AI-Powered Algorithmic Trading

Dr. Yves J. Hilpisch

Refinitiv Developer Day

“Data is the new oil.”

“Software is eating the world.”

“Data and AI are eating finance.”

The Group

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Wanted: Finance graduates with AI and programming skills

Quant funds are crying out for tech skills, and schools are responding with specialist courses

Looking ahead: Pierre Foret © Magali Delporte

The AI Machine

http://aimachine.io

THE PYTHON QUANTS

recognized by Capital Markets CIO Outlook *magazine as*

TOP 10
ALGO TRADING
SOLUTION PROVIDERS - 2019

An annual listing of 10 companies that are at the forefront of providing Algo Trading solutions

http://certificate.tpq.io/tpq_top_algo_2019.pdf

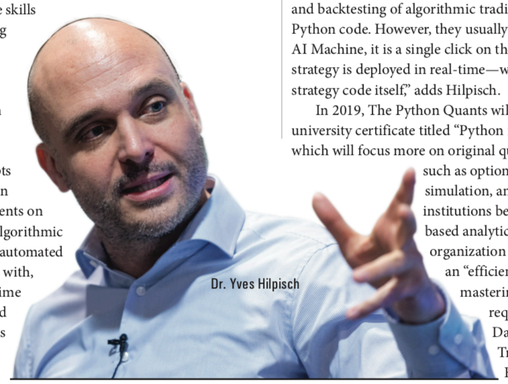
The Python Quants

First University Certificate in Python for Algorithmic Trading

Python programming has become a key skill in the financial industry. In areas such as financial data science, computational finance or algorithmic trading, Python has established itself as the primary technological platform. At the same time, the level of Python sophistication the industry is expecting from its employees and applicants is increasing steadily. The Python Quants Group is one of the leading providers of Python for Finance training programs.

Among others, The Python Quants have tailored a comprehensive online training program leading to the first University Certificate in Python for Algorithmic Trading. Be it an ambitious student with intrigue for algorithmic trading, or a major financial institution, The Python Quants, through this systematic training program, is equipping delegates with requisite skills and tools to formulate, backtest and deploy algorithmic trading strategies based on Python.

The topics covered in the training programs offered by The Python Quants are generally not found in the typical curriculum of financial engineering or quantitative finance Master programs. Dr. Yves Hilpisch, the firm's founder and managing partner, explains, "There are courses out there that show students how to apply machine learning for the formulation and backtesting of algorithmic trading strategies. However, none of them explains the difficulties or the skills required in deploying such algorithmic trading strategies in the real world. Besides providing an introductory course that teaches Python and financial concepts from scratch, we train our delegates and clients on how best to deploy algorithmic trading strategies in automated fashion in the cloud, with, among others, real-time risk management and monitoring," explains Hilpisch, an author of three books on the topic, with "Python for Finance" (2nd ed., O'Reilly) being the standard reference in the field.


Dr. Yves Hilpisch

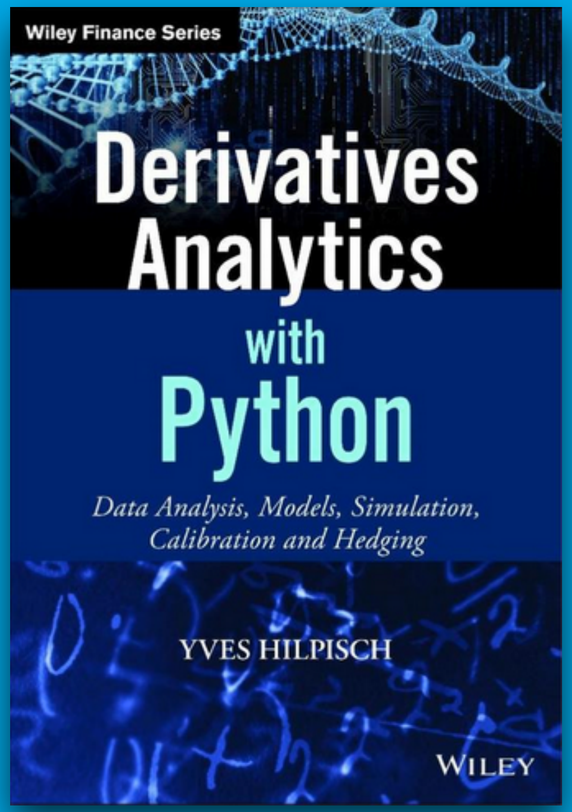
The organization's "Python for Algorithmic Trading University Certificate" consists of 200 hours of instruction, 1,200 pages of documentation and 1,000s of lines of Python code. In addition to offering both online and offline Python training, Hilpisch and his team also organize bespoke training events for financial institutions, hedge funds, banks, and asset management companies. "Most of the training is online since we have students and delegates from about 65 different countries in general. Most recently, we noticed that it's not just financial firms and students who want to deepen their algorithmic trading knowledge, but even professors of finance who want to get more involved in this popular topic," says Hilpisch.

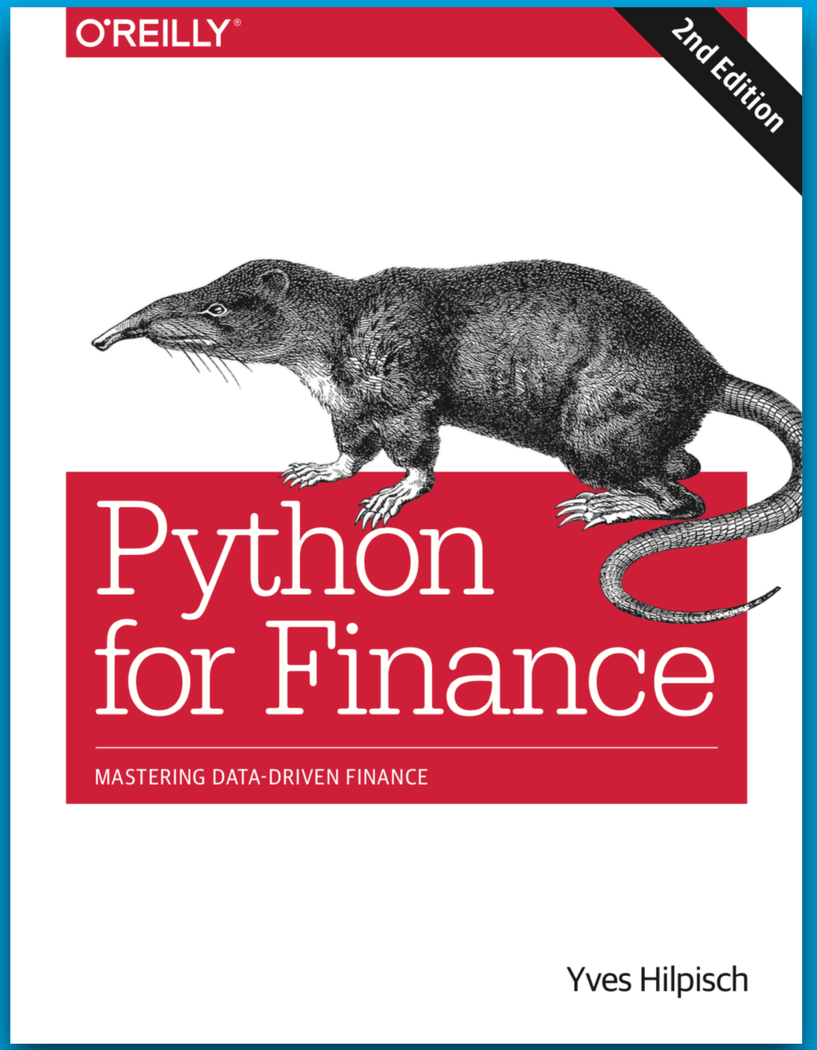
While the Quant Platform is the most popular choice, especially for users in the financial sector who don't have access to a full-fledged, interactive, financial analytics environment, the team at The Python Quants is currently developing The AI Machine—a new platform which leverages artificial intelligence to formulate and deploy algorithmic trading strategies in a standardized manner. Hilpisch explains that it's relatively easy to write Python code for an algorithmic trading strategy, but the same can't be said about the deployment of such a strategy. "There are a few platforms out there that allow the formulation and backtesting of algorithmic trading strategies by the use of Python code. However, they usually stop exactly there. With The AI Machine, it is a single click on the 'GO LIVE' button and the strategy is deployed in real-time—without any changes to the strategy code itself," adds Hilpisch.

In 2019, The Python Quants will be introducing a new university certificate titled "Python for Computational Finance," which will focus more on original quantitative finance topics, such as option pricing, Monte Carlo simulation, and hedging. As financial institutions begin to perceive Python-based analytics as a prerequisite skill, the organization will continue to provide an "efficient and structured way of mastering all the tools and skills required in Python for Financial Data Science, Algorithmic Trading, and Computational Finance."CM

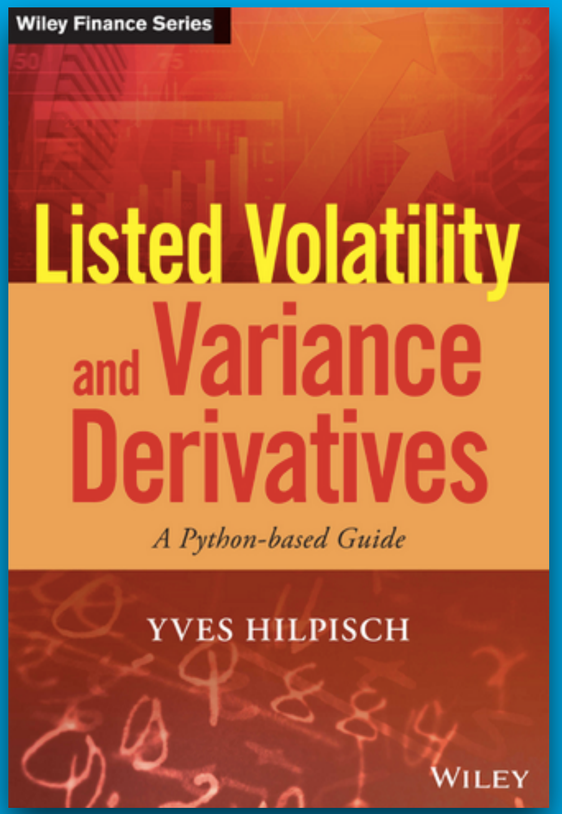
About Myself

http://hilpisch.com





NEW book project:
Artificial Intelligence in Finance
— A Python-based Guide



http://books.tpq.io

Meetup

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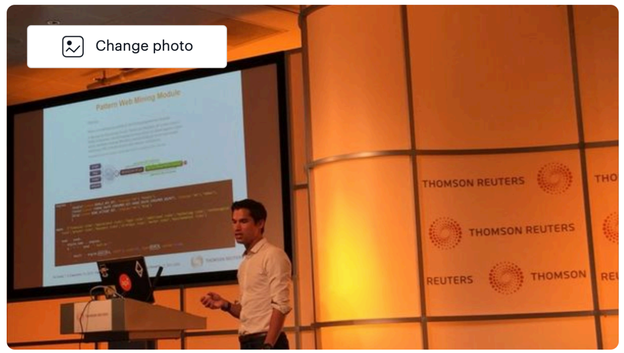

