## Algorithmic Trading For the Masses

— How Data-Driven & Al-First Finance Change the Landscape

FXCM Algo Summit, London, 15. June 2018

Dr. Yves J. Hilpisch





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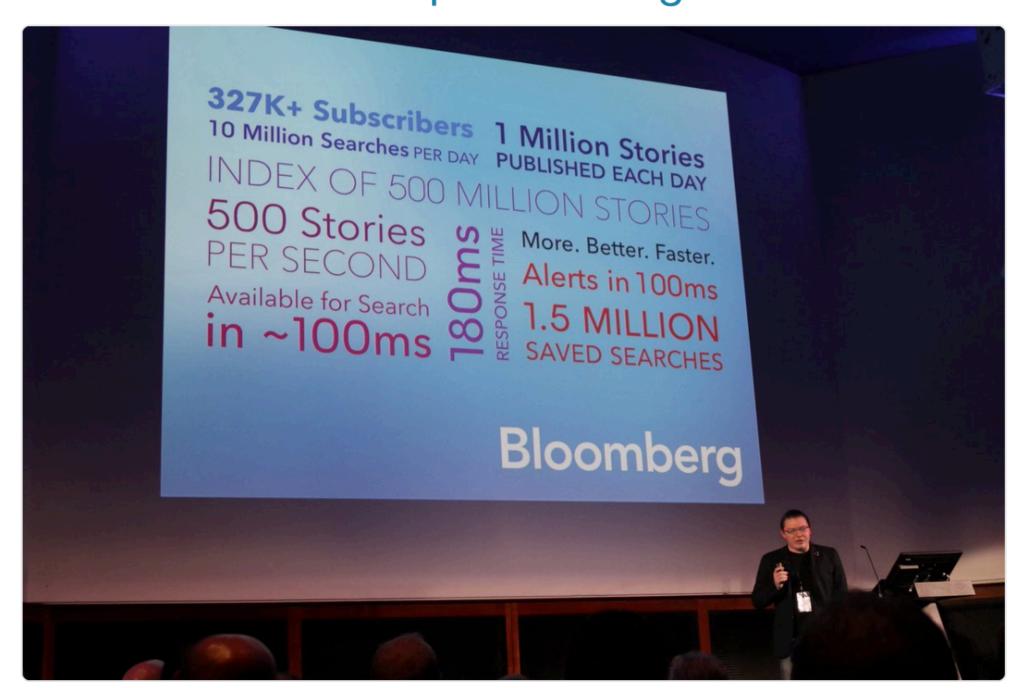
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9:53 AM - 31 May 2018

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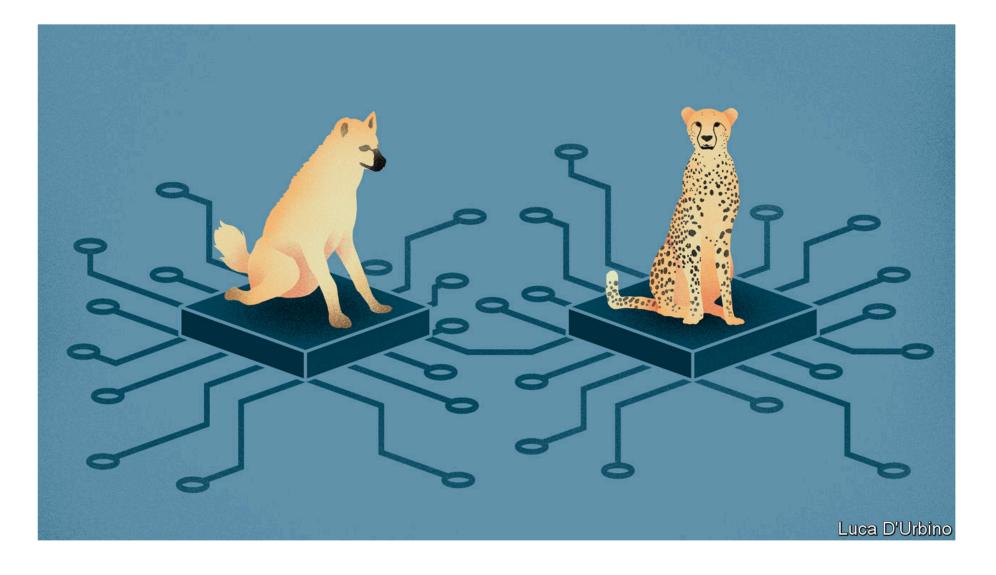




#### Hyenas and cheetahs

## Artificial intelligence is awakening the chip industry's animal spirits

Generalist chips are ceding some of the savannah to new, specialist processors



Print edition | Business > Jun 7th 2018 | BRISTOL

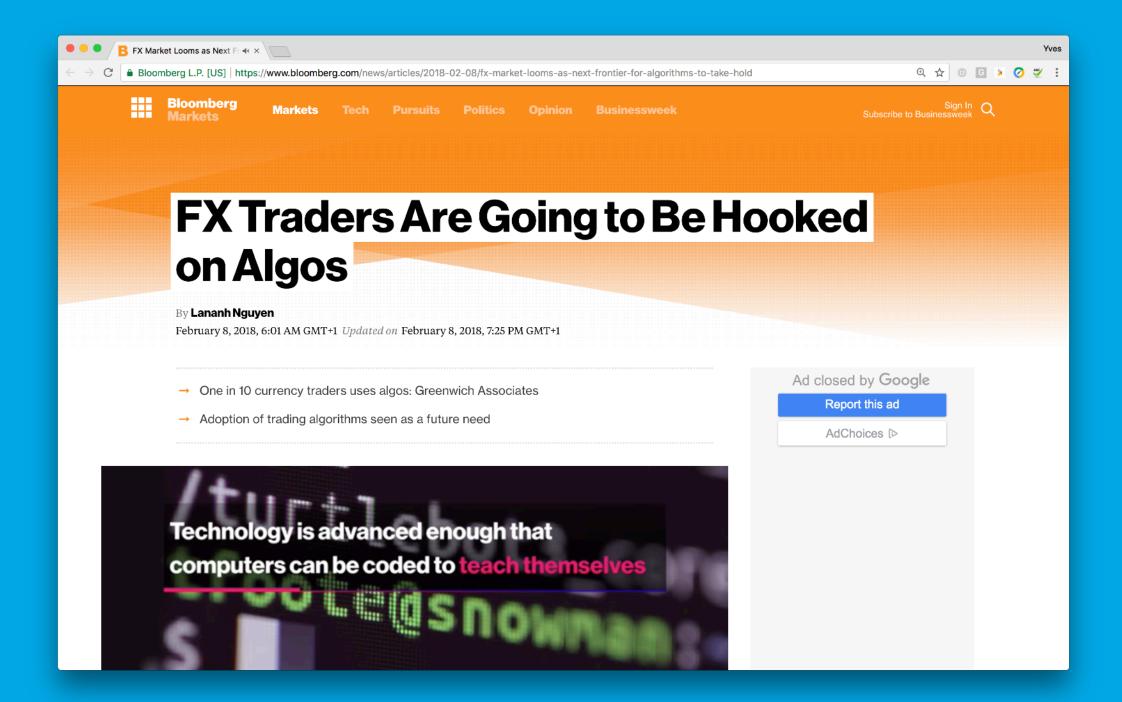








SUPERCOMPUTERS usually fill entire rooms. But the one on the fifth floor of an office building in the centre of Bristol fits in an average-sized drawer. Its 16 processors punch more than 1,600 teraflops, a measure of computer performance. This puts the machine among the world's 100 fastest, at least when solving certain artificial-intelligence (AI) applications, such as recognising speech and images.



Bloomberg, 8. February 2018

#### **Bloomberg**Markets ▼

FX Traders Are Going to Be Hooked on Algos

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.

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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



# Georgetown Students turn \$1 Million into \$383 Billion in University Challenge.

A <u>Georgetown McDonough</u> team won the "Best Hedge Fund Strategy Award" in the <u>Peeptrade Challenge</u>, a simulated investment competition, the event was hosted by the University of Chicago. The students set up a global record with a 38 million percent return.

