

Python for Financial Analytics

— A Glimpse at Data-Driven & AI-First Finance

House of Finance, Goethe Universität

Frankfurt, 24. June 2018

Dr. Yves J. Hilpisch | @dyjh



AGENDA

- **Introduction**
- **The Environment**
- **Data-Driven Finance**
- **AI-First Finance**
- **Practical Python**
- **Outlook**

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



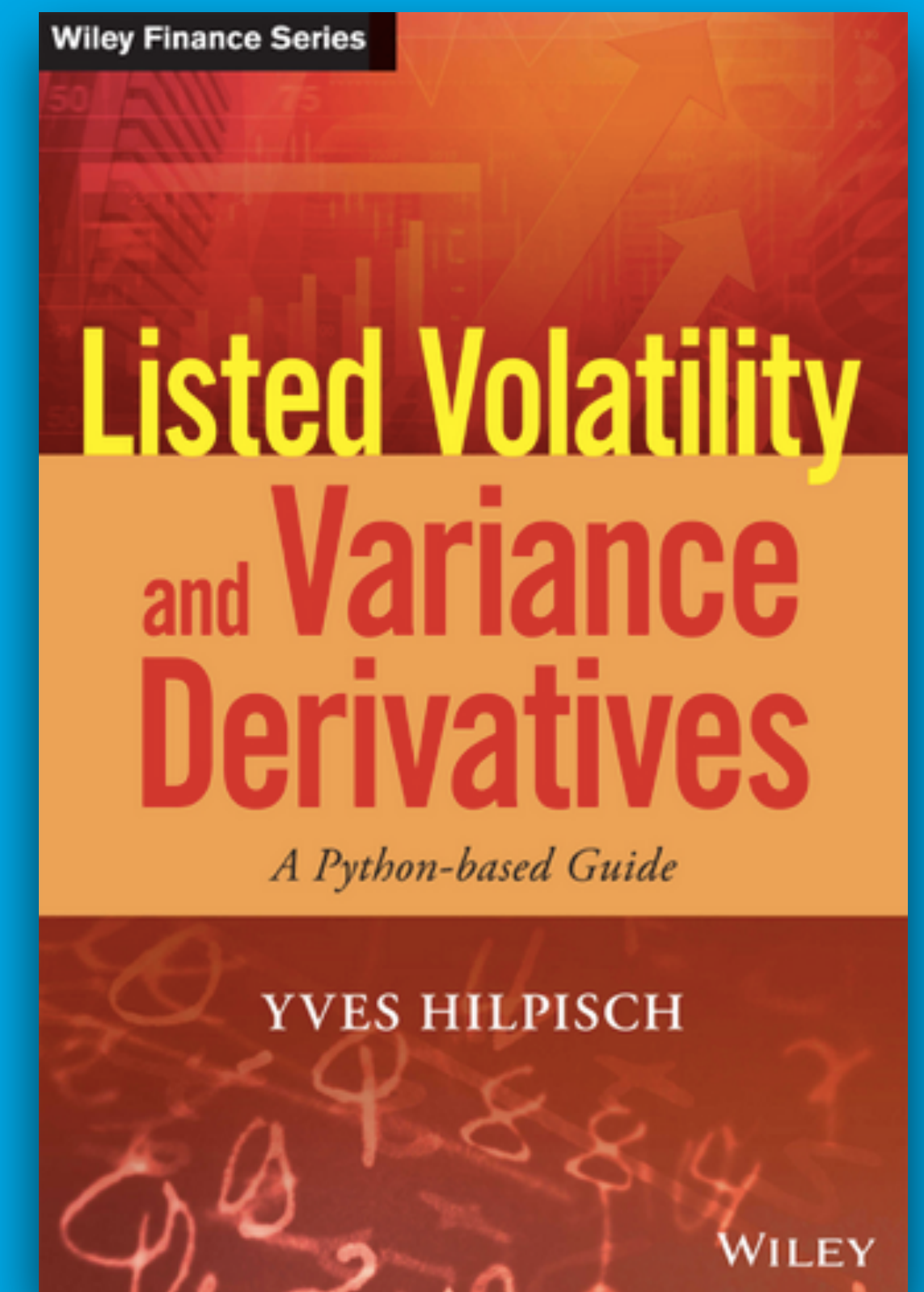
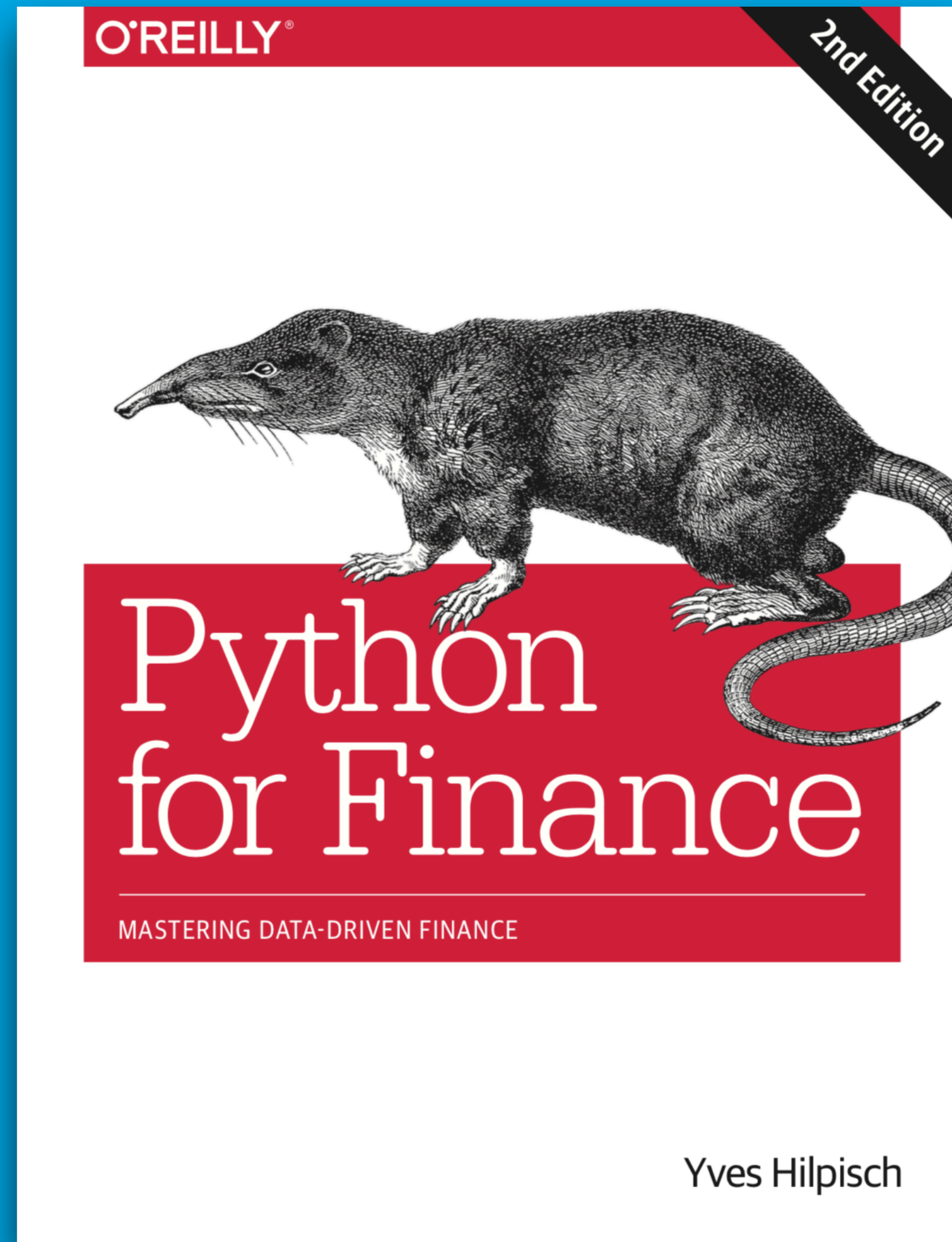
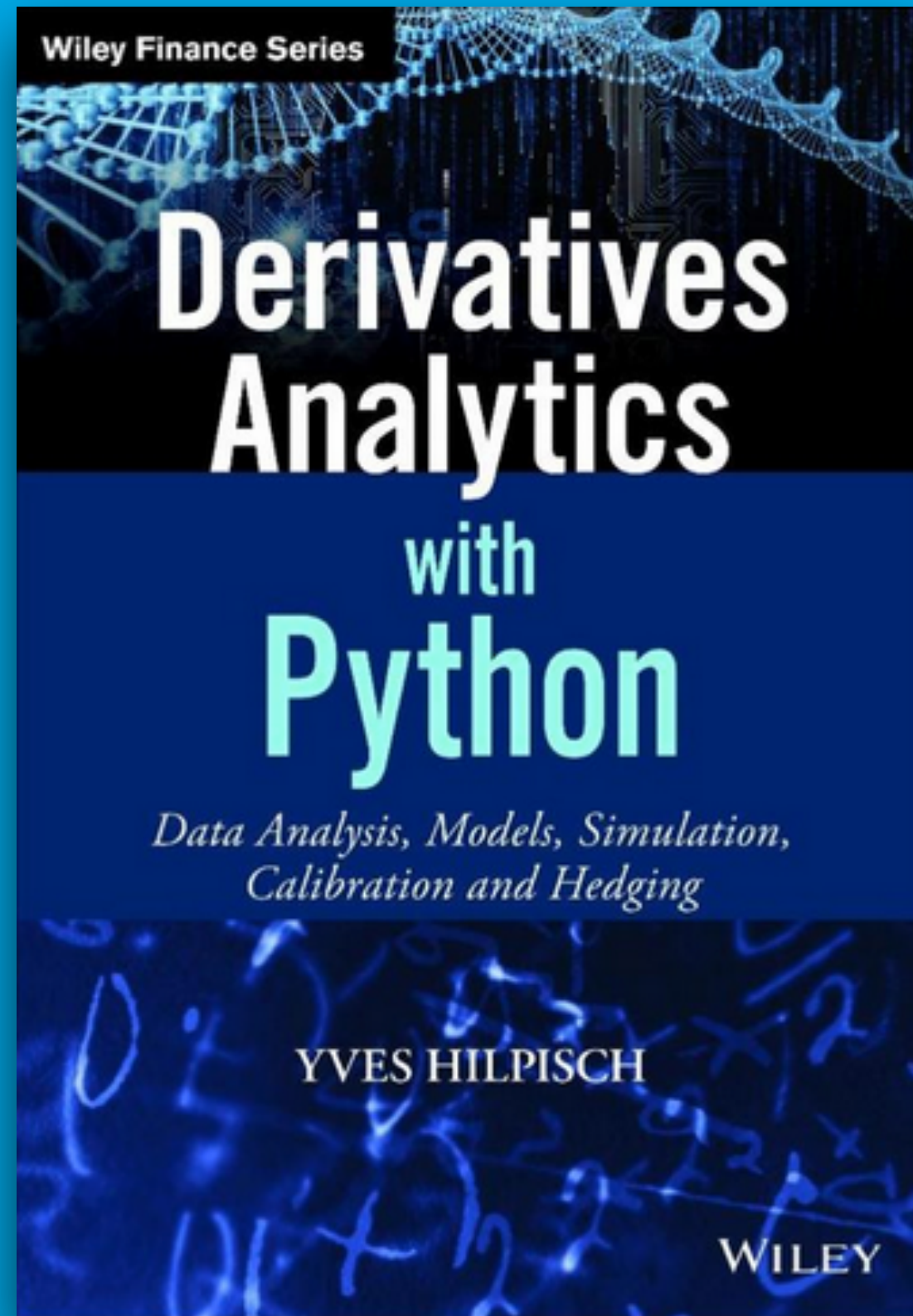
PLATFORM
for browser-based data analytics



