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Webinar

How to Build Better Portfolios in Python Using Riskfolio-Lib

Welcome

We will begin promptly at 11 AM ET.

If you are unable to hear the speakers, please let us know in the chat box. You may enter your questions in the Q&A, we will address them at the end of the presentation.

You can find a copy of the recording of this webinar:

www.fdpinstitute.org/webinars

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Financial Data Professional Institute

FDP Institute provides world class training and education to financial professionals to meet the accelerating needs of digital transformation in the industry.

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The FDP Institute

The FDP Charter

The FDP Institute offers a self-study program that provides financial data professionals an efficient path to learn the essential aspects of financial data science.

The FDP Study Guide is now accessible on our website at:

https://fdpinstitute.org/Candidate-Study-Guide

TOPICS COVERED INCLUDE:

1. Introduction to Data Science
2. Linear & Logistic Regression, Support Vector Machines, Regularization and Time Series
3. Decision Trees, Supervised Segmentation and Ensemble Methods
4. Classification, Clustering and Naïve Bayes
5. Neural Networks and Reinforcement Learning
6. Performance Evaluation, Back-Testing and False Discoveries
7. Text Mining
8. Ethical & Privacy Issues
9. Fintech Applications

FDP EXAM Q4-2023 IMPORTANT DATES:

Open Registration: June 1, 2023

FDP Exam Test Center Dates: October 9-22, 2023

Remote Proctor Testing Dates: October 23 & 23, 2023

How to Build Better Portfolios in Python Using Riskfolio-Lib

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Riskfolio-Lib

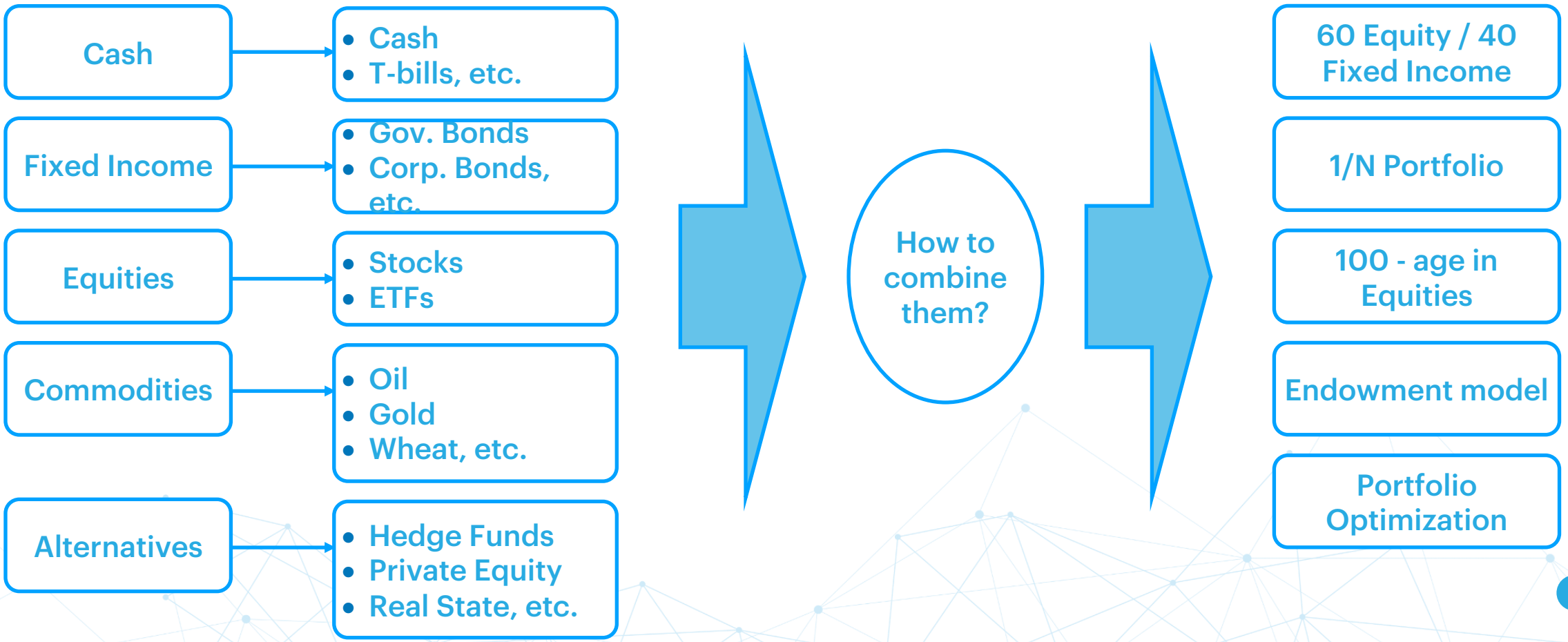
Quantitative Strategic Asset Allocation with Python

