智慧金融量化分析
(Artificial Intelligence in Finance and Quantitative Analysis)

數據驅動財務金融
(Data-Driven Finance)

1101AIFQA06
MBA, IM, NTPU (M6132) (Fall 2021)
Tue 2, 3, 4 (9:10-12:00) (8F40)

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2021-11-09

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

1 2021/09/28 智慧金融量化分析概論
(Introduction to Artificial Intelligence in Finance and Quantitative Analysis)

2 2021/10/05 AI 金融科技: 金融服務創新應用
(AI in FinTech: Financial Services Innovation and Application)

3 2021/10/12 投資心理學與行為財務學
(Investing Psychology and Behavioral Finance)

4 2021/10/19 財務金融事件研究法 (Event Studies in Finance)

5 2021/10/26 智慧金融量化分析個案研究 I
(Case Study on AI in Finance and Quantitative Analysis I)

6 2021/11/02 財務金融理論 (Finance Theory)

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

7 2021/11/09 數據驅動財務金融 (Data-Driven Finance)

8 2021/11/16 期中報告 (Midterm Project Report)

9 2021/11/23 金融計量經濟學 (Financial Econometrics)

10 2021/11/30 人工智慧優先金融 (AI-First Finance)

11 2021/12/07 智慧金融量化分析產業實務
(Industry Practices of AI in Finance and Quantitative Analysis)

12 2021/12/14 智慧金融量化分析個案研究 II
(Case Study on AI in Finance and Quantitative Analysis II)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
13	2021/12/21	財務金融深度學習(Deep Learning in Finance); 財務金融強化學習 (Reinforcement Learning in Finance)
14	2021/12/28	演算法交易 (Algorithmic Trading); 風險管理 (Risk Management); 交易機器人與基於事件的回測 (Trading Bot and Event-Based Backtesting)
15	2022/01/04	期末報告 I (Final Project Report I)
16	2022/01/11	期末報告 II (Final Project Report II)
17	2022/01/18	學生自主學習 (Self-learning)
18	2022/01/25	學生自主學習 (Self-learning)

Data-Driven Finance

Data-Driven Finance

- Scientific Method
- Financial Econometrics and Regression
- Data Availability
- Normative Theories Revisited
- Debunking Central Assumptions in Finance

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Data-driven finance

- **Financial context** (**theory, model, application**) **that is primarily driven by and based on insights gained from data.**

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Data-driven finance

Robin Wigglesworth (2019)

- Nowadays, analysts sift through non-traditional information such as satellite imagery and credit card data, or use artificial intelligence techniques such as machine learning and natural language processing to glean fresh insights from traditional sources such as economic data and earnings-call transcripts.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O’Reilly Media.

Scientific Method

- Generally accepted principles that should guide scientific effort
- The scientific method is an empirical method of acquiring knowledge that has characterized the development of science
- It involves careful observation, applying rigorous skepticism about what is observed, given that cognitive assumptions can distort how one interprets the observation.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Scientific Method

- **It involves formulating hypotheses, via induction, based on such observations; experimental and measurement-based testing of deductions drawn from the hypotheses; and refinement (or elimination) of the hypotheses based on the experimental findings**

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Normative Finance and Scientific Method

- **Normative financial theories** mostly rely on assumptions and axioms in combination with deduction as the major analytical method to arrive at their central results.
  - **Expected utility theory (EUT)** assumes that agents have the same utility function no matter what state of the world unfolds and that they maximize expected utility under conditions of uncertainty.
  - **Mean-variance portfolio (MVP)** theory describes how investors should invest under conditions of uncertainty assuming that only the expected return and the expected volatility of a portfolio over one period count.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Normative Finance and Scientific Method

- The **capital asset pricing model (CAPM)** assumes that only the nondiversifiable market risk explains the expected return and the expected volatility of a stock over one period.
- **Arbitrage pricing theory (APT)** assumes that a number of identifiable risk factors explains the expected return and the expected volatility of a stock over time; admittedly, compared to the other theories, the formulation of APT is rather broad and allows for wide-ranging interpretations.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Financial Econometrics and Regression

- [Financial] econometrics is the quantitative application of statistical and mathematical models using [financial] data to develop financial theories or test existing hypotheses in finance and to forecast future trends from historical data.
- It subjects real-world [financial] data to statistical trials and then compares and contrasts the results against the [financial] theory or theories being tested.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Financial Econometrics and Regression

- One of the major tools in **financial econometrics** is **regression**, in both its univariate and multivariate forms
- **Regression** is also a central tool in **statistical learning** in general

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Data Availability

- **Types of (financial) data**
  - **Financial econometrics is driven by statistical methods, such as regression, and the availability of financial data**
  - **Theoretical and empirical financial research was mainly driven by relatively small data sets and was mostly comprised of end-of-day (EOD) data**
  - **Types of financial and other data available in ever increasing granularity, quantity, and velocity.**
- **Quality and quantity via programmatic APIs**
  - **Finance professionals have relied on data terminals from Refinitiv or Bloomberg**
  - **Major breakthrough in data-driven finance via programmatic APIs**

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Relevant types of financial data

Time	Structured data	Unstructured data	Alternative data
Historical	Prices, fundamentals	News, texts	Web, social media, satellites
Streaming	Prices, volumes	News, filings	Web, social media, satellites, Internet of Things

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Normative Theories Revisited

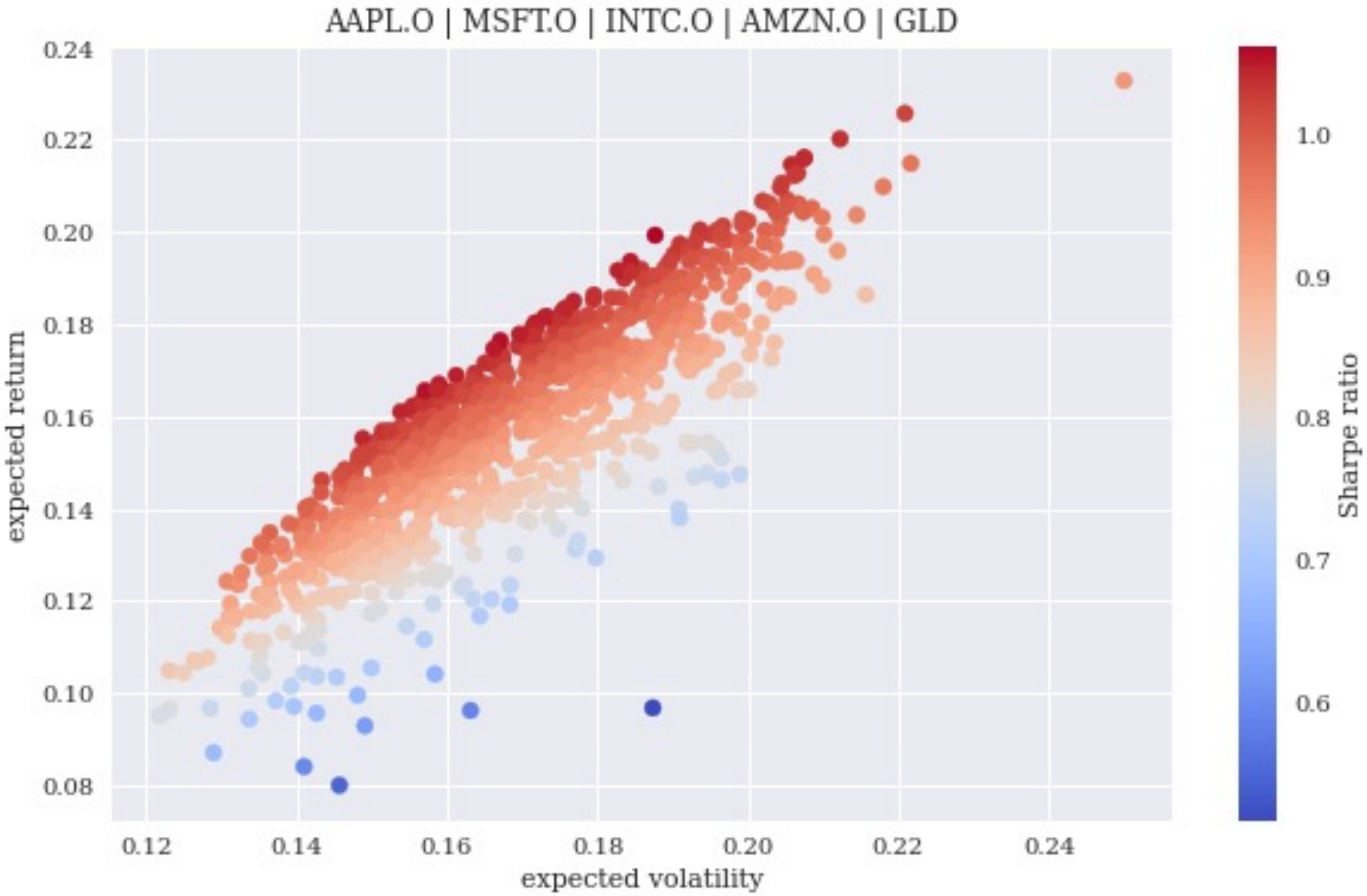
- Revisits the normative theories and analyzes them based on real financial time series data
- Expected Utility and Reality
- Mean-Variance Portfolio Theory (MVPT)
- Capital Asset Pricing Model (CAPM)
- Arbitrage Pricing Theory (APT)

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Normalized financial time series data

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Simulated portfolio volatilities, returns, and Sharpe ratios



Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Expected versus realized portfolio volatilities

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O’Reilly Media.

Expected versus realized portfolio returns

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

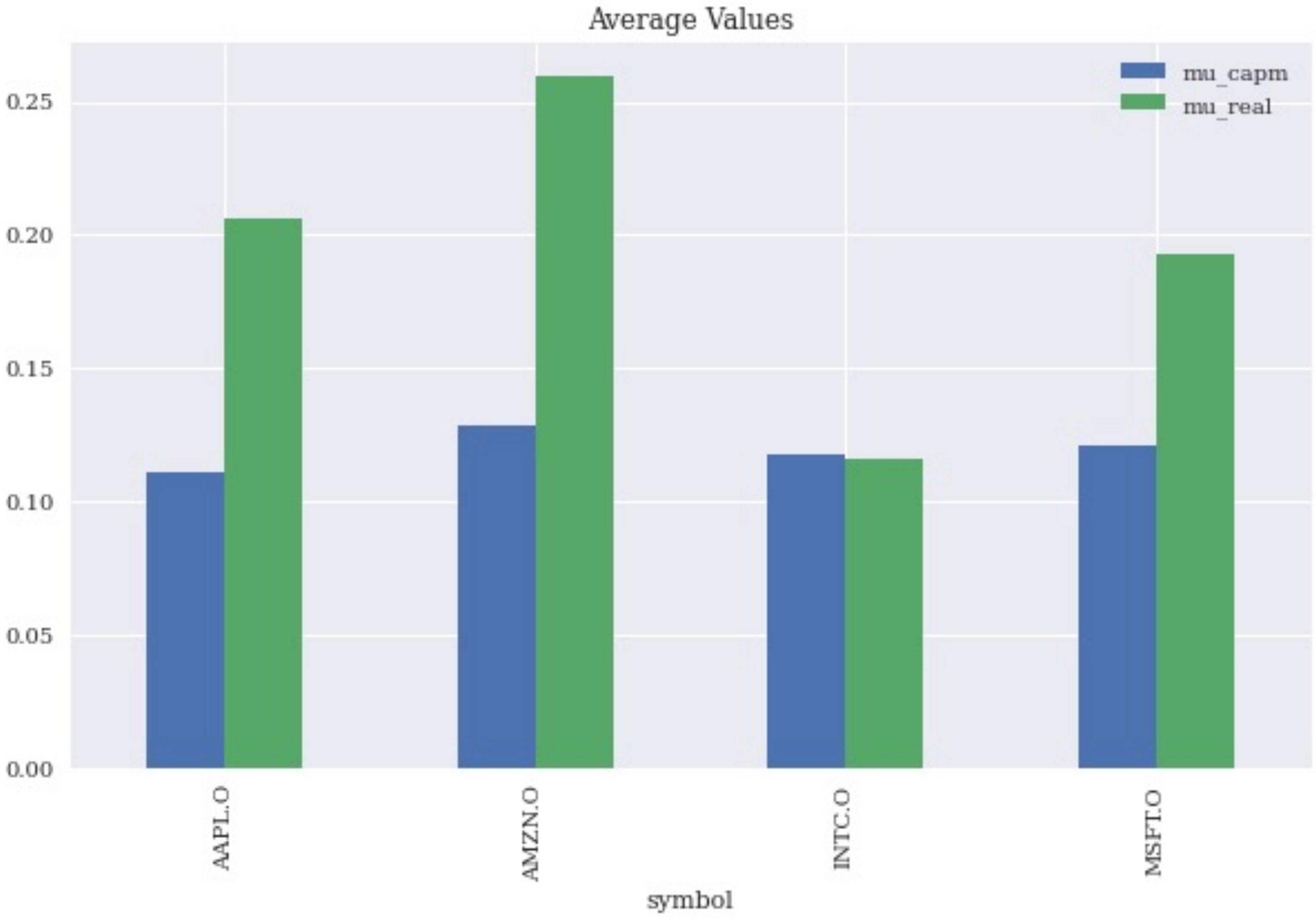
Expected versus realized portfolio Sharpe ratios

