the portfolio**: Labeled above  $\beta$ .
- Risk Premium**: A bracket labeled above the term  $(R_m - R_f)$ , indicating the product of Beta and the Risk Premium.
- Return of a portfolio**: Labeled below  $R_p$ .
- Average return of the market**: Labeled below  $R_m$ .

# Factor Models



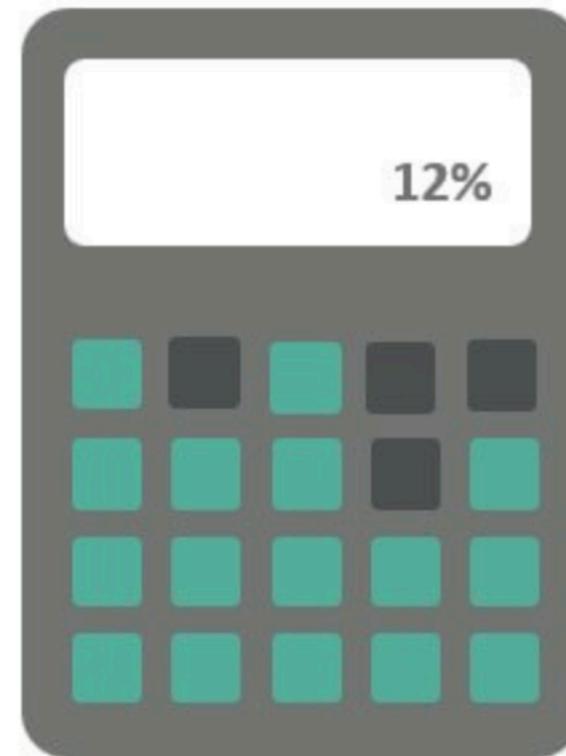
## Types of Factor Model

### 1. Single Factor Formula

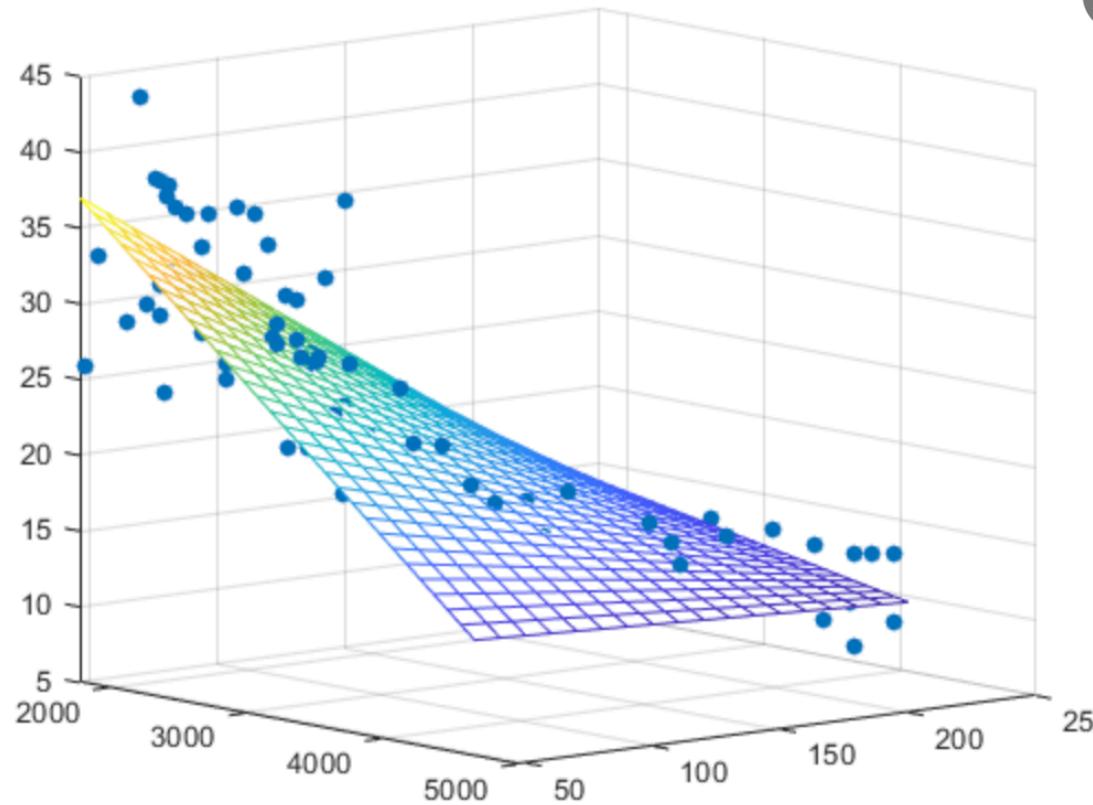
$$E(R)_i = R_f + \beta(E(R_m) - R_f)$$

### 2. Multiple Factor Formula

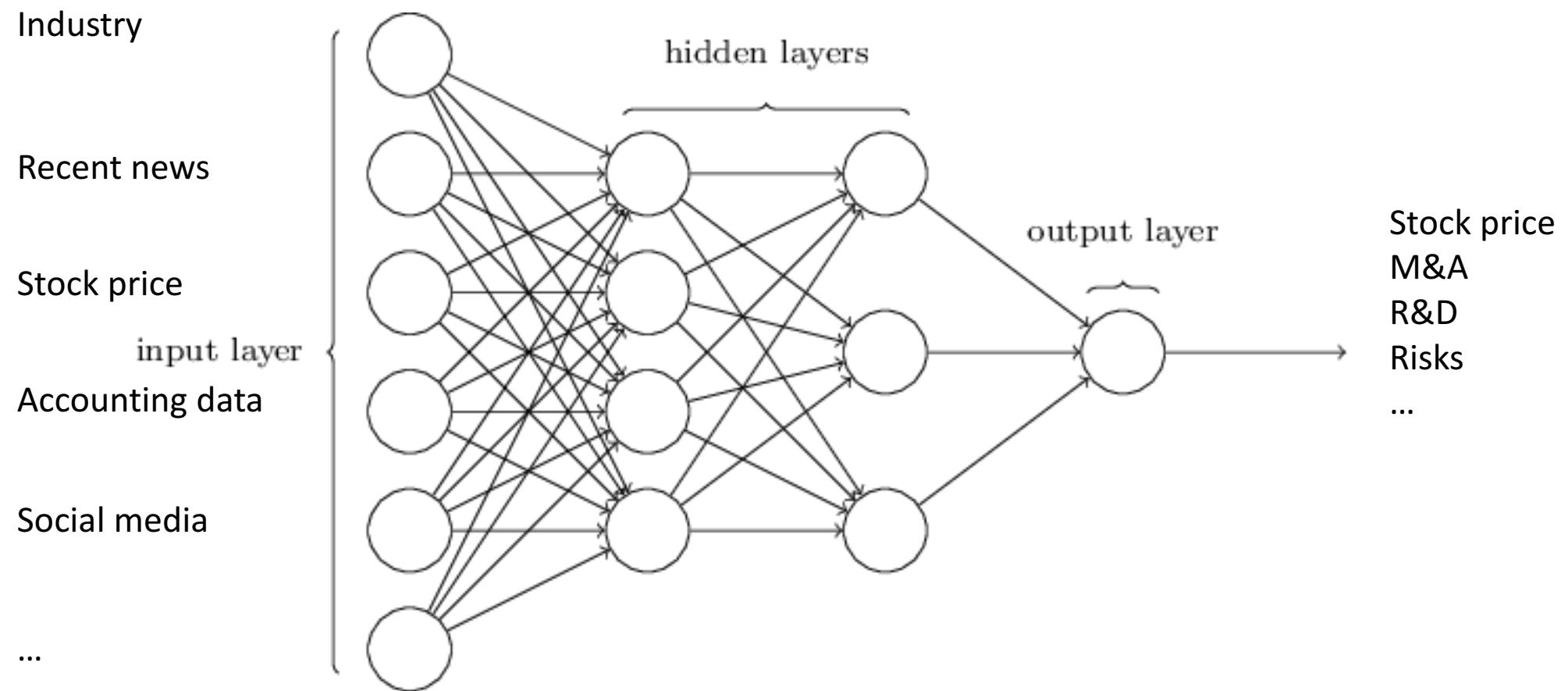
$$R_{s,t} = R_f + \alpha + \beta_1 \times F_{1,t} + \beta_2 \times F_{2,t} + \dots + \beta_n \times F_{n,t} + \epsilon$$