Python for Quant Finance

London, United Kingdom
2,817 members · Public group
Organized by **Yves Hilpisch** and **2 others**

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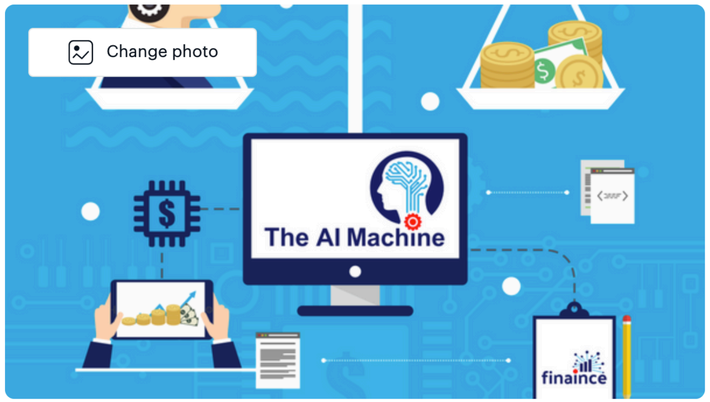
What we're about

This group is about the use of Python for Quantitative Financial Applications and Interactive Financial Analytics.

Organizers

Yves Hilpisch an
Message



Artificial Intelligence in Finance & Algorithmic Trading

New York, NY
345 members · Public group
Organized by **Yves Hilpisch**

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What we're about

This Meetup group is concerned with data-driven and AI-first finance in general and algorithmic trading in particular. Its events cover the latest...

Organizer

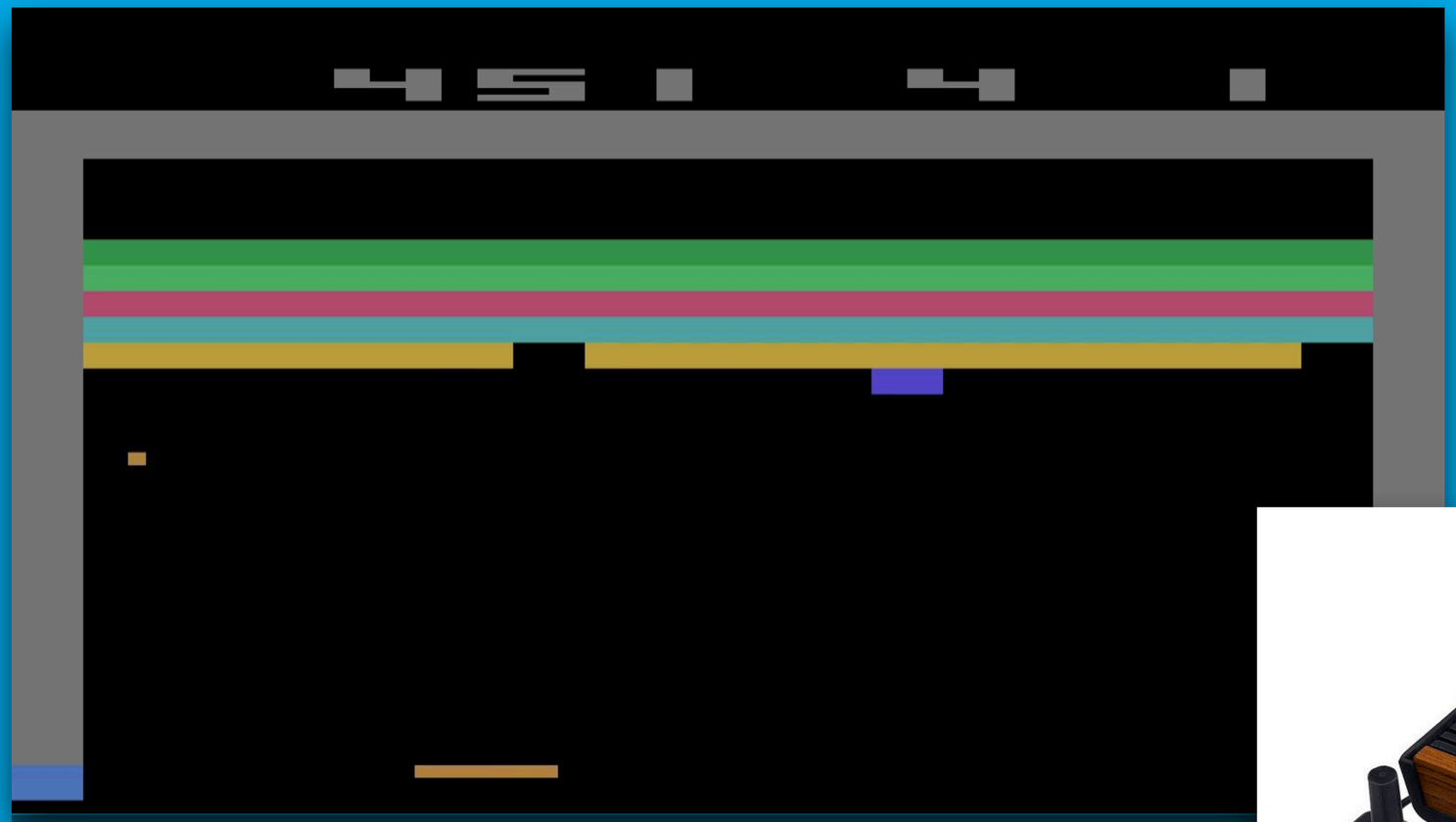
Yves Hilpisch
Message

AI-Powered Algorithmic Trading

1. AI Success Stories
2. The Beauty Myth
3. Data-Driven Finance
4. Efficient Markets
5. AI-First Finance
6. Deep Learning
7. The AI Machine
8. Conclusions

AI Success Stories

AI Success Stories —Atari Games and Reinforcement Learning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“We present the first deep learning model to successfully learn control policies directly from high-dimensional sensory input using reinforcement learning. The model is a convolutional neural network, trained with a variant of Q-learning, whose input is raw pixels and whose output is a value function estimating future rewards. We apply our method to seven Atari 2600 games from the Arcade Learning Environment, with no adjustment of the architecture or learning algorithm. We find that it outperforms all previous approaches on six of the games and surpasses a human expert on three of them.”

Mnih, V. (2013): “Playing Atari with Deep Reinforcement Learning”. https://arxiv.org/pdf/1312.5602v1.pdf

arXiv:1312.5602v1 [cs.LG] 19 Dec 2013

Playing Atari with Deep Reinforcement Learning

Volodymyr Mnih **Koray Kavukcuoglu** **David Silver** **Alex Graves** **Ioannis Antonoglou**
Daan Wierstra **Martin Riedmiller**
DeepMind Technologies
{vlad,koray,david,alex.graves,ioannis,daan,martin.riedmiller} @ deepmind.com

Abstract

We present the first deep learning model to successfully learn control policies directly from high-dimensional sensory input using reinforcement learning. The model is a convolutional neural network, trained with a variant of Q-learning, whose input is raw pixels and whose output is a value function estimating future rewards. We apply our method to seven Atari 2600 games from the Arcade Learning Environment, with no adjustment of the architecture or learning algorithm. We find that it outperforms all previous approaches on six of the games and surpasses a human expert on three of them.

1 Introduction

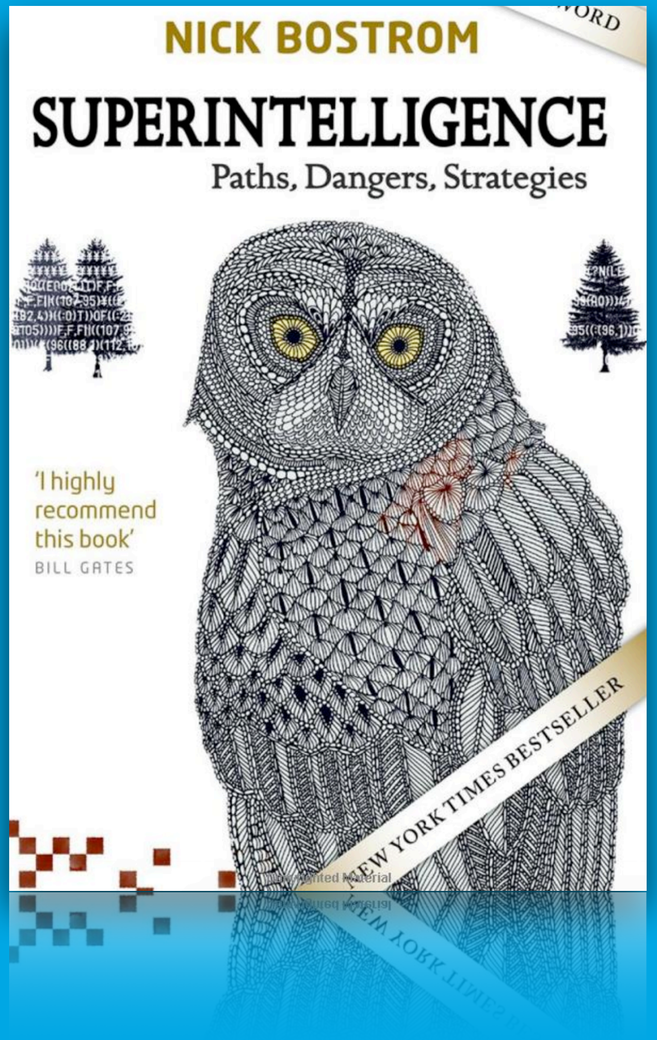
Learning to control agents directly from high-dimensional sensory inputs like vision and speech is one of the long-standing challenges of reinforcement learning (RL). Most successful RL applications that operate on these domains have relied on hand-crafted features combined with linear value functions or policy representations. Clearly, the performance of such systems heavily relies on the quality of the feature representation.

