Financial Singularity — Paths, Dangers, Strategies

Dr. Yves J. Hilpisch

Machine Learning & AI in Quantitative Finance London | 17. November 2017







"Pichai said that as an 'AI first' company, this is a 'unique moment in time' for Google to combine hardware, software and artificial intelligence. 'It's radically rethinking how computing should work', he said."

Business Standard, "Google Ramps up Hardware Business", 06. October 2017.

This talk is about

AI-first Finance

and the potential for a

Financial Singularity.

Introduction



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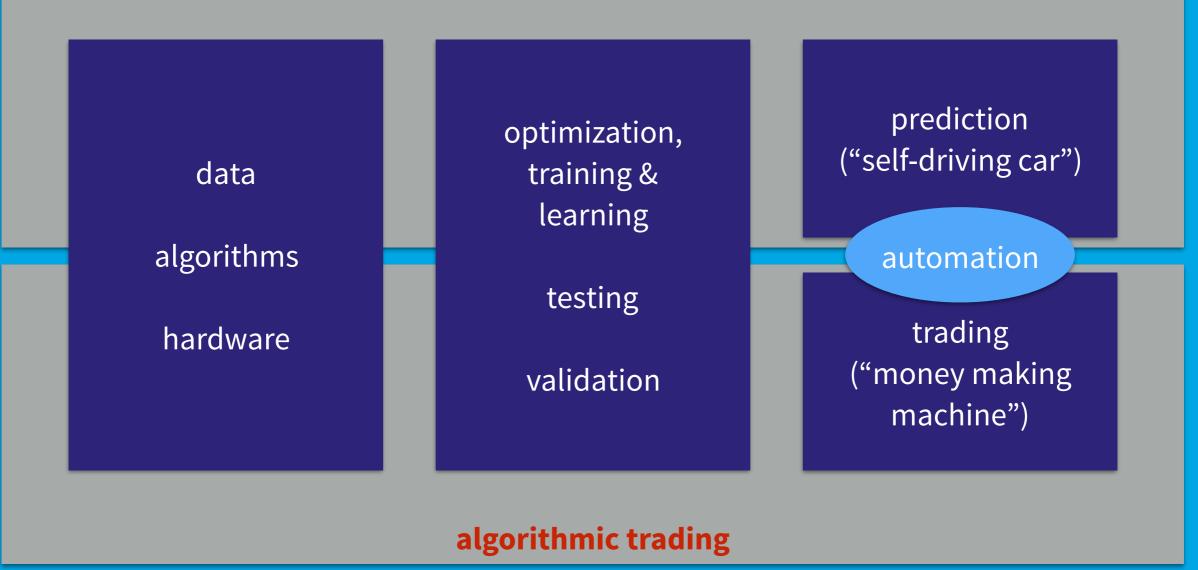
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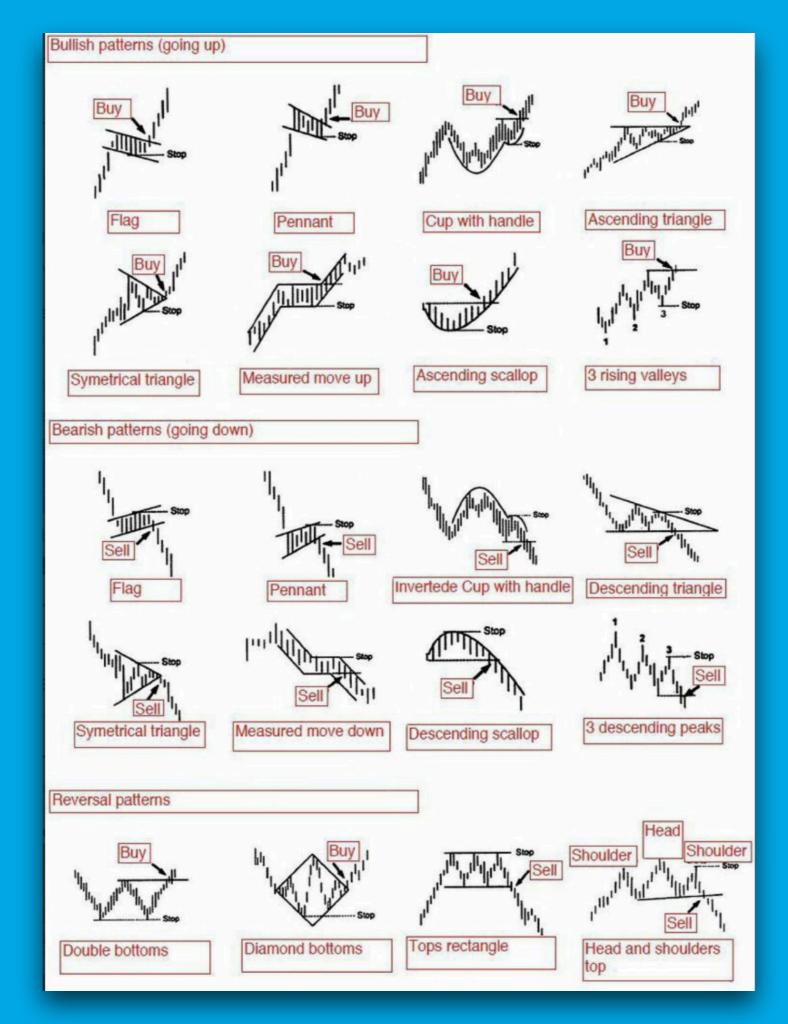
ANTS