Dany Cajas - April 2023

Sleeping Beauty - Tingo Maria - Peru

How asset managers build a Portfolio?

Asset managers have a wide universe of assets, asset classes and models to choose:



What is Portfolio Optimization?

Portfolio optimization is the process to select the best possible combination of asset according to a set of desired objectives and constraints using mathematical techniques.

Advantages	Disadvantages
Diversification, reduce of idiosyncratic risk.	Risk of over-diversification, too many assets increase cost of rebalancing.
Lead to more efficient portfolios in a risk return relationship.	More appropriate for frictionless markets and liquid assets.
Allows to build custom portfolios designed to meet investor needs.	**Complex mathematical models. Some models are hard to implement and solve.**

Riskfolio-Lib

Riskfolio-Lib is a library for portfolio optimization in Python made in Peru. It is built on top of CVXPY and closely integrated with Pandas data structures. It allows users to solve two kinds of portfolio optimization models:

Convex Portfolio Optimization	Machine Learning Portfolio Optimization
Risk-Return Trade off	Hierarchical Risk Parity
Risk Parity Risk Budgeting Approach	Hierarchical Equal Risk Contribution
Risk Parity Least Squares Approach	Nested Clustered Optimization
Worst Case Optimization	

Convex Portfolio Optimization

Risk-Return Trade Off

Risk Minimization

$$\begin{array}{ll} \min\limits_{x} & \phi_0(x) \\ \text{s.t.} & Ax \geq B \\ & \mu' x \geq \overline{\mu} \\ & \phi_i(x) \leq \overline{\phi}_i, \quad i = 1, \ldots, m \end{array}$$

Return Maximization

$$\begin{array}{ll} \max\limits_{x} & \mu' x \\ \text{s.t.} & Ax \geq B \\ & \phi_i(x) \leq \overline{\phi}_i, \quad i = 0, \ldots, m \end{array}$$

Utility Maximization

$$\begin{array}{ll} \max\limits_{x} & \mu' x - \lambda \phi_0(x) \\ \text{s.t.} & Ax \geq B \\ & \phi_i(x) \leq \overline{\phi}_i, \quad i = 1, \ldots, m \end{array}$$

Return/Risk Maximization

$$\begin{array}{ll} \max\limits_{x} & \dfrac{\mu' x}{\phi_0(x)} \\ \text{s.t.} & Ax \geq B \\ & \phi_i(x) \leq \overline{\phi}_i, \quad i = 1, \ldots, m \end{array}$$

Risk Parity Least Squares

$$\begin{array}{ll} \min\limits_{x} & \displaystyle\sum_{i=1}^{N} \left(\frac{x_i (\Sigma x)_i}{x^T \Sigma x} - b_i \right)^2 \\ \text{s.t.} & \mathbf{1}' x = 1 \\ & x \geq 0 \end{array}$$

Risk Parity Risk Budgeting

$$\begin{array}{ll} \min\limits_{y,t} & \phi(y) \\ \text{s.t.} & b' \ln(y) \geq c \\ & \mathbf{1}' y = t \\ & y, t \geq 0 \\ & x = \dfrac{y}{t} \end{array}$$

