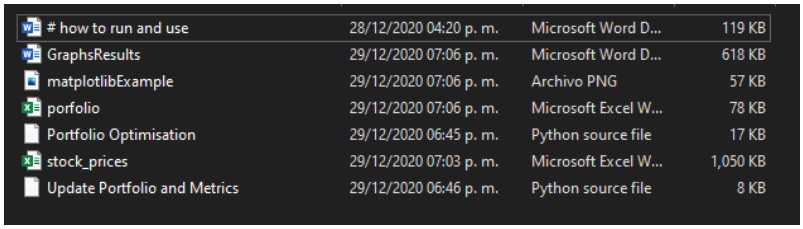
Portfolio Optimization

The objective of this code is to provide a tool for portfolio optimization using data from Yahoo Finance! and a library called mlfinlab. We divided the tasks in two main codes:

→ Update Portfolio and Metrics – this code help us update the excel portfolio data and generate a cluster analysis using return and volatility to visualize and understand the assets of our investable universe.

→ Portfolio Optimisation – the seconds step contains 8 optimisation solutions to generate scenarios and a custom example to find optimal portfolios under different assumptions.

This is the link to watch an explanation of the code functionalities:
https://www.youtube.com/watch?v=K4ZK9pVqrTg



# how to run and use	28/12/2020 04:20 p. m.	Microsoft Word D...	119 KB
GraphsResults	29/12/2020 07:06 p. m.	Microsoft Word D...	618 KB
matplotlibExample	29/12/2020 07:06 p. m.	Archivo PNG	57 KB
porfolio	29/12/2020 07:06 p. m.	Microsoft Excel W...	78 KB
Portfolio Optimisation	29/12/2020 06:45 p. m.	Python source file	17 KB
stock_prices	29/12/2020 07:03 p. m.	Microsoft Excel W...	1,050 KB
Update Portfolio and Metrics	29/12/2020 06:46 p. m.	Python source file	8 KB

In the excel file named portfolio.xlsx you can edit the tickers you want to analyze and add your current investment position with the average cost to track your PnL. Currently you can find some ETFs that replicate the ACWI, US Sectors, Fixed Income Strategies, Commodities, and some Currencies.

