2021 Dec 30

Project Capstone
Efficient Frontier Financial Analytics
Codecademy assignment

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Background - Read Me

This presentation is inspired by Codecademy Python Financial Course - Capstone Project assignment.

The presentation uses python programming to calculate Efficient Frontier analytics for stock portfolio and investment optimization.

Basic knowledge of financial analysis and portfolio investment is needed for analytics content.

Contents

- Select Portfolio
- Aggregate Adjusted Closing Price
- Calculate Daily Simple Return
- Calculate Variance and Volatility(Standard Deviation) for Single Stock
- Calculate Covariance and Correlation
- Calculate Efficient Frontier
- Develop Max Sharpe Ratio Scenario
- Develop Min Volatility Scenario

Select Portfolio

In order to demonstrate Efficient Frontier in real world, 5 stocks are selected

	Symbols	Company	Industry	Stock Exchange	Background	Market Cap
1	AMD	AMD	IT Semi conductor	NASDAQ	Advanced Micro Devices, Inc. (AMD) is an American multinational semiconductor company based in Santa Clara, California, that develops computer processors and related technologies for business and consumer markets.	179 billlion USD
2	AMZN	Amazon	Internet Ecommerce	NASDAQ	amazon.com, **Inc** is an American multinational technology company which focuses on e-commerce, cloud computing, digital streaming, and artificial intelligence. It is one of the Big Five companies in the U.S. information technology industry, along with Alphabet (Google), Apple, Meta (Facebook), and Microsoft.	1,716 billion USD
3	FB	Facebook (Meta)	Internet Social media	NASDAQ	**Facebook** is an American online social media and social networking service owned by Meta Platforms. Founded in 2004 by Mark Zuckerberg with fellow Harvard College students and roommates Eduardo Saverin, Andrew McCollum, Dustin Moskovitz, and Chris Hughes, its name comes from the face book directories often given to American university students.	954 billlion USD
4	PETS	PETS	Pet Pharmacy Ecommerce	NASDAQ	Petmed Express was founded in Florida in 1996 by Marc Puleo, **PetMed Express, Inc.**, also known as **1-800-PetMeds**,[2] is an online pet pharmacy based in the United States. It is publicly traded and sells prescription and non-prescription pet medication.	526 million USD
5	CRM	Salesforce	Software Saas	NYSE	**Salesforce** is an American cloud-based software company headquartered in San Francisco, California. It provides customer relationship management (CRM) service and also provides enterprise applications focused on customer service, marketing automation, analytics, and application development. The company was founded on February 3, 1999 by former Oracle executive Marc Benioff, together with Parker Harris, Dave Moellenhoff, and Frank Dominguez as a software as a service (SaaS) company	251 billion USD

Source: wikipedia, yahoo finance

Aggregate Adjusted Closing Price

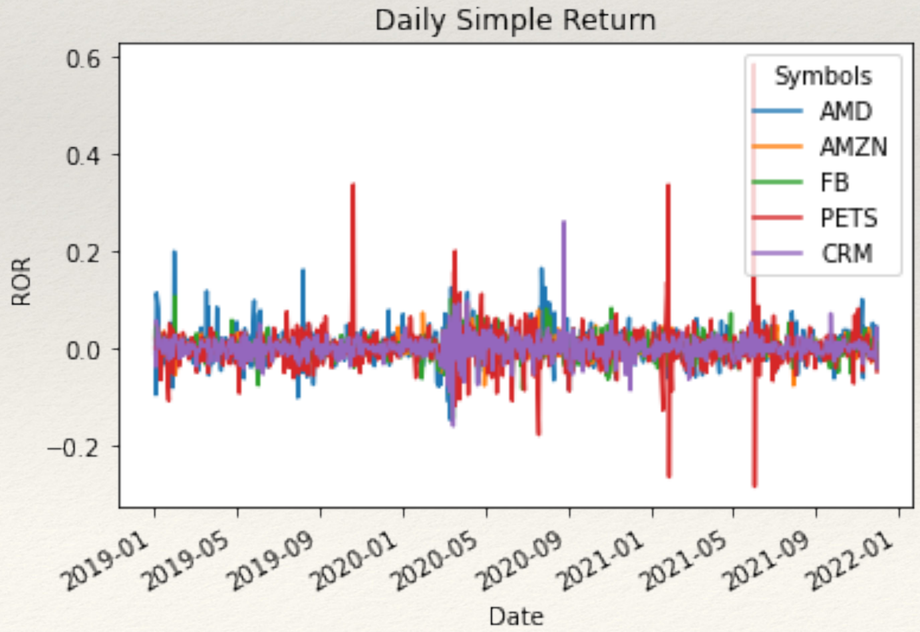
According to common financial practices , adjusted closing prices of the 5 stocks are collected for foundation of financial analytics.