A Bit of Background

machine & deep learning



automation trading code connecting code backtesting code strategy code financial data infrastructure The Benchmark Case of Random Walks



"For many years, economists, statisticians, and teachers of finance have been interested in developing and testing models of stock price behavior. One important model that has evolved from this research is the theory of random walks. This theory casts serious doubt on many other methods for describing and predicting stock price behavior—methods that have considerable popularity outside the academic world. For example, we shall see later that, if the random-walk theory is an accurate description of reality, then the various "technical" or "chartist" procedures for predicting stock prices are completely without value."

Eugene F. Fama (1965): "Random Walks in Stock Market Prices".

If a stock price follows a (simple) **random walk** (no drift & normally distributed returns), then it rises and falls with the same probability of 50% ("toss of a coin").

In such a case, the best predictor of tomorrow's stock price — in a least-squares sense— is today's stock price.



"A market is efficient with respect to an information set S if it is impossible to make economic profits by trading on the basis of information set S."

Michael Jensen (1978): "Some Anomalous Evidence Regarding Market Efficiency".

"Statistical research has shown that to a close approximation stock prices seem to follow a random walk with no discernible predictable patterns that investors can exploit. Such findings are now taken to be evidence of market efficiency, that is, evidence that market prices reflect all currently available information. Only new information will move stock prices, and this information is equally likely to be good news or bad news."

"We have covered many of the so-called anomalies [eg small firms, January effect] cited in the literature, but our list could go on and on. Some wonder whether these anomalies are really unexplained puzzles in financial markets or whether they instead are an artefact of data mining."

"By and large, the performance record of professionally managed funds lends little credence to claims that most professionals can consistently beat the market."

Bodie-Kane-Marcus (2013): Essentials of Investments. 9th ed.

Technological Singularity

NICK BOSTROM

SUPERINTELLIGENCE Paths, Dangers, Strategies

ORD

SINGULARITY

Copyrighted Material "There are things in this book that could mess with your head."

-VERNOR VINGE, computer scientist; essayist, "The Coming Technological Singularity"

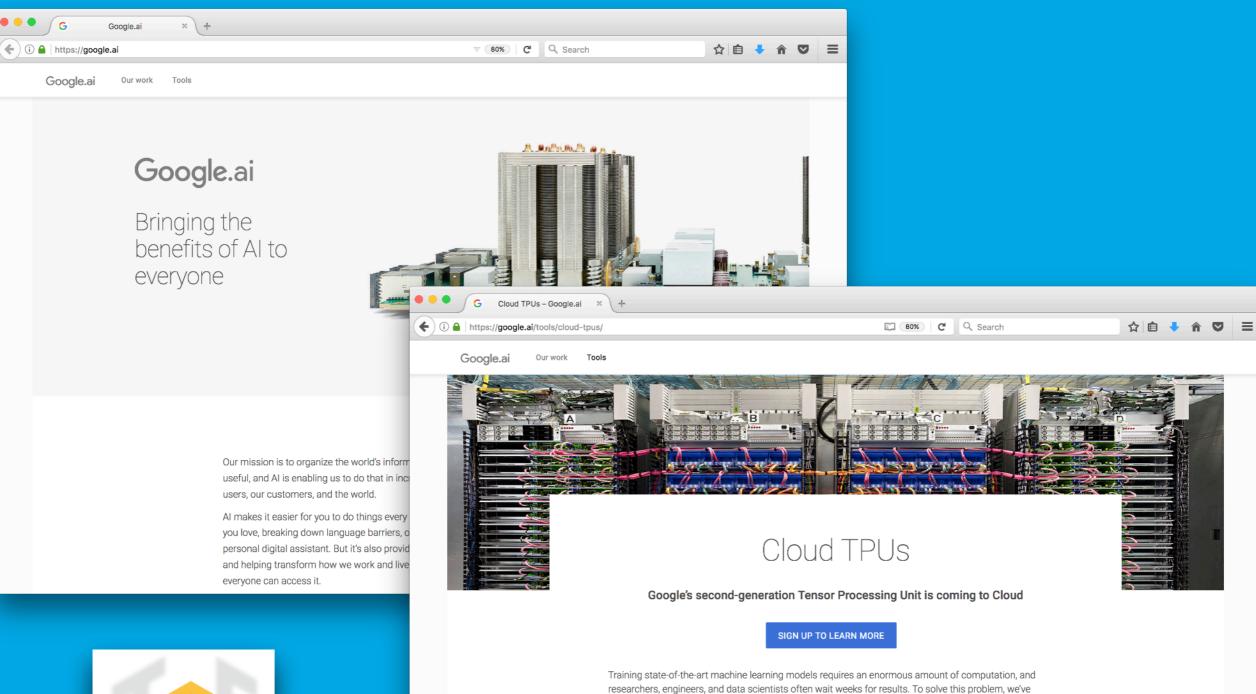
'I highly recommend this book' BILL GATES

