

# Portfolio Optimisation

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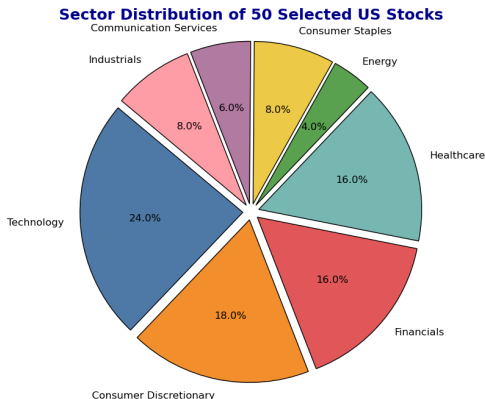
# Introduction

The motivation for this project is to effectively manage a \$500,000 investment by identifying optimal, financially sound portfolio strategies (full project:GitHub).

- ▶ Use of Modern Portfolio Theory (MPT) to balance risk and return.
- ▶ Focus on three portfolios: Min Variance, Tangency, and Max Return.
- ▶ Historical data (2014–2024) on 50 US large-cap stocks.
- ▶ Benchmark: S&P 500 index.

# Stocks and Data

- ▶ 50 US large-cap stocks from various sectors (technology, healthcare, energy, etc.).
- ▶ Data: Adjusted closing prices (Jan 2014–Jan 2024).
- ▶ Data source: Yahoo Finance via `yfinance` Python library.



**Figure:** Distribution of the 50 selected US stocks by industry.

# Methodology: Portfolio Optimization

1. Data Collection and Return Computation.
2. Covariance Matrix and Portfolio Performance.
3. Portfolio Optimization for Min Variance, Tangency, and Max Return portfolios.

# Sharpe Ratio

The Sharpe ratio is used to measure the risk-adjusted return of a portfolio and is defined as:

$$\text{Sharpe Ratio} = \frac{\mu_p - r_f}{\sigma_p} \quad (1)$$

where:

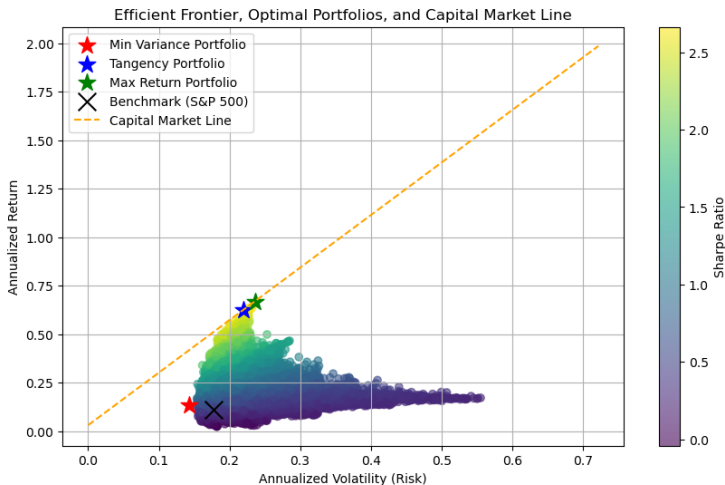
- ▶  $\mu_p$  = Expected portfolio return,
- ▶  $r_f$  = Risk-free rate,
- ▶  $\sigma_p$  = Portfolio volatility.

# Portfolio Optimization Types

- ▶ Minimum Variance Portfolio: Minimizes risk.
- ▶ Tangency Portfolio: Maximizes Sharpe ratio.
- ▶ Maximum Return Portfolio: Assigns all weight to the highest-returning stock.

# Efficient Frontier and CML

- ▶ Efficient frontier: Shows optimal portfolios at different risk levels.
- ▶ Capital Market Line (CML): Reflects risk-free rate + optimal portfolio mix.



# Portfolio Weights

Asset	Min Variance Weights	Tangency Weights	Max Return Weights
AAPL	0.000000	0.264700	0.000000
MSFT	0.035500	0.000000	0.000000
V	0.022700	0.000000	0.000000
WMT	0.217900	0.000000	0.000000
PG	0.000000	0.009200	0.000000
XOM	0.220900	0.000000	0.000000
BAC	0.000000	0.426800	0.000000
KO	0.013100	0.091200	0.000000
PFE	0.093400	0.000000	0.000000
CSCO	0.153600	0.000000	0.000000
NFLX	0.000000	0.178200	0.000000
NKE	0.185400	0.029800	0.000000
C	0.057600	0.000000	0.000000
MDT	0.000000	0.000000	1.000000
Return	0.1460	0.6102	0.6641
Volatility	0.1569	0.2396	0.2655
Sharpe Ratio	0.9305	2.5470	2.5009

**Table:** Portfolio Weights and Statistics for Min Variance, Tangency, and Max Return Portfolios



# Results

- ▶ Min Variance Portfolio: Lower risk, moderate return.
- ▶ Tangency Portfolio: Best risk-adjusted return.
- ▶ Max Return Portfolio: Highest return, highest risk.

# Conclusion

- ▶ Tangency Portfolio offers the best balance of risk and return.
- ▶ Min Variance Portfolio is ideal for risk-averse investors.
- ▶ Max Return Portfolio is for aggressive investors seeking high returns.