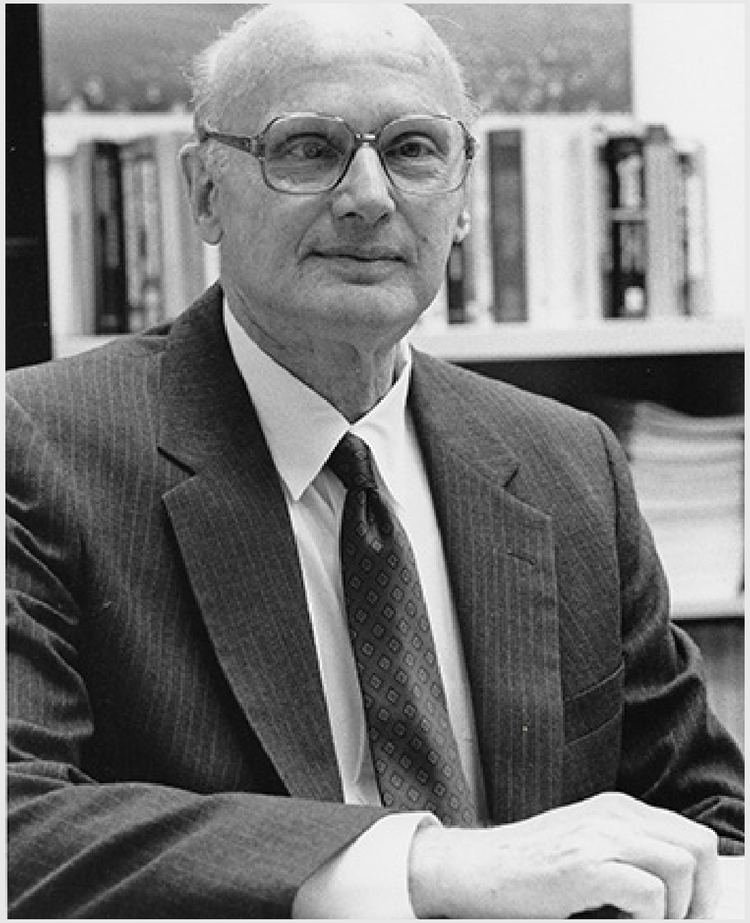
Portfolio Optimization

1. Download data [Cryptocurrencies/Stocks in our case]
2. Processing and evaluation of data
3. Simulation of optimization

