

Algorithmic Trading & Artificial Intelligence

— *How to Get Started Easily*

Dr. Yves J. Hilpisch



Introduction

SERVICES

for financial institutions globally



EVENTS

for Python quants & algorithmic traders



TRAINING

about Python for finance
& algorithmic trading



CERTIFICATION

in cooperation with university



BOOKS

about Python and
finance



PLATFORM

for browser-based
data analytics

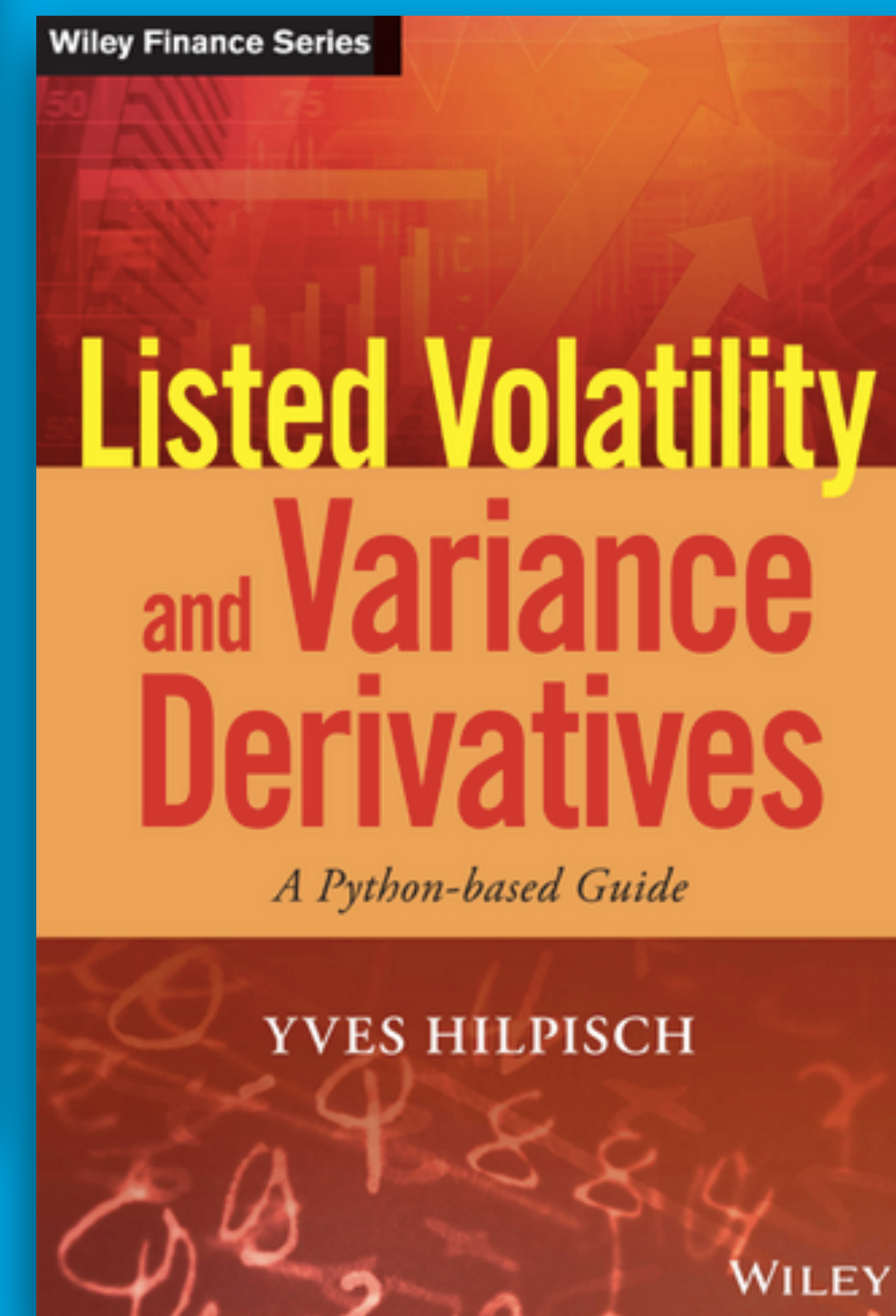
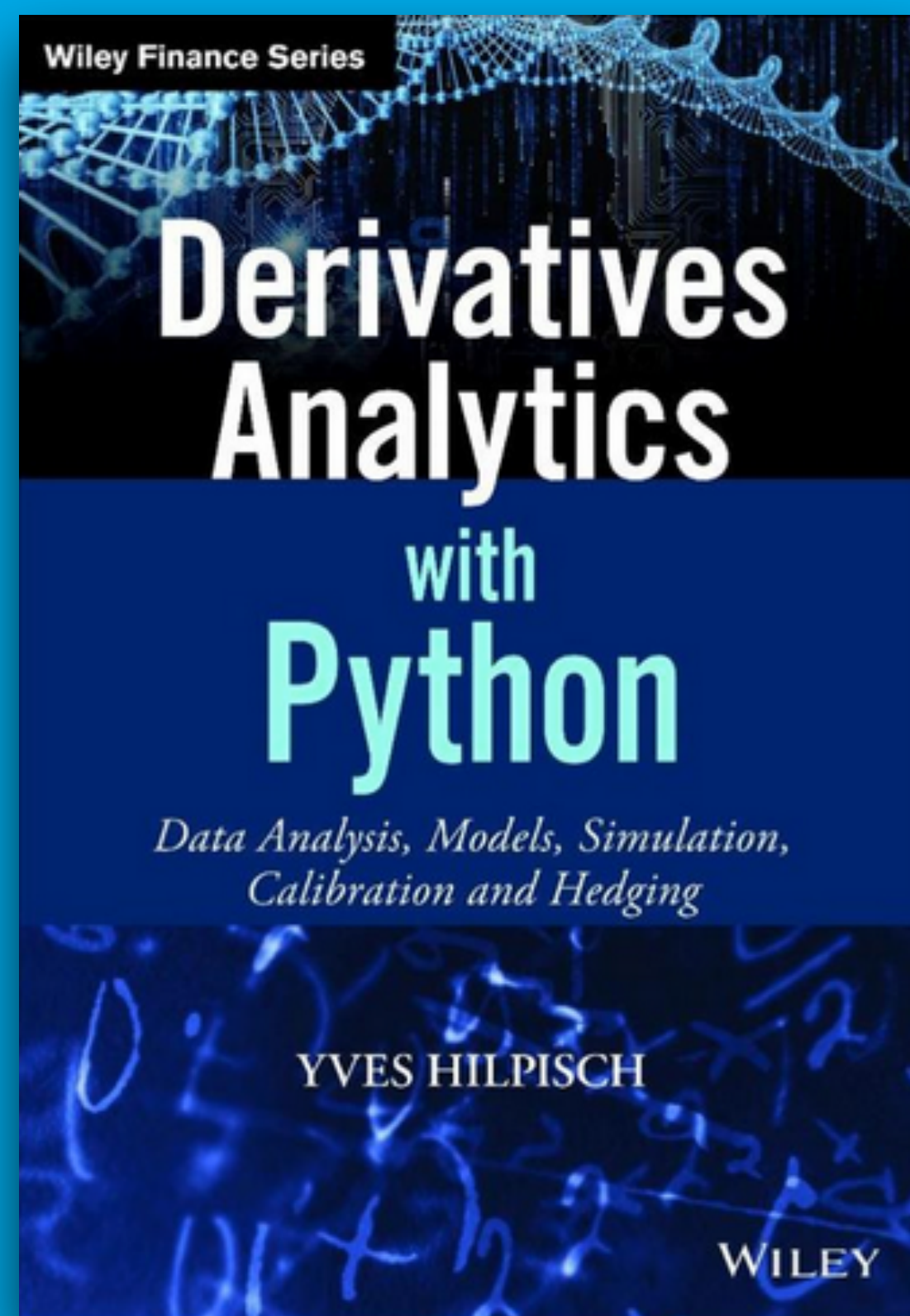


OPEN SOURCE

Python library
for financial analytics







O'REILLY®

2nd Edition



Python for Finance

MASTERING DATA-DRIVEN FINANCE

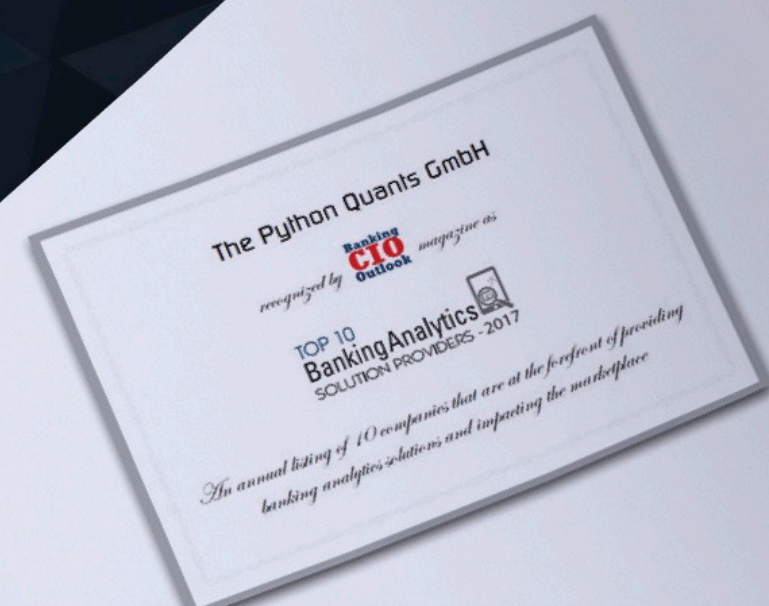
Yves Hilpisch

PROGRAM DIRECTOR

Dr. Yves J. Hilpisch is founder and managing partner of The Python Quants (<http://tpq.io>), a group focusing on the use of open source technologies for financial data science, algorithmic trading and computational finance. He is the author of the books:

- Python for Finance (O'Reilly)
- Derivatives Analytics with Python (Wiley)
- Listed Volatility and Variance Derivatives (Wiley)

He has written the financial analytics library DX Analytics (<http://dx-analytics.com>) and organizes conferences and Meetup events about Python for finance and algorithmic trading in Frankfurt, London and New York. He has given keynote speeches at technology conferences in the United States, Europe and Asia.



