# Artificial Intelligence in Finance and Quantitative Analysis

# Finance Theory

1111AIFQA05
MBA, IM, NTPU (M6132) (Fall 2022)
Tue 2, 3, 4 (9:10-12:00) (B8F40)

https://meet.google.com/paj-zhhj-mya


## Min-Yuh Day, Ph.D,
## Associate Professor

Institute of Information Management, National Taipei University

https://web.ntpu.edu.tw/~myday


2022-10-18

# Syllabus

| Week | Date | Subject/Topics |
|---|---|---|
| 1 | 2022/09/13 | Introduction to Artificial Intelligence in Finance and Quantitative Analysis |
| 2 | 2022/09/20 | AI in FinTech: Metaverse, Web3, DeFi, NFT, Financial Services Innovation and Applications |
| 3 | 2022/09/27 | Investing Psychology and Behavioral Finance |
| 4 | 2022/10/04 | Event Studies in Finance |
| 5 | 2022/10/11 | Case Study on AI in Finance and Quantitative Analysis I |
| 6 | 2022/10/18 | Finance Theory |

# Syllabus

| Week | Date | Subject/Topics |
|---|---|---|
| 7 | 2022/10/25 | Data-Driven Finance |
| 8 | 2022/11/01 | Midterm Project Report |
| 9 | 2022/11/08 | Financial Econometrics |
| 10 | 2022/11/15 | AI-First Finance |
| 11 | 2022/11/22 | Industry Practices of AI in Finance and Quantitative Analysis |
| 12 | 2022/11/29 | Case Study on AI in Finance and Quantitative Analysis II |

# Syllabus

| Week | Date | Subject/Topics |
|---|---|---|
| 13 | 2022/12/06 | Deep Learning in Finance; Reinforcement Learning in Finance |
| 14 | 2022/12/13 | Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting |
| 15 | 2022/12/20 | Final Project Report I |
| 16 | 2022/12/27 | Final Project Report II |
| 17 | 2023/01/03 | Self-learning |
| 18 | 2023/01/10 | Self-learning |

# Financial Theories

# Financial Theories

- Uncertainty and Risk
- Expected Utility Theory (EUT)
- 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.

# Major Normative Financial Theories and Models

- **Normative Theory**
  - **Based on assumptions (mathematically, axioms) and derives insights, results, and more from the set of relevant assumptions.**
- **Positive theory**
  - **Based on observation, experiments, data, relationships, and the like and describes phenomena given the insights gained from the available information and the derived results.**

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

# Normative Finance

- **The CAPM is based on many unrealistic assumptions.**
  - **The assumption that investors care only about the mean and variance of one-period portfolio returns is extreme.**
    **(Eugene Fama and Kenneth French, 2004)**

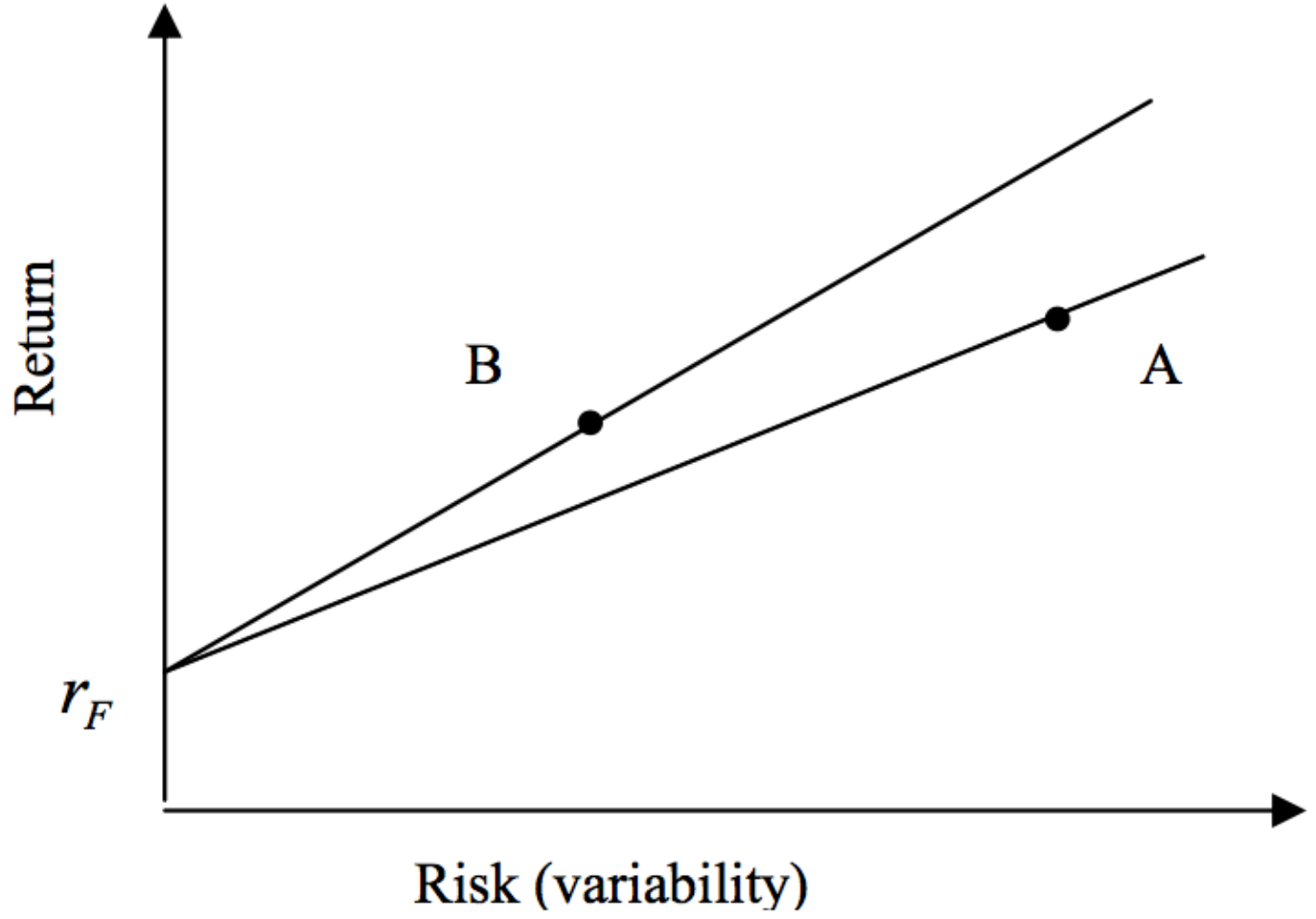
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Uncertainty and Risk

- Financial theory deals with investment, trading, and valuation in the presence of **uncertainty** and **risk**.
- The focus is on fundamental concepts from **probability theory** that build the backbone of **quantitative finance**.

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

# Risk and Return




Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

# Sharpe Ratio

$$\textbf{Sharpe Ratio} = \frac{Portofolio\ Return - Risk\ Free\ Return}{Portofolio\ Risk}$$

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

# Sharpe Ratio

$$\textbf{Sharpe Ratio } SR = \frac{r_P - r_F}{\sigma_P}$$

Where

$r_P$ = portfolio return

$r_F$ = risk free rate

$\sigma_P$ = portfolio risk

(variability, standard deviation of return)

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

# Sortino Ratio

$$\textbf{Sortino Ratio} = \frac{r_P - r_T}{\sigma_D}$$

Where

$r_P$ = portfolio return

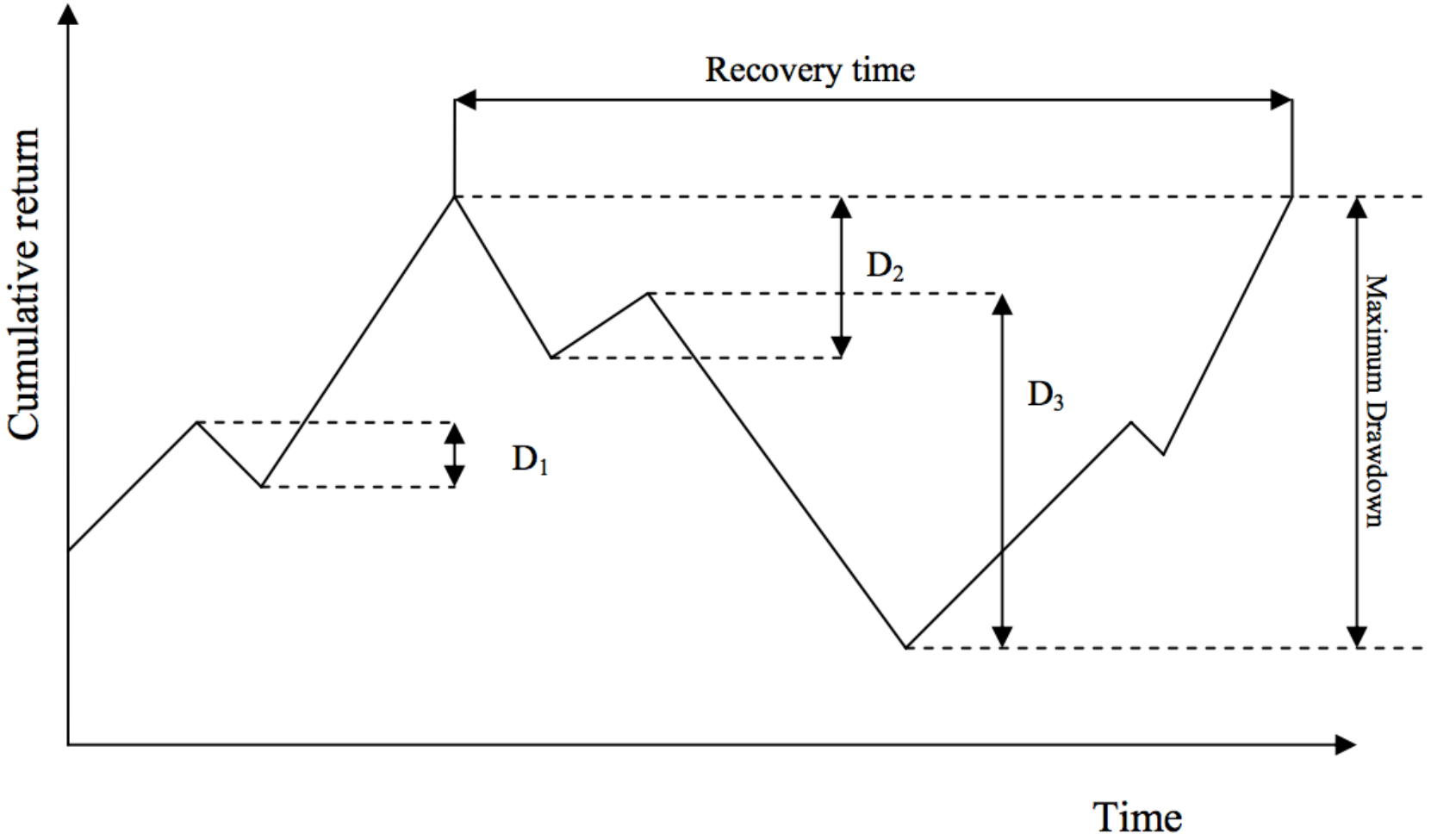
$r_T$ = Minimum Target Return

$\sigma_D$ = Downside Risk

$$\textbf{Downside Risk } \sigma_D = \sqrt{\sum_{i=1}^{n} \frac{\min[(r_i - rT), 0]^2}{n}}$$

Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

# Max Drawdown




Source: Bacon, Carl. "How sharp is the Sharpe-ratio?-Risk-adjusted Performance Measures." *Statpro White Paper* (2000).

# Traded Assets

- In the economy, two assets are traded.
  - The first is a risky asset, the stock, with a certain price today of $S_0 = 10$ and an uncertain payoff tomorrow.
  - The second is a risk-less asset, the bond, with a certain price today of $B_0 = 10$ and a certain payoff tomorrow.