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

CAPM-predicted versus realized stock returns for a single stock

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Average CAPM-predicted versus average realized stock returns for multiple stocks



Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Arbitrage Pricing Theory (APT)

Relevant types of financial data

Factor	Description
Market	MSCI World Gross Return Daily USD (PUS = Price Return)
Size	MSCI World Equal Weight Price Net Index EOD
Volatility	MSCI World Minimum Volatility Net Return
Value	MSCI World Value Weighted Gross (NUS for Net)
Risk	MSCI World Risk Weighted Gross USD EOD
Growth	MSCI World Quality Net Return USD
Momentum	MSCI World Momentum Gross Index USD EOD

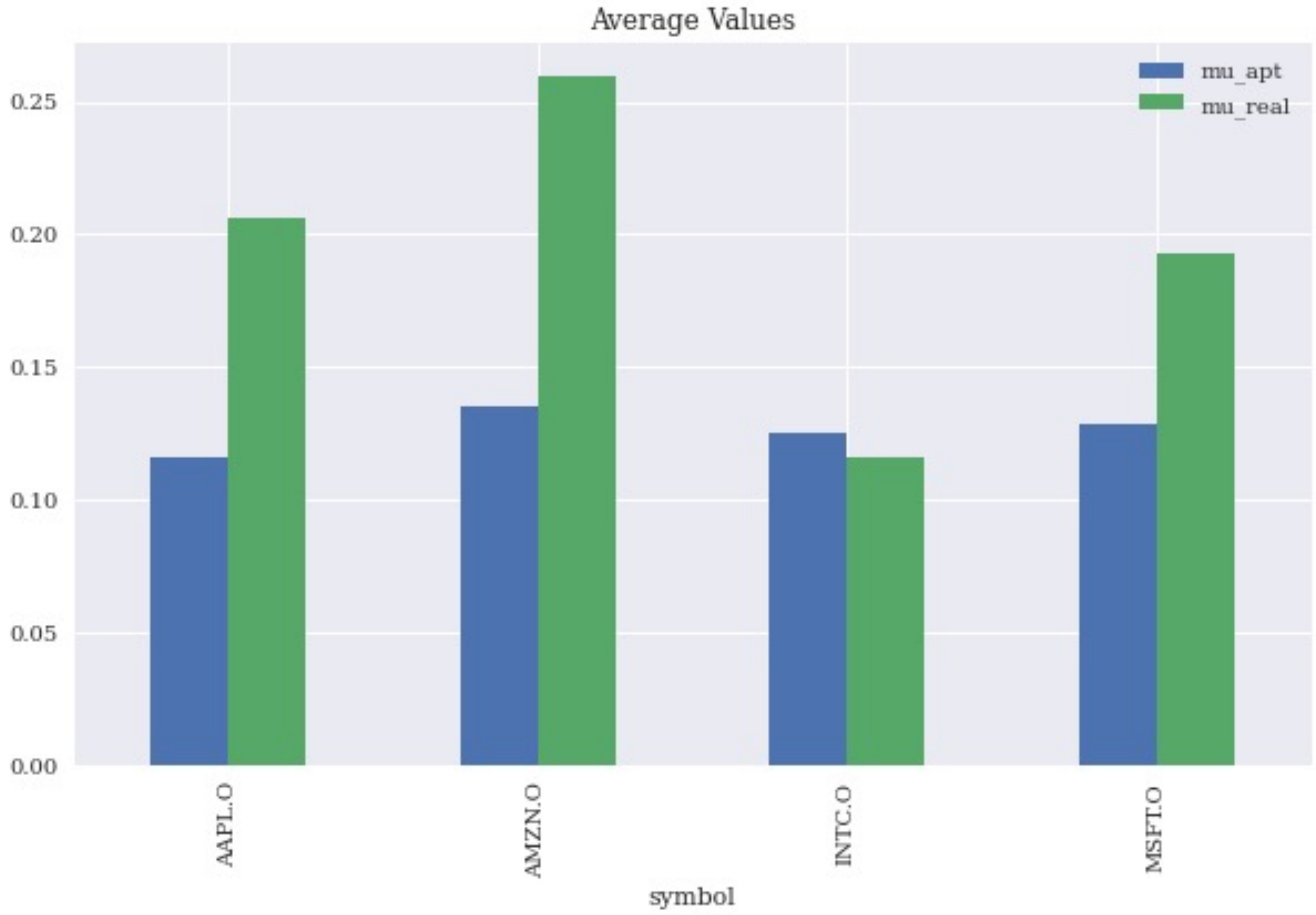
```
factors = pd.read_csv('http://hilpisch.com/aiif_eikon_eod_factors.csv’,
                      index_col=0, parse_dates=True)
```

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O’Reilly Media.

APT-predicted versus realized stock returns for a stock

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Average APT-predicted versus average realized stock returns for multiple stocks

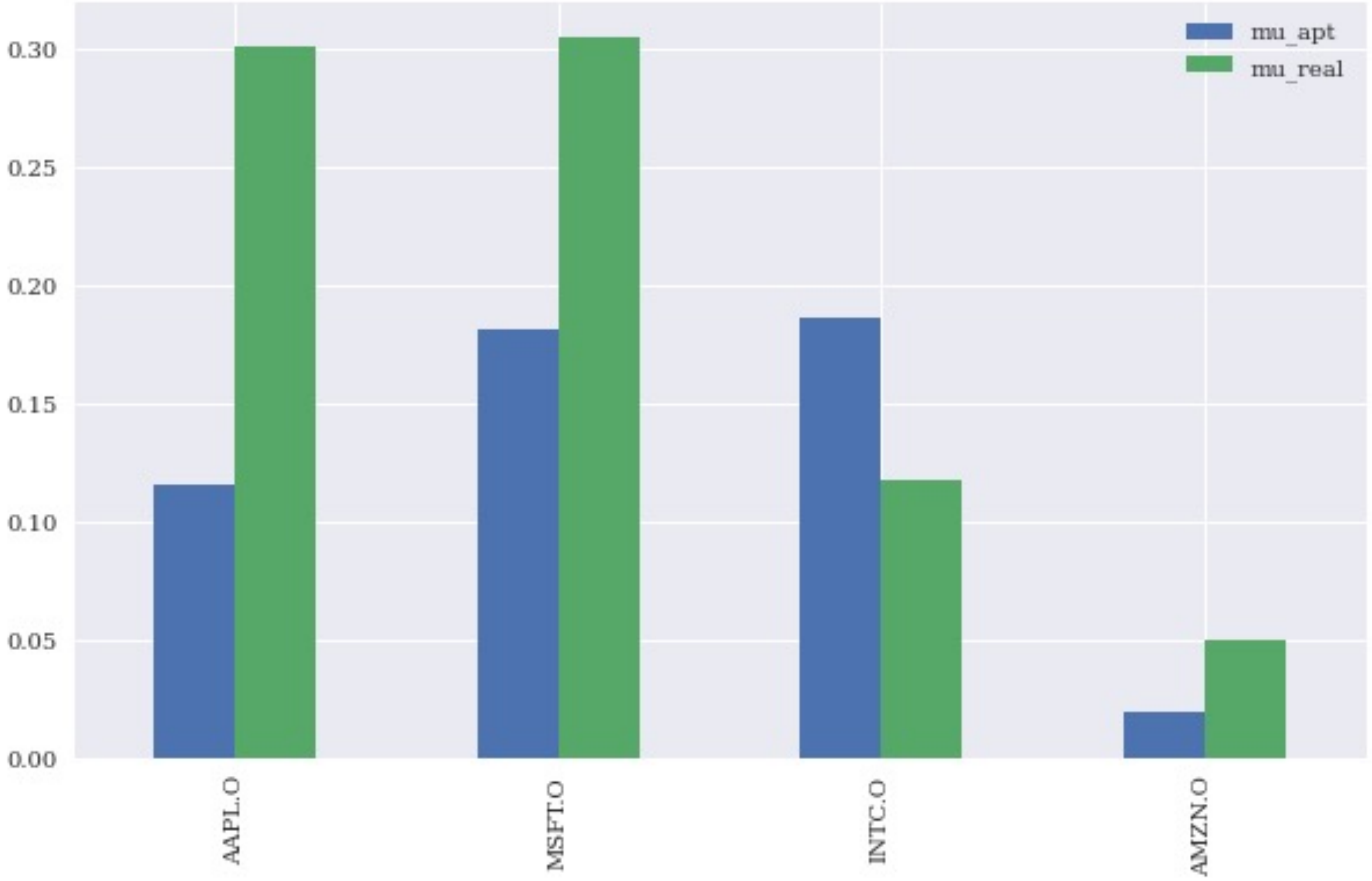


Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Normalized factors time series data