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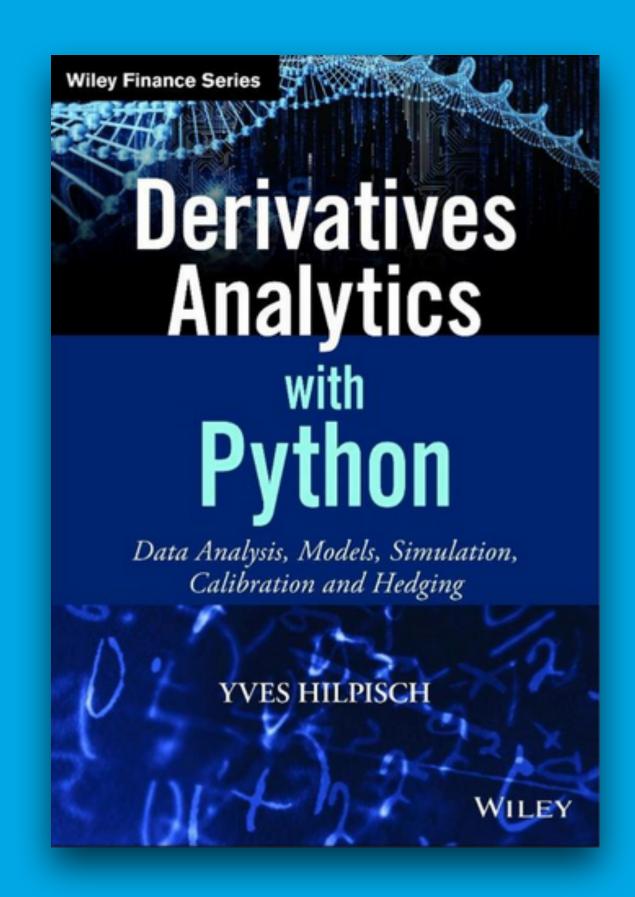
## **AGENDA**

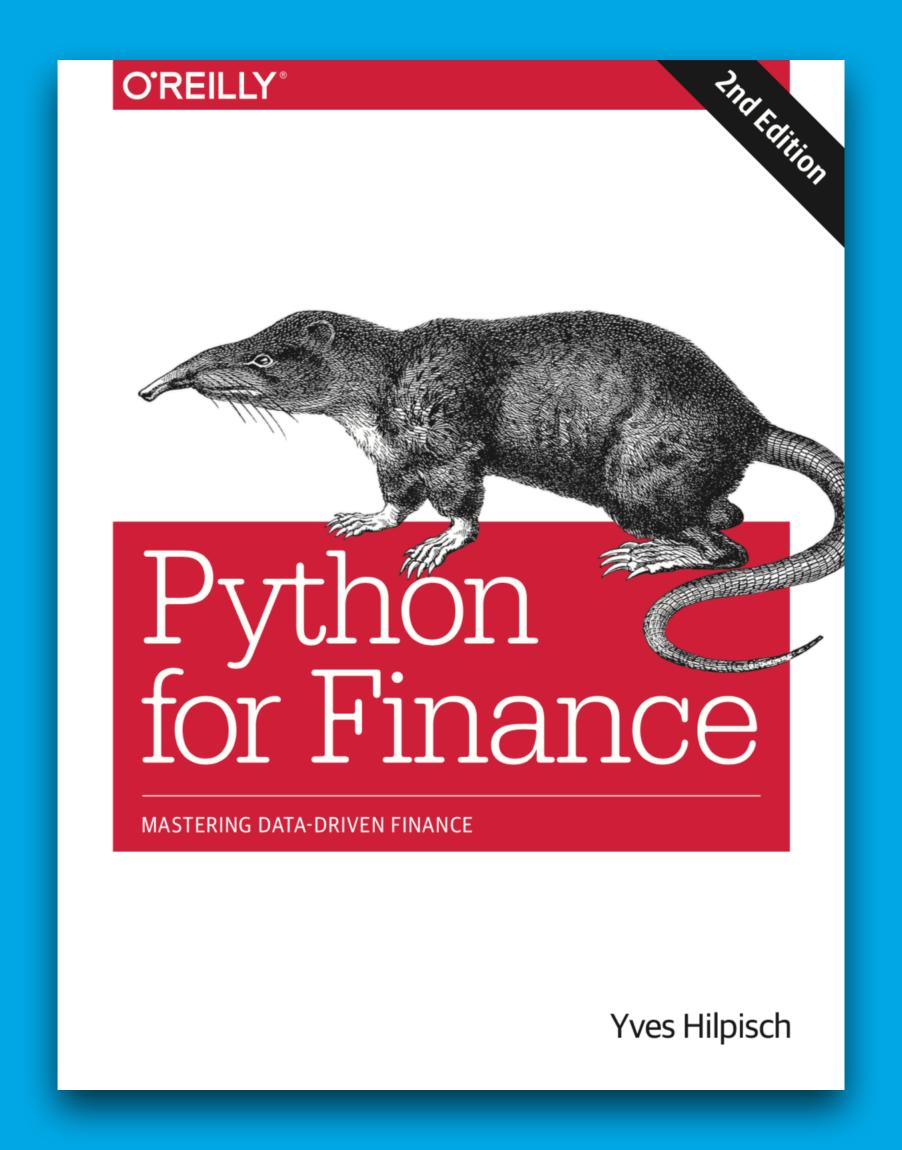
- Introduction
- Data-Driven Finance
- Al-First Finance
- Example Strategy
- The Al Machine
- Outlook

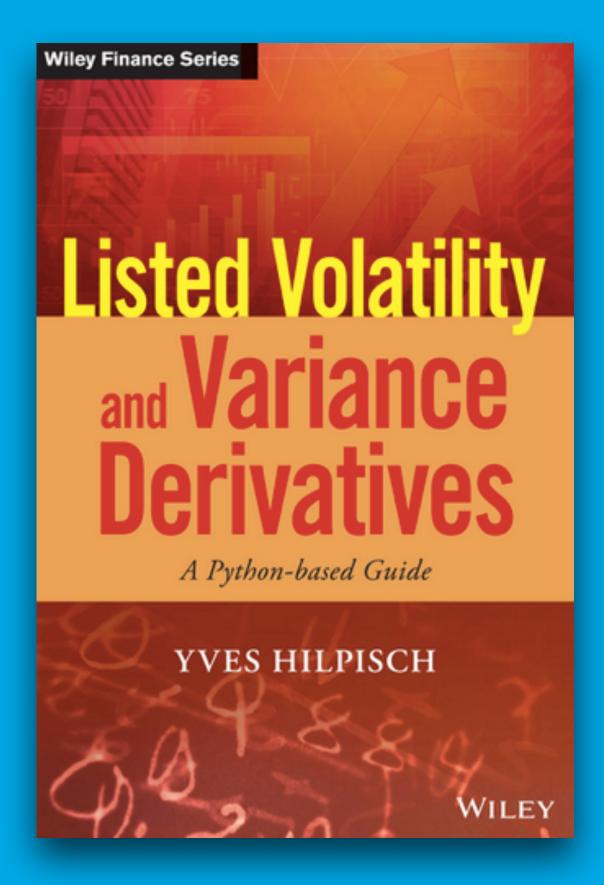
Introduction











**Data-Driven Finance** 

## FINANCIAL TIMES

ohamed El-Erian

Torturing Theresa

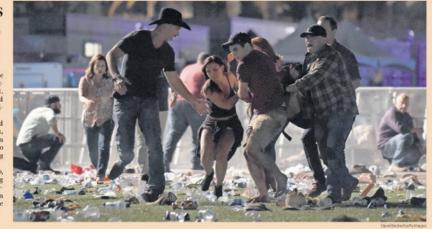


Confined in a circle he myths that hold back women

#### Las Vegas reels from worst US mass shooting

goers in Las Vegas on Sunday night.

More than 58 people were killed and
over 515 wounded, making it the deadli-



## Catalan president urges Brussels to mediate in independence clash

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

MICHAEL STOTHARD — BARCELONA
IAM 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 signsit was holding back from
an early declaration of independence
after Sunday's secession referendum.

Carles Puigdemont, the Catalan president, is
open error of the 2.3m ballots cast were
dent, said that after Sunday's vecession referendum.

We call on all relevant players to now
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move very weight from confrontation to
sovernment pushes for full independsovernment pushes for full independsovernment pushes for full independsovernment pushes for full independsolven for the very supports the suspension of Catalonia's
autonomy—to enforce the rule of law.
There were also hawkish calls by
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to spen also hawkish calls by
of the Spanish state that threatens to
be plung the country into a political and
commission condemned the violent
cathes between police seeking to block
the poll and voters. It turged both sides to
reach an agreement.

We call on all relevant players to now
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dent, said that after Sunday's vote, when 90 per cent of the 2.5m 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 Puiglemont at a press conference. He called on the EU to help broker negotiations: "It's obvious we need mediation."

"We call on all relevant players to now move very eviftly from confrontation to dialogue," it said. But it stopped short of offering to broker talks, repeating the sisse was an "internal matter".
Financial markets have been rattled by the vote, which raised lears of an immediate break with Spain. Madrid's main equities benchmark, the ibex 55, closed down 1.2 per cent and yields on 10-year Spanish bonds were up 7 basis to the solos at its disposal – including if



▶ Puerto Rico calls for billions in aid 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 flies in Jo Bertram, Uber's UK boss, has quit the company a day before a visit to London by Dara Khosrowshahi, chief executive, to meet regulators over a threat to revoke the ride-hailing app's

▶ Koike faces Japan election dilemma 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

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

▶ Western envoys warn on Kenya re-run Western ambassadors have condemned President Uhuru Kenyatta and Raila Odinga, opposition

▶ Huawei beats Apple as top China choice spot for intended smartphone purchases in China, according to a survey of 1,000 consumers.— PAGE 14



02 05 10 15 17 since the summer of 2004

## Scientists who unwound the workings of human body clock win Nobel Prize

Three American scientists have won the Nobel medicine prize for discovering the molecular workings of the "body dock" in humans and animals that synchronises with the Earth's cycle through night and day.