# Arbitrage Pricing

- **Deriving the fair value of a European call option on the stock with a strike price of K = 14.5**
- **Arbitrage pricing theory can be considered one of the strongest financial theories with some of the most robust mathematical results, such as the fundamental theorem of asset pricing (FTAP).**

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

# Expected Utility Theory (EUT)

- Expected utility theory (EUT)
  - 1940s
  - cornerstone of financial theory
  - One of the central paradigms for modeling decision making under uncertainty

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

# Expected Utility Theory

- **Expected utility theory (EUT)**
  - **EUT is an axiomatic theory**
    - von Neumann and Morgenstern (1944)
  - **Axiomatic**
    - Major results of the theory can be deduced from a small number of axioms only
- **Axioms and normative theory**
  - **An axiom is a proposition regarded as self-evidently true without proof.**

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

# Preferences of an Agent

- Assume an agent with preferences $\succeq$ is faced with the problem of investing in the two traded assets of the model economy $M^2$.
- One possible set of axioms leading to EUT
  - Completeness
  - Transitivity
  - Continuity
  - Independence
  - Dominance

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

# Utility functions

- **A utility function is a way to represent the preferences $\succeq$ of an agent in a mathematical and numerical way in that such a function assigns a numerical value to a certain payoff.**

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

# Expected Utility Functions

- **Von Neumann and Morgenstern (1944) show that if the preferences of an agent $\succeq$ satisfy the preceding five axioms, then there exists an expected utility function.**

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

# Risk aversion

- In finance, the concept of risk aversion is important.
- The most commonly used measure of risk aversion is the Arrow-Pratt measure of absolute risk aversion (ARA) (Pratt, 1964).
  - ARA(x) > 0, risk-averse
  - ARA(x) = 0, risk-neutral
  - ARA(x) < 0, risk-loving

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

# Mean-Variance Portfolio Theory (MVPT)

- **Mean-variance portfolio (MVP) theory**
  - **Markowitz (1952)**
  - **cornerstone in financial theory**
- **One of the first theories of investment under uncertainty that focused on statistical measures only for the construction of stock investment portfolios.**
- **MVP completely abstracts from fundamentals of a company that might drive its stock performance or assumptions about the future competitiveness of a company that might be important for the growth prospects of a company.**

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

# Mean-Variance Portfolio Theory (MVPT)

- **The only input data that counts is the time series of share prices and statistics derived therefrom,**
  **such as the (historical) annualized mean return and the (historical) annualized variance of the returns.**
- **The central assumption of MVP, according to Markowitz (1952), is that investors only care about expected returns and the variance of these returns.**

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

# Mean-Variance Portfolio Theory (MVPT)

- **Portfolio statistics**
  - **returns vector**
  - **expected return**
  - **vector of expected returns**
  - **expected return of the portfolio**
  - **covariance matrix**
  - **expected variance of the portfolio**
  - **expected volatility of the portfolio**

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

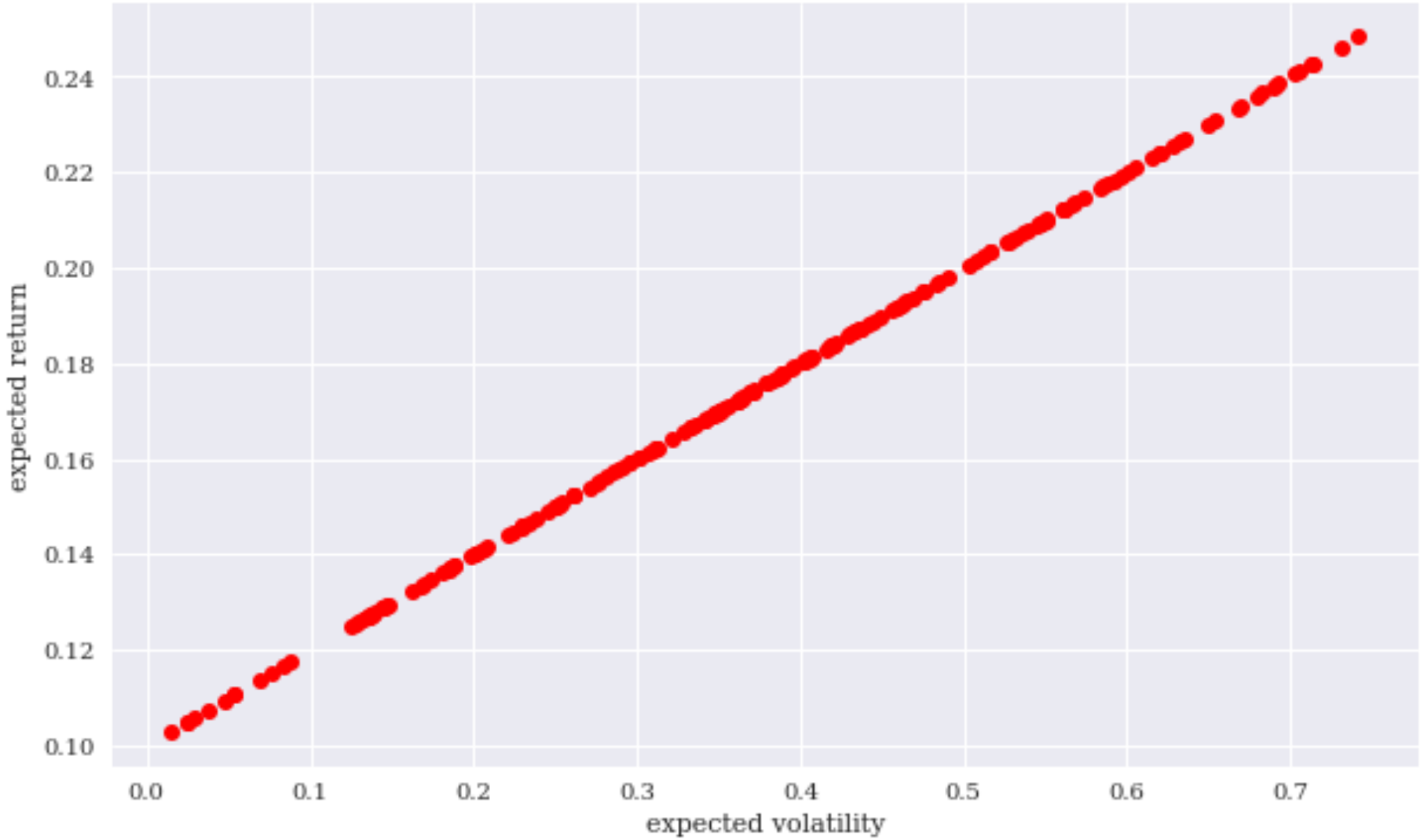
# Sharpe ratio

- **Sharpe (1966) introduces a measure to judge the risk-adjusted performance of mutual funds and other portfolios, or even single risky assets.**
- **It relates the (expected, realized) return of a portfolio to its (expected, realized) volatility.**
  - **Sharpe ratio** $\pi = \frac{\mu}{\sigma}$
- **If r represents the risk-less short rate, the risk premium or excess return of a portfolio phi over a risk-free alternative is defined by** $\mu^{phi} - r$
  - **Sharpe ratio** $\pi = \frac{\mu - r}{\sigma}$

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

# Investment Opportunity Set

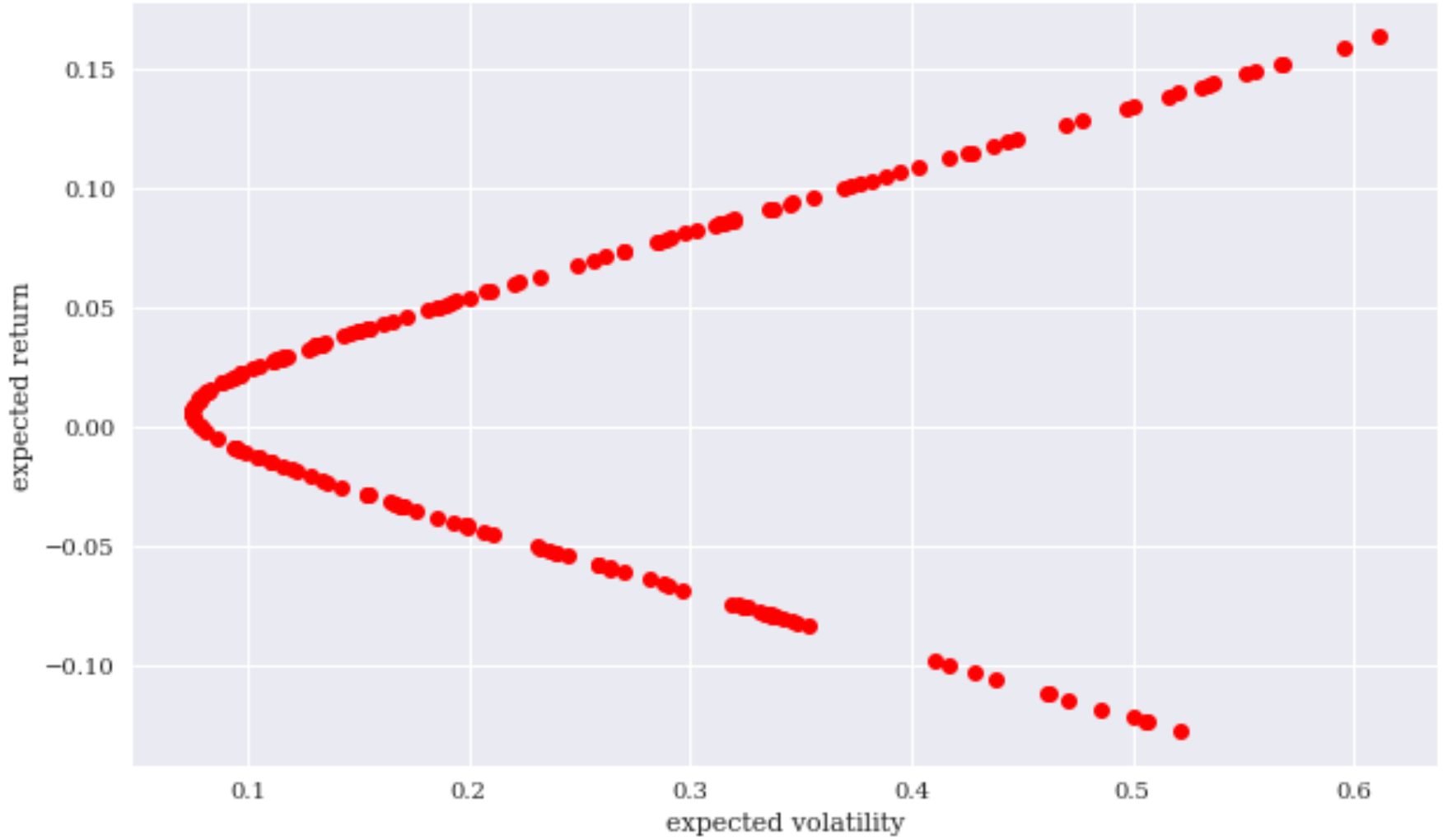
## Simulated expected portfolio volatility and return (one risky asset)