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

APT-predicted returns based on typical factors compared to realized returns



Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

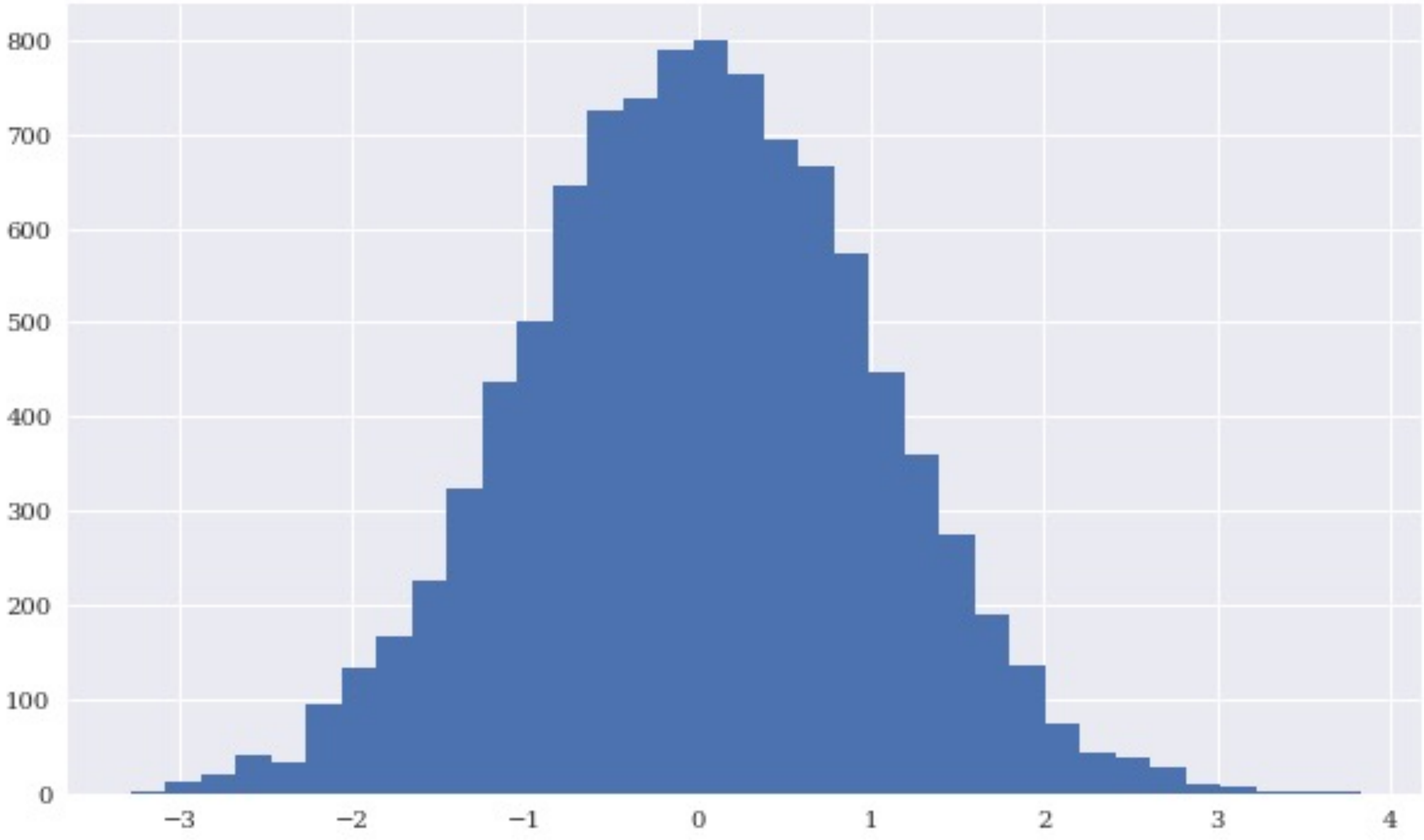
APT-predicted performance and real performance over time (gross)

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Debunking Central Assumptions in Finance

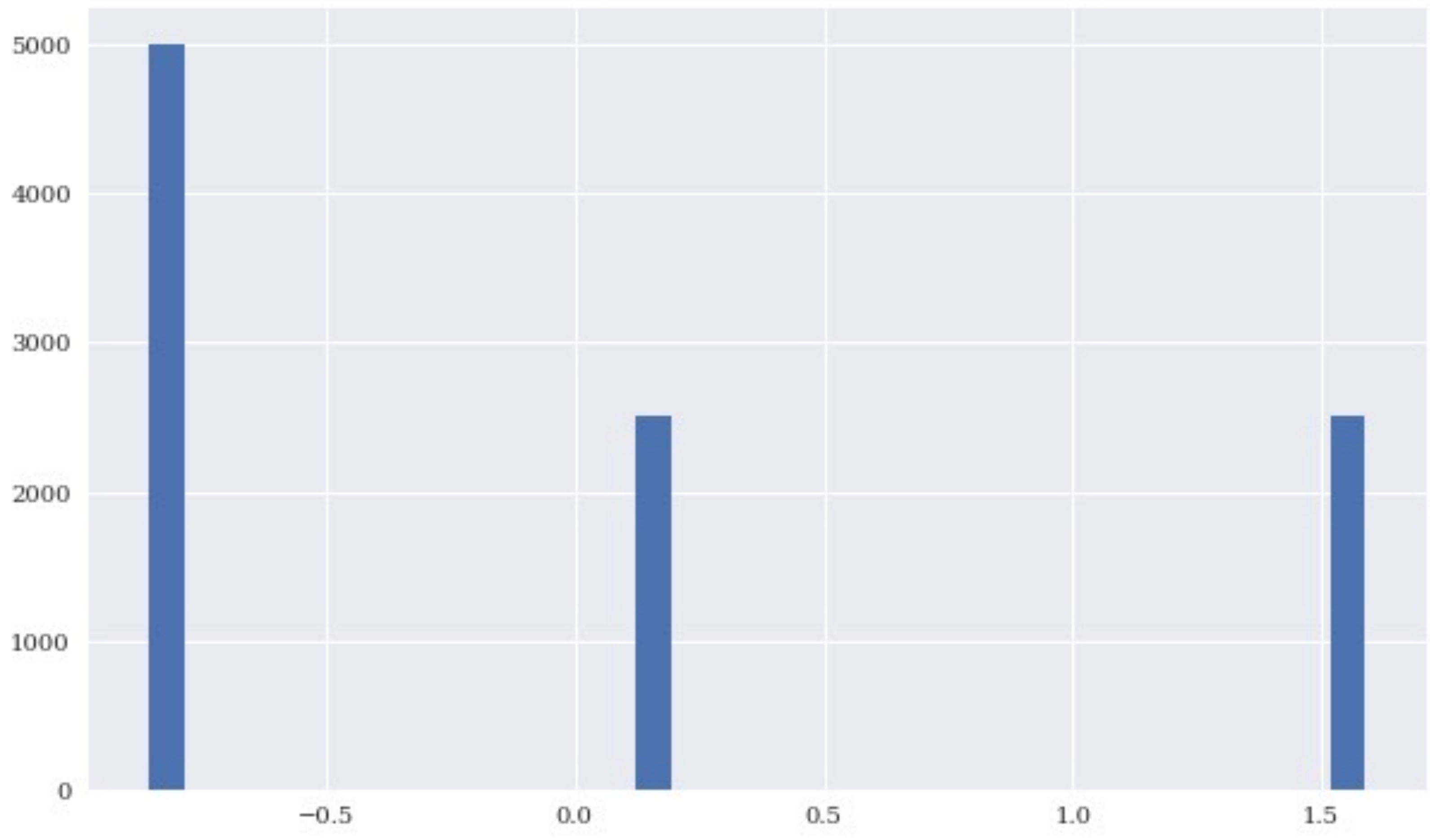
- **Debunks two of the most commonly found assumptions in financial models and theories**
  - **Normality of returns**
  - **Linear relationships**

Standard normally distributed random numbers



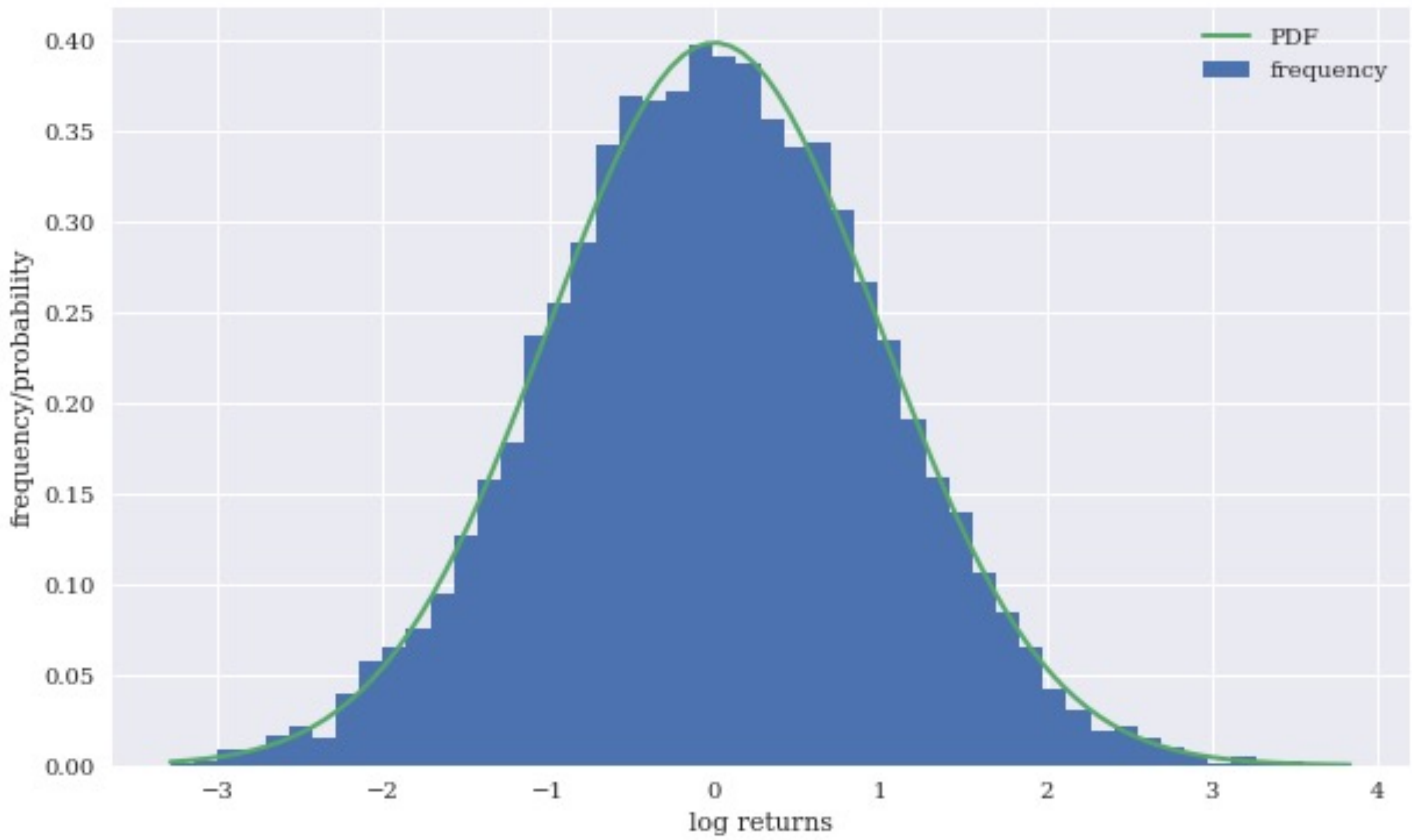
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Distribution with first and second moment of 0.0 and 1.0, respectively