Jeffrey Hall, Michael Rosbash and Michael Young worked out how a biomatian sour circadian rhythm, the 24- bour cycle of sleep and wakefulness, feeding behaviour, hormone release, blood pressure and dother physiological functions. Their research was carried out mainly during the 1980s and 1990s, working with fruit flies as a "model organism" at Brandeis University in Boston and Rockefeller University in Boston and Rockefeller University in Source of the physiological functions of the proper importance of selep had wakefulness, feeding with fruit flies as a "model organism" at Brandeis University in Boston and Rockefeller University in New York. The body clock works in essentially the same way across the animal kingdom,

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Francisco, Washington DC, Orlanda, Tokyo, Ho
Kong, Singapore, Seoul, Dubai, Doha



STOCK MARKETS				CURREN	CIES					INTERESTRATES			
	Oct 2	prev	%drg		Oct 2	prev		Oct 2	prev		price	yield	
S&F 500	2522.54	2519.36	D.13	\$ per €	1.174	1,182	€per\$	0.852	D.846	US Gov 1D yr	99.31	2.33	. D.
Nasdaq Composite	6491.42	8495.96	-0.07	S per £	1.327	1,342	Eper \$	0.753	D.745	UK Gov 10 yr	98.98	1,38	-0
Dow Jones Ind	22480.23	22405.09	0.34	£per€	0.884	0.881	€perf	1.131	1,135	Ger Gov 10 yr	100.48	0.45	-0.
FTSEurofirst 300	1532.5D	1524,79	D.51	¥per\$	112,710	112,565	¥per €	132.276	133.074	Jpn Gov 1D yr	100.34	0.07	D.
Euro Stoxx 50	3599.02	3594.85	0.12	¥per£	149.612	151,023	£index	78.309	78.630	US Gov 30 yr	97.87	2.85	D
FTSE 100	7438.84	7372,76	0.90	€index	94,204	53,505	\$ index	99.385	99,438	Ger Gov 2 yr	101.97	-D.71	0
FTSE All-Share	4062.95	4049.69	0.82	SFr per €	1.142	1,144	SFr per E	1,292	1,298		price	prev	3
CAC 40	5350.44	5329.81	0.39	COMMODITIES						Fed Funds Eff	1.07	1,07	0
Xetra Dax	12902.65	12828.86	0.58				Oct 2	prev	Sichg	US 3m Bills	1.06	1.06	0
Nikkei	20400.78	20356.28	0.22	QI WTI\$			50.48	51.67	-2.30	Euro Libor 3m	-0.38	-D.38	D
Hang Song	27554.30	27421,60	0.48	Oil Brent	3		56.05	56.79	-1.30	UK 3m	0.34	D.33	D
FTSE All World \$	321.95	321.66	0.09	Gold \$ 12			73.70	1283.10	-0.73	Prices are fallest for edition	Data pro	sided by Mi	unings

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#### TODAY IN PERSONAL JOURNAL

### A Celebrity Selfie Machine

**PLUS Secondhand Stress at Work** 



## Deal Brings Stability to U.S. Budget

Thousands Honor Memory of South Africa's Liberator

■ Discovery is considering a bid for Food Network major-

ity owner Scripps, presaging a possible wave of TV deals. **B1** ■ Stocks declined as investor

■ Smith & Wesson said profit

■ Pacific trade talks adjourned without a deal amid discord be tween the U.S. and Japan. A17

■ Italy pulled out of a two-■ Three Swiss banks agreed to participate in a U.S. tax-eva sion-disclosure program. C5 ■ LightSquared can proceed with a suit against Dish over a debt purchase, a judge ruled. B3

■ Monsanto is teaming up with a Danish firm to develop

#### World-Wide

■ Congressional negotiato struck a budget deal that we allow more domestic and m

■ Ukrainian forces storm ■ Obama's disapproval rate hit 54%, the high for his presi-dency, amid the flawed health-law rollout, a Wall Street Journal/NBC poll found. A4

■ World leaders gathered to

■ A key Senate Democrat administration's request to delay new Iran sanctions. A17

Bank Rule ■ Supreme Court justices

■ Uruguay's Senate voted to legalize marijuana. The president plans to sign the bill. A15 France's leader flew to the



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

#### Longtime Insider Is GM's First Female CEO

DETROIT—General Motors Co.
tapped product chief Mary Barra
as its next chief executive, smashing a century-old gender barrier
while choosing a longtime insider
who grew up steeped in Detroit's
car culture.
Ms. Barra will succeed Dan Akerson as CEO next month and be-

Ms. Barra will succeed Dan Ak-erson as CEO next month and be-come the first woman to run a major global auto maker. The 51-year-old joined GM 33 years ago as a college intern, eventually be-coming an engineering manager before running one of its big U.S. assembly plants. She got global experience managing human re-sources and, more recently, the company's world-wide product development group. She will become the 22nd woman currently running a For-

#### China Spins New Lesson From Soviet Fall

BELJING—The Communist Party boss in eastern China's Jiangsu province summoned local officials recently to a compulsory study session. Their task was to watch a six-part documentary on the Soviet Union's collapse. The film begins with images of the Soviet Union in its heyday, but quickly cuts to graphic footage of unrest in China's northern neighbor in the 1990s, set to ominous music and punctuated by Russian communists lamenting their nation's fate.

When the screening in Jiangsu ended, state media reported, local party chief Luo Zhijiun exhorted the assembled officials to "correctly understand the lessons of history." The film's message: The Soviet Union's date.

The film's part of an ideological cambia point in the 1990s, set to ominous music and punctuated by Russian communists lamenting their nation's fate.

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Challenges Wall Street ■ An AIDS group called for a

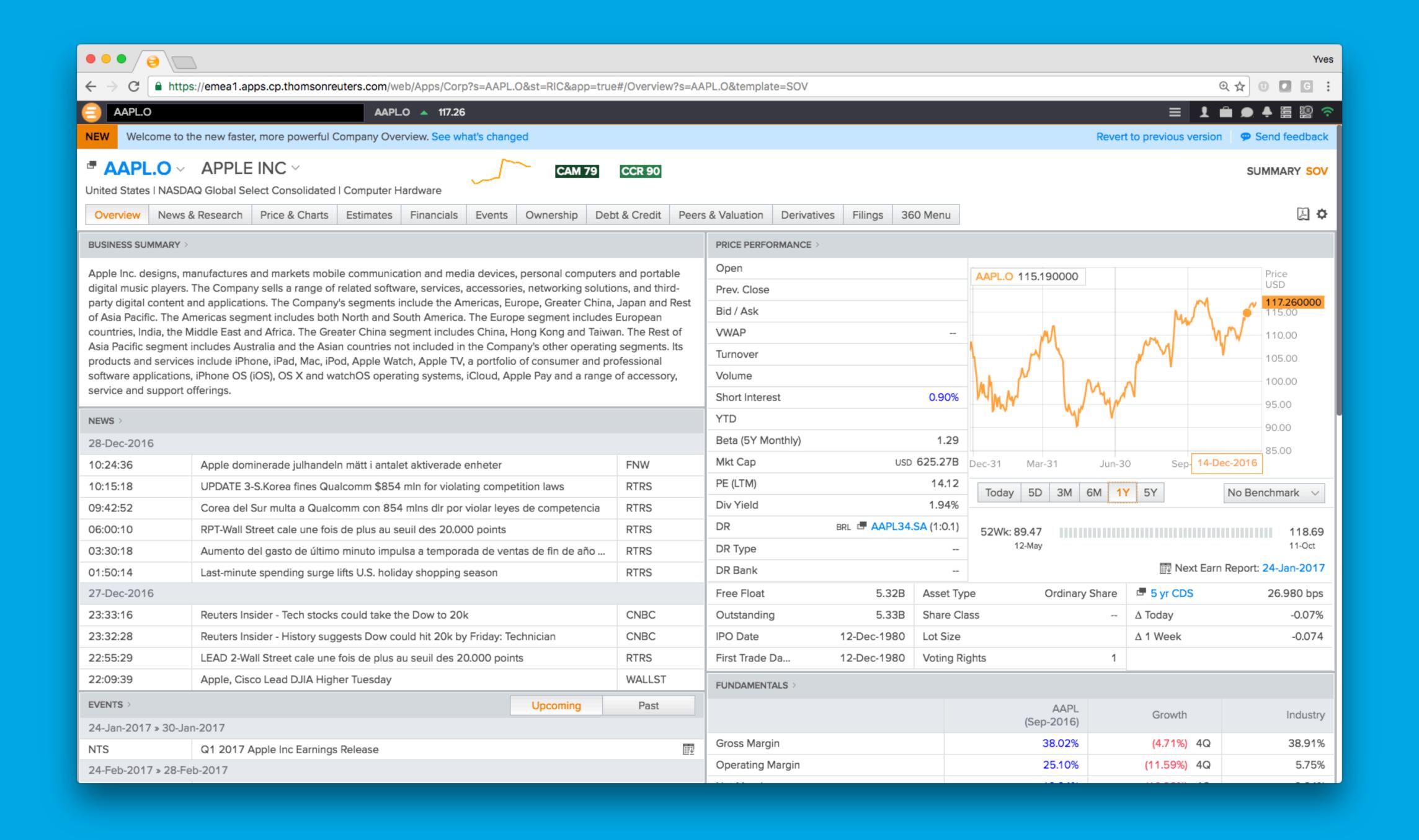
Here's Your Holiday Bonus, Now Start Running \* \* \*

Workers Win All-They-Can-Grab Sprees From Companies; 'Supermarket Sweep'

A broad new government rule to limit risk-taking by Wall Street will force banks to rethink virtur ally every aspect of their trading activities, setting the stage for more tumult at the largest U.S. financial institutions.

