Matlab for Finance – Long Group Assignment – to be completed in class

General instructions

- Submit your solution until December 5th, 5:00 p.m. on Brightspace.
- This assignment consists of nine tasks, all of which must be completed.
- Create a published m-file for your solution, i.e., an m-file from which an HTML report can be generated using the "Publish" function. The header of the m-file should contain the names of the team members. Use the provided template as a guide for the structure of the files.
- The task m-file must be executable and the evaluation takes place on the basis of the printed output of the "Publish" function. Use markup elements of the publish function to make the report clear (headings, body text, bullet points, etc.). Check the course slides for formatting examples. Comment important parts of the code sufficiently (not excessively).
- The form of the report, programming style and clarity of the code are included in the evaluation. The axes of graphs should be meaningfully labeled, and graphs with multiple curves should have a legend.
- Your submission should consist of a zip file containing all the **m-files** you wrote that are necessary to run the code. Likewise, the **html** folder that was created by publishing should be included in the zip file.
- If you are missing an important piece of information to solve a task, make a plausible assumption and briefly justify it.
- Important: Explain your reasoning behind what you do in your code. Comment on everything that is not self-explanatory.
- Information in brackets represents the maximum number of points you can collect throughout the exercise. All points will sum up to 120.
- *Hint: feel free to use the course script, tasks, Matlab help files, etc. to complete this assignment.*

Learnings from the first assignments:

- Please read the tasks on the next page BEFORE you start working in Matlab.
- The best is to extract the assignment folder on your computer and work within this folder. Don't work in the zip-folder.
- Think about what you are doing. The tasks are not meant to be blindly executed. Check whether your result makes sense!
- Please use semicolons to suppress output wherever possible. Rule of thumb: don't show output if it is too long to be seen without scrolling in the command window!
- Read error messages and try to solve the indicated problem(s) first.

Good luck!

Investment Types – [120]

1. **Load the data and briefly describe the dataset (4)**
   Load the dataset `"Data.mat"` containing adjusted closing price data. Note that the Treasury Bills "prices" are set to a starting value of one (rebased return index based on the daily interest rates) to make sure you can use them the same way as all other investment opportunities in your further calculations. Please provide a brief *description* of the dataset.
   Hint: look at the content and not just matrix size, or similar.
   Sufficient code length: 1 line
2. **Calculate log-returns (3)**
   Compute the log-returns based on the adjusted closing prices obtained in step (1).
   Sufficient code length: 1 line
3. **Descriptive Statistics (15)**
   Provide an overview of the descriptive statistics of your log-returns. For this, estimate the mean, median, standard deviation, minimum, maximum of each investment option's log-returns. Annualize these values. Provide an overview of the annualized statistics by generating a `Descriptives` table and present the results for each investment option in one row in the table.
   Hint 1: `Descriptives= table(variableVec,meanVec,medianVec,...,'VariableNames',{'ticker','mean','median',...})`, while each input vector is a column vector.
   Hint 2: Use 252 trading days for one year when annualizing. Note that standard deviations are annualized by multiplying the daily volatility with sqrt(252).
   Sufficient code length: 7 lines
4. **Scatter Plot (6)**
   Construct a scatterplot, in which each investment opportunity's annual return and standard deviation corresponds to one dot. The x-axis should show the standard deviation (i.e., volatility) and the y-axis should show the return (remember how return-volatility graphs looked like in your Corporate Finance class). Make sure to meaningfully format your figure. The figure should be self-explanatory.
   Hint: to construct a scatterplot, Matlab provides the function `'scatter(x,y)'`.
   Sufficient code length: 3-6 lines
5. **Sharpe Ratio (5)**
   Estimate the Sharpe ratio for each investment opportunity's log-returns. The Sharpe ratio of realized returns is calculated as $\left(\frac{mean(r_i)-mean(r_f)}{standard\ deviation(r_i)}\right)$. Use the 3-month Treasury Bill provided in the material as r_f. Add the Sharpe ratios to the `Descriptives` table.
   Hint 1: More information on the Sharpe ratio: https://www.forbes.com/advisor/investing/sharpe-ratio/.
   Hint 2: You can add a variable to an existing table using `tableName.newVar=newVar`.
   Sufficient code length: 1-2 lines
6. **Risk and Return Characteristics (4)**
   Comment on the stocks' risk and return characteristics and potential implications for investors.

7. **Investment Period (22)**
   a. Split the log-return data into two equally long time periods and again calculate mean, median, standard deviation, minimum, maximum, and Sharpe ratios of each investment opportunity within each of the two time periods. Present your descriptive statistics in another table with a similar layout as in task (3) / (5).
      Sufficient code length: ~16 lines
   b. Comment on potentially different implications for investors looking at these values compared to the results in (6).
8. **Correlations and Diversification (29)**
   a. Calculate the pairwise correlations between all different investment opportunities' log-returns over the entire time period and present them in a comprehensive way.
      Hint: `array2table(array,'RowNames',RowNames,'VariableNames',ColumnNames)` can use a 2-dimensional matrix as an input. RowNames and ColumnNames should be cell vectors.
      Sufficient code length: 2-3 lines
   b. Looking at your correlations, comment on the degree to which diversification advantages could be achieved when investing in more than one of the presented investment opportunities.
   c. Find the two investment opportunities with the lowest pairwise correlation over the entire time period (use Matlab code for finding it, do not just look at the results and report them). Extract the correct variable names from these two investment opportunities and present them in your published output.
      Sufficient code length: 3-4 lines
   d. Build an equally weighted portfolio from these two investment opportunities and report the portfolio's mean, standard deviation, and Sharpe ratio. Comment on whether you observe diversification and which variables you look at to come to your conclusion.
      Sufficient code length: 4 lines
9. **Diversification Potential (32)**
   a. Find all possible combinations of 3 stocks within your data.
      Hint: `C = nchoosek(v,k)` returns all possible combinations of a set of values v (e.g., an ID-vector containing the numbers (1:n) for n companies), given combinations of length k.
      Sufficient code length: 1 line
   b. The goal of this task is to find the portfolio containing three equally weighted investment options with the best return to risk relation (i.e., the portfolio with the highest Sharpe ratio). Write a for-loop in which you
      i. loop over all combinations found in (9a);
      ii. construct an equally weighted portfolio of each of the investment combinations;
      iii. calculate Sharpe ratios for each of these portfolios.

      Make sure you save all means, standard deviations, and Sharpe ratios for all the investment opportunity combinations that contain three investments in one vector

each. Find the portfolio with the highest Sharpe ratio and show the portfolio constituents.
Sufficient code length: 13 lines

c. Again, construct a scatterplot, in which each portfolio's return and standard deviation corresponds to one dot. The x-axis should show the standard deviation (i.e., volatility) and the y-axis should show the return. Make sure to meaningfully format your figure. The figure should be self-explanatory.
Sufficient code length: 3-6 lines

d. Compare your results on mean, standard deviation, and Sharpe Ratios to the results on individual investment opportunities in tasks (3) – (5).