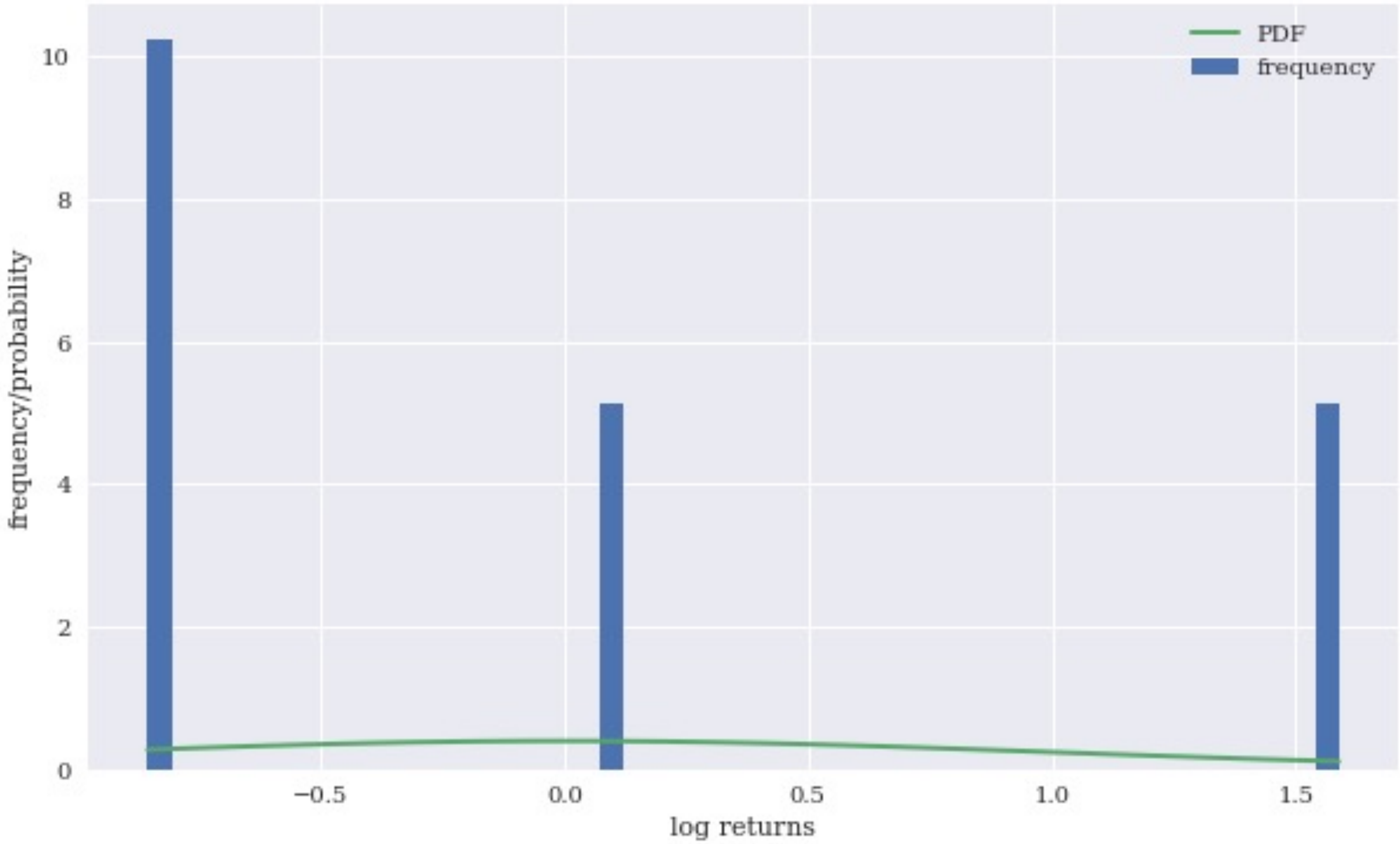
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Histogram and PDF for standard normally distributed numbers



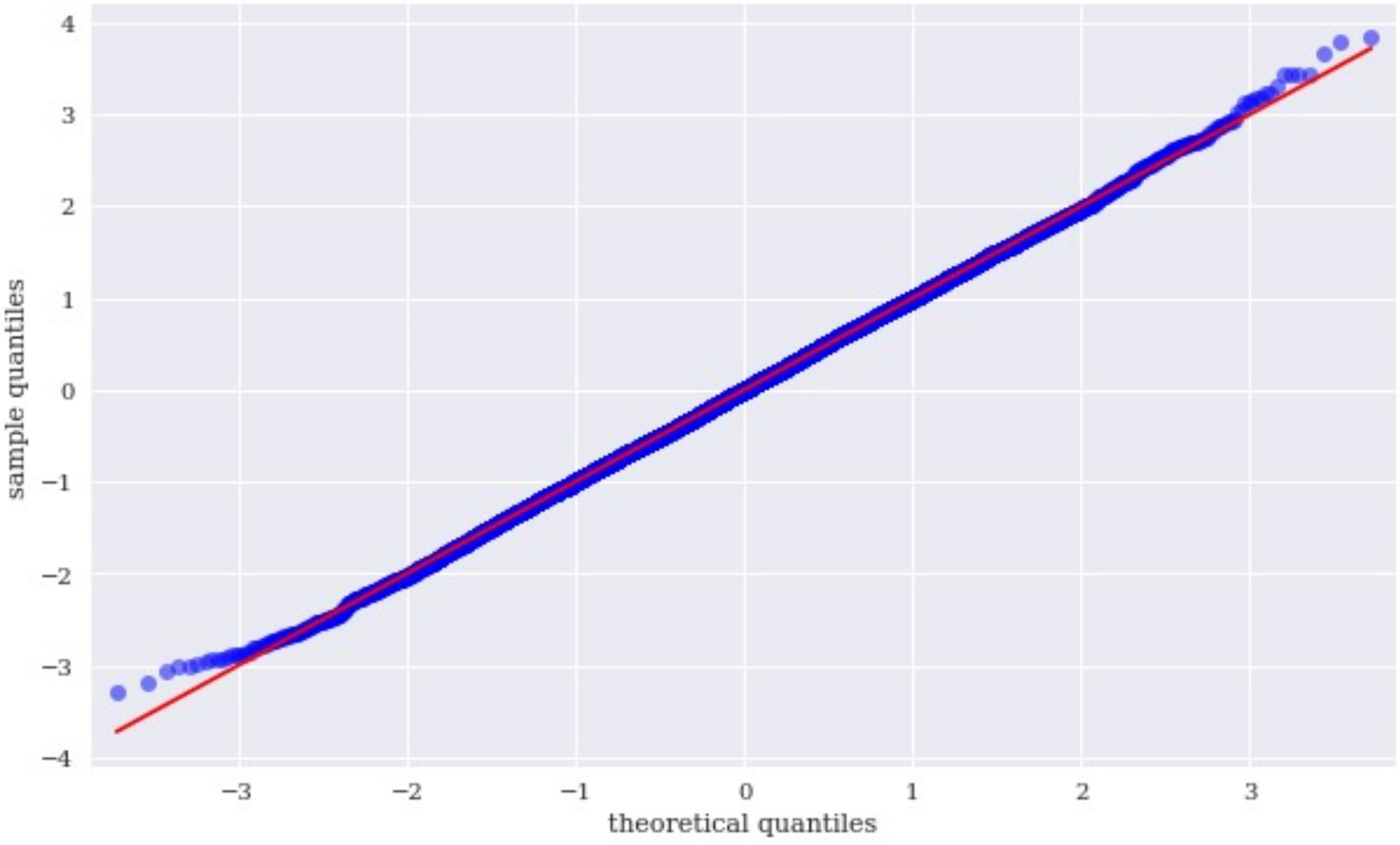
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Histogram and normal PDF for discrete numbers



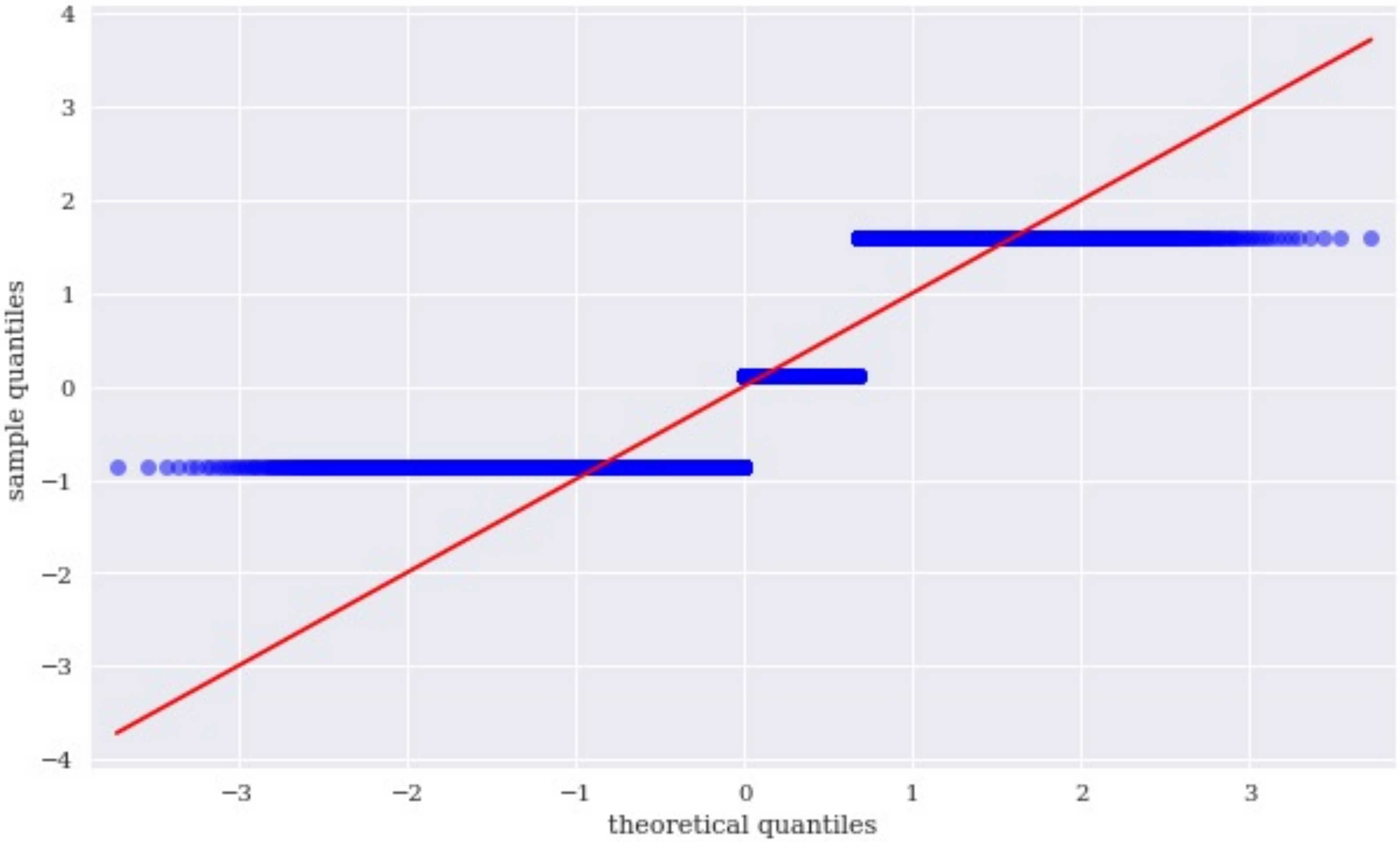
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Q-Q plot for standard normally distributed numbers