The so-called Volcker rule, approved by five financial regular tory asengies on Tuesday could. But his employer, coupon website tory asengies on Tuesday could. Betail MeMott fine, takes a cere are restaurants unleashes high

IEFA IShares
Core ETFs Every investor is unique That's why there's iShares Core. Find out why 9 out of 10 large pr choose iShares for their ETFs. iShares 🕯



### **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):
                     1892 non-null float64
          VALUE
                  1898 non-null float64
          VOLUME
          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
           2017-07-11 16:14:59.708 144.9899
                                     1305.0
```

### **News**

```
news = ek.get_news_headlines('R:.SPX AND "Trump" AND Language:LEN', count=5)
In [29]:
            news
Out[29]:
                                  versionCreated
                                                                                                                                 storyld sourceCode
                                                                                          text
             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
                                                                                                                                            NS:RTRS
                                                 CORRECTED-U.S. STOCKS PARE LOSSES, TRADERS CIT... urn:newsml:reuters.com:20170818:nL4N1L44IK:1
             2017-08-18 15:53:08 2017-08-18 15:53:08
             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
                                                     US STOCKS-Futures flat amid growing concerns o... urn:newsml:reuters.com:20170818:nL4N1L43RR:5
             2017-08-18 11:24:30 2017-08-18 11:24:30
                                                                                                                                            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
            storyId = news.iloc[4, 2]
In [30]:
             storyId
             'urn:newsml:reuters.com:20170817:nL4N1L34N1:5'
Out[30]:
In [31]: from IPython.display import display, HTML
            display(HTML(ek.get_news_story(storyId)))
In [32]:

    Gary Cohn resignation rumors knocked down

    Wal-Mart drops after reporting margin fall

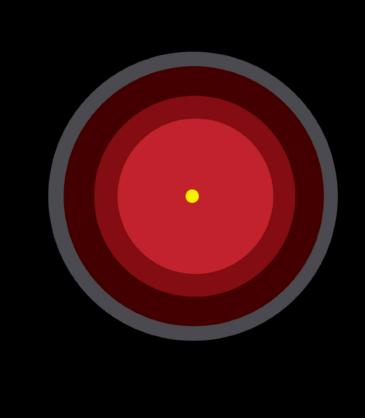
    Indexes down: Dow 0.81 pct, S&P 1.03 pct, Nasdaq 1.39 pct

            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
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**Al-First Finance** 

## THE TECHNOLOGICAL SINGULARITY

MURRAY SHANAHAN

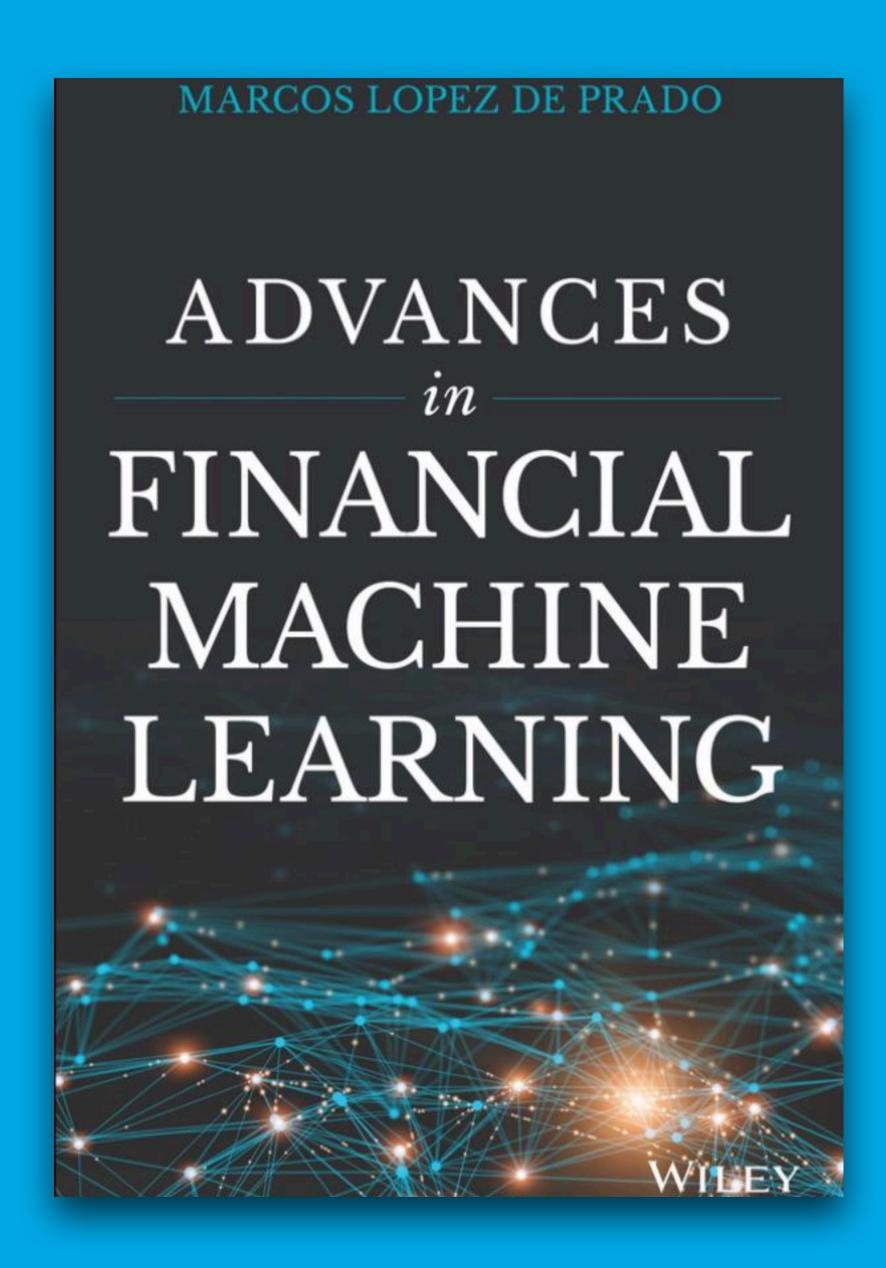


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"Today's algorithmic trading programs are relatively simple and make only limited use of AI. However, this is sure to change. Artificial intelligence is beneficial in any domain where patterns have to be found in large quantities of data and effective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

Murray Shanahan (2015)



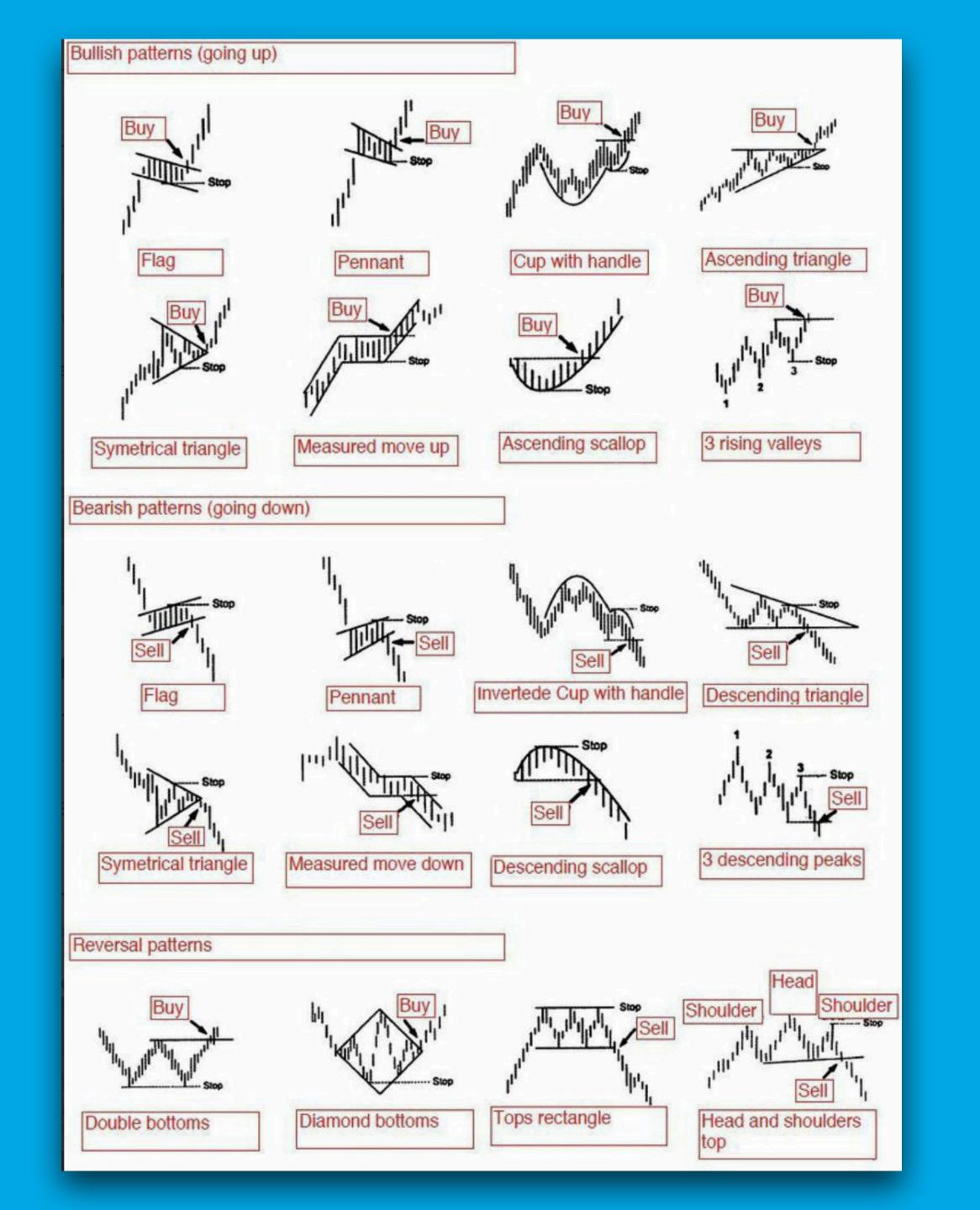
"The essential tool of econometrics is multivariate linear regression, an 18th-century technology that was already mastered by Gauss before 1794 ... It is hard to believe that something as complex as 21st-century finance could be grasped by something as simple as inverting a covariance matrix."