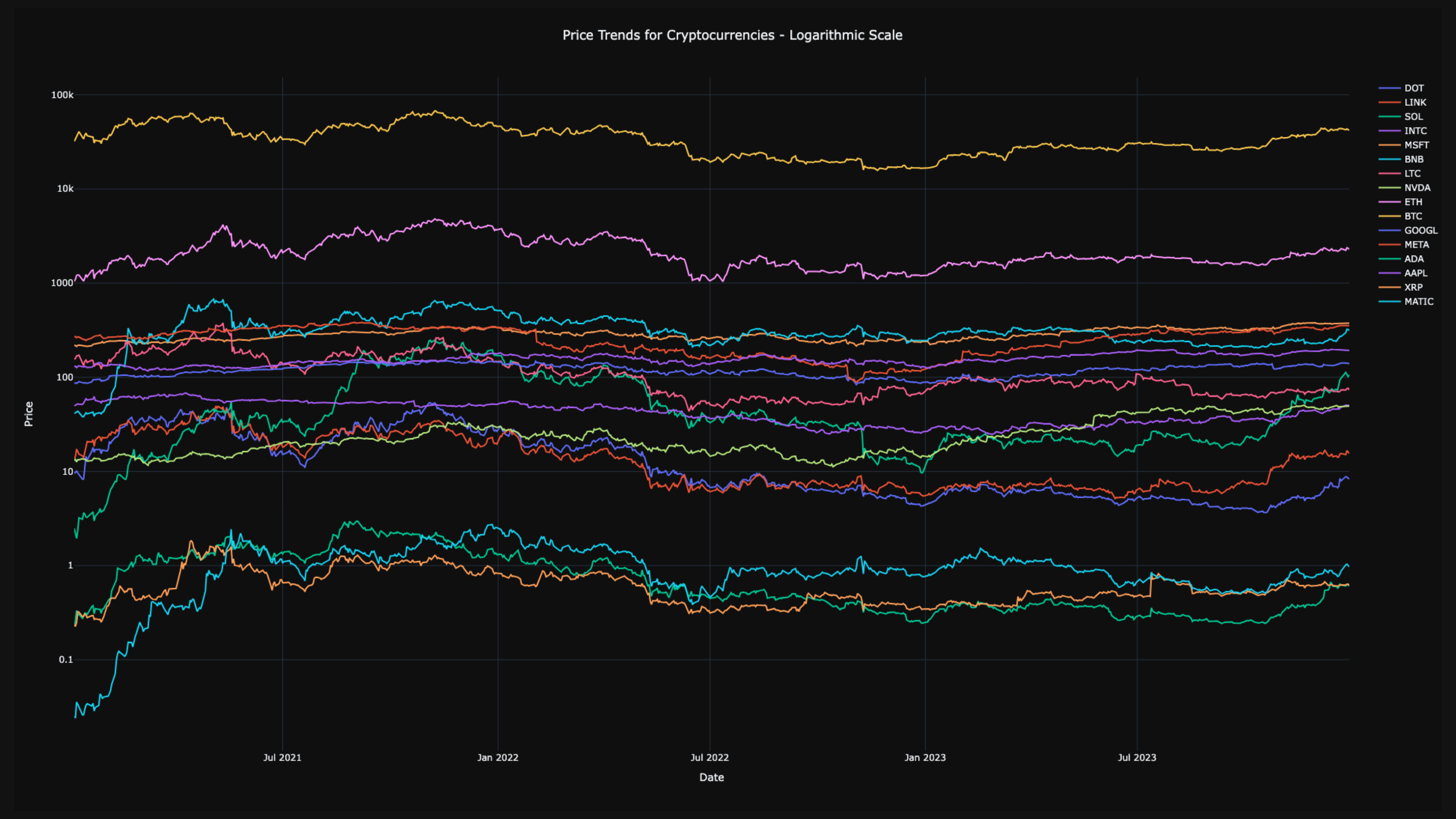
Presented by Mikhail Yagudaev & Basel Massarweh



Harry Markowitz [1927-2023]

Downloading of data

- Downloaded the following coins from Binance [Start 2021 - End of 2023]:
  - BTC\USDT
  - ETH\USDT
  - LTC\USDT
  - ADA\USDT
  - SOL\USDT
  - BNB\USDT
  - MATIC\USDT
  - XRP\USDT
  - LINK\USDT
  - DOT\USDT
- Downloaded the following stocks from YFinance [Start 2021 - End of 2023]:
  - AAPL
  - MSFT
  - META
  - GOOGL
  - NVDA
  - INTC


Price Trends for Cryptocurrencies - Logarithmic Scale
100k
10k
1000
100
10
1
0.1
Price
Jul 2021
Jan 2022
Jul 2022
Jan 2023
Jul 2023
Date
DOT
LINK
SOL
INTC
MSFT
BNB
LTC
NVDA
ETH
BTC
GOOGL
META
ADA
AAPL
XRP
MATIC