UNIVERSITY CERTIFICATE IN PYTHON FOR ALGORITHMIC TRADING



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April 2017



Data-Driven Finance

FINANCIAL TIMES

TUESDAY 3 OCTOBER 2017

WORLD BUSINESS NEWSPAPER

MIDDLE EAST

Mohamed El-Erian

Reasons to worry about the Fed's 'beautiful normalisation' — PAGE 20

Torturing Theresa

Boris Johnson's bid to dictate May's Brexit strategy — JANAN GANESH, PAGE 11

Confined in a circle

The myths that hold back women in Indian society — AMY KAZMIN, PAGE 10

Las Vegas reels from worst US mass shooting

A casualty is carried from the scene after a gunman opened fire on concert goers in Las Vegas on Sunday night. More than 50 people were killed and over 150 wounded, making it the deadliest mass shooting in US history.

Las Vegas police said the suspected gunman, 64-year-old Stephen Paddock, fired shots from his 32nd-floor room in the Mandalay Bay Hotel and Casino into the crowd of 22,000 people attending the Route 91 Harvest Festival.

In televised remarks, Donald Trump, the US president, called the shooting "an act of pure evil" but made no reference to guns. He plans to visit the city on Wednesday to meet the families of the victims and law enforcement officials. Report page 2



David Becker/Reuters

Catalan president urges Brussels to mediate in independence clash

◆ Region seeks to avoid 'traumatic split' from Spain ◆ EU says dispute is 'internal matter'

MICHAEL TOTHARD — BARCELONA

IAN MOUNT — GIRONA

The Catalan government said it wanted to avoid a "traumatic split" from Spain and appealed to the EU to mediate with Madrid in signals to hold back from an early declaration of independence after Sunday's secession referendum.

Celso Fajó, the Catalan president, said that after Sunday's vote, when 90 per cent of the 2.3m ballots cast were in favour of independence, Catalonia now had the right to be free from Spain. But he hinted that this would not happen immediately.

"There is no button to push for independence, it does not exist," said Mr Fajó at a press conference. He called on the EU to help broker negotiations. "It's obvious we need mediation."

He added: "We don't want a traumatic break... We want a new understanding with the Spanish state."

Breaking with its previous reticence to speak out on Catalonia, the European Commission condemned the violent clashes between police seeking to block the poll and voters. It urged both sides to reach an agreement.

"We call on all relevant players to now move very swiftly from confrontation to dialogue," it said, but it stopped short of offering to broker talks, repeating the issue was an "internal matter".

Financial markets have been rattled by the vote, which raised fears of an immediate break with Spain. Madrid's main equities benchmark, the Ibex 35, closed down 1.2 per cent and yields on 10-year Spanish bonds were up 7 basis

points. Sunday's referendum, while illegal and invalid under Spanish law, was also a historic challenge to the authority of the Spanish state that threatens to plunge the country into a political and constitutional crisis.

As Mariano Rajoy, Spain's prime minister, met other party leaders, his government gave little sign it was open to talks as long as the separatist Catalan government pushes for full independence from Spain.

Fernando Martínez Sallat, a senior member of the governing Popular party, said the election had been a "grand farce" and the Catalan regional government has been "delegitimised".

Rafael Catalá, the justice minister, said the government would use all the tools at its disposal — including if



Carles Puigdemont, the Catalan president, is leaving the door open to a unilateral declaration of independence unless talks with Madrid can start.

News & analysis page 3
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Gideon Rachman page 11
Short View page 15

necessary the suspension of Catalonia's autonomy — to enforce the rule of law. There were also hawkish calls by Albert Rivera, the head of the liberal Ciudadanos party which supports the poll, for the full independence of Catalonia.

Mr Puigdemont demanded the central government withdraw the national police reinforcements it deployed to the region over the weekend to thwart the poll, forcibly in many instances.

The Catalan leader has still left the door open to a unilateral declaration of independence unless talks with Madrid can start.

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Briefing

► **Puerto Rico calls for billions in aid**
Raul Maldonado Gasset, Puerto Rico's treasury secretary, says the island will need "tens of billions" of dollars in aid from the US as it struggles to recover after Hurricane Maria. — PAGE 2

► **Portugal's Socialists reap benefits**
Portugal's ruling Socialists reaped the rewards of a recovering economy by winning a decisive victory in local elections midway through the first term of an anti-austerity government. — PAGE 3

► **Uber's UK head quits as chief files in**
Jo Bertram, Uber's UK boss, has quit the company a day before a visit to London by Dara Khosroshahi, chief executive, to meet regulators over a threat to revoke the ride-hailing app's licence in the capital. — PAGE 13

► **Kolke faces Japan election dilemma**
Tokyo governor Yuriko Koike is under pressure to stand in Japan's general election later this month, amid fears she and her party lack the resources to beat Shinzo Abe, the prime minister. — PAGE 4

► **Equifax defends silence over hack**
Credit reference agency Equifax has claimed ahead of a hearing at the US Congress later today that disclosing that it had been hacked would have encouraged "copycat" cyber attacks. — PAGE 13

► **Western envoys warn on Kenya re-run**
Western ambassadors have condemned President Uhuru Kenyatta and Ruto's coalition opposition leader, for undermining the electoral commission's ability to re-stage its election this month. — PAGE 4

► **Huawei beats Apple as top China choice**
Huawei has for the first time beaten Apple to top spot for intended smartphone purchases in China, according to a survey of 1,000 consumers. — PAGE 16

Datawatch



TODAY IN PERSONAL JOURNAL

A Celebrity Selfie Machine

PLUS Secondhand Stress at Work

THE WALL STREET JOURNAL.

DOW JONES

WEDNESDAY, DECEMBER 11, 2013 - VOL. CCLXII NO. 138

WSJ.com

★★★★★ \$2.00

DJIA 15973.13 ▲ \$2.40 0.3% NASDAQ 4060.49 ▼ 0.2% NIKKEI 15613.31 ▼ 0.25% STOXX600 3145.91 ▼ 0.7% 10-YR TREAS. ▲ 16/32, yield 2.797% OIL \$98.51 ▲ \$1.17 GOLD \$1,262.40 ▲ \$27.10 EURO \$1.3761 YEN 102.84

What's News

Business & Finance

House and Senate negotiators, in a rare bipartisan act, announced a budget agreement Tuesday designed to avert another economy-rattling government shutdown and to bring a Revenues to meet Congress's fiscal policy-making, over the next two years.

Sen. Patty Murray (D, Wash.) and Rep. Paul Ryan (R, Wis.), who struck the deal after weeks of tense talks, said it would allow more spending for domestic and defense programs in the near term, while adopting deficit-reduction measures over a decade to offset the costs.

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Deal Brings Stability to U.S. Budget

Congressional Negotiators Avert January Shutdown and Soften Sequester Cuts; Airline Fees to Climb

By JANET HOEK

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extension of long-term jobless benefits wasn't included in the deal, said Mr. Ryan.

Mr. Murray joined him in welcoming the prospect that lawmakers would steer away from a crisis-driven budget process. "We have hunched from crisis to crisis, from one cliff to the next," he said. "That uncertainty was devastating to our fragile economic recovery."

The deal, which goes to the House and Senate for approval in the coming days, marks a major change in the 2011 budget-cutting law, which set in motion 10 years of fiscal austerity, including across-the-board spending cuts known as sequestration.

The annual discretionary spending target will be raised to \$1.2 trillion from \$1.1 trillion.

◆ **Farm groups fight limits**... A6

◆ **Pension-charges pushback**... A8

◆ **U.S. trade talks**... A10

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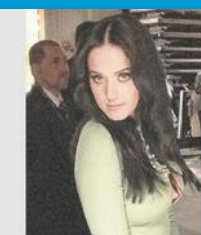
◆ **U.S. trade talks**... A10

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PLUS Secondhand Stress at Work

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United States | NASDAQ Global Select Consolidated | Computer Hardware

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Peers & Valuation

Derivatives

Filings

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BUSINESS SUMMARY >

Apple Inc. designs, manufactures and markets mobile communication and media devices, personal computers and portable digital music players. The Company sells a range of related software, services, accessories, networking solutions, and third-party digital content and applications. The Company's segments include the Americas, Europe, Greater China, Japan and Rest of Asia Pacific. The Americas segment includes both North and South America. The Europe segment includes European countries, India, the Middle East and Africa. The Greater China segment includes China, Hong Kong and Taiwan. The Rest of Asia Pacific segment includes Australia and the Asian countries not included in the Company's other operating segments. Its products and services include iPhone, iPad, Mac, iPod, Apple Watch, Apple TV, a portfolio of consumer and professional software applications, iPhone OS (iOS), OS X and watchOS operating systems, iCloud, Apple Pay and a range of accessory, service and support offerings.