Please note that Amazon price is way higher comparing with other stocks, however this does not mean Amazon has favorable return.

Calculate Daily Simple Return

Daily Simple Return

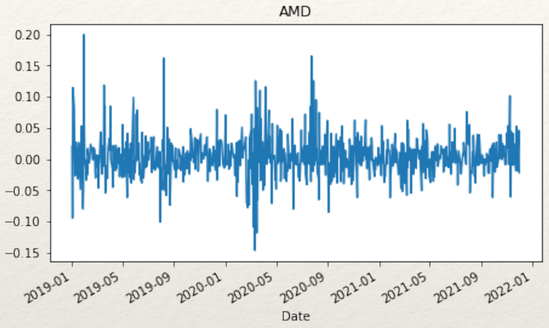
Symbols	AMD	Amazon	Facebook	PETS	Salesforce
Date					
2018-12-31	NaN	NaN	NaN	NaN	NaN
2019-01-02	0.020043	0.024741	0.035014	0.000860	-0.010367
2019-01-03	-0.094530	-0.025242	-0.029039	-0.021907	-0.037993
2019-01-04	0.114370	0.050064	0.047138	0.021080	0.057976
2019-01-07	0.082632	0.034353	0.000725	0.014194	0.030878

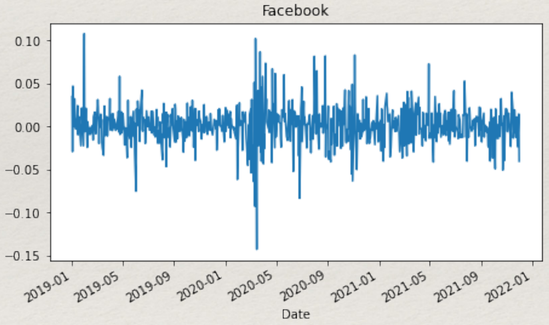


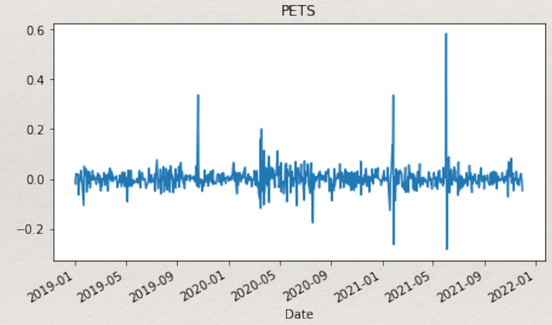
In order to compare return of each stock, daily simple return is used.

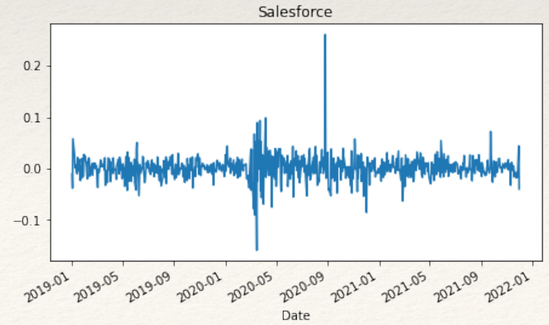
(If further wants to annualized return, log return is needed, which is not included in the presentation)

Calculate Daily Simple Return - cont'