OPEN SOURCE
Python library for financial analytics







<http://books.tpq.io>

16 week program

150+ hours
of instruction

PROGRAM DIRECTOR

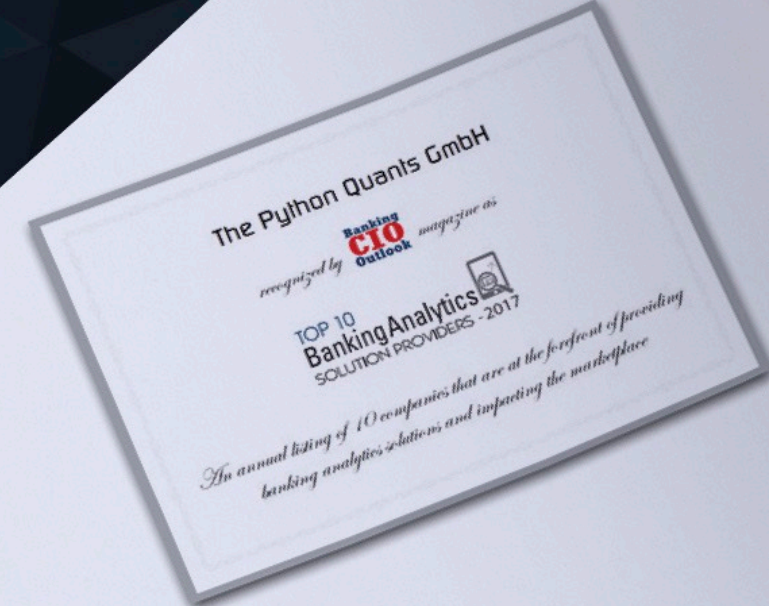
Dr. Yves J. Hilpisch is founder and managing partner of The Python Quants (<http://tpq.io>), a group focusing on the use of open source technologies for financial data science, algorithmic trading and computational finance. He is the author of the books:

- 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**



5,000+ lines
of code

1,200 pages PDF

The Python Quants GmbH
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Germany
T/F +49 3212 112 91 94
<http://training.tpq.io>
training@tpq.io

April 2017

<http://certificate.tpq.io>

The AI Machine

Standardized deployment of AI-based algorithmic trading strategies.