> in a Smarter, gerous World



"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.



TensorFlow

designed an all-new ML accelerator from scratch – a second-generation TPU, or Tensor Processing Unit – that can accelerate both training and running ML models.

Each device delivers up to 180 teraflops of floating-point performance, and these new TPUs are designed to be connected into even larger systems. A 64-TPU pod can apply up to 11.5 petaflops of computation to a single ML training task.

We're extremely excited about these new TPUs, and we want to share this technology with the world so that everyone can access their benefits. That's why we're bringing our second-generation TPUs to Google Cloud for the first time as Cloud TPUs on GCE, the Google Compute Engine. You'll be able to mix-and-match Cloud TPUs with Skylake CPUs, NVIDIA GPUs, and all of the rest of our infrastructure and services to build and optimize the perfect machine learning system for your needs. Best of all, Cloud TPUs are easy to program via TensorFlow, the most popular open-source machine learning framework.

Emulation

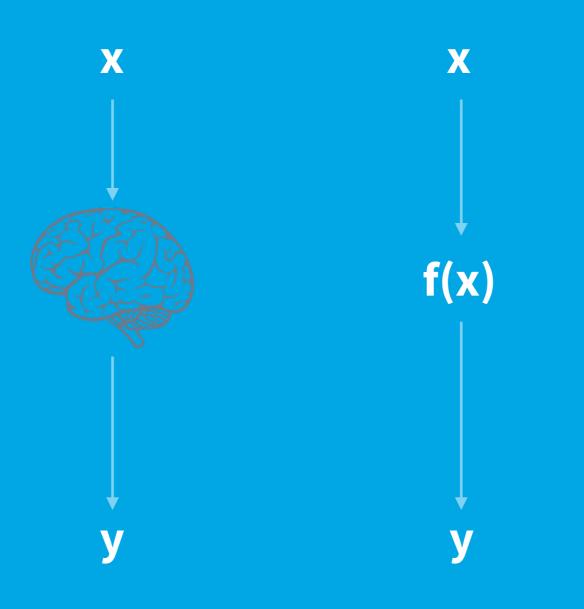




powerful hardware & software

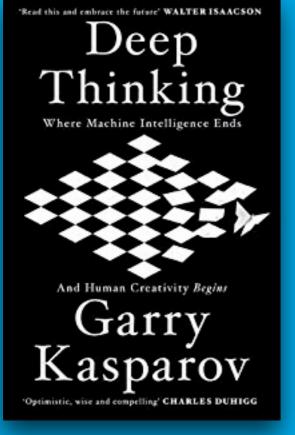
human level Al

Humans Algorithms



Chess Singularity

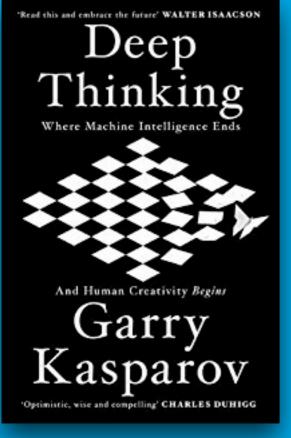
Chess singularity is a a threshold of time from which on chess programs play better chess than any human being.



"It was a pleasant day in Hamburg in June 6, 1985, ... Each of my opponents, all thirty-two of them, was a computer. ... it didn't come as much of a surprise, ..., when I achieved a perfect 32–0 score."

"Twelve years later I was in New York City fighting for my chess life. Against just one machine, a \$10 million IBM supercomputer nicknamed 'Deep Blue'."

"Jump forward another 20 years to today, to 2017, and you can download any number of free chess apps for your phone that rival any human Grandmaster." Did the human race resign and stop playing chess?



"The world is changing too quickly to teach kids everything they need to know; they must be given the methods and means to teach themselves. This means creative problem-solving, dynamic collaboration online and off, real-time research, and the ability to modify and make their own digital tools."