Processing & Data Evaluation

Expected Return of Coins/Stocks

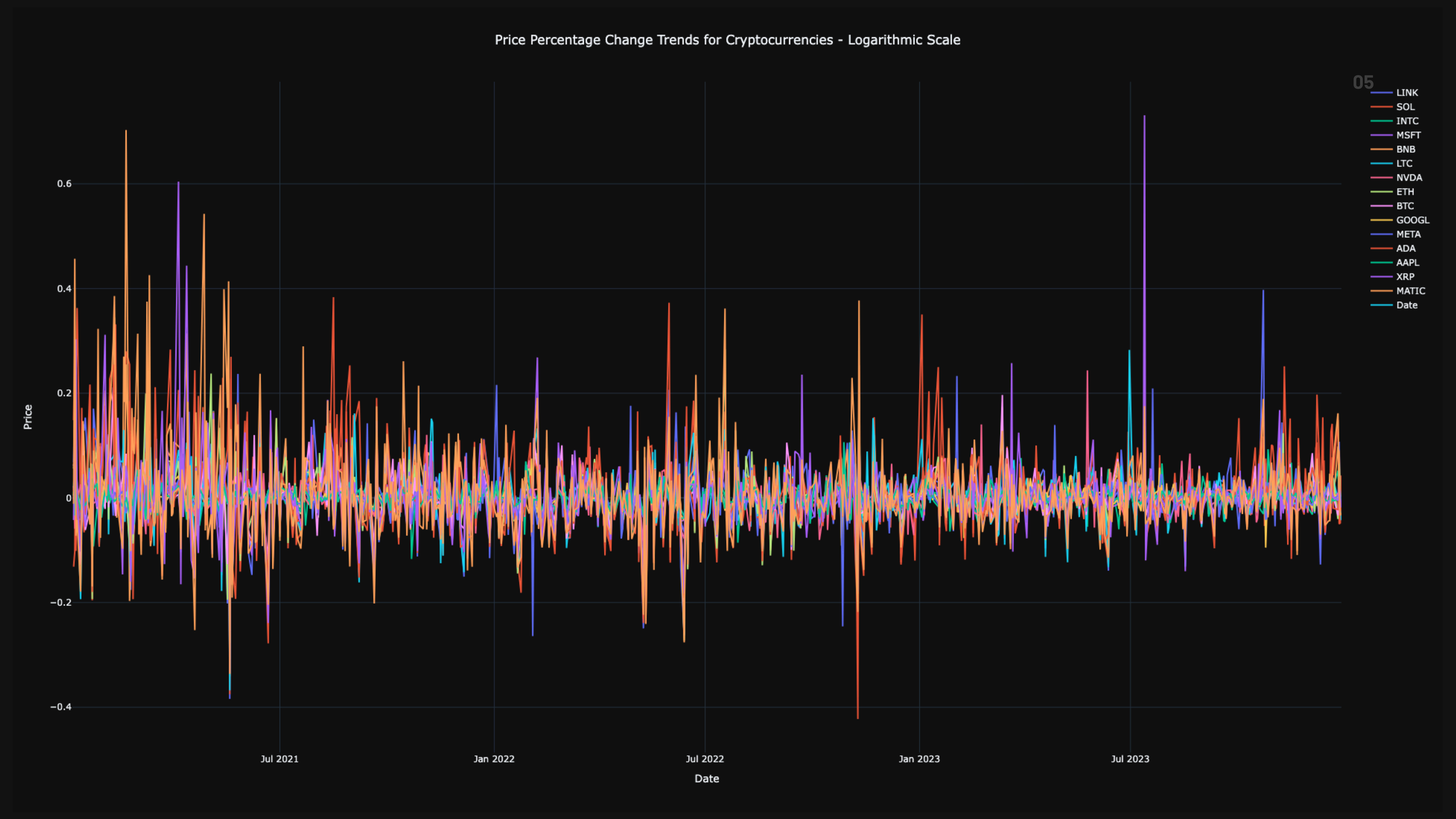
The weighted average of the expected returns of the assets in the portfolio.