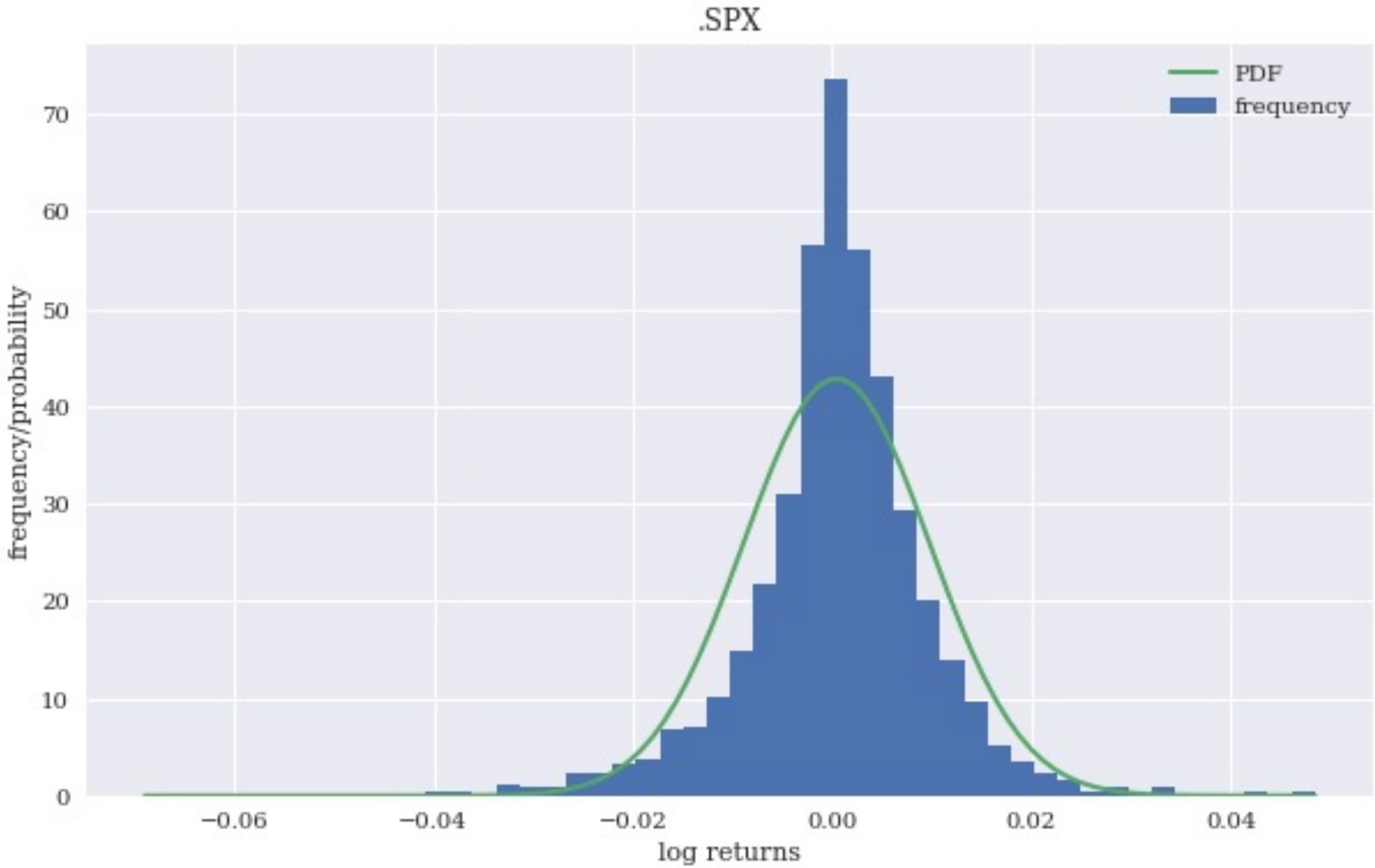
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Q-Q plot for discrete numbers



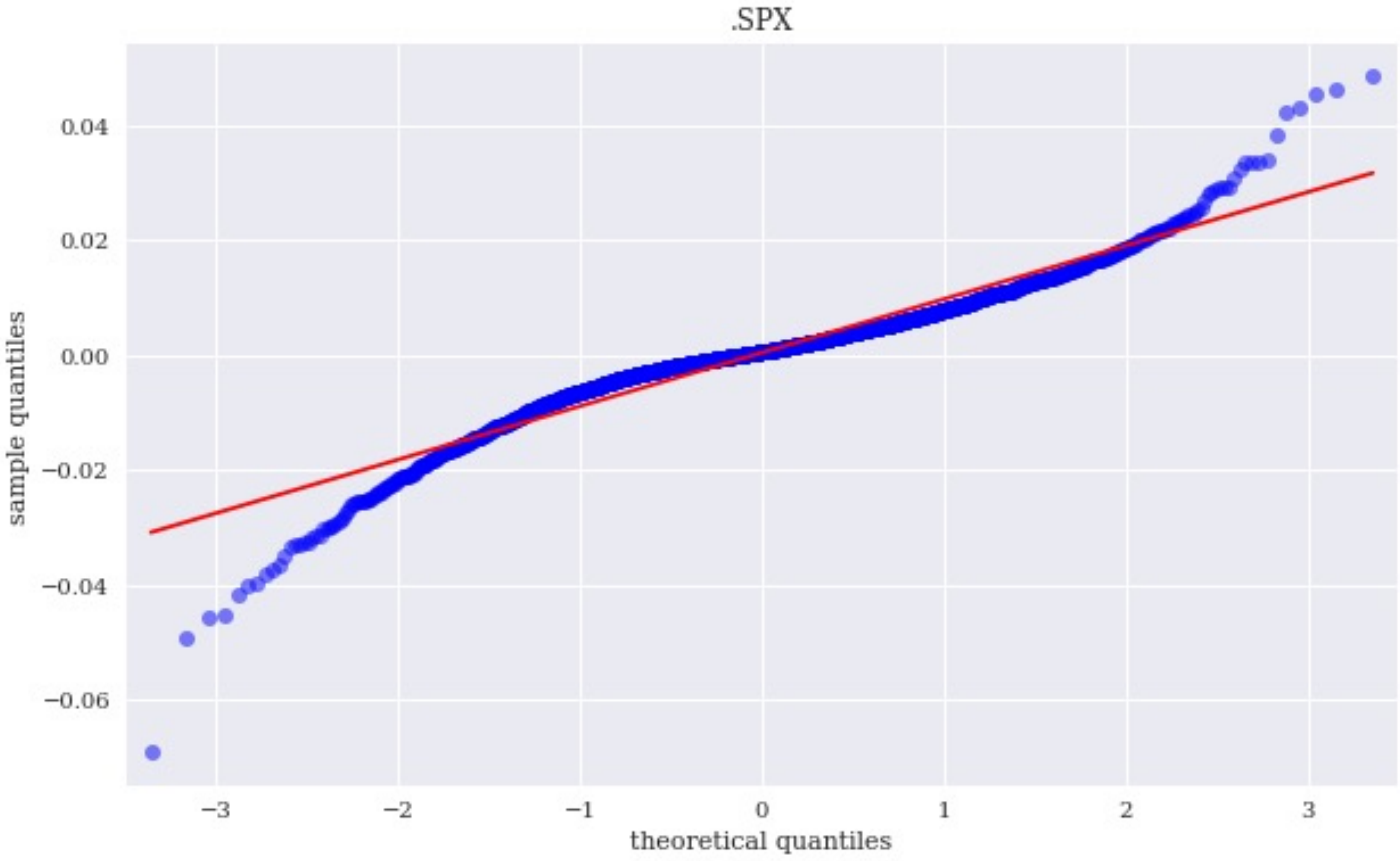
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O’Reilly Media.

Frequency distribution and normal PDF for S&P 500 log returns



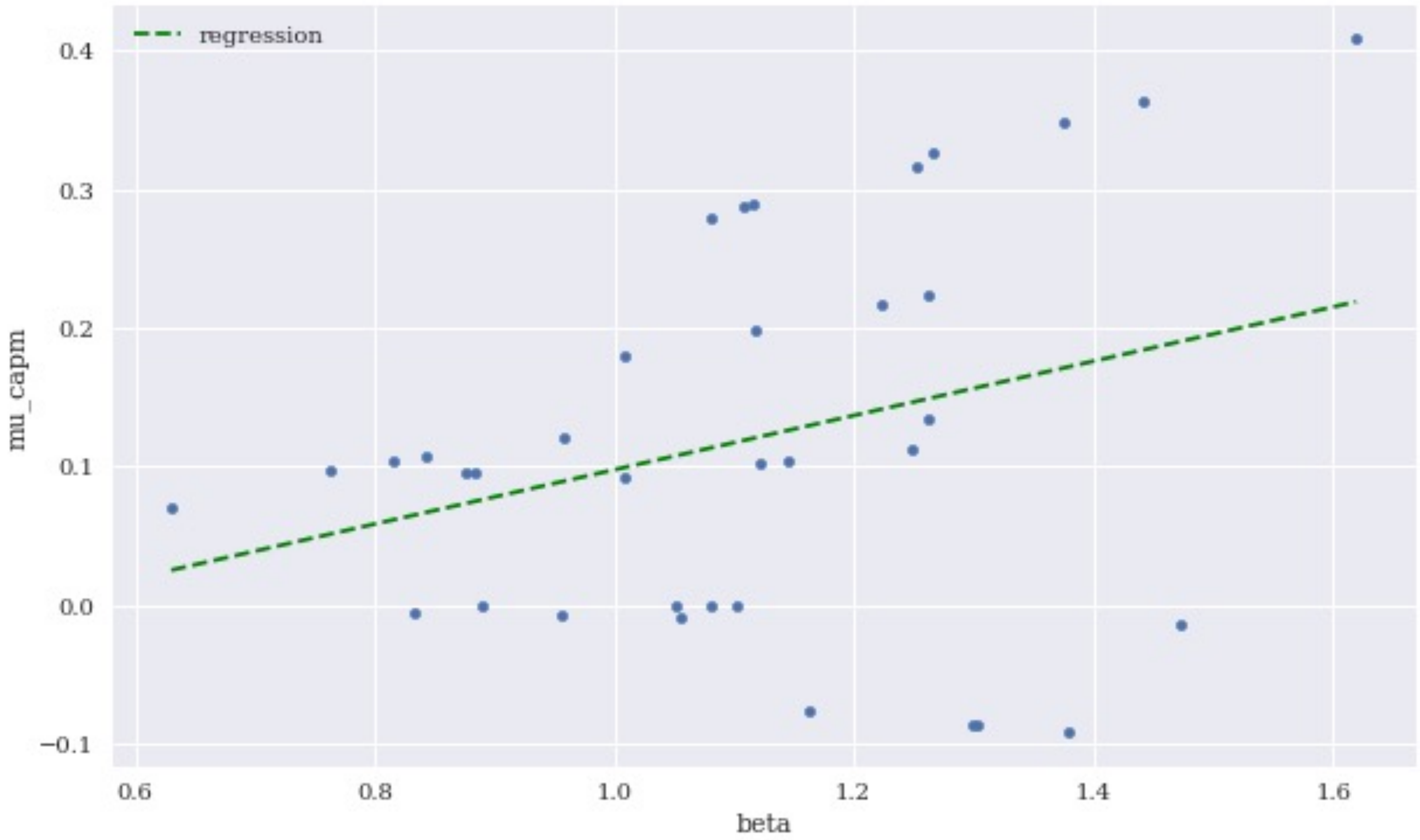
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Q-Q for S&P 500 log returns