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

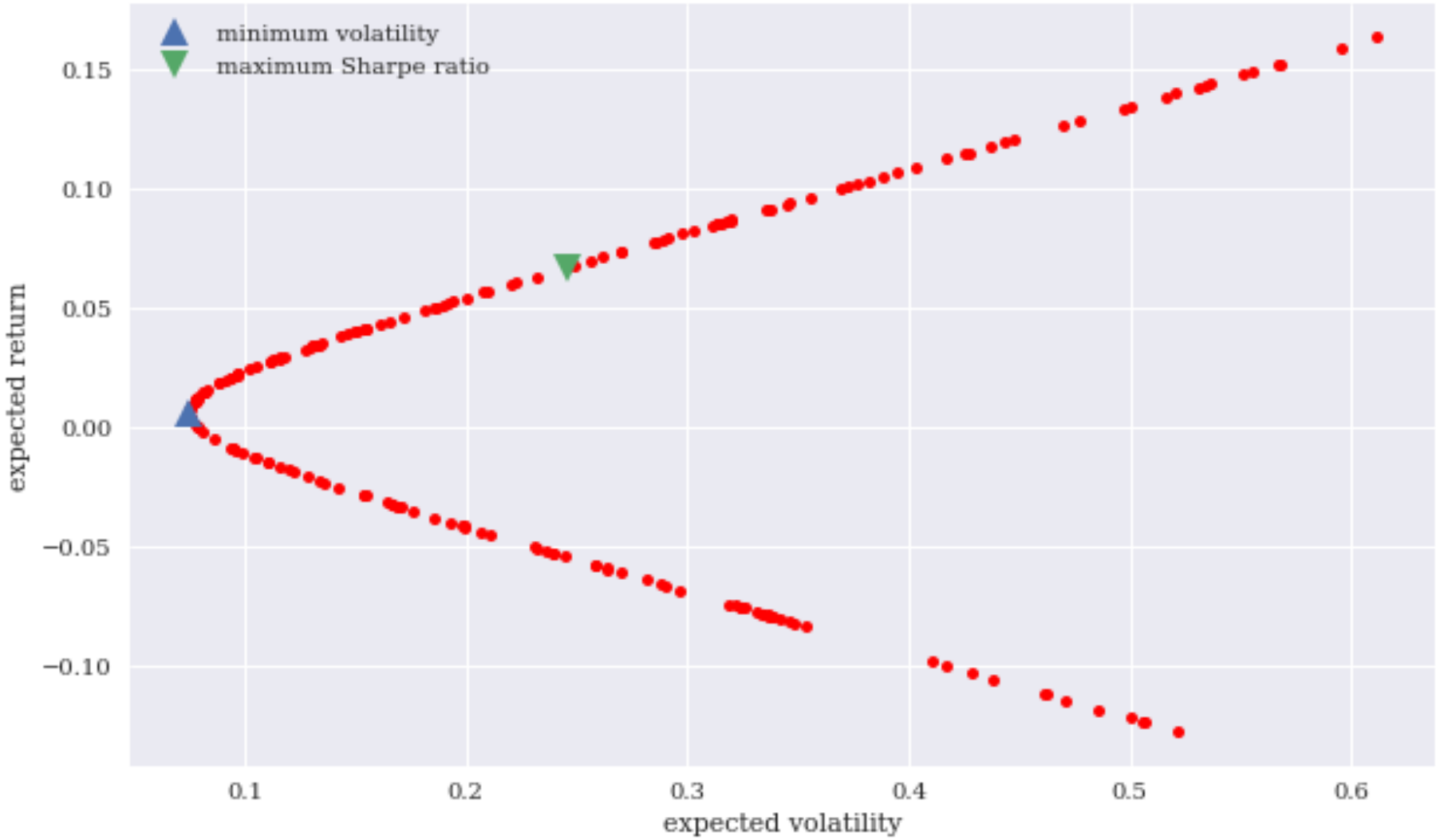
# Investment Opportunity Set

## Simulated expected portfolio volatility and return (two risky assets)




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

# Minimum volatility and maximum Sharpe ratio portfolios



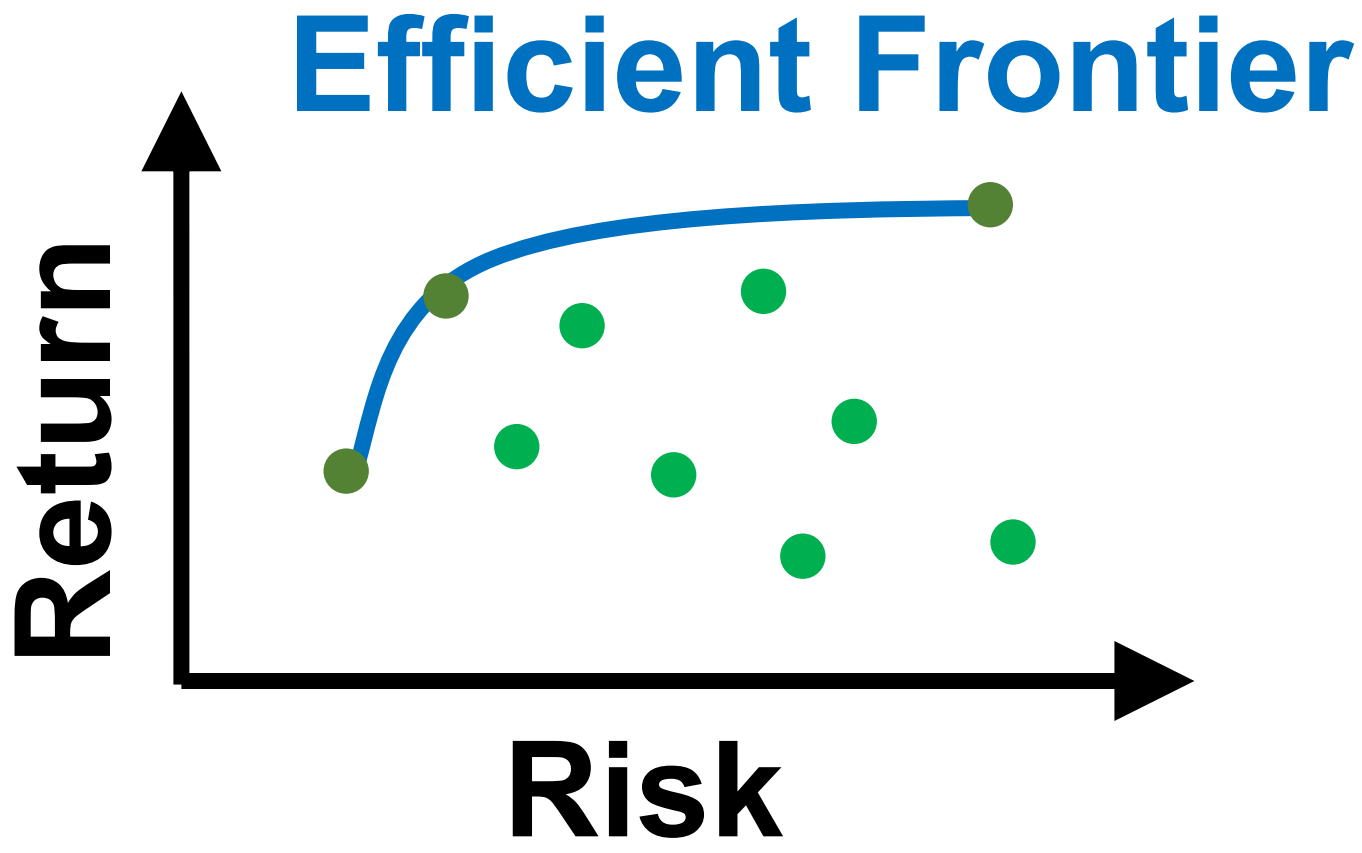

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Efficient Frontier

- An efficient portfolio
  - has a maximum expected return (risk) given its expected risk (return)
- All those portfolios that have a lower expected return than the minimum risk portfolio are inefficient.
- Efficient frontier
  - The set of all efficient portfolios
  - Agents will only choose a portfolio that lies on the efficient frontier

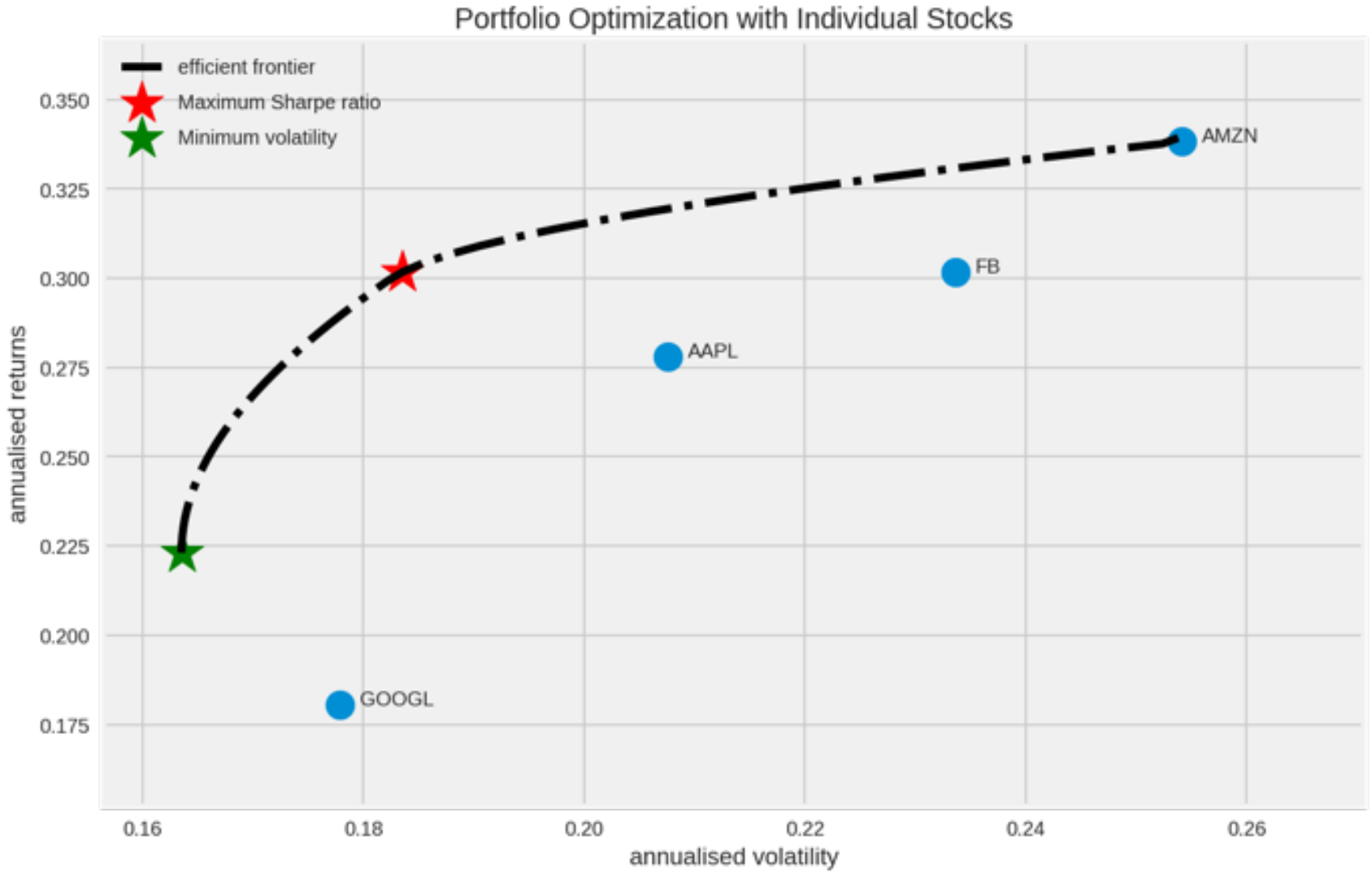
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Portfolio Optimization
## Efficient Frontier



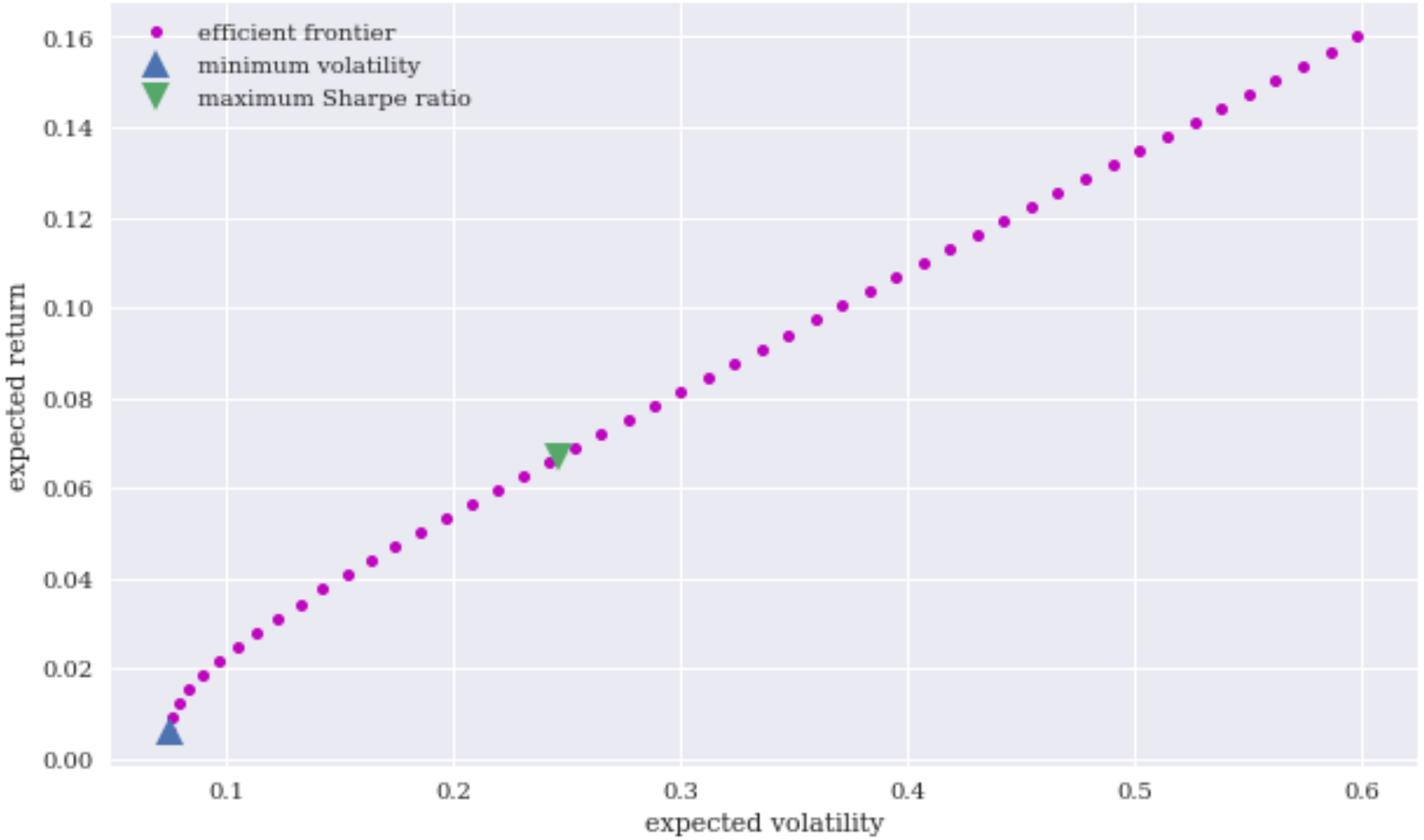

Source: Tucker Balch (2012), Investment Science: Portfolio Optimization, https://www.youtube.com/watch?v=5qbMhXXq0vI

# Portfolio Optimization
# Efficient Frontier




https://tinyurl.com/aintpupython101

# Efficient Frontier




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

# Portfolio Optimization and Algorithmic Trading

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

python101.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share A

Table of contents

- Python101
- Python File Input / Output
- OS, IO, files, and Google Drive
- Python Programming
- Pythong String and Text
- Python Numpy
- Python Pandas
- Deep Learning for Financial Time Series Forecasting
- Portfolio Optimization and Algorithmic Trading
  - Investment Portfolio Optimisation with Python
  - **Efficient Frontier Portfolio Optimisation in Python**
  - Investment Portfolio Optimization
- Text Analytics and Natural Language Processing (NLP)
  - Python for Natural Language Processing
    - spaCy Chinese Model
  - Open Chinese Convert (OpenCC, 開放中文轉換)
  - Jieba 結巴中文分詞
  - Natural Language Toolkit (NLTK)
  - Stanza: A Python NLP Library for Many Human Languages

