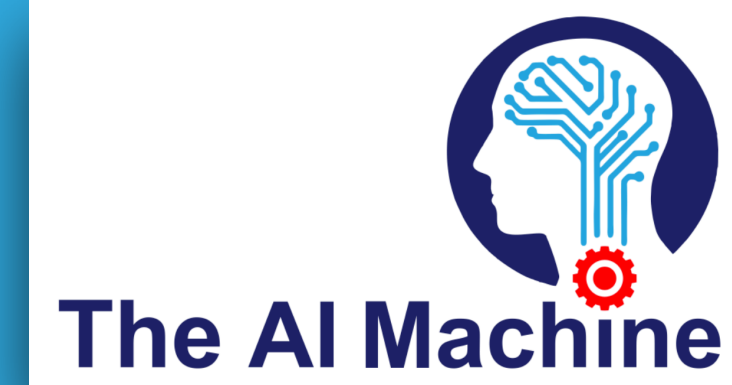
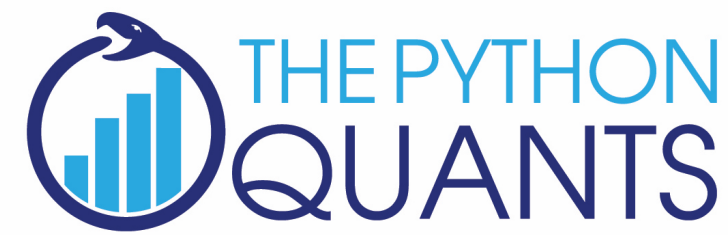


DIY Quantitative Stock Market Investing with Python

Dr. Yves J. Hilpisch

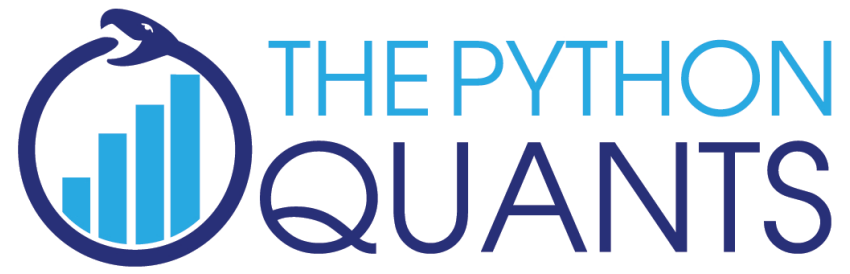
Online, PyData Botswana Webinar, 15. September 2022



AGENDA

- **Introduction**
- **Data-Driven Finance**
- **Case Study: APIs**
- **Case Study: MVP**
- **Case Study: Risk**

Introduction



SERVICES
for financial institutions globally

The illustration shows a globe with a circular arrow around it, indicating global reach. Below the globe, there are several call center agents wearing headsets and working at computers.

EVENTS
for Python quants & algorithmic traders

The illustration shows a group of seven people in business suits, representing a professional community or event attendees.

TRAINING
about Python for finance
& algorithmic trading

The illustration shows a man in a suit pointing at a presentation board that displays the Python Quants logo and some charts. The board is on a stand.

CERTIFICATION
in cooperation with university

The illustration shows a certificate with a red ribbon seal, symbolizing a formal certification or award.

PLATFORM
for browser-based
data analytics

The illustration shows a white paper airplane with a yellow tail, symbolizing a platform or a forward-looking technology.

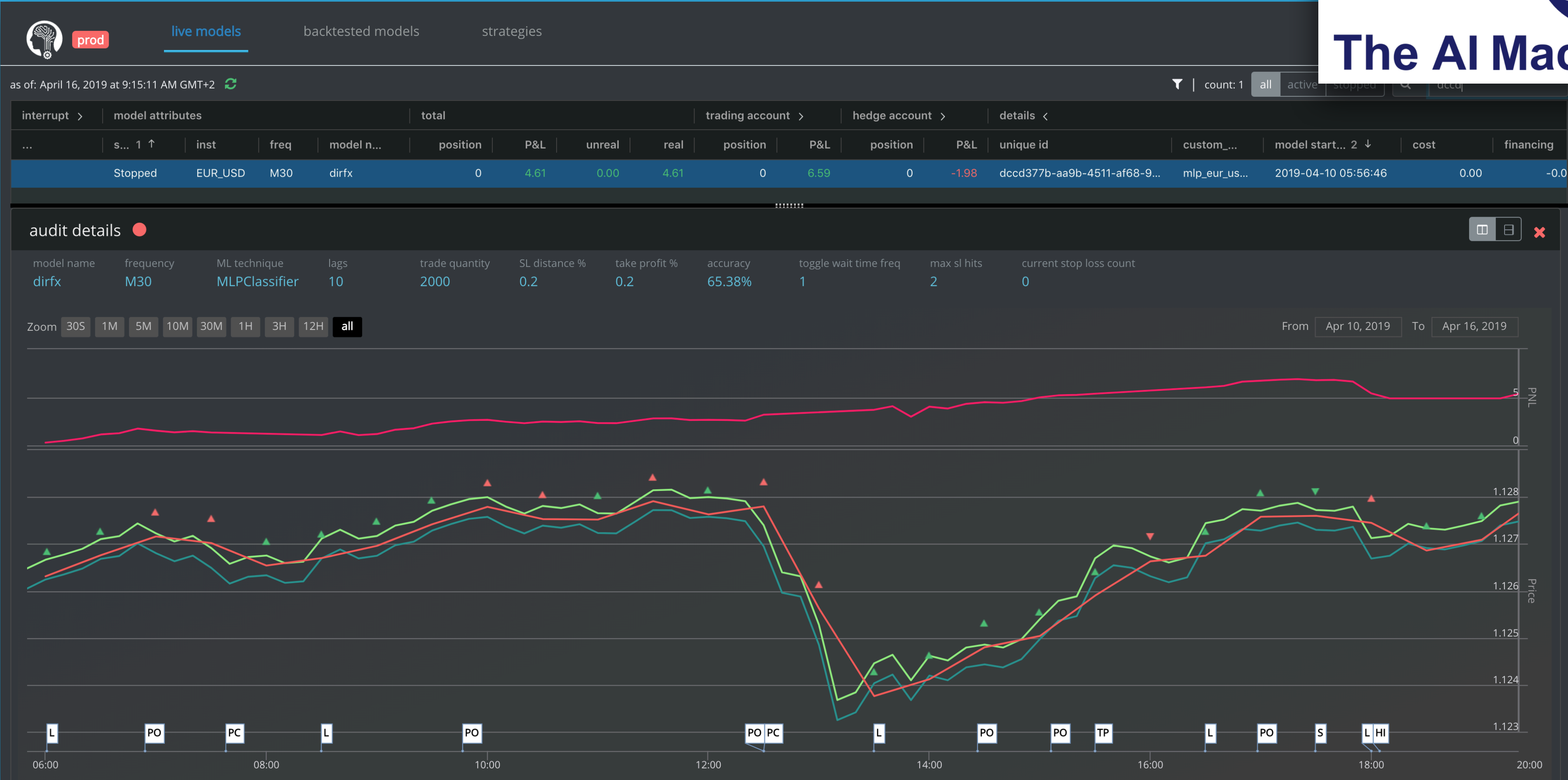
BOOKS
about Python and
finance

The illustration shows an open book with a red cover, symbolizing knowledge and learning.

OPEN SOURCE
Python library
for financial analytics

The illustration shows a group of four people in business attire, with a white paper airplane flying towards them from the left.

The illustration shows a person in a white shirt working at a laptop. The laptop screen displays the Python logo. Surrounding the laptop are various icons: a target, a lightbulb, a globe, a calculator, and an open book.



<http://aimachine.io>

Dr. Yves J. Hilpisch is founder and CEO of **The Python Quants** (<http://tpq.io>), a group focusing on the use of open source technologies for financial data science, artificial intelligence, algorithmic trading, and computational finance. He is also the founder and CEO of **The AI Machine** (<http://aimachine.io>), a company focused on AI-powered algorithmic trading based on a proprietary strategy execution platform.

Yves has a Diploma in Business Administration, a Ph.D. in Mathematical Finance, and is Adjunct Professor for Computational Finance.