The Machine

Not Secure machine.tpq.io:3020/home

THE MACHINE

Trader Desk

Live Models | Backtested Models

As Of: April 4, 2018 at 12:16:12 PM GMT+2 | Count: 0 | 2018-04

Actions	Status (↑)	Model Start Time (↓)	Instrument	Model Name	Frequency
Toggle Stop	Running	2018-04-04 10:9:25	EUR_GBP	SimpleMovingAverageSignal...	S5
Toggle Stop	Running	2018-04-03 18:28:19	EUR_USD	SimpleMovingAverageSignal...	M1
Toggle Stop	Stopped	2018-04-03 9:50:14	EUR_USD	SimpleMovingAverageSignal...	M1
Toggle Stop	Stopped	2018-04-03 12:7:58	EUR_GBP	SimpleMovingAverageSignal...	S5
Toggle Stop	Stopped	2018-04-03 12:12:11	EUR_GBP	SimpleMovingAverageSignal...	S5
Toggle Stop	Stopped	2018-04-03 10:3:4	EUR_GBP	SimpleMovingAverageSignal...	S5
Toggle Stop	Stopped	2018-04-02 9:29:34	EUR_GBP	SimpleMovingAverageSignal...	S5
Toggle Stop	Stopped	2018-04-02 11:41:33	EUR_GBP	SimpleMovingAverageSignal...	M1
Toggle Stop	Stopped	2018-04-02 10:32:53	EUR_USD	SimpleMovingAverageSignal...	M1

Audit Details

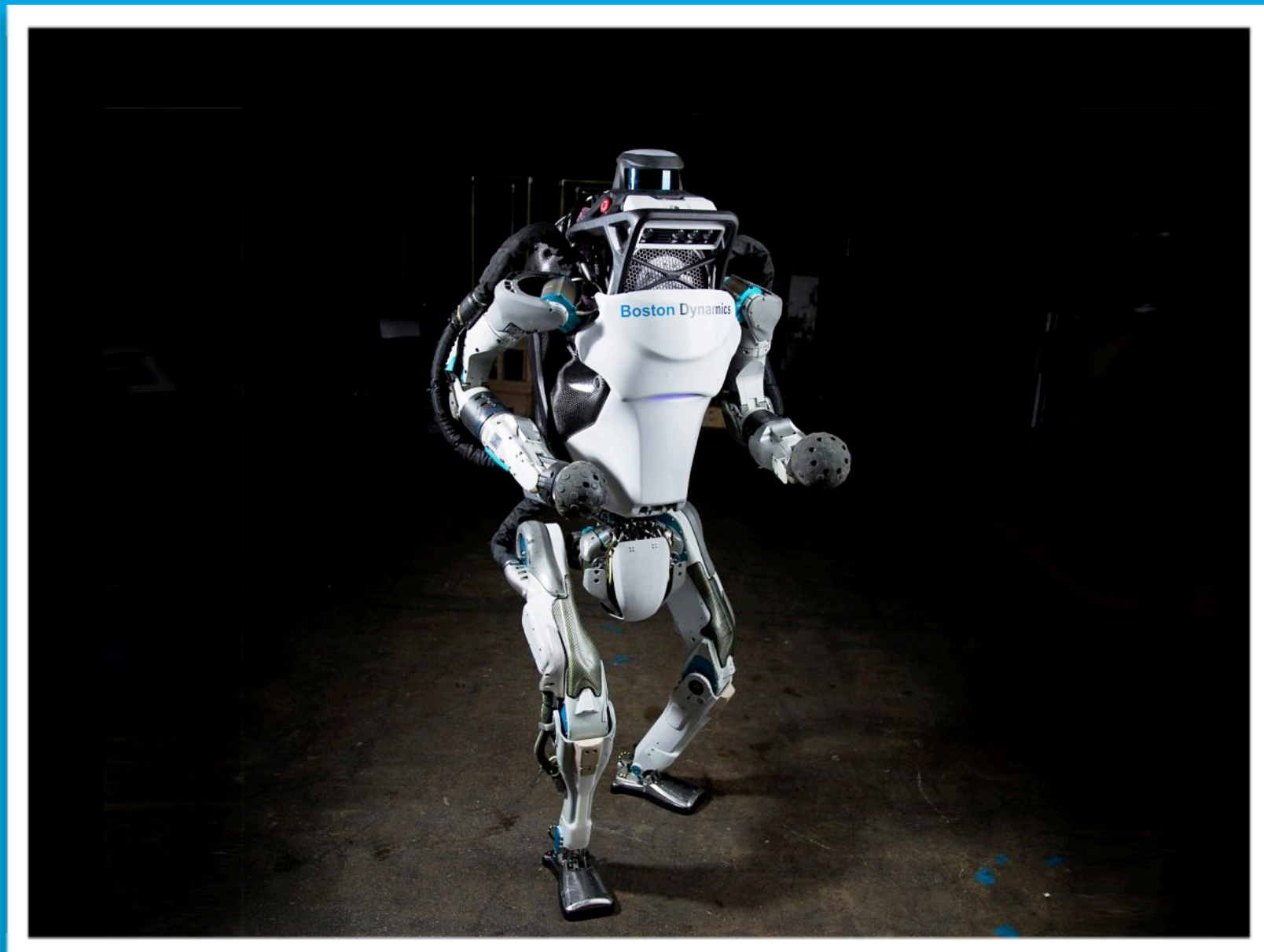
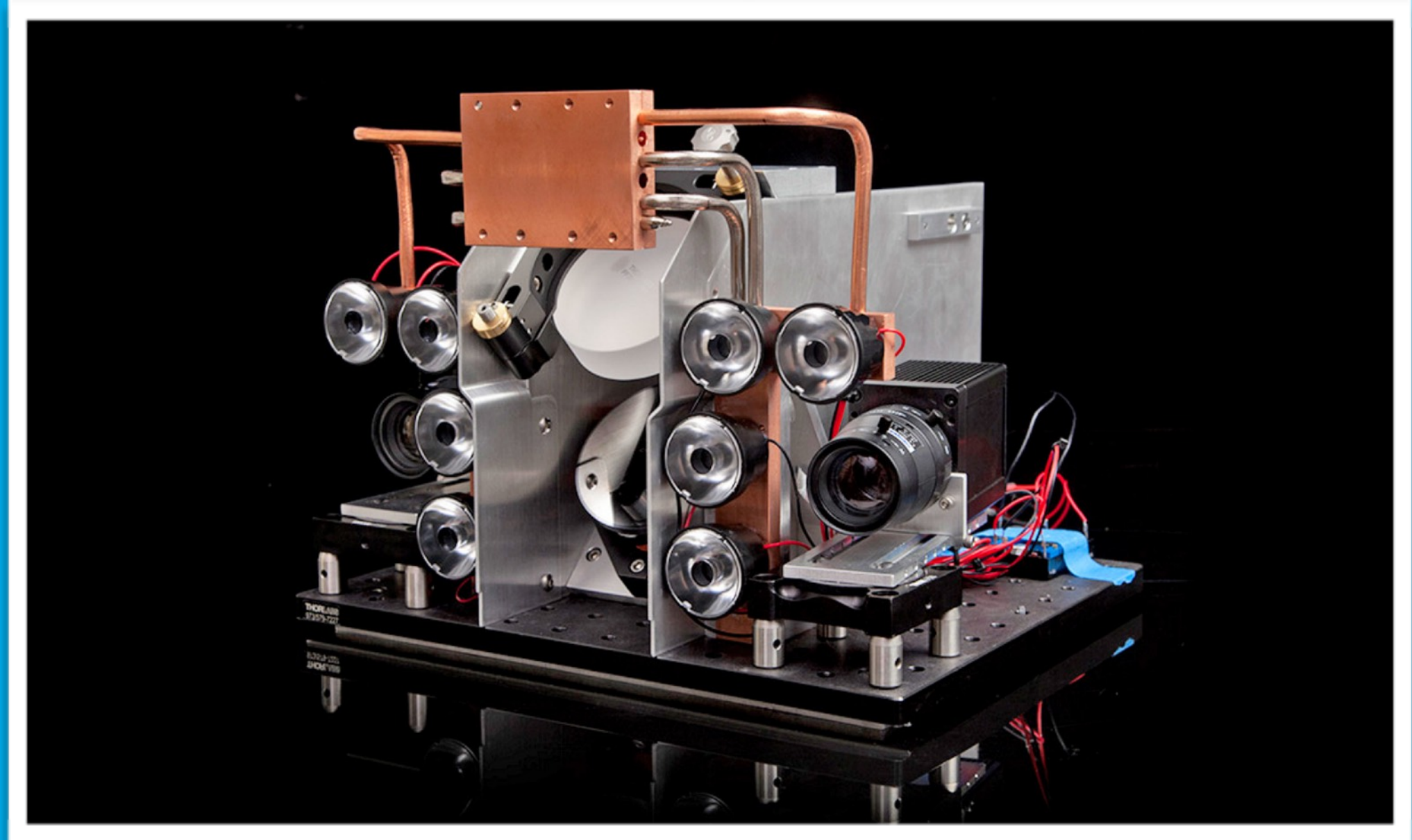
Instrument: EUR_GBP | Accuracy: 56.44%
 Model Name: | Frequency: S5