+ Code + Text

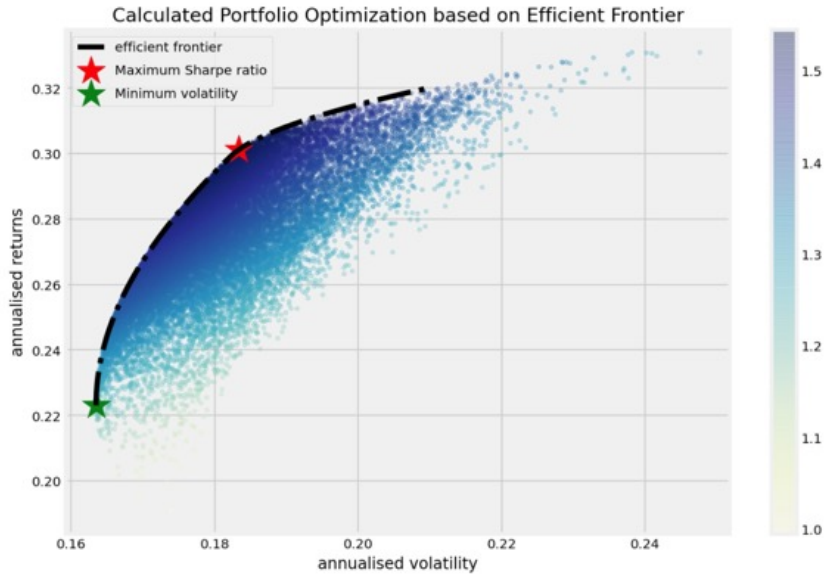
RAM Disk Editing

```
Annualised Volatility: 0.18


              AAPL   AMZN     FB  GOOGL
allocation  44.67  29.05  26.28    0.0
--------------------------------------------------------------------------------
Minimum Volatility Portfolio Allocation

Annualised Return: 0.22
Annualised Volatility: 0.16


              AAPL  AMZN    FB  GOOGL
allocation  34.02  0.73  6.98  58.26
```




https://tinyurl.com/aintpupython101

# Capital Asset Pricing Model (CAPM)

- Capital Asset Pricing Model (CAPM)
  - One of the most widely documented and applied models in finance
  - It relates in linear fashion the expected return for a single stock to the expected return of the market portfolio, usually approximated by a broad stock index such as the S&P 500.
  - Sharpe (1964) and Lintner (1965)

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

# Capital Asset Pricing Model (CAPM)

Capital asset prices: A theory of market equilibrium under conditions of risk
WF Sharpe - The journal of finance, 1964 - Wiley Online Library
ONE OF THE PROBLEMS which has plagued those attempting to predict the behavior of capital markets is the absence of a body of positive microeconomic 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 …
Cite Cited by 30490 Related articles All 26 versions

Source: Sharpe, William F. "Capital asset prices: A theory of market equilibrium under conditions of risk." *The journal of finance* 19, no. 3 (1964): 425-442.

# Capital Asset Pricing Model (CAPM)

*The Journal of* FINANCE

VOL. XIX SEPTEMBER 1964 No. 3

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

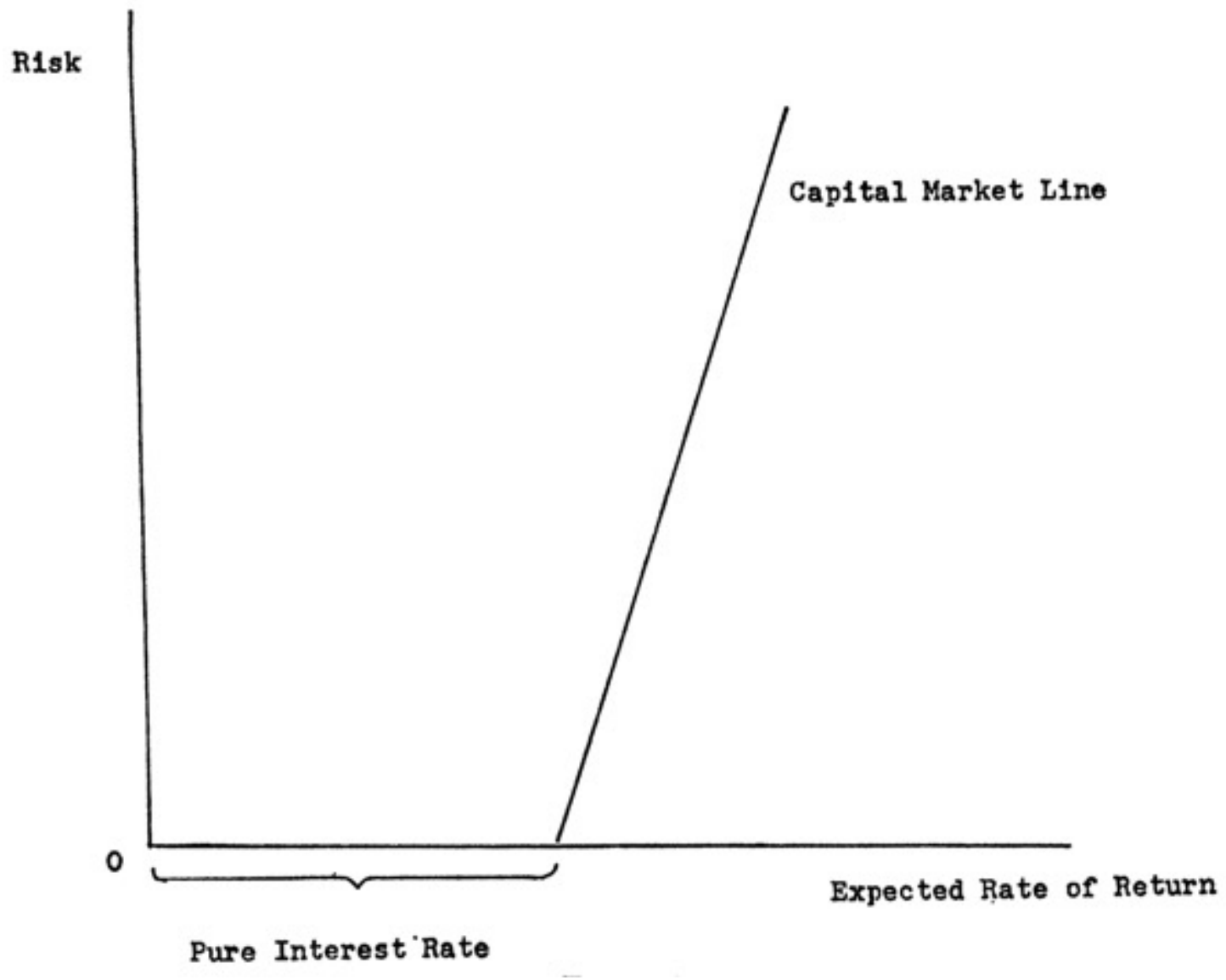
WILLIAM F. SHARPE†

### 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.

Source: Sharpe, William F. "Capital asset prices: A theory of market equilibrium under conditions of risk." *The journal of finance* 19, no. 3 (1964): 425-442.

# Capital Asset Pricing Model (CAPM)




Source: Sharpe, William F. "Capital asset prices: A theory of market equilibrium under conditions of risk." *The journal of finance* 19, no. 3 (1964): 425-442.

# Capital Asset Pricing Model (CAPM)

*Journal of Economic Perspectives—Volume 18, Number 3—Summer 2004—Pages 25–46*

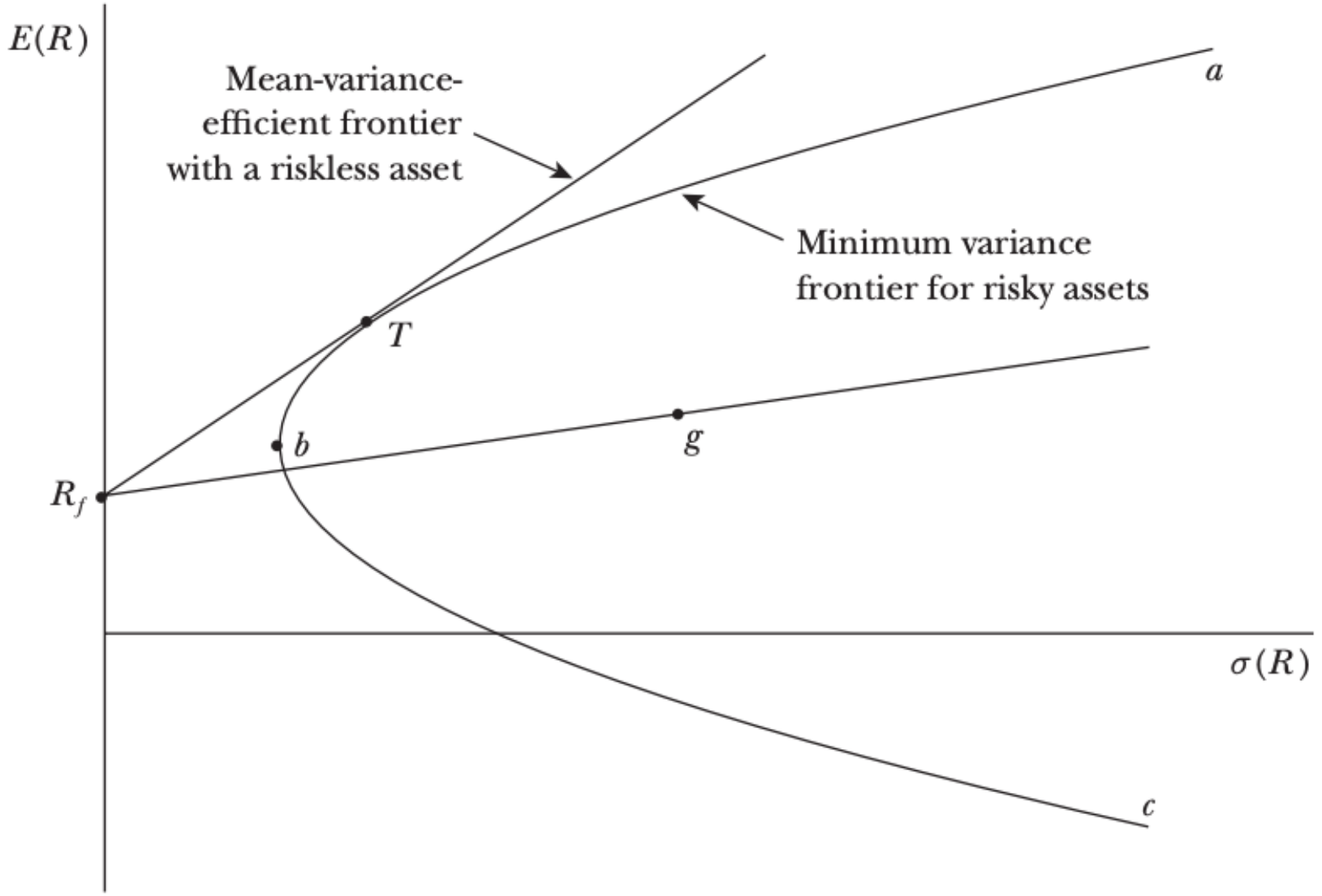
## The Capital Asset Pricing Model: Theory and Evidence

Eugene F. Fama and Kenneth R. French

The capital asset pricing model (CAPM) of William Sharpe (1964) and John Lintner (1965) marks the birth of asset pricing theory (resulting in a Nobel Prize for Sharpe in 1990). Four decades later, the CAPM is still widely used in applications, such as estimating the cost of capital for firms and evaluating the performance of managed portfolios. It is the centerpiece of MBA investment courses. Indeed, it is often the only asset pricing model taught in these courses.[1]

Source: Fama, Eugene F., and Kenneth R. French. "The capital asset pricing model: Theory and evidence." Journal of economic perspectives 18, no. 3 (2004): 25-46.

# Investment Opportunities




Source: Fama, Eugene F., and Kenneth R. French. "The capital asset pricing model: Theory and evidence." Journal of economic perspectives 18, no. 3 (2004): 25-46.