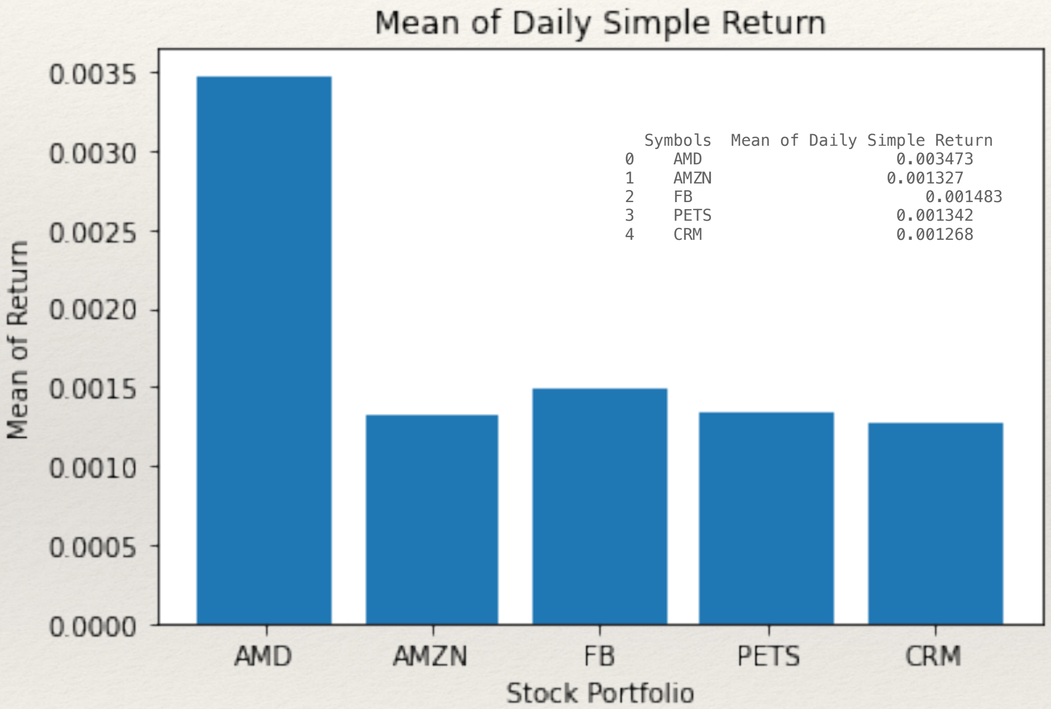






By creating subplots, we can see daily simple return of each stock separately.

