20598 – Finance with Big Data

PC Lab #1: Applied Portfolio Theory (Week 2)

Clément Mazet-Sonilhac
clement.mazetsonilhac@unibocconi.it

Finance Department, Bocconi University


PC Lab Groups

PC Labs Groups

Student Name	PC Lab Group
ALI CHAER SAM HEPINEUZE CLAUDIO LEONELLI	1
MICAELA MASIA EDOARDO MORRESI RICCARDO VALDO	2
PIETRO DEL BIANCO LUDOVICO PASQUALI ANDREA SANTORO	3
BAILEY AARON MILICA TERZIC GAIA MARIA GIULIA TRIGGIANI	4
MATTEO MELOCCHI YANGXIN YAO ELEONORA BERNARDI	5
ALEKSANDR LEON JUKOWSKI FEDERICA OLIVA IULIA TEONA SAVOIU	6
YUN KUI ALESSANDRO HU TOMMASO RENSO ELENA ROSSI	7
PAOLO DALLA TORRE DI SANGUINETTO ELISA DEL FRARI GIUSEPPE ALBERTO DELL'OGLIO	8
OMID ABDOLLAHINIA VIANNEY GAMBY GISOO SHAMS	9

PC Labs Groups

Student Name	PC Lab Group
VALENTINA ARIZZI	**Not attending**
ALESSANDRA BARRA	
ROBERTO BERNARDELLI	
TOMMASO CANALICCHIO	
SAMUELE COMPAGNONI	
GIORGIA DE BORTOLI	
DOMITILLA IZZO	
SOFIA MASELLI	
ALFREDO MAURI	
FEDERICO PEANO	
ANTONIO PREITI	
GIORGIA VASTOLA	
EMANUELE COCCIA	
LORENZO D'IMPORZANO	
FILIPPO MASSELLUCCI	

PC Labs Groups

Still waiting for an answer:
Andrea SORTENI

PC Labs Grading

- PC Labs solutions are submitted as Jupyter Notebooks, via email to me and Andrea (TA): andrea.andolfatto@phd.unibocconi.it
  - Email title : PCLab#1 - Group X - Name1 Name2 Name3
  - Your Jupyter Notebook starts in the same way

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- PC Labs grade will depend on :
  - Your ability to submit it before the deadline **(Friday, 12pm)**
  - The quality of your code (comments, readability, use of functions, etc.)
  - The structure of the Jupyter Notebook : well organized, explain what you are doing and why
  - Your ability to complete the tasks

Applied Portfolio Theory

Goals

- Manipulate and visualize stock market data (S&P 500)
- Create portfolios and compute basics statistics
- Draw the efficient frontier and find the *best* (i.e., tangency) portfolio
- Test the Markowitz mean-variance theory in practice : can you beat the market ?