You can also define your Target Prices, Lower and Upper Bounds for the optimisation scenarios we will generate using the Mean-Variance Optimisation approach from mlfinlab library.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Label	Ticker	Shares	Average Cost	Price	Equity	Current Weight	% PnL		Target Price	Expected Return	Lower Bound	Upper Bound	Optimized Weights
41	Thailand	THD	200	62.8880	78.0100	4,905.8930	1.41%	24%		88.8293	14%	0%	10%	
42	Turkey	TUR	300	19.7200	26.6500	525.5380	0.15%	35%		26.2160	-2%	0%	10%	
43	United Kingdom	EWU	400	23.5815	29.6800	699.8989	0.20%	26%		34.6260	17%	0%	10%	
44	Energy	XLE	400	44.6930	37.6300	1,681.7976	0.48%	-16%		38.5985	3%	0%	10%	
45	Materials	XLB	200	75.3690	71.1300	5,360.9968	1.54%	-6%		53.8350	-24%	0%	10%	
46	Industrials	XLI	1,000	80.2890	87.5800	7,031.7108	2.02%	9%		111.5125	27%	0%	10%	
47	Consumer Discretionary	XLY	500	126.4240	159.7300	20,193.7050	5.80%	26%		176.9936	11%	0%	10%	
48	Consumer Staples	XLP	200	57.4855	67.0500	3,854.4030	1.11%	17%		76.4219	14%	0%	10%	
49	Health Care	XLV	300	88.9066	112.2800	9,982.4329	2.87%	26%		114.7908	2%	0%	10%	
50	Financials	XLF	500	31.8780	28.9900	924.1432	0.27%	-9%		32.7474	13%	0%	10%	
51	Information Technology	XLK	400	132.3420	129.9000	17,191.2250	4.94%	-2%		146.2064	13%	0%	10%	
52	Telecommunication Services	VOX	400	106.5690	120.0800	12,796.8057	3.68%	13%		112.4895	-6%	0%	10%	
53	Utilities	XLU	200	49.9280	61.4700	3,069.0742	0.88%	23%		46.8075	-24%	0%	10%	
54	Real Estate	XLRE	1,000	29.8640	35.9200	1,072.7148	0.31%	20%		38.0766	6%	0%	10%	
55	Extended Duration Treasury	EDV	500	131.7925	151.7600	20,000.8291	5.75%	15%		175.2065	15%	0%	10%	
56	Long-Term Treasury	VGLT	300	74.8051	95.5300	7,146.1311	2.05%	28%		109.8404	15%	0%	10%	
57	Intermediate-Term Treasury	VGIT	200	76.6590	69.3700	5,317.8350	1.53%	-10%		66.2055	-5%	0%	10%	
58	Short-Term Treasury	VGSH	500	65.0685	61.6100	4,008.8703	1.15%	-5%		46.4775	-25%	0%	10%	
59	Mortgage-Backed Securities	VMBS	400	48.6720	54.0400	2,630.2349	0.76%	11%		56.7840	5%	0%	10%	
60	Short-Term Inflation-Protected Securities	VTIP	400	40.8800	51.0000	2,084.8800	0.60%	25%		45.9900	-10%	0%	10%	
61	Long-Term Corporate Bond	VCLT	1,000	93.1940	110.8000	10,325.8955	2.97%	19%		122.7968	11%	0%	10%	
62	Intermediate-Term Corporate Bond	VCIT	200	76.3851	96.9700	7,407.0632	2.13%	27%		109.2597	13%	0%	10%	
63	Short-Term Corporate Bond	VCSH	500	91.2890	83.2000	7,595.2445	2.18%	-9%		84.6498	2%	0%	10%	
64	Long-Term High Yield Corporate Bond	HYG	200	91.1925	87.0500	7,938.3074	2.28%	-5%		98.1405	13%	0%	10%	
65	Intermediate-Term High Yield Corporate Bond	SHYG	300	49.7420	45.3400	2,255.3023	0.65%	-9%		52.4552	16%	0%	10%	
66	EM High Yield Bond	EMHY	500	48.0900	46.3100	2,227.0480	0.64%	-4%		43.5100	-6%	0%	10%	
67	Precious Metals	DBP	400	45.4170	52.2538	2,373.2092	0.68%	15%		37.8475	-28%	0%	10%	
68	Energy	DBE	200	8.3040	10.7650	89.3926	0.03%	30%		10.5876	-2%	0%	10%	
69	Oil	DBO	500	6.8425	8.3600	57.2033	0.02%	22%		9.0965	9%	0%	10%	
70	Agriculture	DBA	500	12.0870	15.8200	191.2163	0.05%	31%		17.7480	12%	0%	10%	
71	Base Metals	DBB	400	19.1620	17.3000	331.5026	0.10%	-10%		16.5490	-4%	0%	10%	
72	Palladium	PALL	200	230.6640	218.2500	50,342.4180	14.46%	-5%		164.7600	-25%	0%	10%	
73	AUD	FXA	20	59.2240	75.8200	4,490.3637	1.29%	28%		59.2240	-22%	0%	10%	
74	GBP	FXB	15	110.3895	130.4000	14,394.7901	4.14%	18%		123.3765	-5%	0%	10%	
75	CAD	FXC	30	60.8379	76.7700	4,670.5254	1.34%	26%		57.7575	-25%	0%	10%	
76	EUR	FXE	54	125.4000	115.0400	14,426.0161	4.14%	-8%		116.2800	1%	0%	10%	
77	CHF	FXF	66	107.4465	103.0570	11,073.1139	3.18%	-4%		115.6329	12%	0%	10%	
78	JPY	FXY	10	99.7480	91.1900	9,096.0204	2.61%	-9%		105.1888	15%	0%	10%	
79	Cash	USD				3,000.0000	0.86%							

Once you update all the specifications in the excel file, you just need to run the code '*Update Portfolio and Metrics*' mentioned above; to update the latest Prices, Metrics and Clusters for each Ticker in the excel file. This code will also generate each assets' returns histograms as the one showed below and a word document with all the graphs named GraphsResults.docx.