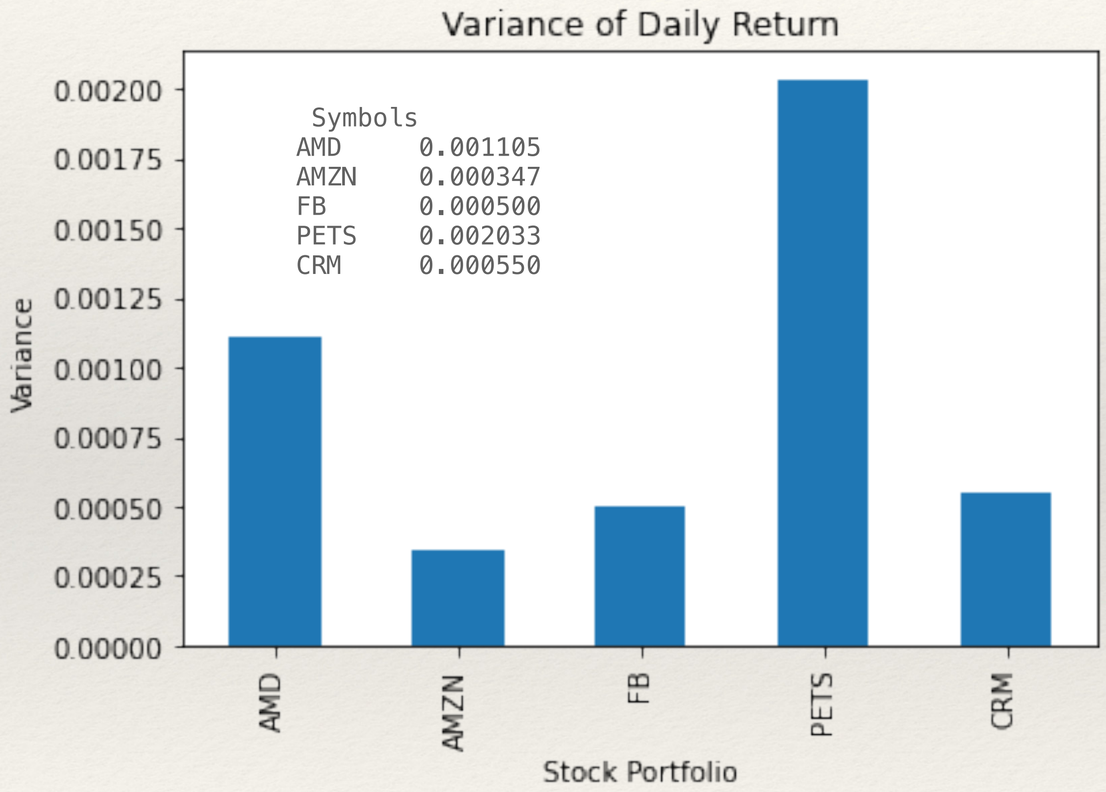
Calculate Mean of Daily Simple Return



	Symbols	Mean of Daily Simple Return
0	AMD	0.003473
1	AMZN	0.001327
2	FB	0.001483
3	PETS	0.001342
4	CRM	0.001268

As further calculate more, we can see that Amazon has the highest daily simple return, nearly triple Amazon's.