Worst Case Optimization

Robust Variance Minimization

$$\begin{array}{ll} \min\limits_{x} & \max\limits_{\Sigma \in U_\Sigma} x^T \Sigma x \\ \text{s.t.} & Ax \geq b \end{array}$$

Robust Return Maximization

$$\begin{array}{ll} \max\limits_{x} & \min\limits_{\mu \in U_\mu} \mu x \\ \text{s.t.} & Ax \geq b \end{array}$$

Robust Utility Maximization

$$\begin{array}{ll} \max\limits_{x} & \min\limits_{\mu \in U_\mu} \mu x - \lambda \max\limits_{\Sigma \in U_\Sigma} x^T \Sigma x \\ \text{s.t.} & Ax \geq b \end{array}$$

Robust Return/Standard Deviation Maximization

$$\begin{array}{ll} \max\limits_{x} & \dfrac{\min\limits_{\mu \in U_\mu} \mu x - r_f}{\max\limits_{\Sigma \in U_\Sigma} \sqrt{x^T \Sigma x}} \\ \text{s.t.} & Ax \geq b \end{array}$$

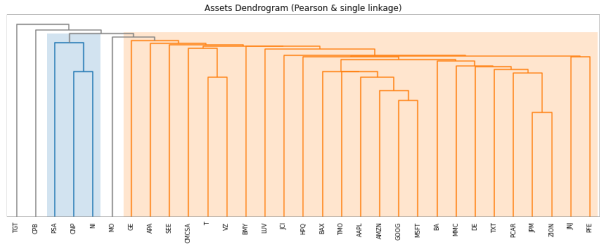
Convex Portfolio Optimization

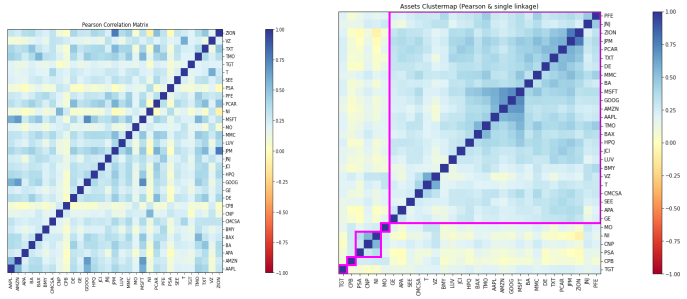
It is the traditional approach for portfolio optimization. Using convex optimization techniques, we can create portfolios that meets investor's needs like:

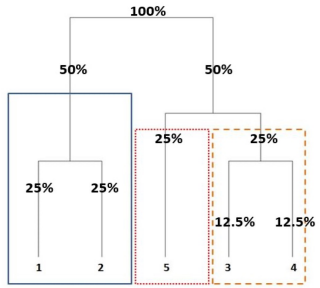
- Minimize the risk of a portfolio.
- Create constraints on asset classes.
- Create tracking error constraints.
- Create long-short portfolios.
- Constraints on risk measures, among other investor's needs.