NEWS >

28-Dec-2016

10:24:36	Apple dominerade julhandeln mätt i antalet aktiverade enheter	FNW
10:15:18	UPDATE 3-S.Korea fines Qualcomm \$854 mln for violating competition laws	RTRS
09:42:52	Corea del Sur multa a Qualcomm con 854 mlns dlr por violar leyes de competencia	RTRS
06:00:10	RPT-Wall Street cale une fois de plus au seuil des 20.000 points	RTRS
03:30:18	Aumento del gasto de último minuto impulsa a temporada de ventas de fin de año ...	RTRS
01:50:14	Last-minute spending surge lifts U.S. holiday shopping season	RTRS

27-Dec-2016

23:33:16	Reuters Insider - Tech stocks could take the Dow to 20k	CNBC
23:32:28	Reuters Insider - History suggests Dow could hit 20k by Friday: Technician	CNBC
22:55:29	LEAD 2-Wall Street cale une fois de plus au seuil des 20.000 points	RTRS
22:09:39	Apple, Cisco Lead DJIA Higher Tuesday	WALLST

EVENTS >

Upcoming

Past

24-Jan-2017 > 30-Jan-2017

NTS	Q1 2017 Apple Inc Earnings Release	📅
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24-Feb-2017 > 28-Feb-2017

PRICE PERFORMANCE >

Open	
Prev. Close	
Bid / Ask	
VWAP	--
Turnover	
Volume	
Short Interest	0.90%
YTD	
Beta (5Y Monthly)	1.29
Mkt Cap	USD 625.27B
PE (LTM)	14.12
Div Yield	1.94%
DR	BRL 📄 AAPL34.SA (1:0.1)
DR Type	--
DR Bank	--

AAPL.O 115.190000

Price USD

117.260000

115.00

110.00

105.00

100.00

95.00

90.00

85.00

Dec-31

Mar-31

Jun-30

Sep-

14-Dec-2016

Today

5D

3M

6M

1Y

5Y

No Benchmark ▼

52Wk: 89.47 12-May 118.69 11-Oct

📅 Next Earn Report: 24-Jan-2017

Free Float	5.32B	Asset Type	Ordinary Share	📄 5 yr CDS	26.980 bps
Outstanding	5.33B	Share Class	--	Δ Today	-0.07%
IPO Date	12-Dec-1980	Lot Size		Δ 1 Week	-0.074
First Trade Da...	12-Dec-1980	Voting Rights	1		

FUNDAMENTALS >

	AAPL (Sep-2016)	Growth	Industry
Gross Margin	38.02%	(4.71%) 4Q	38.91%
Operating Margin	25.10%	(11.59%) 4Q	5.75%

Tick Data

```
In [23]: tick = ek.get_timeseries(['AAPL.O'],  
                                fields='*',  
                                start_date='2017-07-11 16:00:0000',  
                                end_date='2017-07-11 16:15:0000',  
                                interval='tick')
```

```
In [24]: tick.info()
```

```
<class 'pandas.core.frame.DataFrame'>  
DatetimeIndex: 1898 entries, 2017-07-11 16:00:00.686000 to 2017-07-11 16:14:59.708000  
Data columns (total 2 columns):  
VALUE      1892 non-null float64  
VOLUME     1898 non-null float64  
dtypes: float64(2)  
memory usage: 44.5 KB
```

```
In [25]: tick.tail()
```

```
Out[25]:
```

	AAPL.O	VALUE	VOLUME
	Date		
	2017-07-11 16:14:59.693	144.9900	100.0
	2017-07-11 16:14:59.693	144.9900	100.0
	2017-07-11 16:14:59.693	144.9900	100.0
	2017-07-11 16:14:59.707	144.9899	400.0
	2017-07-11 16:14:59.708	144.9899	1305.0

News

```
In [29]: news = ek.get_news_headlines('R:.SPX AND "Trump" AND Language:LEN', count=5)
news
```

```
Out[29]:
```

	versionCreated	text	storyId	sourceCode
2017-08-18 16:46:19	2017-08-18 16:46:19	U.S. STOCKS EXTEND GAINS AFTER NEW YORK TIMES ...	urn:newsml:reuters.com:20170818:nL4N1L44L9:1	NS:RTRS
2017-08-18 15:53:08	2017-08-18 15:53:08	CORRECTED-U.S. STOCKS PARE LOSSES, TRADERS CIT...	urn:newsml:reuters.com:20170818:nL4N1L44IK:1	NS:RTRS
2017-08-18 15:16:27	2017-08-18 15:16:27	US STOCKS-Wall St lower on growing concerns ov...	urn:newsml:reuters.com:20170818:nL4N1L44F2:5	NS:RTRS
2017-08-18 11:24:30	2017-08-18 11:24:30	US STOCKS-Futures flat amid growing concerns o...	urn:newsml:reuters.com:20170818:nL4N1L43RR:5	NS:RTRS
2017-08-17 17:09:05	2017-08-17 17:09:05	US STOCKS-Wall St extends losses on Trump poli...	urn:newsml:reuters.com:20170817:nL4N1L34N1:5	NS:RTRS

```
In [30]: storyId = news.iloc[4, 2]
storyId
```

```
Out[30]: 'urn:newsml:reuters.com:20170817:nL4N1L34N1:5'
```

```
In [31]: from IPython.display import display, HTML
```

```
In [32]: display(HTML(ek.get_news_story(storyId)))
```

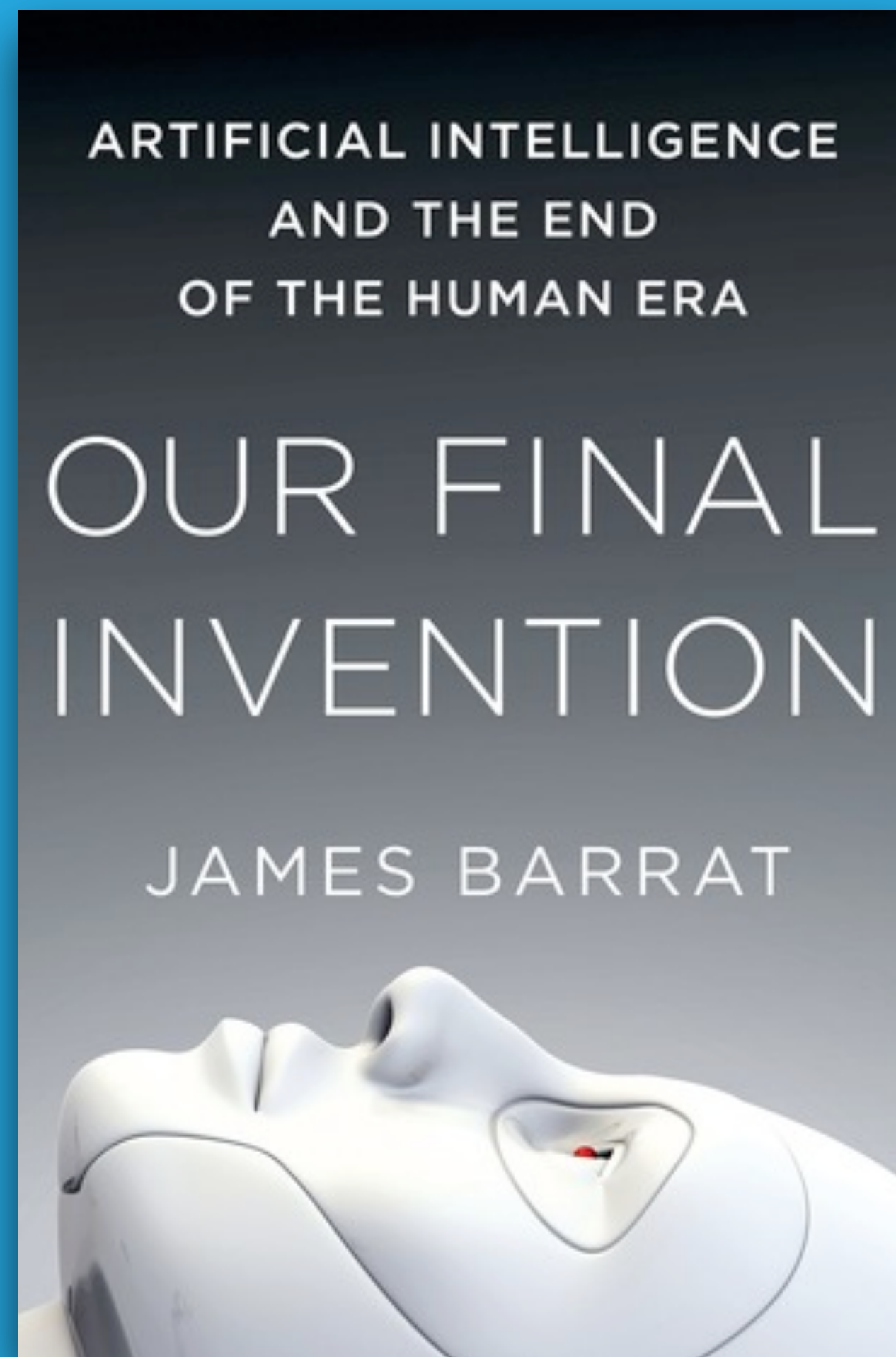
- Gary Cohn resignation rumors knocked down
- Wal-Mart drops after reporting margin fall
- Indexes down: Dow 0.81 pct, S&P 1.03 pct, Nasdaq 1.39 pct