Zoom: 30S 1M 5M 10M 30M 1H 3H 12H All | From: Apr 4, 2018 | To: Apr 4, 2018

Count: 163 | quick filter..

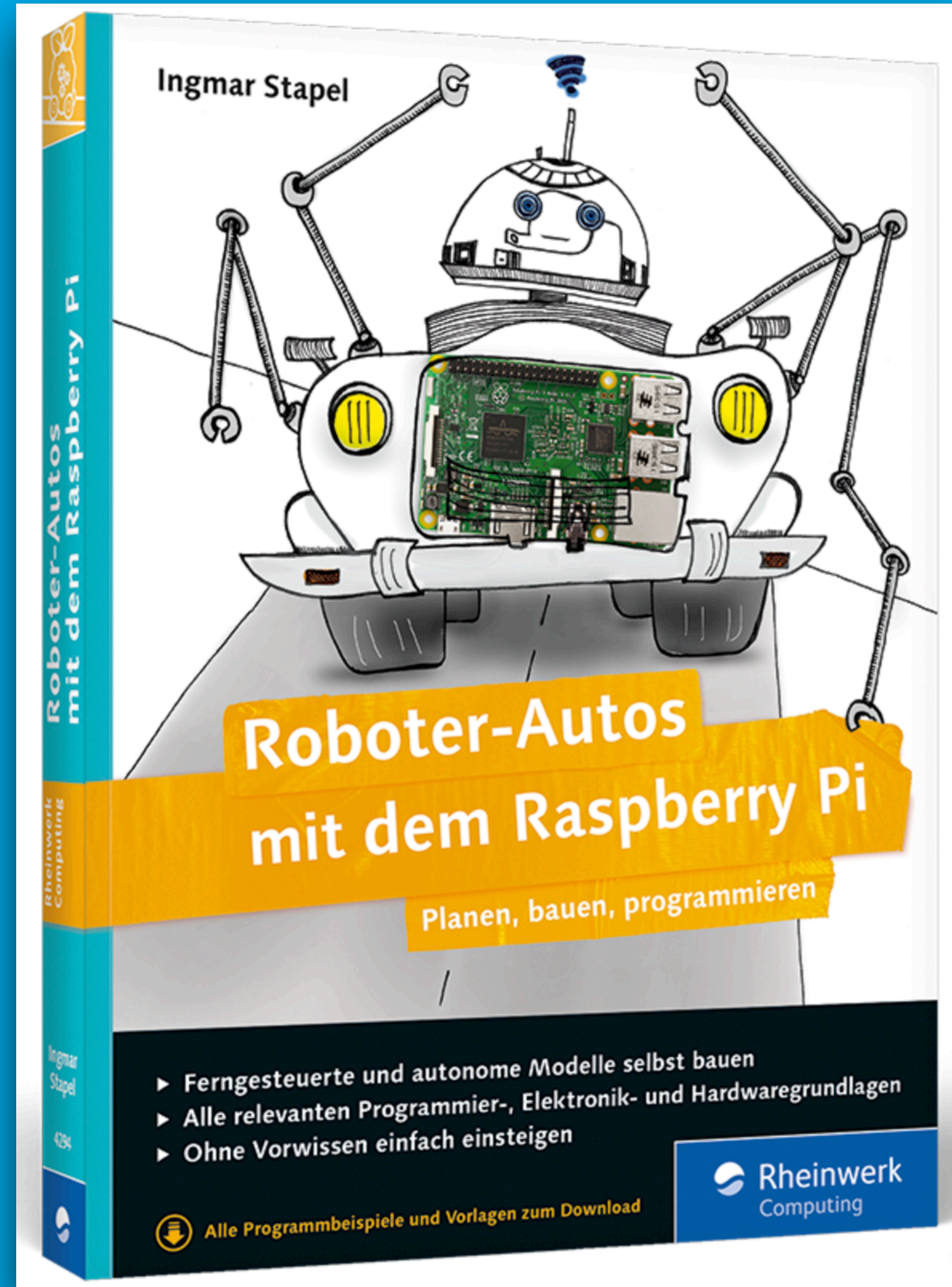
Prediction Direction	Prediction Time	Trade Execution Time	Target Signal Time	Previ
PricePrediction.INCREASE	2018-04-04T10:09:26.997648Z	2018-04-04T10:09:27.50879...	2018-04-04T10:09:30Z	0.874
PricePrediction.DECREASE	2018-04-04T10:09:30.999865Z	2018-04-04T10:09:31.44409...	2018-04-04T10:09:35Z	0.874
PricePrediction.DECREASE	2018-04-04T10:09:35.995286Z		2018-04-04T10:09:40Z	0.874
PricePrediction.DECREASE	2018-04-04T10:09:40.986754Z		2018-04-04T10:09:45Z	0.874
PricePrediction.INCREASE	2018-04-04T10:09:26.997648Z	2018-04-04T10:09:27.50879...	2018-04-04T10:09:30Z	0.874