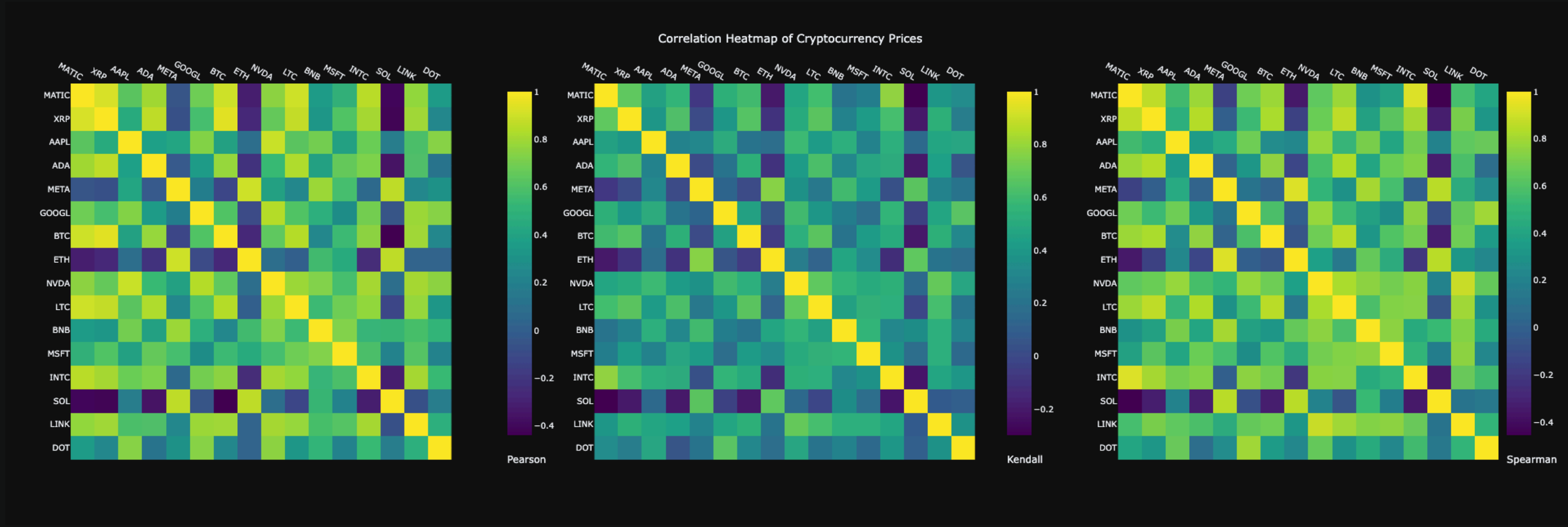
Variance of Coins/Stocks

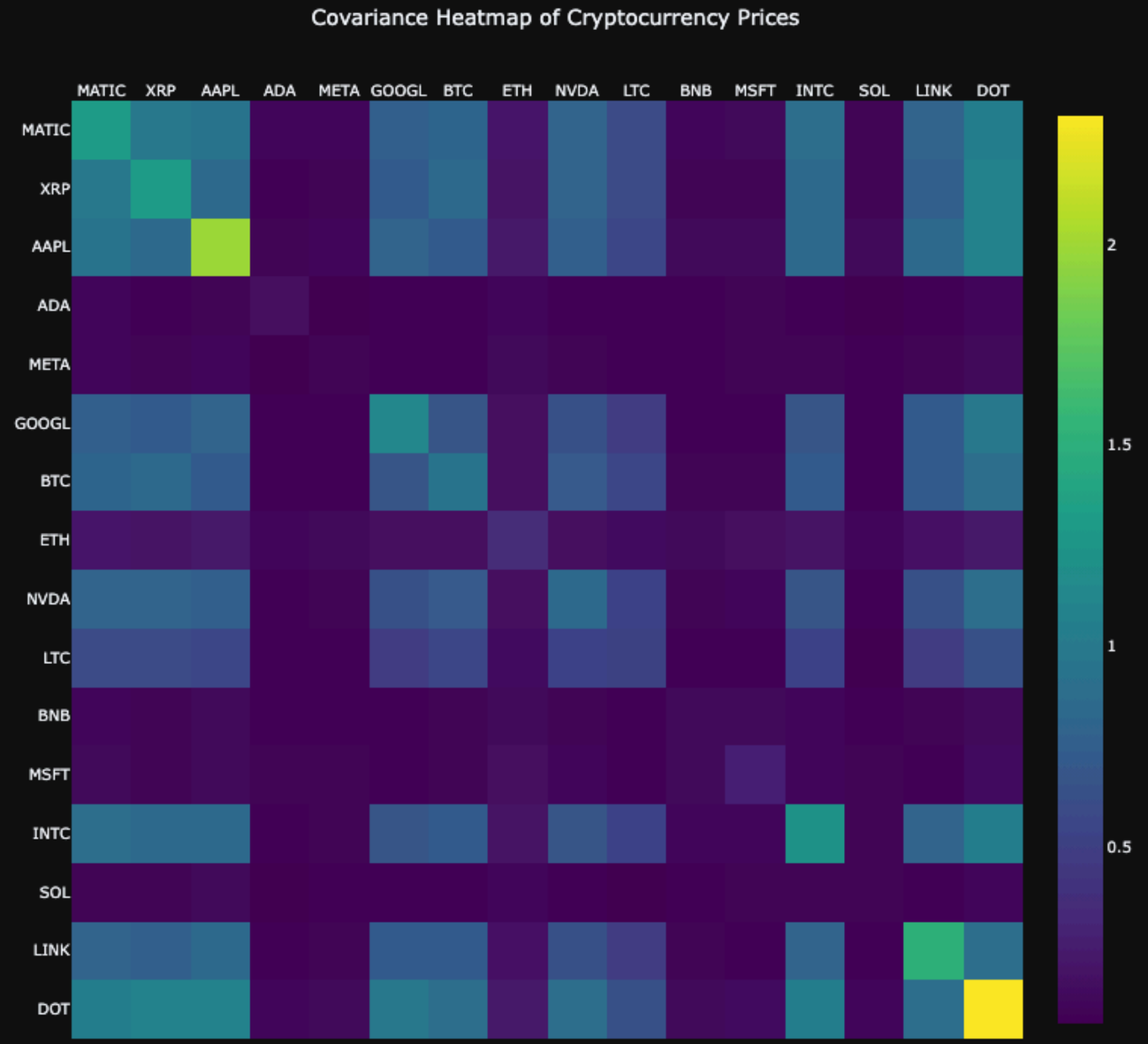
A measure of the dispersion of returns for an asset. In portfolio context, it captures the overall risk.

Covariance between Coins/Stocks

Measures how two assets move together. It is crucial for understanding the benefits of diversification.


Price Percentage Change Trends for Cryptocurrencies - Logarithmic Scale
05
LINK
SOL
INTC
MSFT
BNB
LTC
NVDA
ETH
BTC
GOOGL
META
ADA
AAPL
XRP
MATIC
Date
0.6
0.4
0.2
0
−0.2
−0.4
Price
Jul 2021
Jan 2022
Jul 2022
Jan 2023
Jul 2023
Date


Correlation Heatmap of Cryptocurrency Prices
MATIC
XRP
AAPL
ADA
META
GOOGL
BTC
ETH
NVDA
LTC
BNB
MSFT
INTC
SOL
LINK
DOT
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
Pearson
Kendall
Spearman



- The covariance between a variable and itself is just the variance of the variable, which is seen on the diagonal