Updates to early afternoon

By Sruthi Shankar and Tanya Agrawal

Aug 17 (Reuters) - U.S stocks hit session lows in early afternoon trading on Thursday as investors worried about President Donald Trump's ability to

Algorithmic Trading



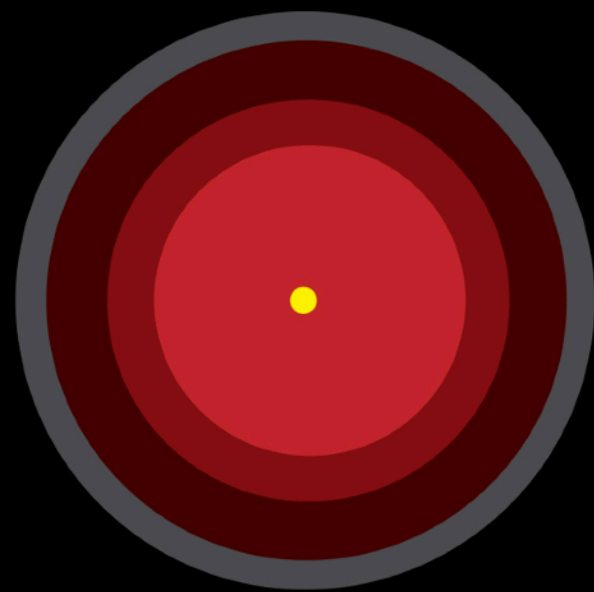
“It’s certainly possible that a real living AGI [Artificial General Intelligence] could emerge on the financial markets,’ Wissner-Gross told me.”

“Wissner-Gross said quants use the same tools as AI researchers—neural nets, genetic algorithms, automatic reading, hidden Markov models, you name it. Every new AI tool gets tested in the crucible of finance.”

James Barrat (2013): Our Final Invention.

THE TECHNOLOGICAL SINGULARITY

MURRAY SHANAHAN

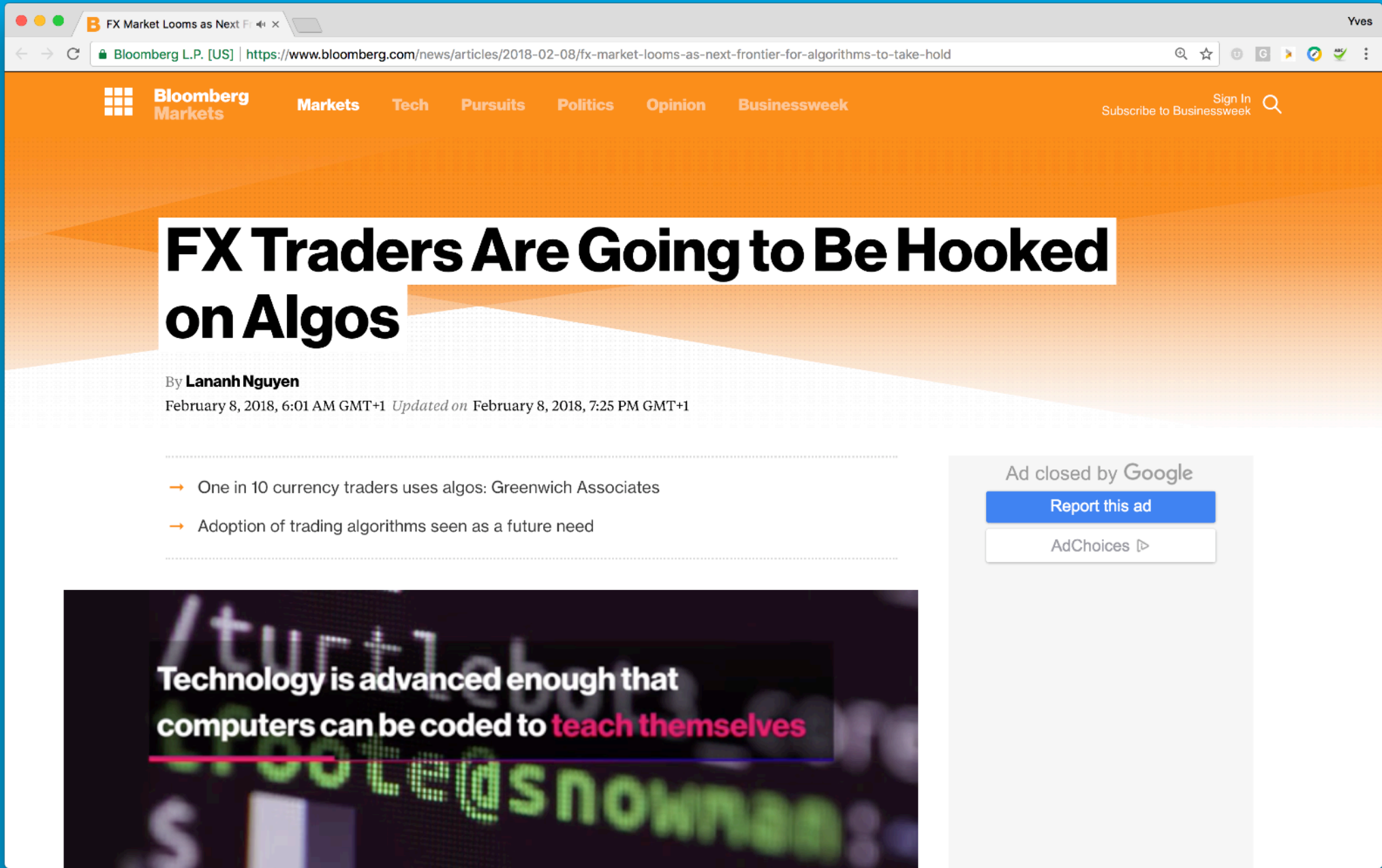


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“Today’s algorithmic trading programs are relatively simple and make only limited use of AI. However, this is sure to change. Artificial intelligence is beneficial in any domain where patterns have to be found in large quantities of data and effective decisions have to be taken on the basis of those patterns, especially when the decisions have to be taken rapidly.”

Murray Shanahan (2015)



In a few years, currency traders will be hooked on algos like their stock-market colleagues.

That’s the view of David Stryker, a principal at consulting firm Greenwich Associates LLC, who sees foreign-exchange markets following equities in the widespread adoption of computerized trading.

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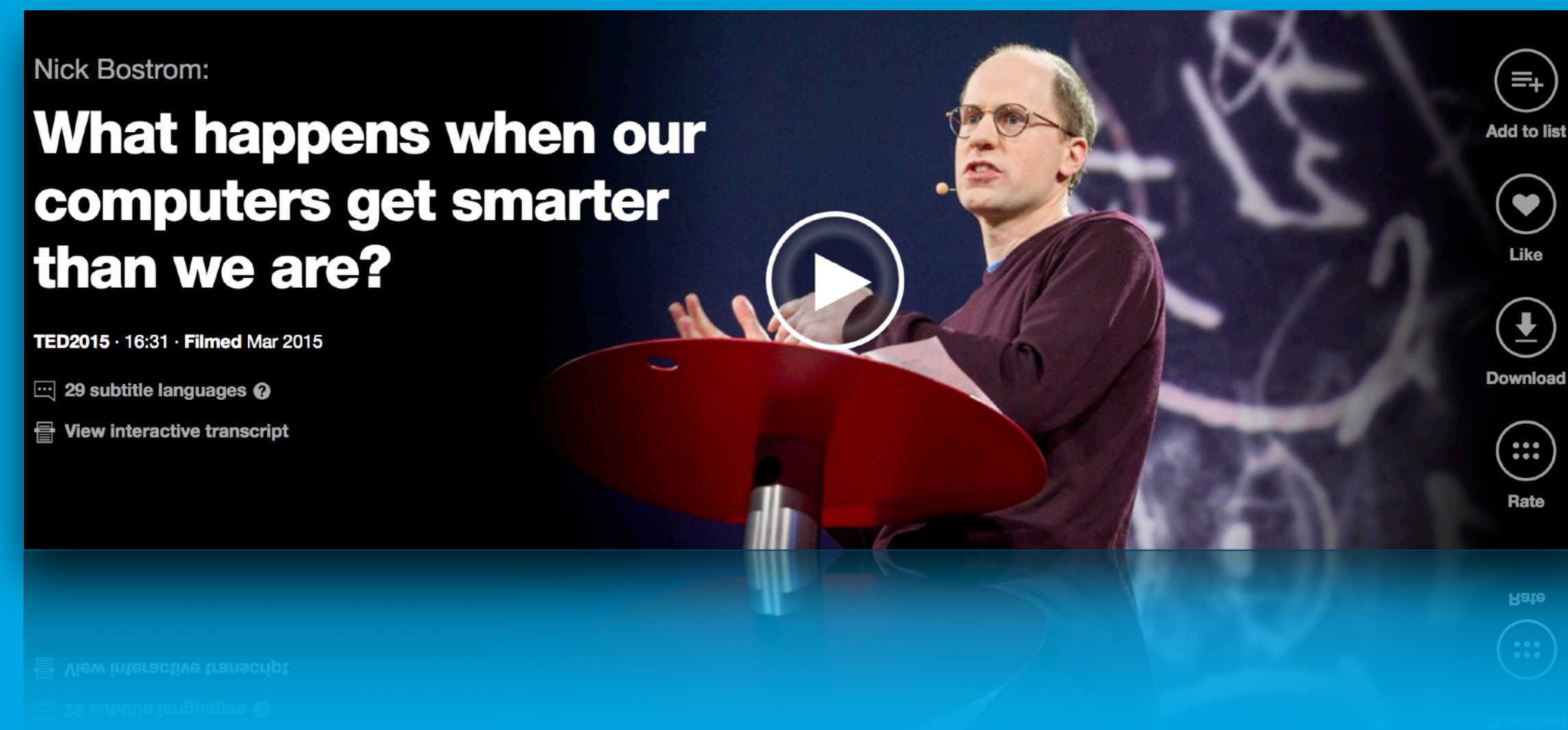
While only one in 10 FX traders currently uses algos to execute trades, the adoption rate is higher at the largest institutions, with one in four deploying the systems, according to a Greenwich study released Thursday. In comparison, in equities more than half of volume is done through an algorithm. The firm surveyed 79 currency-market participants at hedge funds, asset managers, corporations and other financial institutions in the U.S. and Europe.