Yves is the author of six books (<https://home.tpq.io/books>):

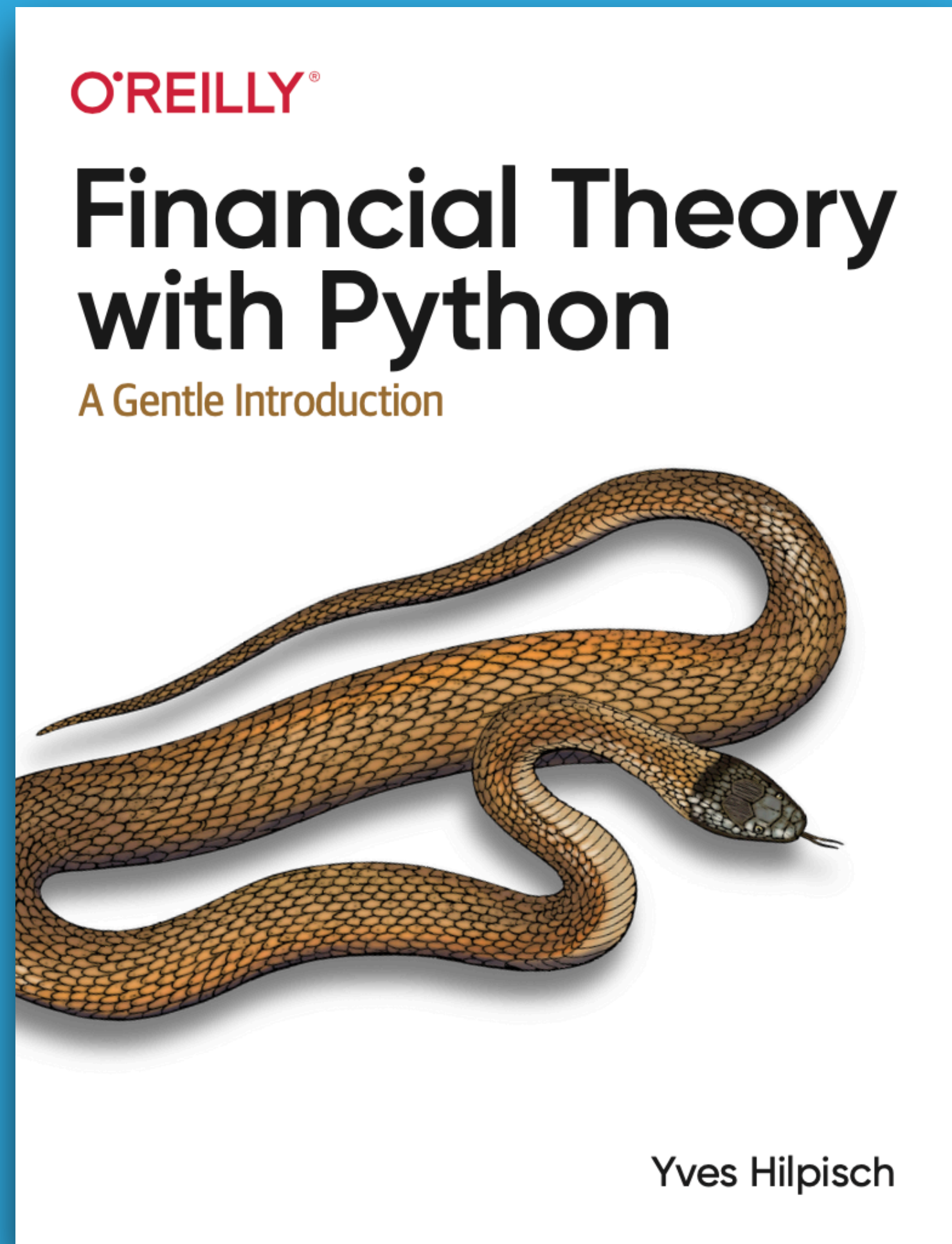
- * Financial Theory with Python (2021, O'Reilly)
- * Artificial Intelligence in Finance (2020, O'Reilly)
- * Python for Algorithmic Trading (2020, O'Reilly)
- * Python for Finance (2018, 2nd ed., O'Reilly)
- * Listed Volatility and Variance Derivatives (2017, Wiley Finance)
- * Derivatives Analytics with Python (2015, Wiley Finance)



Yves is the director of the first online training program leading to **Certificates in Python for Algorithmic Trading** (<https://home.tpq.io/certificates/pyalgo>), **Asset Management** (<https://home.tpq.io/certificates/pyam>), and **Computational Finance** (<https://home.tpq.io/certificates/compfin>). He also lectures on computational finance, machine learning, and algorithmic trading at the **CQF Program** (<http://cqf.com>).

Yves is the originator of the financial analytics library **DX Analytics** (<http://dx-analytics.com>) and organizes Meetup group **events, conferences, and bootcamps** about Python, artificial intelligence and algorithmic trading in London (<http://pqf.tpq.io>), New York (<http://aifat.tpq.io>), Frankfurt, Berlin, and Paris. He has given **keynote speeches** at technology conferences in the United States, Europe, and Asia.

Financial Theory with Python – A Gentle Introduction



Finance with Python and Python environments

Basic Finance Concepts and Models:

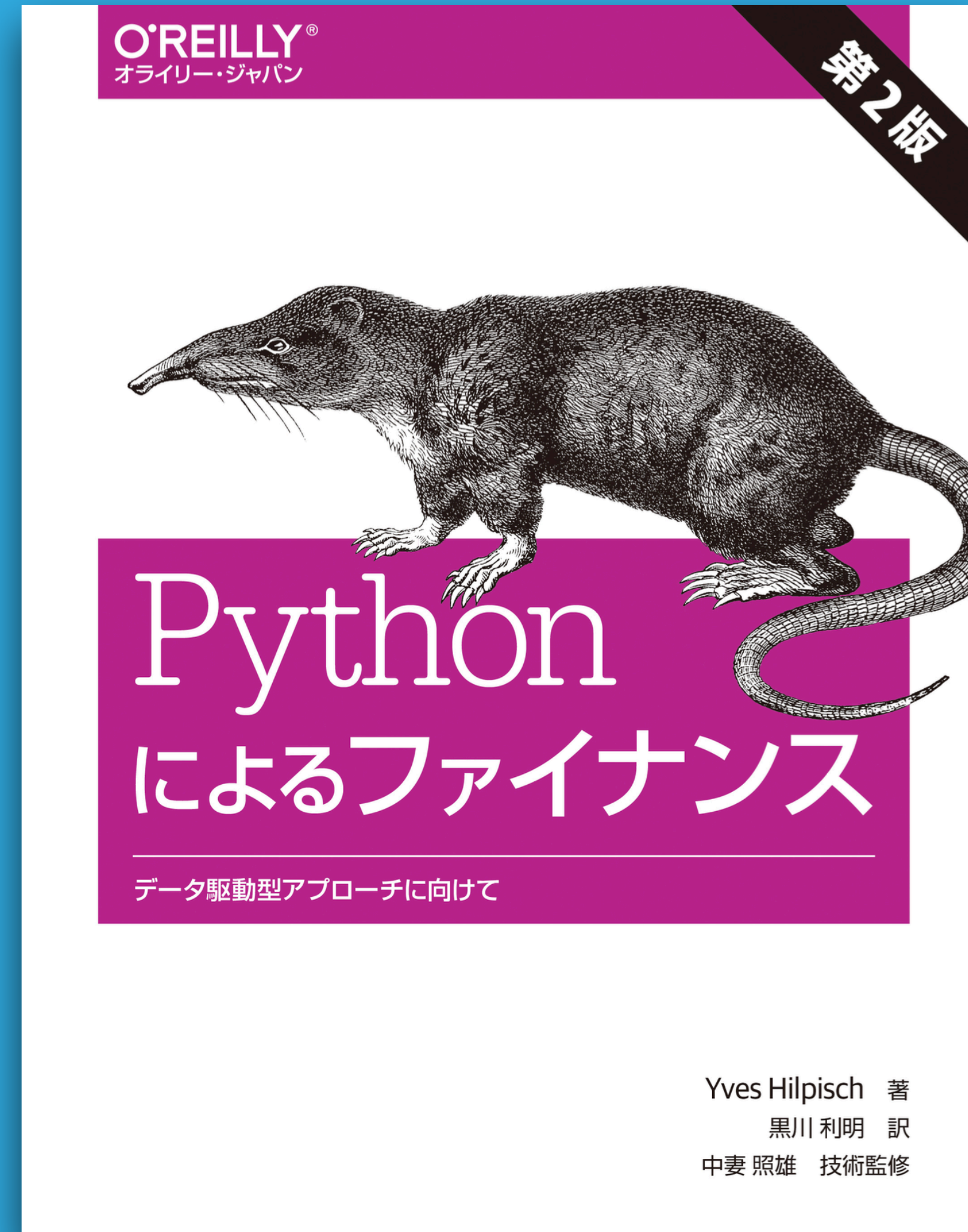
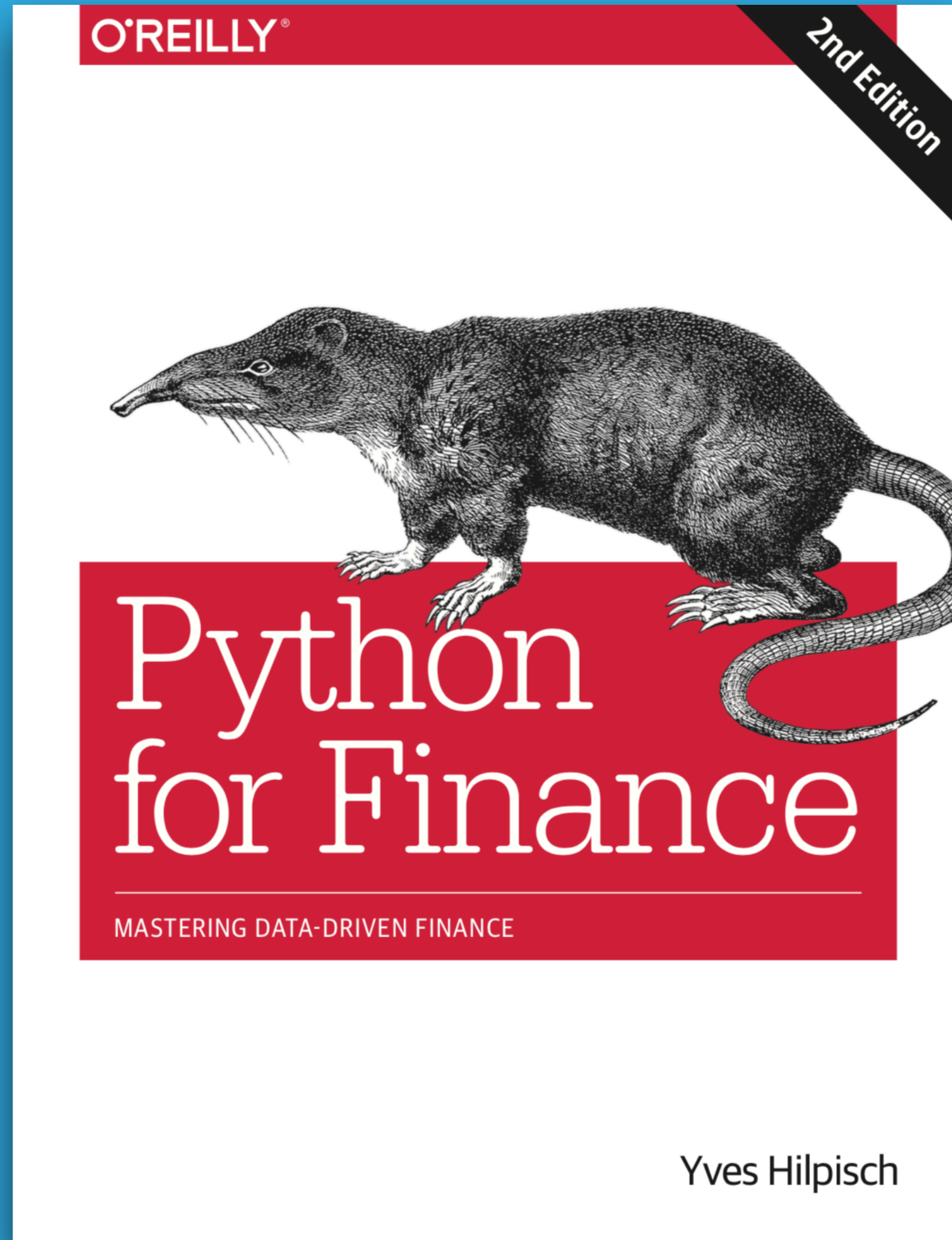
- Risk–Return
- Pricing of Instruments
- Expected Utility Theory
- Mean–Variance Portfolio Theory
- Capital Asset Pricing Model
- Portfolio Optimization