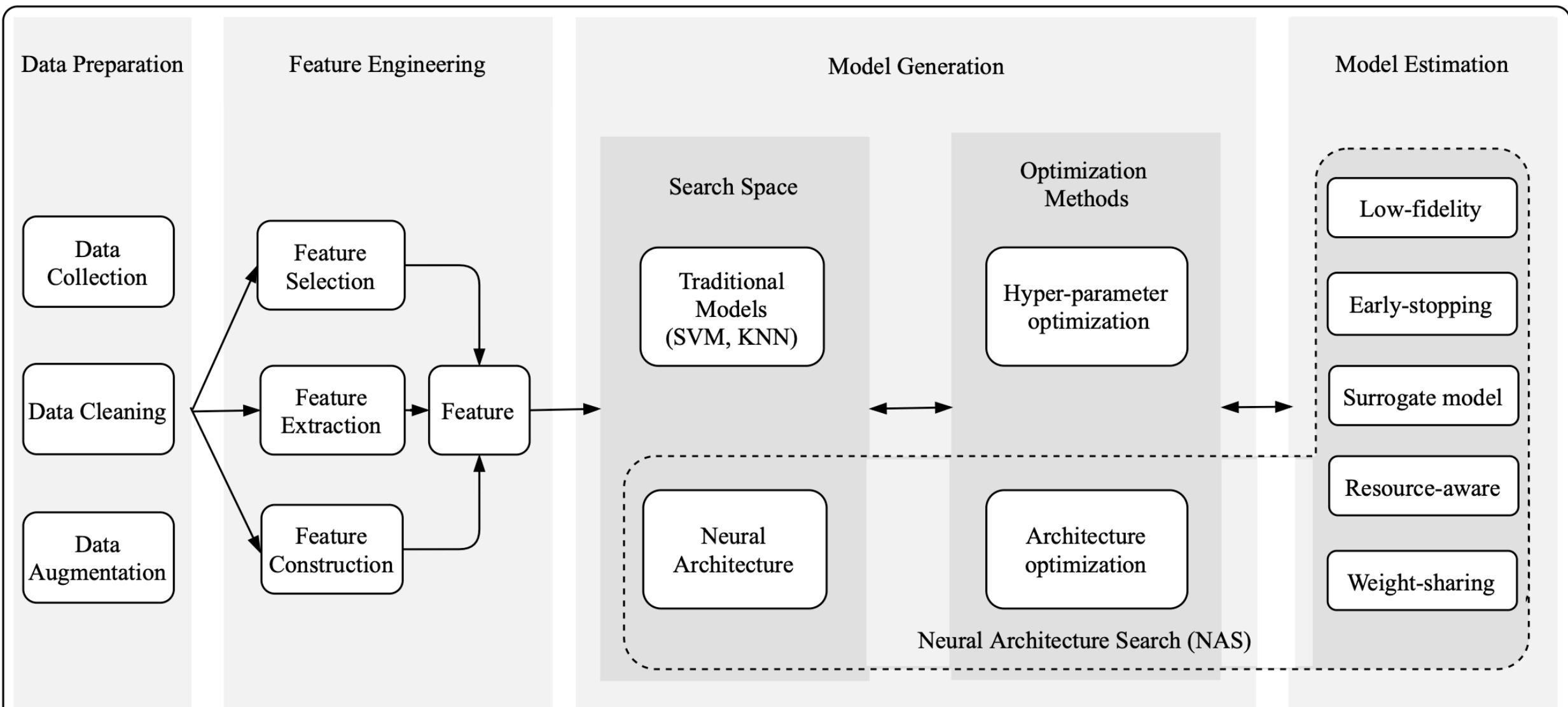
# Quant 1.0



# Quant 2.0

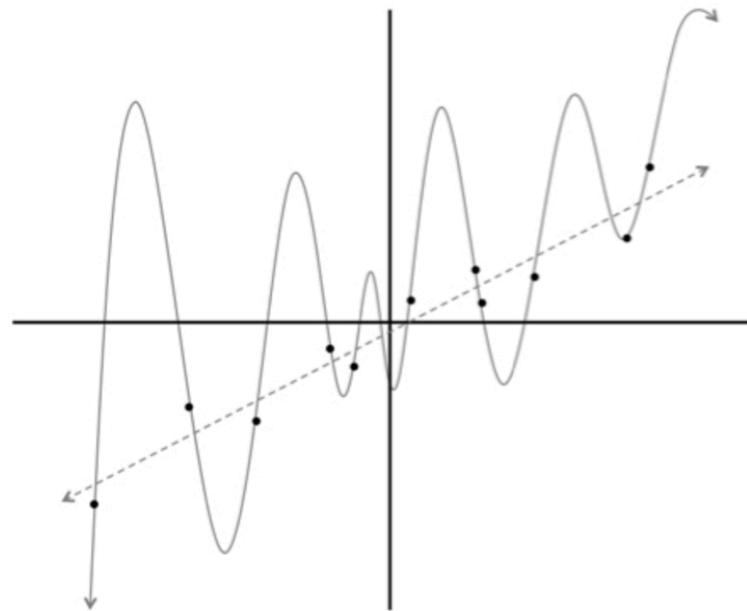


# Quant 2.0



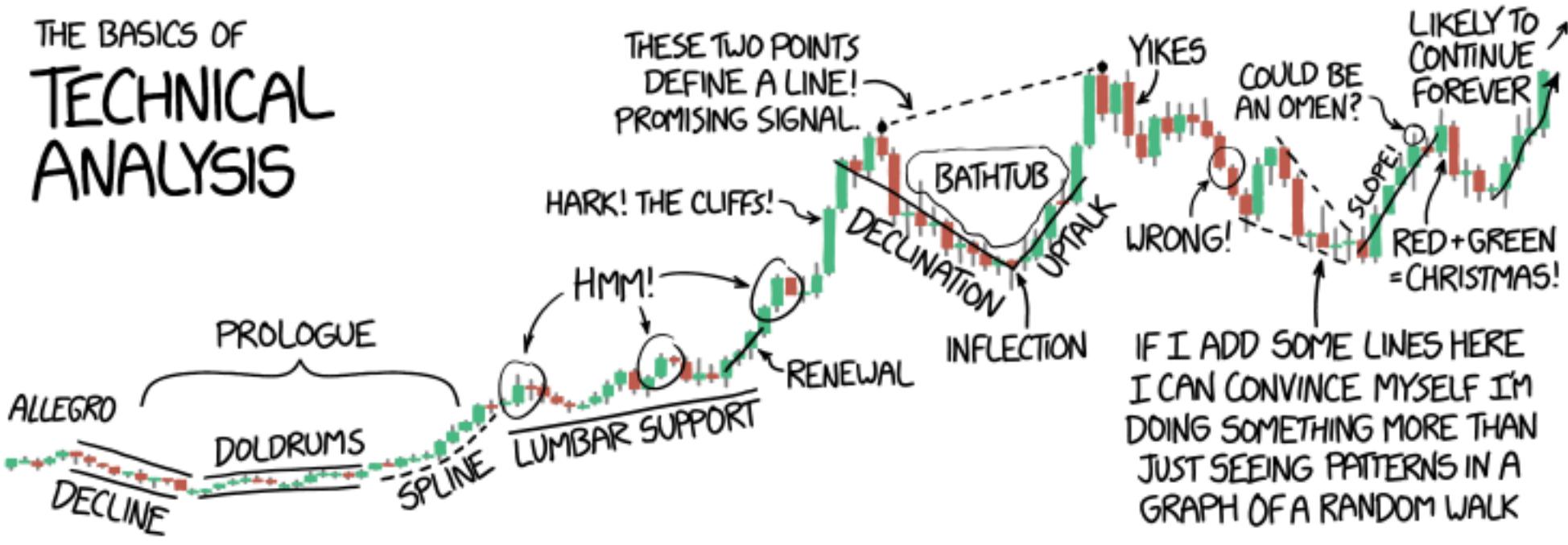
# One Important Challenge of AI

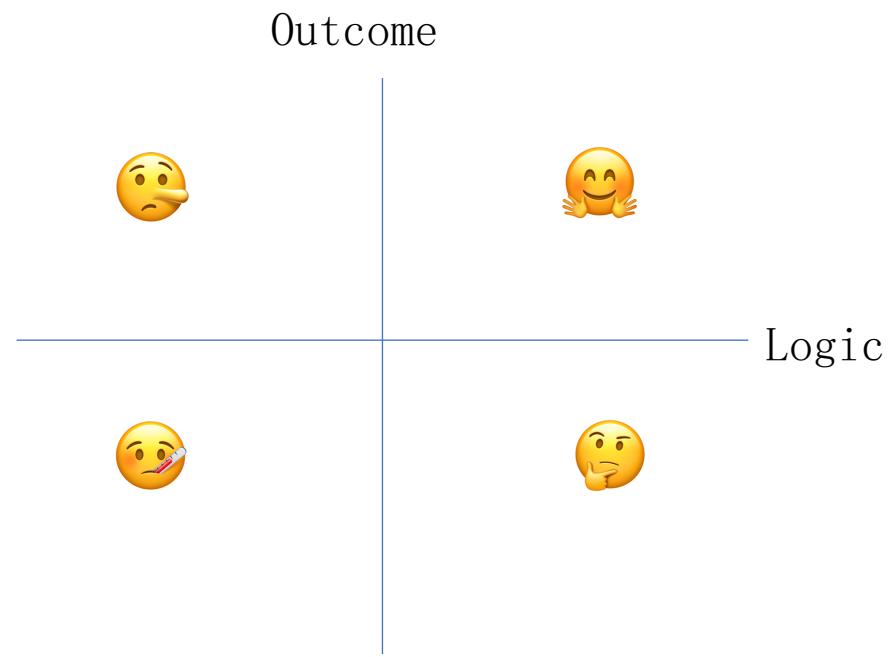
- Challenge: Overfitting
- Potential solution: Causal Inference



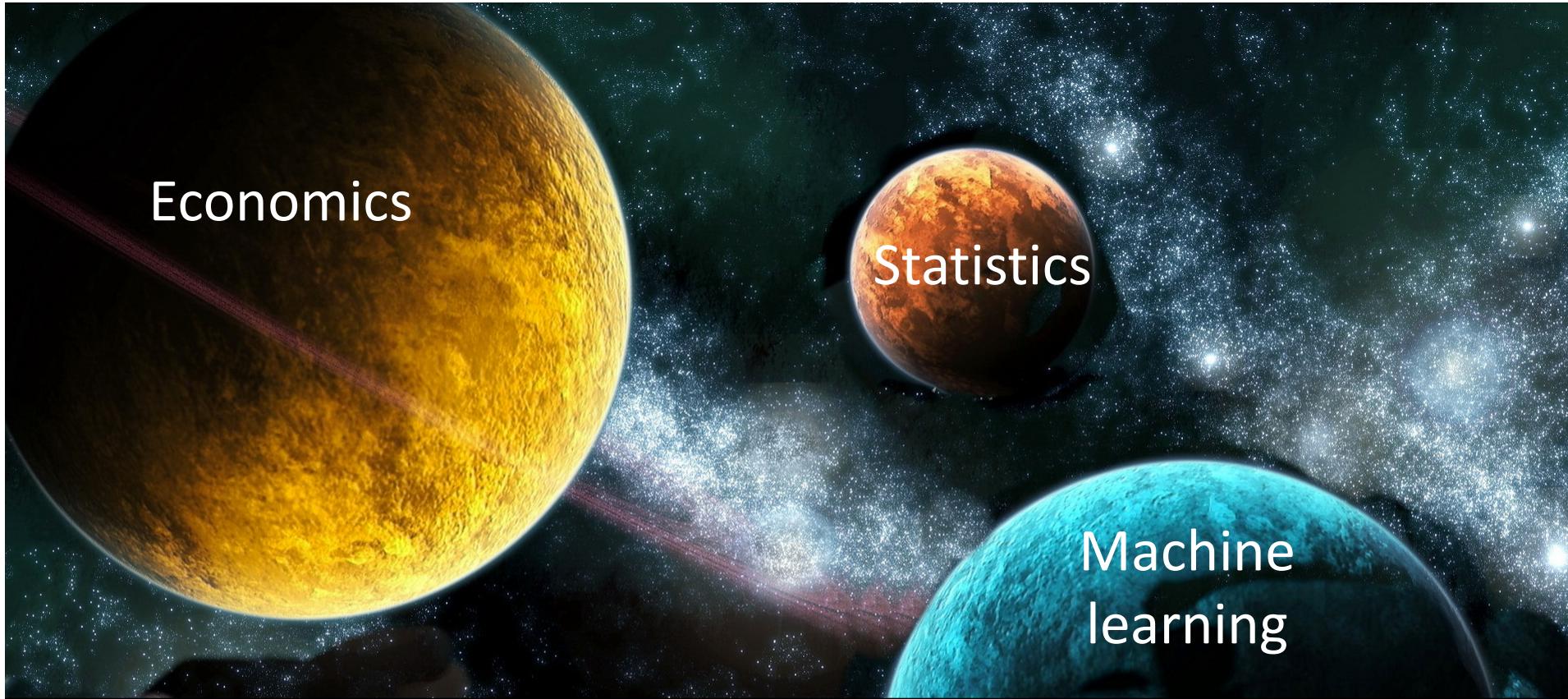


# THE BASICS OF TECHNICAL ANALYSIS





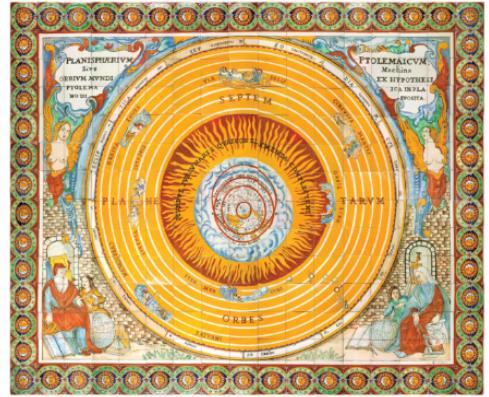
# AI means very different things



Explain

Describe

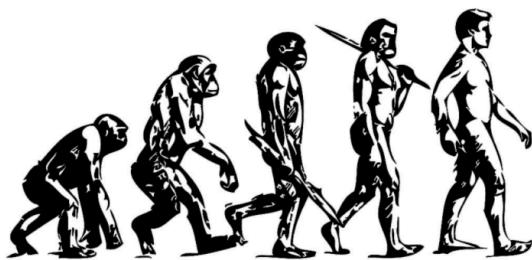
Predict



Predictive Power



Explanatory Power



# Quant 3.0

- Machine Learning + Financial Mathematics + Stats

$$x(t) := \exp \left\{ \int_0^t \left[ \frac{\alpha^2(s)}{2} - a(s) \right] ds - \alpha(s) dB(s) \right\} \\ \times \left[ 1/N_0 + \int_0^t b(s) \exp \left\{ \int_0^s \left[ a(\tau) - \frac{\alpha^2(\tau)}{2} \right] d\tau + \alpha(\tau) dB(\tau) \right\} ds \right]; \quad (2.2)$$

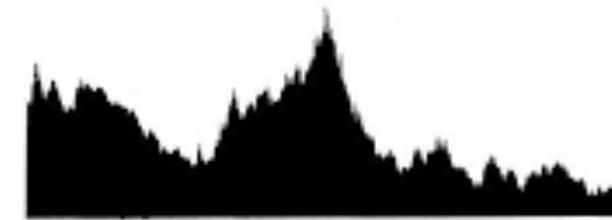
then  $x(t)$  satisfies the equation

$$dx(t) = [(\alpha^2(t) - a(t)) dt - \alpha(t) dB(t)] x(t) + b(t) dt. \quad (2.3)$$

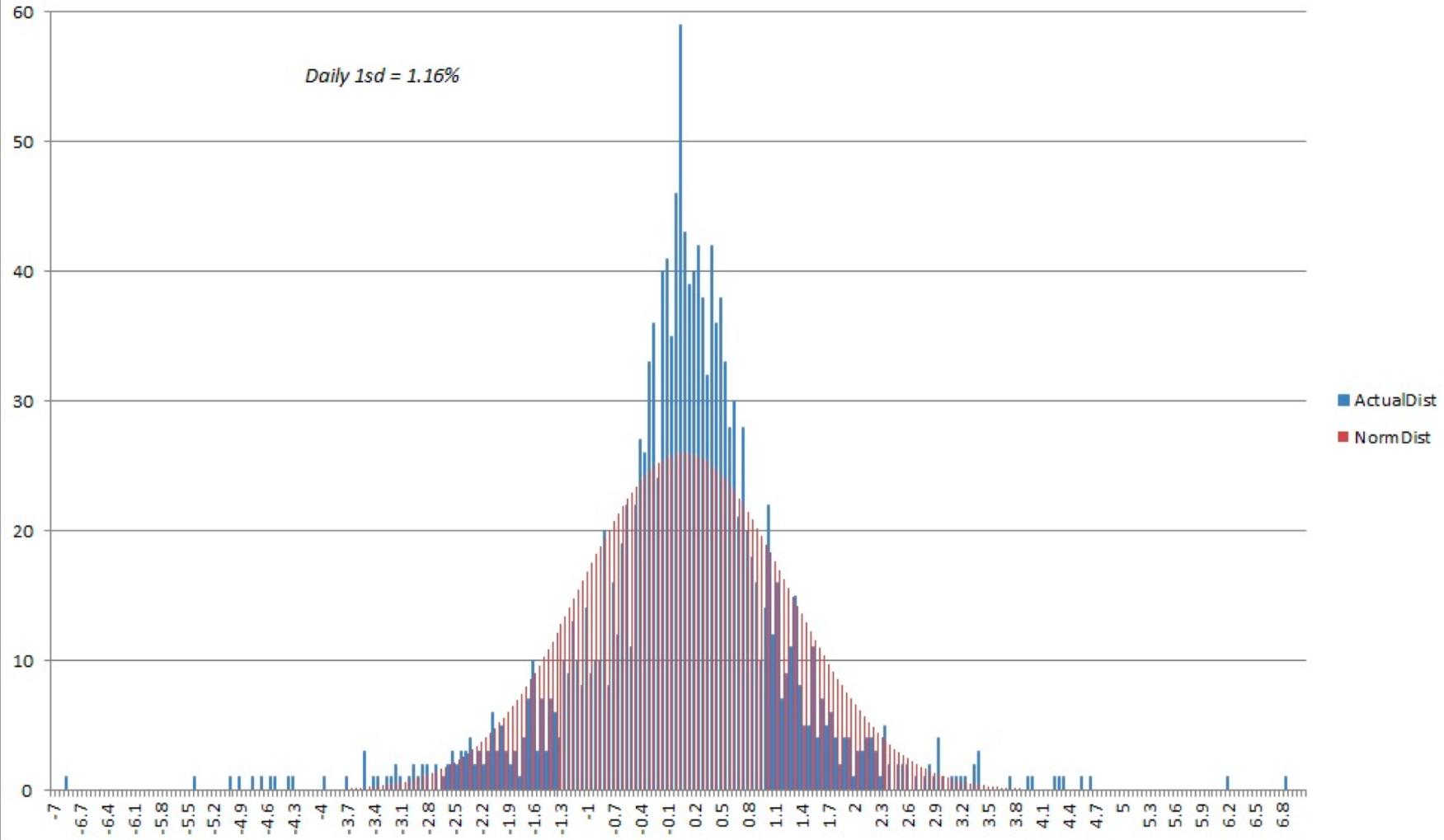
Let  $N(t) := 1/x(t)$ , then  $N(t) > 0$  and  $N(t)$  is continuous and global on  $t \in [0, \infty)$ . By Itô's formula

$$dN(t) = -\frac{dx(t)}{x^2(t)} + \frac{(dx(t))^2}{x^3(t)} \\ = -[(\alpha^2(t) - a(t)) dt - \alpha(t) dB(t)] N(t) - b(t) N^2(t) dt + N(t) \alpha^2(t) dt \\ = N(t) [(a(t) - b(t) N(t)) dt + \alpha(t) dB(t)].$$

Which one is NOT real financial data?