Recent advances in deep learning have made it possible to extract high-level features from raw sensory data, leading to breakthroughs in computer vision [11, 22, 16] and speech recognition [6, 7]. These methods utilise a range of neural network architectures, including convolutional networks, multilayer perceptrons, restricted Boltzmann machines and recurrent neural networks, and have exploited both supervised and unsupervised learning. It seems natural to ask whether similar techniques could also be beneficial for RL with sensory data.

However reinforcement learning presents several challenges from a deep learning perspective. Firstly, most successful deep learning applications to date have required large amounts of hand-labelled training data. RL algorithms, on the other hand, must be able to learn from a scalar reward signal that is frequently sparse, noisy and delayed. The delay between actions and resulting rewards, which can be thousands of timesteps long, seems particularly daunting when compared to the direct association between inputs and targets found in supervised learning. Another issue is that most deep learning algorithms assume the data samples to be independent, while in reinforcement learning one typically encounters sequences of highly correlated states. Furthermore, in RL the data distribution changes as the algorithm learns new behaviours, which can be problematic for deep learning methods that assume a fixed underlying distribution.

This paper demonstrates that a convolutional neural network can overcome these challenges to learn successful control policies from raw video data in complex RL environments. The network is trained with a variant of the Q-learning [26] algorithm, with stochastic gradient descent to update the weights. To alleviate the problems of correlated data and non-stationary distributions, we use

AI Success Stories
—Go and AlphaGo



"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.

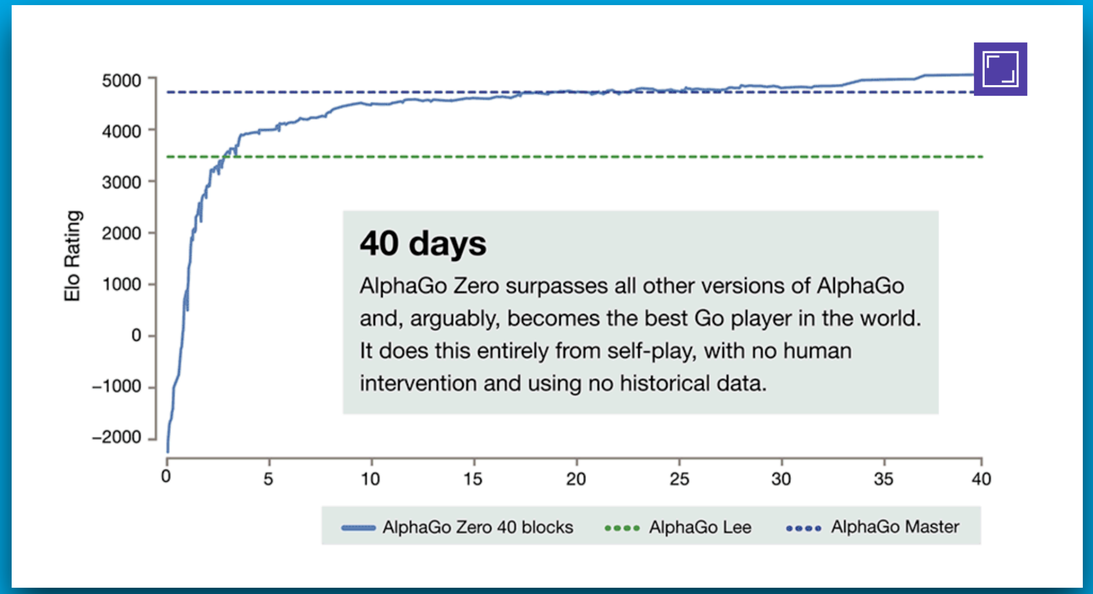
The story of AlphaGo so far

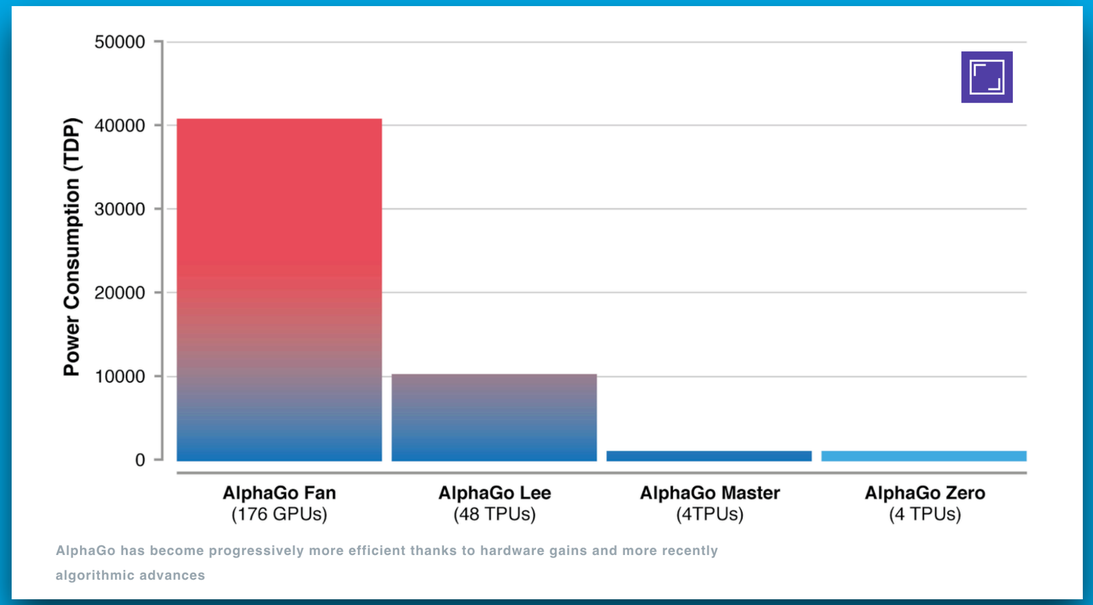
AlphaGo is the first computer program to defeat a professional human Go player, the first program to defeat a Go world champion, and arguably the strongest Go player in history.

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.

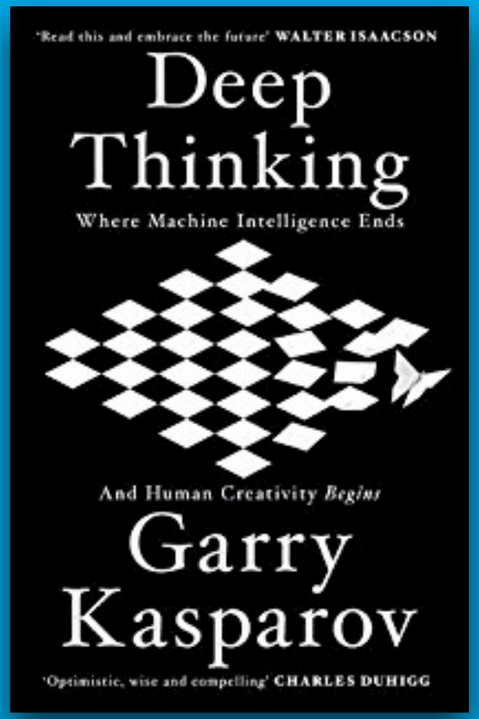
During the games, AlphaGo played a handful of **highly inventive winning moves,** several of which - including move 37 in game two - were so surprising they overturned hundreds of years of received wisdom, and have since been examined extensively by players of all levels. In the course of winning, AlphaGo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





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

AI Success Stories
—Chess, Deep Blue & AlphaZero



"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."

"Traditional chess engines — including the world computer chess champion Stockfish and IBM's ground-breaking Deep Blue — rely on **thousands of rules and heuristics handcrafted by strong human players** that try to account for every eventuality in a game. …

AlphaZero takes a totally different approach, replacing these hand-crafted rules with a **deep neural network** and **general purpose algorithms** that know nothing about the game beyond the basic rules."

"The amount of **training** the network needs depends on the style and complexity of the game, taking **approximately 9 hours for chess**, 12 hours for shogi, and 13 days for Go."

"In Chess, for example, it searches **only 60 thousand positions** per second in chess, compared to roughly 60 million for Stockfish."

Source: http://deepmind.com

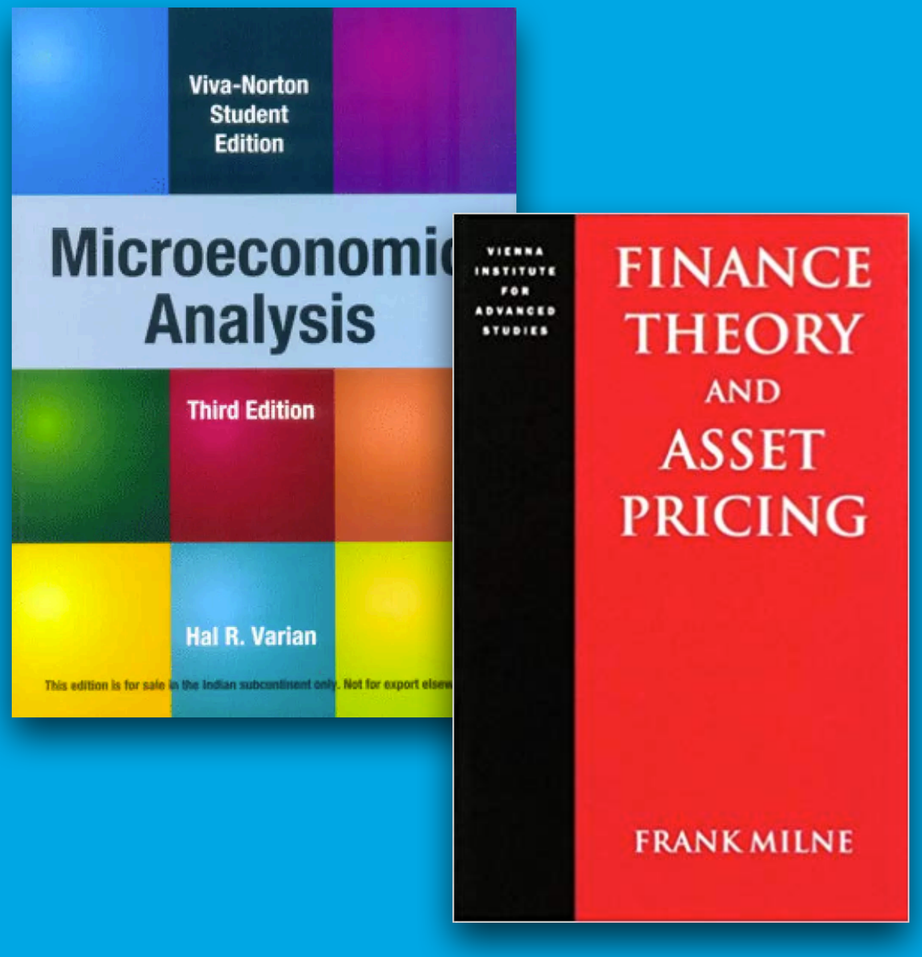
The Beauty Myth

Particle physics

Fundamental physics is frustrating physicists

GUTs are among several long-established theories that remain stubbornly unsupported by the big, costly experiments testing them. …