"... what if economists finally started to consider non-linear functions?"

"An ML algorithm can spot patterns in a 100-dimensional world as easily as in our familiar 3-dimensional one."

"Econometrics might be good enough to succeed in financial academia (for now), but succeeding in practice requires ML."

Marcos López de Prado (2018)

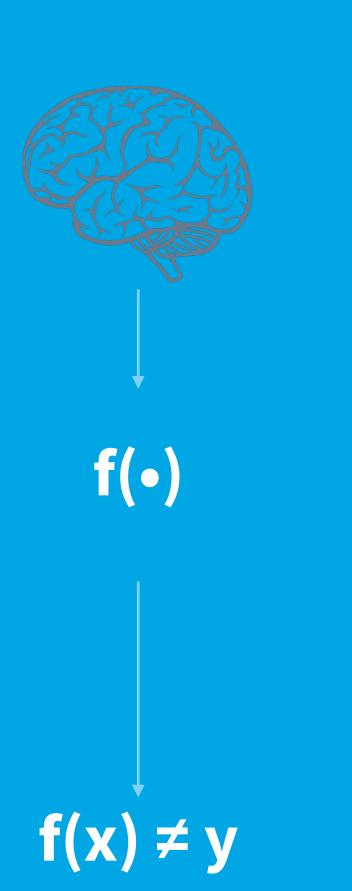


## Financial Markets

X

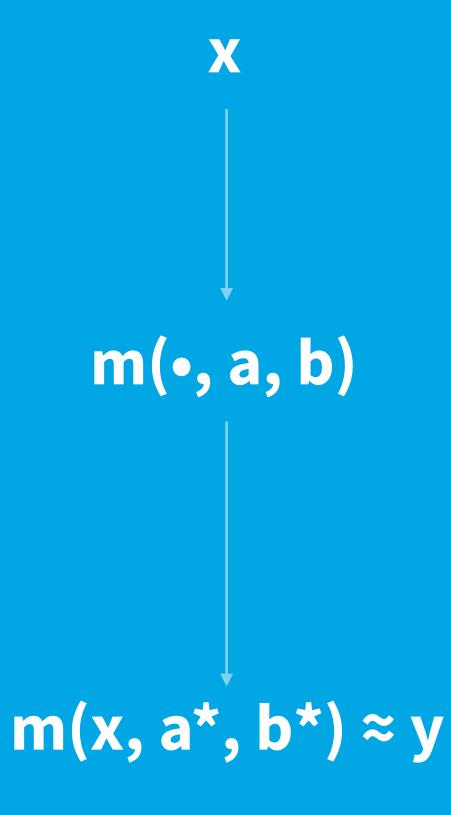
"non-linear, complex, changing"

## Finance History

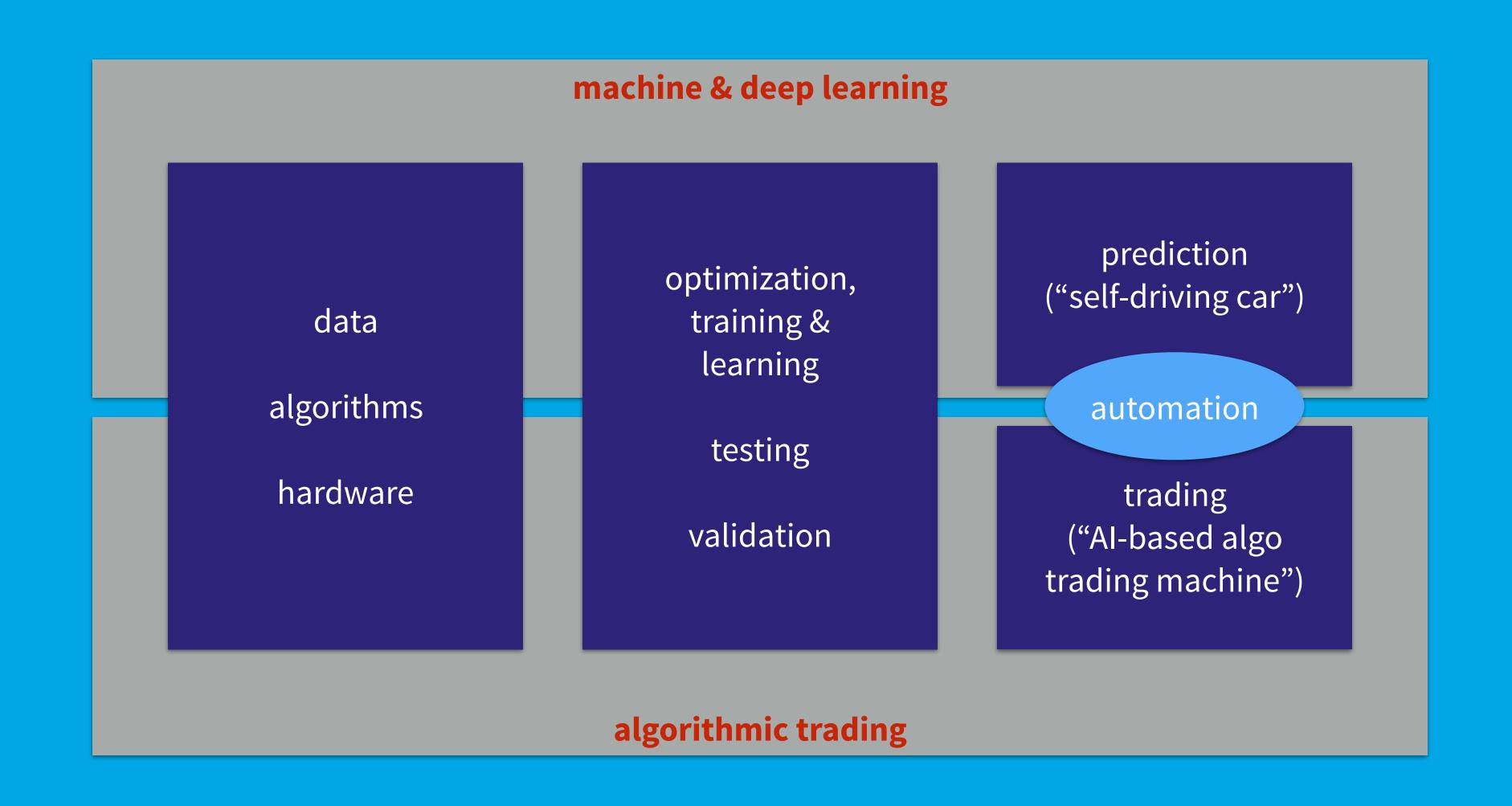


"brain-driven & beauty myth"

## Al in Finance = finaince



"data-driven & Al-first"