**SP500 Returns - No Truncation**  
31/12/2008 - 31/12/2014



"All the News  
That's Fit to Print"

# The New York Times

VOL.CXXXVII... No. 47,298

Copyright © 1987 The New York Times

NEW YORK, TUESDAY, OCTOBER 20, 1987

50 cents beyond 75 miles from New York City,  
except on Long Island. 30 CENTS

## Late Edition

New York: Today, increasing clouds.  
High 62-67. Tonight, cloudy, breezy,  
showers likely. Low 51-57. Tomorrow,  
showers ending. High 58-63. Yesterday:  
High 68, low 48. Details on page B6.

## STOCKS PLUNGE 508 POINTS, A DROP OF 22.6%; 604 MILLION VOLUME NEARLY DOUBLES RECORD

### U.S. Ships Shell Iran Installation In Gulf Reprisal

### Offshore Target Termned a Base for Gunboats

By STEVEN V. ROBERTS  
Special to The New York Times

WASHINGTON, Oct. 19 — United States naval forces struck back at Iran today for attacks on American-registered vessels and other Persian Gulf shipping by shelling two connected offshore platforms that American officials said were a base for Iranian gunboats.

A few hours later, a naval commando detachment boarded a third platform five miles away and destroyed radar and communications equipment, Pentagon officials said.

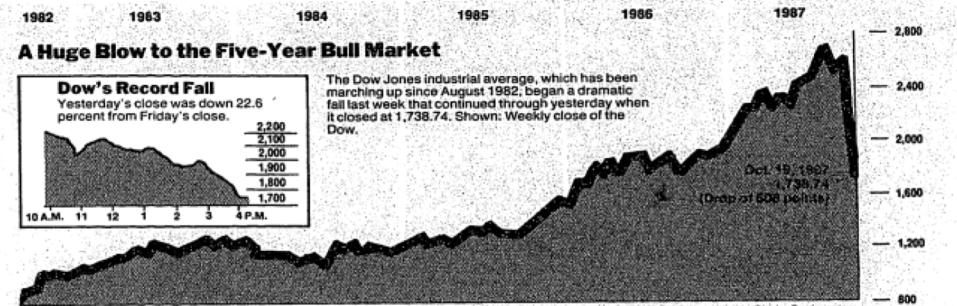
No American casualties were reported in the actions, which occurred 120 miles east of Bahrain at about 2 P.M. (7 A.M., Eastern daylight time).

#### A 20-Minute Warning

American officials said the attacking force took pains to avoid killing Iranians, giving the crew on the first two platforms a 20-minute warning before four destroyers, stationed about three miles away, began the shelling.

At the United Nations, an Iranian delegate said "several innocent people" had been killed in the attack, but the assertion could not be confirmed.

With the bombardment, the Administration intended to send a message to Iran: The United States had shown restraint in the level of its attack this



## Does 1987 Equal 1929?

By ERIC GELMAN

As stock prices soared this year, a chorus of pessimists warned that 1987 was looking more like 1929, when a stock market crash helped to usher in the Great Depression. Yesterday, after

the plunge reminiscent of the worst days of 1929, one pressing question was whether the aftershocks would be as devastating to individuals and the nation.

The quick answer, many economists say, is no. The huge losses on Wall Street constitute a substantial blow to the economy at large. But there are many safeguards in place today — some instituted directly in response to the Depression — that would tend to



## WORLDWIDE IMPACT

### Frenzied Trading Raises Fears of Recession — Tape 2 Hours Late

By LAWRENCE J. DE MARIA

Stock market prices plunged in a tumultuous wave of selling yesterday, giving Wall Street its worst day in history and raising fears of a recession.

The Dow Jones industrial average, considered a benchmark of the market's health, plummeted a record 508 points, to 1,738.74, based on preliminary calculations. That 22.6 percent decline was the worst since World War I and far greater than the 12.82 percent drop on Oct. 28, 1929, that along with the next day's 11.7 percent decline preceded the Great Depression.

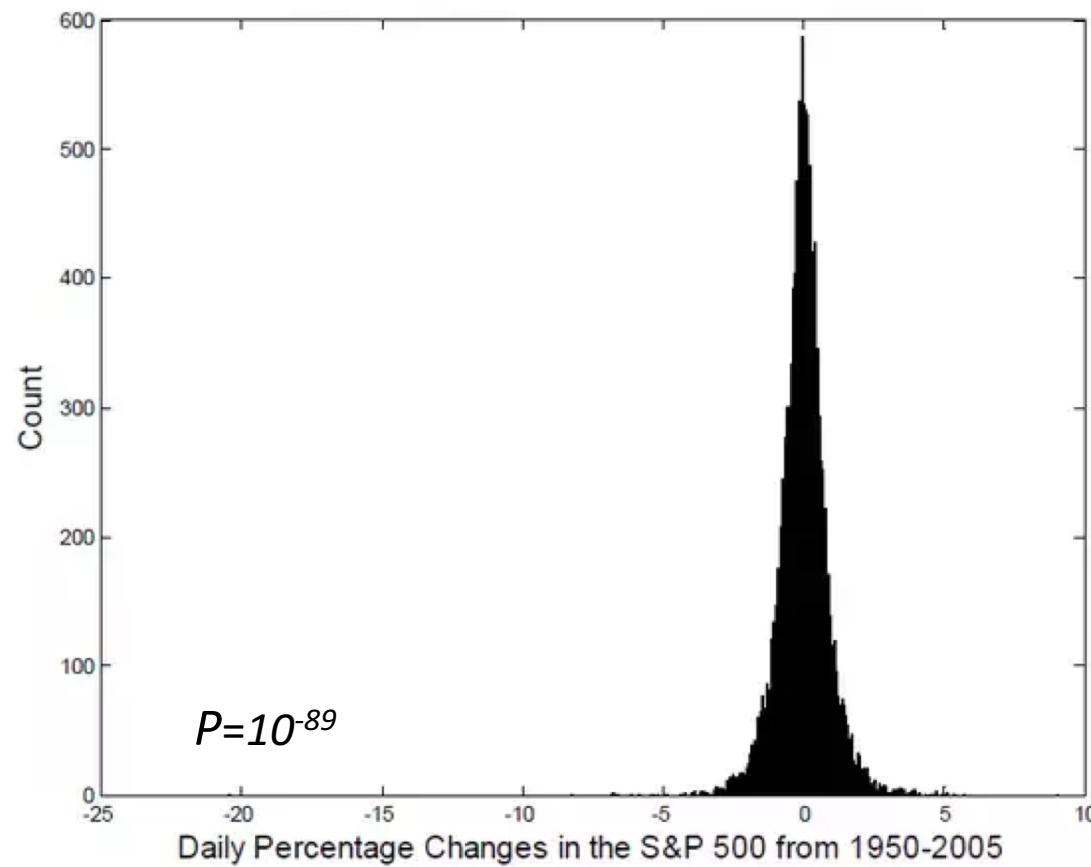
Since hitting a record 2,722.42 on Aug. 25, the Dow has fallen almost 1,600 points, or 36 percent, putting the blue-chip indicator 157.5 points below the level at which it started the year. With Friday's plunge of 108.35 points, the Dow has fallen more than 26 percent in the last two sessions.

#### Unprecedented Trading

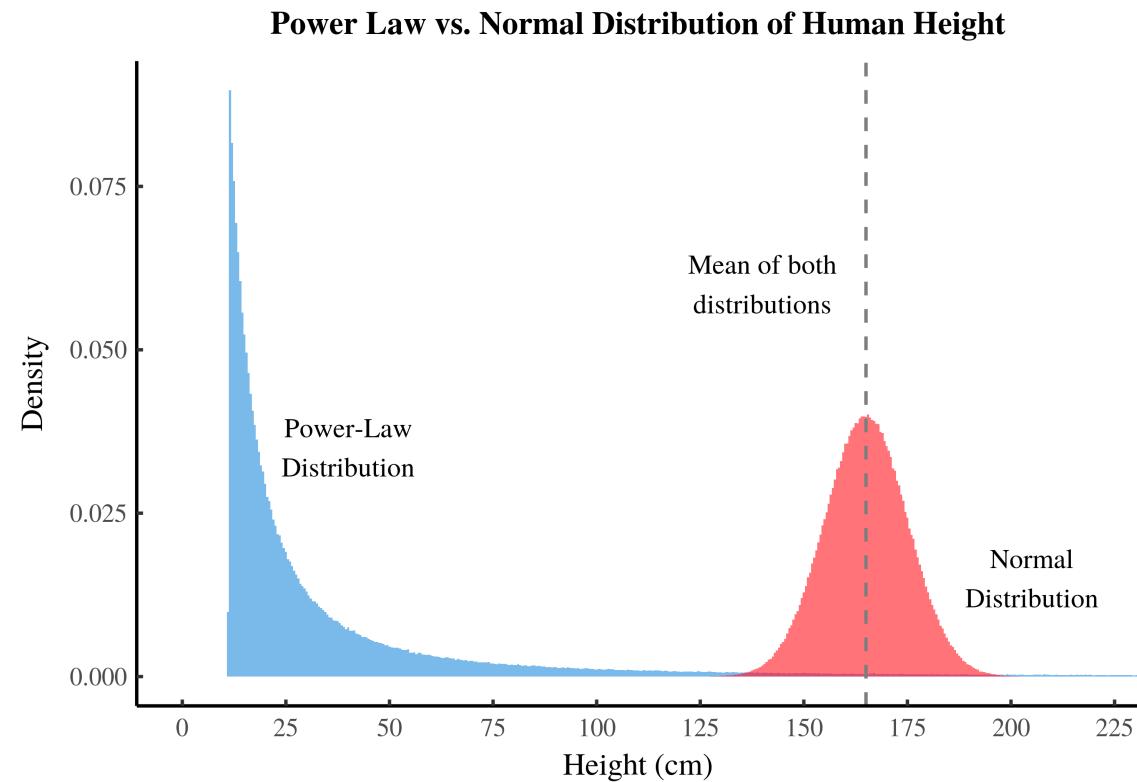
Yesterday's frenzied trading on the nation's stock exchanges lifted volume to unheard-of levels. On the New York Stock Exchange, an estimated 604.3 million shares changed hands, almost double the previous record of 338.5 million shares set just last Friday.

With the tremendous volume, reports of brokers' trades on the New York Stock Exchange were delayed by more than two hours at one point. The New

1987 Stock market crash



Science      Engineering      Business



# The Black-Scholes Formulas

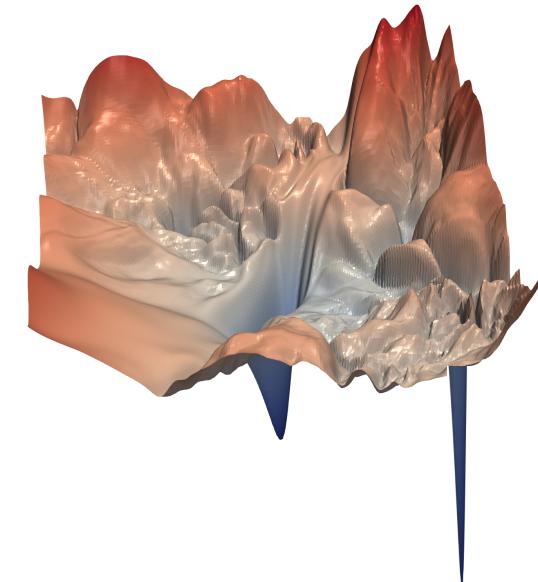
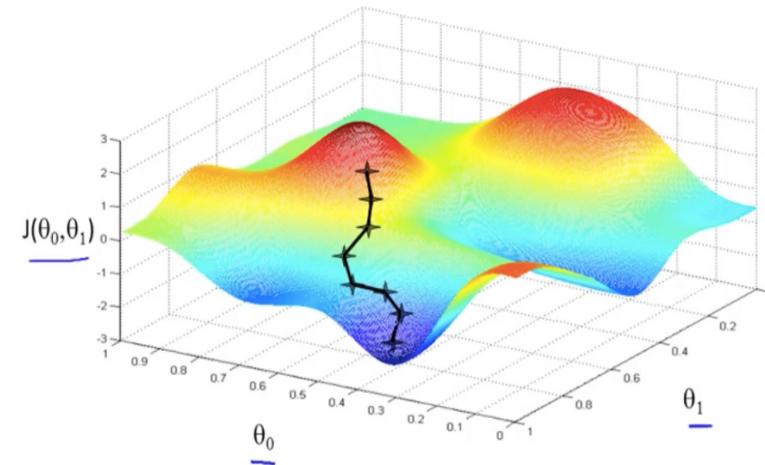
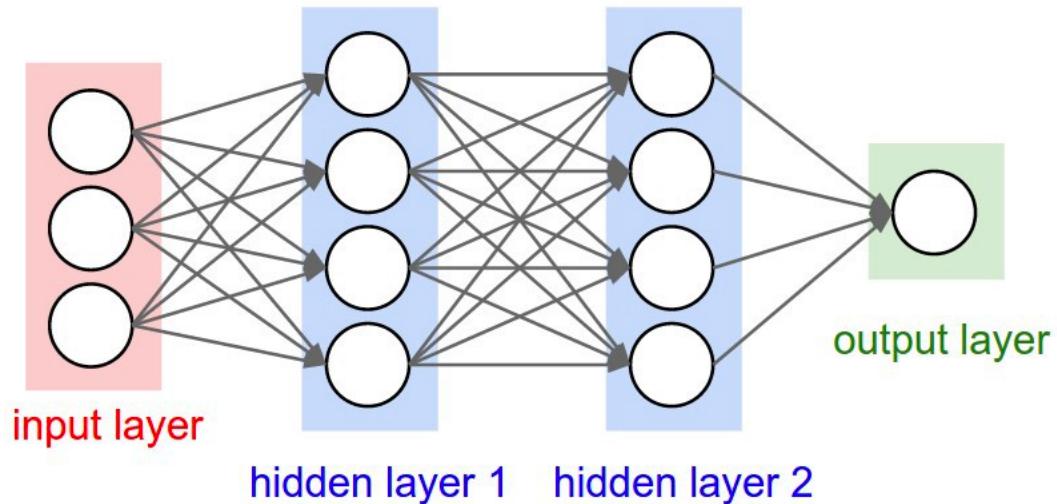
$$c = S N(d_1) - X e^{-rT} N(d_2)$$

$$p = X e^{-rT} N(-d_2) - S N(-d_1)$$

where  $d_1 = \frac{\ln(S / X) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$

$$d_2 = \frac{\ln(S / X) + (r - \sigma^2 / 2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

# Limitations of Machine Learning

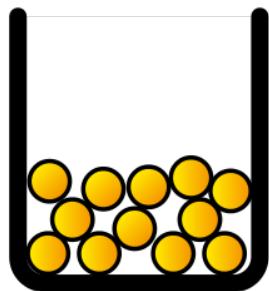


# Devil is in the details

- Normal
- Static
- Stationary
- ...