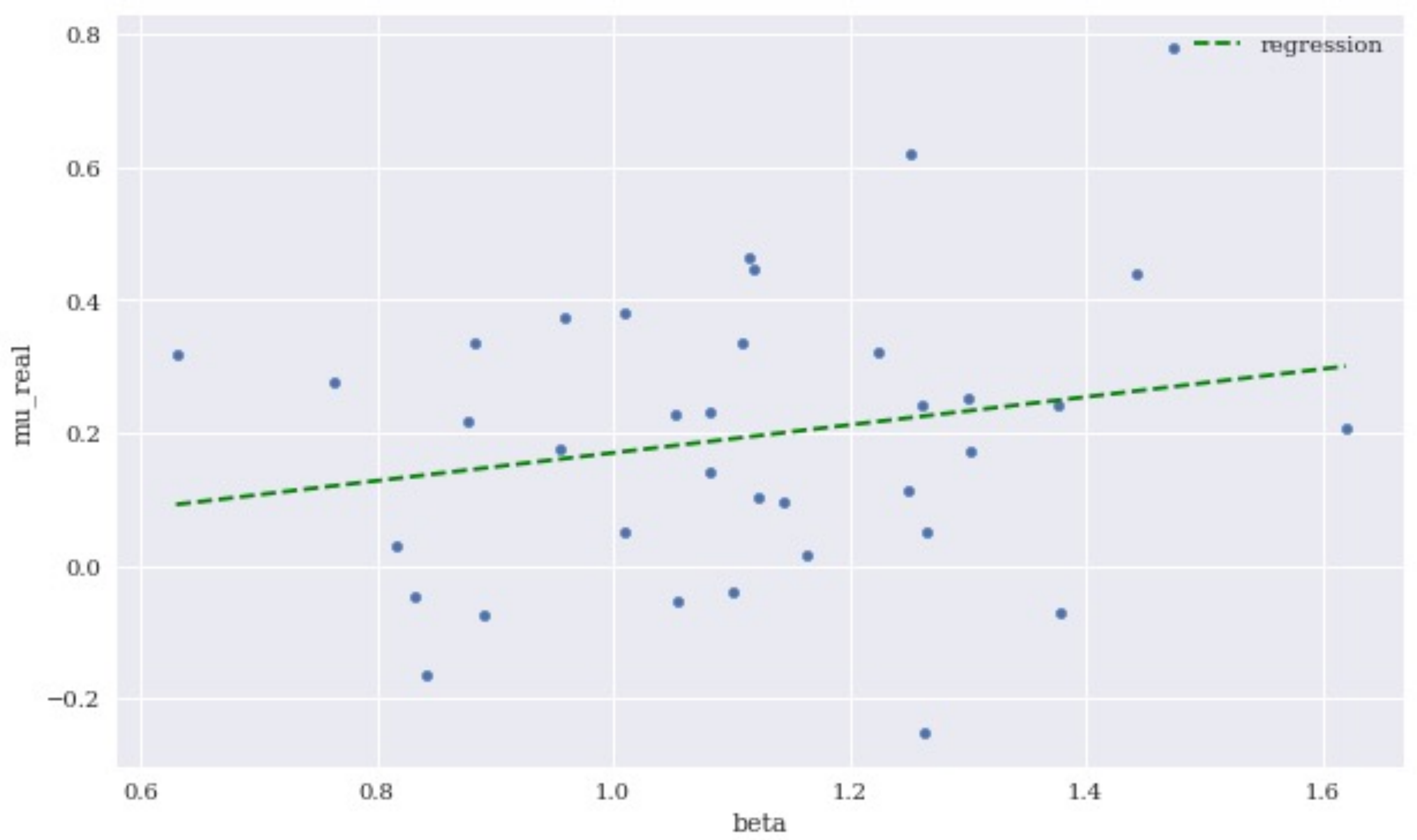
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Expected CAPM return versus beta (including linear regression)



Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Expected CAPM return versus beta (including linear regression)



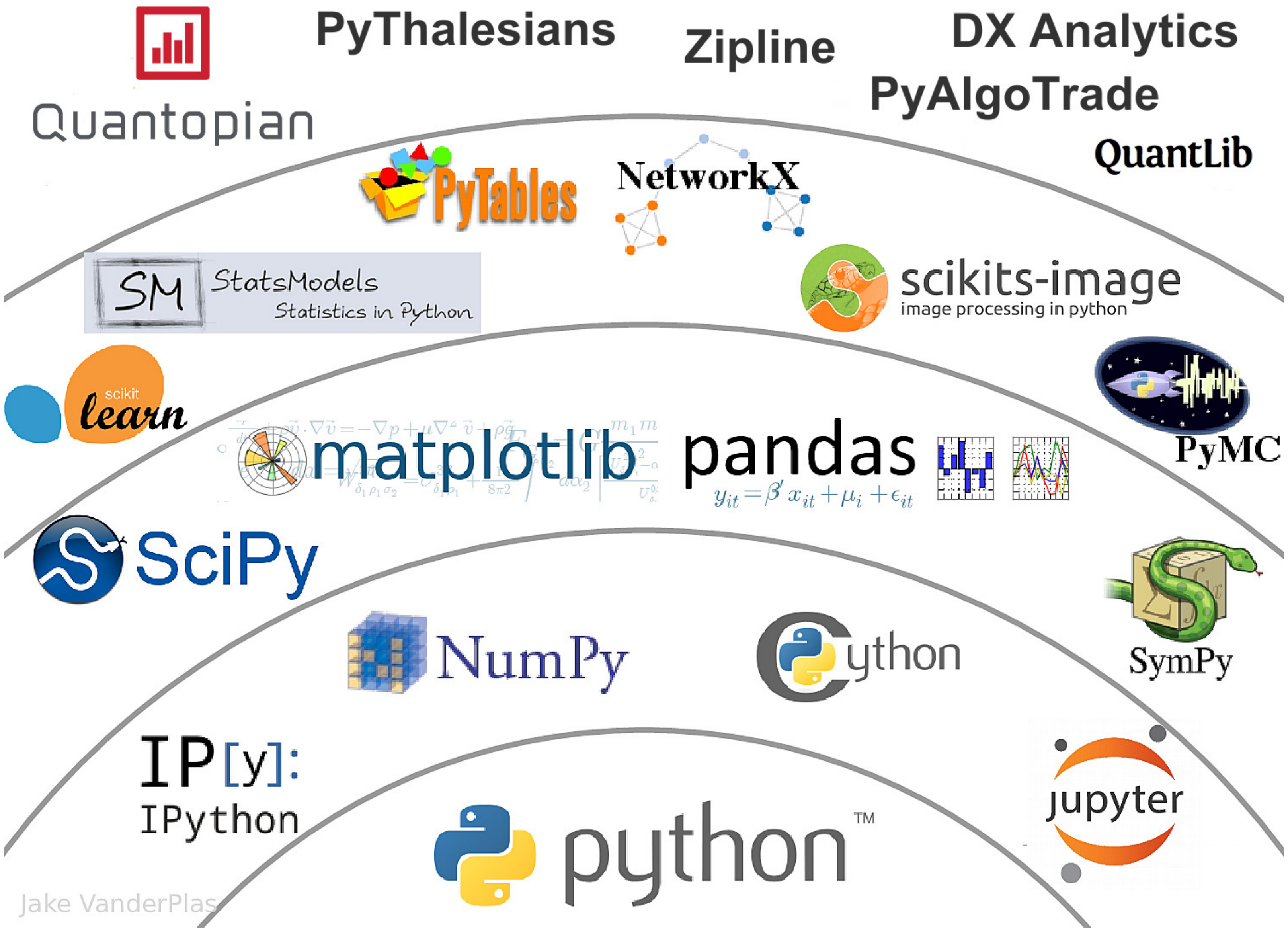
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

Theory-First to Data-Driven Finance

- Finance used to be characterized by normative theories based on simplified mathematical models of the financial markets, relying on assumptions such as normality of returns and linear relationships.
- The almost universal and comprehensive availability of (financial) data has led to a shift in focus from a theory-first approach to data-driven finance.
- Several examples based on real financial data illustrate that many popular financial models and theories cannot survive a confrontation with financial market realities.
- Although elegant, they might be too simplistic to capture the complexities, changing nature, and nonlinearities of financial markets.

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

The Quant Finance PyData Stack

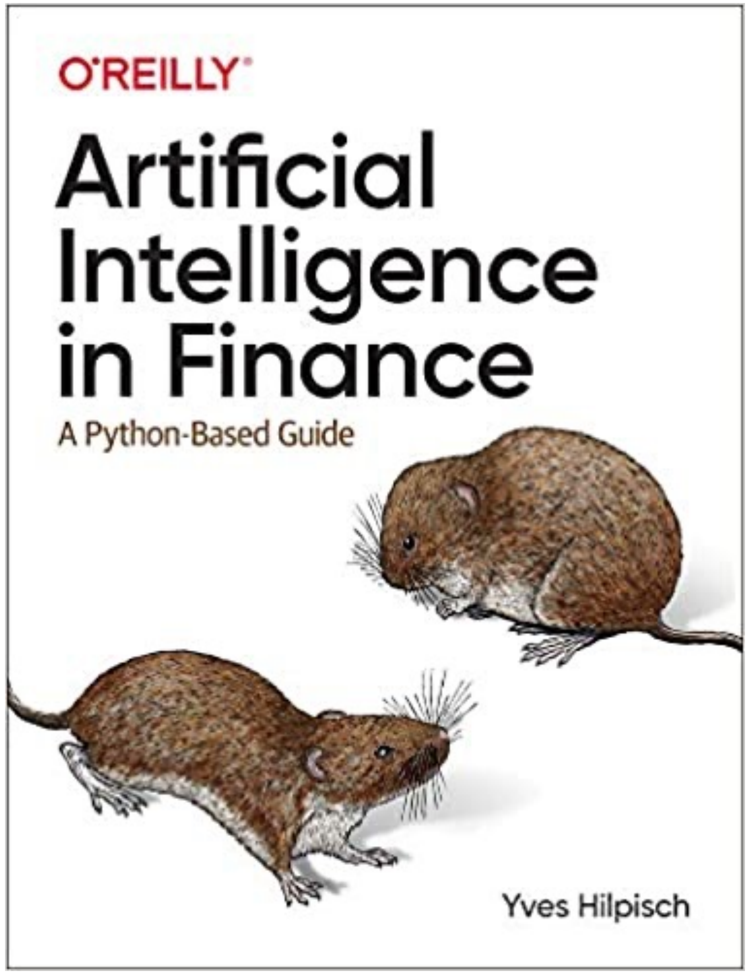


Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5

Yves Hilpisch (2020),

Artificial Intelligence in Finance: A Python-Based Guide,

O’Reilly



Source: https://www.amazon.com/Artificial-Intelligence-Finance-Python-Based-Guide/dp/1492055433

Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly

yhilpisch / aiif Public

https://github.com/yhilpisch/aiif

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Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights

main | 1 branch | 0 tags | Go to file | Code

yves Code updates for TF 2.3.		e334251 on Dec 8, 2020 · 4 commits
code	Code updates for TF 2.3.	11 months ago
.gitignore	Code updates for TF 2.3.	11 months ago
LICENSE.txt	Code updates.	11 months ago
README.md	Code updates.	11 months ago

README.md

Artificial Intelligence in Finance

About this Repository

This repository provides Python code and Jupyter Notebooks accompanying the **Artificial Intelligence in Finance** book published by O'Reilly.

