# Assignment 5.

**NB**: The code for the assignment has to be developed in Python, using the IDE PyCharm by JetBrains.

**0. Exercise**. Variance-covariance method for VaR & ES in linear portfolio: a simple example of data mining

At the end of the 20th of March 2019 for an equally weighted equity portfolio with *Adidas*, *Allianz*, *Munich Re* and *L'Oréal*. Compute daily VaR and ES with a 3y estimation using the dataset provided via Gaussian parametric approach. The notional of the portfolio is €10 MIO and the significance level is $\alpha$=0.95%.

[Hint: Pay attention that the trading days of the different stocks are not the same. Add previous day value in case of missing share price.]

**1. Case study**: Historical (HS & WHS) Simulation, Bootstrap and PCA for VaR & ES in a linear portfolio

At the end of the 20th of March 2019 an asset manager due to different rules on three company units (portfolios) has to compute risk measures according to the following rules ($\alpha$=0.99%):

A. Portfolio 1 with: *Total* (25K shares), *Danone* (20K Shares), *Sanofi* (20K Shares), *Volkswagen* (10K Shares). Compute daily VaR and ES with a 3y estimation using the dataset provided via a Historical Simulation approach and a Bootstrap method with 200 simulations.
B. Portfolio 2 with equally weighted equity: *Adidas*, *Airbus*, *BBVA*, *BMW* and *Schneider*. Compute daily VaR and ES with a 3y estimation using the dataset provided via a Weighted Historical Simulation approach with lambda = 0.97.
C. Portfolio 3. An equally weighted equity portfolio with shares of the first 20 companies in the provided csv file "_indexes.csv" (leave out *Adyen* - due to missing data - and take *Eni*, the 21st, instead). Compute 10 days VaR and ES with a 3y estimation using the dataset provided via a Gaussian parametric PCA approach using the first n principal components, with the parameter n =1,..,6. Comment the results.

For the three portfolios he checks results' order of magnitude via a Plausibility check.

**2. Exercise**: Full Monte-Carlo and Delta normal VaR

At the end of the 31st of January 2023 consider a portfolio formed by stocks of *Vonovia* for 25,870,000 Euro and the same <u>number</u> of put options with expiry on the 5th of April 2023, with strike 25 Euro and volatility equal to 15.4% (dividend yield of 3.1%). Compute a 10dd/99% VaR via a Full Monte-Carlo and a Delta normal approaches (only delta term). Use a 2y Historical Simulation for the underlying.
Can you improve the Delta normal VaR? How?
Why the Full Monte-Carlo can be numerical intensive for an <u>exotic</u> derivative that cannot be priced via a closed formula?

**3. Case Study**: **Pricing in presence of counterparty risk**
On the 31st of January 2023 at 10:45 C.E.T. bank XX buys form ISP a 4y Cliquet option for a 50 MIO € notional. Option yearly payoff (annual bond) at payment date is

$$[S(t_i) - S(t_{i-1})]^+.$$

The option is on an equity stock (with no dividends) and constant volatility 25%.
What should be the correct price? At what price ISP would try to sell it?

[Hint: consider the dynamics of the underlying not of the corresponding forward]

ROBERTO BAVIERA
POLITECNICO MILANO
E.Mail: financial.engineering.polimi@gmail.com

**Function signatures**

[ES, Var] = AnalyticalNormalMeasures(alpha, weights, portfolioValue, riskMeasureTimeIntervalInDay, returns)
[ES, VaR] = HSMeasurements(returns, alpha, weights, portfolioValue, riskMeasureTimeIntervalInDay)
samples = bootstrapStatistical(numberOfSamplesToBootstrap, returns)
[ES, VaR] = WHSMeasurements(returns, alpha, lambda, weights, portfolioValue, riskMeasureTimeIntervalInDay)
[ES, VaR] = PrincCompAnalysis(yearlyCovariance, yearlyMeanReturns, weights, H, alpha, numberOfPrincipalComponents, portfolioValue)
VaR = plausibilityCheck(returns, portfolioWeights, alpha, portfolioValue, riskMeasureTimeIntervalInDay)
VaR = FullMonteCarloVaR(logReturns, numberOfShares, numberOfPuts, stockPrice, strike, rate, dividend, volatility, timeToMaturityInYears, riskMeasureTimeIntervalInYears, alpha,NumberOfDaysPerYears)
VaR = DeltaNormalVaR(logReturns, numberOfShares, numberOfPuts, stockPrice, strike, rate, dividend, volatility, timeToMaturityInYears, riskMeasureTimeIntervalInYears, alpha, NumberOfDaysPerYears)

Delivery date: Friday 31st of March at 14:00.
Delivery date for correctors: Tuesday 4th of April at 23:00.
Corrector groups: **1,6,7,14**.

*Useful* Python packages:

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|---|---|
| numpy | for vector and matrix management |
| pandas | for working with dataframes |
| scipy (and scipy.stats) | for PDFs, CDFs and quantile functions |
| datetime | for dates management |

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POLITECNICO MILANO
E.Mail: financial.engineering.polimi@gmail.com