# Decision-making Scenarios

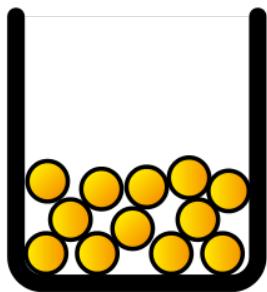
Certainty



(1)

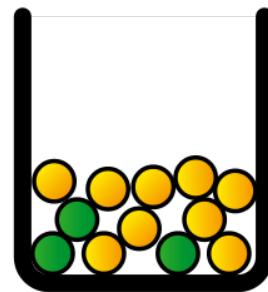
# Decision-making Scenarios

Certainty



(1)

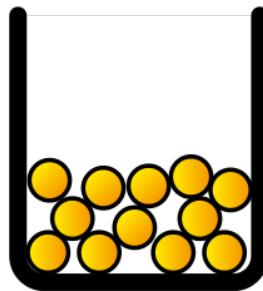
Risk



(2)

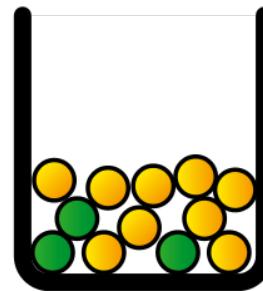
# Decision-making Scenarios

Certainty



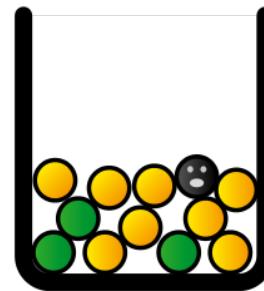
(1)

Risk



(2)

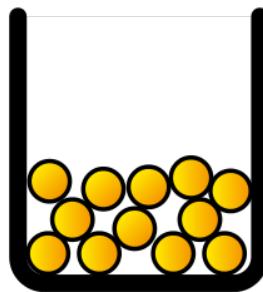
Black Swan



(3)

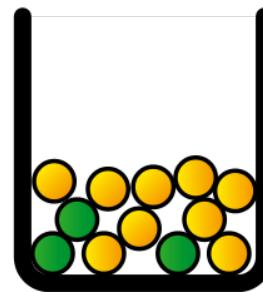
# Decision-making Scenarios

Certainty



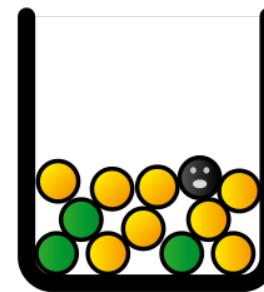
(1)

Risk



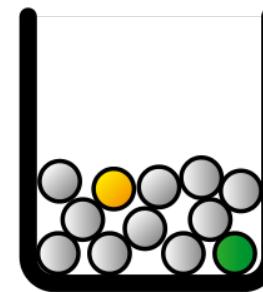
(2)

Black Swan



(3)

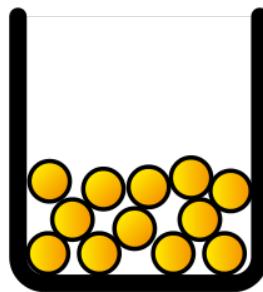
Ambiguity



(4)

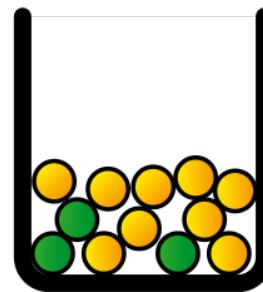
# Decision-making Scenarios

Certainty



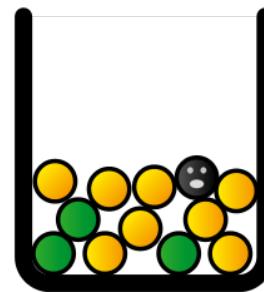
(1)

Risk



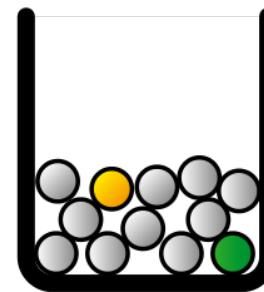
(2)

Black Swan



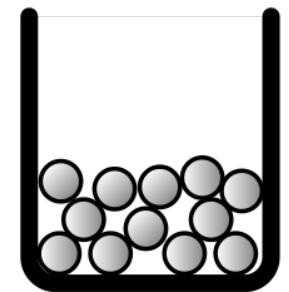
(3)

Ambiguity

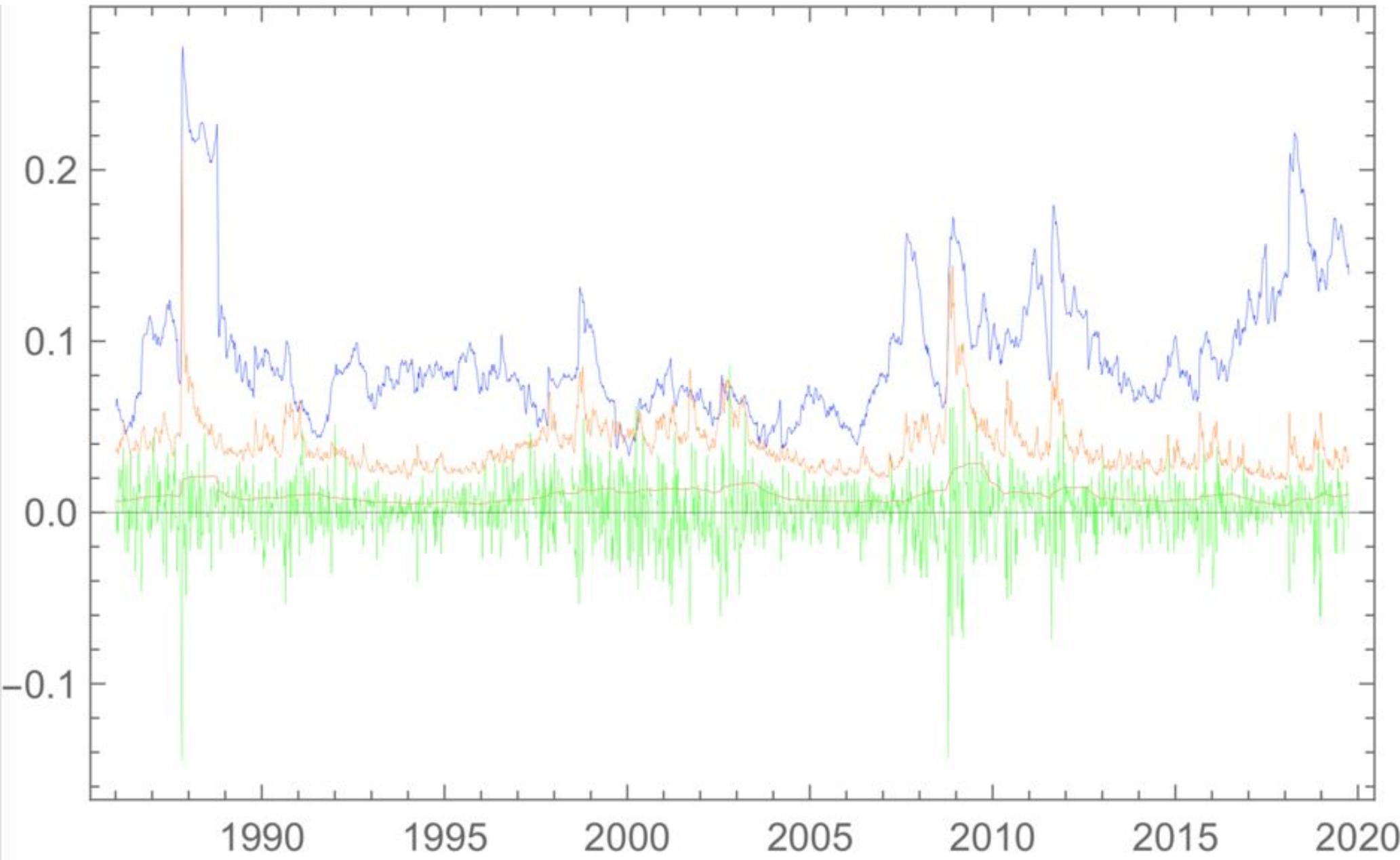


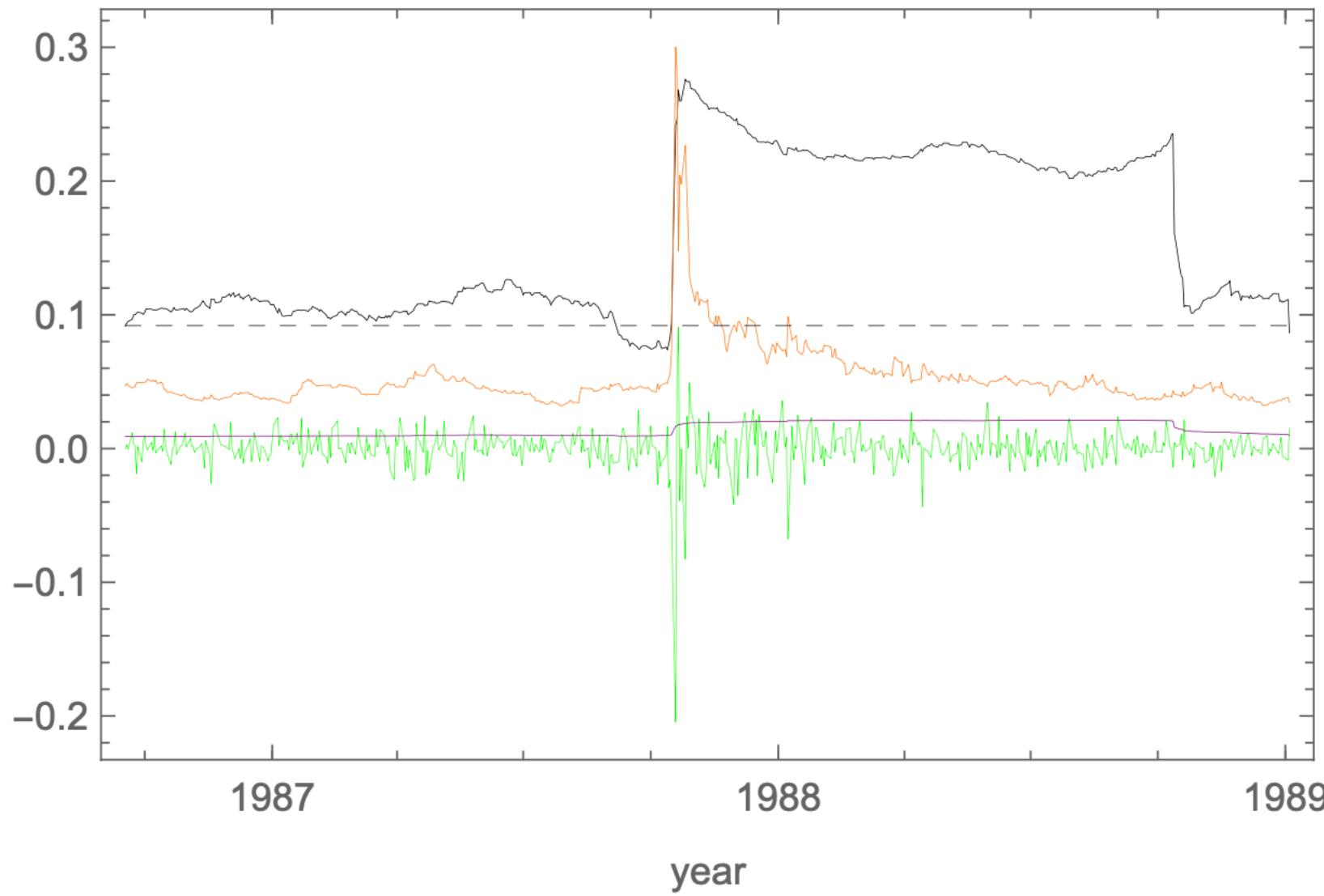
(4)

