Exercise Session - May 22, 2024

Python Lab – A.Y. 2023/2024

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Exercise 1

Consider the tickers:

`GOOG`, `AMZN`, and `TSLA`.

1. Download from `Yahoo! finance` a joint DataFrame of closing prices for the last 1 year.
2. Build a portfolio with weights $w_1 = 0.2$, $w_2 = 0.3$, $w_3 = 0.5$ and initial investment equal to \$100000.
3. Compute the return rates as
$$u_i^j = \frac{S_i^j - S_{i-1}^j}{S_{i-1}^j} = \frac{S_i^j}{S_{i-1}^j} - 1 \quad \text{for } j = 1,2,3.$$
4. Determine the mean vector $\underline{\mu}$ and the variance-covariance matrix Σ of the return rates.
5. Compute the mean and standard deviation of the portfolio.
6. Compute the (absolute) VaR of the portfolio for a 2 days horizon and a confidence level of 95%.
7. Extract the return rates of `GOOG` and `AMZN`, and save them in a csv file named `'GARR.csv'`, *not saving the index as a new column*.

Exercise 2

Load the file `'GARR.csv'` in a DataFrame named `return_rates`.

1. Draw the plot and histogram of return rates of `GOOG` and `AMZN` using the DataFrame built-in methods.
2. Compute the parameters a, b of the regression line $y = ax + b$ of `GOOG` return rates (seen as y variable) over `AMZN` return rates (seen as x variable) and plot the regression line.
3. Define a function named `prediction(x, a, b)` that returns the prediction of the regression line and call it on `x = 0`, with `a` and `b` estimated in previous point.

Exercise 3

Consider the one-period three-state market whose payoffs at time $T = 1$ are

$$\begin{array}{c} \\ \text{Payoffs:} \quad M_1 = \end{array} \begin{array}{c} \begin{array}{ccc} B_1 & S_1^1 & S_1^2 \end{array} \\ \left[\begin{array}{ccc} 10 & 20 & 5 \\ 10 & 30 & 5 \\ 10 & 5 & 10 \end{array}\right] \end{array}$$

1. Build the market.
2. Verify that the market is complete and there are no redundant assets.
3. Define the payoff $C_1 = \max\{S_1^1 - K\}$ of a call option on S_1^1 with strike price $K = 20$.
4. Compute the replicating portfolio `theta` of the payoff of the call.
5. Compute the "best hedge" portfolio `theta_best` through ordinary least-square regression, and the Mean Absolute Error (MAE) between `theta` and `theta_best`.