Basic Python Concepts and Packages:

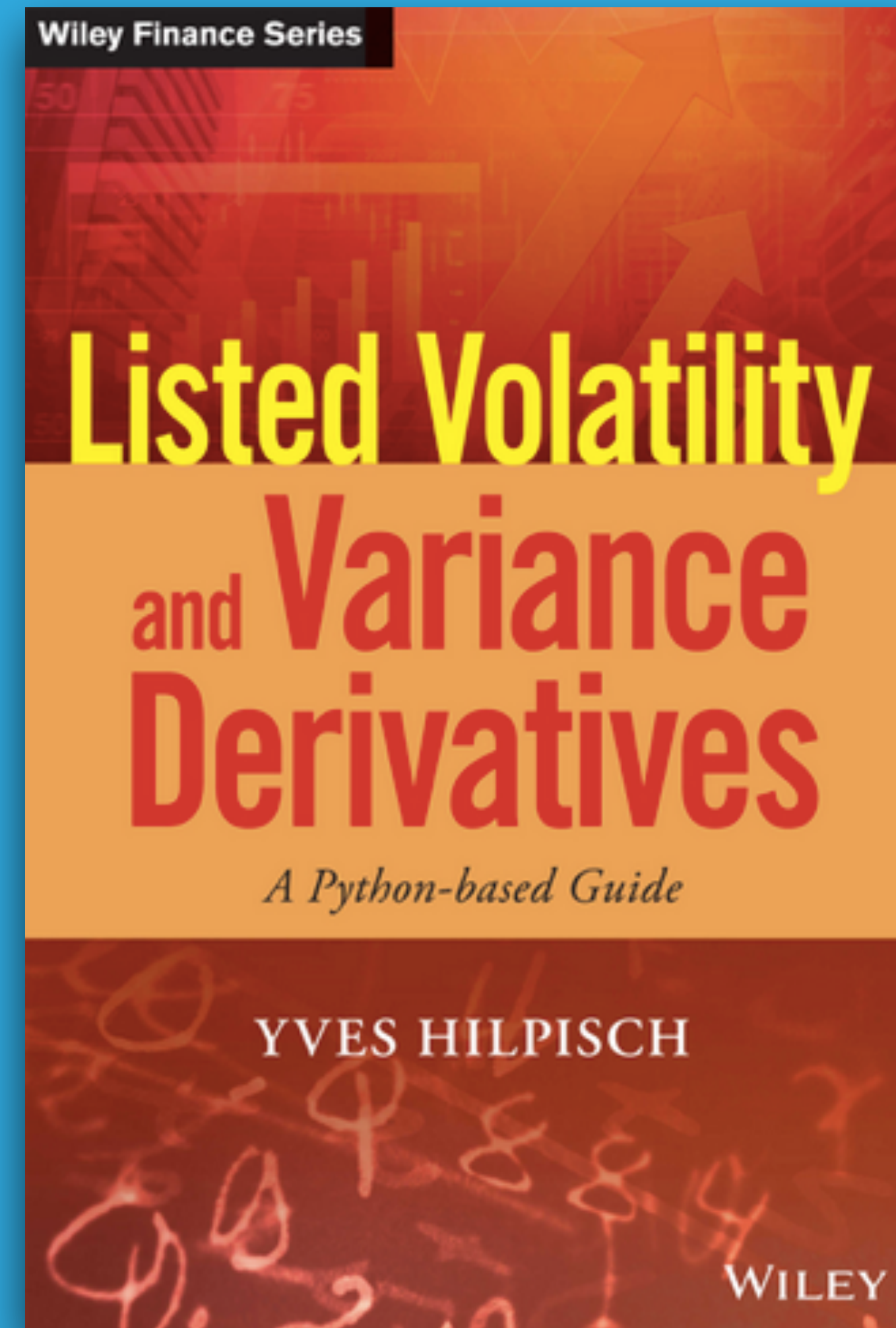
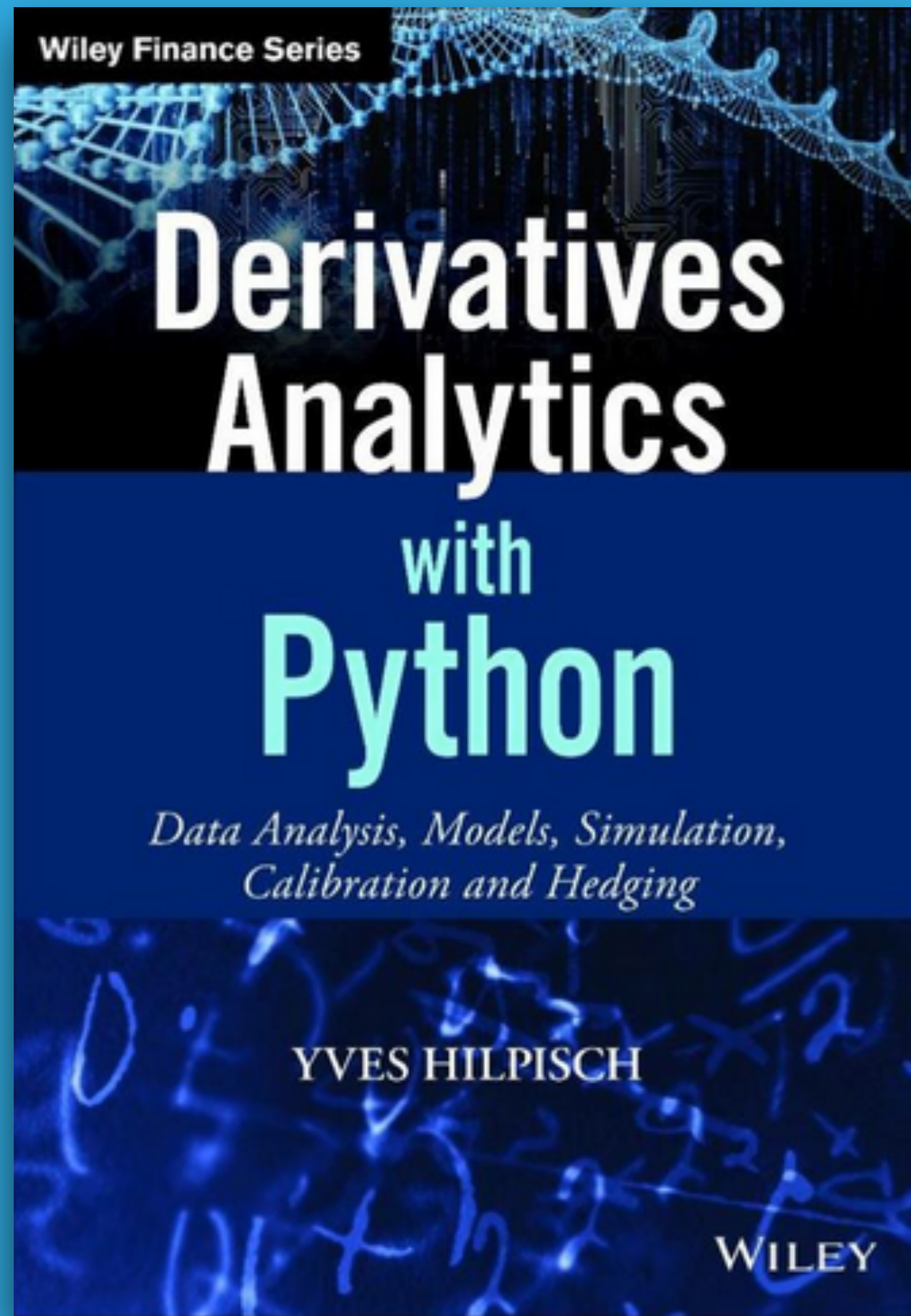
- Major Python Idioms
- NumPy Package
- SciPy & SymPy Packages