The Environment





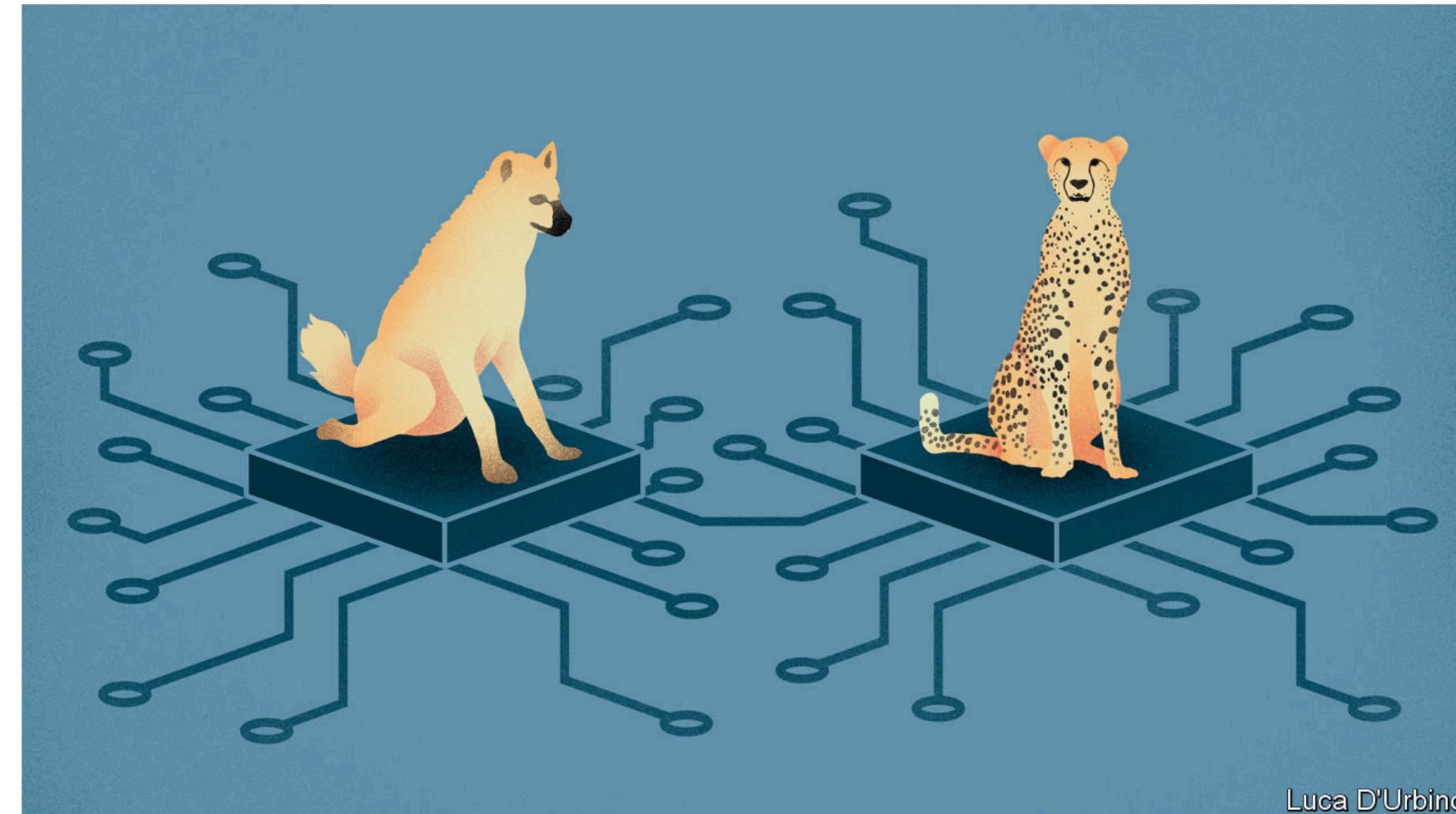
TensorFlow



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



Luca D'Urbino

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.



Saeed
@saeedamenfx

Following



we ingest 1.5m articles a day at @Bloomberg
- Gary Kazantsev talking about machine
readable news #ImperialCollege

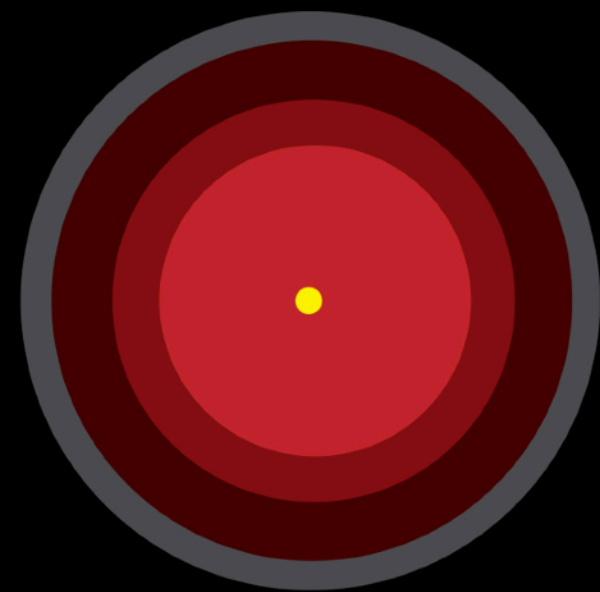


9:53 AM - 31 May 2018

9:53 AM - 31 May 2018

THE TECHNOLOGICAL SINGULARITY

MURRAY SHANAHAN



THE MIT PRESS ESSENTIAL KNOWLEDGE SERIES

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)

Data-Driven Finance

FINANCIAL TIMES

TUESDAY 3 OCTOBER 2013

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

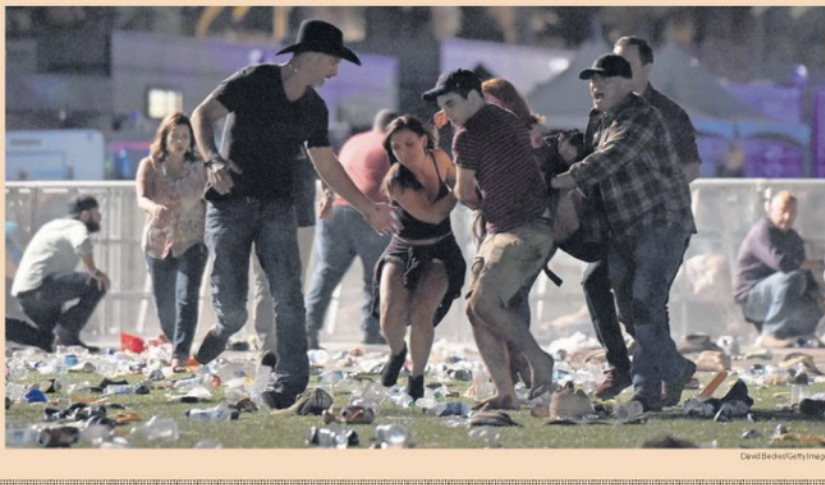
The myths that hold back women in Indian society — AMY KAZMIN, PAGE 10



Las Vegas reels from worst US mass shooting

A casualty is carried from the scene after a gunman opened fire on concertgoers in Las Vegas on Sunday night. More than 50 people were killed and over 125 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.



Dead bodies lie on the ground after the shooting in Las Vegas.

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
BAR MOUR — GIBRALTAR

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

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.



Carles Puigdemont, the Catalan president, is leaving the door open to a unilateral declaration of independence.

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

CLIVE COOKSON — SCIENCE EDITOR

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

World Markets

STOCK MARKETS	Oct 2	Oct 1	Change
S&P 500	2,922.04	2,915.36	+6.68
Nasdaq Composite	4,441.42	4,426.16	+15.26
Dow Jones Ind	2,940.23	2,935.09	+5.14
FTSE 100	6,150.00	6,140.00	+10.00
Nikkei 225	12,100.00	12,050.00	+50.00
Hong Kong	20,000.00	19,950.00	+50.00
Shanghai	3,000.00	2,980.00	+20.00

Briefing

- **Puerto Rico calls for billions in aid** Raül Maldonado Gaubert, 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 an attempt to revoke the ride-hailing app's licence in the capital. — PAGE 13
- **Koike 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 this month 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 Raila Odinga, 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 14

Datawatch



US manufacturing activity as measured by the Purchasing Managers' Index rose in September from a year earlier.