	A	B	U	V	W	X	Y	Z
1	Label	Ticker	Cluster	Mean	Variance	Skew	Kurtosis	Max Drawdown
43	United Kingdom	EWU	1	0.01%	0.02%	-1.8721	22.4991	
44	Energy	XLE	4	-0.02%	0.04%	-1.1356	21.4304	
45	Materials	XLB	2	0.05%	0.02%	-0.7518	12.9103	
46	Industrials	XLI	2	0.05%	0.02%	-0.8128	16.2168	
47	Consumer Discretionary	XLY	2	0.06%	0.02%	-1.3627	20.1520	
48	Consumer Staples	XLP	1	0.03%	0.01%	-0.4519	19.4296	
49	Health Care	XLV	1	0.04%	0.01%	-0.4675	11.9684	
50	Financials	XLF	0	0.06%	0.03%	2.2285	53.2529	
51	Information Technology	XLK	0	0.10%	0.02%	-0.7816	15.7229	
52	Telecommunication Services	VOX	2	0.04%	0.02%	-0.9025	12.5980	
53	Utilities	XLU	2	0.04%	0.02%	-0.2819	21.8330	
54	Real Estate	XLRE	1	0.03%	0.02%	-1.6524	26.6829	
55	Extended Duration Treasury	EDV	1	0.04%	0.01%	0.0181	6.4363	
56	Long-Term Treasury	VGLT	1	0.03%	0.01%	0.1233	11.6084	
57	Intermediate-Term Treasury	VGIT	3	0.01%	0.00%	0.2359	5.7099	
58	Short-Term Treasury	VGSH	3	0.01%	0.00%	0.4827	7.3244	
59	Mortgage-Backed Securities	VMBS	3	0.01%	0.00%	-0.4135	88.8907	
60	Short-Term Inflation-Protected Securities	VTIP	3	0.01%	0.00%	0.7192	64.2552	
61	Long-Term Corporate Bond	VCLT	1	0.04%	0.01%	-0.3011	51.3154	
62	Intermediate-Term Corporate Bond	VCIT	3	0.02%	0.00%	0.2320	66.3138	
63	Short-Term Corporate Bond	VCSH	3	0.01%	0.00%	-2.7833	120.6353	
64	Long-Term High Yield Corporate Bond	HYG	3	0.03%	0.00%	-0.1412	31.4552	
65	Intermediate-Term High Yield Corporate Bond	SHYG	3	0.02%	0.00%	-0.6215	38.3177	
66	EM High Yield Bond	EMHY	1	0.03%	0.01%	-5.6573	87.2043	
67	Precious Metals	DBP	1	0.04%	0.01%	-0.1375	6.8644	
68	Energy	DBE	4	0.00%	0.03%	-0.9049	7.5616	
69	Oil	DBO	4	0.00%	0.04%	-0.8497	7.9516	
70	Agriculture	DBA	3	-0.02%	0.01%	-0.3121	2.0816	
71	Base Metals	DBB	1	0.03%	0.01%	-0.1792	0.6210	
72	Palladium	PALL	0	0.11%	0.04%	-0.8794	18.7995	
73	AUD	FXA	3	0.01%	0.00%	-0.2412	2.2696	
74	GBP	FXB	3	-0.01%	0.00%	-2.0707	27.6825	
75	CAD	FXC	3	0.01%	0.00%	0.0780	1.4349	
76	EUR	FXE	3	0.01%	0.00%	-0.1004	1.9123	
77	CHF	FXF	3	0.01%	0.00%	0.0746	1.2021	
78	JPY	FXY	3	0.01%	0.00%	0.3780	5.7209	
79	Cash	USD						