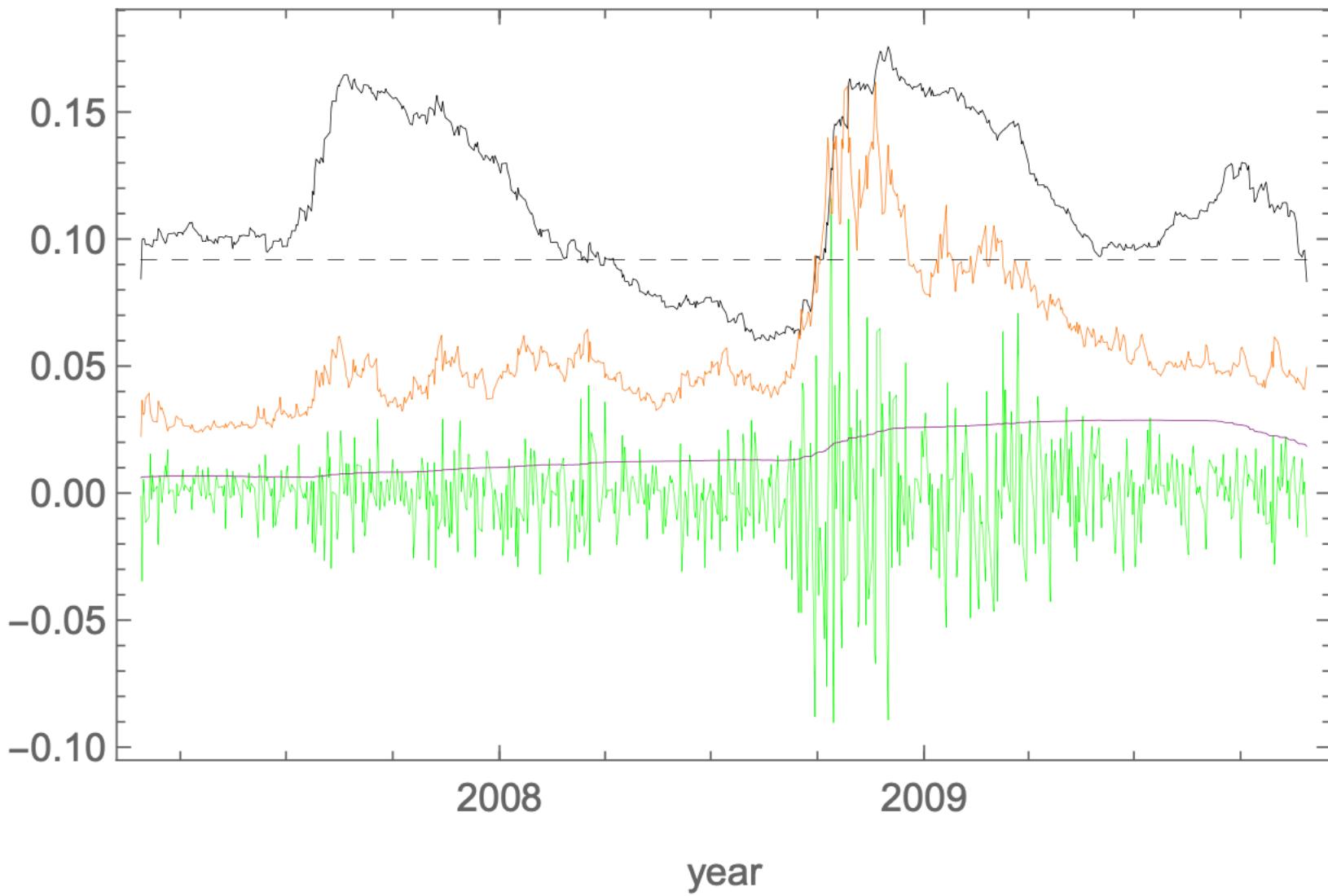
Radical Uncertainty

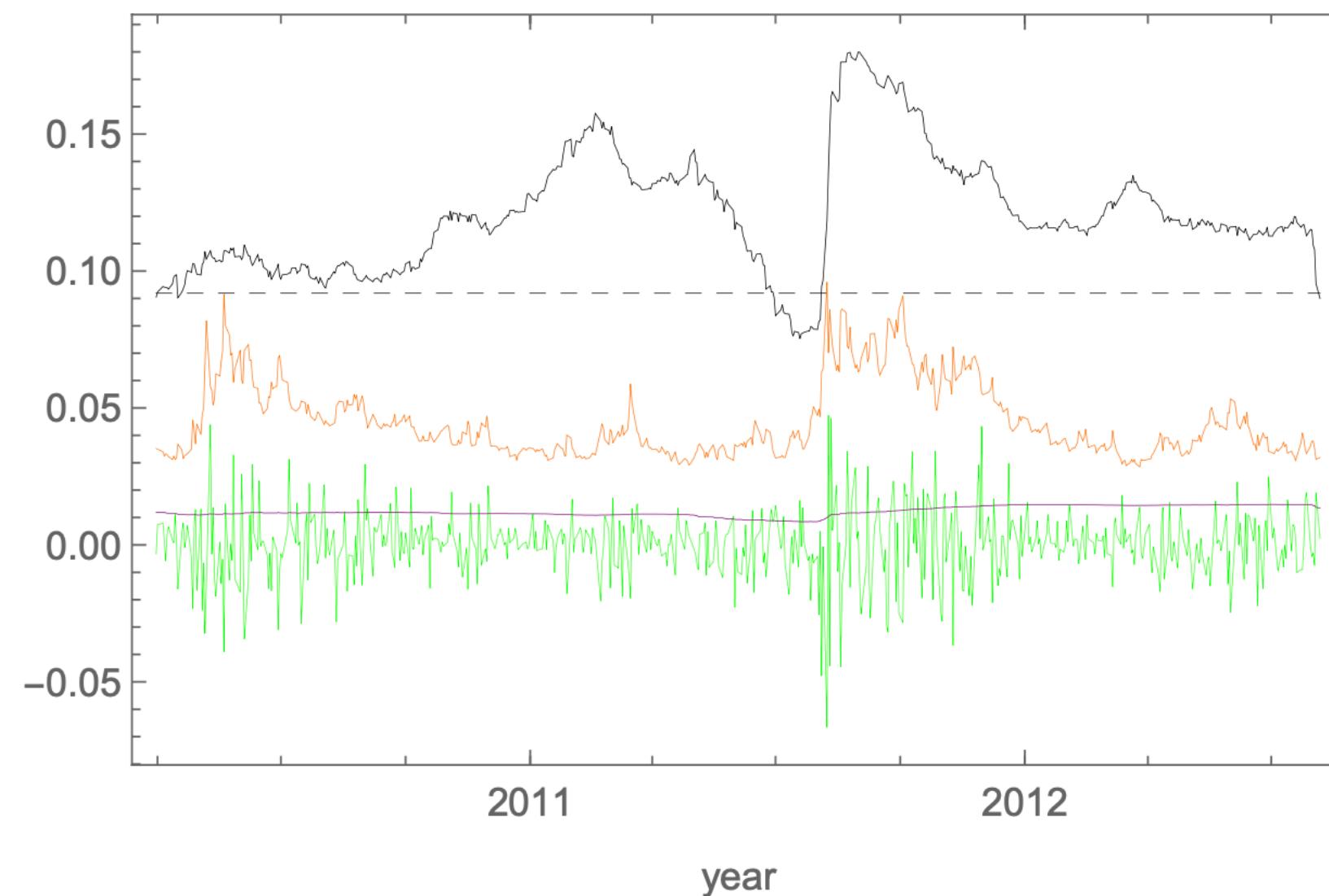


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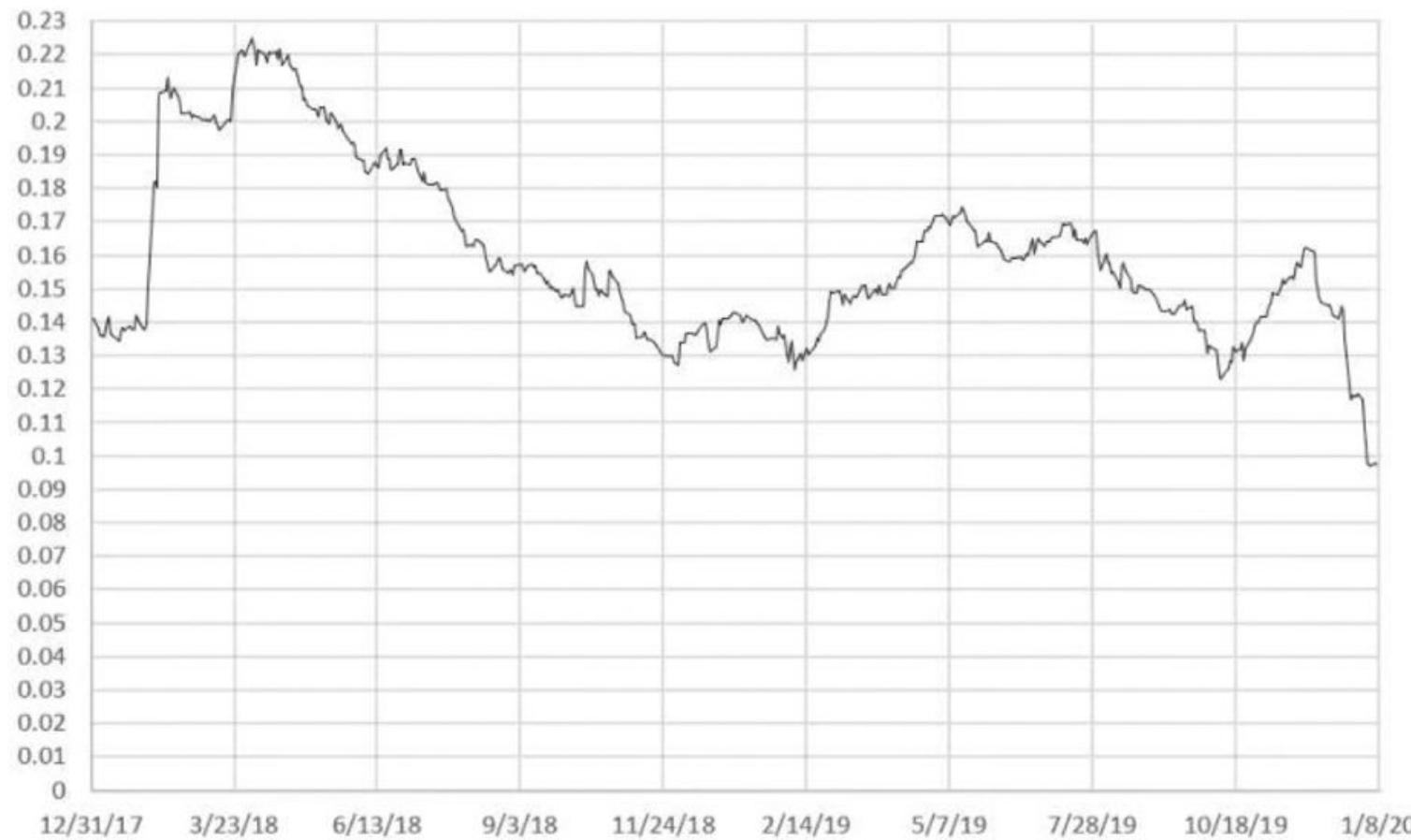