A Celebrity Selfie Machine

PLUS Secondhand Stress at Work

THE WALL STREET JOURNAL

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

What's News

House and Senate negotiators in a rare bipartisan act, announced a budget agreement Thursday designed to avert another economy-rattling government shutdown and to bring a decade of deficit-cutting measures over a five-year period.

Deal Brings Stability to U.S. Budget

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

By JAMES HOOK

House and Senate negotiators in a rare bipartisan act, announced a budget agreement Thursday designed to avert another economy-rattling government shutdown and to bring a decade of deficit-cutting measures over a five-year period.

Revenues to fund the higher spending would come from changes to federal employee and military pension programs, and higher fees for airline passengers, among other sources. An extension of long-term jobless benefits wasn't included.

The plan is modest in scope, compared with past budget deals and to one-year amendments in Congress to craft a "grand bargain" to restructure the tax code and federal entitlement programs. But in a year and an institution characterized by gridlock, lawmakers were relieved they could reach even a minimal agreement.

"In divided government, you don't always get what you want," said Mr. Ryan. Ms. Murray joined him in welcoming the prospect that lawmakers would steer away from a crisis-driven budget process. "We have lurched from crisis to crisis, from one cliff to the next," she 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 \$1.05 trillion. Please turn to page A8

Thousands Honor Memory of South Africa's Liberator



REST IN PEACE: A boy attended the memorial service for former South African President Nelson Mandela at a soccer stadium in Johannesburg on Tuesday that drew celebrities and dozens of heads of state, including President Obama, along with thousands of other mourners. A12

Longtime Insider Is GM's First Female CEO

By JOY BENNETT AND SARA MURRAY

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 become the first woman to run a major global auto maker. The 51-year-old joined GM 23 years ago as a college intern, eventually becoming an engineering manager before running one of its big U.S. assembly plants. She got global experience managing human resources and, more recently, the company's world-wide product development group.

She will become the 22nd woman currently running a Fortune 500 company. Please turn to page A10

China Spins New Lesson From Soviet Fall

By JENNIFER PAGE

BELLING—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 a graphic footage of unrest in China's northern neighbor in the 1990s, set to ominous music punctuated by Russian communist leaders meeting their nation's fate.

Bank Rule Challenges Wall Street

By JUSTIN BARR AND ANNA STEINBERG

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

Here's Your Holiday Bonus, Now Start Running

By RACHEL FEINSTEIN

On Thursday, Alan Conley will get the holiday gift he never knew he always wanted: two minutes at a Texas Costco.

Brussels calls for battery development consortium

Report • PAGE 4

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Ukrainian Forces Confront Protesters




Government security forces cracked down on protesters in Kiev hours after U.S. and EU diplomats called for a nonviolent resolution. A13

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AAPLO ▼ **APPLE INC** ▼  **CAM 79** **CCR 90** SUMMARY **SOV**

United States | NASDAQ Global Select Consolidated | Computer Hardware

Overview News & Research Price & Charts Estimates Financials Events Ownership Debt & Credit Peers & Valuation Derivatives Filings 360 Menu

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	
-----	------------------------------------	---

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	--



AAPLO 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

AI-First Finance

MARCOS LOPEZ DE PRADO

ADVANCES
in
FINANCIAL
MACHINE
LEARNING

WILEY

“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)

Bullish patterns (going up)



Flag



Pennant



Cup with handle



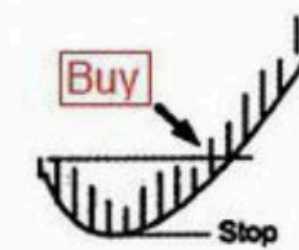
Ascending triangle



Symmetrical triangle



Measured move up



Ascending scallop



3 rising valleys

Bearish patterns (going down)



Flag



Pennant



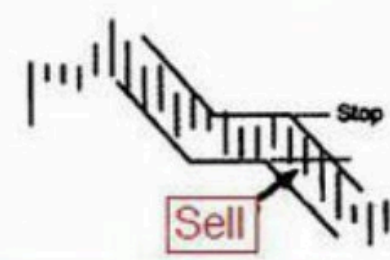
Inverted Cup with handle



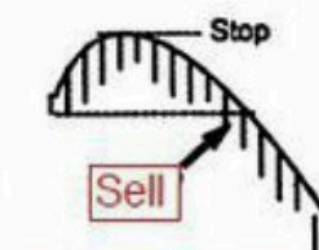
Descending triangle



Symmetrical triangle



Measured move down



Descending scallop



3 descending peaks

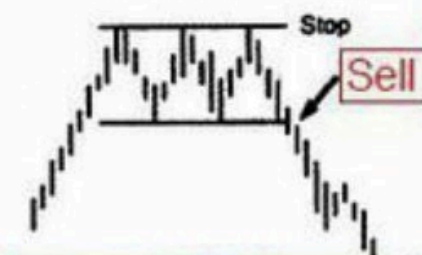
Reversal patterns



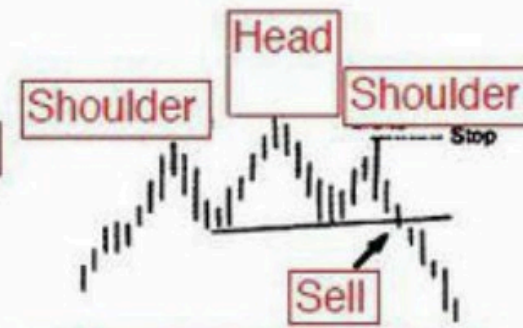
Double bottoms



Diamond bottoms



Tops rectangle



Head and shoulders top

Financial Markets



x

y

“non-linear, complex, changing”

Finance History



$f(\cdot)$

$f(x) \neq y$

“brain-driven & beauty myth”