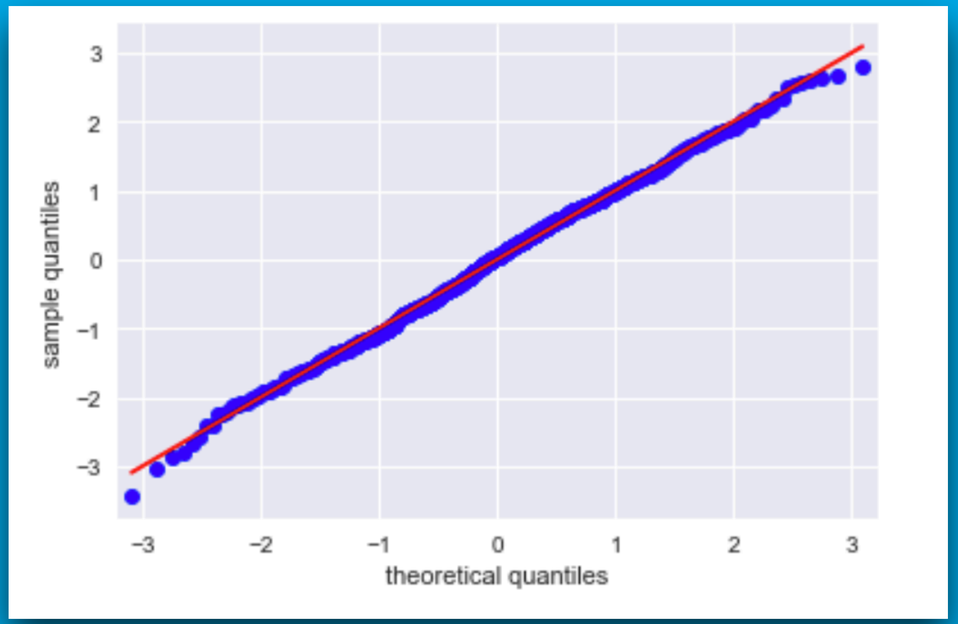
Despite the dearth of data, the answers that all these theories offer to some of the most vexing questions in physics are so elegant that they populate postgraduate textbooks. As Peter Woit of Columbia University observes, “Over time, these ideas became institutionalised. People stopped thinking of them as speculative.” That is understandable, for they appear to have great explanatory power.



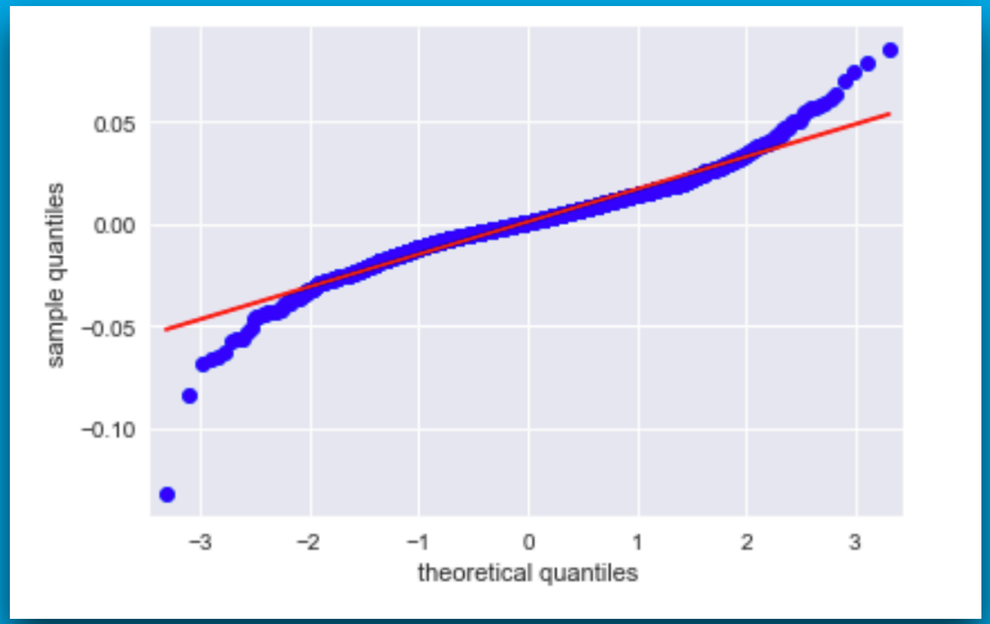
Cornerstones of Economics

A. Arbitrage Pricing
B. Expected Utility
C. Equilibrium
D. Normal Distributions
E. Linear Relationships
F. Efficient Markets

Theory



Reality



The Journal of FINANCE

VOL. XIX SEPTEMBER 1964 No. 3

CAPITAL ASSET PRICES: A THEORY OF MARKET EQUILIBRIUM UNDER CONDITIONS OF RISK*

WILLIAM F. SHARPE†

I. INTRODUCTION

ONE OF THE PROBLEMS which has plagued those attempting to predict the behavior of capital markets is the absence of a body of positive micro-economic theory dealing with conditions of risk. Although many useful insights can be obtained from the traditional models of investment under conditions of certainty, the pervasive influence of risk in financial transactions has forced those working in this area to adopt models of price behavior which are little more than assertions. A typical classroom explanation of the determination of capital asset prices, for example, usually begins with a careful and relatively rigorous description of the process through which individual preferences and physical relationships interact to determine an equilibrium pure interest rate. This is generally followed by the assertion that somehow a market risk-premium is also determined, with the prices of assets adjusting accordingly to account for differences in their risk.

A useful representation of the view of the capital market implied in such discussions is illustrated in Figure 1. In equilibrium, capital asset prices have adjusted so that the investor, if he follows rational procedures (primarily diversification), is able to attain any desired point along a *capital market line*.[1] He may obtain a higher expected rate of return on his holdings only by incurring additional risk. In effect, the market presents him with two prices: the *price of time*, or the pure interest rate (shown by the intersection of the line with the horizontal axis) and the *price of risk*, the additional expected return per unit of risk borne (the reciprocal of the slope of the line).

* A great many people provided comments on early versions of this paper which led to major improvements in the exposition. In addition to the referees, who were most helpful, the author wishes to express his appreciation to Dr. Harry Markowitz of the RAND Corporation, Professor Jack Hirshleifer of the University of California at Los Angeles, and to Professors Yoram Barzel, George Brabb, Bruce Johnson, Walter Oi and R. Haney Scott of the University of Washington.

† Associate Professor of Operations Research, University of Washington.

1. Although some discussions are also consistent with a non-linear (but monotonic) curve.

$$\mu_i = r + \beta_i(\mu_M - r)$$

"Market Risk"
"Idiosyncratic Risk"

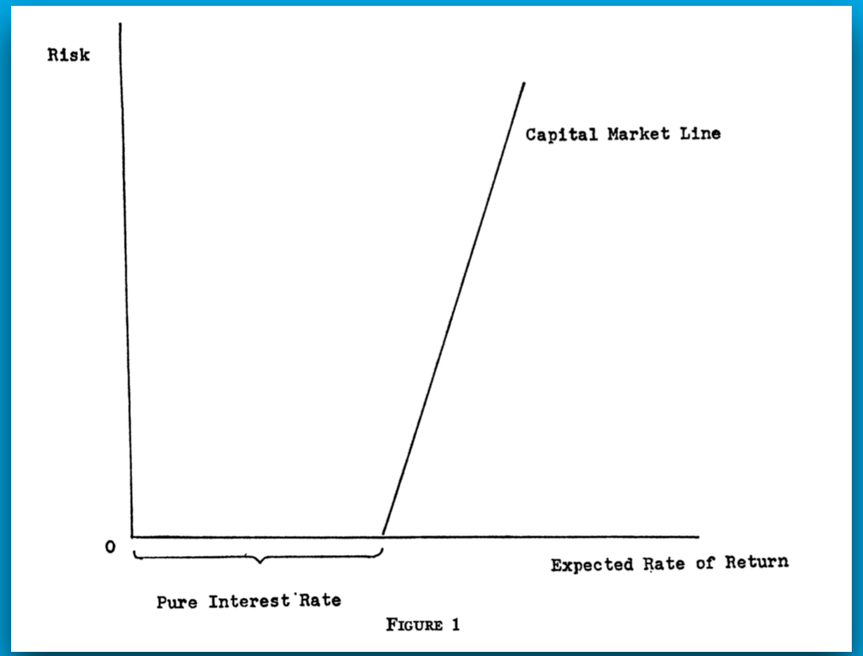


FIGURE 1

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 58 people were killed and over 515 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/Getty Images

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

He added: "We don't want a traumatic split from Spain. Today's referendum, while ille- necessary the suspension of Catalonia's