O'REILLY

About

Jupyter Notebooks and code for the book Artificial Intelligence in Finance (O'Reilly) by Yves Hilpisch.

home.tpq.io/books/aiif

Readme

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Releases

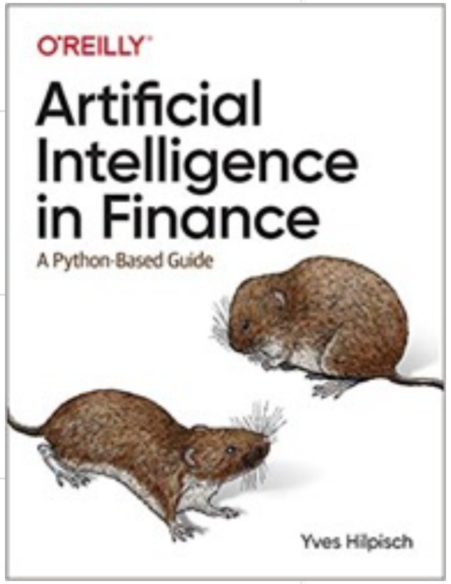
No releases published

Packages

No packages published

Languages

Jupyter Notebook 97.4% · Python 2.6%



Source: https://github.com/yhilpisch/aiif

Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly

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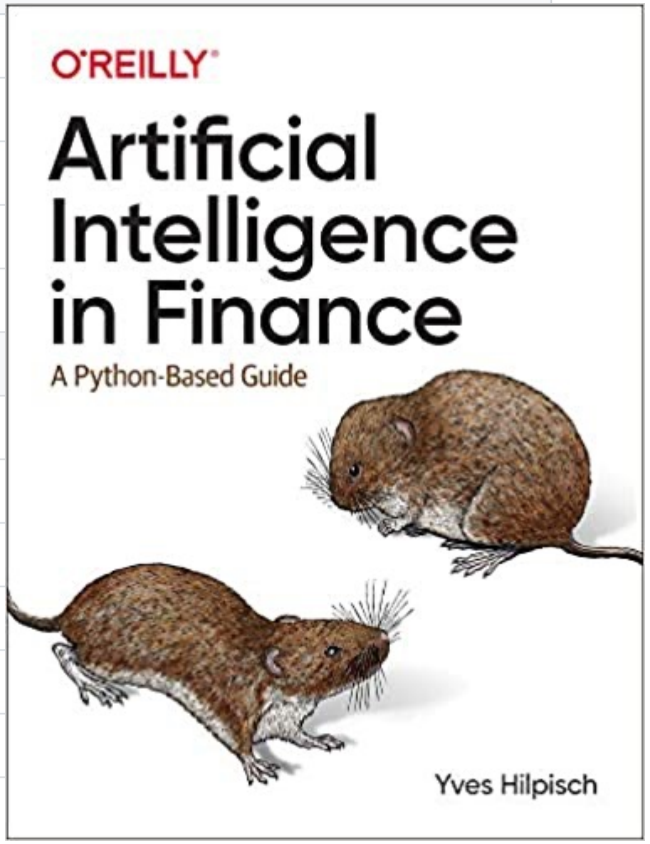
main ▾ aiif / code /

https://github.com/yhilpisch/aiif/tree/main/code

Go to file

yves Code updates for TF 2.3. e334251 on Dec 8, 2020 History

..	
oanda	Code updates for TF 2.3.
01_artificial_intelligence.ipynb	Code updates for TF 2.3.
02_superintelligence.ipynb	Code updates for TF 2.3.
03_normative_finance.ipynb	Code updates for TF 2.3.
04_data_driven_finance_a.ipynb	Initial commit.
04_data_driven_finance_b.ipynb	Initial commit.
05_machine_learning.ipynb	Code updates for TF 2.3.
06_ai_first_finance.ipynb	Code updates for TF 2.3.
07_dense_networks.ipynb	Code updates for TF 2.3.
08_recurrent_networks.ipynb	Code updates for TF 2.3.
09_reinforcement_learning_a.ipynb	Code updates.
09_reinforcement_learning_b.ipynb	Code updates for TF 2.3.



Source: https://github.com/yhilpisch/aiif/tree/main/code

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

python101.ipynb

```python
# Future Value
pv = 100
r = 0.1
n = 7
fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```

```
194.87
```

```python
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```

```
194.87
```

```python
# Python Function def
def getfv(pv, r, n):
    fv = pv * ((1 + (r)) ** n)
    return fv
fv = getfv(100, 0.1, 7)
print(round(fv, 2))
```

```
194.87
```

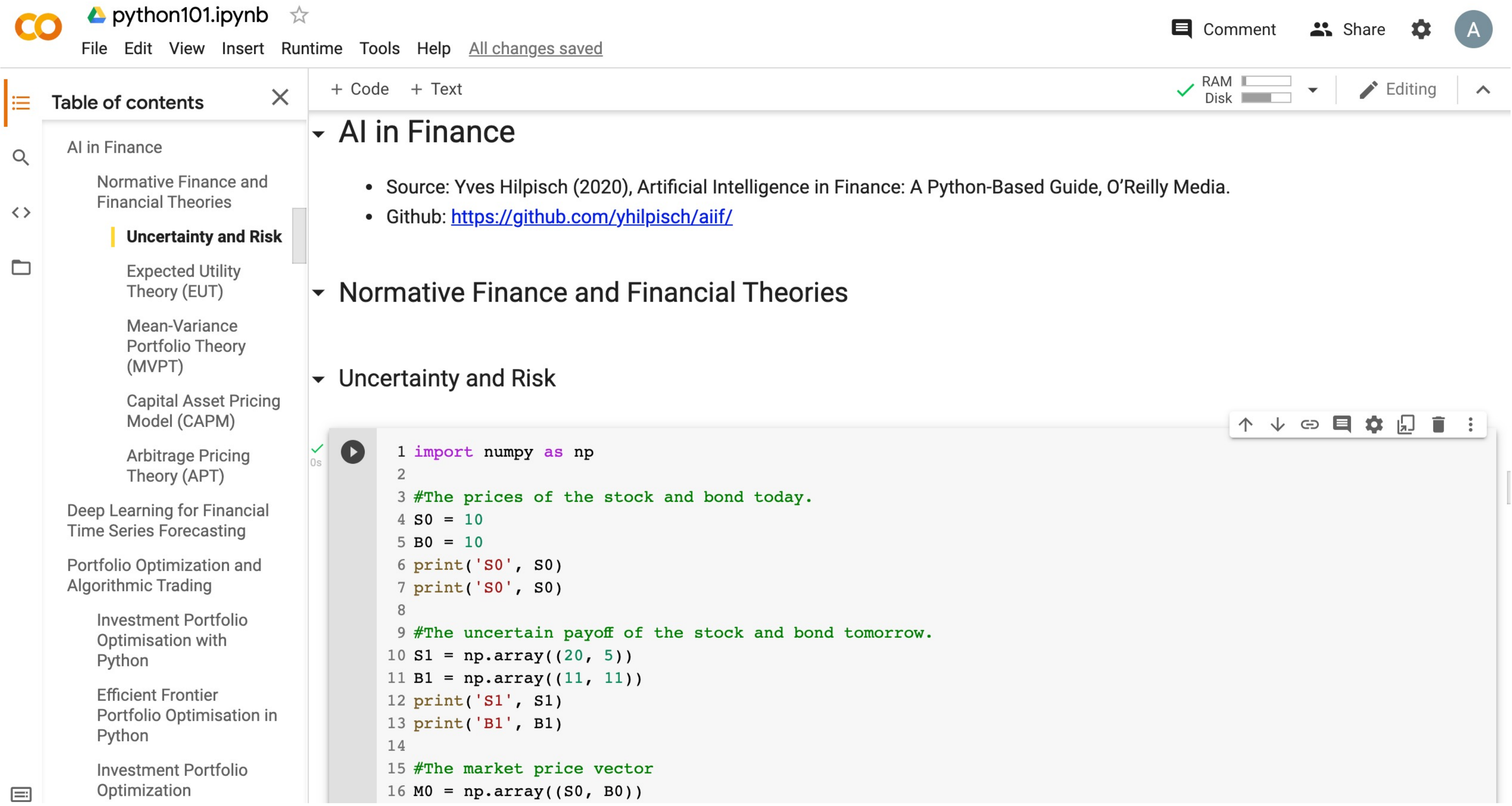
```python
# Python if else
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```