Big picture context

- You've just been hired by a large *old-school* Asset Management Company
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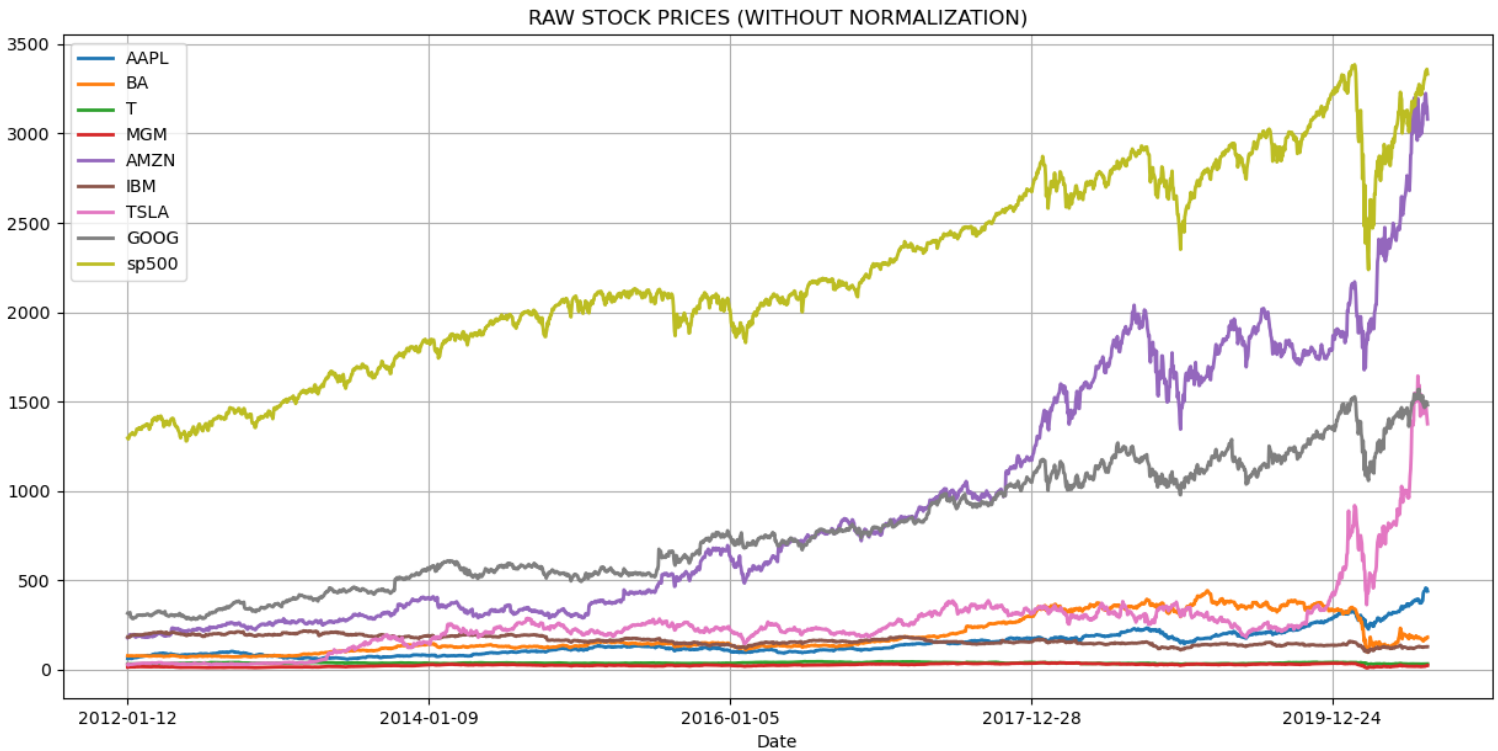
- You've just been hired by a large *old-school* Asset Management Company
- Your team manages a regulated mutual fund
- The fund manager asks you to figure out the optimal weights to create a tangency portfolio with some stocks, for which your broker offers no transaction fees.
- The data is on Bboard or on my website

Task #1 :Import the data and describe the sample

- Sort the stock data by date and print the number of stocks
- Check if data contains any null values
- What is the average market value of the S&P500 ?
- Which stock or index has the minimum dispersion in dollar value ?
- What is the maximum price for Amazon stock over the specified time period ?

Task #2 : Plot the data

- Define a function to plot the entire dataframe
  - The function takes in a dataframe as an input argument and does not return anything back



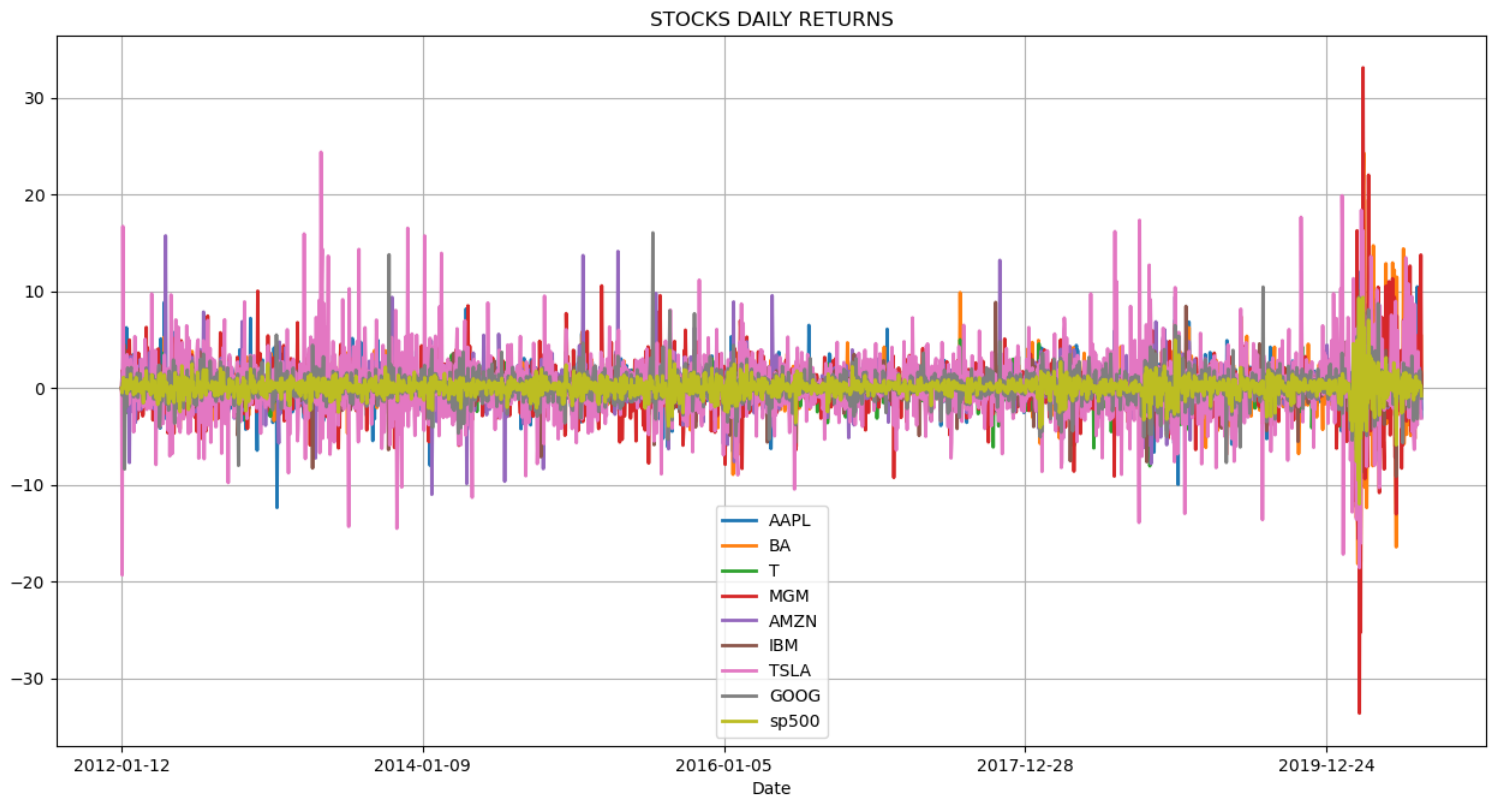
Task #3 : Print out normalized (scaled) stock prices