“Given the myriad benefits that algos offer, FX traders currently not using algos (and not considering them) may soon have to determine whether they’re putting themselves at a disadvantage,” Stryker wrote in the study. “With all of the data available demonstrating the benefits/cost savings, the ability to execute a trade with an algo will soon become a ‘need’ as opposed to a ‘nice to have.’”

Almost 60 percent of respondents said algos had materially cut trading costs, according to the survey. The push to save money, combined with stricter regulation, will boost the appeal of trading software, Greenwich concluded.

appeal of trading software, Greenwich concluded. to the survey. The push to save money, combined with stricter regulation, will boost the appeal of trading software, Greenwich concluded.

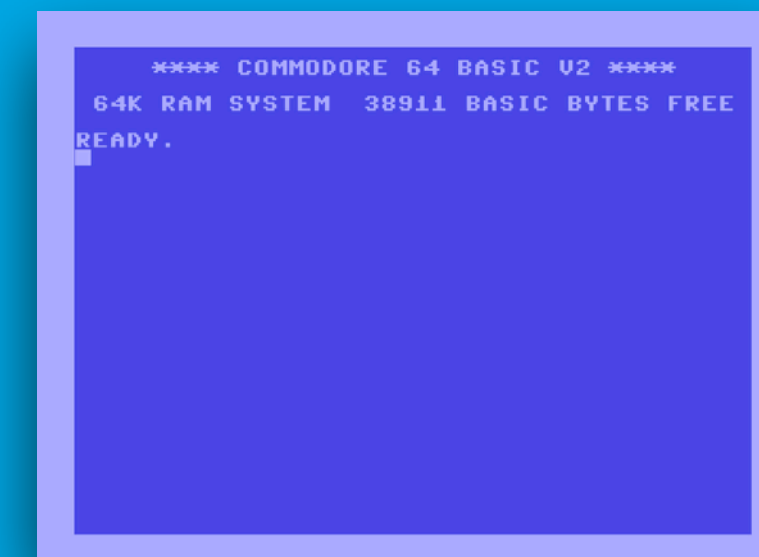
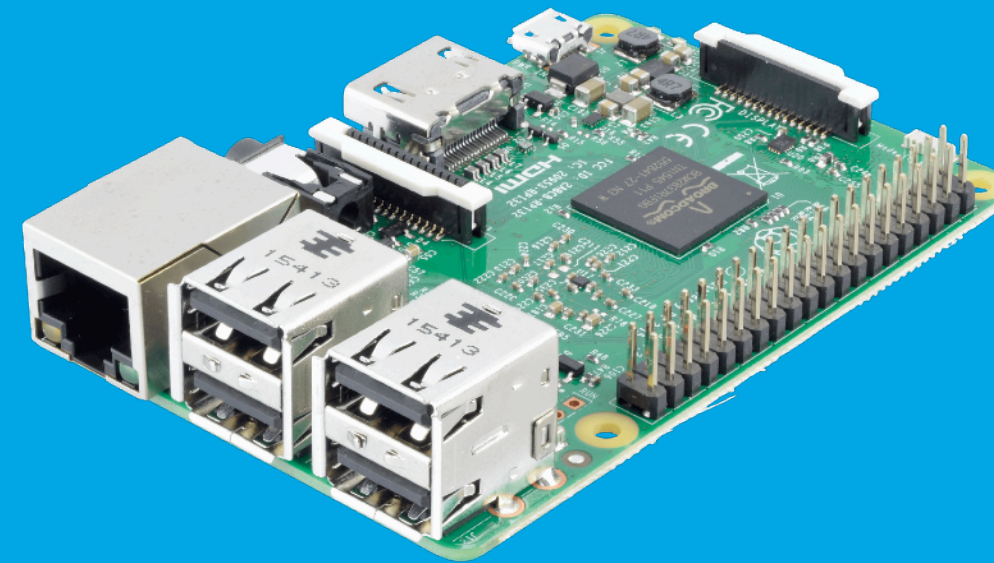
AI-First Finance



“Vast increases in biological and machine intelligences will create what’s being called the Singularity—a threshold of time at which AIs that are at least as smart as humans, and/or augmented human intelligence, radically remake civilization.”

James Miller (2012): Singularity Rising. BenBella Books.

Emulation



**powerful
hardware**

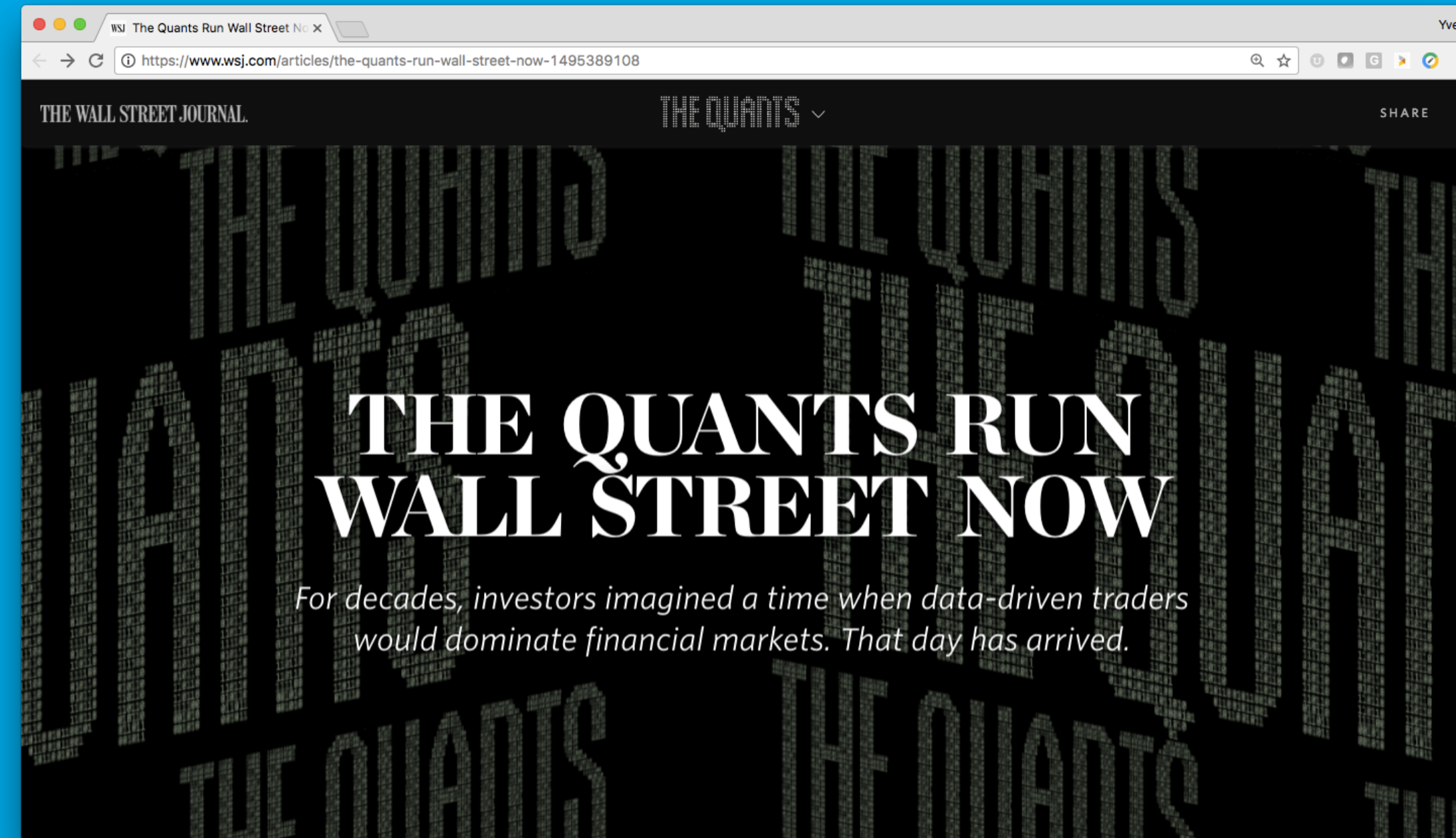
**human level
AI**

Humans



Algorithms





“Financial singularity is the point at which all investment decisions are made by intelligent machines rather than human agents. ... When all human fallibility is eliminated from markets, efficient markets, which have only existed so far in theory, could become a reality.”