Yves Hilpisch

Python for Finance



Quant Finance with Python

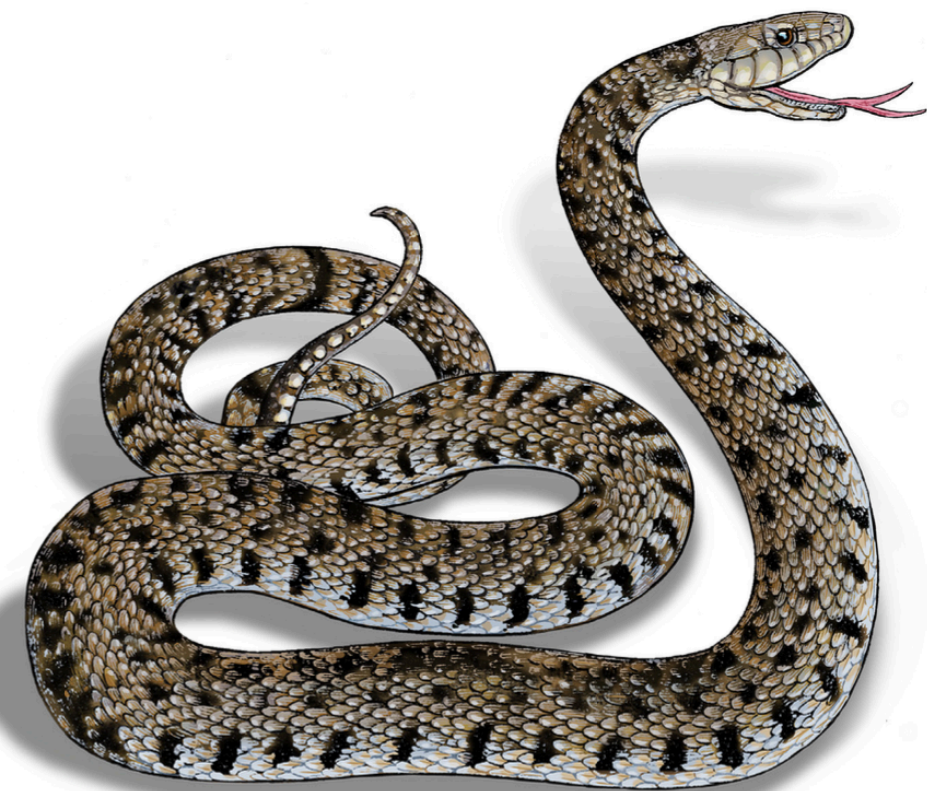


Python & AI for Finance & Trading

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From Idea to Cloud Deployment

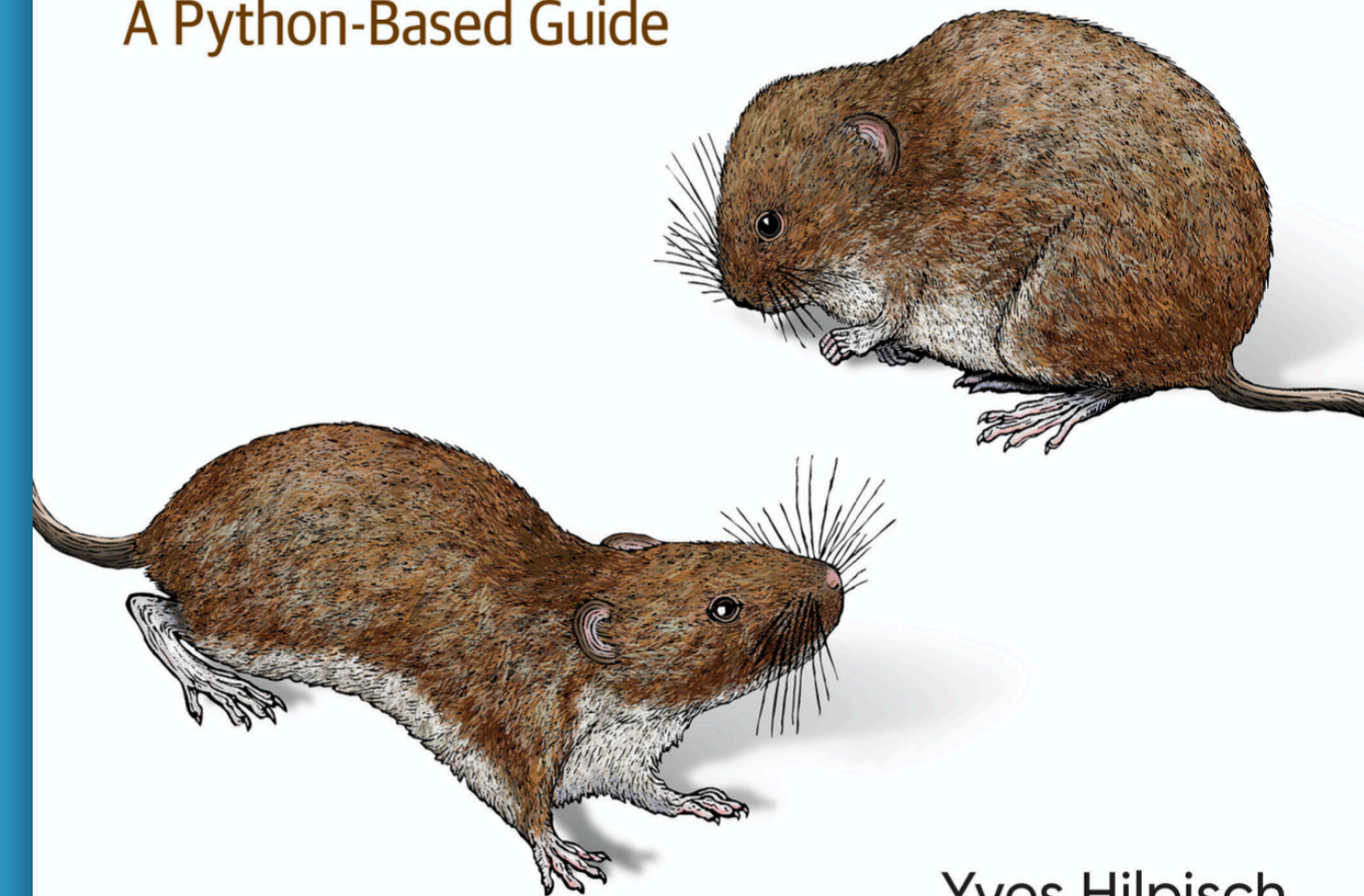


Yves Hilpisch

O'REILLY®

Artificial Intelligence in Finance

A Python-Based Guide



Yves Hilpisch

O'REILLY®
オライリー・ジャパン

Pythonからはじめる アルゴリズムトレード

自動売買の基礎と機械学習の本格導入に向けた
Pythonプログラミング



Yves Hilpisch 著
村上 振一郎 訳

YVES HILPISCH

Trading con Python



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人工智慧的金融應用

運用 Python 的學習指南

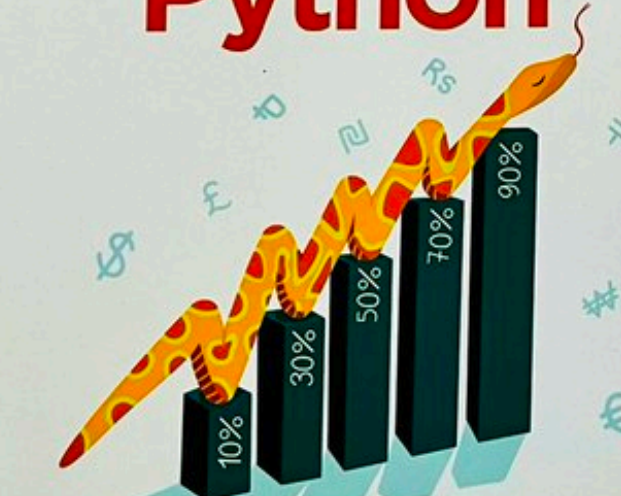


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파이썬을 이용한 알고리즘 트레이딩

Python for Algorithmic Trading
From Idea to Cloud Deployment

아이디어 도출부터
클라우드 배포까지



이브스 힐피쉬 지음
박진수 옮김

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Data-Driven Finance

FINANCIAL TIMES

FRIDAY 12 NOVEMBER 2021 NEWS PROVIDER OF THE YEAR UK £3.95 Channel Islands €3.20 Republic of Ireland €3.20

COP clock runs down



Summit's 'blah blah blah' is welcomed — GILLIAN TRITT, PAGE 25
Business climate pledges' credibility gap — BIG READ, PAGE 25
The struggle to write the carbon market rule book — PAGE 4