- Define a function to normalize the prices based on the initial price
  - The function simply divides every stock by it's price at the start date (i.e. : Date = 2012-01-12)
- Plot normalized data
- **Optional** : Define a function to perform an interactive data plotting using `plotly express`

Task #5 : Calculate stock returns (1)

- Define a function to calculate stocks daily returns (for all stocks)
  - Loop through each stock
  - Loop through each row belonging to the stock

- Plot it !



Task #5 : Calculate stock returns (2)

- Calculate the correlations between daily returns
- Plot the correlation table as in heat-map
- What are the top 2 stocks that are positively correlated with the S&P500 ?
- What is the correlation between Amazon and Boeing ? Comment on your answer
- What is the correlation between MGM and Boeing ? Comment on your answer

Task #5 : Calculate stock returns (3)

- Plot the histograms of daily returns and comment
- **Optional** : Define a function to perform an interactive and fancy histograms plots using `Plotly`
  - Plotly's Python API contains a super powerful module known as figure factory module

Task #6 : Portfolio weights

Simulation exercise

- Write a function that will :
  - Simulate 1000 portfolios with random weights
  - Compute the return, the variance and the Sharpe ratio of each portfolio
  - Return the maximum Sharpe ratio and its weights

- What are the weights of your tangency portfolio ? What would have been the performance of this portfolio over the sample period ? Plot it !

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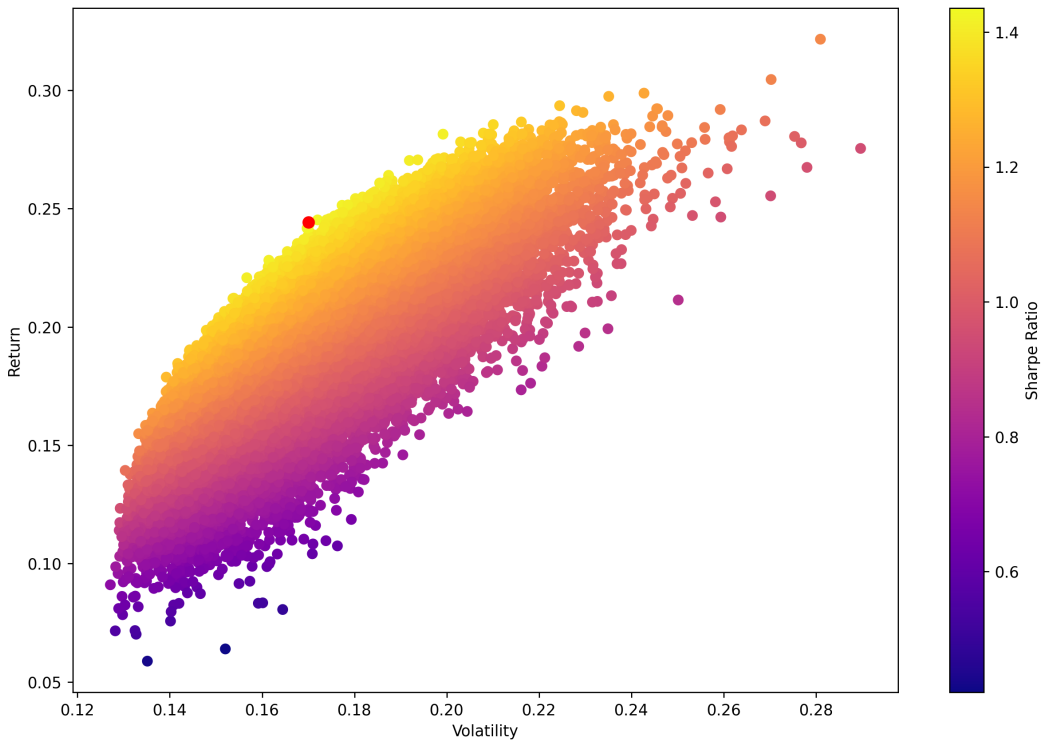
Simulation exercise