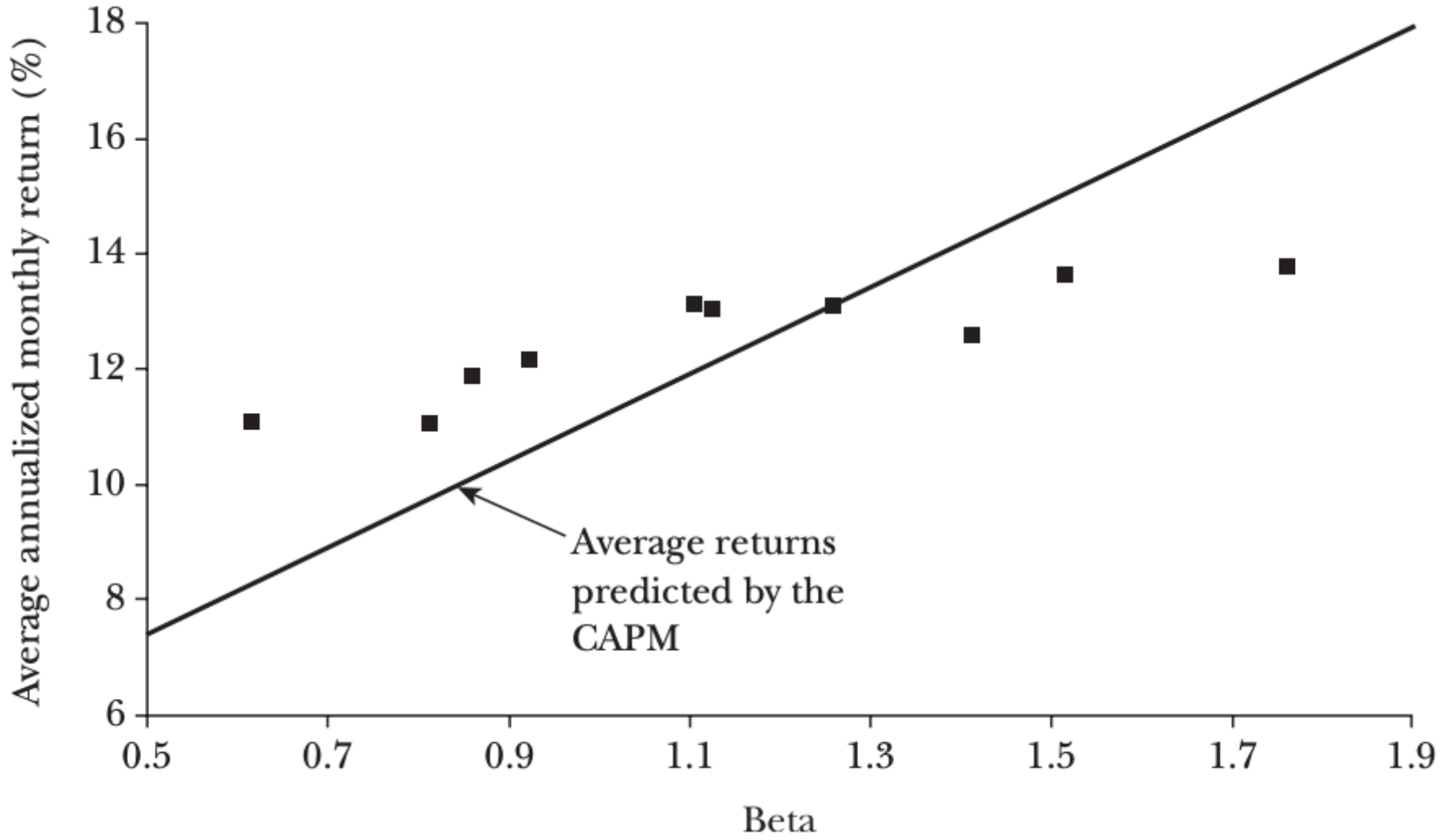
# Capital Asset Pricing Model (CAPM)

$$E(R_i) = R_f + \beta_{iM}\,[E(R_M) - R_f]$$

The expected return on any asset $i$
is the risk-free interest rate, $R_f$, plus a risk premium,
which is the asset's market beta, $\beta_{iM}$ ,
times the premium per unit of beta risk, $E(R_M)$-$R_f$

Source: Fama, Eugene F., and Kenneth R. French. "The capital asset pricing model: Theory and evidence." Journal of economic perspectives 18, no. 3 (2004): 25-46.

# Capital Asset Pricing Model (CAPM)




**Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on Prior Beta, 1928–2003**

Source: Fama, Eugene F., and Kenneth R. French. "The capital asset pricing model: Theory and evidence." Journal of economic perspectives 18, no. 3 (2004): 25-46.

# Capital Asset Pricing Model (CAPM)

- **Capital market theory is a positive theory in that it hypothesizes how investors do behave rather than how investors should behave, as in the case of modern portfolio theory (MVP)**
  - **It is reasonable to view capital market theory as an extension of portfolio theory, but it is important to understand that MVP is not based on the validity, or lack thereof, of capital market theory.**

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

# Capital Asset Pricing Model (CAPM)

- **The specific equilibrium model of interest to many investors is known as the capital asset pricing model, typically referred to as the CAPM.**
  - **It allows us to assess the relevant risk of an individual security as well as to assess the relationship between risk and the returns expected from investing.**
  - **The CAPM is attractive as an equilibrium model because of its simplicity and its implications.**

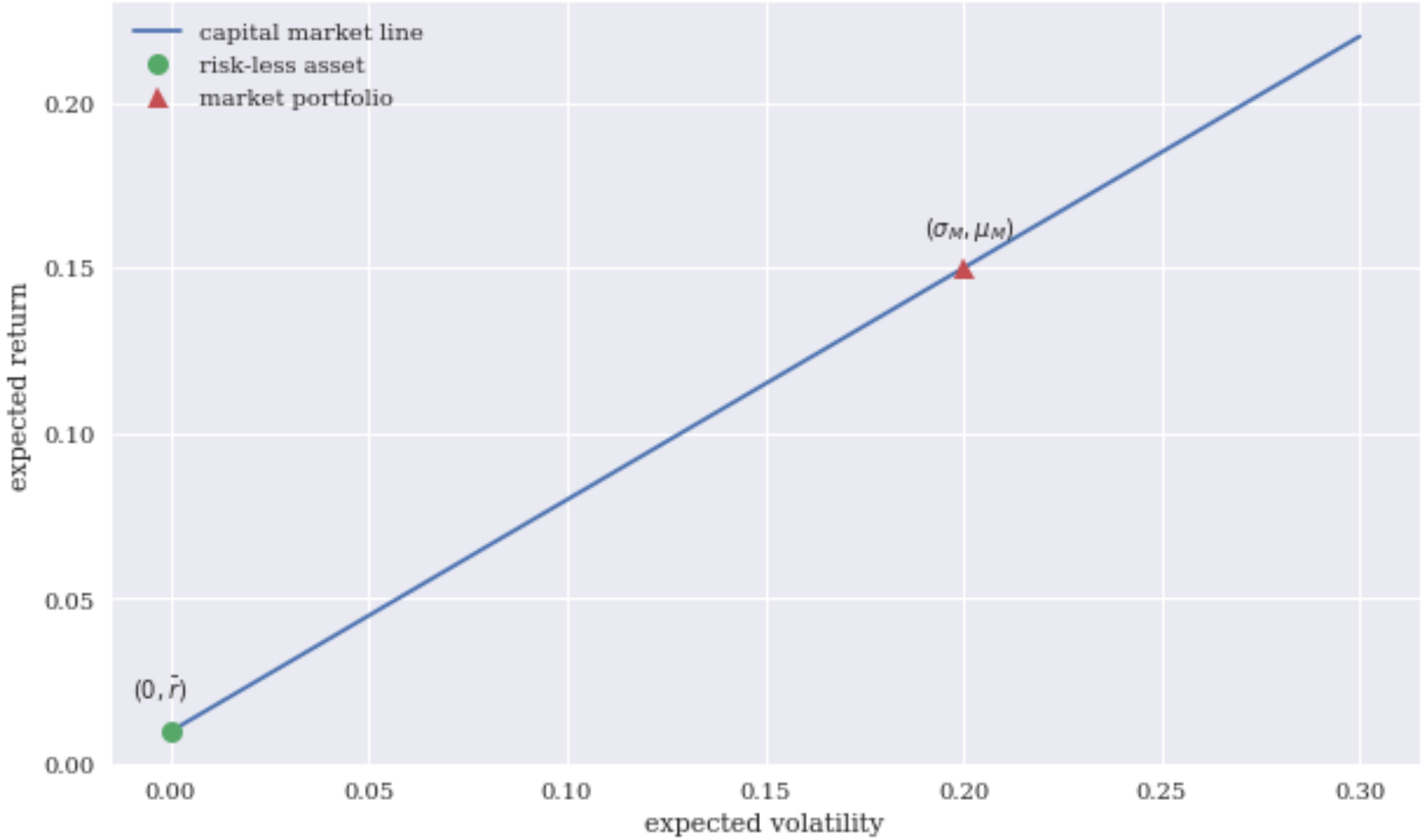
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Capital Asset Pricing Model (CAPM)

- In the CAPM, agents are assumed to invest according to MVP, caring only about the risk and return statistics of risky assets over one period.
- In a capital market equilibrium, all available assets are held by all agents and the markets clear.
- Market portfolio (set of tradable assets) must lie on the efficient frontier.
- Two fund separation theorem
  - Every agent will hold a combination of the market portfolio and the risk-free asset in equilibrium.
  - The set of all such portfolios is called the Capital Market Line (CML).

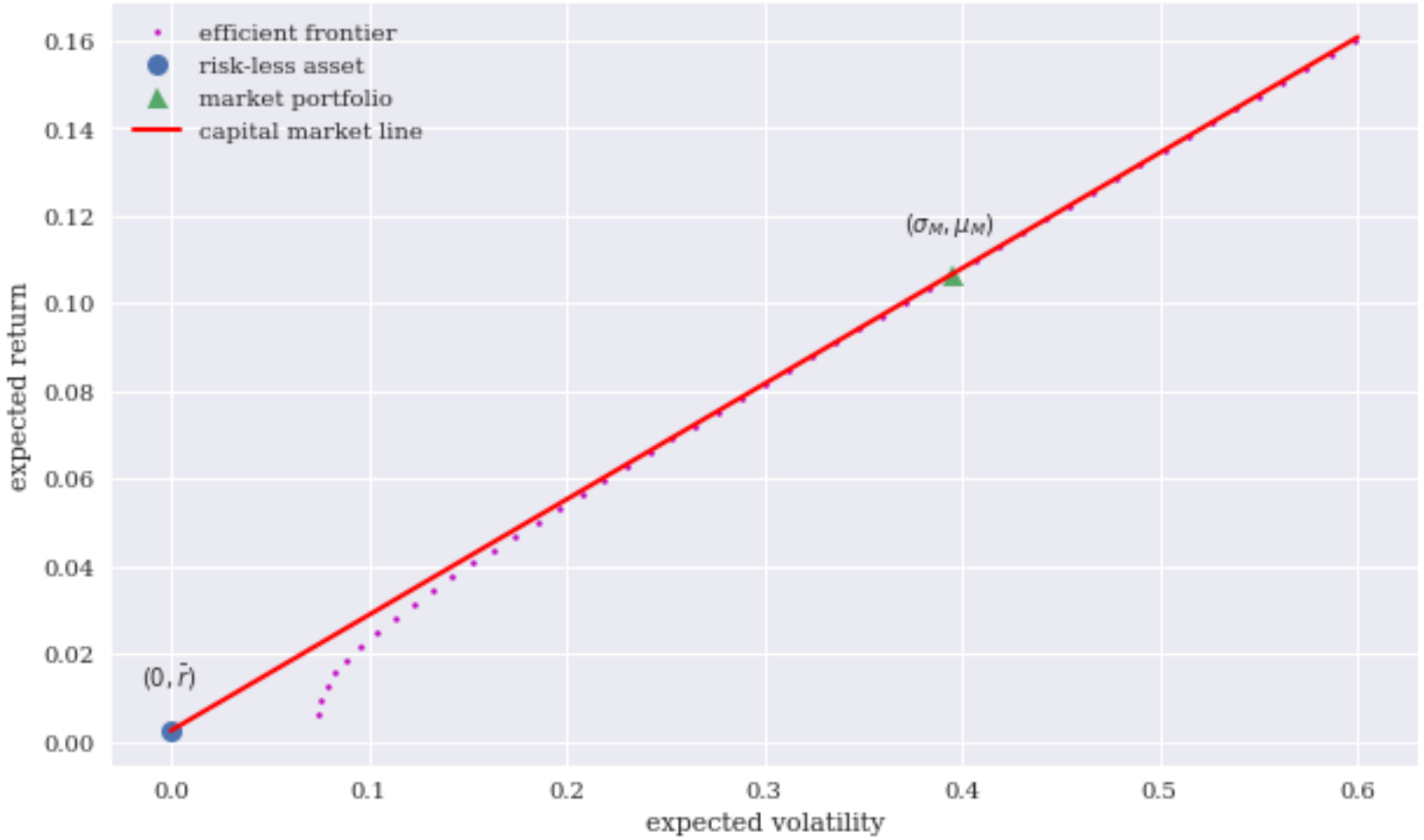
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Capital Market Line (CML)



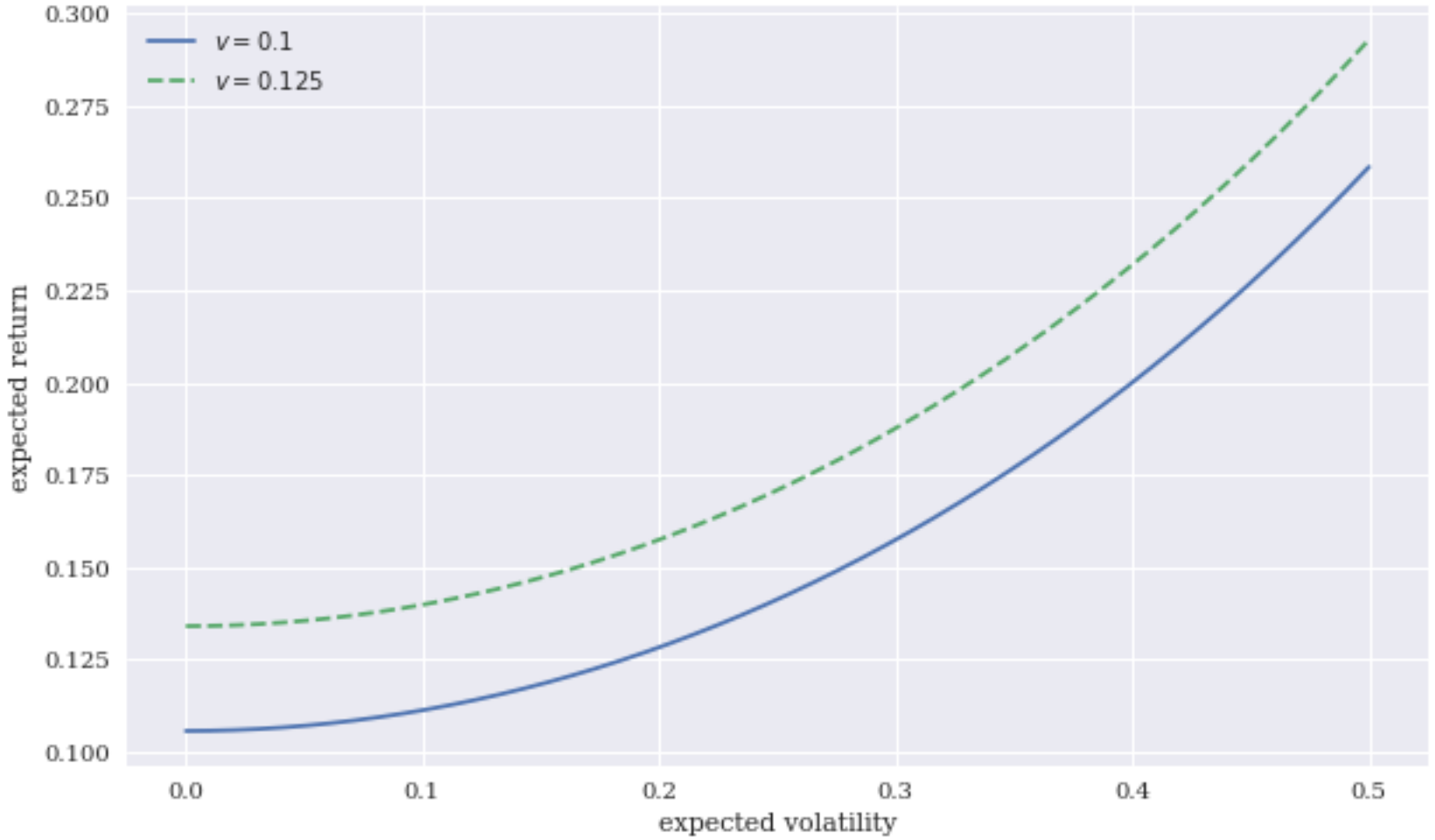

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Capital Market Line with Two Risky Assets