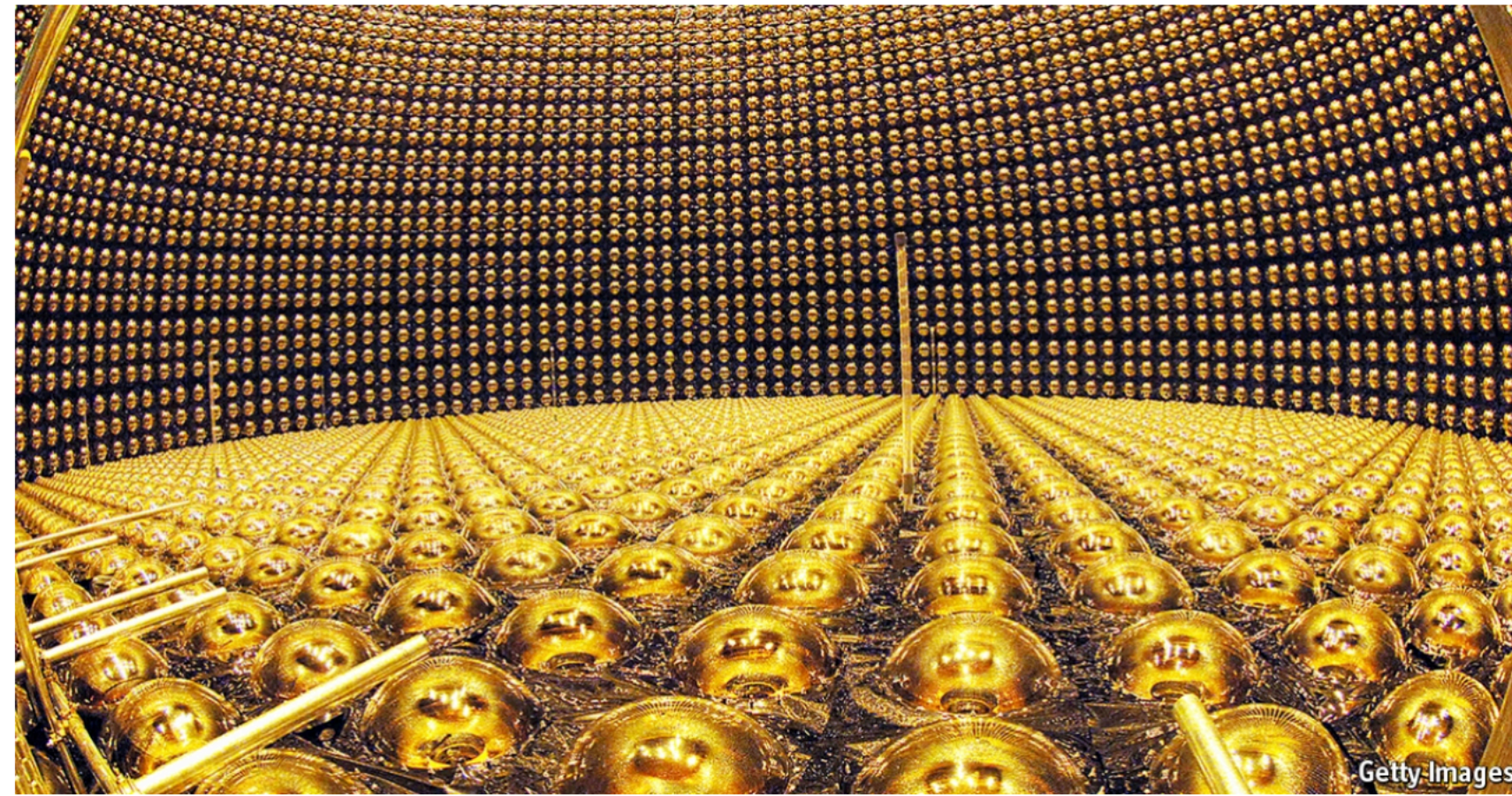
Read more: Financial Singularity Definition | Investopedia
<http://www.investopedia.com/terms/f/financial-singularity.asp>

Particle physics

Fundamental physics is frustrating physicists

The Economist

No GUTs, no glory



Print edition | Science and technology >

Jan 13th 2018



DEEP in a disused zinc mine in Japan, 50,000 tonnes of purified water held in a vast cylindrical stainless-steel tank are quietly killing theories long cherished by physicists. Since 1996, the photomultiplier-tube detectors (pictured above) at Super-Kamiokande, an experiment under way a

The beauty myth

One such is Sabine Hossenfelder of the Frankfurt Institute for Advanced Studies, in Germany. She argues that the appeal of GUTs, supersymmetry and the like rests on their ability to explain “numerological coincidences” that do not need to be explained. Perhaps, to take one example, the universe simply started out with more matter than antimatter in it, rather than this being a consequence of its subsequent evolution. As she points out, no theory precludes this possibility—it is just that it is not very elegant. Similarly, she says, “It’s not like anybody actually needs supersymmetry to explain anything. It’s an idea widely praised for its aesthetic appeal. Well, that’s nice, but it’s not science.”

aesthetic appeal. Well, that's nice, but it's not science.

supersymmetry to explain anything. It's an idea widely praised for its

Markets &
Agents

Algorithms

x

x

Data-Driven



$m(\bullet, a, b)$

AI-First

y

y

Finance

Financial Markets

x



y

Finance History



$f(\bullet)$



$f(x) \neq y$

“brain-driven & beauty myth”

AI in Finance = finaince

x



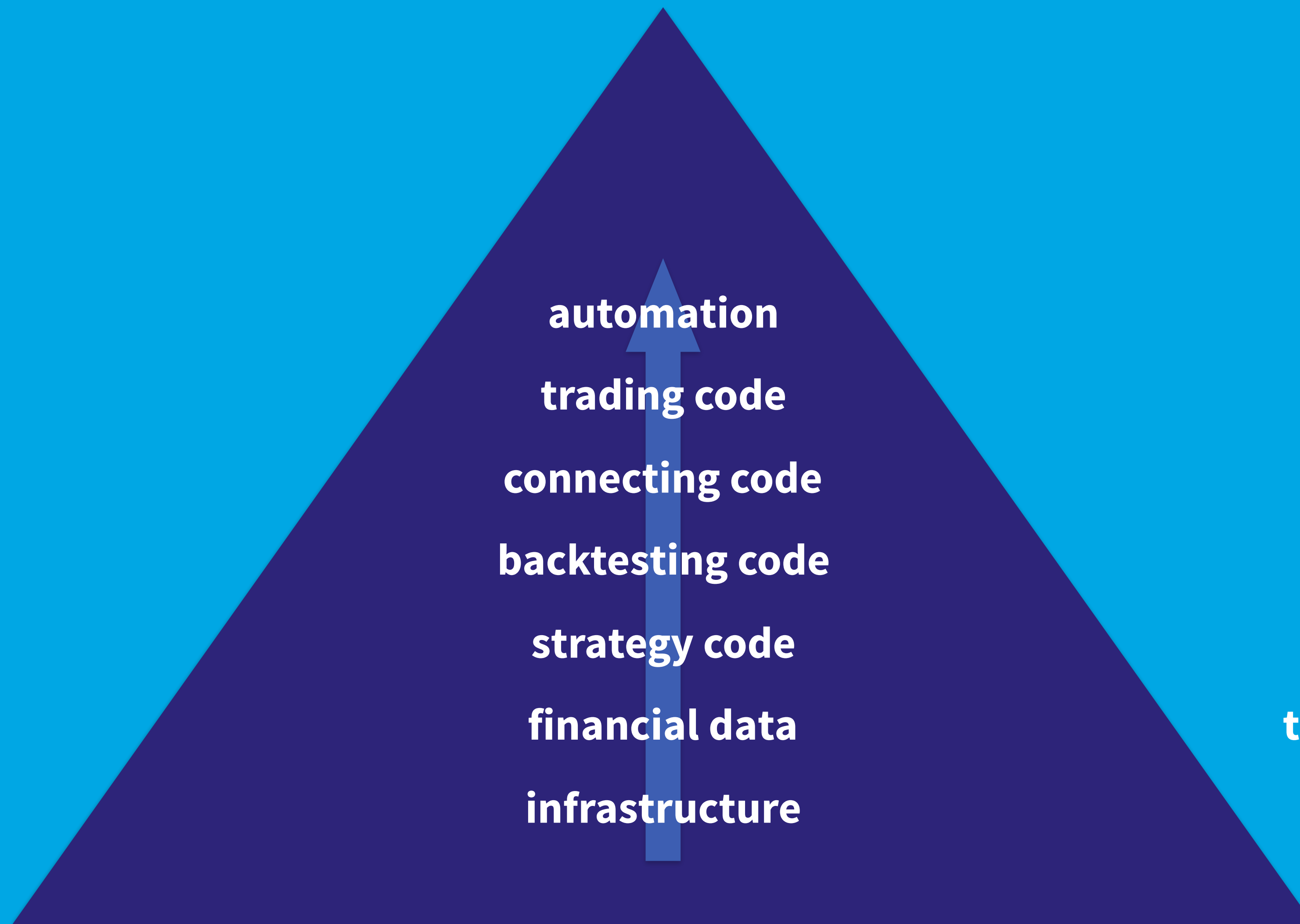
$m(\bullet, a, b)$



$m(x, a^*, b^*) \approx y$

“data-driven & AI-first”

FXCM REST API Demo



FXCM

simple algorithm

order placement

streaming

vectorized backtesting

SVM classifier

tick, historical, real-time

Python, Jupyter

**Skynet begins to learn at a geometric rate.
It becomes self-aware at 2:14 a.m. Eastern time, August 29th.**

—The Terminator (Terminator 2)

The Machine

Tick Data Streamer

(retrieval, processing, storage, etc.)