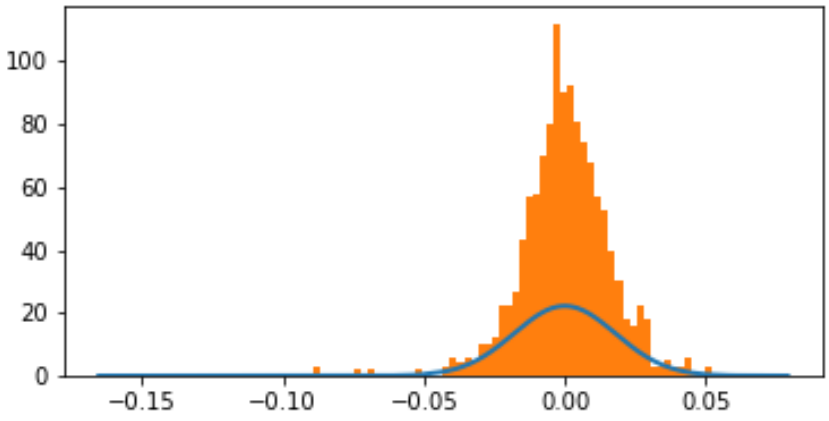
EWW

Mean: -1.3873347711262883e-05

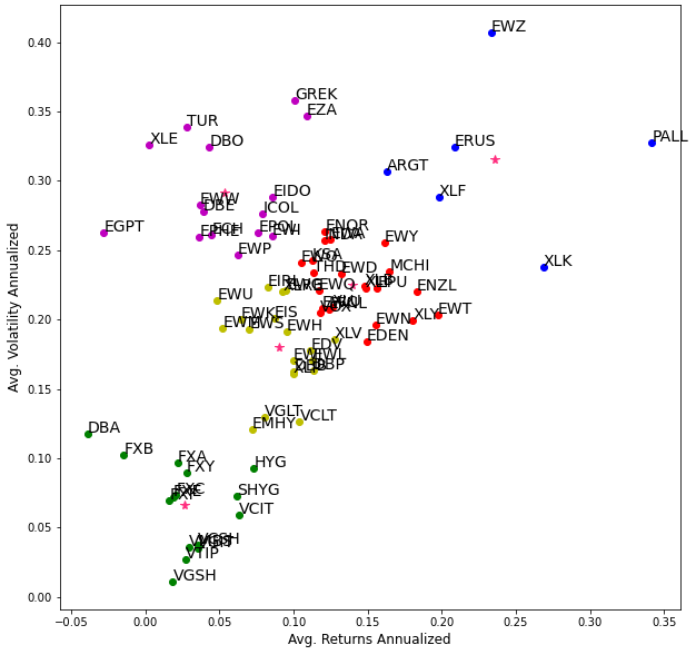
Variance: 0.0003235195431894183

Skew: -1.2968940885107845

Kurtosis: 10.136792703668549



Finally, this code performs a clustering analysis using volatility and return to understand the main groups of ETFs to perform a quick photo of how they behave as you can see in the following chart:

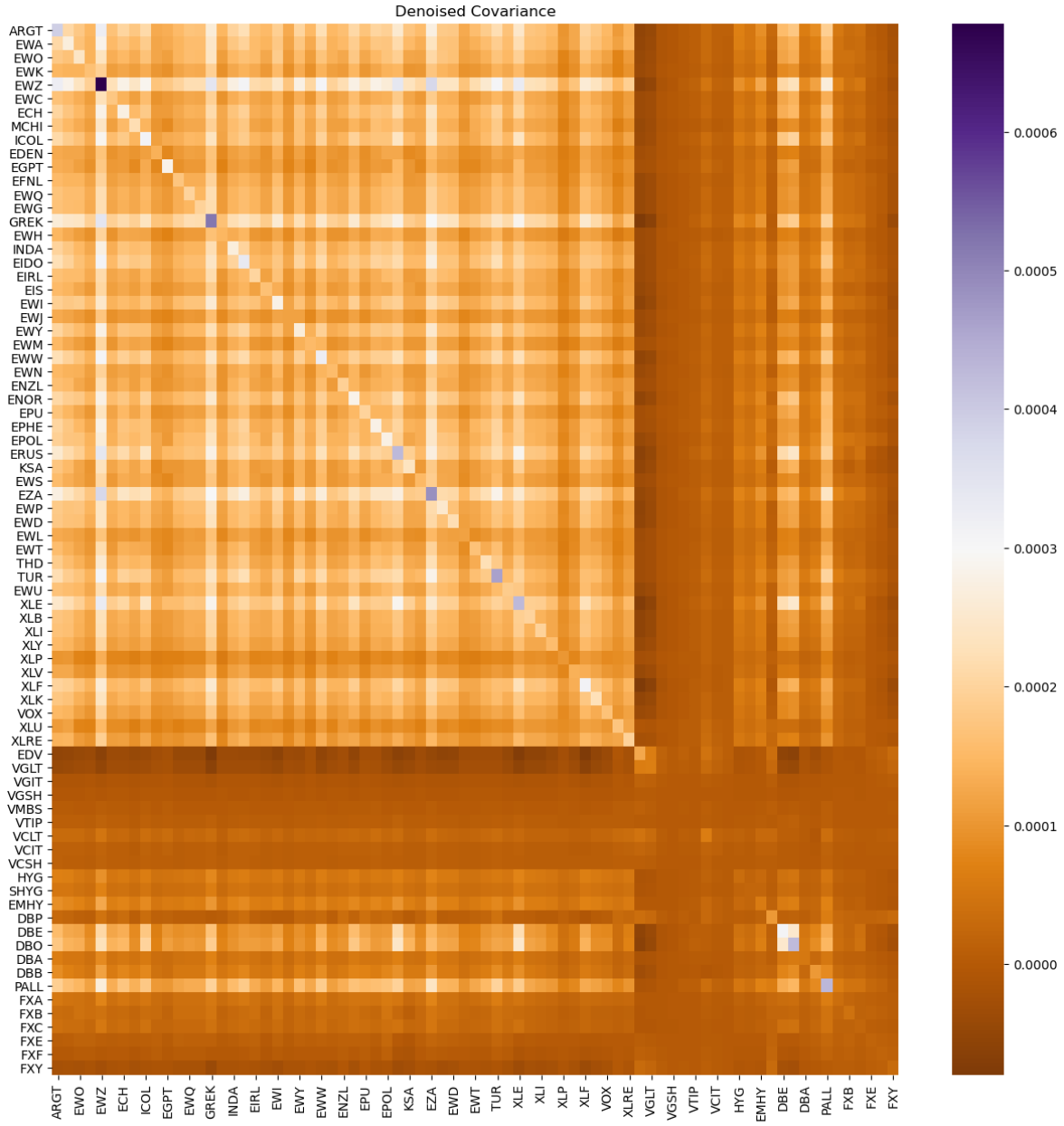


Once you updated the data, we can run the second code 'Portfolio Optimisation' to generate the Denoised Covariance Matrix, Portfolios and Efficient Frontier.

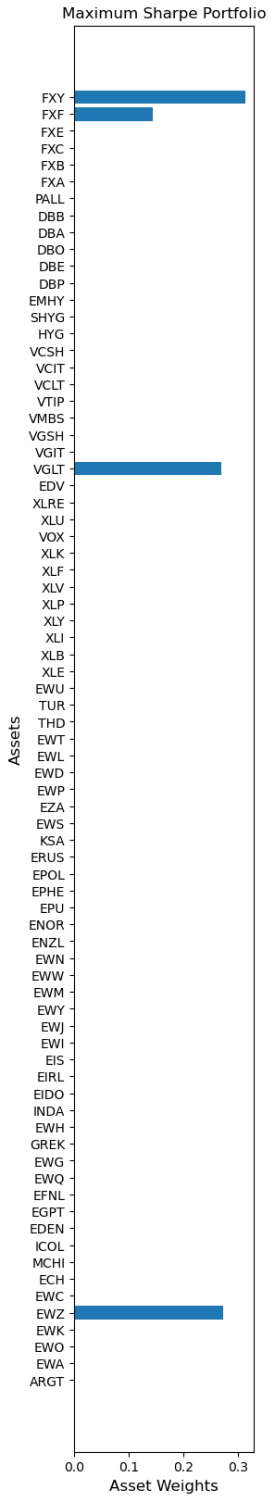
You can find the Mean-Variance Optimisation methods in this link:
https://mlfinlab.readthedocs.io/en/latest/portfolio_optimisation/mean_variance.html

1. Inverse Variance
2. Maximum Sharpe
3. Minimum Volatility
4. Efficient Risk
5. Maximum Return - Minimum Volatility
6. Efficient Return
7. Maximum Diversification
8. Maximum Decorrelation
9. Custom Objective Function