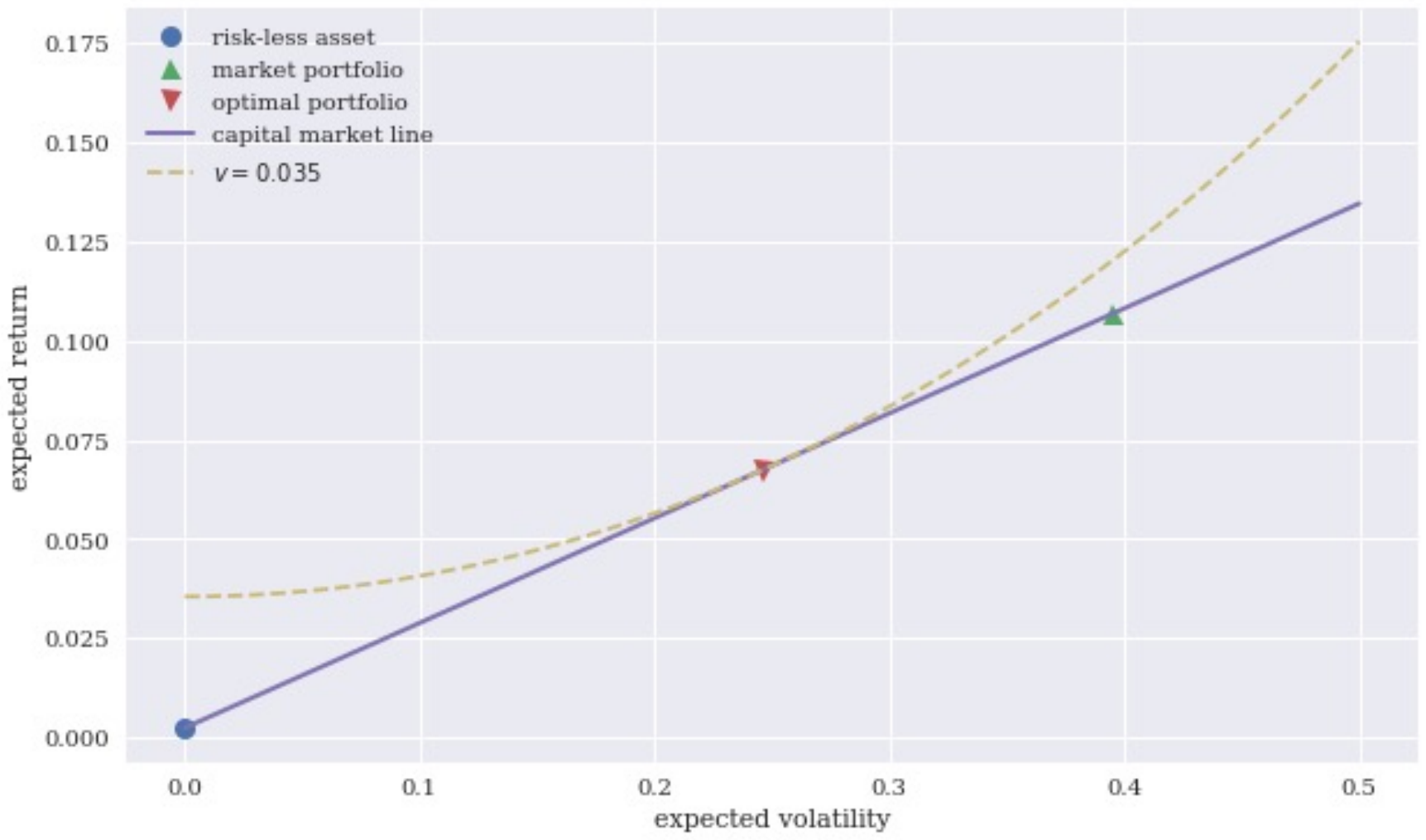

Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Indifference curves in risk-return space




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

# Optimal Portfolio on the Capital Market Line (CML)




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

# Arbitrage Pricing Theory (APT)

- **Arbitrage Pricing Theory (APT)**
  - **One of the major generalizations of the Capital Asset Pricing Model (CAPM)**
  - **Ross (1971) and Ross (1976)**
  - **The purpose of this paper is to examine rigorously the arbitrage model of capital asset pricing developed in Ross (1971).**
    - The arbitrage model was proposed as an alternative to the mean variance capital asset pricing model, introduced by Sharpe, Lintner, and Treynor, that has become the major analytic tool for explaining phenomena observed in capital markets for risky assets.

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

# Arbitrage Pricing Theory (APT)

JOURNAL OF ECONOMIC THEORY 13, 341–360 (1976)

## The Arbitrage Theory of Capital Asset Pricing

STEPHEN A. ROSS*

*Departments of Economics and Finance, University of Pennsylvania, The Wharton School, Philadelphia, Pennsylvania 19174*

Received March 19, 1973; revised May 19, 1976

The purpose of this paper is to examine rigorously the arbitrage model of capital asset pricing developed in Ross [13, 14]. The arbitrage model was proposed as an alternative to the mean variance capital asset pricing model, introduced by Sharpe, Lintner, and Treynor, that has become the major analytic tool for explaining phenomena observed in capital markets for risky assets. The principal relation that emerges from the mean variance model holds that for any asset, $i$, its (ex ante) expected return

$$E_i = \rho + \lambda b_i , \qquad (1)$$

Source: Ross, Stephen A. "The arbitrage theory of capital asset pricing." Journal of Economic Theory 13, no. 3 (1976): 341-360.

# Arbitrage Pricing Theory (APT)

- The APT is a generalization of the CAPM to multiple risk factors.
- APT does not assume that the market portfolio is the only relevant risk factor
  - There are rather multiple types of risk that together are assumed to drive the performance (expected returns) of a stock.
  - Such risk factors might include size, volatility, value, and momentum.

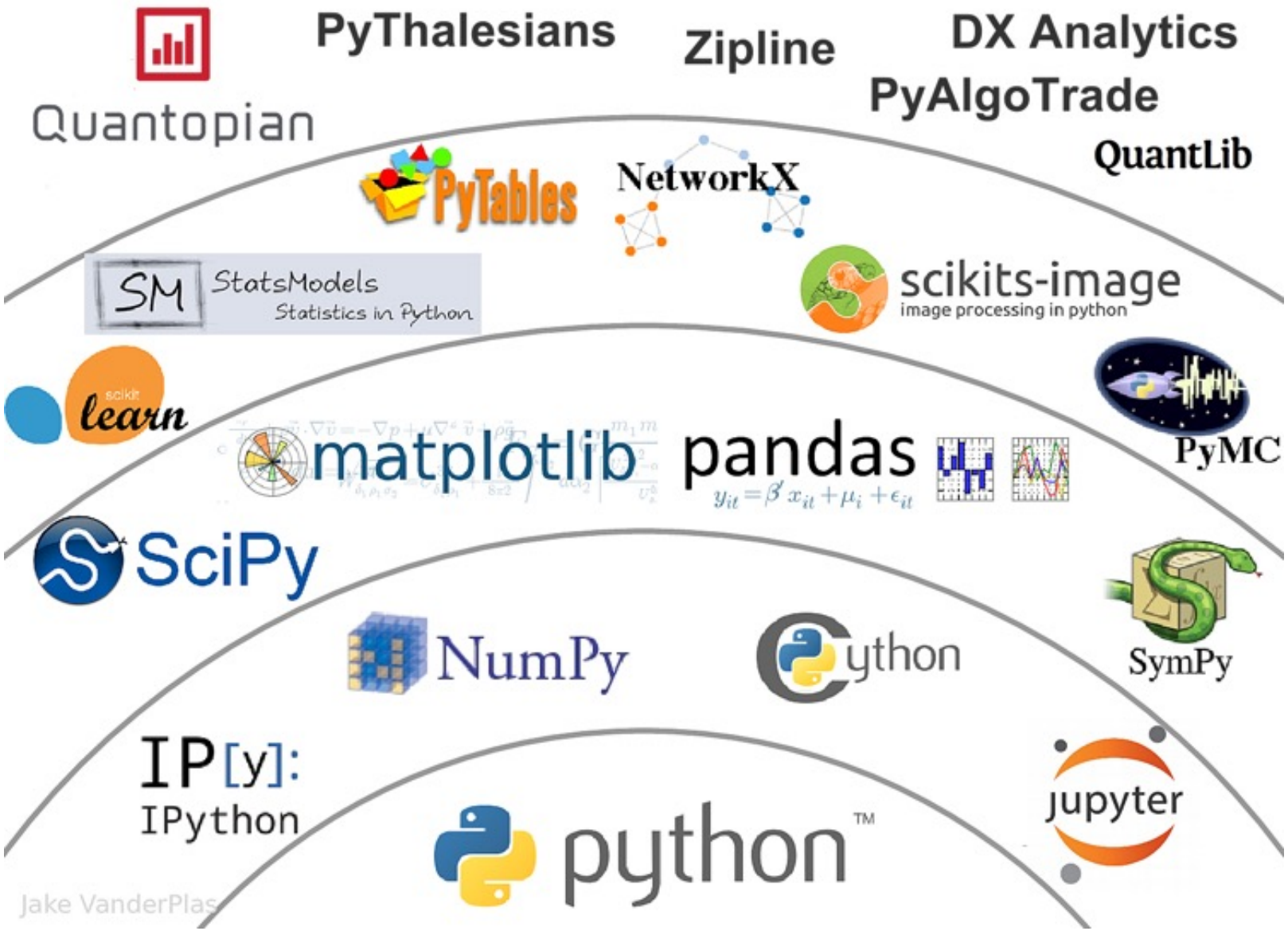
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# Capital Asset Pricing Model (CAPM)
# Arbitrage Pricing Theory (APT)

- **Capital Asset Pricing Model (CAPM)**
  - **univariate ordinary least-squares (OLS) regression**
- **Arbitrage Pricing Theory (APT)**
  - **multivariate ordinary least-squares (OLS) regression**

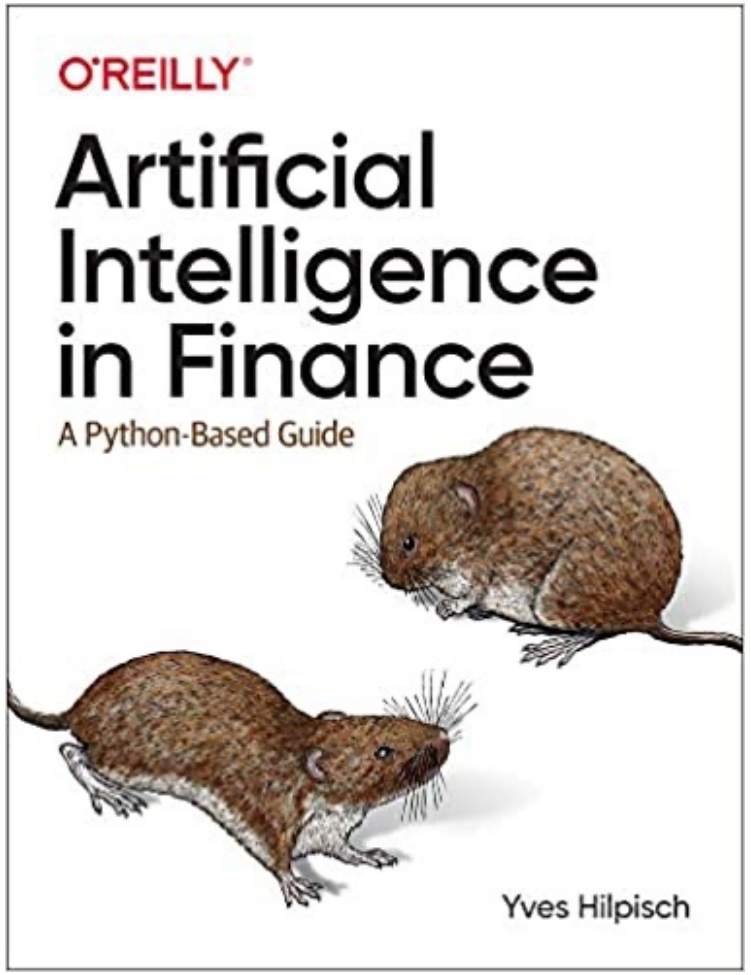
Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.