Briefing

Puerto Rico calls for billions in aid
Raúl Maldonado Gautier, 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 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 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 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 Raila Odinga, opposition leader, for undermining the electoral commission's ability to restage 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 purchasing managers' index
Above 50 = growth

US manufacturing activity as measured by the Institute of Supply Management was at its highest level in September since the summer of 2004

Sources: Thomson Reuters Datastream; ISM

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FTSE 100	7430.04	7372.70	0.80	4 mths	94.256	93.905	3 mths	99.285	99.435	See Geo 2 yr		101.97	0.71	0.00
FTSE All Share	4051.95	4041.09	0.87	5th qtr E	1.142	1.144	5th qtr F	1.292	1.298			pm pr	prev	chg
CAC 40	5302.44	5329.01	0.30	COMMODITIES						Fed Funds FT		1.07	1.07	0.00
Xetra Dax	12822.65	12828.86	0.00			Oct 2		prev	%chg	WE 3m Eris		1.05	1.05	0.00
Nikkei	20402.78	20398.28	0.22	Oil WTI $		50.48		51.87	-2.81	Euro Libor 3m		0.38	-0.38	0.00
Hang Seng	27554.80	27421.85	1.48	Gl Brent $		56.05		56.79	-1.30	$R 3m		0.34	0.33	0.00
FTSE All World $	301.85	301.88	0.00	Gold $		1273.70		1269.10	-0.73	Price as latest for edition			Data provided by Morningstar	

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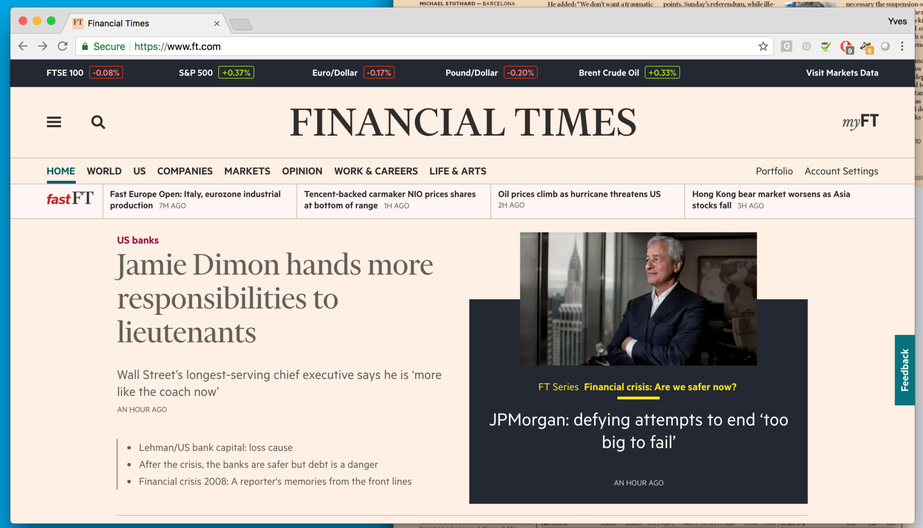

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THE WALL STREET JOURNAL.

DOW JONES

WEDNESDAY, DECEMBER 11, 2013 - VOL. CCLXII NO. 138 — WSJ.com — ★★★★ $2.00

DJIA 15973.13 ▼ 52.40 0.3% NASDAQ 4060.49 ▼ 0.2% NIKKEI 15611.31 ▼ 0.25% STOXX 600 314.91 ▼ 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

TODAY IN PERSONAL JOURNAL

A Celebrity Selfie Machine

PLUS Secondhand Stress at Work

What's News

Business & Finance

GM named its first female CEO, tapping company veteran and product chief Mary Barra to run the auto maker. **A1**

■ **Financial regulators** approved the Volcker rule, which curbs banks' risk-taking and could slash their profits. **A1**

■ **The FDIC board** approved a draft plan to keep parts of a failing financial firm open without a taxpayer bailout. **C3**

■ **Finance ministers** from big euro-zone nations reached an understanding on winding down failing banks. **C3**

■ **Discovery is considering** a bid for Food Network majority owner Scripps, presaging a possible wave of TV deals. **B1**

■ **Stocks declined** as investors weighed the potential impact of reduced Fed stimulus. The Dow dropped 52.40 points. **C4**

■ **OTC stock trading** was halted for about an hour because of a hardware error. **C4**

■ **Smith & Wesson said** profit slid 20% and revenue rose just 2%, as gun sales slow from their recent torrid pace. **B2**

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

■ **Italy pulled out** of a two-year contraction in the third quarter, posting flat GDP. **A13**

■ **Three Swiss banks** agreed to participate in a U.S. tax-evasion-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 useful microbes for plants. **B4**

World-Wide

■ **Congressional negotiators** struck a budget deal that would allow more domestic and military spending and include deficit-cutting measures. **A1, A8**

■ **Ukrainian forces** stormed a protesters' encampment in Kiev, hours after Western diplomats called for a nonviolent end to the political crisis. **A13**

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

■ **World leaders gathered** to honor Mandela. In a rare encounter, Obama shook hands with Cuba's Raúl Castro. **A12**

■ **Senate Democrats** confirmed an Obama appeals-court pick and the head of Fannie and Freddie's overseer. **A4**

■ **A key Senate Democrat** said he would back the Obama administration's request to delay new Iran sanctions. **A17**

■ **Supreme Court justices** expressed sympathy for the EPA approach to air pollution that crosses state lines. **A2**

■ **An AIDS group called** for a probe to see if HIV-infected patients were discouraged from enrolling in health plans. **A6**

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

■ **France's leader** flew to the Central African Republic after two French troops died. **A13**

■ **Singapore police** charged 24 Indian citizens in connection with a night of rioting. **A13**

■ **Died: Jim Hall**, 83, acclaimed jazz guitarist.

Deal Brings Stability to U.S. Budget

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

By Janet Hook

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 dose of stability to 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 private 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.

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 once-grand ambitions 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

Please turn to page A8

◆ Farm groups fight limits..... A6
◆ Pension-change pushback?... 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 Jeff 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 33 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 For-

Please turn to page A10

◆ Milestone is hailed, but women continue to face obstacles..... B7
◆ Heard on the Street..... C14

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**

Reuters

PARTY DISCIPLINE

China Spins New Lesson From Soviet Fall

By Jeremy Page

BEIJING—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 Zhijun exhorted the assembled officials to "correctly understand the lessons of history." The film's message: The Soviet Union didn't fall apart because of the communist system itself, but because of individuals who betrayed it, especially Mikhail Gorbachev.

The film is part of an ideological campaign launched by China's new leader, Xi Jinping, to re-energize the party and enforce discipline among its members. It has been shown at dozens of political meetings since September.

The frequent showings suggest Mr. Xi believes China needs to reinforce its Leninist political system rather than limit the party's powers. Party insiders and academics say it is part of an effort to combat what is portrayed as an American conspiracy to overthrow the party through "peaceful evolution"—the spread of Western ideas via media, academia and popular culture.

The office in charge of Mr. Xi's campaign didn't respond to questions about the film, called "20th Anniversary of the Death of the Soviet Party and State: As the Russians Relate," but said the campaign drew on experiences from China and the rest of the world.

The film, which was produced by a retired Chinese major general, has drawn criticism from some Chinese scholars of Soviet history, including some within the party. They argue that Moscow's mistake was to overlook deep flaws in the Soviet political and economic systems that emerged long before Mr. Gorbachev.

The film "lacks rational analysis, is mainly aimed at defending the Stalinist system and is illogical in many places," wrote Zuo Fen-

Please turn to page A18

Bank Rule Challenges Wall Street

By Justin Baer And Julie 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 tumult at the largest U.S. financial institutions.

The so-called Volcker rule, approved by five financial regulatory agencies on Tuesday, could top as much as $10 billion total in yearly pretax profit from the eight largest U.S. banks through lower revenue and higher compliance costs, according to estimates from Standard & Poor's.

The 953-page edict, part of the 2010 Dodd-Frank financial overhaul, codifies and restricts the way banks trade securities. It curbs banks' ability to bet with their own capital and forces

Please turn to page A6

◆ Plan for ailing banks detailed... C3
◆ Heard on the Street: Rule is a means to an end..... C14

Here's Your Holiday Bonus, Now Start Running

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

By Rachel Feintzeig

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

The 27-year-old wasn't even a member of the wholesale warehouse store until a few days ago. But his employer, coupon website RetailMeNot Inc., takes a cue from the game show "Supermarket Sweep" when it comes to rewarding employees. As a prize for his work as a software engineer, Mr. Comley will have 120 seconds to run unbridled through the big-box store's aisles, grabbing a plasma television, a videogame console and almost anything else that he can hoist onto his cart. "I'm looking to break a record," he says.

At a time of year when many workers anticipate a Christmas bonus check or a holiday ham, some companies say one of the best ways to reward outstanding performance and inspire employee loyalty is a chance to shop 'til they drop.

Jordan, Nicholas, Elliott Inc., a Florida company that runs several restaurants, unleashes high performers on a Lakeland, Fla., Winn-Dixie, where they get two to four minutes to fill their carts as co-workers race alongside. Still other companies hit the mall—one gives workers $150 and an hour to buy what they like, while an Ohio health-care system awards 20-year employees a $300 trip to a shopping center, after which they strut down a

Please turn to page A18

iXUS iTOT IVV AGG
IEFA iShares Core ETFs iLTB iSTB
IEMG IJH IJR
International Stocks
US Stocks
US Bonds

Every investor is unique.
That's why there's iShares Core.

10 ETFs that help you construct your personal portfolio.

Find out why 9 out of 10 large professional investors choose iShares for their ETFs.