"We are fantastic at teaching our machines how to do our tasks, and we will only get better at it. The only solution is to keep creating new tasks, new missions, new industries that even we don't know how to do ourselves. We need new frontiers and the will to explore them."

Financial Singularity



"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-singlularity.asp

Emulation

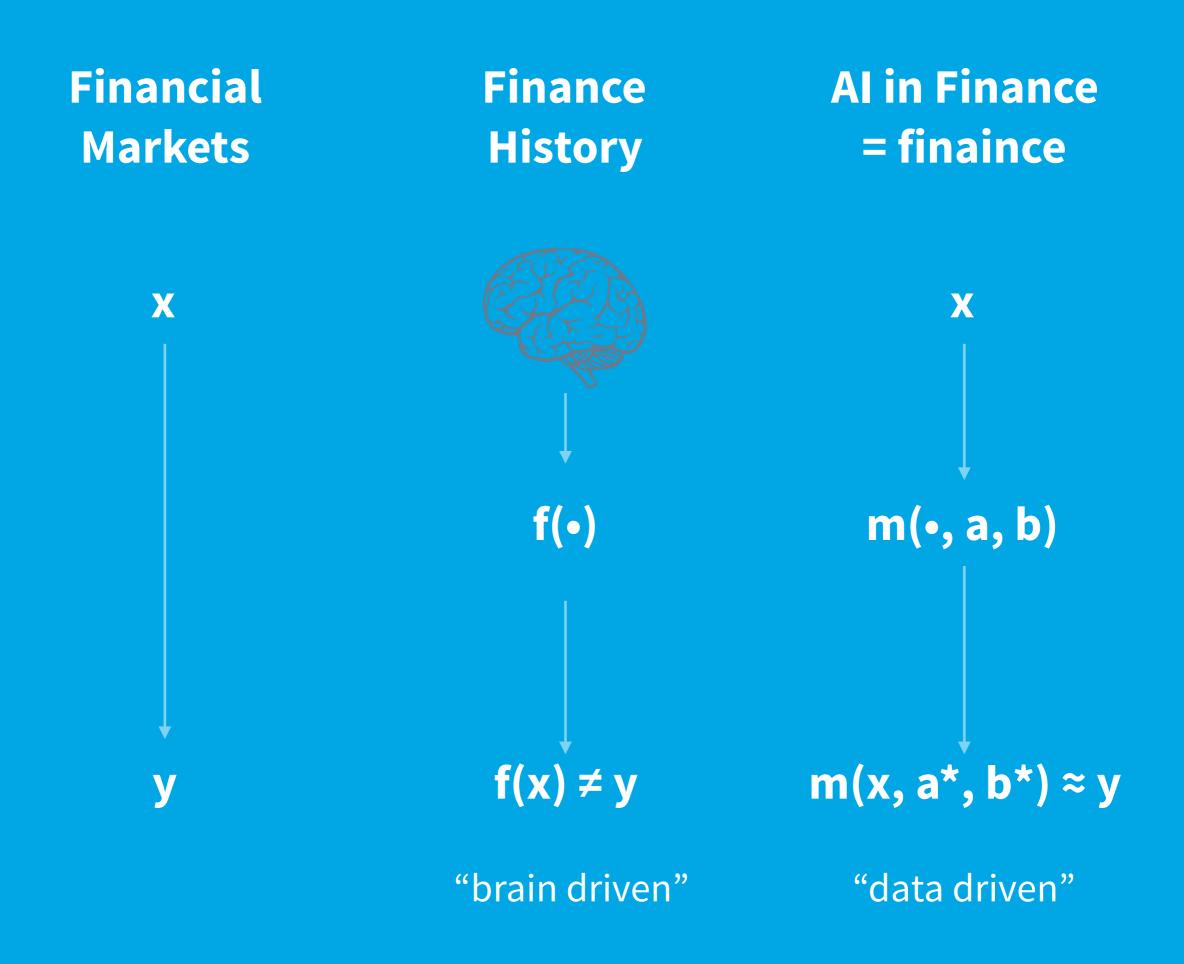


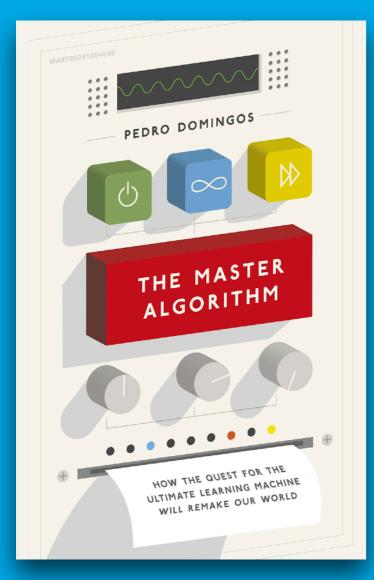




powerful hardware & software

complete market emulation with all agents

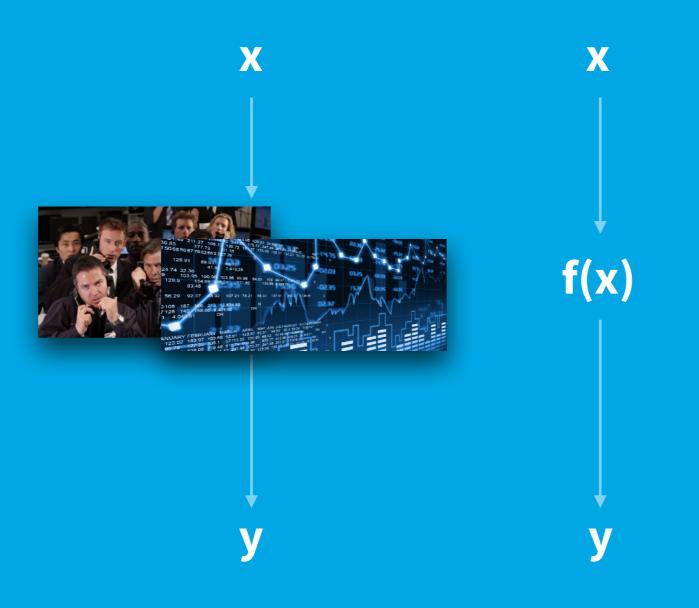




"The grand aim of science is to cover the greatest number of experimental facts by logical deduction from the smallest number of hypotheses or axioms." — Albert Einstein

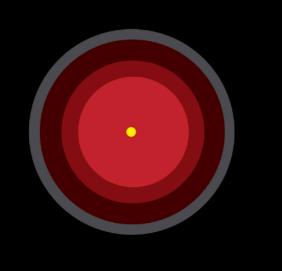
"Machine learning is the scientific method on steroids. It follows the same process of generating, testing, and discarding or refining hypotheses. But while a scientist may spend his or her whole life coming up with and testing a few hundred hypotheses, a machine-learning system can do the same in a second. Machine learning automates discovery.
It's no surprise, then that it's revolutionizing science as much as it's revolutionizing business."

Markets & Algorithms



THE TECHNOLOGICAL SINGULARITY

MURRAY SHANAHAN



THE MIT PRESS ESSENTIAL KNOWLEDGE SERIES

"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)

Man + Machine

"We are impressed by small feats accomplished by computers alone, but we ignore big achievements from complementarity because the human contribution makes them less uncanny."

ZERO

NOTES ON STARTUPS, OR HOW TO BUILD THE FUTURE

Peter Thiel

"Watson, Deep Blue and ever better machine learning algorithms are cool."

"But the most valuable companies of the future won't ask what problems can be solved with computers alone. Instead they'll ask: *How can computers help humans solve hard problems*?"

BlackRock cofounder: Artificial intelligence won't replace humans



- BlackRock has been betting big on artificial intelligence in finance in recent years.
- But President Rob Kapito said he believes the future "will be human and machines."
- A.I. is "just a way to make us much more efficient," Kapito said at a conference in London.

LONDON — The cofounder and president of asset management giant BlackRock believes artificial intelligence will never fully replace humans in the investment world.