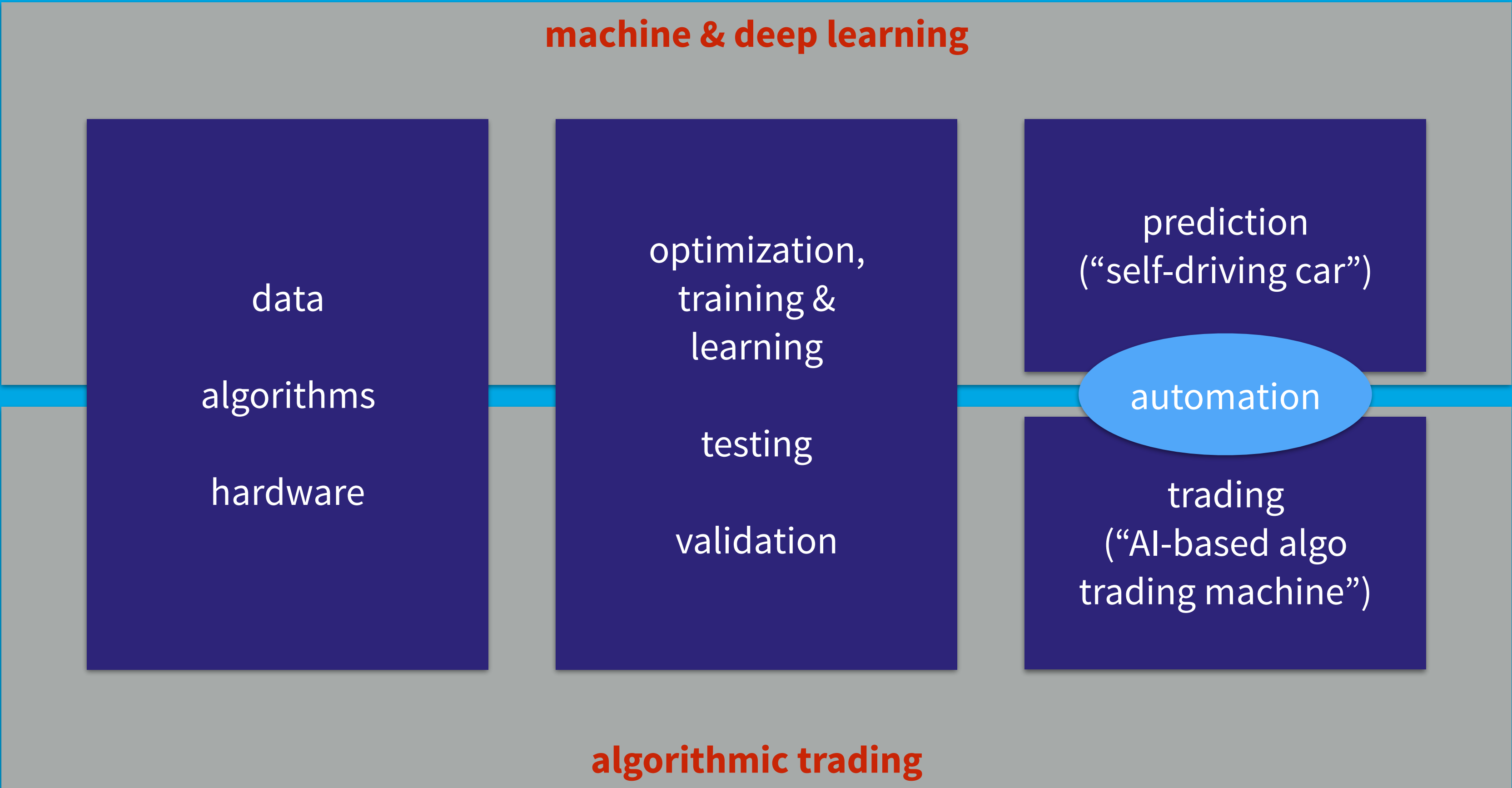
AI in Finance = finance

x

$m(\cdot, a, b)$

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

“data-driven & AI-first”



Practical Python

Link to Gist

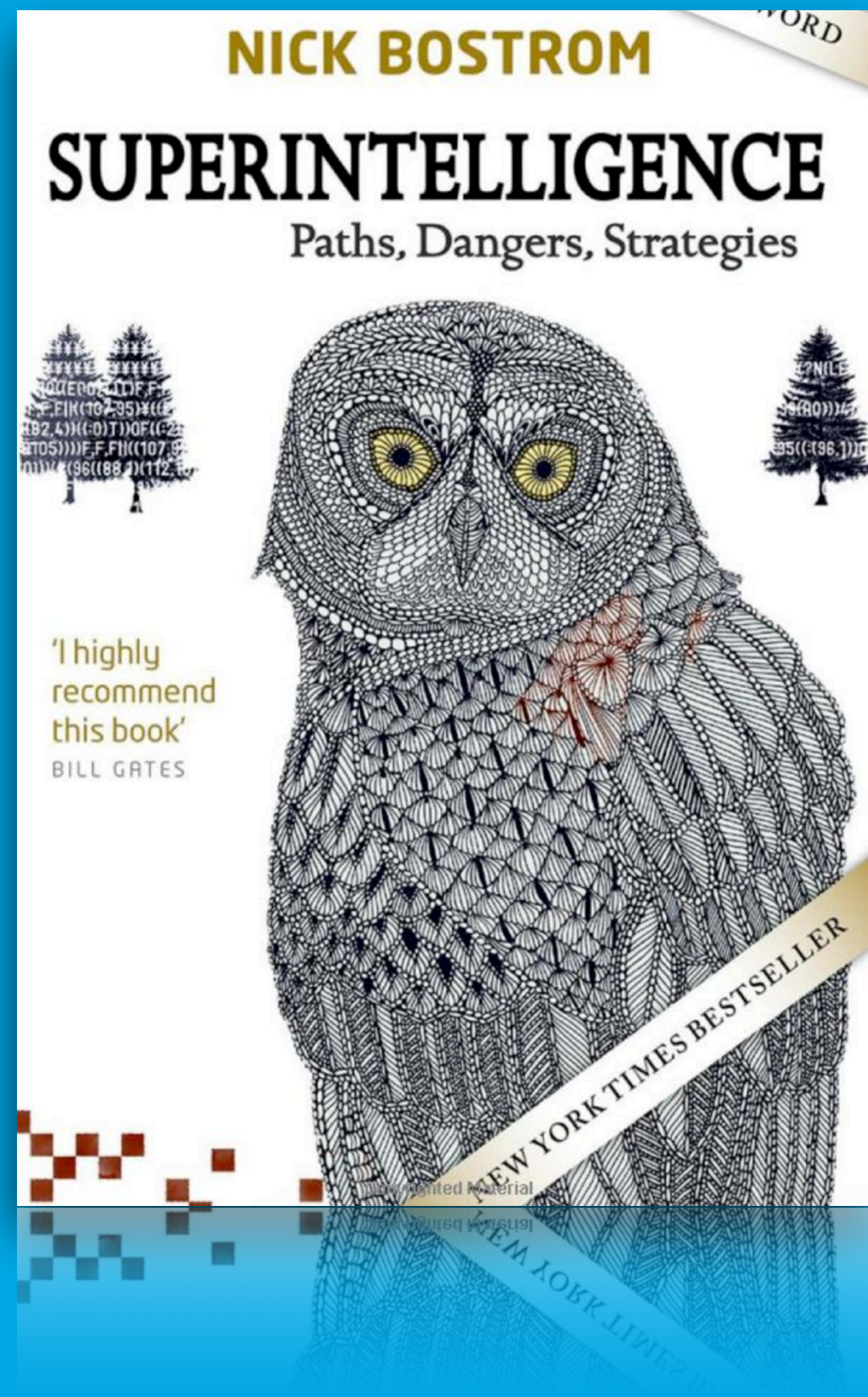
http://bit.ly/ffm_workshop

USE CASES

- **Random Walk Hypothesis Revisited**
- **Mean Variance Portfolio Theory**
- **Machine Learning for Stock Market Prediction**