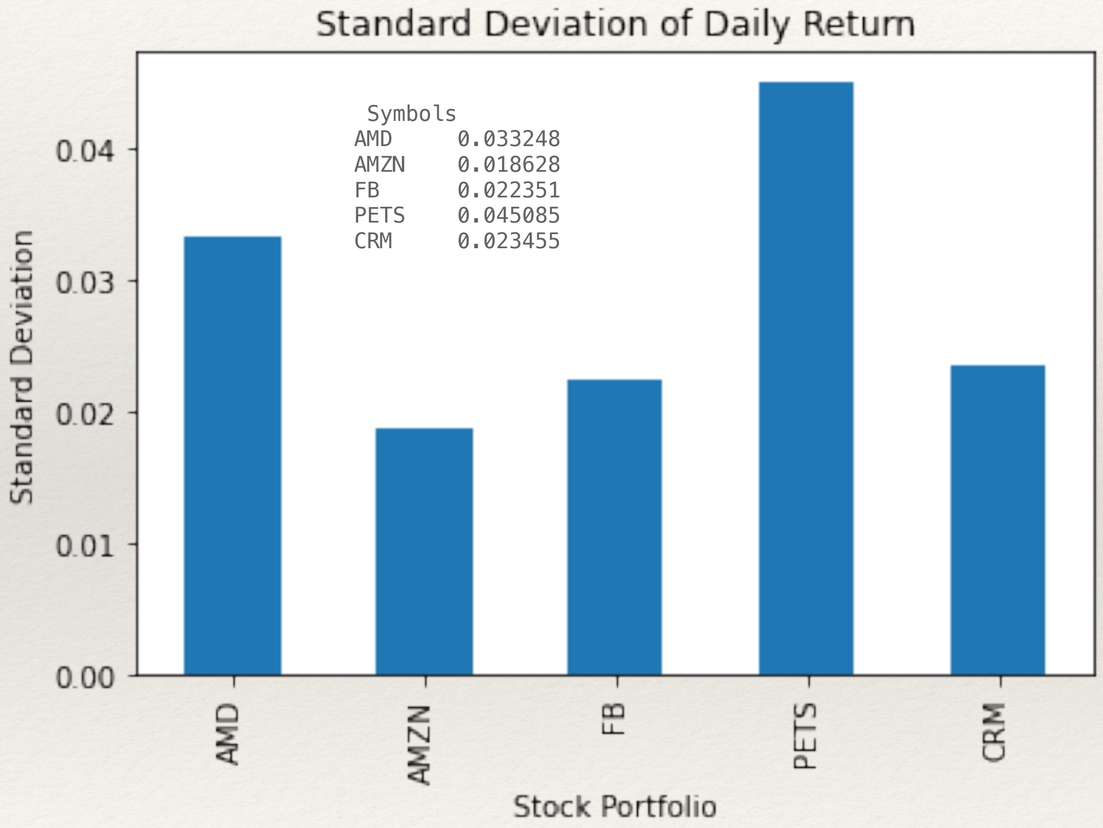
Calculate Variance for Single Stock



By calculating variance of single stock, we can see PETS and Amazon have top 2 box of variance.

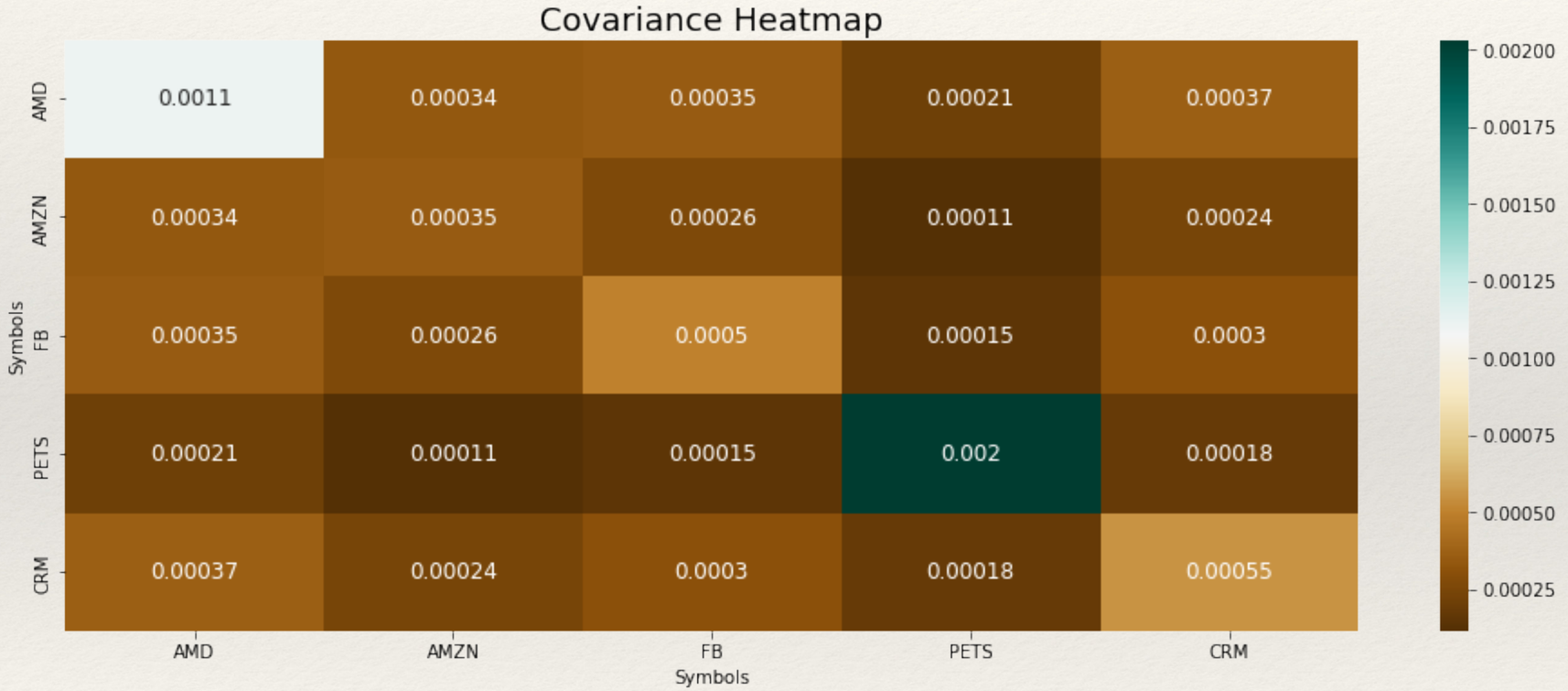
While PETS doubled Amazon's variance.