LONDON — The cofounder and president of asset management giant BlackRock believes artificial intelligence will never fully replace humans in the investment world.

Data as the Driving Force



Mohamed El-Erian

Torturing Theresa

Las Vegas reels from worst US mass shooting

A casualty is carried from the scene after a gumman opened fire on concert-goers in Las Vegas on Sunday night. More than 56 people were killed and over 515 wonded, making it the deadli-est mass shooting in US history. est mass shooting in US history. Las Vegas police said the suspected gumman, 64-year-old Skephen Paddock, fired shots from his 52nd floor room in the Mandalay Bay Hotel and Casino into the Corowl of 22,000 people attending the Route 91 Harvest Festival. In televised remarks, Donald Trump, due 10% excellent collect the landst he US president, called the shooting an act of pure evil" but made no refer



Catalan president urges Brussels to mediate in independence clash

He added: "We don't want a traumatic We want a new understand-



	pment	for bat		CLIVE CORESON – SCIENCE EDITOR Three American scientists have wan the Nobel medicine princip discovery ing the molecular workings of the "body decie" in humans and animalis- that synchronises with the Earth's cycle through night and day. [Frirey 11d], Michael Robush and Michael Young worked on thore abio- hemical feetback mechanism main	from insects to mammals. Flants too have a similar timeleoping system. Thomas Perlmann, secretary of the boled assembly solid leverable Profes- sor Roshah by pinnes shortly before the strokhoim." He was siles and then he assembly the second second second second According to the citation for the SkrChoi (SLIm) prize, the researchers were able to peek inside our biological	When we travel across several tim zones there is a mismatch between ou internal clock and external environ ment, which produces jet Lag. Whil some people take the hordy clock, scientist are wetking on annae effective remody tumin to reset the hody clock, scientist are wetking on annae effective remody have a science was start a pair of grave called "period" and "timeless" act up cellski loog, in which their activity"
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Region seeks to avoid 'traumatic split' from Spain
 EU says dispute is 'internal matter'