Ask your financial advisor.
Visit iShares.com/core

iShares by BLACKROCK

Call 1-800-iShares for a prospectus, which includes investment objectives, risks, fees, expenses and other information you should read and consider carefully before investing. Risk includes loss of principal. 90% of all institutional investors (pensions, foundations and endowments; asset managers; insurance companies and investment advisors) surveyed in 2012 U.S. Exchange Traded Funds Study by Greenwich Associates used iShares ETFs. Survey included 176 institutional investors already using ETFs, interviewed 2/2013–4/2013. Distributed by BlackRock Investments, LLC. ©2013 BlackRock, Inc. All rights reserved. iShares®, BlackRock® and the iShares Core ETFs graphic are trademarks of BlackRock, Inc. G-0103-0213

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Yves

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AAPL.O APPLE INC

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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	--

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%

In [28]:
```
data = ek.get_timeseries('AAPL.O',
                         fields='*',
                         start_date='2019-06-28 16:00:00',
                         end_date='2019-06-28 17:00:00',
                         interval='tick')
```

In [29]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 20530 entries, 2019-06-28 16:00:00.132000 to 2019-06-28 16:59:58.984000
Data columns (total 2 columns):
VALUE     20499 non-null float64
VOLUME    20530 non-null float64
dtypes: float64(2)
memory usage: 481.2 KB
```

In [30]:
```
data.head()
```

Out[30]:

	AAPL.O	VALUE	VOLUME
Date			
2019-06-28 16:00:00.132		198.64	100.0
2019-06-28 16:00:00.132		198.64	100.0
2019-06-28 16:00:00.132		198.64	10.0
2019-06-28 16:00:00.133		198.64	400.0
2019-06-28 16:00:00.133		198.64	1300.0

In [31]:
```
news = ek.get_news_headlines('R:TSLA.O PRODUCTION',
                             date_from='2019-07-01',
                             date_to='2019-07-19',
                             count=5
                            )
```

In [32]:
```
news
```

Out[32]:

	versionCreated	text	storyId	sourceCode
2019-07-18 07:37:32.841	2019-07-18 07:37:32.841	Tesla takes production global	urn:newsml:reuters.com:20190718:nNRA98d8a7:1	NS:GLOBML
2019-07-16 15:55:30.319	2019-07-16 15:55:30.319	Reuters Insider - Tesla workers say they use s...	urn:newsml:reuters.com:20190716:nRTV7qNh5s:1	NS:CNBC
2019-07-11 14:20:18.249	2019-07-11 14:20:18.249	Auto Stock Roundup: TSLA to Raise Production, ...	urn:newsml:reuters.com:20190711:nNRA96h0jy:1	NS:ZACKSC
2019-07-11 13:15:45.895	2019-07-11 13:15:45.895	Tesla (TSLA) Prepares to Increase Production i...	urn:newsml:reuters.com:20190711:nNRA96ghdy:1	NS:ZACKSC
2019-07-11 08:36:17.569	2019-07-11 08:36:17.569	Tesla signals it's in hiring mode The company ...	urn:newsml:reuters.com:20190711:nNRA96d7au:1	NS:LATIME

In [33]:
```
storyId = news['storyId'][0]
```

In [34]:
```
from IPython.display import HTML
```

In [35]:
```
HTML(ek.get_news_story(storyId))
```

Out[35]:

A new Tesla factory is seen under construction in Shanghai on Tuesday. The electric-car manufacturer is building its first overseas car factory to accelerate its annual production

EXPERT OPINION

Contact Editor: **Brian Brannon**, bbrannon@computer.org

The Unreasonable Effectiveness of Data

Alon Halevy, Peter Norvig, and Fernando Pereira, *Google*

Eugene Wigner's article "The Unreasonable Effectiveness of Mathematics in the Natural Sciences"[1] examines why so much of physics can be neatly explained with simple mathematical formulas such as $f = ma$ or $e = mc^2$. Meanwhile, sciences that involve human beings rather than elementary particles have proven more resistant to elegant mathematics. Economists suffer from physics envy over their inability to neatly model human behavior. An informal, incomplete grammar of the English language runs over 1,700 pages.[2] Perhaps when it comes to natural language processing and related fields, we're doomed to complex theories that will never have the elegance of physics equations. But if that's so, we should stop acting as if our goal is to author extremely elegant theories, and instead embrace complexity and make use of the best ally we have: the unreasonable effectiveness of data.

One of us, as an undergraduate at Brown University, remembers the excitement of having access to the Brown Corpus, containing one million English words.[3] Since then, our field has seen several notable corpora that are about 100 times larger, and in 2006, Google released a trillion-word corpus with frequency counts for all sequences up to five words long.[4] In some ways this corpus is a step backwards from the Brown Corpus: it's taken from unfiltered Web pages and thus contains incomplete sentences, spelling errors, grammatical errors, and all sorts of other errors. It's not annotated with carefully hand-corrected part-of-speech tags. But the fact that it's a million times larger than the Brown Corpus outweighs these drawbacks. A trillion-word corpus—along with other Web-derived corpora of millions, billions, or trillions of links, videos, images, tables, and user interactions—captures even very rare aspects of human behavior. So, this corpus could serve as the basis of a complete model for certain tasks—if only we knew how to extract the model from the data.

Learning from Text at Web Scale