Protest legacy

Huge Hong Kong police population keeps itself busy — NOTEBOOK, PAGE 24

Iran impasse

Long wait for liberty goes on

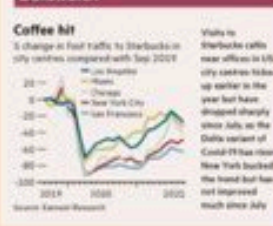
Richard Ratcliffe holds up a picture of the British woman woman who has been imprisoned by Tehran since 2006. Ratcliffe has been on hunger strike outside the Foreign, Commonwealth and Development Office for 19 days, trying to get pressure on the government to do more to secure her release.
Talks between British officials and Iran's foreign minister yesterday — principally to discuss reviving the nuclear deal with the Islamic republic — had raised hopes of a possible breakthrough. However, Ratcliffe said he had been told "nothing" after speaking to General Clerici, the foreign minister involved in negotiations.
[UK web page](#)



Briefing

- **NHS waiting list soars to almost 6m**
New data have shown 5.6m people were waiting for hospital care in England in September, up by more than 1m in a year. Medical bodies said the figures were "unacceptable" and "shocking". — [page 1](#)
- **Wall St coaxes in on GE's decline and fall**
General Electric has paid more than 37% in losses to banks since 2009 as lenders sought to ensure the troubled debt-holding that culminated in a falling share price and the break-up of the group. — [page 4](#)
- **Johnson's Matthew can battery chemicals**
The 204-year-old company has done a U-turn in its ambition to develop a national champion in the new-to-power electric cars with a division to stop making chemicals for batteries. — [page 10](#), [page 11](#)
- **Uber chief flies in to its London crisis**
Dara Khosrowshahi has held the FT that resolving a shortage of 20,000 drivers in the UK was a priority. The taxi company has raised fares and paid out several licences. — [page 11](#)
- **Race to feed Afghan as winter looms**
All agencies have said they have weeks to supply food to remote regions before winter sets in for all for months, as Afghanistan faces the world's worst humanitarian crisis. — [page 11](#), [page 12](#)
- **Lukashenko threatens EU gas supplies**
The Belarusian president has threatened to cut the transit of gas and goods to Europe if the EU imposes further sanctions on his regime over the migrant crisis on his country's border with Poland. — [page 1](#)
- **Foreign buyers triple home ownership**
The number of homes in England and Wales owned by overseas buyers has tripled in the past decade, with cities outside London also their target. Foreign ownership in Liverpool has risen from 4% to 14%. — [page 1](#)

Datawatch



Xi cements grip on China after vote puts him on par with Mao

Party says nation 'rejuvenated' • Third five-year term likely • New emphasis on socialism

BY REPORTERS
China's Communist party has passed its first "historical resolution" in 40 years, paving the way for President Xi Jinping to serve until at least 2028.
The resolution, formally adopted by the party's central committee at the end of its annual meeting, set the scene for Xi's second five-year term in office. It also declared that Xi's leadership was "the key to the great rejuvenation of the Chinese nation".
The resolution's annual plenary is particularly significant as it comes just a year before a party congress is expected to elect a new leadership team to serve until 2027.
Communist China has almost reversed its decline, Mao Zedong and Deng Xiaoping, and similar revolutions to secure

its grip on power in 1949 and 1989, respectively. Xi declared "the great rejuvenation of the Chinese nation has entered an irreversible historical process" under Xi's leadership, the party has in effect elevated him as an equal of Mao and Deng, replacing his predecessor as the party's general secretary, Hu Jintao, and Jiang Zemin.
Xi, the plenary said, had "resolved many problems that [the party] failed to address for a long time despite setbacks and setbacks".
Xi and Jiang presided over peaceful and orderly transitions of power, with their successors identified five years in advance. Xi is expected to dispense with that tradition and secure a third five-year term as the party's general secretary late next year. Xi did not identify a successor at the start of his second term in 2017. His third term as president would begin in March 2023.
"The central purpose of the plenary is to cement Xi Jinping's leadership," said Wang Kang, a China expert at Singapore Management University.
Xi led the party to its revolutionary victory in 1949, while Deng set it on course to be a global economic power with his "reform and opening" policies introduced in the early 1980s.
But Xi has discarded what many regard as Deng's greatest accomplishment, such as the introduction of a one-party state, the presidency and clearer party-state divisions, while rejecting the egalitarian ideals of the reforms and Mao's early years in power.
"The plenary's message in the return



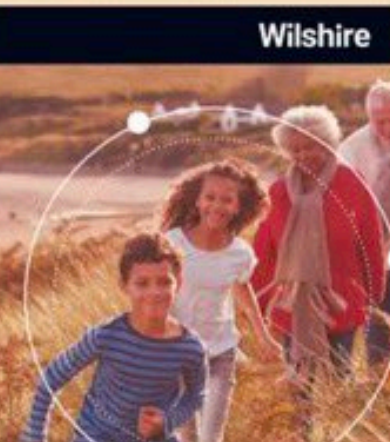
Xi Jinping's leadership was declared to have resolved many problems that the party failed to address for a long time despite setbacks and setbacks.

De Klerk, last president of apartheid era, dies at 85

BY PETER HARRISON
Felix de Klerk, who shared the Nobel Peace Prize with Nelson Mandela for dismantling apartheid, has died at the age of 85. As South African president he had the courage to initiate the country's engagement in social engineering that not only ended that brutal apartheid but also paved the way for a new South Africa.
Mr. de Klerk's death comes at a time when the world is celebrating the 30th anniversary of the end of apartheid. He was mayor of Johannesburg between 2006 and 2014. His tenure followed when he was mayor of Johannesburg of 12 years from 2007 to 2011. He

Johnson's £4m outside earnings open him to charges of hypocrisy from MPs

BY JIM PICKARD AND KATHY DUNN
Boris Johnson, who this week ordered his MPs to donate themselves "where all in your constituencies" instead of working on second jobs, has himself earned more than £4m from his own outside interests in the past 18 years.
Since he was elected parliament in 2010 he made £3.6m, mostly in his last year as a backbencher in 2019 and 2020 when he was in charge of the country's engagement in social engineering that not only ended that brutal apartheid but also paved the way for a new South Africa.
These earnings include £4.8 million from speeches, £400,000 from columns and £1,000,000 from book advances and royalties. He was mayor of London between 2006 and 2014. His tenure followed when he was mayor of Johannesburg of 12 years from 2007 to 2011. He



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World Markets	
INDEXES	CURRENCIES
DAX 30,000.00 (+0.2%)	EUR/USD 1.1785 (+0.0001)
NASDAQ 14,500.00 (+0.1%)	GBP/USD 1.3750 (+0.0001)
S&P 500 4,500.00 (+0.1%)	USD/JPY 109.50 (+0.01)
FTSE 100 7,500.00 (+0.1%)	AUD/USD 0.7800 (+0.0001)
Nikkei 225 26,000.00 (+0.1%)	HKD/HK\$ 7.7500 (+0.0001)
Hang Seng 26,000.00 (+0.1%)	SGD/S\$ 1.3500 (+0.0001)
Shanghai 3,500.00 (+0.1%)	INR/USD 0.1900 (+0.0001)
ASX 7,500.00 (+0.1%)	BRL/USD 0.5000 (+0.0001)
IBEX 12,000.00 (+0.1%)	RUB/USD 0.0800 (+0.0001)
SEMI-CONDUCTORS	COMMODITIES
ICE 100 100.00 (+0.1%)	WTI 65.00 (+0.10)
COMMODITIES	COMMODITIES
WTI 65.00 (+0.10)	WTI 65.00 (+0.10)
WTI 65.00 (+0.10)	WTI 65.00 (+0.10)
WTI 65.00 (+0.10)	WTI 65.00 (+0.10)

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THE WALL STREET JOURNAL

WEDNESDAY, NOVEMBER 10, 2021 - VOL. CCLXXVIII NO. 112 WSJ.com \$5.00
DOW JONES | News Corp | NASDAQ 15886.54 +0.6% | STOXX 600 482.71 +0.2% | 10-YR. TREAS. 1.93% | OIL \$84.15 +\$2.22 | GOLD \$1,830.20 +\$2.80 | EURO \$1.1596 | YEN 112.88

What's News

Business & Finance

- **General Electric, the company that for more than a century stood as a beacon of U.S. manufacturing might and management prowess, will split into three public companies, drawing the curtain on an era of business—the dominance of industrial conglomerates. AI, A12, A13**
- **U.S. stocks fell back, from record levels, with the Nasdaq, S&P 500 and Dow declining 0.6%, 0.4% and 0.3%, respectively. B12**
- **Rivian priced its highly anticipated IPO at \$78 a share, well above its raised expectations, valuing the electric-vehicle maker at more than \$77 billion on a fully diluted basis. B1**
- **Palmer plans to go public and has secured an unconventional investment from restaurateur Danny Meyer's SPAC. B1**
- **Semiconductor makers have earned less than 17% of the roughly \$146 billion the industry will devote to capital spending this year to legacy chips, Gartner estimates. B1**
- **Hertz, which emerged from bankruptcy this summer, listed on the Nasdaq, with shares closing down nearly 10% in the first day of trading. B1**
- **DoorDash said it agreed to acquire European food-delivery company Wolt in a deal valued at over \$8 billion. B3**
- **Presto is close to a deal to combine with a SPAC and go public in a merger that would value the restaurant-technology firm at about \$1 billion. B3**
- **Video game company Unity agreed to pay \$1.3 billion for major parts of its rival-effects studio Weta. B4**