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of human body clock win Nobel Prize

World Markets

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TO. autonomy – to enforce the rule of law. There were also havekins calls by Albert Rivera, the head of the liberal Ciudadanos party which supports the Fr government, to suspend catalonia's autonomy immediately. Mr Puiglemont demanded the cen-tral government withdraw the national police reinforcements' at deposed to the region over the weekend to thwart 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 News & analysis page 3

Editorial Comment page 10 Gideon Rachman page 11

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-0.38 -0.38 D.0 0.34 D.33 D.0

A Nikkei Company

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 1 Datawatch

Confined in a circle

Puerto Rico calls for billions in aid Raúl Maldonado Gautier, Puerto Rico's treasury secretary, says the island will need "tens of billio of dollars in aid from the US as it struggles to

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 flies in

Der SUK near quits as chief mesin Jo Bertran, Uber SUK loss, has quit the company a day before aviit to iomoton by Dara Khorrowshahi, chief executive, to meet regulators over a threat to reveck the hief has ling appy licence in the capital—pAct to

► Koike faces Japan election dilemma Tokyo governor Yuriko Koike is under pressure to stard in Japan's general election later this month, and 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 al of a hearing at the US Congress later today that disclosing that it had been hacked would have

encouraged "copycat" cyber attacks -- PAGE 12

• Western envoys warn on Kenya re-run

Western ambassadors have condemned Presider Uhuru Kenyatta and Raila Odinga, opposition leader, for undermining the electoral commissio ability to restage its election this month... PAGE 4

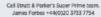


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27-Dec-2016		Free Float	5.32B	Asset Typ		5 yr CDS	26.980 bps
23:33:16 Reuters Insider - Tech stocks could take the Dow to 20k	CNBC	Outstanding	5.33B	Share Cla	iss		-0.07%
23:32:28 Reuters Insider - History suggests Dow could hit 20k by Friday: Technician 22:55:20 LEAD 2 Well Street cells use failed a los an appli des 20.000 paints	CNBC	IPO Date	12-Dec-1980	Lot Size		∆ 1 Week	-0.074
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22:09:39 Apple, Cisco Lead DJIA Higher Tuesday	WALLST	FUNDAMENTALS >					
EVENTS > Upcoming 24-Jan-2017 » 30-Jan-2017	Past				AAPL (Sep-2016)	Growth	Industry
NTS Q1 2017 Apple Inc Earnings Release	<u></u>	Gross Margin			38.02%	(4.71%) 4Q	38.91%
24-Feb-2017 » 28-Feb-2017	122 <u>T</u>	Operating Margin			25.10%	(11.59%) 4Q	5.75%

