

**Portfolio Optimisation   
using Modern Portfolio Theory & Python**

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**Acknowledgements**

**Abstract**

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# Introduction

## Background

An investment is defined as “The Action or process of investing money for profit” (Oxford Dictionary, 2017). There are lots of different options that investors are faced with when it comes to choosing what to invest in. There are stocks, bonds, options, futures and countless more to consider. For this project, the focus is going to be on stocks. A stock is a portion of shares issued by a company (Oxford Dictionary, 2017). When investing into stocks, or anything for that matter, the general goal is going to be that when it comes time to sell, they have risen in value enough that the investor has made a profit. However, making that profit almost never comes free. Each investment typically has an “Expected Return” and a “Risk” aspect associated with it. These can be defined in a number of ways. In the context of this project, “Expected Return” is defined as the anticipated profit or loss on an investment characterised by a historical average. “Risk” is defined as the volatility of an investment’s return, which is effectively the likelihood that an investment’s actual return will be different to the expected return. This is characterised as variance. The best possible investment would be one that had a very high return with no risk attached. Sadly, this is never the case as almost every investment is guaranteed to have some kind of inherent risk (Thangavelu, 2015). To achieve those higher returns, investors have to be prepared to take on the extra risk involved in doing so.

It would be unusual for investors to invest in one asset at a time. They tend to create what is called a portfolio. A portfolio is “a range of investments held by a person or organisation” (Oxford Dictionary, 2017). Traditionally when creating portfolios, investors would select assets using anecdotal analysis or using statistics of each asset individually. This changed when Harry Markowitz’s paper “Portfolio Selection” was released in March 1952 compiled within The Journal of Finance. Markowitz put forward among others, the idea of looking at how assets move and interact with the portfolio as a whole rather than on an individual basis. Instead of looking at an asset’s individual variance, it instead considers the risk of the portfolio to be determined by the covariance between each asset. In finance, covariance is a measure of how much the returns of two assets move together, contextualising the risk of a specific asset with the rest of the portfolio (Investopedia, 2017). Markowitz theorised that investors can potentially decrease the amount of risk they are having to take for the same return through means of diversification (Shipway, 2009). By spreading investments out over a larger number of diverse assets, the risk associated is generally going to be lower than if the investments were made in only one or two assets. This is due to each asset reacting differently to certain scenarios. With a large and diverse portfolio, there are going to be scenarios in which some assets will pay off, and some that won’t (Elton and Gruber, 1997).

The main goal of portfolio theory is to distribute your investments between each asset optimally. Markowitz assumes that all investors are risk averse when it comes to choosing portfolios, meaning that if there are two portfolios with the same return, the investor will always go for the one with less risk (Kaplan, 1998). The Mean-Variance analysis techniques featured within Modern Portfolio Theory provides insight into ways of identifying and calculating the best level of diversification by optimising the trade-off between risk and return. Portfolios can be optimised to achieve lots of different aims. Not all investors are the same, some are a lot more comfortable making higher risk investments to get those bigger returns. With the introduction of mathematics and computation into finance, optimisations can be performed to easily achieve portfolios with minimum variance, maximum return or somewhere in between.

## Aims & Objectives

### Aim

The aim of this project is to create a proprietary investment management system using the programming language Python. The system should be able to retrieve relevant and up-to date stock data providing visualisation and descriptive analysis to the user. It will allow the user to craft a portfolio using their choice of stocks from the available selection. Using concepts from Modern Portfolio Theory, this portfolio can then be optimised in order to achieve the user’s desired goals. The statistics of the portfolio’s potential performance will be displayed by the system so the user then decide whether to proceed with that portfolio as their investment strategy.

### Objectives