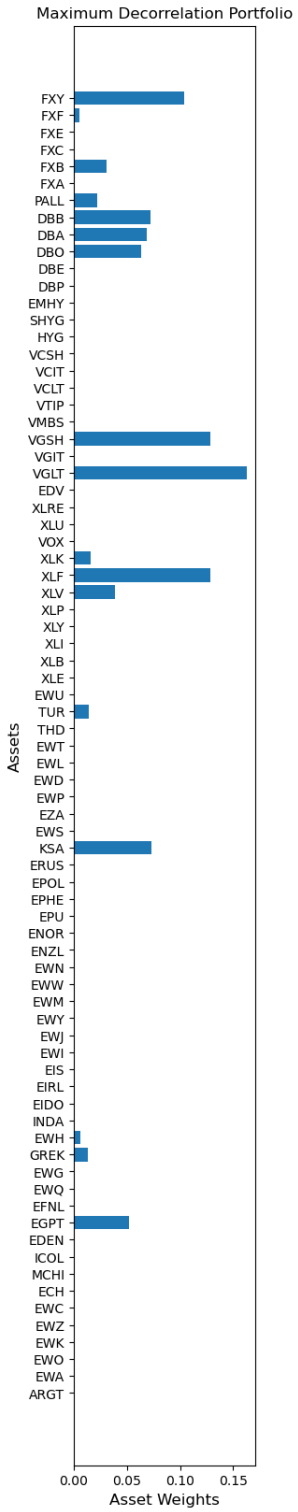
Below you can see the denoised covariance matrix we used for our custom optimisation, as well as the portfolios that represent the maximum sharpe ratio, maximum diversification, and custom MVO portfolio.


Denoised Covariance
ARGT
EWA
EWO
EWK
EWZ
EWC
ECH
MCHI
ICOL
EDEN
EGPT
EFNL
EWQ
EWG
GREK
EWH
INDA
EIDO
EIRL
EIS
EWI
EWJ
EWY
EWM
EWW
EWN
ENZL
ENOR
EPU
EPHE
EPOL
ERUS
KSA
EWS
EZA
EWP
EWD
EWL
EWT
THD
TUR
EWU
XLE
XLB
XLI
XLY
XLP
XLV
XLF
XLK
VOX
XLU
XLRE
EDV
VGLT
VGIT
VGSH
VMBS
VTIP
VCLT
VCIT
VCSH
HYG
SHYG
EMHY
DBP
DBE
DBO
DBA
DBB
PALL
FXA
FXB
FXC
FXE
FXF
FXY
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000

Maximum Sharpe results:
Portfolio Return = 0.5661742717754333
Portfolio Risk = 0.00018560777622612858
Portfolio Sharpe Ratio = 39.355722246397654



Maximum Diversification results:
Portfolio Return = -0.2329411094349746
Portfolio Risk = 5.061845165688684e-07
Portfolio Sharpe Ratio = -369.57625702891704