The biggest successes in natural-language-related machine learning have been statistical speech recognition and statistical machine translation. The reason for these successes is not that these tasks are easier than other tasks; they are in fact much harder than tasks such as document classification that extract just a few bits of information from each document. The reason is that translation is a natural task routinely done every day for a real human need (think of the operations of the European Union or of news agencies). The same is true of speech transcription (think of closed-caption broadcasts). In other words, a large training set of the input-output behavior that we seek to automate is available to us *in the wild*. In contrast, traditional natural language processing problems such as document classification, part-of-speech tagging, named-entity recognition, or parsing are not routine tasks, so they have no large corpus available in the wild. Instead, a corpus for these tasks requires skilled human annotation. Such annotation is not only slow and expensive to acquire but also difficult for experts to agree on, being bedeviled by many of the difficulties we discuss later in relation to the Semantic Web. The first lesson of Web-scale learning is to use available large-scale data rather than hoping for annotated data that isn't available. For instance, we find that useful semantic relationships can be automatically learned from the statistics of search queries and the corresponding results[5] or from the accumulated evidence of Web-based text patterns and formatted tables,[6] in both cases without needing any manually annotated data.

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Eugene Wigner's article "The Unreasonable Effectiveness of Mathematics in the Natural Sciences" examines why so much of physics can be neatly explained with simple mathematical formulas such as $f = ma$ or $e = mc^2$. Meanwhile, sciences that involve human beings rather than elementary particles have proven more resistant to elegant mathematics. Economists suffer from physics envy over their inability to neatly [and successfully] model human behavior. An informal, incomplete grammar of the English language runs over 1,700 pages. Perhaps when it comes to natural language processing and related fields, we're doomed to complex theories that will never have the elegance of physics equations. But if that's so, we should stop acting as if our goal is to author extremely elegant theories, and instead embrace complexity and make use of the best ally we have: the unreasonable effectiveness of data.

How investment analysts became data miners

Banks battle for audiences with new information sets, ‘charticles’ and podcasts

© AP

IP[y]:
IPython

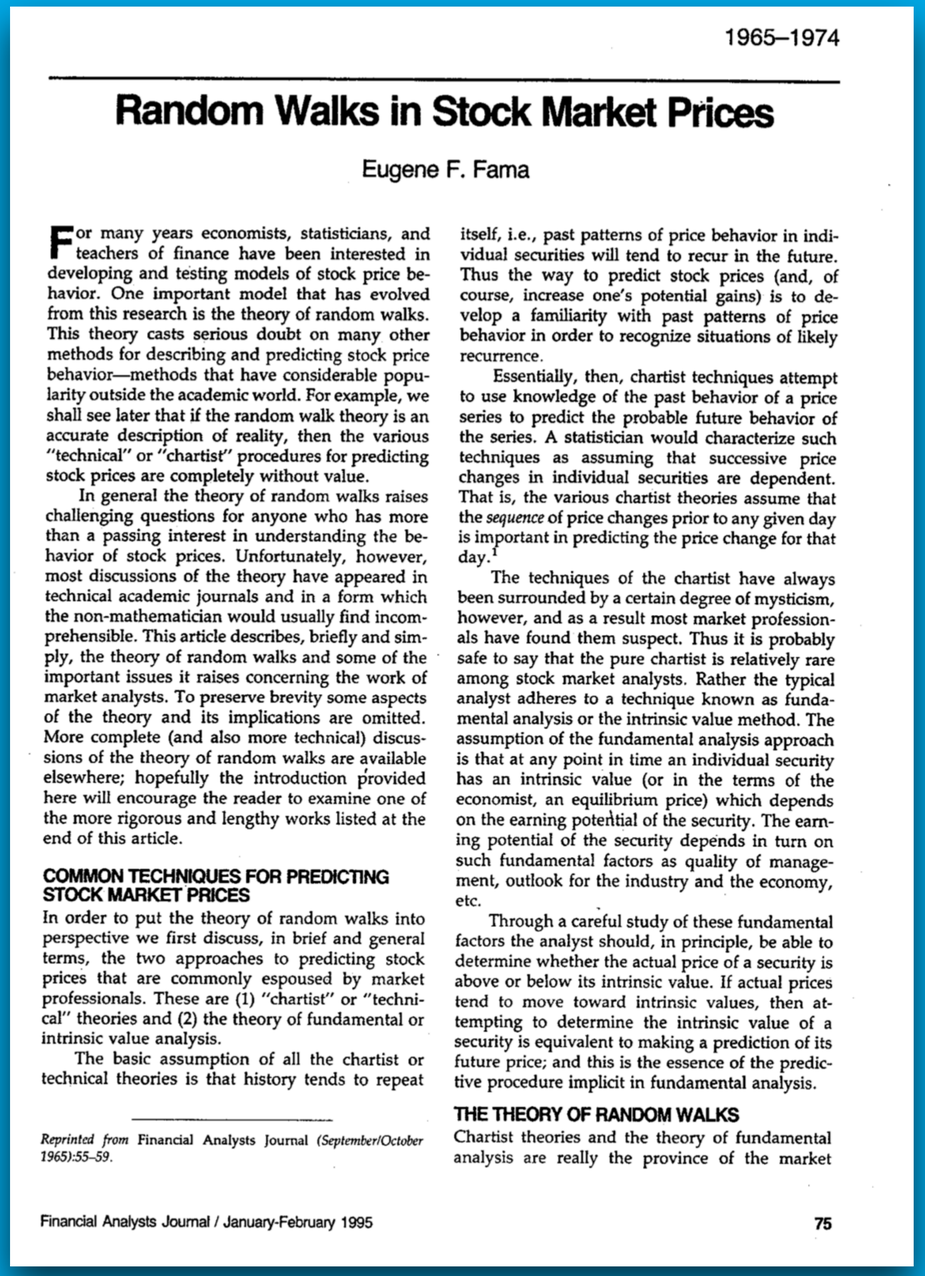
NumPy

matplotlib

pandas

$y_i t = \beta' x_{it} + \mu_i + \epsilon_{it}$

Efficient Markets



1965–1974

Random Walks in Stock Market Prices

Eugene F. Fama

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.

In general the theory of random walks raises challenging questions for anyone who has more than a passing interest in understanding the behavior of stock prices. Unfortunately, however, most discussions of the theory have appeared in technical academic journals and in a form which the non-mathematician would usually find incomprehensible. This article describes, briefly and simply, the theory of random walks and some of the important issues it raises concerning the work of market analysts. To preserve brevity some aspects of the theory and its implications are omitted. More complete (and also more technical) discussions of the theory of random walks are available elsewhere; hopefully the introduction provided here will encourage the reader to examine one of the more rigorous and lengthy works listed at the end of this article.

COMMON TECHNIQUES FOR PREDICTING STOCK MARKET PRICES

In order to put the theory of random walks into perspective we first discuss, in brief and general terms, the two approaches to predicting stock prices that are commonly espoused by market professionals. These are (1) "chartist" or "technical" theories and (2) the theory of fundamental or intrinsic value analysis.

The basic assumption of all the chartist or technical theories is that history tends to repeat itself, i.e., past patterns of price behavior in individual securities will tend to recur in the future. Thus the way to predict stock prices (and, of course, increase one's potential gains) is to develop a familiarity with past patterns of price behavior in order to recognize situations of likely recurrence.

Essentially, then, chartist techniques attempt to use knowledge of the past behavior of a price series to predict the probable future behavior of the series. A statistician would characterize such techniques as assuming that successive price changes in individual securities are dependent. That is, the various chartist theories assume that the *sequence* of price changes prior to any given day is important in predicting the price change for that day.[1]

The techniques of the chartist have always been surrounded by a certain degree of mysticism, however, and as a result most market professionals have found them suspect. Thus it is probably safe to say that the pure chartist is relatively rare among stock market analysts. Rather the typical analyst adheres to a technique known as fundamental analysis or the intrinsic value method. The assumption of the fundamental analysis approach is that at any point in time an individual security has an intrinsic value (or in the terms of the economist, an equilibrium price) which depends on the earning potential of the security. The earning potential of the security depends in turn on such fundamental factors as quality of management, outlook for the industry and the economy, etc.

Through a careful study of these fundamental factors the analyst should, in principle, be able to determine whether the actual price of a security is above or below its intrinsic value. If actual prices tend to move toward intrinsic values, then attempting to determine the intrinsic value of a security is equivalent to making a prediction of its future price; and this is the essence of the predictive procedure implicit in fundamental analysis.