Tax Bill Looms as Musk Eyes Share Sale

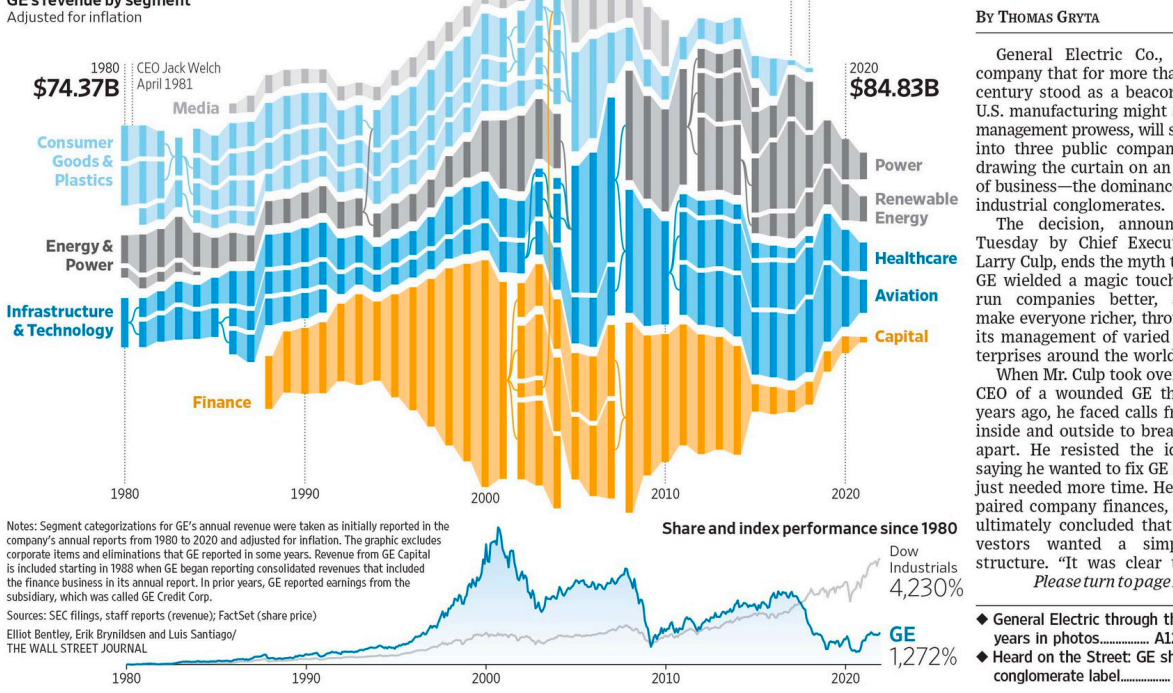
Elon Musk's pledge to sell 10% of his Tesla Inc. stock highlights the complex financial web the world's richest man has spun around his personal fortune.
By Rebecca Elliott, Richard Rubin and Theo Francis

World-Wide

- **Nicaragua, after a presidential election the U.S. called fraudulent, is now widely seen to have become Latin America's third dictatorship and part of a broader trend of democratic backsliding across the region. U.S. officials and political analysts said. A1**
- **Ports snarled with supply-chain problems will be able to redirect money from other federally funded projects to help ease the logjams under a plan outlined by the Biden administration. A2**
- **The Oklahoma Supreme Court overturned a ruling that held J&J liable for contributing to the state's opioid-addiction crisis. A2**
- **Pfizer and partner BioNTech asked U.S. health regulators to expand the authorization of their Covid-19 booster to people as young as 18 years old. A3**
- **A federal judge said records from the Trump White House can be turned over to the House committee investigating the Jan. 6 assault on**

GE Breakup Marks End of an Era

Over the past four decades, GE's revenue swelled and ebbed under four CEOs as it focused on different businesses, including a shift away from consumer goods and a bet on finance.



Facebook Rife With Stolen Content

Facebook has allowed plagiarized and recycled content to flourish on its platform despite having policies against it, the tech giant's researchers warned in internal memos.
About 40% of the traffic to Facebook pages at one point in 2018 went to pages that stole or repurposed most of their content, according to a research report that year by Facebook senior data scientist Jeff Allen, one of a dozen internal communications reviewed by The Wall Street Journal.
Pages are used by businesses and organizations to disseminate content on Facebook, while individual users put content on what Facebook calls "profiles."
The researchers also wrote Facebook has been slow to crack down on copyright infringement for fear of opening itself to legal liability.
"What's the easiest (lowest effort) way to make a big Facebook Page?" Mr. Allen wrote in an internal slide presentation the following year. "Step 1: Find an existing, engaged community on [Facebook]. Step 2: Scrape/Aggregate content popular in that community. Step 3: Repost most popular content on your Page."
Mr. Allen, who left Facebook in late 2019, wrote that Facebook pages seeking big follow-

A \$115,000 USC Degree Yields Low Pay, Huge Debts

Elite school hired for-profit firm to woo students to social-work master's
BY LISA BANNON AND ANDREA FULLER
Over the past decade, the University of Southern California has used a for-profit company to help enroll thousands of students in its online social-work master's program.
The nonprofit school used its status-symbol image to attract students across the country, including low-income minority students it targeted for recruitment, often with aggressive tactics. Most students piled on debt to afford the tuition, which last year reached \$115,000 for the two-year degree.
The majority never set foot on the posh Los Angeles campus but paid the same rate for online classes as in-person students.
Recent USC social-work graduates who took out federal loans borrowed a median \$12,000. Half of them were earning \$52,000 or less annually two years later, a Wall Street Journal analysis of newly released U.S. Education Department data found. Compared with other master's-degree programs, debt to afford the tuition, which last year

Democracy Loses Favor

Is Santa

From print ...

Financial Times | ft.com

FTSE 100 -0.01% | S&P 500 -0.00% | Euro/Dollar +0.04% | Pound/Dollar +0.25% | Brent Crude Oil +0.96% | 10 Year US Gov +2.50%

FINANCIAL TIMES

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HOME | WORLD | US | COMPANIES | TECH | MARKETS | CLIMATE | OPINION | WORK & CAREERS | LIFE & ARTS | HOW TO SPEND IT

US-China relations

Biden urges Xi not to allow competition to 'veer into conflict'

Leaders hold first virtual meeting as ties between US and China fray over Taiwan

UPDATED 43 MINUTES AGO

- Biden and Xi to tackle Taiwan and nuclear build-up in virtual meeting
- Australia vows to help US defend Taiwan from Chinese attacks
- Joe Biden and Xi Jinping to hold virtual summit on Monday



The Big Read

Investors pivot to India after China's tech crackdown

4 HOURS AGO






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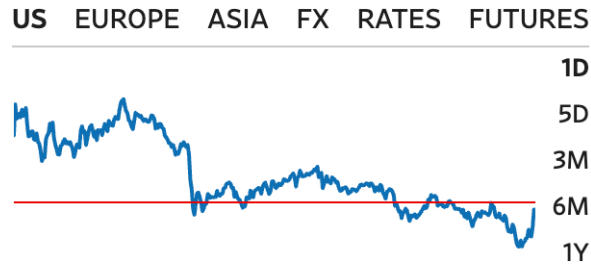
U.S. S&P 500 29808.12 0.11% ▲ | U.S. 10 Yr 1/32 Yield 1.616% ▲ | Crude Oil 81.53 0.80% ▲ | Euro 1.1373 0.05% ▲ | DJIA 36087.45 0.04% ▼

THE WALL STREET JOURNAL.

Yves Hilpisch

U.S. | Politics | Economy | Business | Tech | Markets | Opinion | Books & Arts | Real Estate | Life & Work | WSJ Magazine | Sports

US EUROPE ASIA FX RATES FUTURES



Index	Value	Change	% Change
DJIA	36087.45	-12.86	-0.04%
S&P 500	4682.80	-0.05	-0.00%
Nasdaq	15853.85	-7.11	-0.04%
Russell 2000	2400.93	-10.84	-0.45%
DJ Total Mkt	48582.45	-17.28	-0.04%

View Watchlist | View All Market Data →

OPINION

America Will Be Number One—in Taxes

By The Editorial Board | Review & Outlook

Beto O'Rourke Announces Bid for Texas Governor

4 min read

Kyle Rittenhouse Homicide Trial Wraps Up

5 min read

America's Infrastructure Struggles With New Weather Forecast

Historically anomalous heat and rain have overwhelmed systems designed to withstand old meteorological patterns, and climatologists expect still worse with climate change.

"We've never seen destruction like this before."

523 | Long read

Virtual Meeting

The White House said the U.S. and Chinese presidents discussed a variety of topics including Afghanistan, North Korea and Iran, as well as human rights, climate change and concerns over Taiwan.

492 | 7 min read

How U.S. Plays Catch-Up on China's Push for Influence

President Signs Infrastructure Bill Into Law

The passage of the \$1 trillion bill to repair roads and bridges, upgrade the electrical grid and expand access to broadband internet marks a rare bipartisan policy win for the White House.

6 min read

What's in the Bill? From Amtrak to Roads to Water Systems

Shell to Move Headquarters to London Amid

... to the Web ...

