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Mathematical Finance M.Sc

Technical Appendix for Portfolio Optimisation Project

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Abstract: This report provides technical guidance on how

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1 Introduction

1.1 Aim

The goal of this project is to create a portfolio optimiser based on the following constraint:

- Initial value of the portfolio as of 3 October 2017 is 1 million US dollors.
- Investment can be only on 6 assets in —— industry.
- From 1 January 2018 the investment must always be three long and three short positions
- The investment horizon of each run is 1 week.
- The portfolio has optimum sharp ratio from 5 Feb 2017

that maximises the absolute wealth of the portfolio.

1.2 Software

This algorithm is written mainly in MatLab2017b. However, market data was gathered using python based market crawler written for this purpose. Running the python file in MatLab is relatively easy using 'system()' function to give bash commands. however, since its is not assumed that python with desired libraries is installed on the user's computer, running python is not integrated in MatLab code. if the user wishes to run the python files, it is recommended to install Spyder to run the scripts.

2 Market Crawler

DataGatherer.py is a python based script that is developed to obtain market prices. The user feed the script with the list of tickers in a companies.csv file. Running the script returns the

- Market_Data.csv :gives the closed price of each ticker for each day
- Market_Data_CR.csv :gives the compound return of each day
- Market_Data_NR.csv :gives the normal return of each day

The script downloads the data from Google Finance.

3 Modelling the Market

3.1 Parametric Approach

3.1.1 Moving averages

3.1.2 K nearest Neighbours

3.2 non-parametric Approach

4 Projecting at investment horizon

Projection of prices to the horizon is done through projection function. This function assumes that the compound returns are IID and takes a non-parametric approach at projecting to the horizon. It takes, the t-copula fitted on the invariant (Compound returns) in the form ρ and ν, the distribution of the marginals and the price of last trading day, number of companies and distance (in days) to the horizon. The projection function then simulates 10,000 simulation of the horizon prises using the fitted t-copula.

Simulation of next trading day works by throwing a random number from the copula (to be called U). Using the cdf of the marginal distributions, we obtain simulated next day compound return c_i (Compound return of the asset i). Use the compound return to calculate the simulated next day price P_i^*

$$U = tCopulaRand(\rho, \nu)$$
$$c_i = F_i(U_i)$$
$$P_i^* = P_i e^{c_i}$$

5 Sharp Ratio Optimisation