# 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

Notifications | Star 98 | Fork 77

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

View license

**Releases**

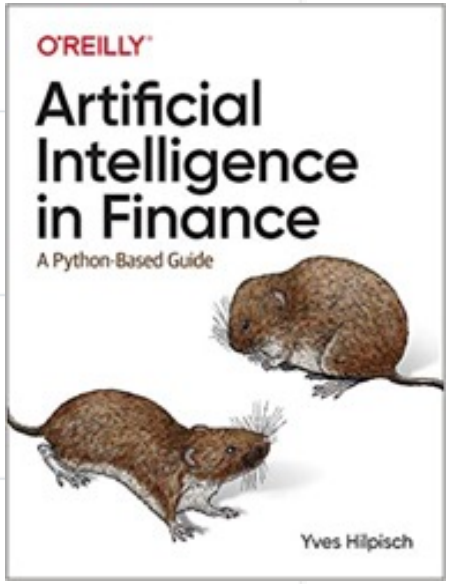
No releases published

**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

yhilpisch / aiif Public

Notifications | Star 98 | Fork 77

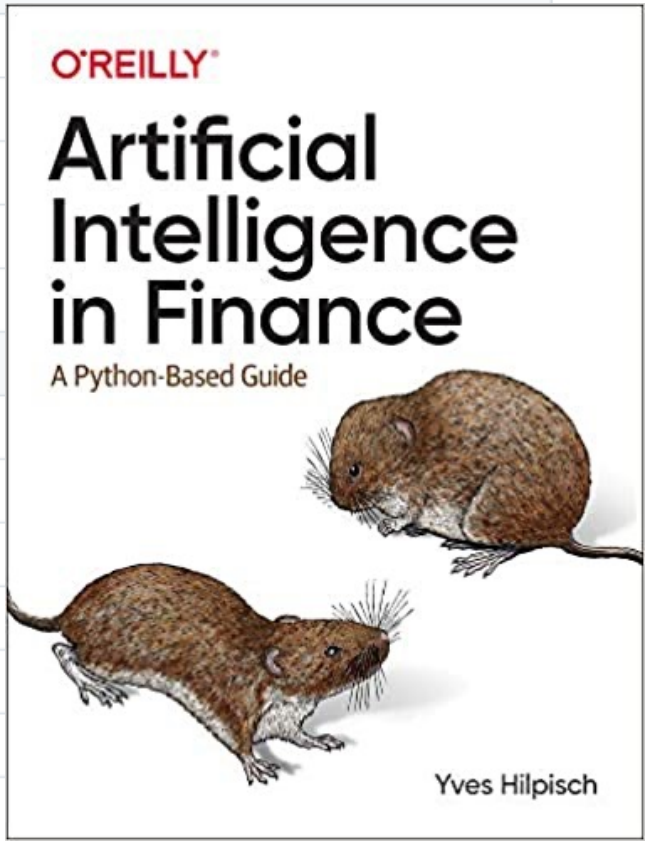
Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights

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

main | aiif / code / | Go to file

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

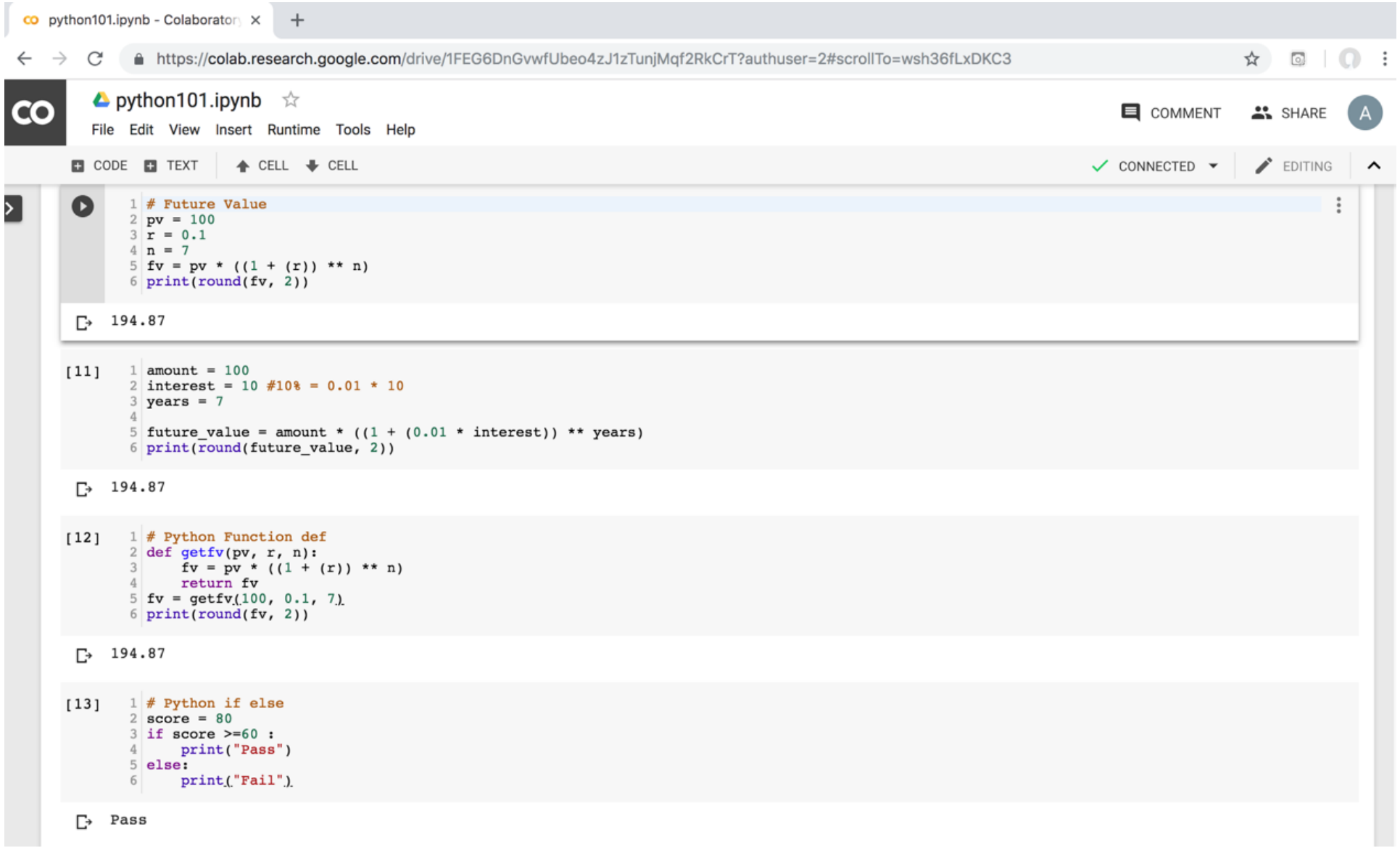
| | |
|---|---|
| .. | |
| oanda | Code updates for TF 2.3. |
| 01_artificial_intelligence.ipynb | Code updates for TF 2.3. |
| 02_superintelligence.ipynb | Code updates for TF 2.3. |
| 03_normative_finance.ipynb | Code updates for TF 2.3. |
| 04_data_driven_finance_a.ipynb | Initial commit. |
| 04_data_driven_finance_b.ipynb | 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)

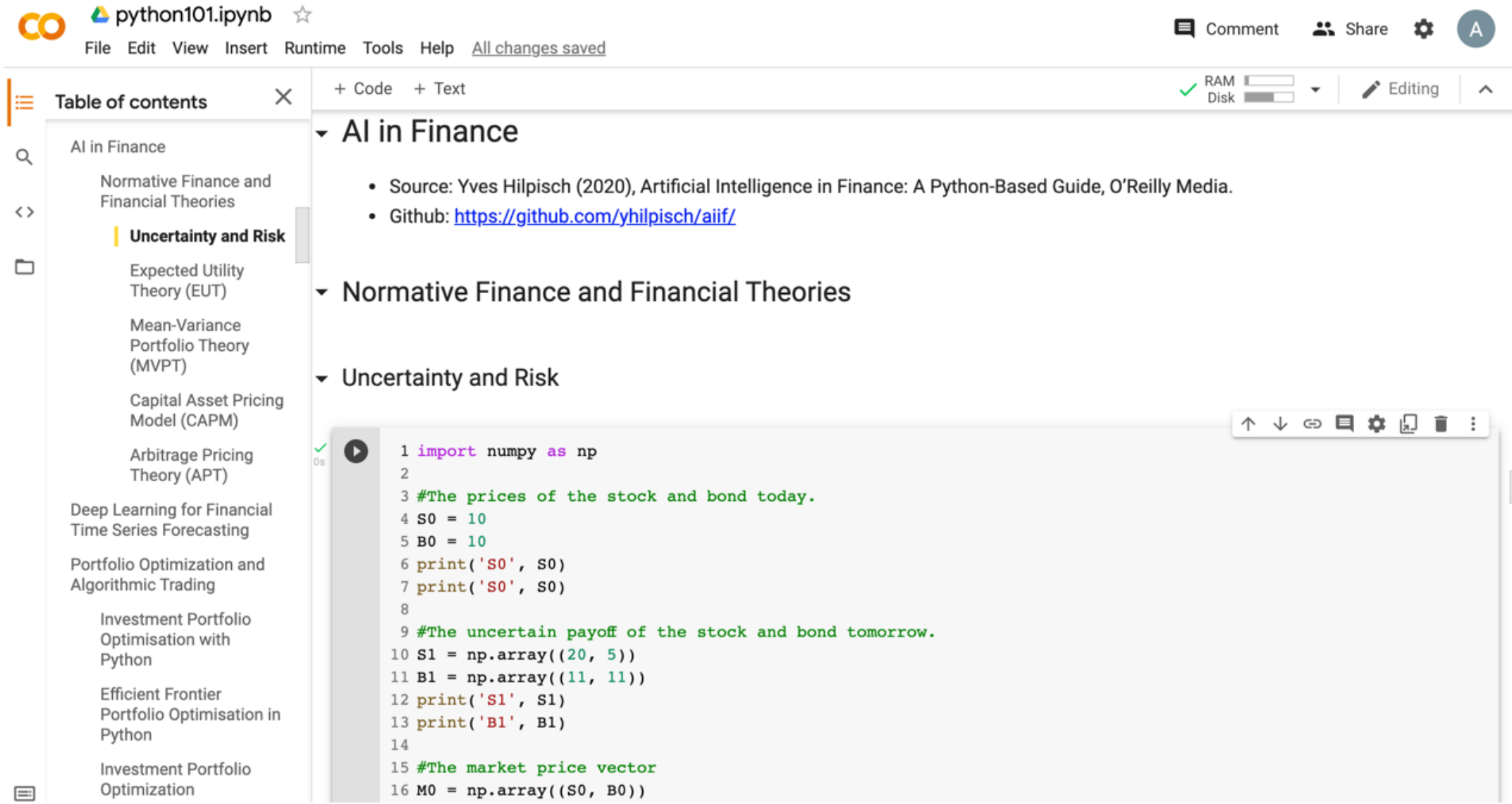
https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT