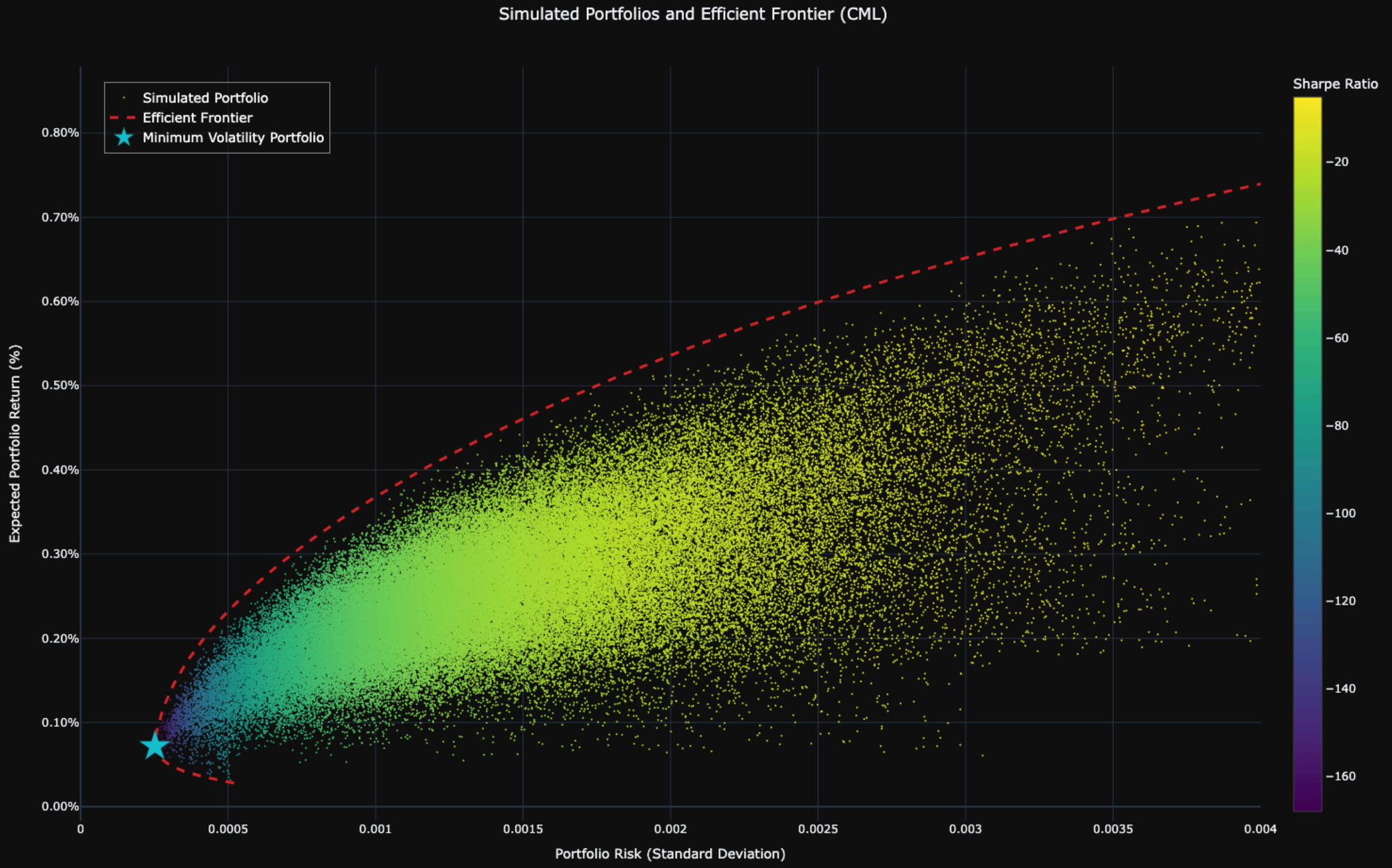
Simulation of Optimization

Let n be the number of assets. Let $w \in \mathbb{R}^n$ be the weights vector, which represents the percentage to allocate for each asset. Then the Objective Function we want to minimize is:

$$\min \left[w^T \Sigma w \right]$$

Where Σ is the covariance matrix of assets returns and w is the weights as described above. The problem is subect to the following constraints:

1. $\forall i \in [0, n] : \ 0 \leq w_i$.
2. $\sum_{i=0}^{n} w_i = 1$.


Simulated Portfolios and Efficient Frontier (CML)
Simulated Portfolio
Efficient Frontier
Minimum Volatility Portfolio
Sharpe Ratio
−20
−40
−60
−80
−100
−120
−140
−160
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Expected Portfolio Return (%)
0
0.0005
0.001
0.0015
0.002
0.0025
0.003
0.0035
0.004
Portfolio Risk (Standard Deviation)

Portfolio Asset Allocation