**Example Strategy** 

## **STRATEGY IDEA**

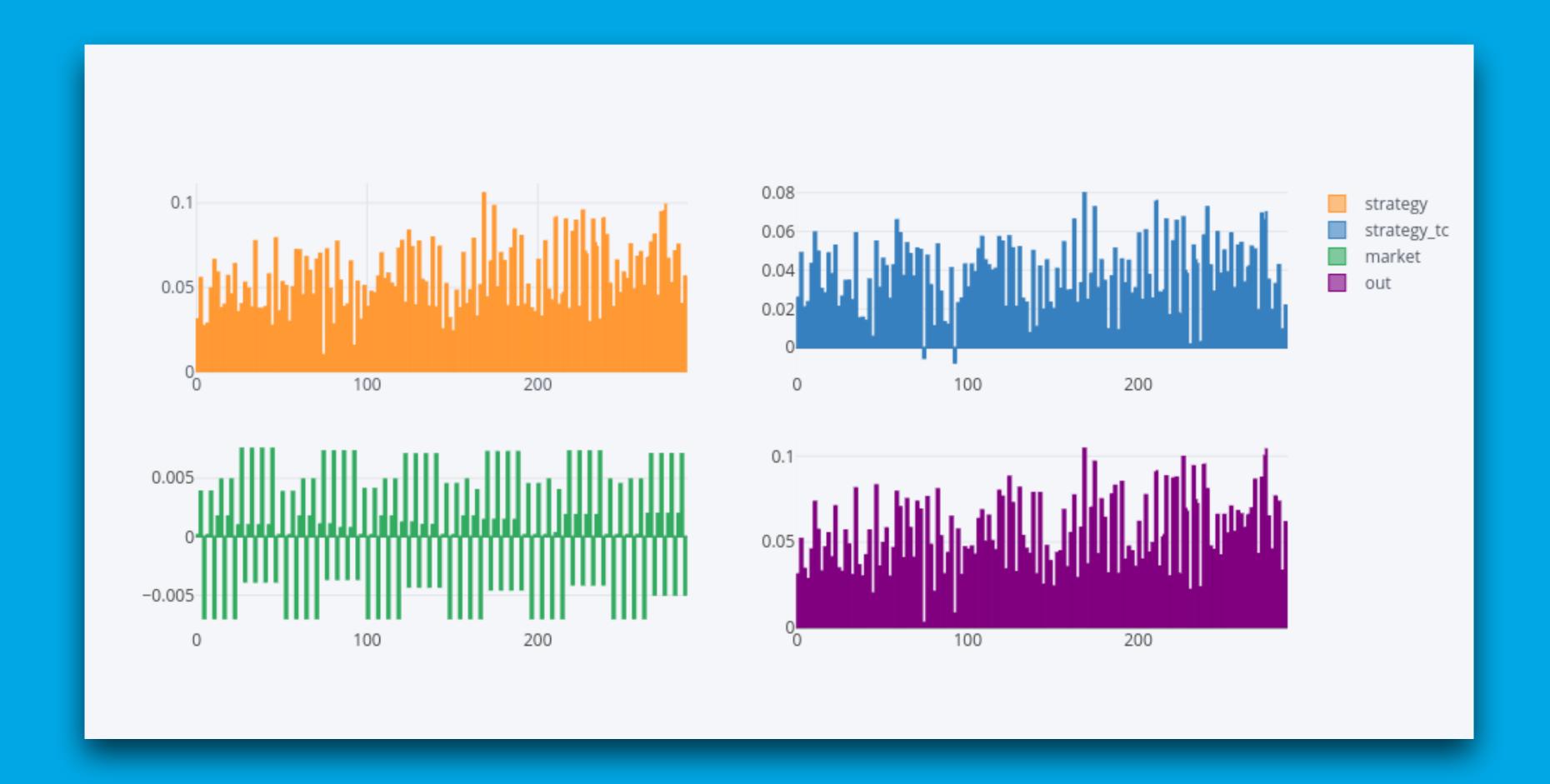
- instruments: single instrument (FX), leveraged
- positions: long and short
- financial data: mid-frequency (5 or 10 mins)
- algorithm: classification (Bayes, LR, LR and similar)
- goal: alpha = outperformance + positive return + low correlation
- robustness: acceptable performance independent of parameters
- programming: Python, NumPy, pandas, scikit-learn



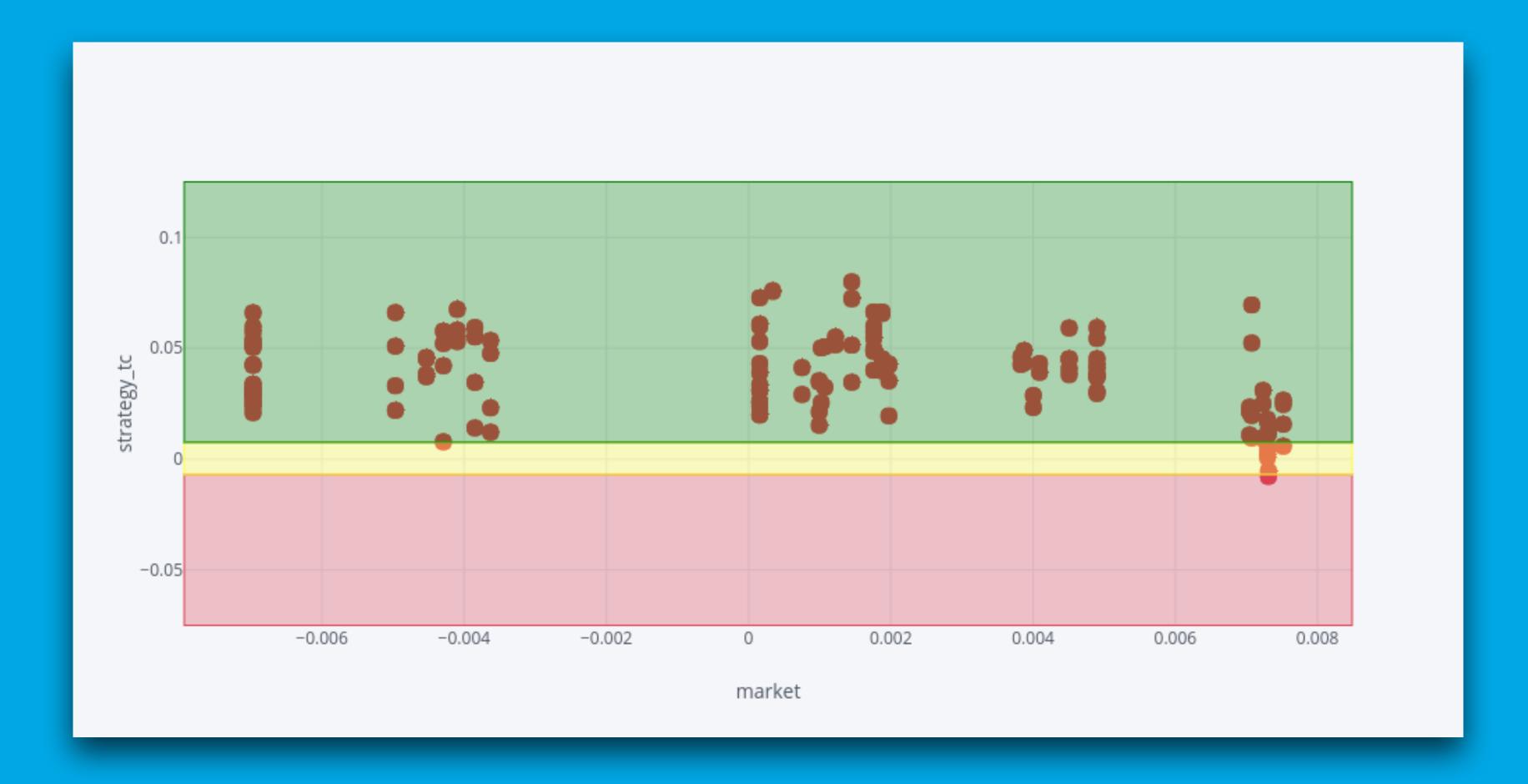
- EUR\_USD, 5min bars
- sequential training/backtest
- 40% to 60% train-test split



- EUR\_USD, 5min bars
- randomized training/backtest
- 40% to 60% train-test split



- EUR\_USD, 10min bars
- randomized training/backtest
- 40% to 60% train-test split
- 288 algorithm configurations



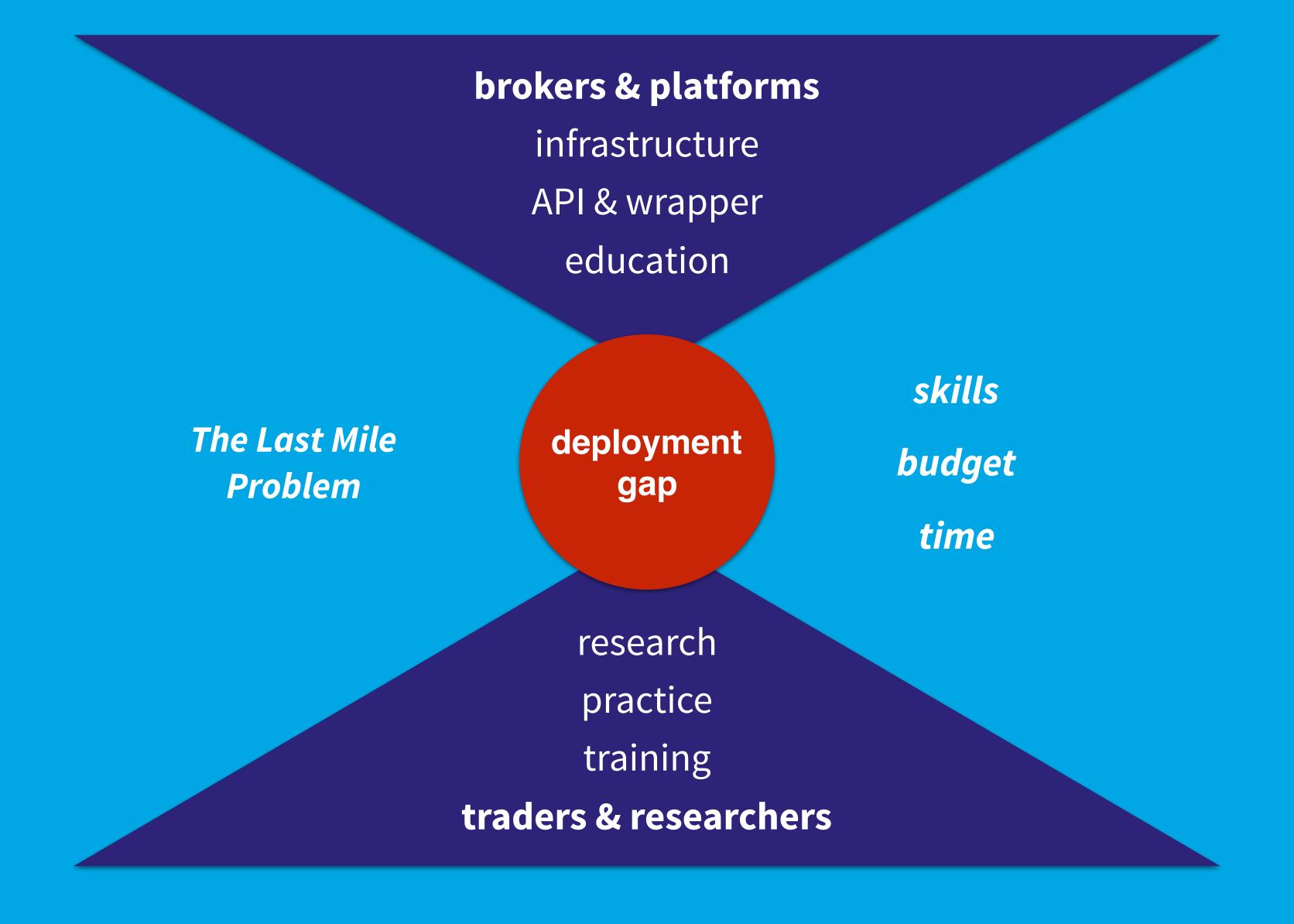
- EUR\_USD, 10min bars
- randomized training/backtest
- 40% to 60% train-test split
- 288 algorithm configurations