Signal Generator

(AI-driven, predicting market movements, creating signals)

Trade Event Streamer

(order information, stop events, etc.)

Signal Listener

(signal pick-up, order execution)

Portfolio Monitoring & Risk Management

(unrealized P&L, aggregated P&L, stop outs, trade visualization, etc.)

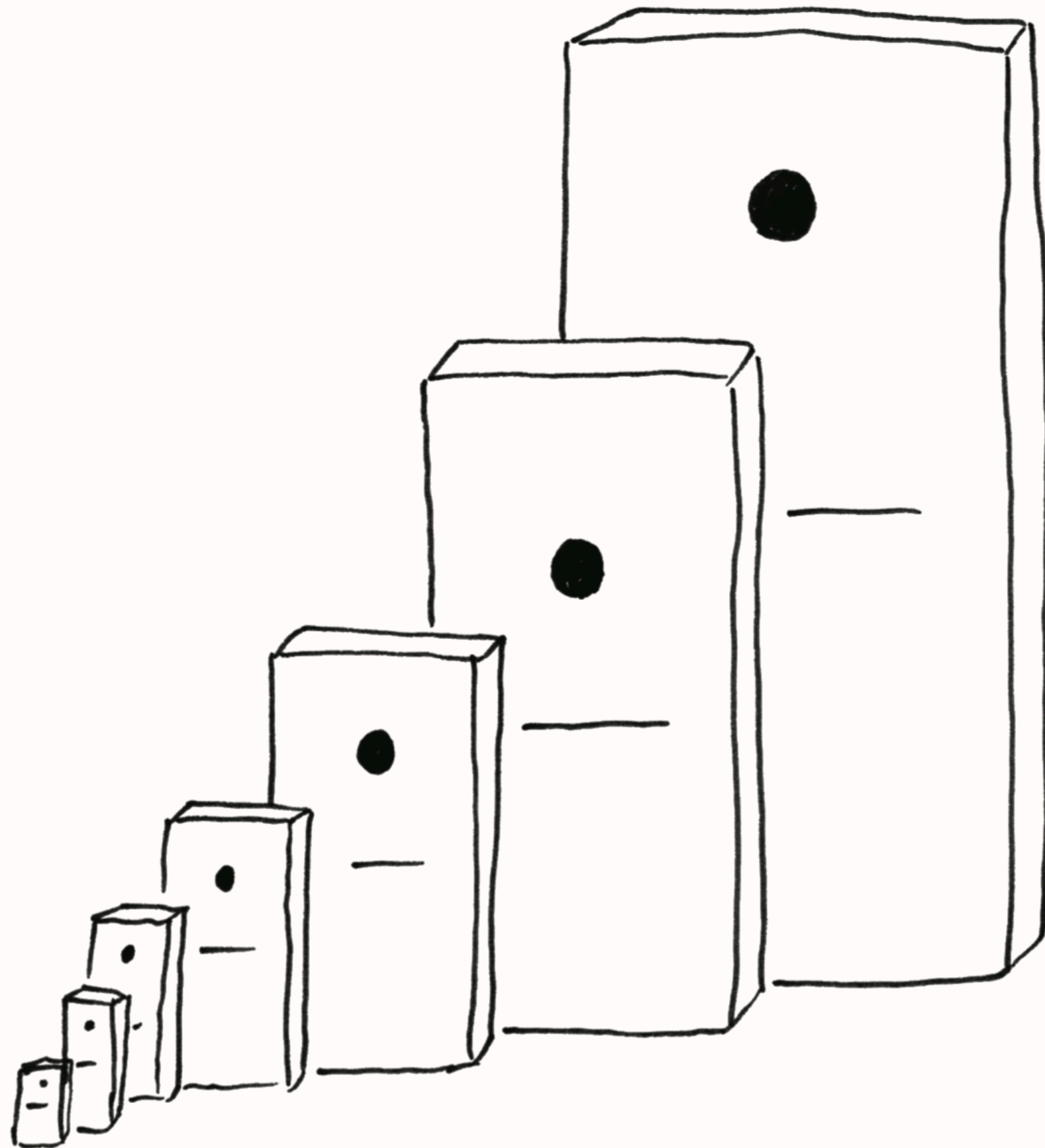
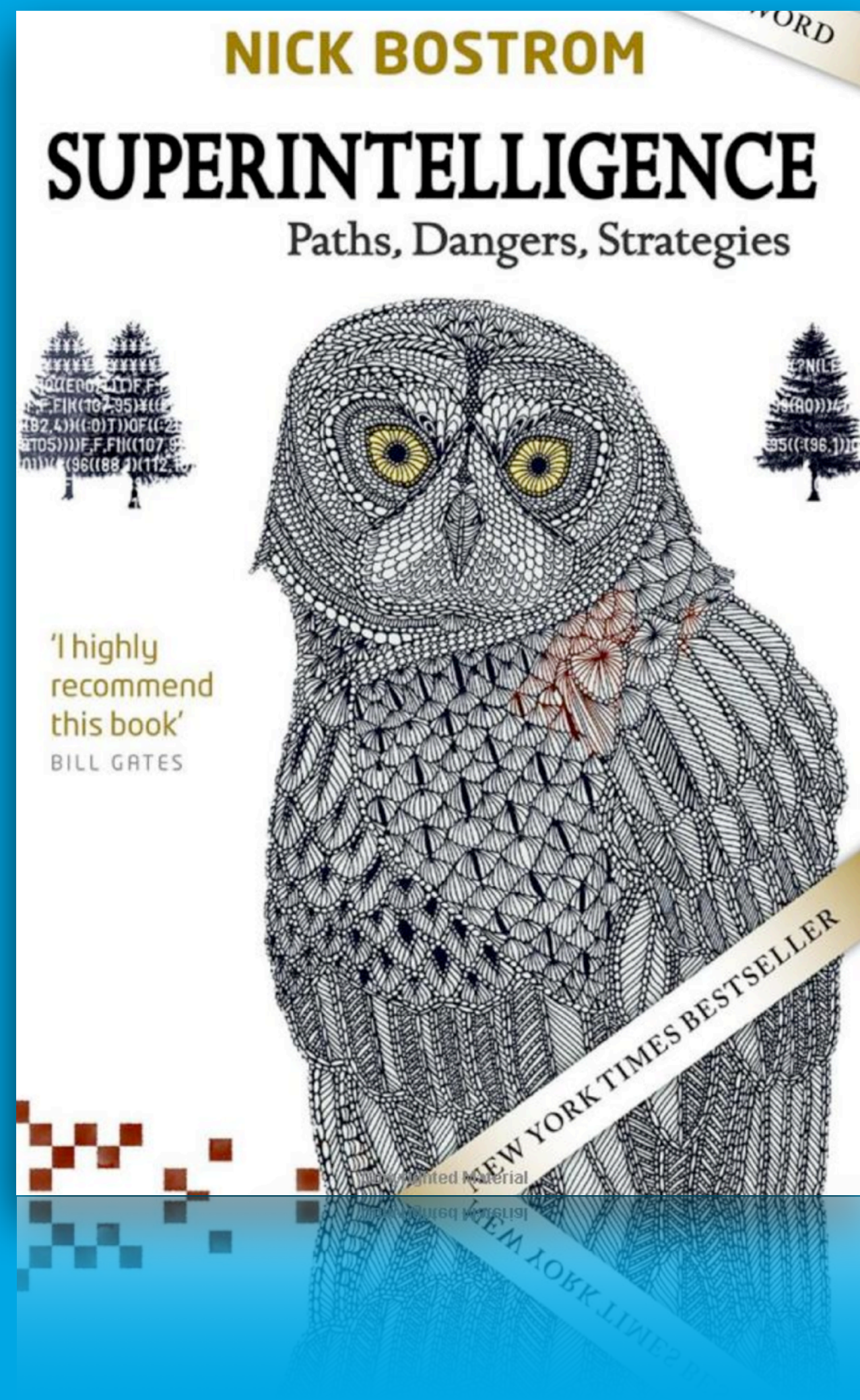


FIG 1 A geometric domino progression.

www.the1thing.com

exponential forces at work:

- technology improvements
- capital accumulation
- talent accumulation



“Go-playing programs have been improving at a rate of about 1 dan/year in recent years. If this rate of improvement continues, they might beat the human world champion in about a decade.”