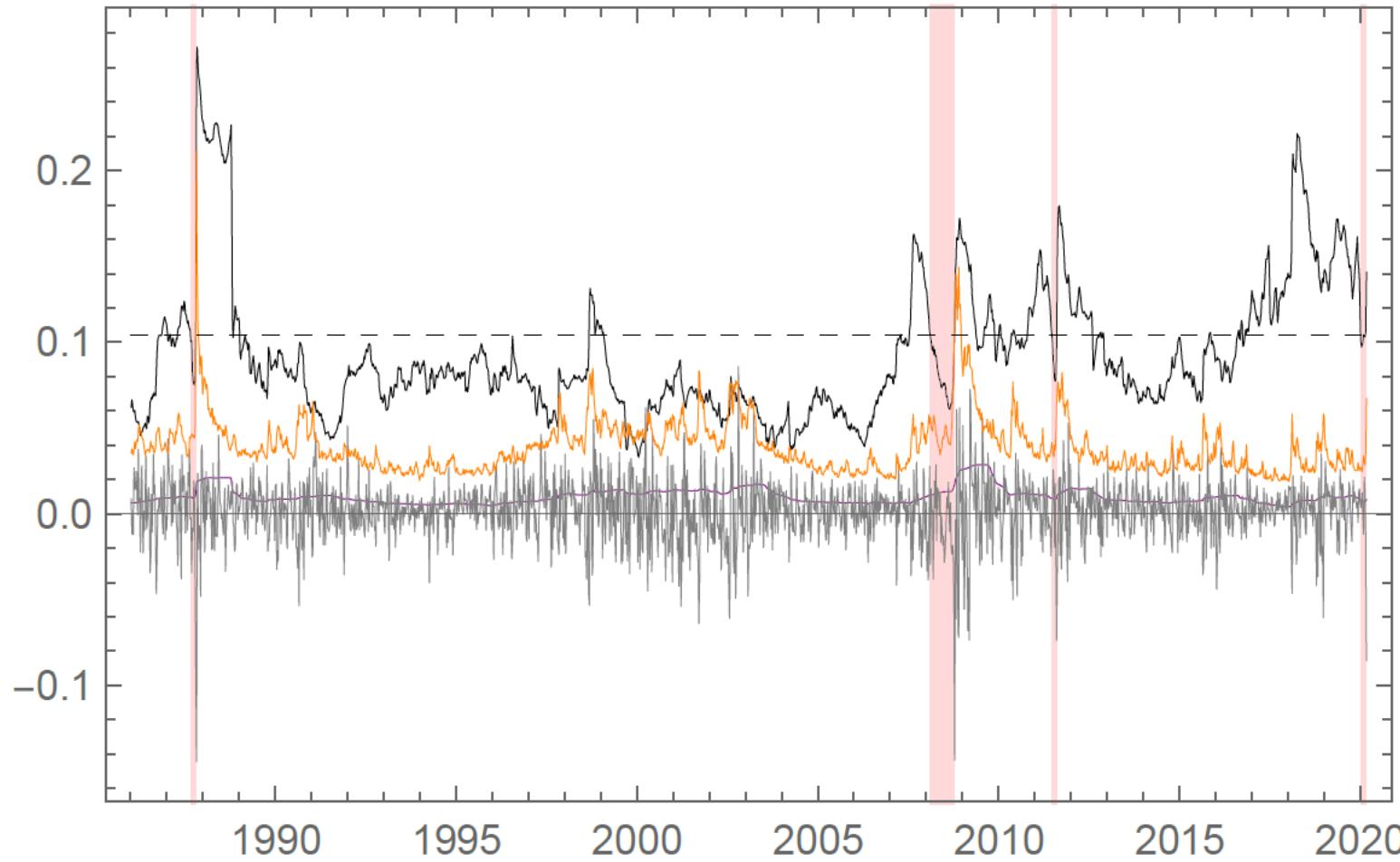








# Warnings



CR SUISSE AG NA/VELOCITY SHS DAILY  
NASDAQ: TVIX

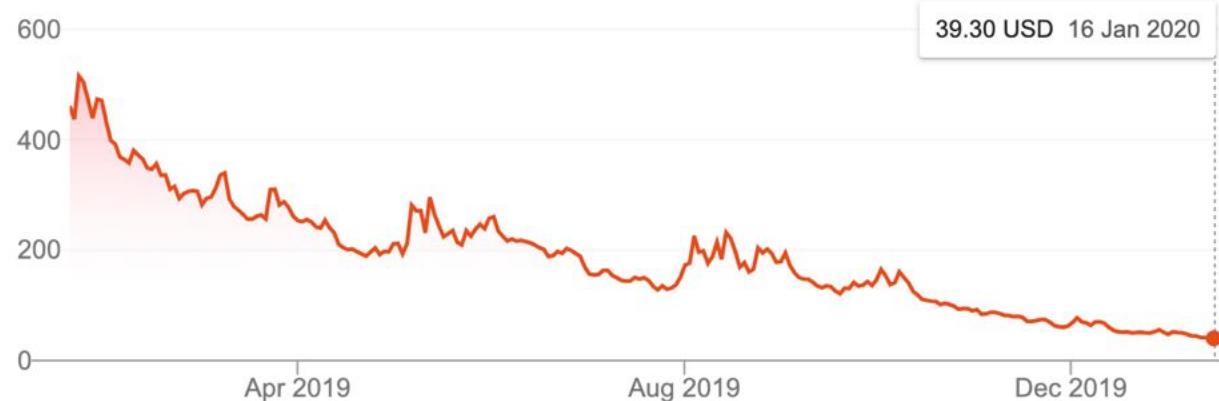
+ Follow

**39.30** USD **-1.94 (4.70%)** ↓

Closed: 17 Jan, 5:33 am GMT-5 · Disclaimer

Pre-market 38.88 **-0.42 (1.07%)**

1 day    5 days    1 month    6 months    YTD    **1 year**    5 years    Max

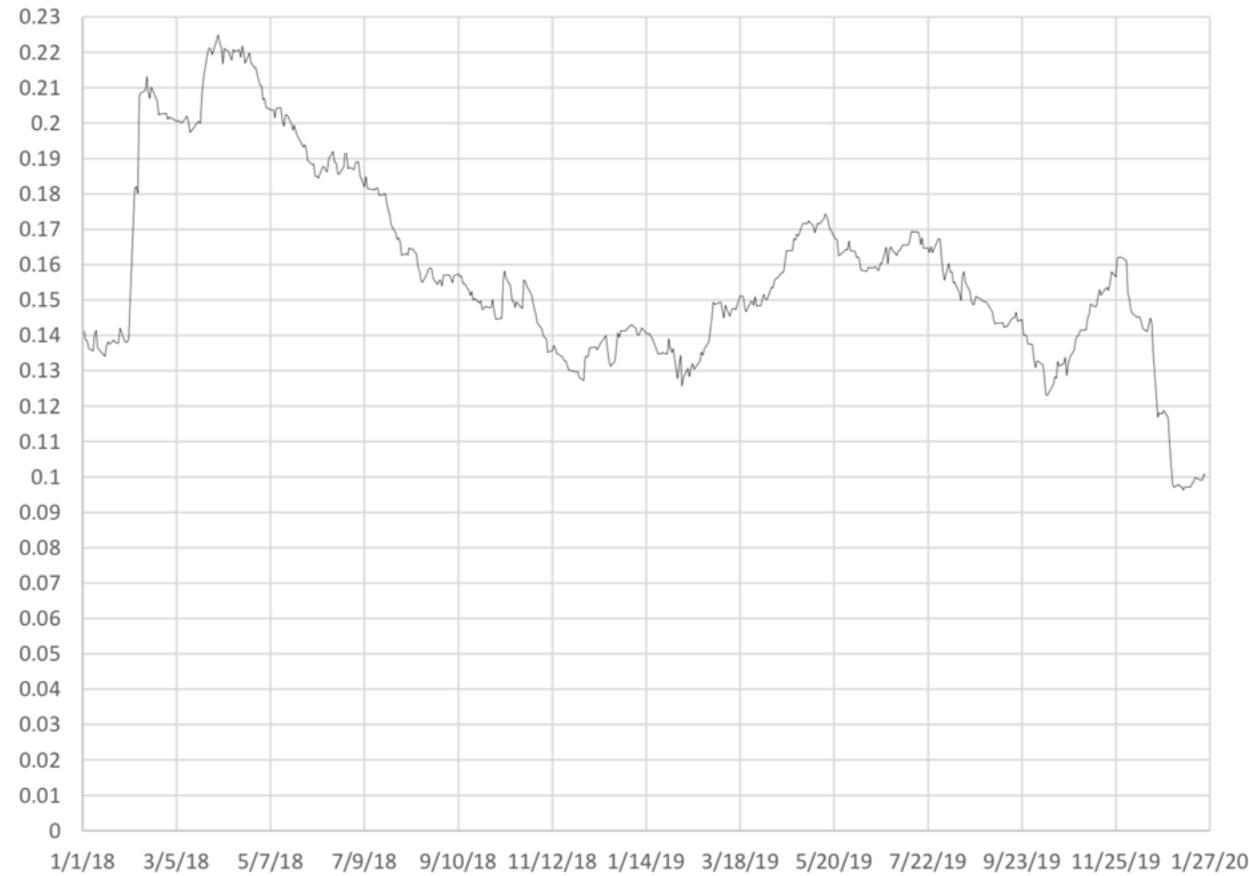


Open	40.16	Div yield	-
High	40.35	Prev close	41.24
Low	39.10	52-wk high	568.30
Mkt cap	-	52-wk low	39.10
P/E ratio	-		





01/24



这个数学模型让我们几天内投资收益率达到204% -- 做空美股中，  
而且股灾还没有到来

原创 Michael 麦教授 麦教授随笔 1月28日

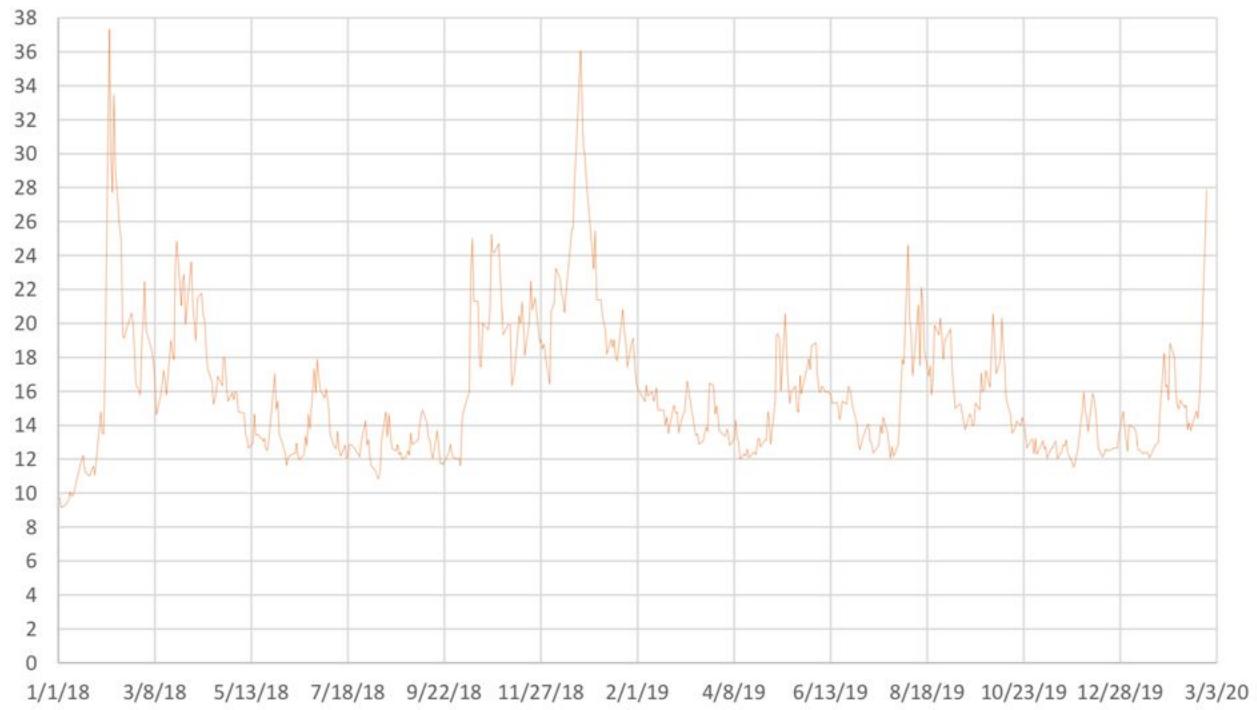
1月19日，也就是大约10天前，我说过我们的研究显示美股会有股灾，建议大家有仓位的避避险，没仓位的冒冒险。（我的朋友们Gordon教授和小雨教授分别都表示听从建议，把钱从股市挪出来，[他们做对了！](#)）

如果10天前你看了我的文章：[【2020想撒欢？去做空美股吧】](#)，买了美股看空期权，那今天你已经赚了两倍多了。



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## VIX



# 【麦教授-投资】用数学模型空袭华尔街 一个月翻了6倍

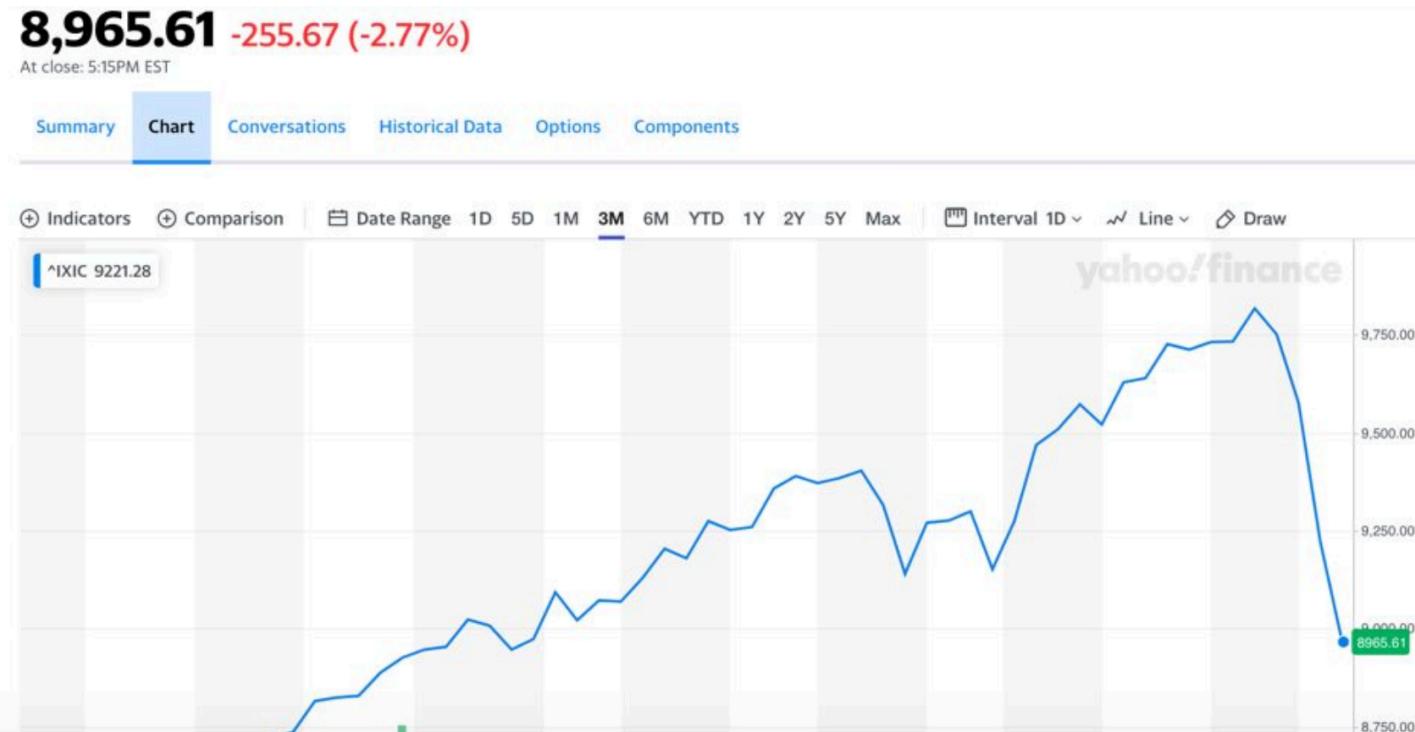
原创 Michael 麦教授 麦教授随笔 2月26日

有的人预测美股会跌，他拿了诺贝尔奖（Robert Shiller 2013年）；有的人预测美股会跌，他赚了6倍的钱（麦教授 2020年）。



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请无视文章标题和上面这句开玩笑的话，看着很像get rich fast scheme，但其实不是，因为真的有严谨的数学模型在支撑决策。