Calculate Volatility(Standard Deviation) for Single Stock



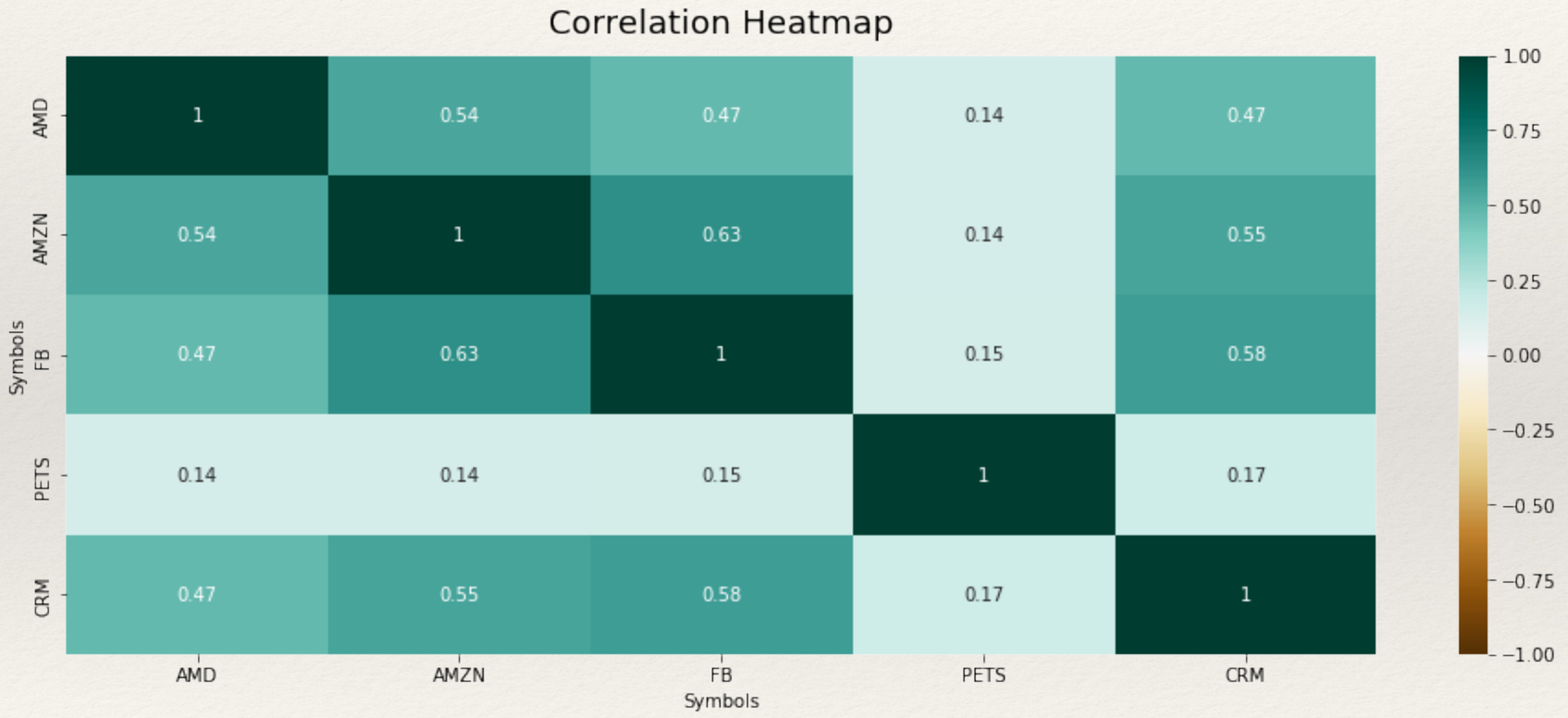
By calculating volatility of daily simple return, we will find PETS and AMD have top 2 highest volatility.

Calculate Covariance



Covariance heat map shows that except PETS, other stocks have positive covariances, which means 1 stock increase prices, others will increase as well.