Tick Data

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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
```

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In [25]: tick.tail()
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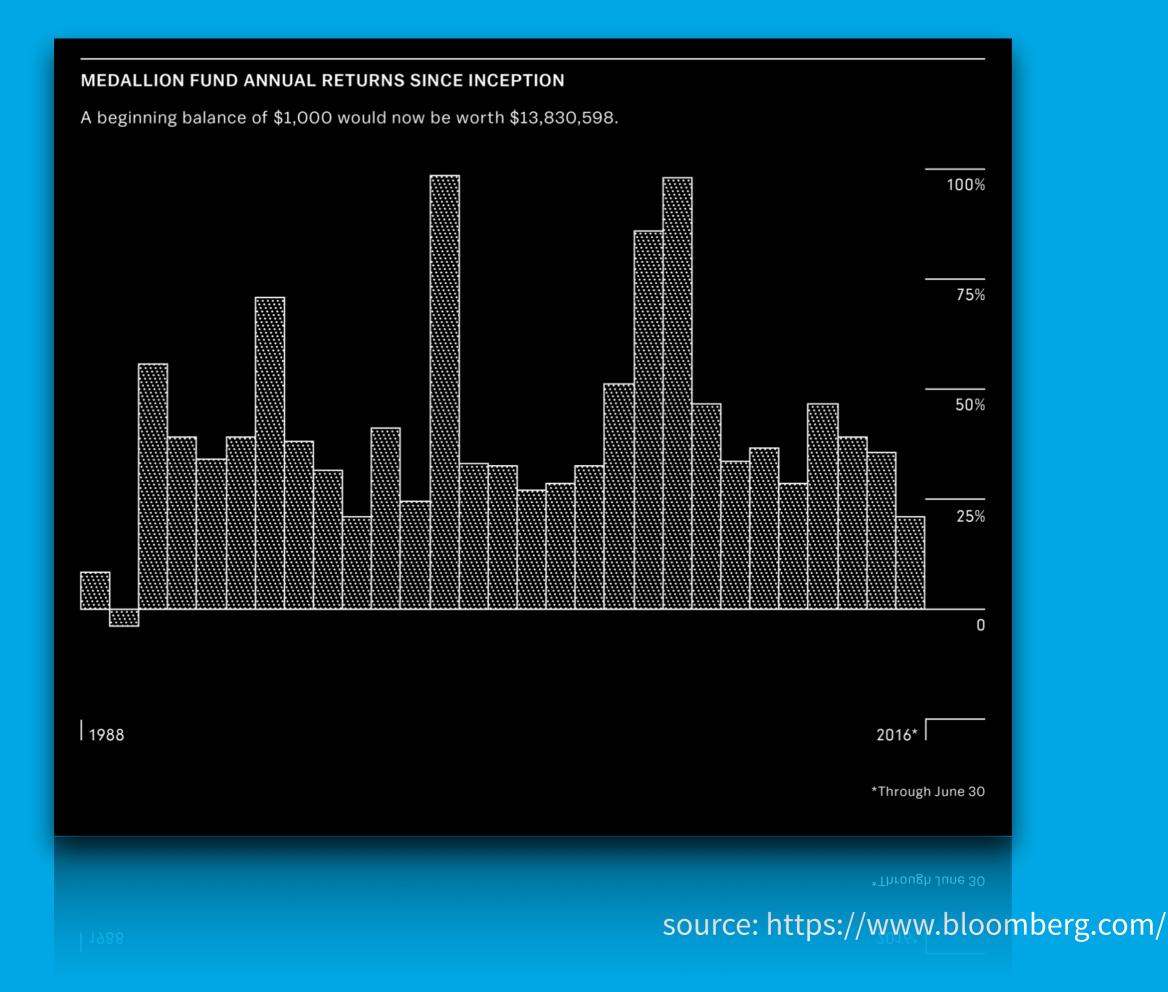
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AAPL.O VALUE VOLUME

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In [31]:	<pre>from IPython.display import display, HTML</pre>							
<pre>In [32]: display(HTML(ek.get_news_story(storyId)))</pre>								
	 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							

Is a Financial Singularity Possible?



Dutch Speed-Trader Turns to Currencies After Conquering ETFs

Flow Traders wants to colonize markets with its approach to trading, but its core business is coming under attack

by Will Hadfield

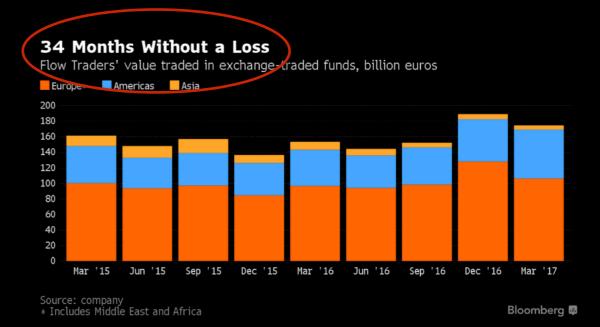
14 June 2017, 06:01 CEST From **Bloomberg Markets**

The bottom shelf of the fridge is laden with Heineken and Corona. The Corona is on rotation, but the Heineken is a permanent fixture: This is Amsterdam. A few strides away there's a dark, well-stocked in-house pub.

Up one flight of stairs, the atmosphere is very different. Behind a door that can only be opened with a security pass is by far the largest trading floor for exchange-traded funds in Europe. The 110 traders here, along with 30 colleagues in offices elsewhere, traded €640 billion (\$719 billion) in ETFs last year and at least that much in futures, commodities, bonds, stocks, and foreign exchange.

The trading volumes are those of a major Wall Street bank, but the refrigerator—and especially the pub, with its arcade games, pool table, and giant television—is pure startup. This isn't an investment bank; this is Flow Traders NV, one of the world's most successful algorithmic trading firms.

This year the firm will undergo its biggest transformation since it opened for business in 2004. Flow, which handles about a third of all ETF trades in Europe, is seeking to do to currency markets what it's already done to its core business. The firm's strategic calculation is that high-speed foreign exchange traders should be able to offer better prices than banks, which typically adjust their bids and offers based on their customers' creditworthiness and the amount of business they do with the lender.