**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.

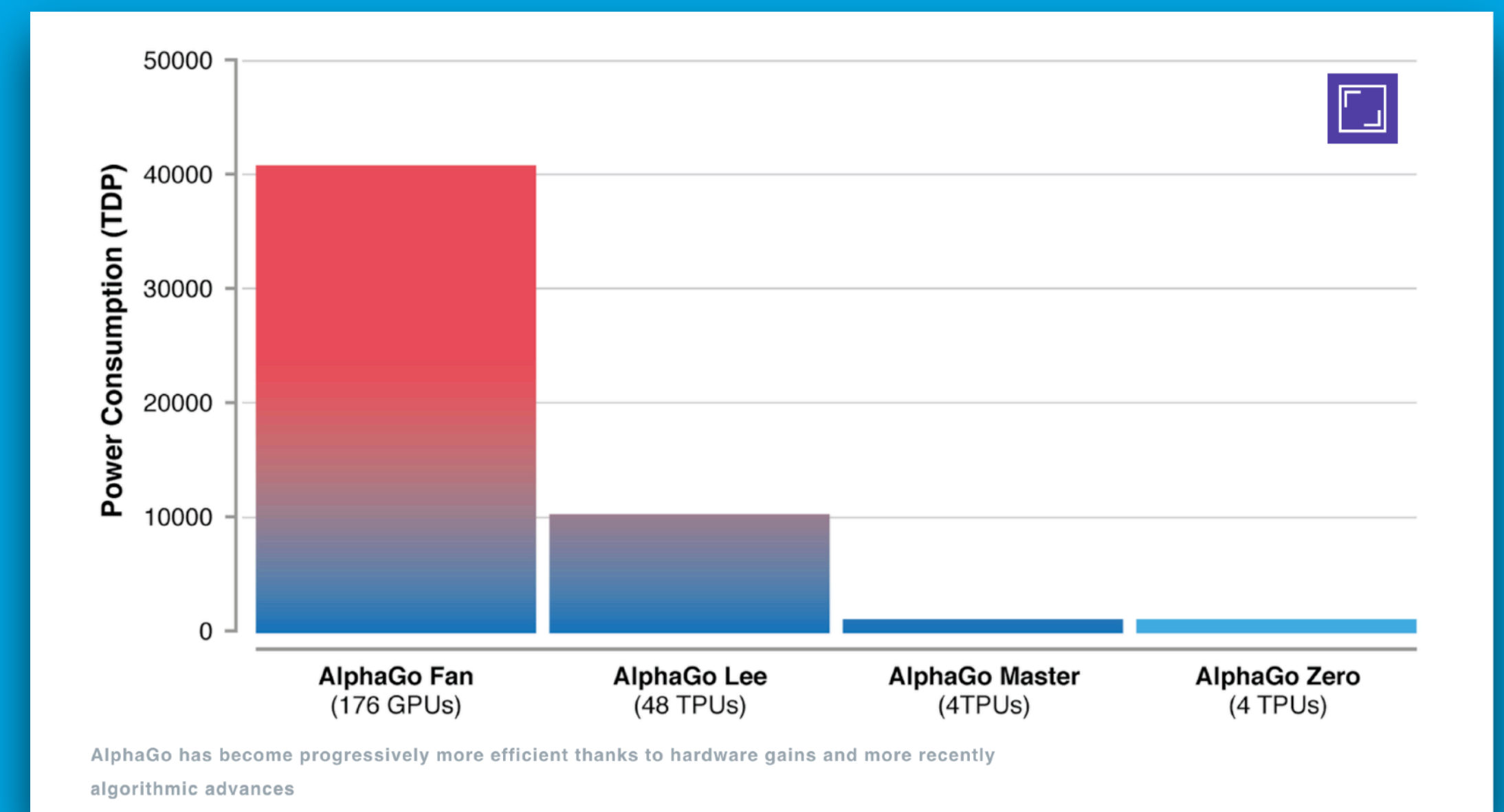
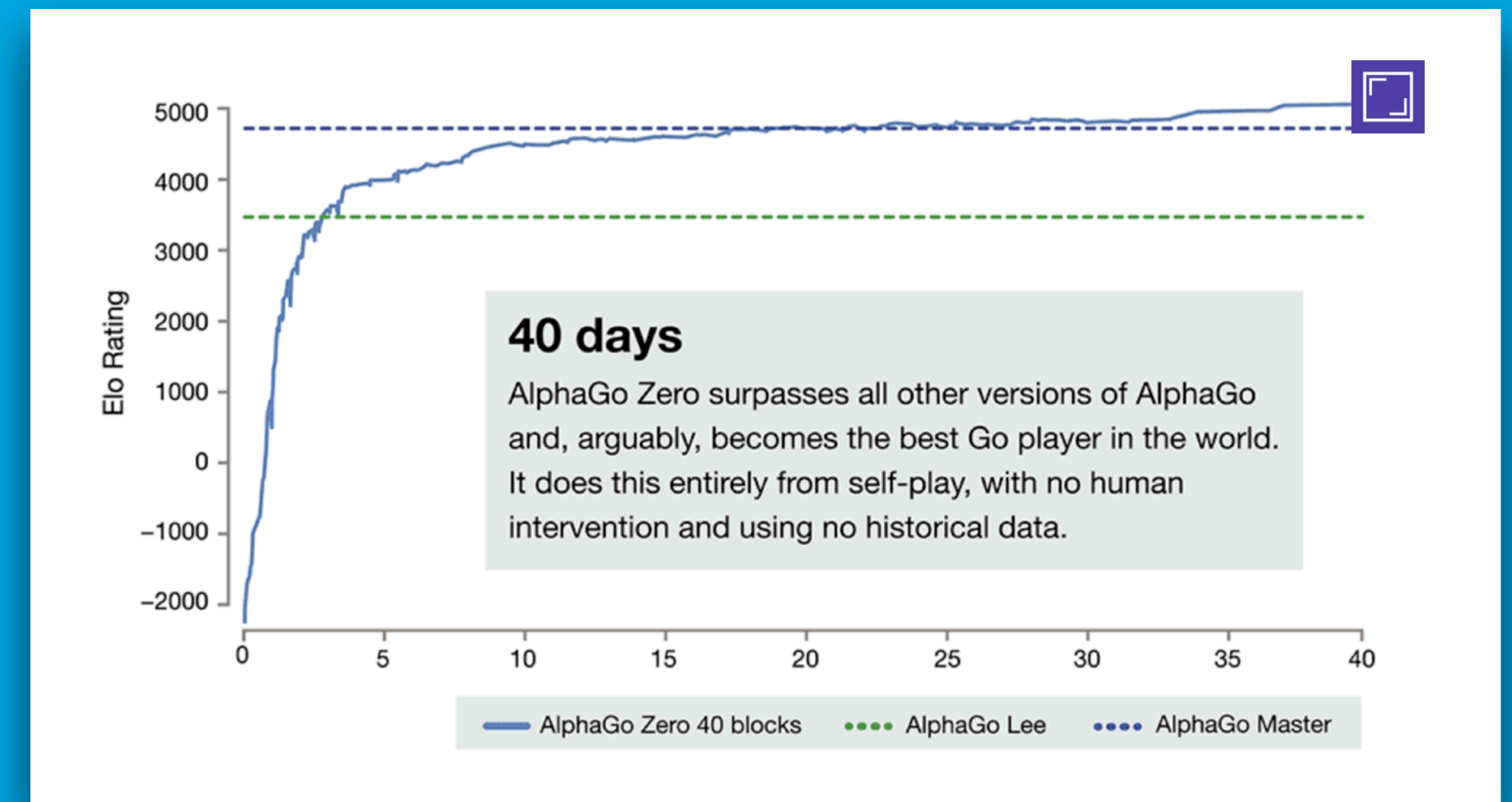
AlphaGo's first formal match was against the reigning 3-times European Champion, Mr Fan Hui, in October 2015. Its 5-0 win was the first ever against a Go professional, and the results were published in full technical detail in the international journal, [Nature](#). AlphaGo then went on to compete against 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 game in history.



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

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