The Al Machine

## A bit of background and some general thoughts

- On the way from The Python Quant to The Al Quant ...
- "Do you trade? Do you do algo trading on your own?"
- Many people fail deploying their algo trading ideas
- Walk the talk ... and come up with a proof-of-concept
- Robust, reliable execution as a conditio sine qua non
- Fascination for markets and betting getting direct feedback





## The Al Machine

Tick Data Streamer

(retrieval, processing, storage, etc.)

Signal Generator

(prediction, positions, signals, etc.)

Al-based,

Algorithmic Trading

eamer Strategies

Signal Listener

(signal pick-up, order execution, etc.)

Trade Event Streamer

(order information, stop events, etc.)

Portfolio Monitoring & Risk Management

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

Multiple Trading Plaforms

## brokers & platforms

infrastructure
API & wrapper
education

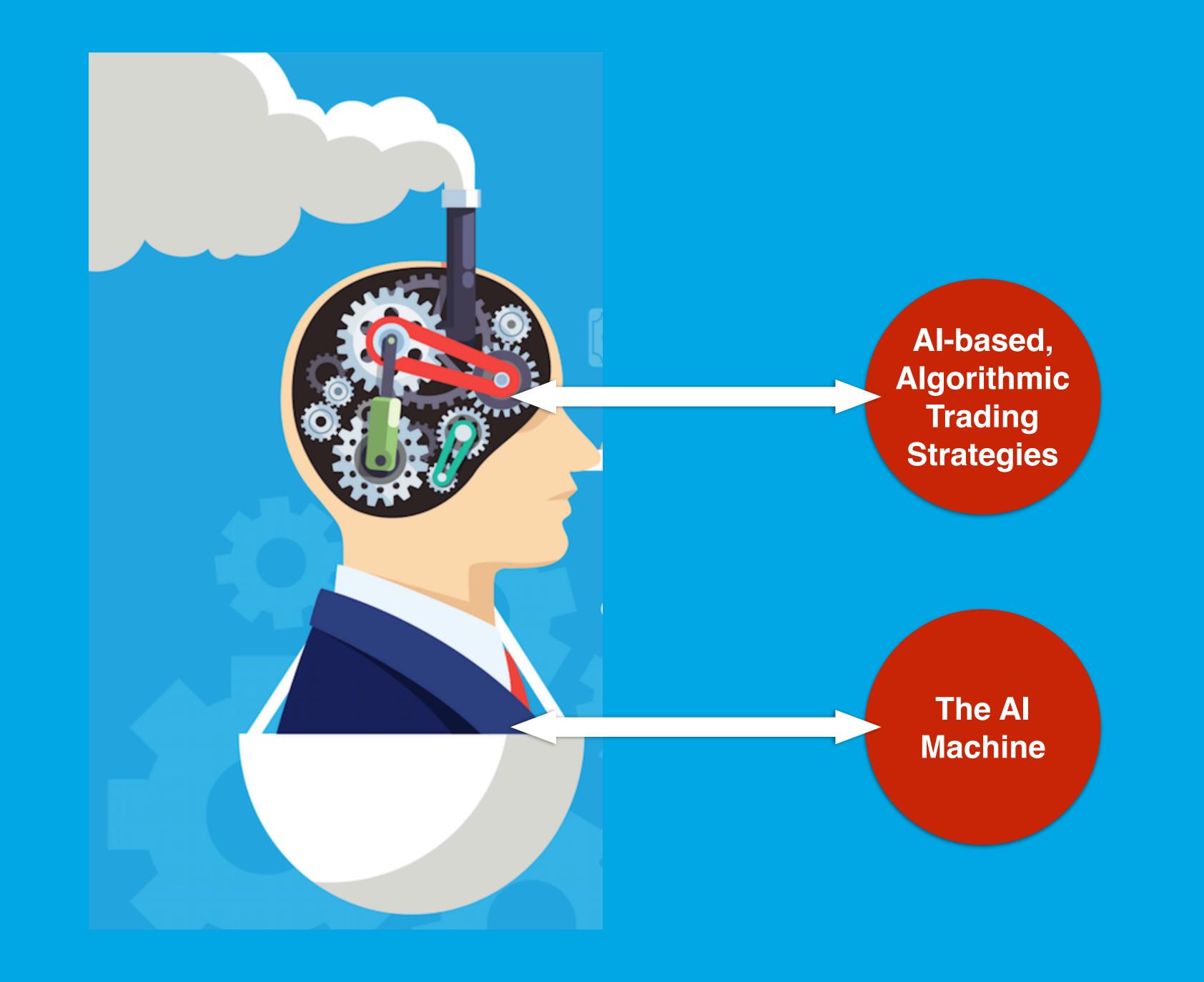
The Machine

deployment

data processing

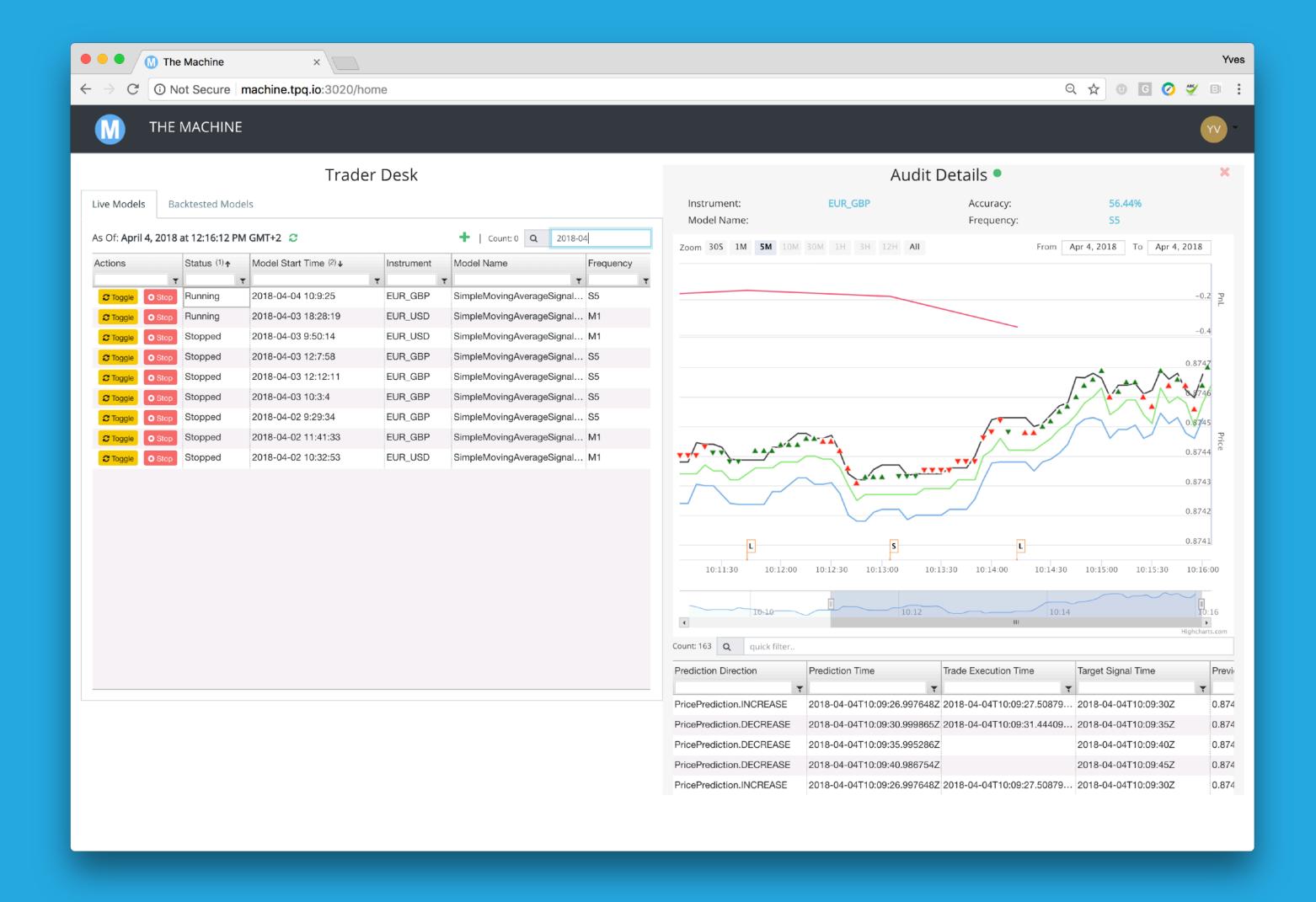
strategy life cycle

research
practice
training
traders & researchers



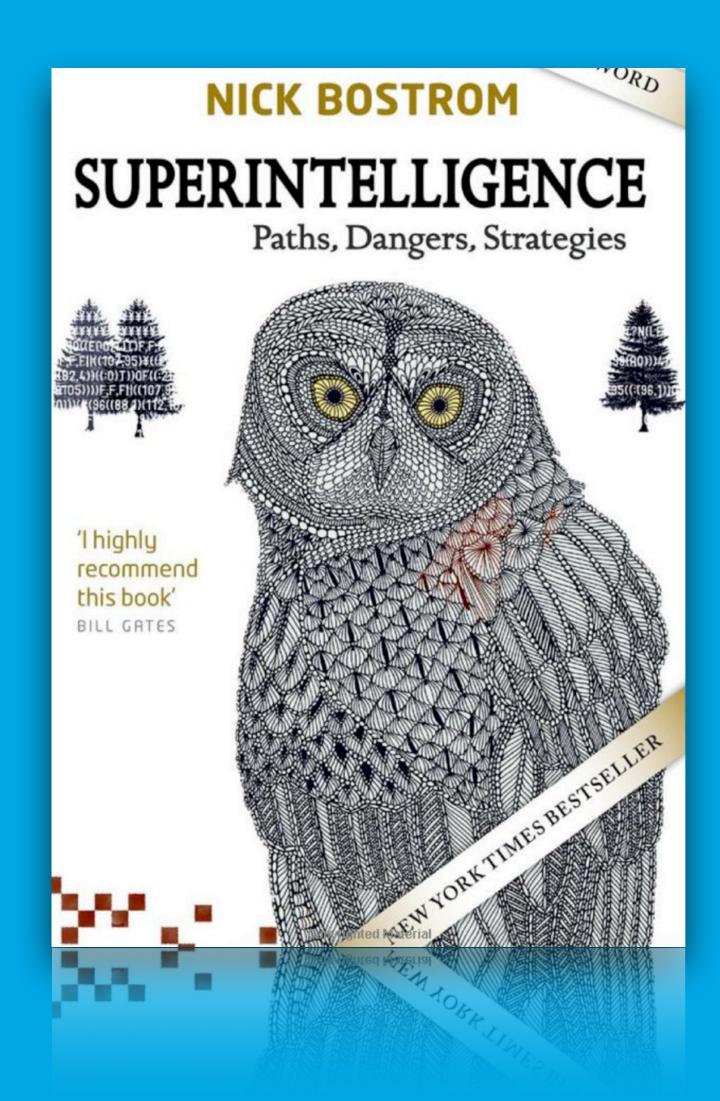
## The Al Machine

standardized deployment of AI-based algorithmic trading strategies



## 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)



"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

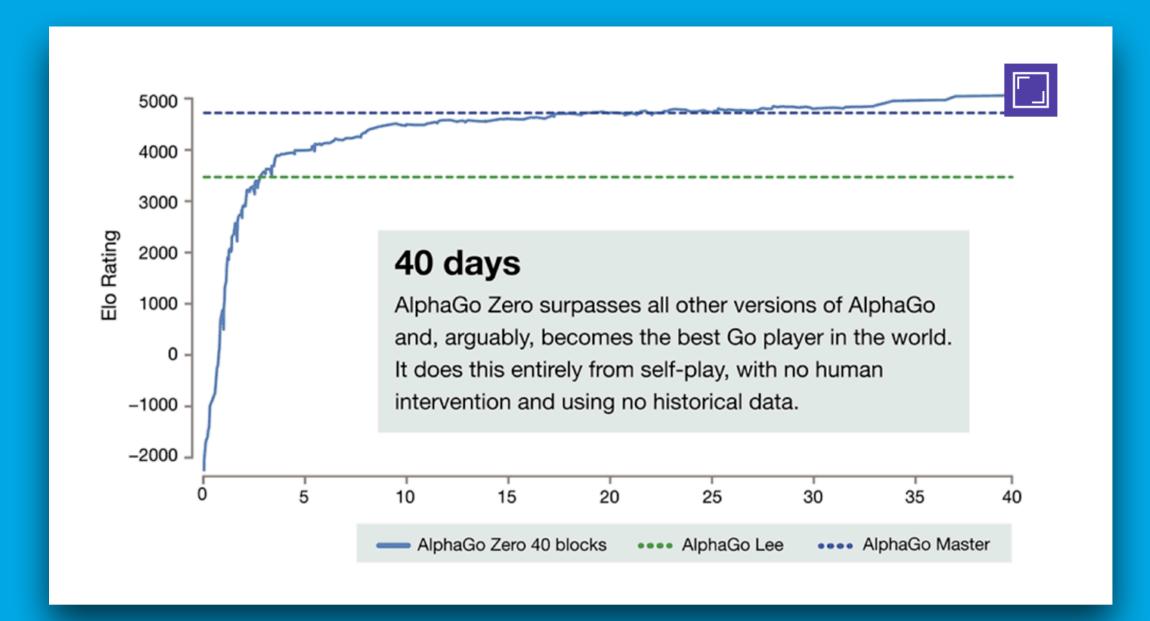
