**Quantitative Stock & Portfolio Analysis: Models, Concepts & Project Design**

**Introduction**

This report outlines the design of a modular codebase for personal stock and portfolio analysis.  The goal is to empower non‑professional investors to conduct quantitative research, forecast asset prices, evaluate risk and construct portfolios informed by financial theory.  The repository is organised with clear separation between single‑stock analysis and multi‑asset (portfolio) workflows and uses Python as the primary language with optional R integration.

**Key Models and Concepts**

**Time‑Series Forecasting**

* **ARIMA (Autoregressive Integrated Moving Average)** – ARIMA models combine autoregression (past values influencing future values), differencing (to make non‑stationary data stationary) and moving average terms.  They are well‑suited to short‑term forecasting of stationary time series .  The model is specified by three orders: p (autoregressive lag), d (degree of differencing) and q (moving average lag) .  ARIMA models depend only on historical data and are effective for near‑term forecasts but may struggle to predict turning points and can be sensitive to parameter choices .
* **Exponential Smoothing & Holt‑Winters** – Exponential smoothing gives exponentially decreasing weights to past observations, making it adaptive to recent changes.  Single exponential smoothing is suitable for data with no trend or seasonality; double (Holt’s method) adds a trend component; and triple (Holt‑Winters) incorporates seasonality  .  Holt‑Winters models the level, trend and seasonal components of a series simultaneously .  These methods are computationally simple and perform well for short‑ to medium‑term forecasting, though they may not handle complex patterns or long‑range forecasting .
* **Prediction Intervals** – Forecasts should be accompanied by prediction intervals that quantify uncertainty.  A 95 % prediction interval means that in the long run 95 out of 100 intervals will contain the true value; higher confidence levels widen the interval .

**Risk Metrics**

* **Value at Risk (VaR)** – VaR estimates the maximum expected loss over a specified horizon with a given confidence level.  It can be computed using the historical method (reordering past returns), the variance–covariance method (assuming normally distributed returns and using mean and standard deviation) or Monte Carlo simulation .  VaR answers questions like “What is the worst expected loss with 95 % confidence?”
* **Monte Carlo Simulation & Geometric Brownian Motion (GBM)** – Monte Carlo methods generate many possible future price paths to create a distribution of outcomes.  GBM models stock prices as following a random walk with drift and volatility; price returns are normally distributed while price levels are log‑normally distributed .
* **Sharpe Ratio** – Measures risk‑adjusted return by dividing the excess return (over a risk‑free rate) by the standard deviation of returns .  A higher Sharpe ratio indicates better risk‑adjusted performance.  It does not account for leverage or differentiate between upside and downside volatility .
* **CAPM Beta** – Relates an asset’s expected return to its systematic risk relative to the market.  Beta is the covariance of the asset’s returns with the market divided by the variance of market returns .  A beta above 1 implies greater volatility than the market, while a beta below 1 implies less.

**Portfolio Theory**

* **Modern Portfolio Theory & Efficient Frontier** – Portfolio optimisation seeks to combine assets to maximise expected return for a given level of risk or minimise risk for a required return.  The set of optimal portfolios forms the efficient frontier .  Diversification allows investors to achieve higher returns without proportionally increasing risk .  Assumptions such as normally distributed returns and rational investors may not always hold, but the framework provides valuable guidance .
* **Mean‑Variance Optimisation** – A quantitative technique that selects portfolio weights to maximise return for a given variance (risk) or to minimise variance for a target return.  It is the backbone of the efficient frontier and forms the basis for risk‑adjusted portfolio construction.

**Proposed Project Structure**

The repository is organised to separate data retrieval, utilities, single‑stock analysis and portfolio analysis.  The structure facilitates extensibility and clarity: