MIE 1622H: Midterm Test

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Due: Sunday, March 17, 2019, not later than 8:00 p.m.

Use MATLAB or Python for all MIE 1622H tests and assignments.

You should hand in:

- Your report (up to 1-page, excluding graphs) and your MATLAB or Python code.
- Compress your report, all of your MATLAB or Python code files and output files into a file **StudentID.zip** (which can be uncompressed by 7-zip (`http://www.7-zip.org`) software under Windows), and submit it via Quercus portal no later than 8:00 p.m. on March 17.

Question 1

File `Daily_closing_prices.csv` contains prices of 20 stocks for years 2015-2016. Your portfolio consists of 100 MSFT, 200 AAPL, and 500 IBM shares and you hold it from the beginning of January 2015 till the end of December 2016.

To compute VaR of the portfolio of stocks we need to compute daily losses for a portfolio, i.e., add daily monetary loss for each stock and use that sum in the calculations for VaR.

To calculate 10-day VaR we need to use moving window method. To compute 10 day loss we compute loss for the first 10 trading days, then loss for second 10 trading days, etc. For example, for the given data, we compute portfolio loss from January 2, 2015 to January 15, 2015 as value of the portfolio on January 2 minus value of the portfolio on January 15. Then we compute loss of the portfolio for January 5, 2015 - January 16, 2015 in the same way as described above, then loss for January 6, 2015 - January 20, 2015, etc.

Part 1

Compute VaR and CVaR for your portfolio value at quantile level 95% for 1-day and 10-day time horizons:

- From historical scenarios for years 2015-2016;
- If we assume Normal distribution of losses (mean and standard deviation are computed from the historical scenarios for years 2015-2016 for each stock). For the Normal distribution model, compute means and covariances for each stock from historical scenarios and after that compute portfolio mean and variance as we have done for Markowitz model.

Plot a histogram of the distribution of losses in portfolio value, indicate VaR and CVaR levels for two time horizons. In the report include two figures (for 1-day and 10-day results) and answer the question below.

Is the following true for the given dataset? Please explain your answer:

- VaR (10 day) = 10 * VaR (one day)
- CVaR(10 day) = 10 * CVaR (one day)

Part 2

Compute 1-day 95% VaR for MSFT, AAPL and IBM stocks separately using historical scenarios and print your results.

Is the following true? Explain: VaR(Portfolio) = VaR(MSFT) + VaR(AAPL) + VaR(IBM)

Would the answer change if we used Normal distribution model to calculate VaR?

Question 2

Consider investment strategies from Assignments 1 and 2. You are given historical data for the time period from 2 January 2015 till 27 February 2015 and asset prices on the first trading day in March 2015.

Part 1

Compute and plot in the (expected 2-month return, std deviation of 2-month return) space:

- Efficient frontier of risky assets under no-short-sales constraint;
- Minimum variance portfolio of risky assets;
- Maximum return portfolio of risky assets;
- Equally-weighted ($1/N$) portfolio of risky assets;
- Initial portfolio from Assignment 1 (asset weights are given to you in Matlab code);
- Maximum Sharpe ratio portfolio (asset weights are given to you in Matlab code);
- Risk-free asset;
- Equal risk contribution portfolio (asset weights are given to you in Matlab code);
- Leveraged equal risk contribution portfolio;
- Efficient frontier of all assets including risk-free asset, if shorting of risk-free asset is allowed but shorting of maximum Sharpe ratio portfolio is prohibited (tangent line).

Assume risk free annual rate of 2.5%.

Clearly label all portfolios and frontiers on your plot.

Part 2

Compute and plot in the (expected 2-month return, std deviation of 2-month return) space:

- Efficient frontier of risky assets under no-short-sales constraint;
- Individual risky assets;
- Randomly generated 1000 portfolios under no-short-sales restriction.

Use uniform distribution for generating random numbers for portfolio weights. Normalize portfolio weights to sum up to one after you generated random numbers.

Report

In your report (up to 1-page, excluding graphs) describe how you answered questions. Include two plots for Question 1 and two plots for Question 2. Use only CPLEX optimization solver in your MATLAB or Python code.