AlphaGo is the first computer program to defeat a professional human Go player, the first program to defeat a Go world champion, and arguably the strongest Go player in history.

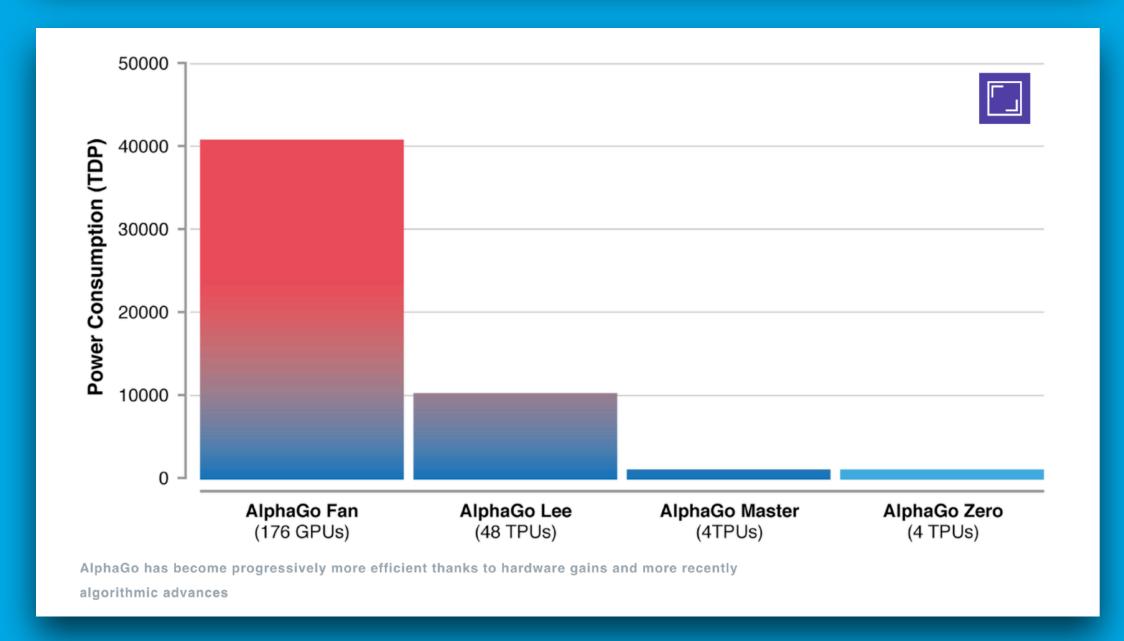
AlphaGo's first formal match was against the reigning 3-times European Champion, Mr Fan Hui, in October 2015. Its 5-0 win was the first ever against a Go professional, and the results were published in full technical detail in the international journal, <a href="Nature">Nature</a>. AlphaGo then went 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 <a href="https://high.nih.google.com/high.line.com/hig

taught the world completely new knowledge about perhaps the most studied and contemplated game in history.







## "Computation Explosion

The power and potential of computation to tackle important problems has never been greater. In the last few years, the cost of computation has continued to plummet. The Pentium IIs we used in the first year of Google performed about 100 million floating point operations per second. The GPUs we use today perform about 20 trillion such operations — a factor of about 200,000 difference — and our very own TPUs are now capable of 180 trillion (180,000,000,000,000) floating point operations per second.

Alphabet Founders' Letter 2017

## **The Python Quants GmbH**

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