**Puts** for January 24, 2020

Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask	Change	% Change	Volume	Open Interest	Implied Volatility
SPY200124P00270000	2020-01-15 3:25PM EST	270.00	0.01	0.00	0.01	0.00	-	18,001	19,304	46.88%
SPY200124P00329000	2020-01-17 11:16AM EST	329.00	0.74	0.73	0.74	-0.14	-15.91%	7,342	6,371	8.62%
SPY200124P00325000	2020-01-17 9:50AM EST	325.00	0.25	0.25	0.26	-0.12	-32.43%	3,948	16,799	10.57%
SPY200124P00330000	2020-01-17 11:16AM EST	330.00	0.98	0.97	0.98	-0.16	-14.04%	3,583	7,823	8.14%
SPY200124P00326000	2020-01-17 11:13AM EST	326.00	0.33	0.34	0.35	-0.13	-28.26%	3,308	11,780	10.23%
SPY200124P00255000	2020-01-10 2:27PM EST	255.00	0.01	0.00	0.01	0.00	-	3,000	4,483	56.25%
SPY200124P00331500	2020-01-17 11:16AM EST	331.50	1.58	1.54	1.55	-0.17	-9.71%	2,809	633	7.72%
SPY200124P00284000	2020-01-13 1:43PM EST	284.00	0.02	0.00	0.01	0.00	-	1,500	1,579	36.33%
SPY200124P00331000	2020-01-17 9:54AM EST	331.00	1.21	1.18	1.20	-0.34	-21.94%	1,328	2,850	7.15%
SPY200124P00333000	2020-01-17 11:13AM EST	333.00	2.30	2.45	2.47	-0.45	-16.36%	1,173	2,024	7.92%
SPY200124P00328000	2020-01-17 9:53AM EST	328.00	0.50	0.49	0.50	-0.18	-26.47%	1,067	7,339	8.66%
SPY200124P00329500	2020-01-17 11:17AM EST	329.50	0.84	0.85	0.86	-0.15	-15.15%	1,015	2,600	8.42%

# Practice

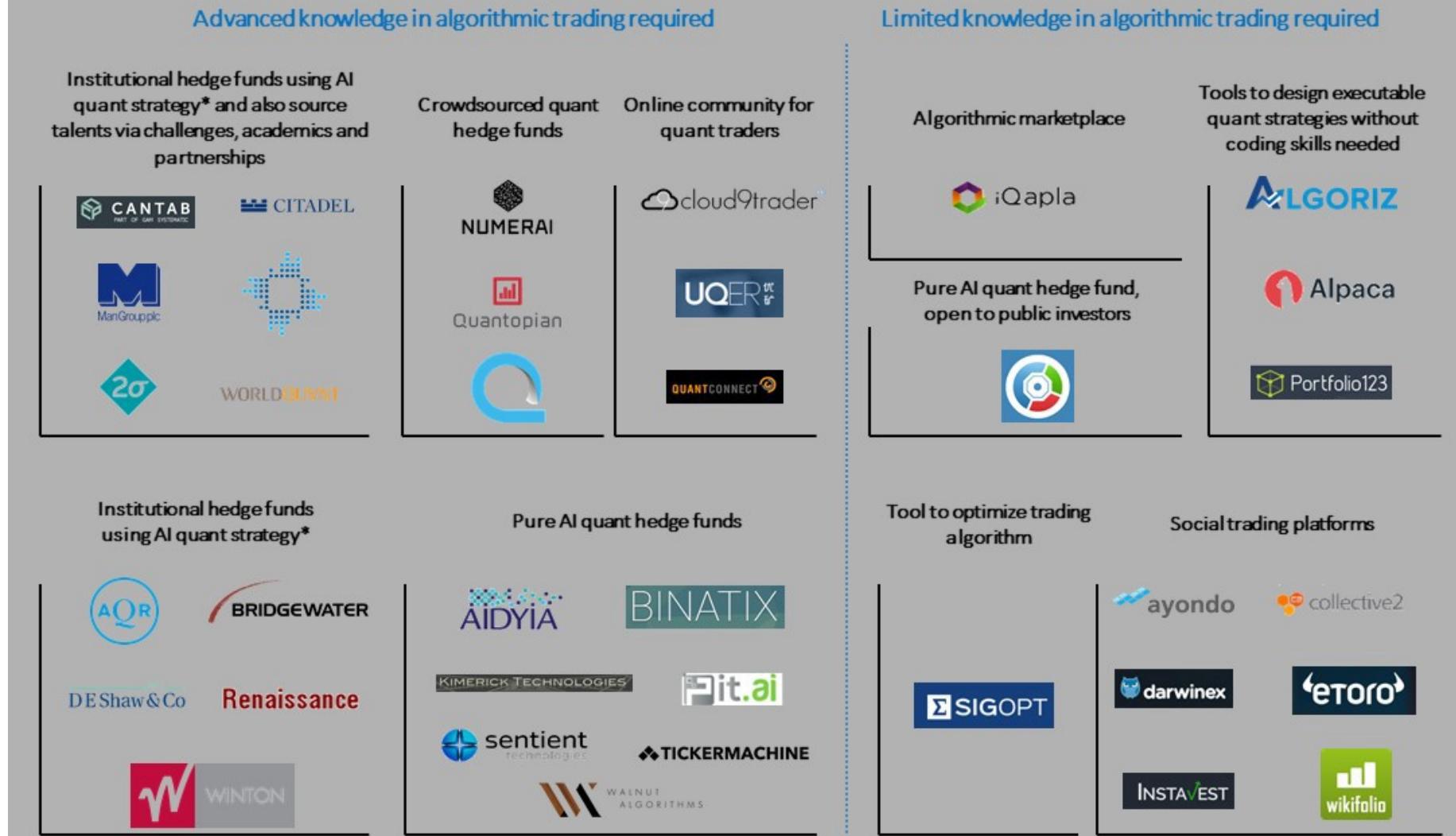
**Renaissance**<sup>®</sup>  
Investment Management



---

DE Shaw & Co

# Artificial intelligence quantitative funds and DIY funds landscape



# Quant Market Outlook of Chinese Stock Market

- A-share AUM: 70 trillion RMB
- AUM by quant funds: 1 trillion RMB
- AUM of top player: 100 billion RMB
- Number of player with more than 10 billion AUM: 17



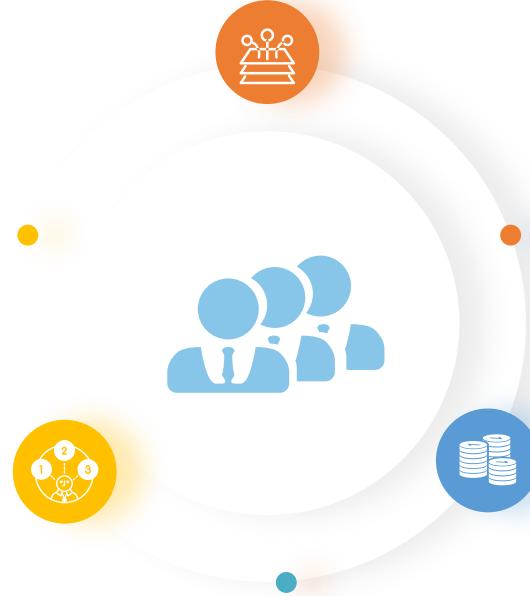
SUPER QUANTUM  
超 量 子 基 金

# ○ Super Quantum Fund



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## A Dynamic, Self-Driven Team



### Experienced Investors/Advisors

C-Level Executives from Baidu, Alibaba, Tencent  
Previous Investment Director of Point72  
HK-based hedge fund founder  
Renowned Chinese Economists  
Former advisor to IMF and the World Bank

Among 25 full time professionals:

- 20 work in research and investment team
- 19 have Master's degrees or above from global top-tier universities
- 6 hold PhD in different fields including Physics, Finance, Economics, etc.

Our connections with top tier universities in China boost our research capacity and we continuously invest in training and retaining young talents.

### Support from Market Veterans

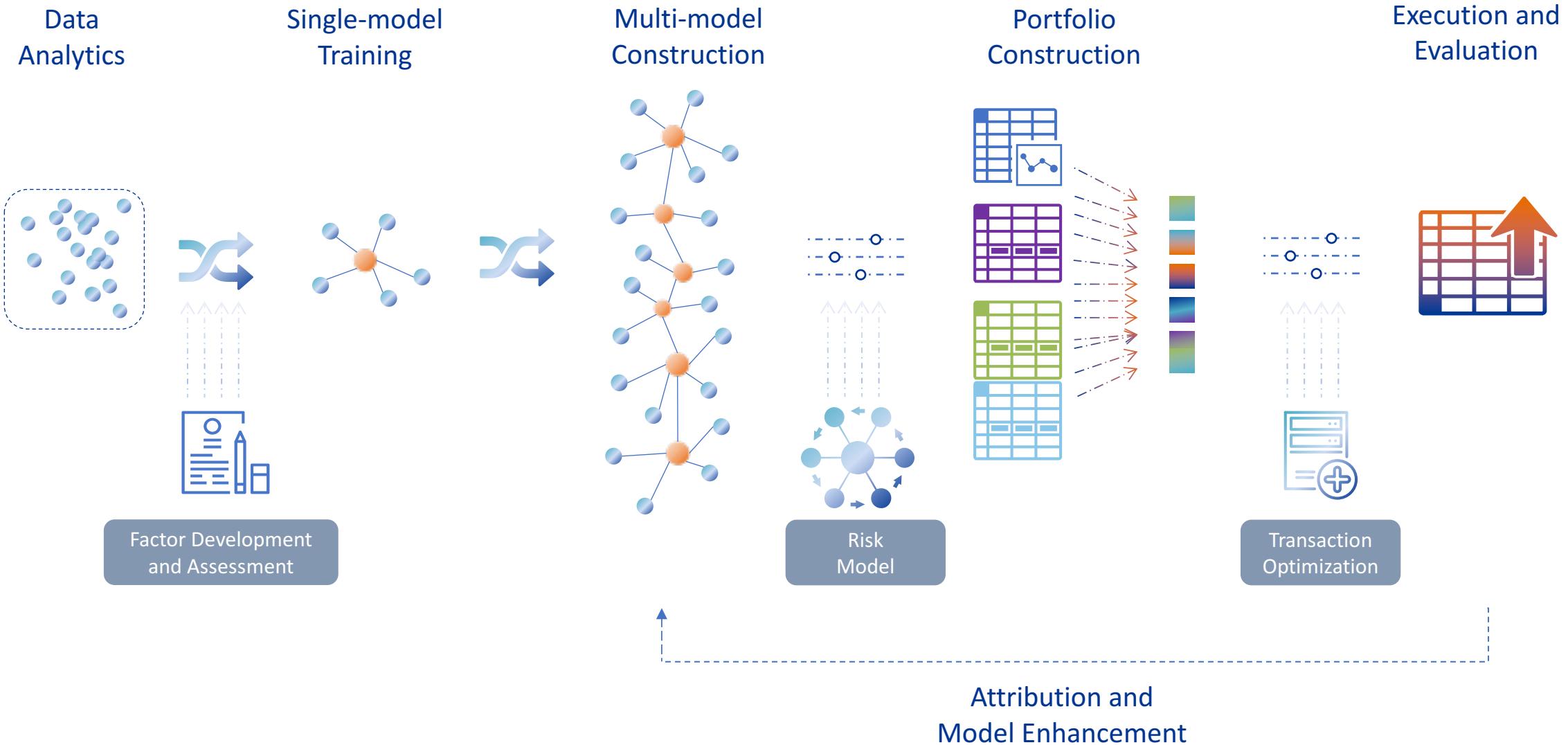
Founders of 21Vianet Group (ViaNET.US)  
Co-founder of Inovance (300124.SZ)

○ Our team members and partners are from global reputable research and industry institutions:





# INVESTMENT PROCESS



# ○ FACTOR DEVELOPMENT AND ASSESSMENT



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TechFin.AI 钛锋智能因子评价系统

因子列表 保存为PDF 再次上传

## AmplitudeDiffHLPrice

### 因子介绍

#### 因子基本信息

required\_window\_size: 20

#### 因子代码

```
1 def AmplitudeDiffHLPrice(close, high, low):
2     """
3     ...
4     ...
5     ...
6     ...
7     ...
8     import numpy as np
9     import pandas as pd
10    def rolling(df, window_size, return_index=False, lookback=True, min_periods=None, step=1, return_rest=True):
11        """
12        ...
13        customized rolling that makes MIMO(Multiple-In Multiple-Out) possible
14        pandas rolling can't deal with MIMO
15        python iteration is not that slow:
16            if your execution time is too long, go to check and try improving the calculation process
```

### 因子评价统计分析

1	0.925	2	0.842	3	0.760	4	0.682	5	0.610	Annual return	0.220	Cumulative retu	1.175	Annual volatili	0.049	Sharpe ratio	4.081	Calmar ratio	5.523	Stability	0.982	Max drawdown	-0.040	Omega ratio	2.145	Sortino ratio	6.245	Skew	0.654
Kurtosis		Tail ratio		Daily value at		Ann. alpha		beta		1D		2D		3D		4D		5D		6D		7D		8D		9D		10D	
15.451		1.573		-0.005		0.223		-0.038		0.043		0.054		0.061		0.068		0.073		0.077		0.081		0.083		0.085		0.086	