Machine Learning Portfolio Optimization

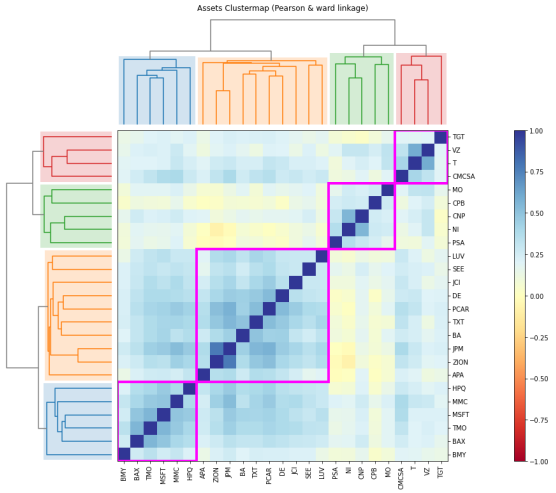
Hierarchical Risk Parity

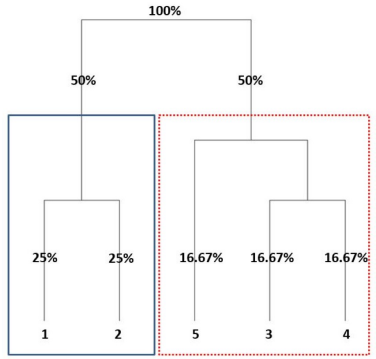




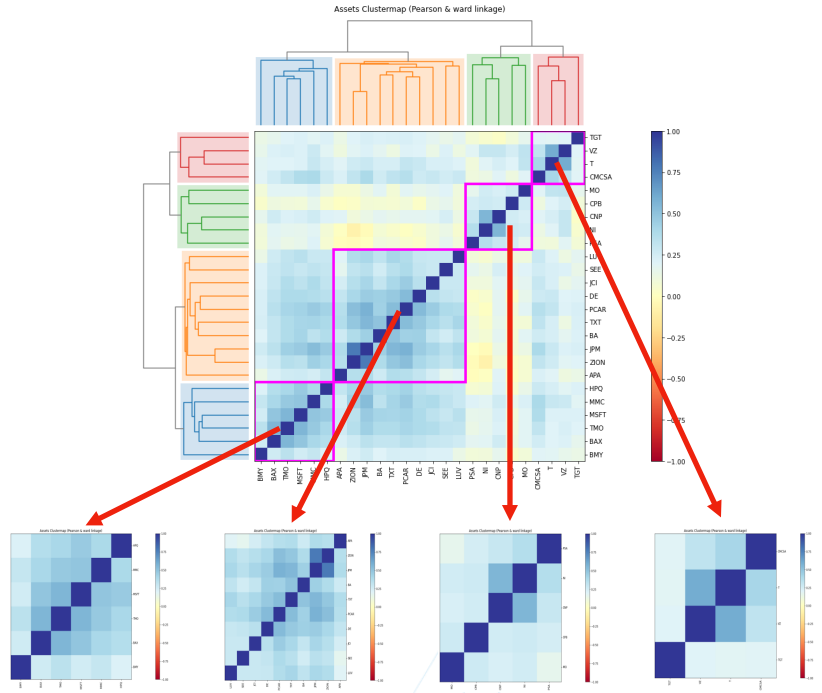


Hierarchical Equal Risk Contribution





Nested Clustered Optimization

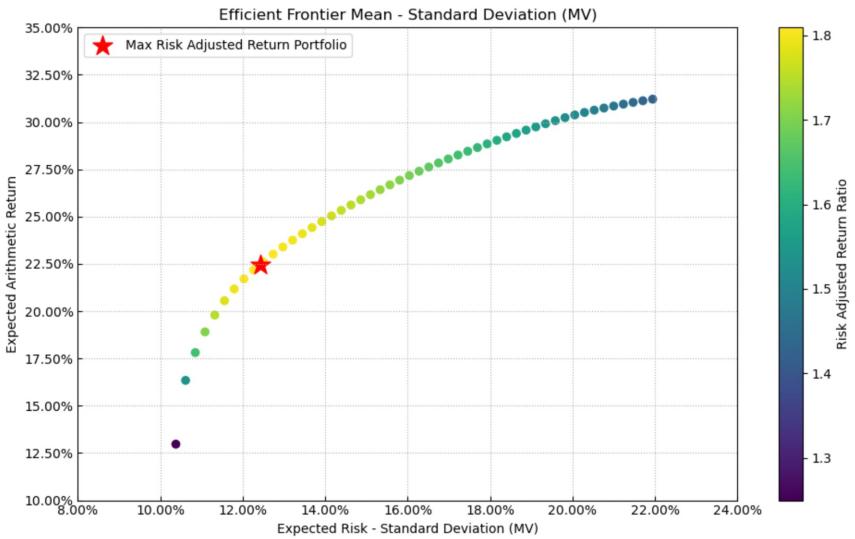


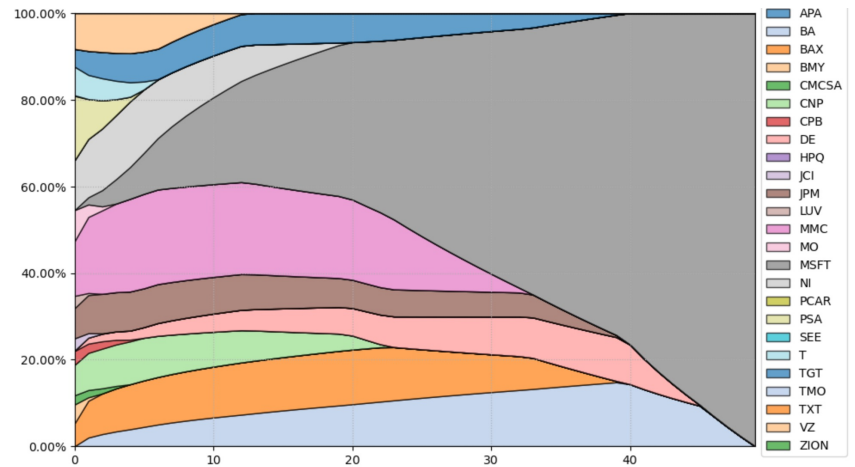