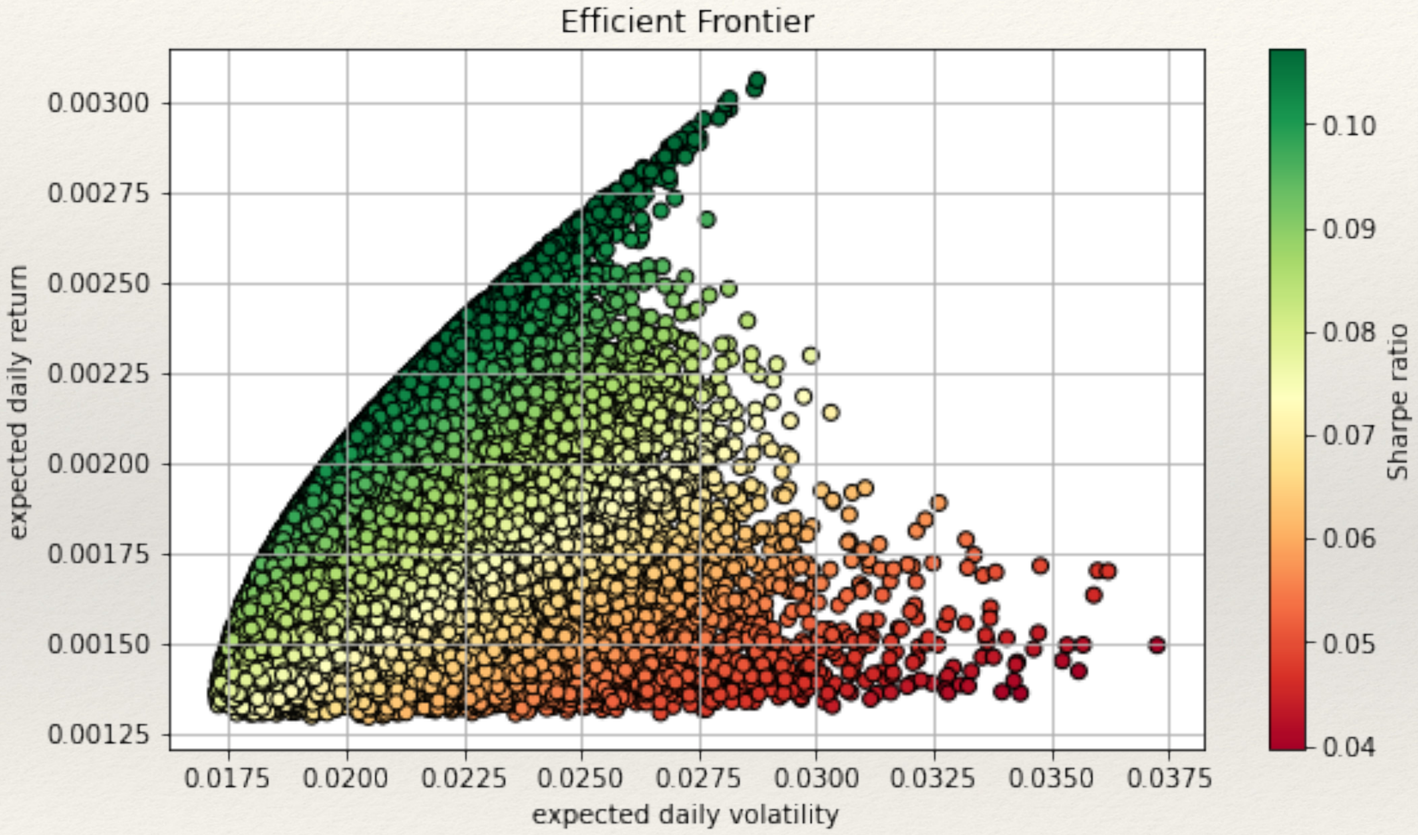
Calculate Correlation



Correlation standardizes covariance into a value that ranges between -1 and 1.