The image displays a financial terminal interface for Apple Inc. (AAPL). The main window shows the stock price at 123.08 USD, with a volume of 13,358 and a market cap of 2.093T USD. The interface is divided into several sections:

- Overview:** Includes a price chart for AAPL.O showing a price of 123.13 and a YTD gain of 67.66%.
- News & Research:** Lists recent news items such as "Refinitiv Newscasts - Evidence of Belarus providing migrants tourist visas" and "S. Korea's new law on in-app payment is 'monumental': CAF chief".
- Price & Charts:** Shows a candlestick chart for AAPL.O with a price of 123.13 and a volume of 13,358.
- Estimates:** Provides financial metrics like PE (LTM) at 37.676, Div Yield at 0.666%, and DR at 1.0:1.
- Financials:** Lists key financial ratios such as EV/EBITDA (24), P/B (2), and P/CF (31).
- RECOMMENDATIONS:** Shows analyst ratings for AAPL, including 11 Strong Buy, 19 Buy, 8 Hold, 1 Sell, and 1 Strong Sell. The Price Target (Mean) is USD 125.92 with a 2% upside.
- ESTIMATES:** Provides guidance for QTR Dec-2020 and FY Sep-2021, including EPS and Rev.
- NEWS:** Lists recent news items such as "Apple sued over old iPhones in Europe Tech giant i..." and "《A股动向》苹果因旧款手机电池问题在欧洲多国面临诉讼".
- RESEARCH:** Lists research reports from various contributors, including Equiti and Trefis.
- EVENTS:** Lists upcoming events such as "AAPL34.SA Final Cash Dividend of gross BRL 0.123473 paid on Nov 18, 2021" and "Q1 2021 Apple Inc Earnings Release".
- PEERS:** Lists peer companies such as HP Inc. with their respective market caps and financial metrics.

... to the Terminal ...

Tick Data

```
[4]: %%time
data = ek.get_timeseries('AAPL.O',
                        start_date='2021-11-15 15:00:00',
                        end_date='2021-11-15 15:30:00',
                        interval='tick',
                        fields=['*'])
```

```
CPU times: user 120 ms, sys: 14.5 ms, total: 135 ms
Wall time: 2.7 s
```

```
[5]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 41213 entries, 2021-11-15 15:00:00.004000 to 2021-11-15 15:29:59.936000
Data columns (total 2 columns):
#   Column  Non-Null Count  Dtype
---  -
0   VALUE   41145 non-null    Float64
1   VOLUME  41213 non-null    Int64
dtypes: Float64(1), Int64(1)
memory usage: 1.0 MB
```

```
[14]: data.tail()
```

```
[14]:
```

	AAPL.O	VALUE	VOLUME
	Date		
	2021-11-15 15:29:59.134	150.4456	10
	2021-11-15 15:29:59.313	150.445	1
	2021-11-15 15:29:59.588	150.4409	150
	2021-11-15 15:29:59.745	150.445	1
	2021-11-15 15:29:59.936	150.4488	5

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Apple Event on 18. October 2021 (<https://www.apple.com/de/apple-events/october-2021/>).

```
[9]: headlines = ek.get_news_headlines(query='R:AAPL.0 macbook',  
                                     count=5,  
                                     date_from='2021-10-18',  
                                     date_to='2021-10-19')
```

```
[10]: headlines
```

```
[10]:
```

	version	Created	text	storyId	sourceCode
	2021-10-18 23:30:18.401	2021-10-18 23:30:18.401000+00:00	Apple is finally fixing the things people hate...	urn:newsml:reuters.com:20211018:nNRAh2psl1:1	NS:WASHPO
	2021-10-18 23:10:18.012	2021-10-18 23:10:18.012000+00:00	Apple event – live: Macbook Pro and other new ...	urn:newsml:reuters.com:20211018:nNRAh2kj3a:1	NS:INDEPE
	2021-10-18 21:41:19.927	2021-10-18 21:41:19.927000+00:00	New MacBook Pro features ultra-fast chips, ret...	urn:newsml:reuters.com:20211018:nNRAh2u38b:1	NS:EFEING
	2021-10-18 21:33:50.860	2021-10-18 21:33:50.860000+00:00	Apple Event: MacBook Pro 2021 alleged pictures...	urn:newsml:reuters.com:20211018:nNRAh2u1wj:1	NS:TIMIND
	2021-10-18 21:33:50.623	2021-10-18 21:33:50.623000+00:00	Apple launches new MacBook Pro: Price, specs a...	urn:newsml:reuters.com:20211018:nNRAh2u1vv:1	NS:TIMIND

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```
[11]: story = headlines.iloc[0]
```

```
[12]: story
```

```
[12]: versionCreated      2021-10-18 23:30:18.401000+00:00  
text      Apple is finally fixing the things people hate...  
storyId      urn:newsml:reuters.com:20211018:nNRAh2psl1:1  
sourceCode      NS:WASHPO  
Name: 2021-10-18 23:30:18.401000, dtype: object
```