MATLAB Script to be Completed

```
clc;
clear all;
format long

% CSV file with price data
input_file_prices  = 'Daily_closing_prices.csv';

% Read daily prices
if(exist(input_file_prices,'file'))
  fprintf('\nReading daily prices datafile - %s\n', input_file_prices)
  fid = fopen(input_file_prices);
     % Read instrument tickers
     hheader  = textscan(fid, '%s', 1, 'delimiter', '\n');
     headers = textscan(char(hheader{:}), '%q', 'delimiter', ',');
     tickers = headers{1}(2:end);
     % Read time periods
     vheader = textscan(fid, '%[^,]%*[^\n]');
     dates = vheader{1}(1:end);
  fclose(fid);
  data_prices = dlmread(input_file_prices, ',', 1, 1);
else
  error('Daily prices datafile does not exist')
end

% Convert dates into array [year month day]
format_date = 'mm/dd/yyyy';
dates_array = datevec(dates, format_date);
dates_array = dates_array(:,1:3);

% Remove datapoints for year 2014
day_ind_start0 = 1;
day_ind_end0 = length(find(dates_array(:,1)==2014));
data_prices = data_prices(day_ind_end0+1:end,:);
dates_array = dates_array(day_ind_end0+1:end,:);
dates = dates(day_ind_end0+1:end,:);

% Compute means and covariances for Question 2
day_ind_start = 1;
day_ind_end = 39;
cur_returns = data_prices(day_ind_start+1:day_ind_end,:) ./ data_prices(day_ind_start:day_ind_end-1,:) - 1;
mu = mean(cur_returns)';  % Expected returns for Question 2
Q = cov(cur_returns);     % Covariances for Question 2


% Question 1

% Specify quantile level for VaR/CVaR
alf = 0.95;

% Positions in the portfolio
positions = [100 0 0 0 0 0 0 0 200 500 0 0 0 0 0 0 0 0 0 0]';

% Number of assets in universe
Na = size(data_prices,2);

% Number of historical scenarios
Ns = size(data_prices,1);

%%%%% Insert your code here

%fprintf('Historical 1-day VaR %4.1f%% = $%6.2f,   Historical 1-day CVaR %4.1f%% = $%6.2f\n',
          100*alf, VaR1, 100*alf, CVaR1)
%fprintf('    Normal 1-day VaR %4.1f%% = $%6.2f,       Normal 1-day CVaR %4.1f%% = $%6.2f\n',
          100*alf, VaR1n, 100*alf, CVaR1n)
%fprintf('Historical 10-day VaR %4.1f%% = $%6.2f,   Historical 10-day CVaR %4.1f%% = $%6.2f\n',
          100*alf, VaR10, 100*alf, CVaR10)
%fprintf('    Normal 10-day VaR %4.1f%% = $%6.2f,       Normal 10-day CVaR %4.1f%% = $%6.2f\n',
          100*alf, VaR10n, 100*alf, CVaR10n)
```

```
% Plot a histogram of the distribution of losses in portfolio value for 1 day
% figure(1)

% Plot a histogram of the distribution of losses in portfolio value for 10 days
% figure(2)


% Question 2

% Annual risk-free rate for years 2015-2016 is 2.5%
r_rf = 0.025;

% Initial portfolio weights
init_positions = [5000 950 2000 0 0 0 0 2000 3000 1500 0 0 0 0 0 0 1001 0 0 0]';
init_value = data_prices(day_ind_end+1,:) * init_positions;
w_init = (data_prices(day_ind_end+1,:) .* init_positions')' / init_value;

% Max Sharpe Ratio portfolio weights
w_Sharpe = [ 0 0 0 0 0 0 0 0.385948690661642 0.172970428625544 0 0
             0 0 0 0.003409676869715 0.260942060896445 0 0.185966939781285 0 0]';

% Equal Risk Contribution portfolio weights
w_ERC = [0.049946771209069 0.049951626261681 0.049955739901370 0.049998404150207 0.050000297368719
         0.050004255546315 0.050006307026730 0.050007308995726 0.050010525832832 0.050013840015521
         0.050014404492514 0.050015932843104 0.050016630302524 0.050017212457105 0.050017600497611
         0.050017998351827 0.050018997074443 0.050019598350121 0.050019778113513 0.049946771209069]';

%%%%% Insert your code here

% Plot for Question 2, Part 1
% figure(3);

% Plot for Question 2, Part 2
% figure(4);
```