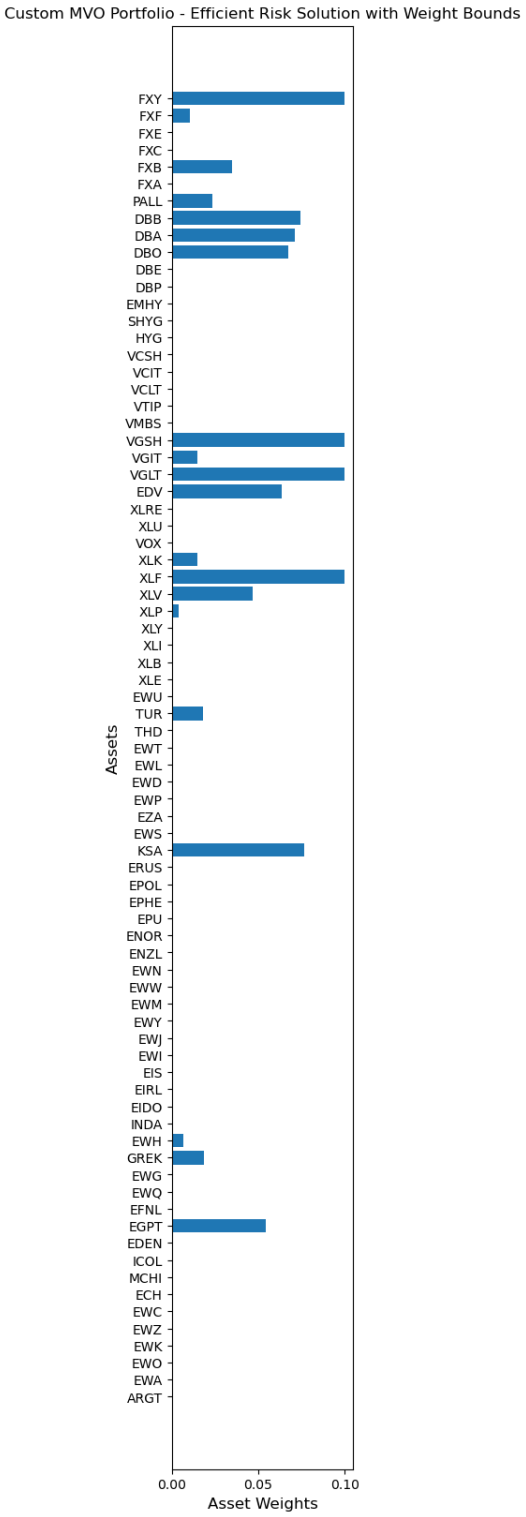


Custom MVO Portfolio - Efficient Risk Solution with Cov Matrix results:

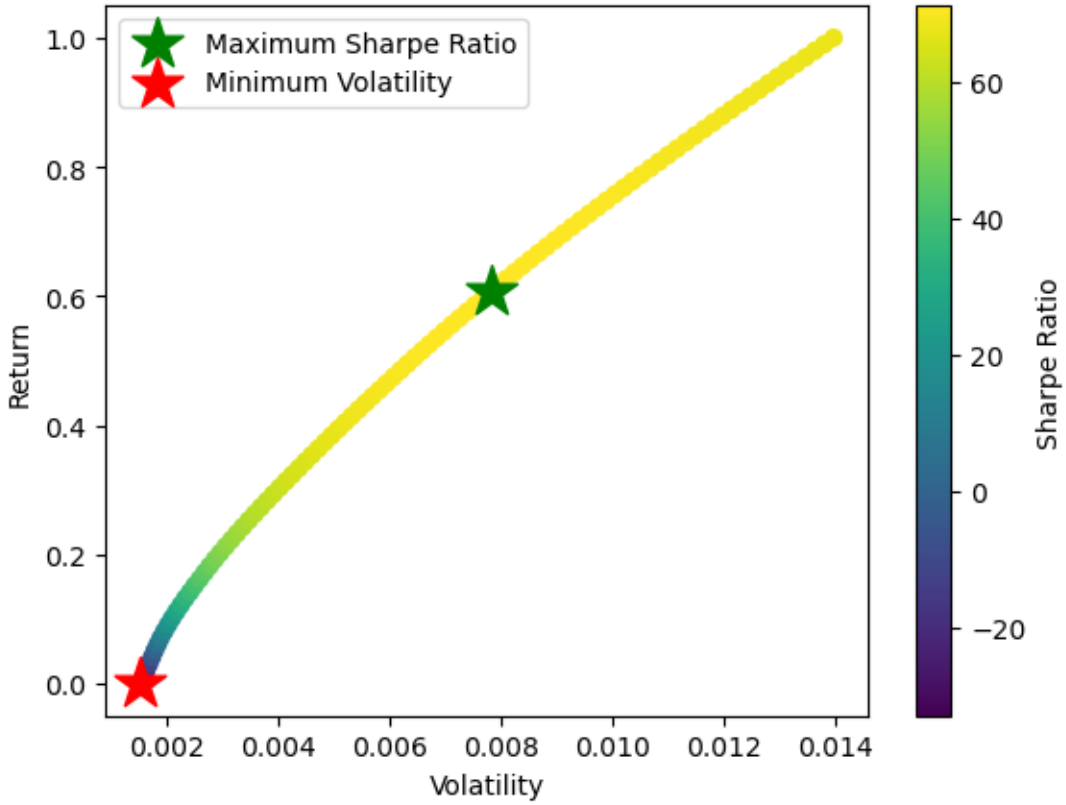
Portfolio Return = 0.2

Portfolio Risk = 8.594109276948223e-06

Portfolio Sharpe Ratio = 57.989382686940296



Efficient Frontier



References

https://mlfinlab.readthedocs.io/en/latest/portfolio_optimisation/mean_variance.html
https://hudsonthames.org/portfolio-optimisation-with-mlfinlab-mean-variance-optimisation/
https://hudsonthames.org/portfolio-optimisation-with-mlfinlab-estimation-of-risk/