```
[13]: news_text = ek.get_news_story(story['storyId'])
```

```
[14]: from IPython.display import HTML
```

```
[15]: HTML(news_text)
```

```
[15]: The demise of MagSafe charging. An inelegant Touch Bar. Limited selection of ports. The laundry list of complaints about Apple's laptops has steadily grown over the past five years. Now, Apple is finally walking back those changes.
```

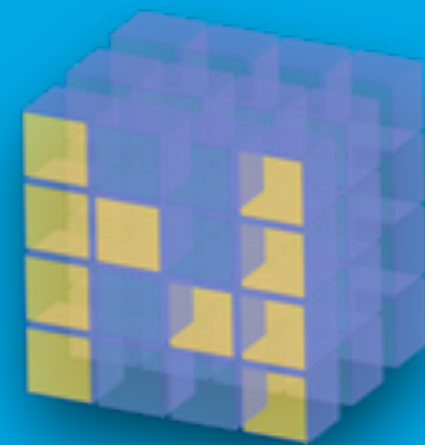
On Monday, the Cupertino, Calif., company unveiled a pair of new MacBook Pro laptops, powered by its latest homegrown processors and free of the many limitations that plagued earlier models. It also showed off a set of updated AirPods and colorful HomePod mini smart speakers. Riding high from record Mac sales last year, Apple made sure to make its new MacBooks the star of its virtual event Monday.

Still, computers that run Apple's MacOS software account for only a fraction of the overall PC landscape — just over 7 percent as of the end of the second quarter, according to market research firm IDC. Its market share has slipped from 8 percent in the first quarter and 7.6 percent a year earlier, IDC data showed. The changes on display Monday seem to be geared more toward

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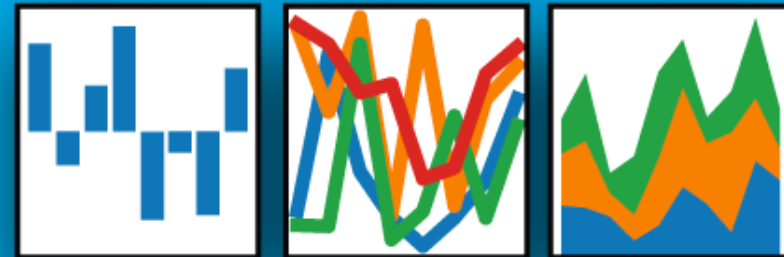
```
IP[y]:  
IPython
```



NumPy



pandas
 $y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$



Keras

Code & Slides

- http://bit.ly/pdb_diy (Gist)
- http://certificate.tpq.io/pdb_diy.pdf (Slides)

Case Study: Financial Data APIs

AAPL 163.1900 AMZN 129.79 BTC-USD 20405.9300 ETH-USD 1586.7600 EURUSD 1.0026 TSLA 289.9100



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Case Study: Asset Allocation

PORTFOLIO SELECTION*

HARRY MARKOWITZ
The Rand Corporation

THE PROCESS OF SELECTING a portfolio may be divided into two stages. The first stage starts with observation and experience and ends with beliefs about the future performances of available securities. The second stage starts with the relevant beliefs about future performances and ends with the choice of portfolio. This paper is concerned with the second stage. We first consider the rule that the investor does (or should) maximize discounted expected, or anticipated, returns. This rule is rejected both as a hypothesis to explain, and as a maximum to guide investment behavior. We next consider the rule that the investor does (or should) consider expected return a desirable thing *and* variance of return an undesirable thing. This rule has many sound points, both as a maxim for, and hypothesis about, investment behavior. We illustrate geometrically relations between beliefs and choice of portfolio according to the "expected returns—variance of returns" rule.

One type of rule concerning choice of portfolio is that the investor does (or should) maximize the discounted (or capitalized) value of future returns.¹ Since the future is not known with certainty, it must be "expected" or "anticipated" returns which we discount. Variations of this type of rule can be suggested. Following Hicks, we could let "anticipated" returns include an allowance for risk.² Or, we could let the rate at which we capitalize the returns from particular securities vary with risk.

The hypothesis (or maxim) that the investor does (or should) maximize discounted return must be rejected. If we ignore market imperfections the foregoing rule never implies that there is a diversified portfolio which is preferable to all non-diversified portfolios. Diversification is both observed and sensible; a rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim.

* This paper is based on work done by the author while at the Cowles Commission for Research in Economics and with the financial assistance of the Social Science Research Council. It will be reprinted as Cowles Commission Paper, New Series, No. 60.

1. See, for example, J. B. Williams, *The Theory of Investment Value* (Cambridge, Mass.: Harvard University Press, 1938), pp. 55-75.

2. J. R. Hicks, *Value and Capital* (New York: Oxford University Press, 1939), p. 126. Hicks applies the rule to a firm rather than a portfolio.

For fixed probability beliefs (μ_i, σ_{ij}) the investor has a choice of various combinations of E and V depending on his choice of portfolio X_1, \dots, X_N . Suppose that the set of all obtainable (E, V) combinations were as in Figure 1. The E - V rule states that the investor would (or should) want to select one of those portfolios which give rise to the (E, V) combinations indicated as efficient in the figure; i.e., those with minimum V for given E or more and maximum E for given V or less.

There are techniques by which we can compute the set of efficient portfolios and efficient (E, V) combinations associated with given μ_i

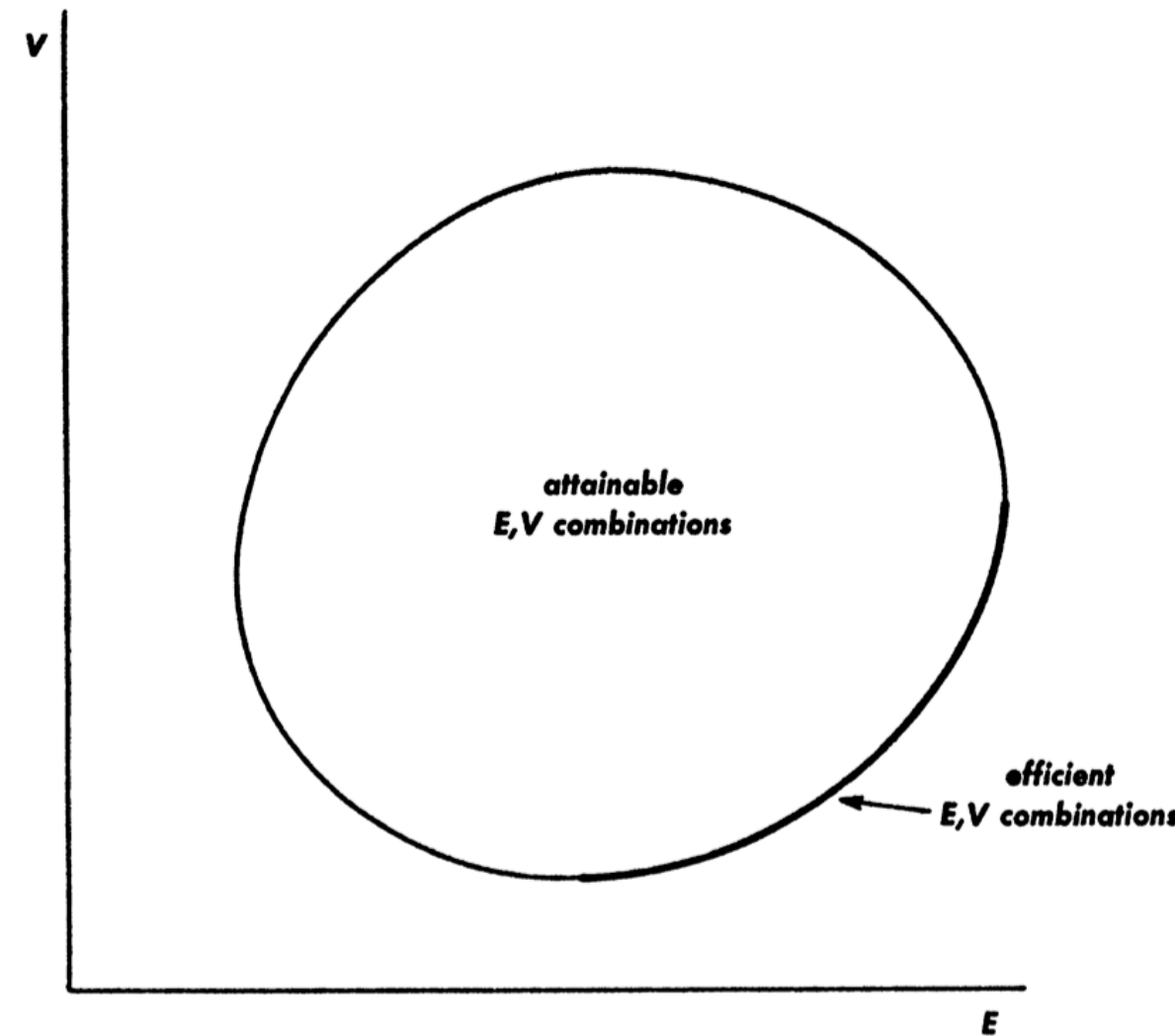


FIG. 1

and σ_{ij} . We will not present these techniques here. We will, however, illustrate geometrically the nature of the efficient surfaces for cases in which N (the number of available securities) is small.

The calculation of efficient surfaces might possibly be of practical use. Perhaps there are ways, by combining statistical techniques and the judgment of experts, to form reasonable probability beliefs (μ_i, σ_{ij}). We could use these beliefs to compute the attainable efficient combinations of (E, V). The investor, being informed of what (E, V) combinations were attainable, could state which he desired. We could then find the portfolio which gave this desired combination.

Two conditions—at least—must be satisfied before it would be practical to use efficient surfaces in the manner described above. First, the investor must desire to act according to the E - V maxim. Second, we must be able to arrive at reasonable μ_i and σ_{ij} . We will return to these matters later.

Let us consider the case of three securities. In the three security case our model reduces to

- 1) $E = \sum_{i=1}^3 X_i \mu_i$
- 2) $V = \sum_{i=1}^3 \sum_{j=1}^3 X_i X_j \sigma_{ij}$
- 3) $\sum_{i=1}^3 X_i = 1$
- 4) $X_i \geq 0$ for $i = 1, 2, 3$.

From (3) we get

$$3') \quad X_3 = 1 - X_1 - X_2$$

If we substitute (3') in equation (1) and (2) we get E and V as functions of X_1 and X_2 . For example we find

$$1') \quad E = \mu_3 + X_1(\mu_1 - \mu_3) + X_2(\mu_2 - \mu_3)$$

The exact formulas are not too important here (that of V is given below).⁸ We can simply write

- a) $E = E(X_1, X_2)$
- b) $V = V(X_1, X_2)$
- c) $X_1 \geq 0, X_2 \geq 0, 1 - X_1 - X_2 \geq 0$

By using relations (a), (b), (c), we can work with two dimensional geometry.

The attainable set of portfolios consists of all portfolios which satisfy constraints (c) and (3') (or equivalently (3) and (4)). The attainable combinations of X_1, X_2 are represented by the triangle \bar{abc} in Figure 2. Any point to the left of the X_2 axis is not attainable because it violates the condition that $X_1 \geq 0$. Any point below the X_1 axis is not attainable because it violates the condition that $X_2 \geq 0$. Any

8. $V = X_1^2(\sigma_{11} - 2\sigma_{12} + \sigma_{22}) + X_2^2(\sigma_{22} - 2\sigma_{23} + \sigma_{33}) + 2X_1X_2(\sigma_{12} - \sigma_{13} - \sigma_{23} + \sigma_{33}) + 2X_1(\sigma_{13} - \sigma_{23}) + 2X_2(\sigma_{23} - \sigma_{33}) + \sigma_{33}$

Primitives

financial assets

$$n = 1, 2, \dots, N$$

points in time

$$t = t_1, t_2, \dots, t_M$$

historical returns

$$r_t^n, t = t_1, \dots, t_M$$

mean returns

$$\mu_n = \frac{1}{M} \sum_t r_t^n$$

expected returns

$$\mu = (\mu_1, \mu_2, \dots, \mu_N)^T$$

Primitives

variance

$$\mathbf{Var}_n = \frac{1}{M} \sum_t (r_t^n - \mu_n) (r_t^n - \mu_n)$$

volatility (std)

$$\sigma = \sqrt{\mathbf{Var}_n}$$

covariance

$$\mathbf{Cov}_{i,j} = \frac{1}{M} \sum_t (r_t^i - \mu_i) (r_t^j - \mu_j)$$

covariance matrix

$$\Sigma \in \mathbb{R}^{N \times N}$$

Portfolio Statistics

weights

$$\phi = (\phi_1, \dots, \phi_N)^T \in \mathbb{R}^N$$

portfolio return

$$\mu_P = \phi\mu$$

portfolio variance

$$\mathbf{Var}_P = \phi^T \Sigma \phi$$

portfolio volatility

$$\sigma_P = \sqrt{\mathbf{Var}_P}$$

Case Study: Risk Parity

Thierry Roncalli

**Introduction to
Risk Parity and
Budgeting**

Chapman & Hall/CRC FINANCIAL MATHEMATICS SERIES

Marginal Risk Contributions

weights

$$\phi = (w_1, \dots, w_N)^T \in \mathbb{R}^N$$

risk measure

$$\mathcal{R}(\phi)$$

risk contribution

$$\mathcal{RC}_n = \phi_n \frac{\partial \mathcal{R}(\phi)}{\partial \phi_n}$$

Euler decomposition

$$\mathcal{R}(\phi) = \sum_n \mathcal{RC}_n$$

Marginal Volatilities

portfolio volatility $\sigma(\phi) = \sqrt{\phi^T \Sigma \phi}$

marginal volatilities $\frac{\partial \sigma(\phi)}{\partial \phi} = \frac{\Sigma \phi}{\sqrt{\phi^T \Sigma \phi}}$

risk contributions $\mathcal{RC}_n = \phi_n \cdot \frac{(\Sigma \phi)_n}{\sqrt{\phi^T \Sigma \phi}}$

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