```
Pass
```

https://tinyurl.com/aintpupython101

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT



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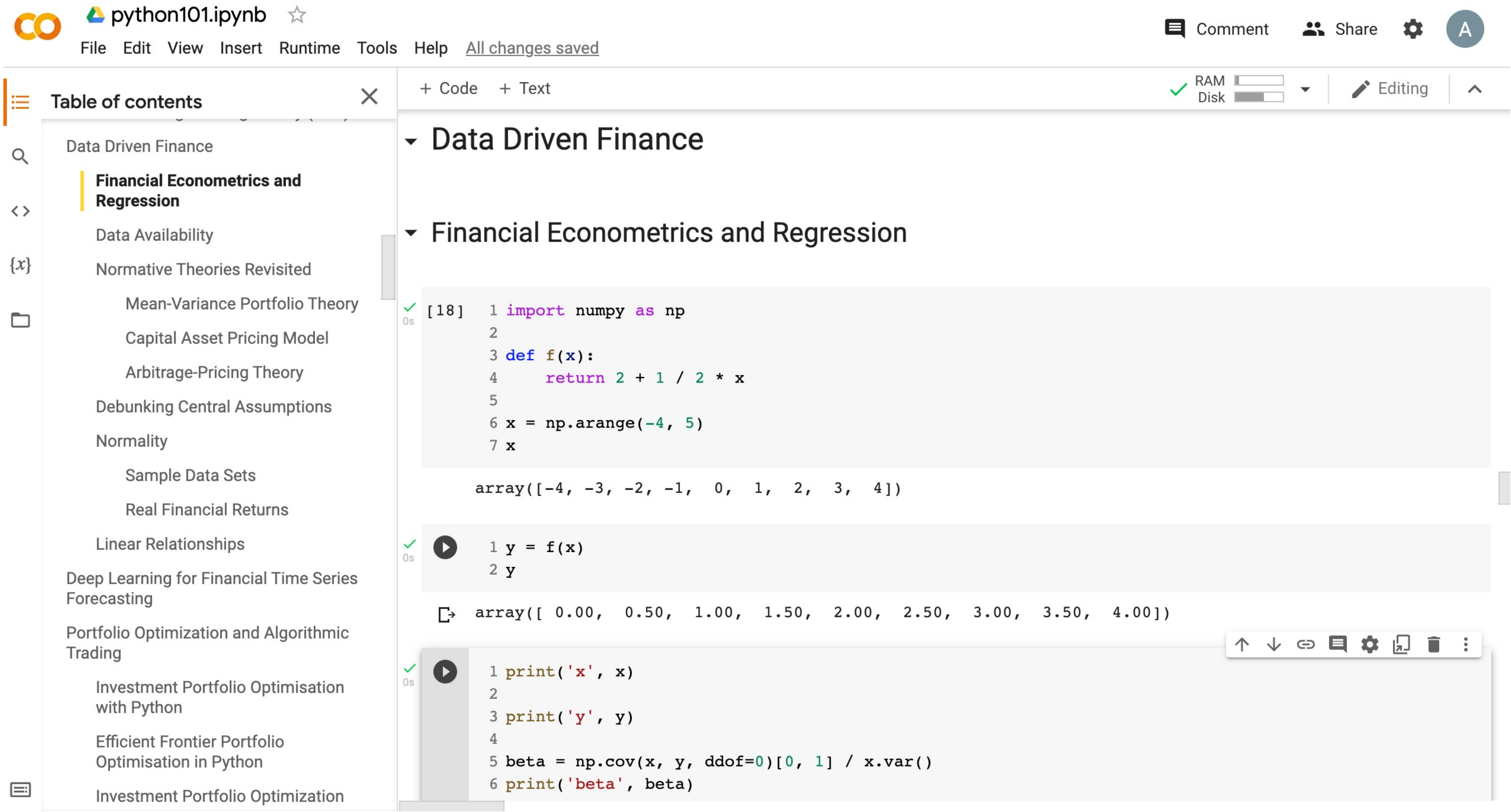

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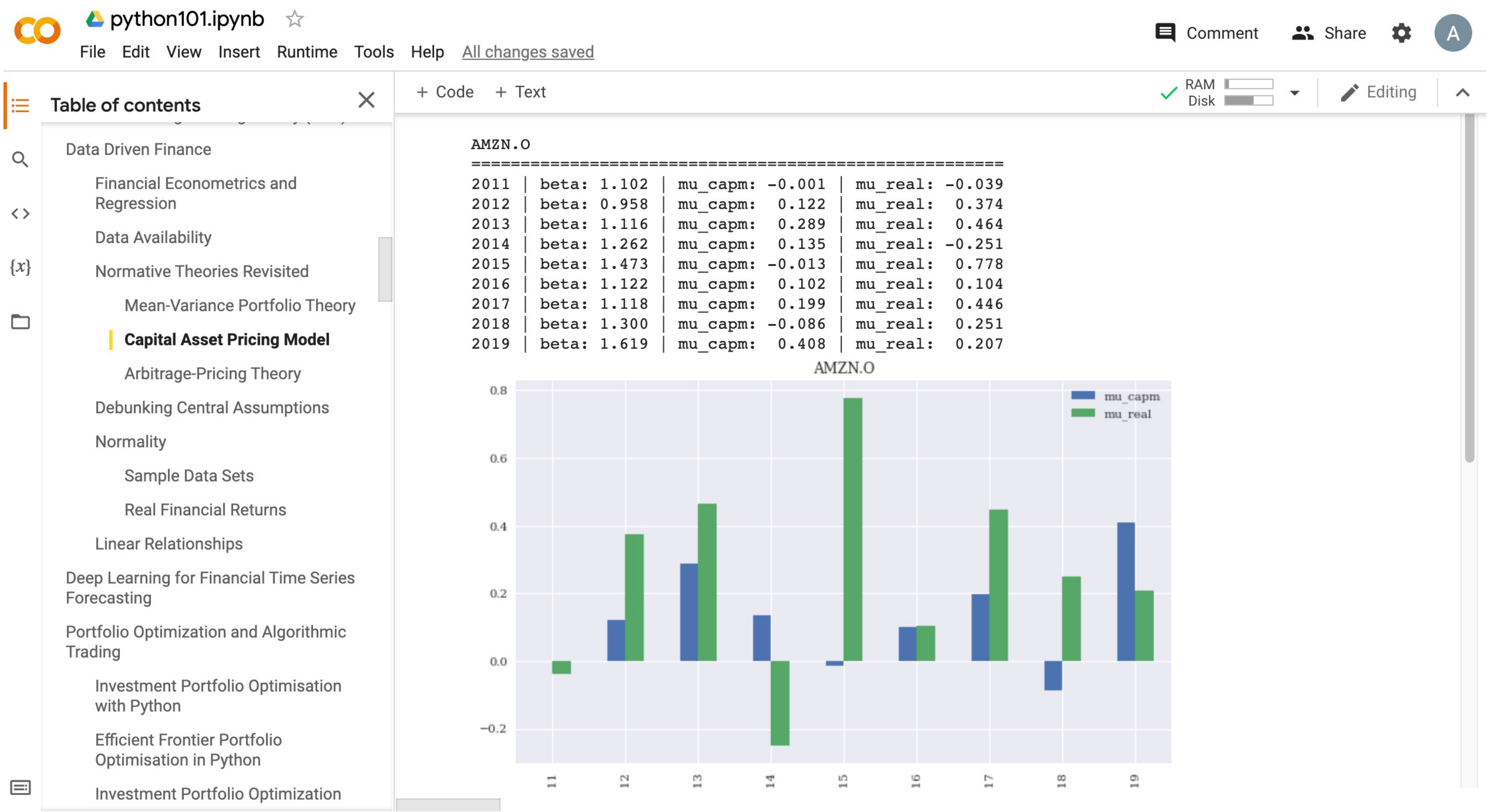

https://tinyurl.com/aintpupython101

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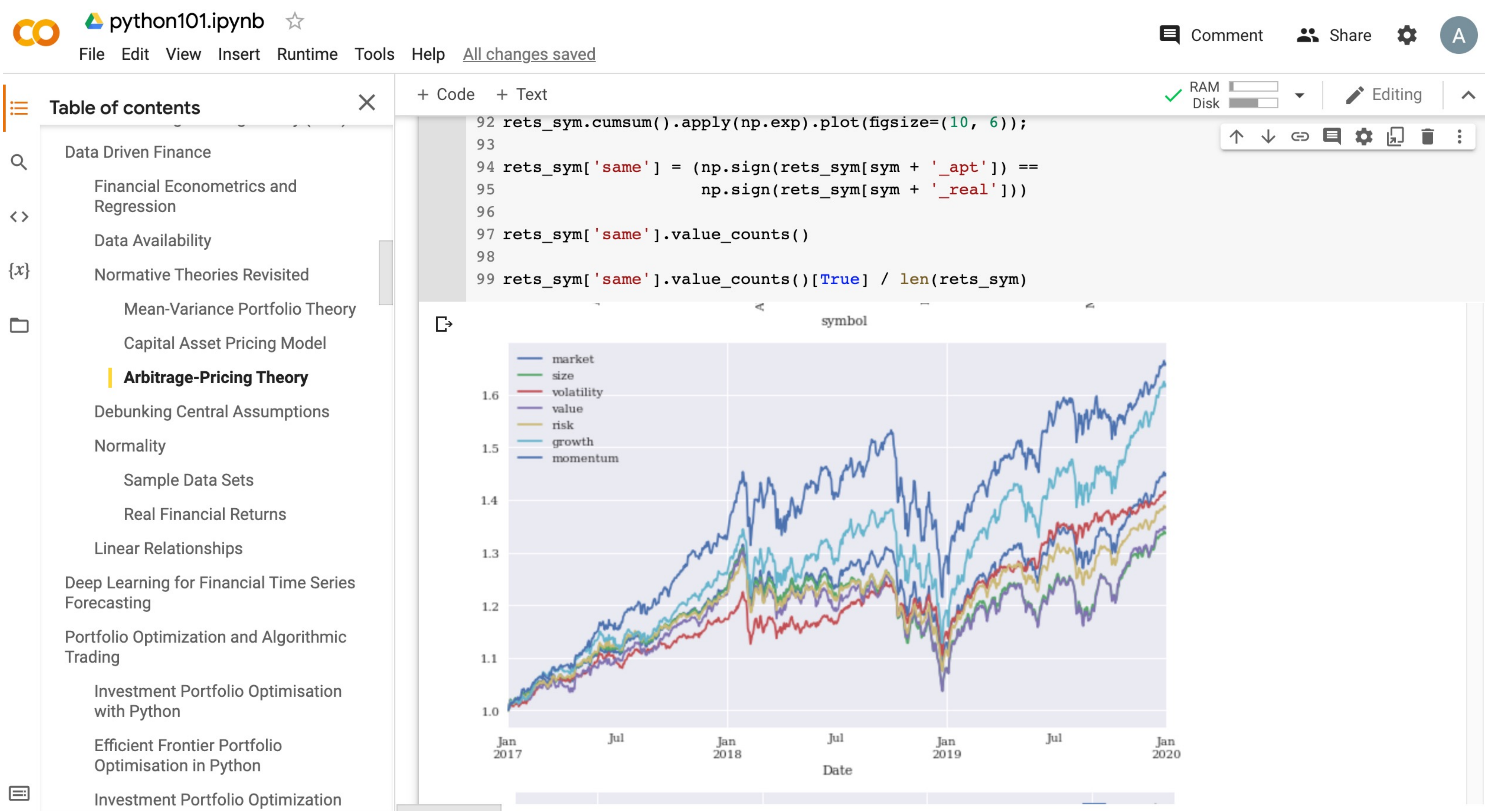

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Python in Google Colab (Python101)

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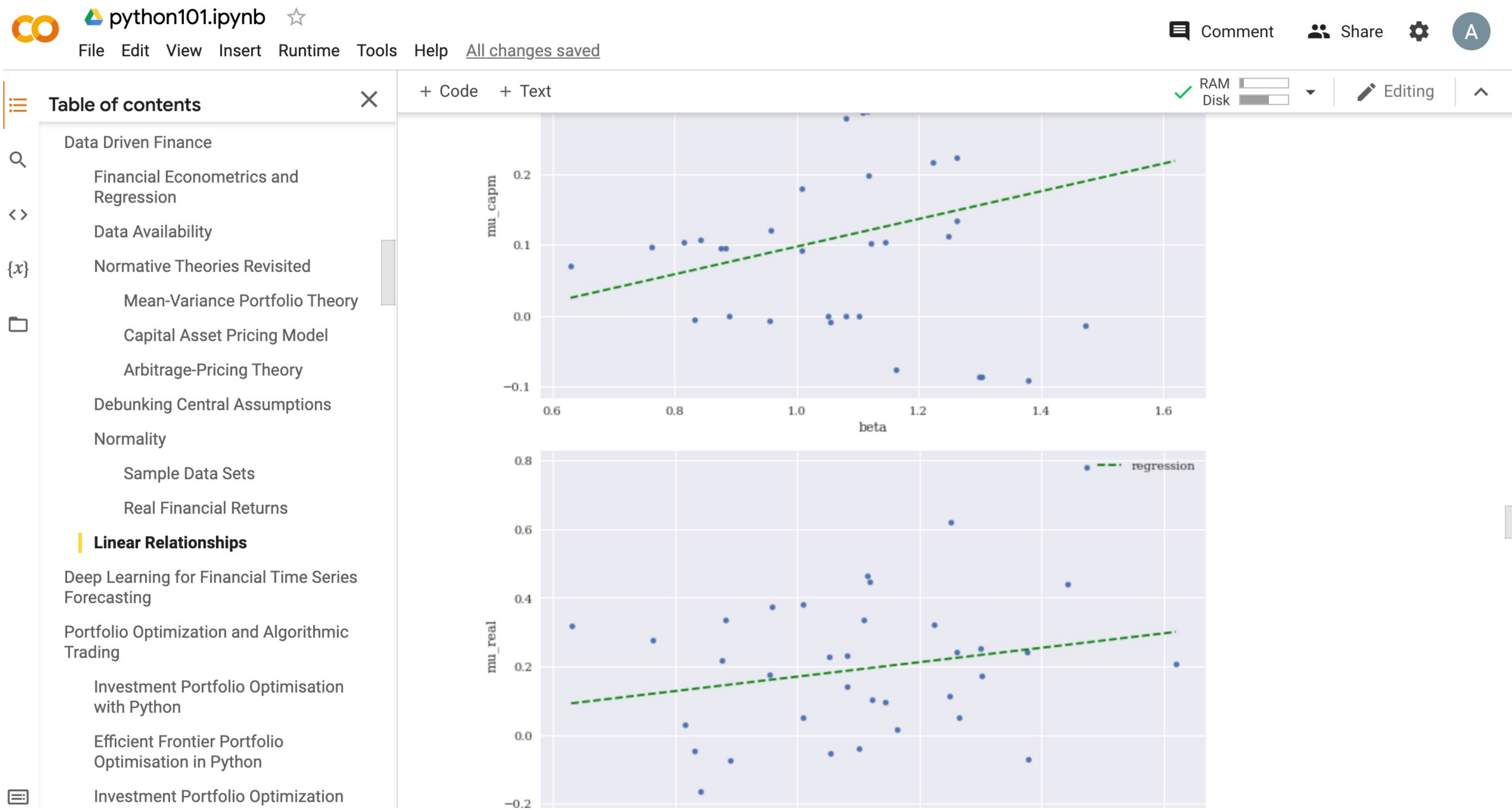

https://tinyurl.com/aintpupython101

Summary

- Data-Driven Finance
- Scientific Method
- Financial Econometrics and Regression
- Data Availability
- Normative Theories Revisited
- Debunking Central Assumptions in Finance

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

References

- Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media, https://github.com/yhilpisch/aiif .
- Fishburn, P. C. (1968). Utility theory. Management science, 14(5), 335-378.
- Fama, E. F., & French, K. R. (2004). The capital asset pricing model: Theory and evidence. Journal of economic perspectives, 18(3), 25-46.
- Markowitz, H. (1952). PORTFOLIO SELECTION. The Journal of Finance, 7(1), 77-91.
- Pratt, J. W. (1964). Risk aversion in the small and in the large, econometrics 32, jan.
- Ross, S. A. (1976). The arbitrage theory of capital asset pricing. Journal of Economic Theory, 13(3), 341-60.
- Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. The journal of finance, 19(3), 425-442.
- Min-Yuh Day (2021), Python 101, https://tinyurl.com/aintpupython101