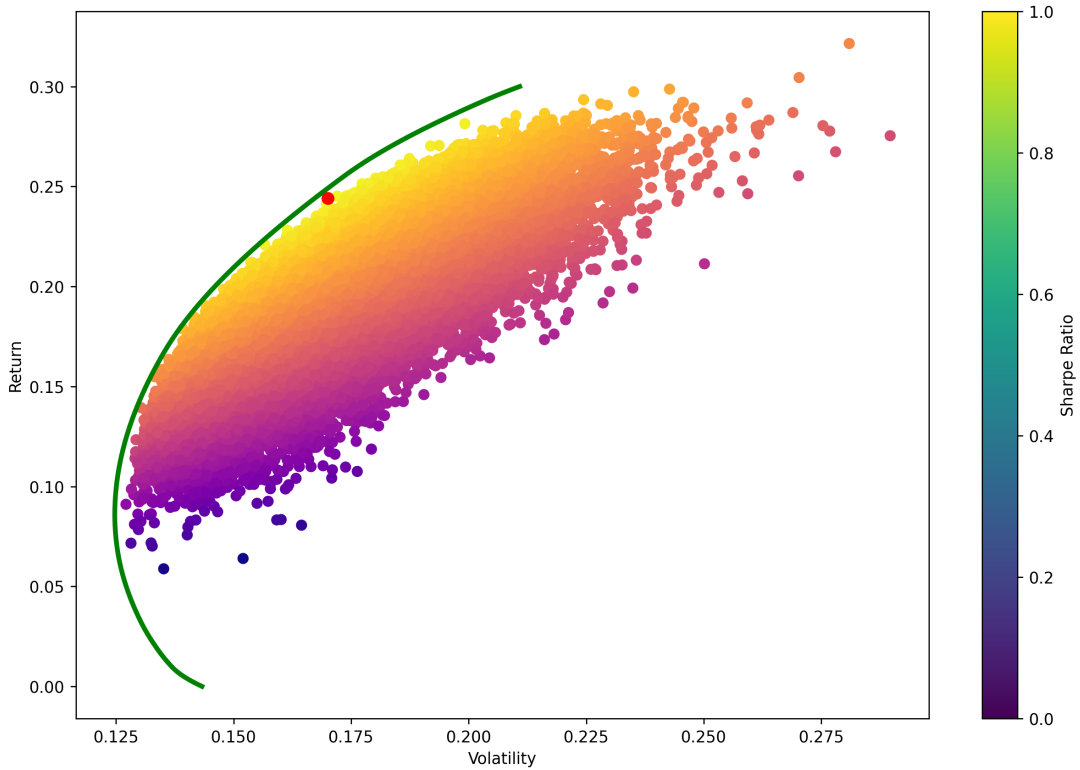
- What are the weights of your tangency portfolio ? What would have been the performance of this portfolio over the sample period ? Plot it !



Task #6 : Portfolio weights

Simulation exercise

- **Optional** : Define a function that finds the weights that minimize the variance for all possible level or return (i.e., that draw the efficient frontier). Plot it against the previous scatter plot



Task #7 : Testing Portfolio Theory - **Optional**

- Re-run Task #6 but only on the first part of the sample (2012-2016)
- Find out what are the optimal weights for this period
- Simulate your optimal portfolio on the second part of the sample (2016-end)
  - How does it perform ?
  - Plot the expected (measured over the 1st period) vs. the realized return and volatility (over the second).
- **Super optional :** Let's go a step further. Every year, you re-balance your portfolio based on last year data. What is your performance overall ?