https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

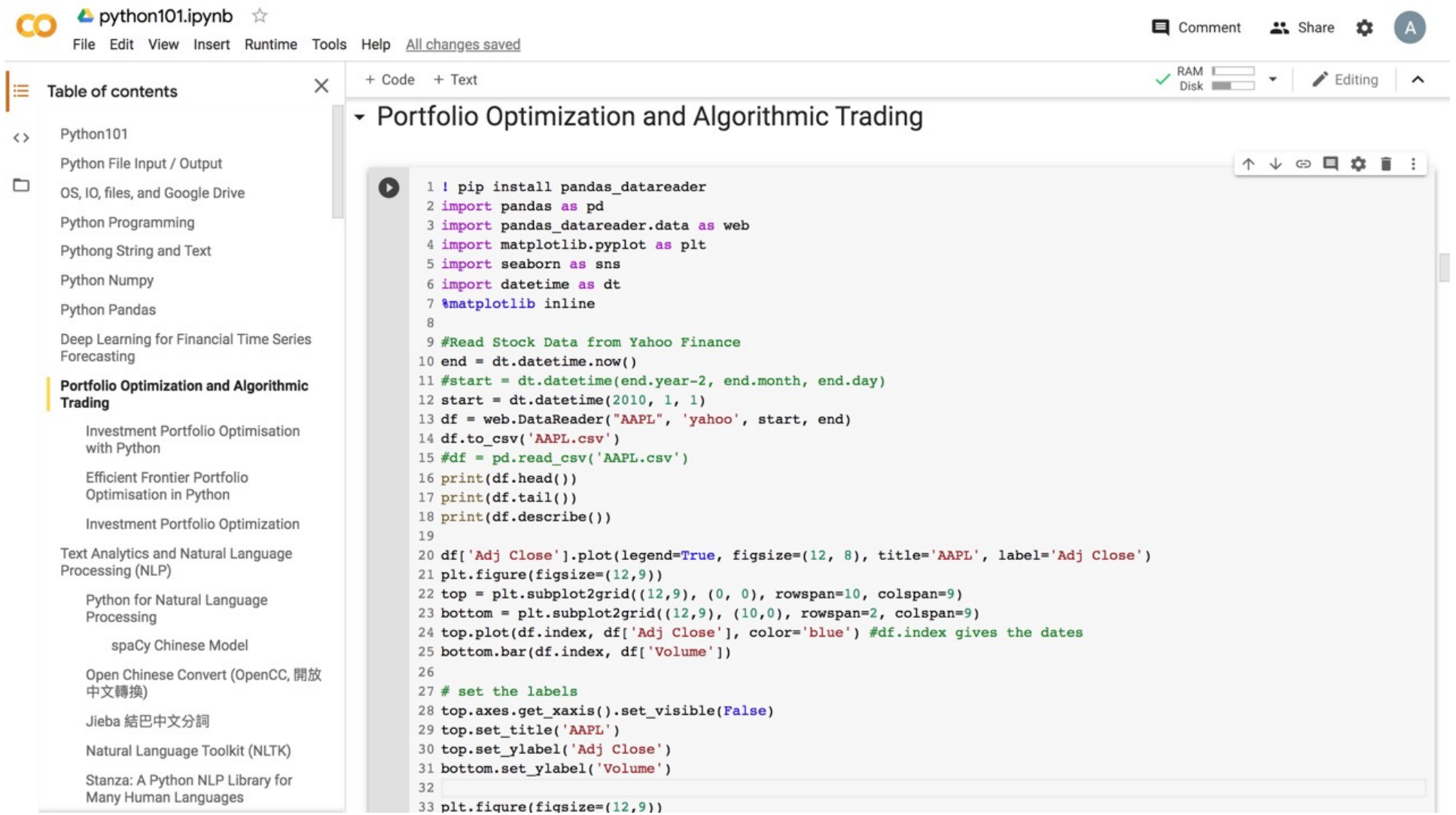
https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT




https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

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




https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

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

python101.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share A

Table of contents



+ Code + Text RAM Disk Editing

```
!pip install plotly
import plotly.graph_objects as go

import pandas as pd
from datetime import datetime
df = pd.read_csv('AAPL.csv')
fig = go.Figure(data=[go.Candlestick(x=df['Date'],
                open=df['Open'],
                high=df['High'],
                low=df['Low'],
                close=df['Close'])])

fig.show()
```

```
Requirement already satisfied: plotly in /usr/local/lib/python3.6/dist-packages (4.4.1)
Requirement already satisfied: retrying>=1.3.3 in /usr/local/lib/python3.6/dist-packages (from plotly) (1.3.3)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from plotly) (1.12.0)
```


https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

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

python101.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share A

Table of contents

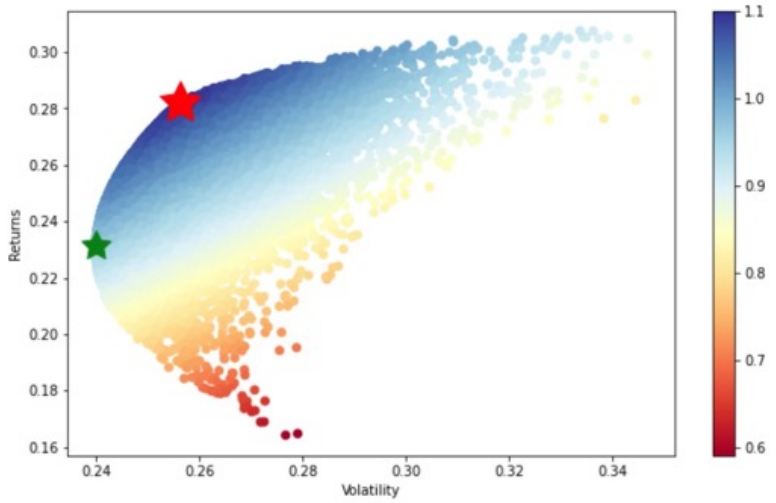
+ Code + Text

RAM Disk Editing

- Python101
- Python File Input / Output
- OS, IO, files, and Google Drive
- Python Programming
- Pythong String and Text
- Python Numpy
- Python Pandas
- Deep Learning for Financial Time Series Forecasting
- Portfolio Optimization and Algorithmic Trading
  - **Investment Portfolio Optimisation with Python**
  - Efficient Frontier Portfolio Optimisation in Python
  - Investment Portfolio Optimization
- Text Analytics and Natural Language Processing (NLP)
  - Python for Natural Language Processing
    - spaCy Chinese Model
  - Open Chinese Convert (OpenCC, 開放中文轉換)
  - Jieba 結巴中文分詞
  - Natural Language Toolkit (NLTK)
  - Stanza: A Python NLP Library for Many Human Languages

```
51 max_sharpe_port = results_frame.iloc[results_frame['sharpe'].idxmax()]
52 #locate positon of portfolio with minimum standard deviation
53 min_vol_port = results_frame.iloc[results_frame['stdev'].idxmin()]
54
55 #create scatter plot coloured by Sharpe Ratio
56 plt.figure(figsize=(10,6))
57 plt.scatter(results_frame.stdev,results_frame.ret,c=results_frame.sharpe,cmap='RdYlBu')
58 plt.xlabel('Volatility')
59 plt.ylabel('Returns')
60 plt.colorbar()
61 #plot red star to highlight position of portfolio with highest Sharpe Ratio
62 plt.scatter(max_sharpe_port[1],max_sharpe_port[0],marker=(5,1,0),color='r',s=1000)
63 #plot green star to highlight position of minimum variance portfolio
64 plt.scatter(min_vol_port[1],min_vol_port[0],marker=(5,1,0),color='g',s=500)
```

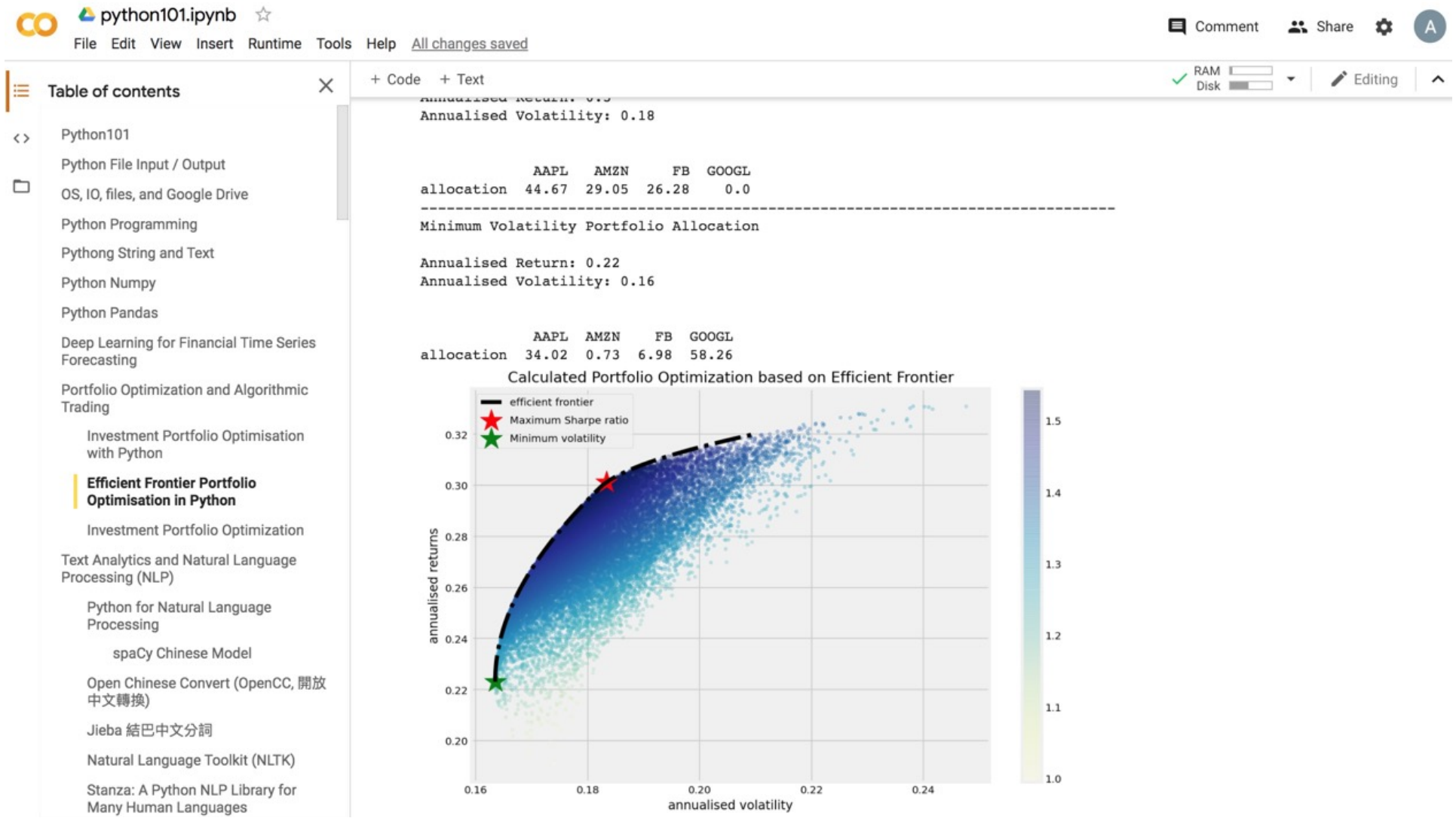
```
<matplotlib.collections.PathCollection at 0x7f13132a01d0>
```




https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

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




https://tinyurl.com/aintpupython101

# Python in Google Colab (Python101)

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

**Portfolio Optimization**
**Efficient Frontier Portfolio Optimization**

python101.ipynb ☆

File Edit View Insert Runtime Tools Help All changes saved

Comment Share A

Table of contents

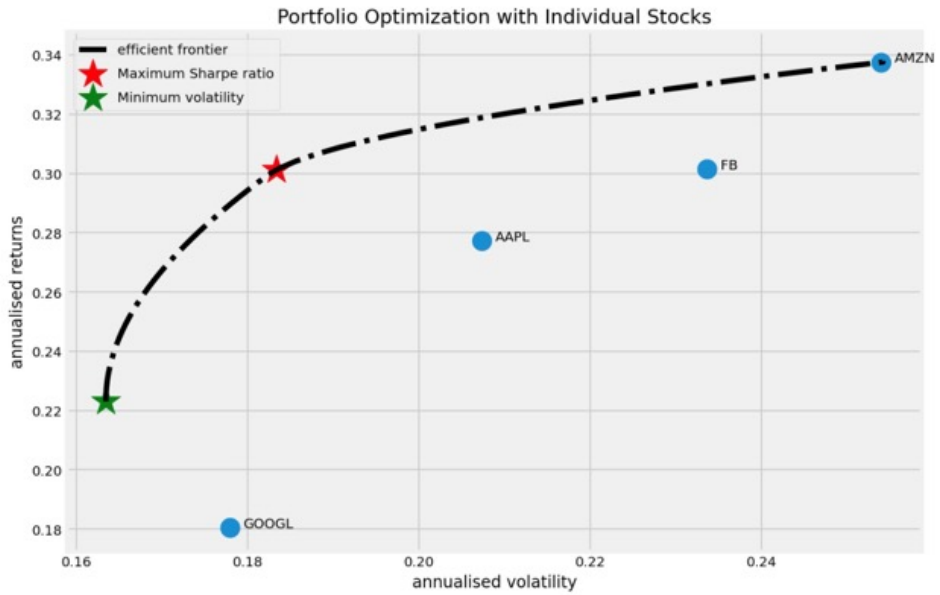
- Python101
- Python File Input / Output
- OS, IO, files, and Google Drive
- Python Programming
- Pythong String and Text
- Python Numpy
- Python Pandas
- Deep Learning for Financial Time Series Forecasting
- Portfolio Optimization and Algorithmic Trading
  - Investment Portfolio Optimisation with Python
  - **Efficient Frontier Portfolio Optimisation in Python**
  - Investment Portfolio Optimization
- Text Analytics and Natural Language Processing (NLP)
  - Python for Natural Language Processing
    - spaCy Chinese Model
  - Open Chinese Convert (OpenCC, 開放中文轉換)
  - Jieba 結巴中文分詞
  - Natural Language Toolkit (NLTK)
  - Stanza: A Python NLP Library for Many Human Languages

+ Code + Text RAM Disk Editing

```
Annualised Return: 0.22
Annualised Volatility: 0.16


              AAPL  AMZN    FB  GOOGL
allocation   34.02  0.73  6.98  58.26
--------------------------------------------------------------------------------
Individual Stock Returns and Volatility

AAPL : annuaised return 0.28 , annualised volatility: 0.21
AMZN : annuaised return 0.34 , annualised volatility: 0.25
FB : annuaised return 0.3 , annualised volatility: 0.23
GOOGL : annuaised return 0.18 , annualised volatility: 0.18
--------------------------------------------------------------------------------
```




https://tinyurl.com/aintpupython101

# Summary

- Uncertainty and Risk
- Expected Utility Theory (EUT)
- 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.

# 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 (2022), Python 101, https://tinyurl.com/aintpupython101