Nick Bostrom (2014): Superintelligence.

The story of AlphaGo so far

AlphaGo is the first computer program to defeat a professional human Go player, the first program to defeat a Go world champion, and arguably the strongest Go player in history.

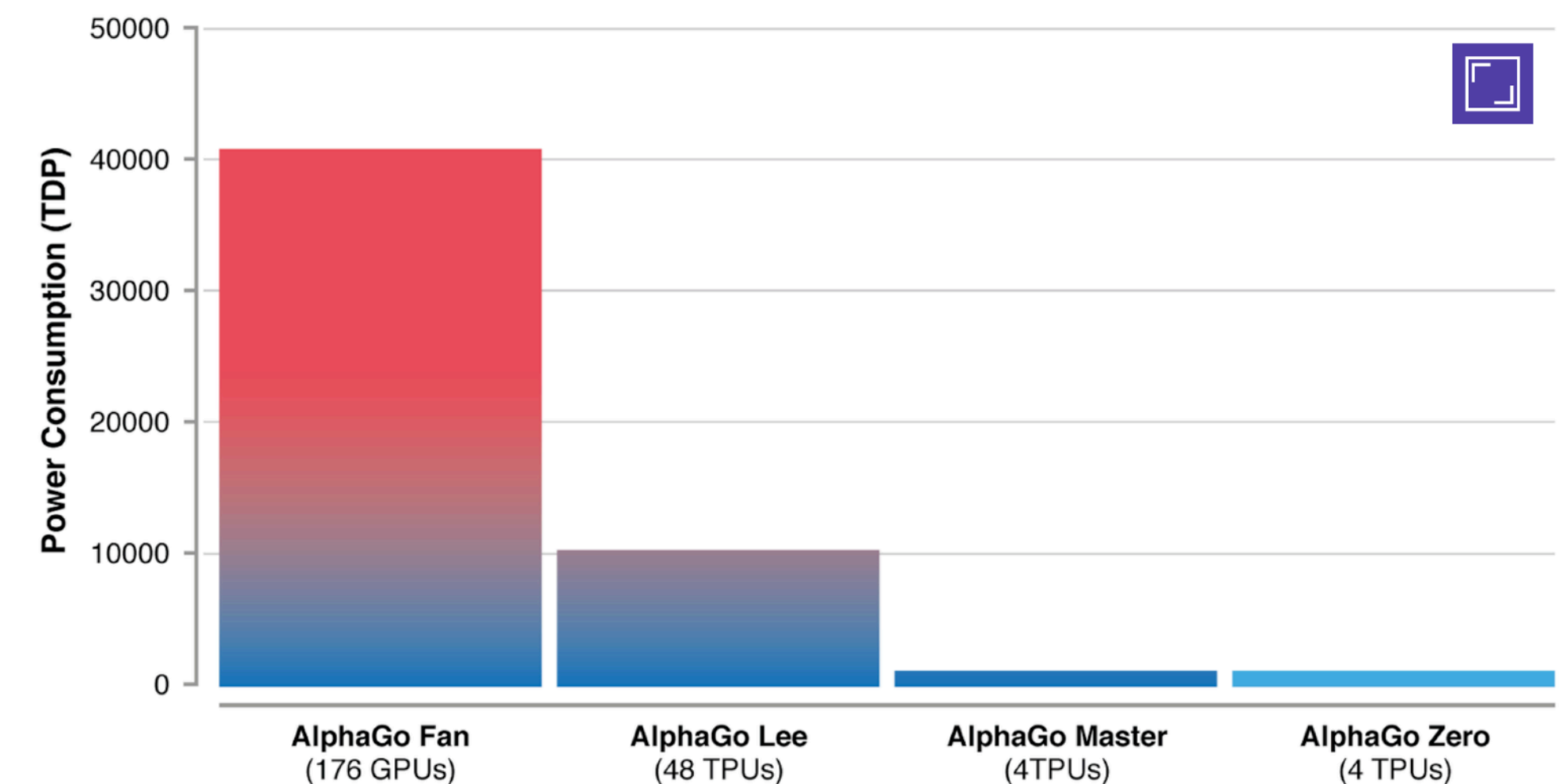
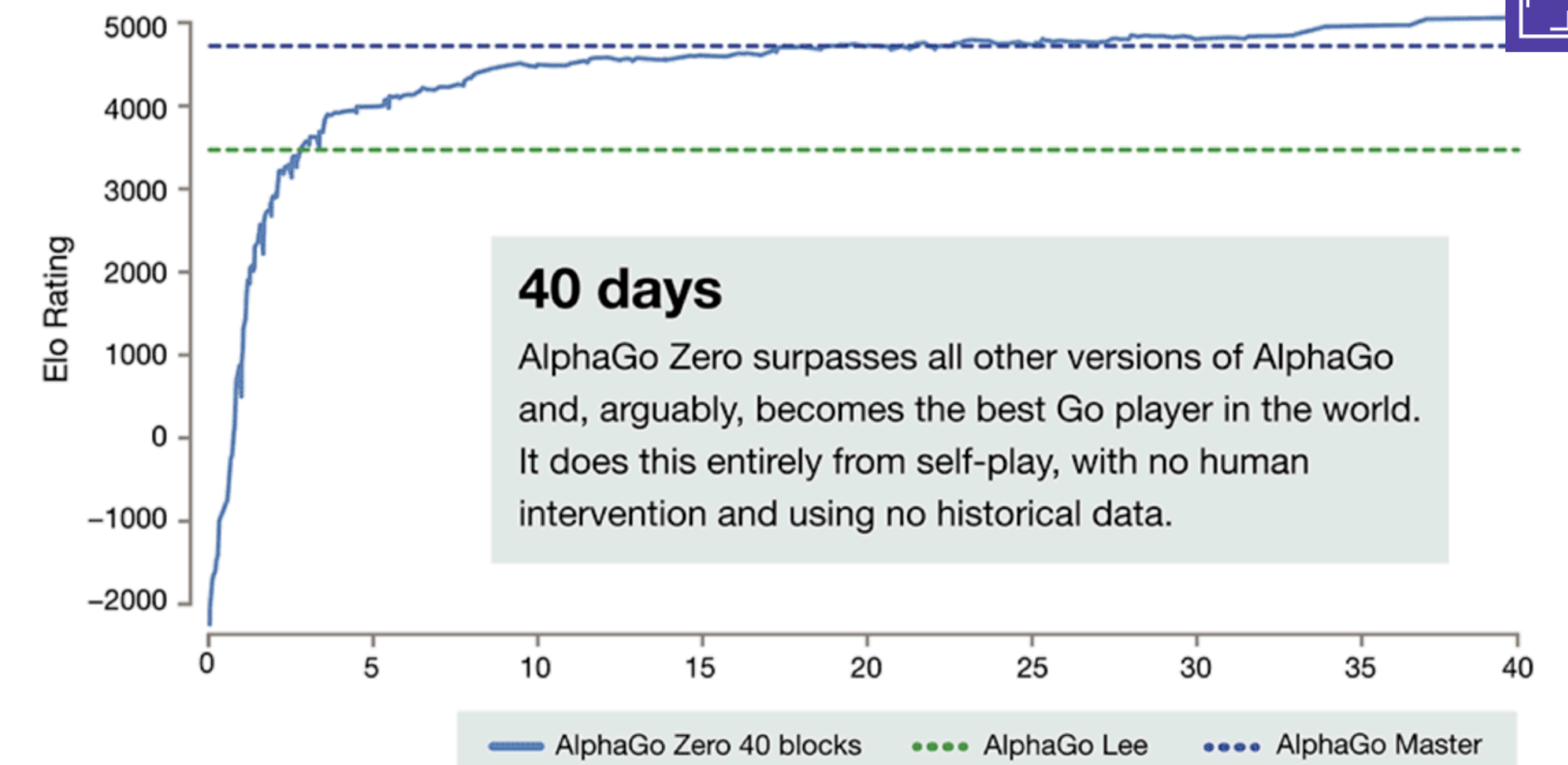
AlphaGo's first formal match was against the reigning 3-times European Champion, Mr Fan Hui, in October 2015. Its 5-0 win was the first ever against a Go professional, and the results were published in full technical detail in the international journal, [Nature](#). AlphaGo then went on to compete against legendary player Mr Lee Sedol, winner of 18 world titles and widely considered to be the greatest player of the past decade.

AlphaGo's 4-1 victory in Seoul, South Korea, in March 2016 was watched by over 200 million people worldwide. It was a landmark achievement that experts agreed was a decade ahead of its time, and earned AlphaGo a 9 dan professional ranking (the highest certification) - the first time a computer Go player had ever received the accolade.

During the games, AlphaGo played a handful of [highly inventive winning moves](#), several of which - including move 37 in game two - were so surprising they overturned hundreds of years of received wisdom, and have since been examined extensively by players of all levels. In the course of winning, AlphaGo somehow taught the world completely new knowledge about perhaps the most studied and contemplated game in history.

contemplated game in history

taught the world completely new knowledge about perhaps the most studied and extensively played games of all levels in the course of winning



AlphaGo has become progressively more efficient thanks to hardware gains and more recently algorithmic advances

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