THE THEORY OF RANDOM WALKS

Chartist theories and the theory of fundamental analysis are really the province of the market

Reprinted from Financial Analysts Journal *(September/October 1965):55–59.*

Financial Analysts Journal / January-February 1995 75

Eugene F. Fama (1965):

"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"

Michael Jensen (1978): “Some Anomalous Evidence Regarding Market Efficiency”:

“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.”

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”).

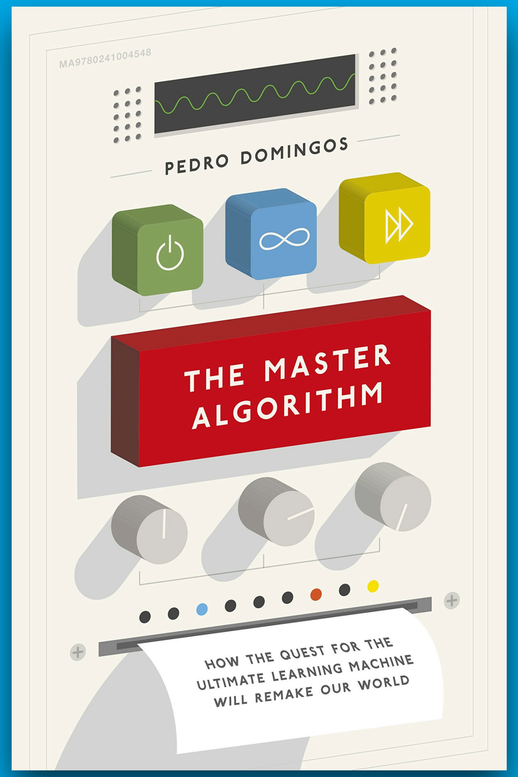
In such a case, the best predictor of tomorrow’s stock price — in a least-squares sense — is today’s stock price.

AI-First Finance

scientific method

noun

a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.
"criticism is the backbone of **the scientific method**"



"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."

Bullish patterns (going up)

Flag

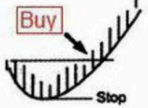
Pennant

Cup with handle

Ascending triangle

Symetrical triangle

Measured move up



Ascending scallop

3 rising valleys

Bearish patterns (going down)

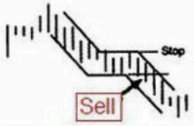
Flag

Pennant

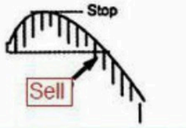
Invertede Cup with handle

Descending triangle

Symetrical triangle



Measured move down



Descending scallop

3 descending peaks

Reversal patterns

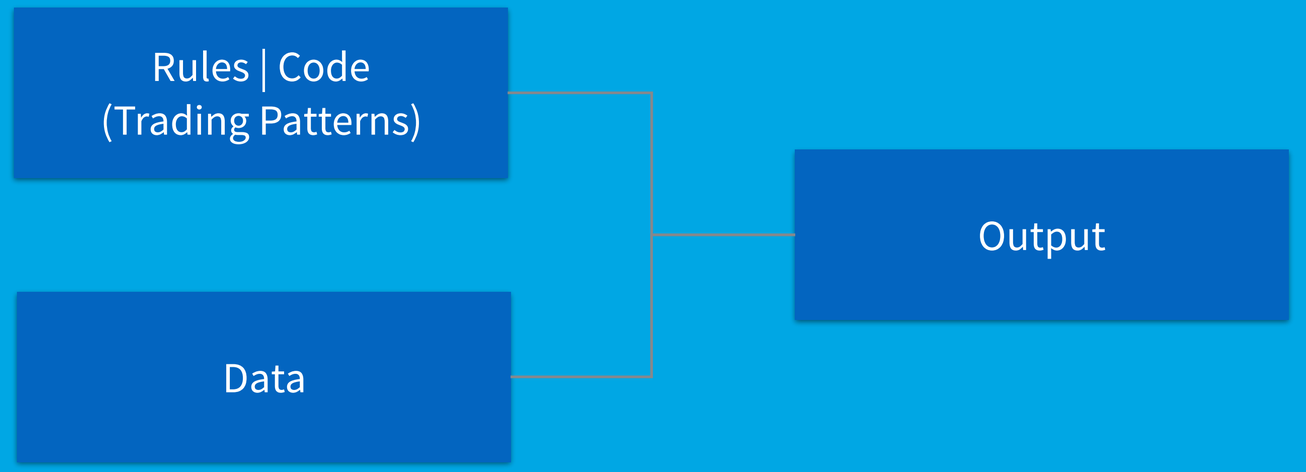
Double bottoms

Diamond bottoms

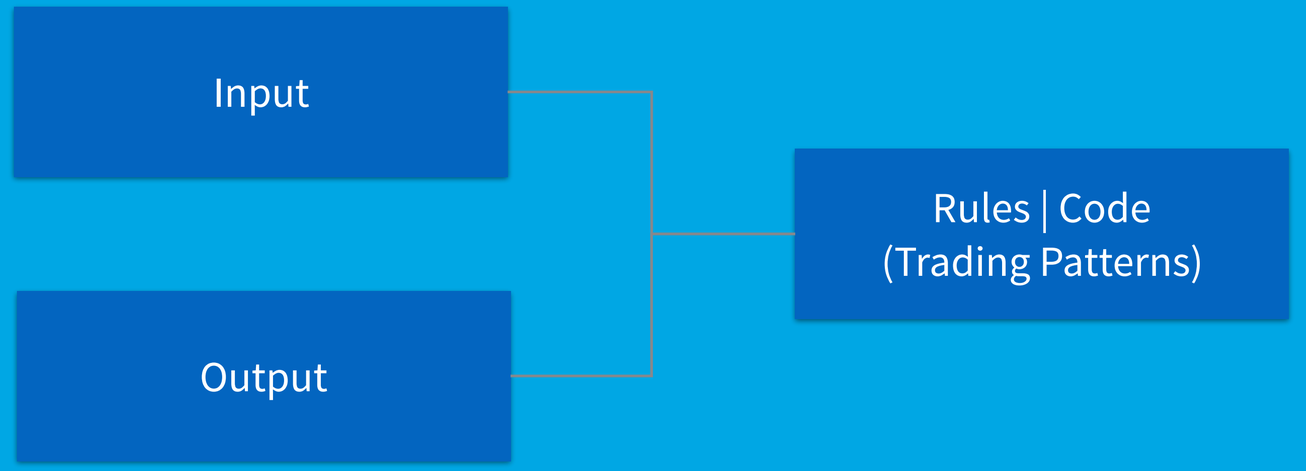
Tops rectangle

Head and shoulders top

Programming.



Machine Learning.



Financial Markets

Finance History

AI in Finance = finaince

“normative economics = assumptions, axioms, etc.”

“positive economics = data, relationships, etc.”

x

x

(too) “simple and elegant theories”

“general, parametrizable, trainable algorithms”

f(•)

m(•, a, b)

“hardly any supporting empirical evidence”

“might show good performance, but black box”

y

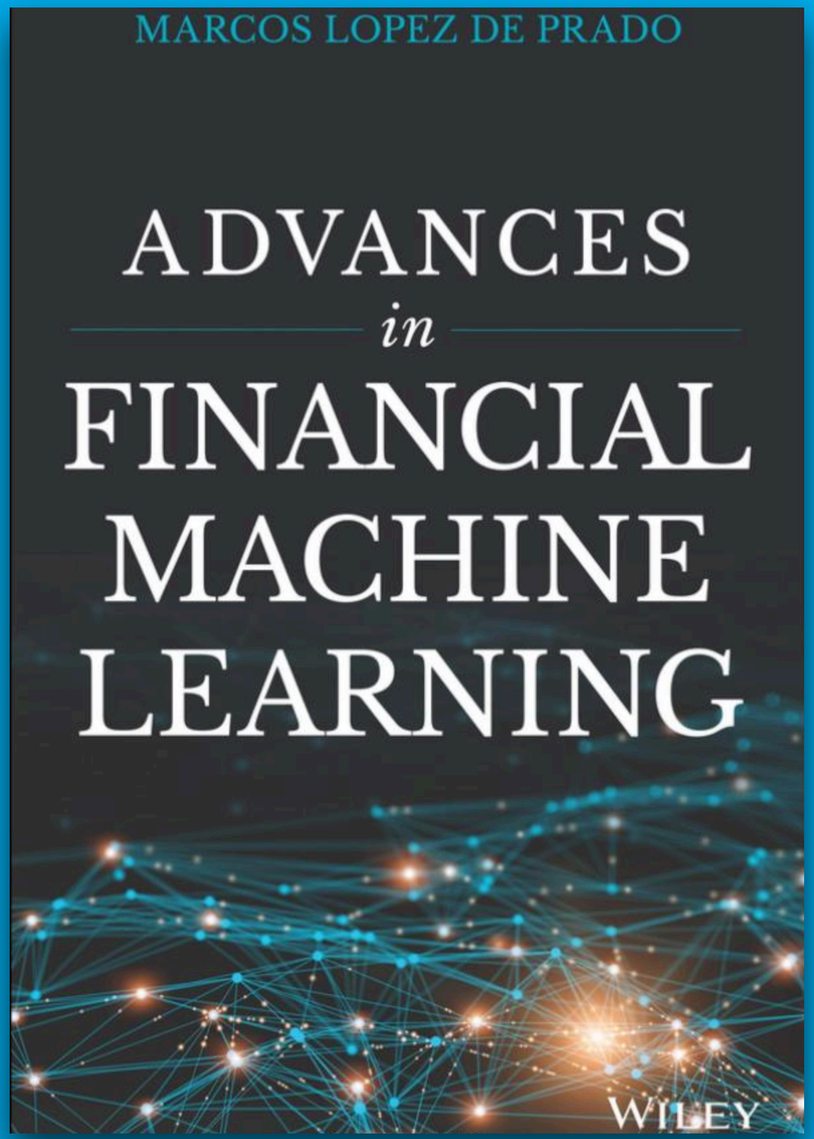
f(x) ≠ y

m(x, a*, b*) ≈ y

“non-linear, complex, changing”

“brain-driven & beauty myth”

“data-driven & AI-first”



"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."

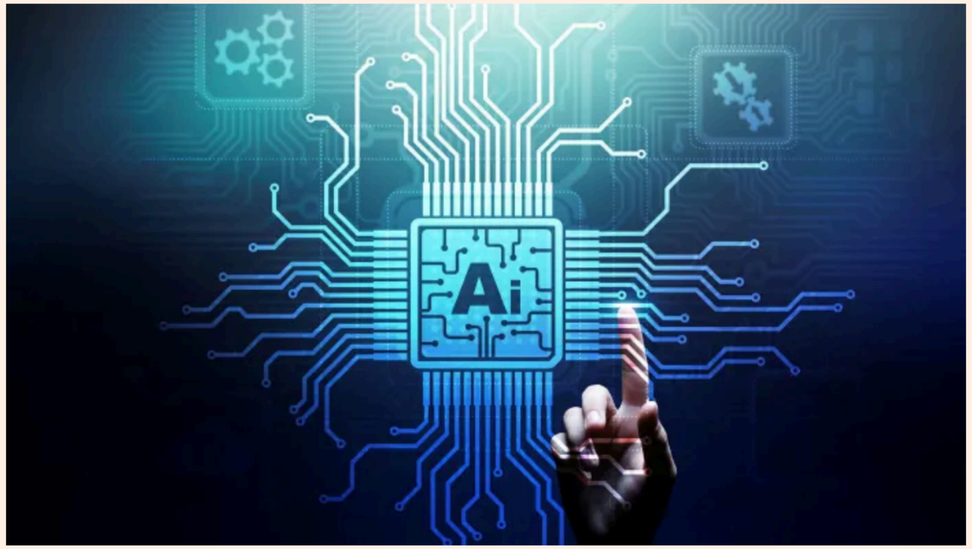
"Econometrics might be good enough to succeed in financial academia (for now), but succeeding in practice requires ML."

Marcos López de Prado (2018)

Will bots replace humans in active equity investment?

Machine learning will implement quant analysis to find the right stocks

ROBERT POZEN + Add to myFT



ML can identify outperforming equities based on patterns that would have not been selected by humans © Dreamstime

How quants and QE shook the cult of the stockpicker

Active investors see their strategies automated while passive alternatives get cheaper

London-based start-up Havelock is currently trying to fashion an algorithm that mimics Warren Buffett. Such attempts are helping to undermine what was once a prominent feature of the investing landscape: the cult of the star stock picker. © Bloomberg

K
Keras

scikit
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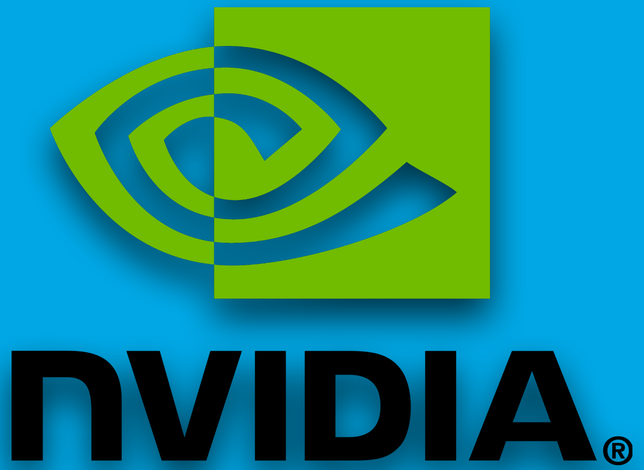
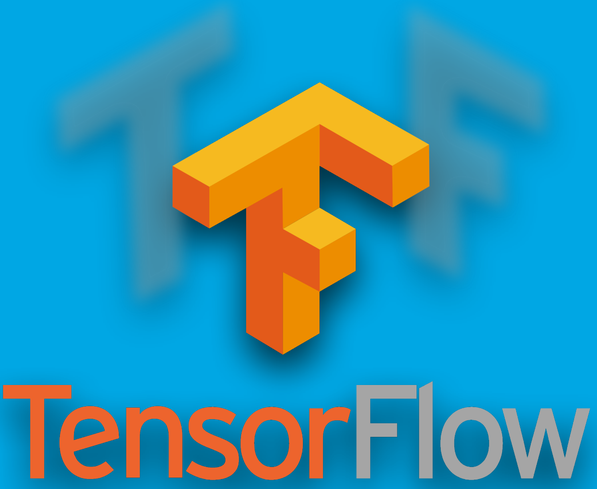

NVIDIA


TensorFlow

Demos

The Random Walk Hypothesis Revisited

Jupyter Notebook 01

Discovering Statistical Inefficiencies with Machine Learning

Jupyter Notebook 02

Jupyter Notebook 03

The AI Machine — AI-Powered Algo Trading

The AI Machine

Algorithmic Trading

Data	Features and Labels	Machine & Deep Learning	Backtesting	Deployment
EUR/USD exchange rate	time series features	support vector machine & DNN classifier	vectorized backtesting	online algorithm
1 minute bars	economic indicators	training & testing	event-based backtesting	cloud deployment
August & September 2019	directional movement	validation	visualization	monitoring & risk management

Algorithmic Trading

Data	Features and Labels	Machine & Deep Learning	Backtesting	Deployment

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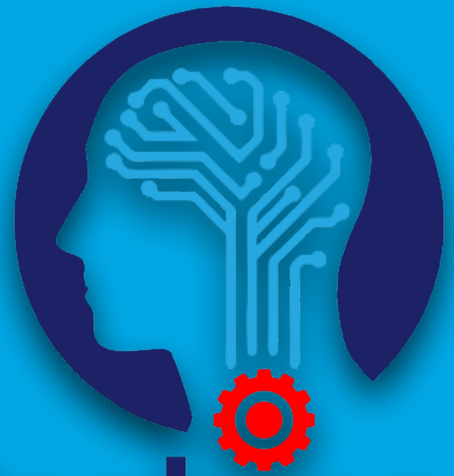
OANDA Solutions for Business



The AI Machine

Standardized deployment of AI-powered algorithmic trading strategies.

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DigitalOcean

docker

OANDA Solutions for Business

Not Secure | algomachine.io/home
prod
live models
backtested models
strategies
as of: September 17, 2019 at 8:39:06 PM GMT+7
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details
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audit details
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Zoom 30S 1M 5M 10M 30M 1H 3H 12H all
From Sep 17, 2019
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The AI Machine

Prediction Engines

Technical Rules
Statistical Methods
Machine Learning
Deep Learning
Automated ML
...

Deployment & Execution

Data Streaming
Transaction Streaming
Position Management
Profit & Loss Calculation
Visualization
Logging & Reporting
...

Decision Rules

Entry Rules
Stop Loss
Trailing Stop Loss
Dynamic Stop Loss
Take Profit
Position Sizing
Capital Allocation
...

Conclusions

1. Finance has long been driven by the **“beauty myth”** — elegant but too simplistic models, equations and approaches.
2. The availability of **big financial data** (historical—streaming, structured—unstructured) gave rise to data-driven finance.
3. It might be assumed that the **“unreasonable effectiveness of big data”** holds true in the financial domain as well.
4. Due to the availability of big data (e.g. billions of hours of virtual car driving, billions of self-played games), **Artificial Intelligence** (AI) is changing almost every area of our lives.
5. It is to be assumed that in the same way the **combination of data-driven and AI-first finance** will influence and change finance and algorithmic trading for good.

The Python Quants
The AI Machine

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