### 因子评测累积收益率图



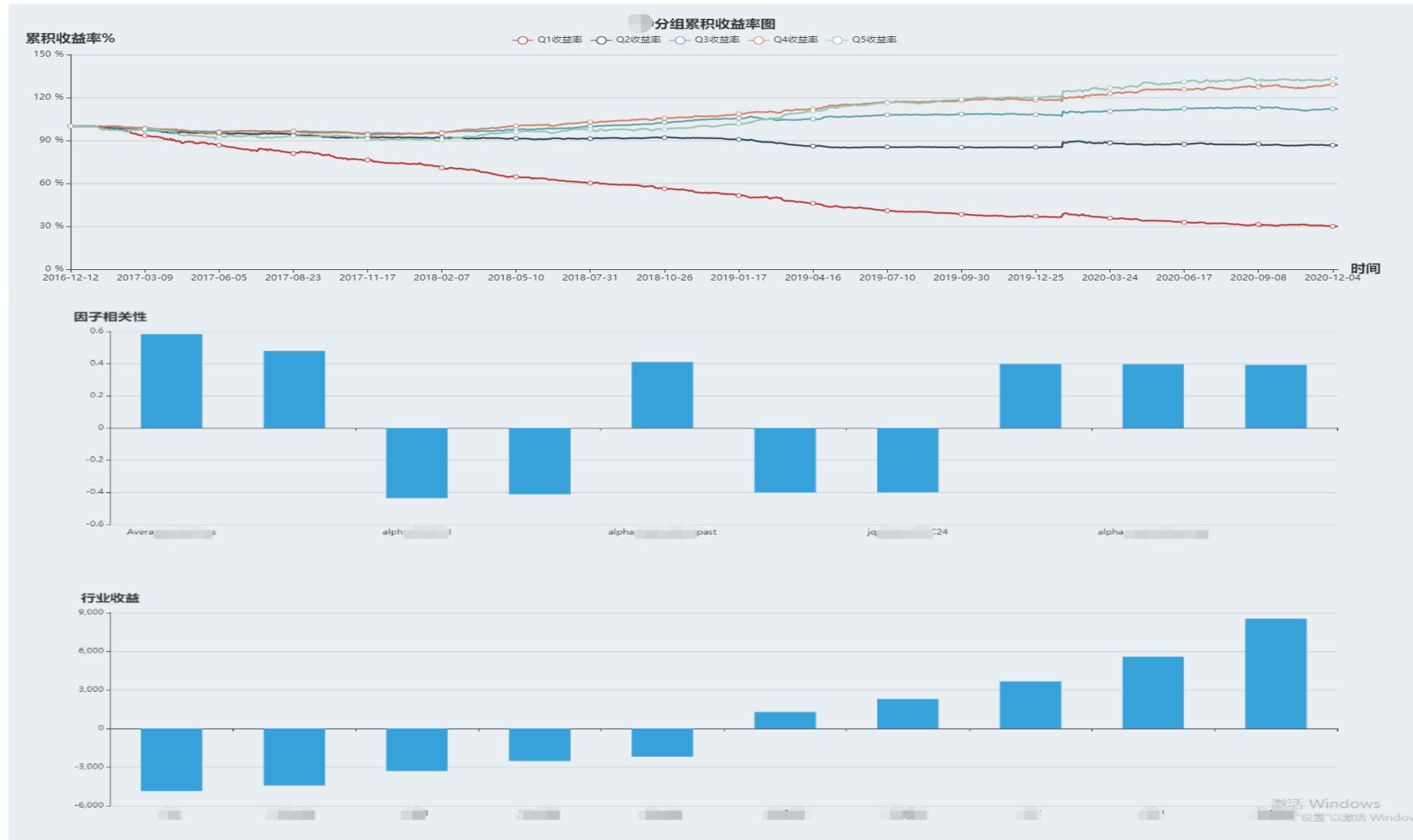
Statistical analysis

Cumulative return

# ○ FACTOR DEVELOPMENT AND ASSESSMENT



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# ○ PERFORMANCE ANALYSIS AND REPORTING

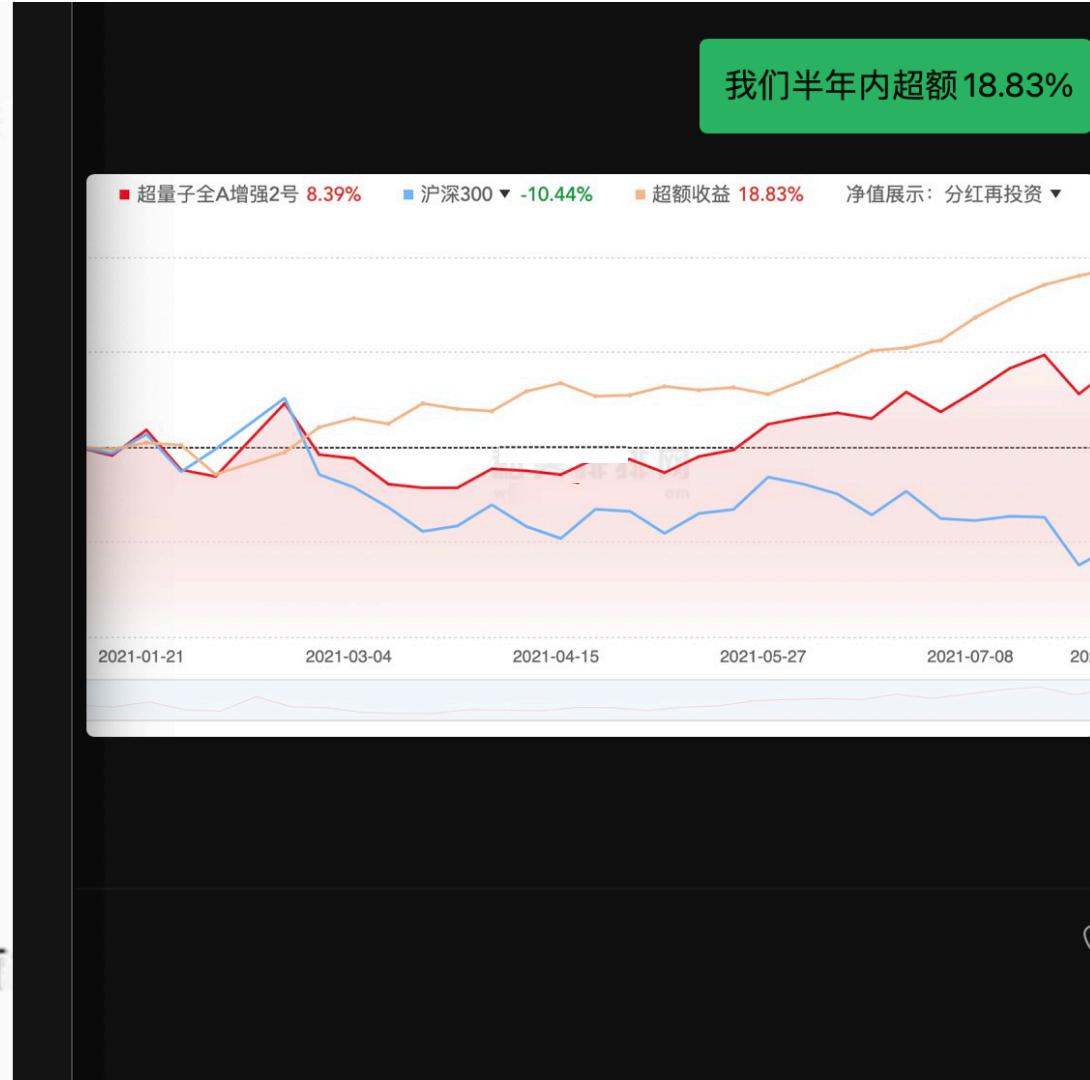


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截至7月底，  
顶流公募张坤今年的业绩为-9.52%，刘彦春  
为-13.21%；  
私募但斌的收益率为-6.55%，林园收益  
率-4.8%；  
少数派周良、丰岭资本金斌、景林高云程、  
汉和资本罗晓春、盈峰蒋峰等价值投资大佬  
的业绩跌幅亦超10%，  
高毅邱国鹭今年则浮亏17.31%。



如果你今年没有跑赢沪深300，请放过自己，  
毕竟从业超5年，年化15%的顶级大佬也没有  
跑赢。

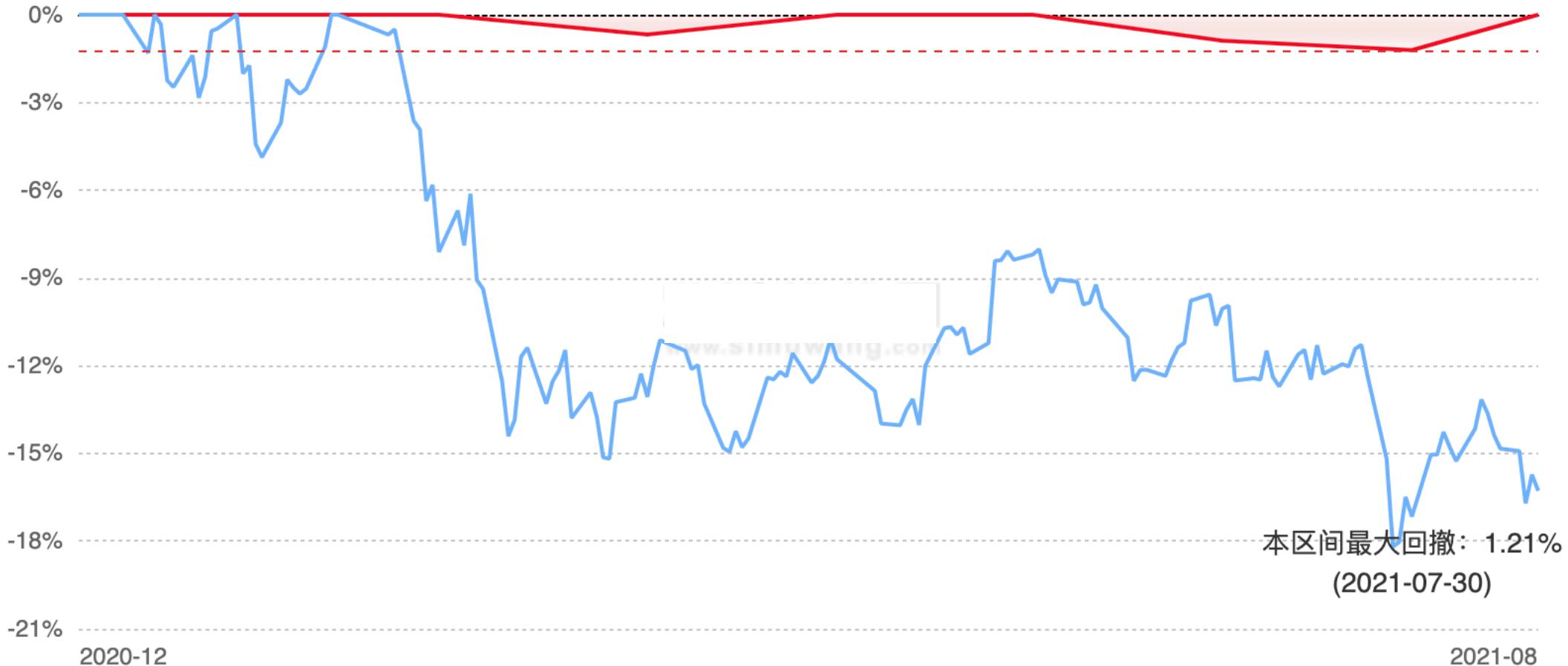


SUPER QUANTUM

动态回撤 ? 截止日期: 2021-08-19

收益计算: 分红再投资

今年以来回撤: ■ 张晓泉 -1.21% ■ 沪深300 ▼ -18.19%





# 4 states of the world

Equilibrium

Rotation

Random

Complex



Georgia O'Keeffe: A Force of Nature ...  
sothebys.com



Georgia O'Keeffe - Wiki...  
en.wikipedia.org



Erotic flowers with Geor...  
artwizard.eu



Georgia O'Keeffe - Exhi...  
tate.org.uk



VISUAL ART On Georgi...  
brooklynrail.org



A New Show Traces Ho...  
news.artnet.com



Pink Tulip by Georgia O'...  
arthistoryproject.com



Lake George Reflection by Georgia O'Keeffe  
anart4life.com



Georgia O'Keeffe: Abstr...  
phillipscollection.org



Bleeding Heart, 1932 b...  
prints.okeeffemuseum.org



Georgia O'Keeffe: Art a...  
amazon.com



Georgia O'Keeffe - Pain...  
biography.com



Georgia O'Keeffe's Vision | The New ...  
newyorker.com



Why Georgia O'Keeffe was a pioneer of...  
dw.com



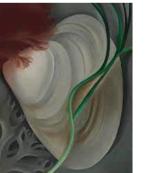
Tumultuous art duo Georgia O'Keeffe ...  
timesofisrael.com



Sources of Inspiration for Georgia O'...  
en.thevalue.com



Georgia O'Keeffe: Abstr...  
whitney.org



Shell No. 2, 1928 by Ge...  
prints.okeeffemuseum.org



Georgia O'Keeffe | ITSLIQUID  
itsliquid.com



Georgia O'Keeffe Hibiscus - Paint By ...  
numpaint.com - In stock



Georgia O'Keeffe | Cow's ...  
metmuseum.org



Hibiscus with Plumeria...  
shop.brooklynmuseum.or...



Georgia O'Keeffe in New Mexico ...  
criticalread.org



CR Muse: Georgia O'Ke...  
crfashionbook.com

- Details are confusing. It is only by **selection**, by **elimination**, by **emphasis** that we get to the real meaning of things.

-- Georgia O'Keeffe

# Q&A



Michael Zhang 麦教授 



扫一扫上面的二维码图案，加我微信