Rietberg and Dijkstra say the move into currency trading is a natural evolution of the business. That may be, but Flow also badly needs to find a new way to grow: Its <u>shares</u> <u>languish below €32</u>—the price when it went public almost two years ago. In the first three months of 2017, <u>its profit dropped</u> 41 percent as quiet markets reduced its ability to earn money from trading. What's more, Flow needs to adjust to a changing landscape. In some markets, the pool of income available to algo trading firms is shrinking as competition increases from established trading companies looking to expand into new asset classes.

source: https://www.bloomberg.com/

Flow is at a crossroads. It's distinctive approach to algorithmic trading could enable it to colonize other financial markets—or it could shrivel as rivals attack its core ETFs business. "Flow could be multiple times the size it currently is in 20 years," says Joost de Rijk, an analyst who covers the company for Amsterdam-based merchant bank Kempen & Co. "But it could also be gone. I think they will reevaluate every year whether this is working. That's the DNA of the company."

When you make only 0.028 percent on a trade, you need to make a lot of them.

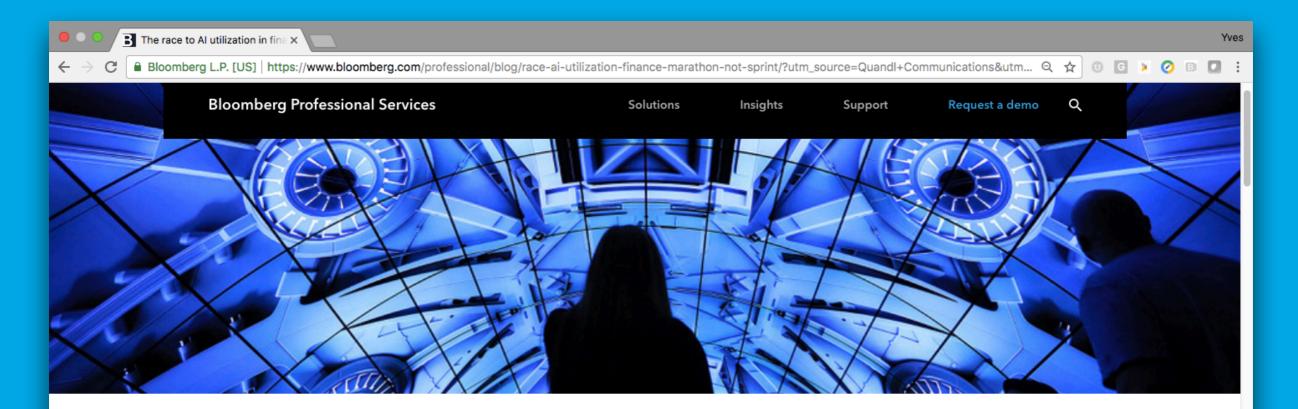
Announcing its first-quarter results in May, Flow reported that it

hadn't lost money on a single trading day in the preceding 34 months. It attributes the stellar run to its use of deterministic modeling, which produces definite outcomes, not probable ones. Most of its rivals calculate prices by means of statistical, or stochastic, modeling, producing hedges that probably (but not definitely) protect them from any downside.

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source: https://www.bloomberg.com/

Outlook



Data Science

The race to AI utilization in finance is a marathon, not a sprint

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Bloomberg Professional October 4, 2017

Development and deployment of artificial intelligence (AI) in financial services has accelerated. In particular, quantitative funds are increasingly applying programming and advanced statistical methods to generate alpha and automate trading strategies. Despite the hype and frequent headlines extoling the virtues

Monopoly

Oligopoly

Perfect Competition

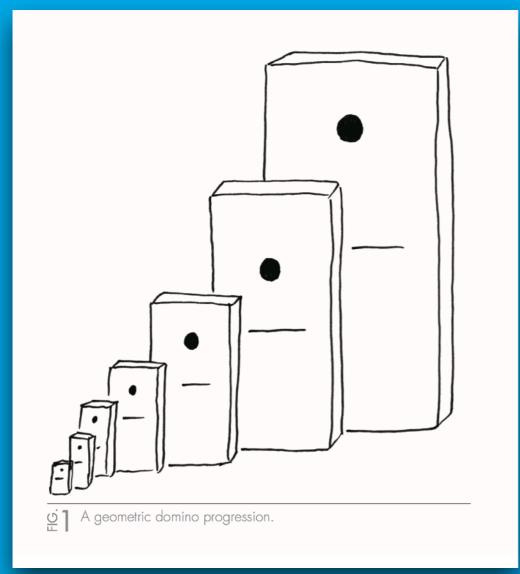






Deep Blue 1997 ("complete pie") Bitcoin Miners Today Hedge Fund Industry Today ("piece of the pie")

Chess Today ("only crumbs")



exponential forces at work:

- technology improvements
- capital accumulation
- talent accumulation



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