

## Instructions

Perform the tasks described in the following pages to prepare for the Advanced Financial Engineering exam project. You will not yet know exactly what the exam questions will be, but you should

- Make small scripts that can calculate various relevant quantities
- Ensure that you know how to analyse results from your calculations
- Have a rough idea of how to present the theory and the results in a concise way
- It will not be a bad idea to start explaining the things you are asked to do on the next page, as this will save you much time later on when you are writing the exam project.

The exercises partly covered the tasks, providing a good starting point.

## Risk Management

### VaR Models

Make a program that, for a portfolio of  $N$  equally weighted stocks, calculates the 1-day VaR for each trading day in 2022. The following methods for calculating VaR for a portfolio should be considered

- Non-parametric approach with equal weights put on past observations
- Non-parametric approach with either probability weighting or volatility adjustment
- Parametric model using the normal distribution
- Parametric model using either the t-distribution or the EWMA method for the covariance matrix of returns
- Univariate GARCH model applied to portfolio returns. Remember to consider how often the GARCH parameters should be re-estimated.

Remember that your calculations for the 1-day VaR calculated at the end of day  $t$  for day  $t + 1$ , should only include information available up to and including day  $t$ . Also, give a bit of thought to how much data your VaR estimations should be based on.

### Backtesting

Make a program that can take a series of VaR predictions and compare these with realisations for each trading day in 2022. Make relevant plots and statistical tests.

## Estimation of stochastic processes

### Geometric Brownian Motion

Make a program that can estimate the parameters of a Geometric Brownian motion from a time series of equidistant prices.

### Ornstein-Uhlenbeck process

Make a program that can estimate the parameters of an Ornstein-Uhlenbeck process from a time series of equidistant prices.

## Simulation

### Geometric Brownian Motion

Make a program that can simulate realisations of a Geometric Brownian motion.

### Ornstein-Uhlenbeck process

Make a program that can simulate realisations of an Ornstein-Uhlenbeck process.

## Option Pricing

### Binomial Model

Make a program price the following options in a binomial tree

- General European type options, where the payoff can be expressed as a function of the underlying's value at the time of maturity  $T$
- American put options, where the option can be exercised early