$$\min_{x_{C_1}} \phi(x_{C_1}) \quad \min_{x_{C_2}} \phi(x_{C_2}) \quad \min_{x_{C_3}} \phi(x_{C_3}) \quad \min_{x_{C_4}} \phi(x_{C_4})$$

$$\min_{[C_1,C_2,C_3,C_4]} \phi([C_1, C_2, C_3, C_4])$$

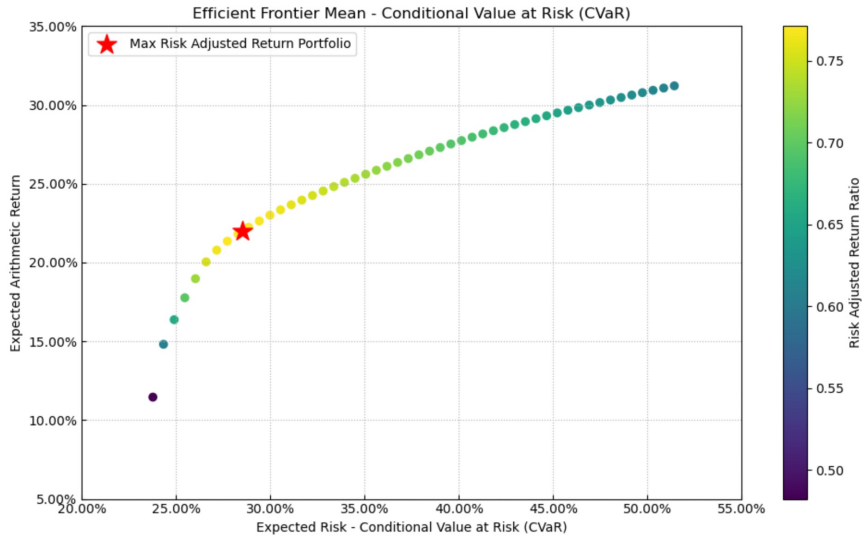
More Riskfolio-Lib Features

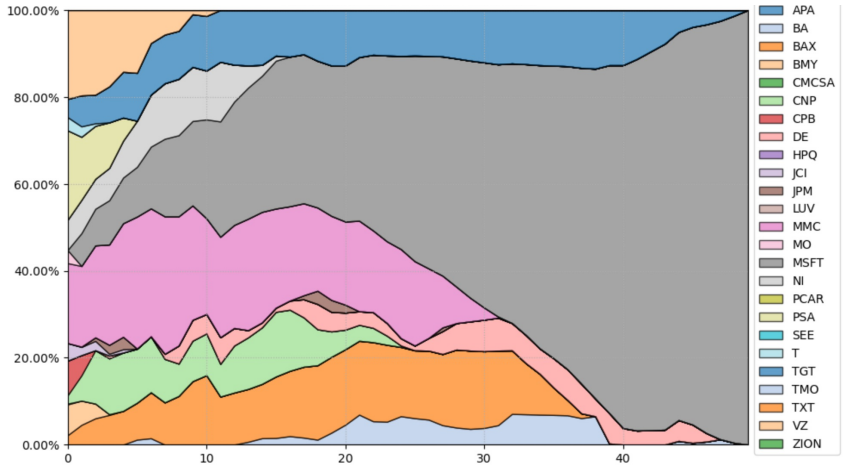
Efficient Frontier Mean-Standard Deviation





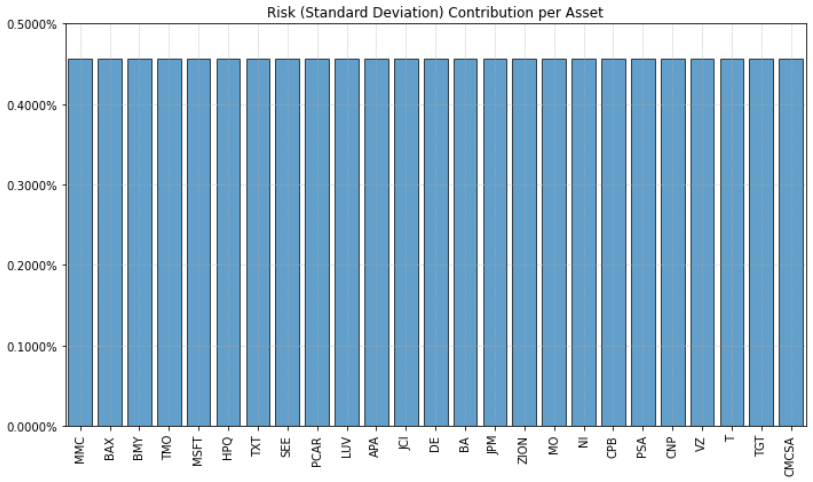
Efficient Frontier Mean-CVaR



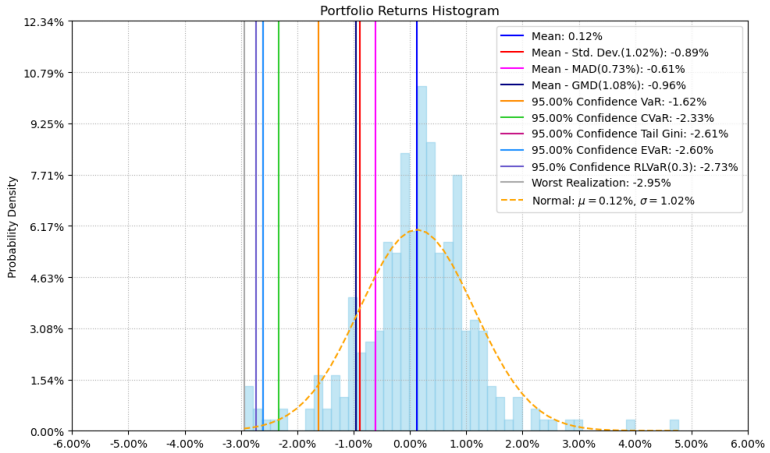


More Riskfolio-Lib Features

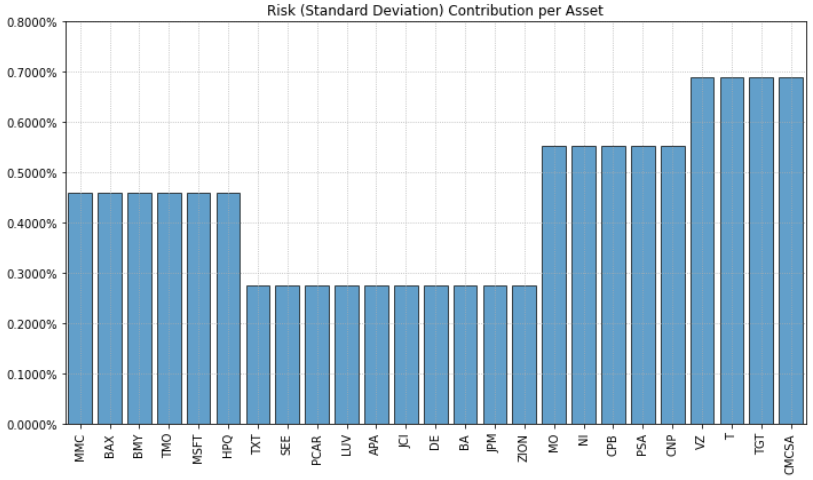
Risk Parity - Equal Risk Contribution



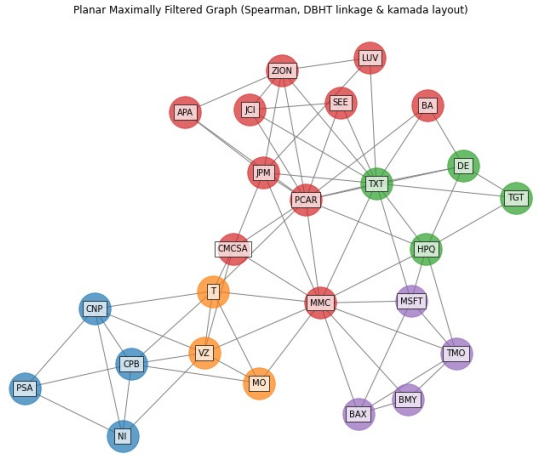
Portfolio Return's Histogram



Risk Parity - Equal Risk Contribution per Asset Class



Assets Cluster's Network



Riskfolio-Lib Links

- Source code is available in https://github.com/dcajasn/Riskfolio-Lib
- Documentation is available in https://riskfolio-lib.readthedocs.io/
- Examples are available in https://riskfolio-lib.readthedocs.io/en/latest/examples.html
- Pypi page for installation is available in https://pypi.org/project/Riskfolio-Lib/
- Support this project (Donations):
  - https://github.com/sponsors/dcajasn
  - https://ko-fi.com/riskfolio

Riskfolio-Lib Tutorial

Riskfolio-Lib Tutorial:

[Financionerioncios]
[Orenji]
[Riskfolio-Lib]
[Dany Cajas]

Buy Me a Coffee

Mean Risk Optimization

1. Downloading the data:

In [1]:
```
import numpy as np
import pandas as pd
import yfinance as yf
import warnings

warnings.filterwarnings("ignore")
pd.options.display.float_format = '{:.4%}'.format

# Date range
start = '2016-01-01'
end = '2019-12-30'

# Tickers of assets
assets = ['JCI', 'TGT', 'CMCSA', 'CPB', 'MO', 'APA', 'MMC', 'JPM',
          'ZION', 'PSA', 'BAX', 'BMY', 'LUV', 'PCAR', 'TXT', 'TMO',
          'DE', 'MSFT', 'HPQ', 'SEE', 'VZ', 'CNP', 'NI', 'T', 'BA']
assets.sort()

# Downloading data
data = yf.download(assets, start = start, end = end)
data = data.loc[:,('Adj Close', slice(None))]
data.columns = assets
```

Selected Questions

- About advanced mathematical portfolio construction models beyond mean-variance theory under ESG context.
- How stable the most recent Machine Learning allocation optimization methods are, compare to more traditional ones ?
- How would you account for tail risk in portfolio optimization programs?
- What is your favorite feature?

Selected Questions

- Does speaker have any experience in integrating Riskfolio-lib with another open-source data aggregation tool OpenBB?
- What is the necessary programming background to build portfolios?
- Recommended mathematics to study?
- Highlight practical differences between RIVaR, EVaR, CVaR and cases where each one where should be over the others?

Thanks

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Sleeping Beauty - Tingo Maria - Peru

Q & A

https://fdpinstitute.org/Webinars/

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Thank You

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