By correlation heat map, we can see that expect PETS (lower that 0.15 with other stocks), all other stocks correlation are positively related around 0.5

Calculate Efficient Frontier



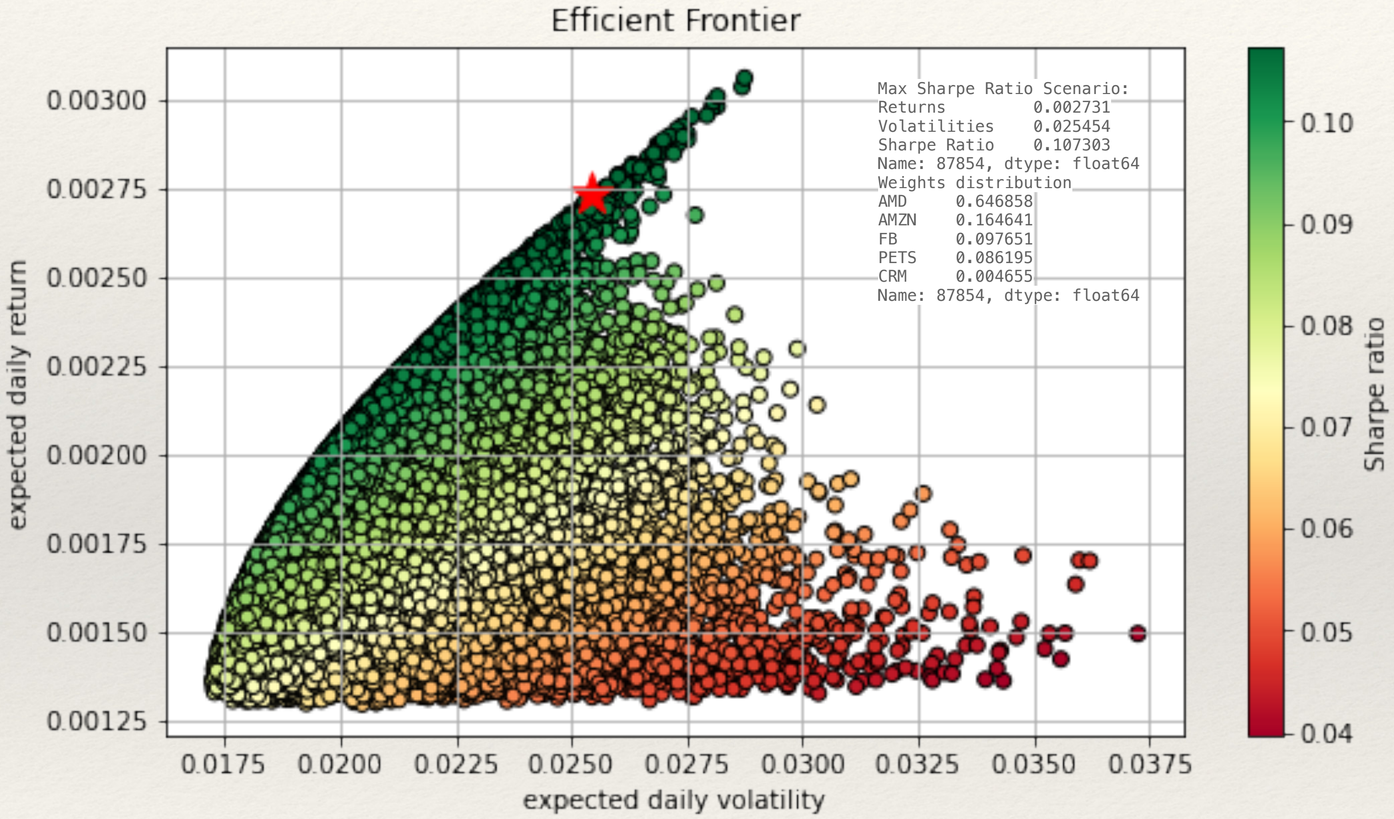
Source: https://www.investopedia.com/terms/e/efficientfrontier.asp

The efficient frontier theory was introduced by Nobel Laureate Harry Markowitz in 1952 and is a cornerstone of modern portfolio theory. The efficient frontier is the set of optimal portfolios that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return.

Portfolios that lie below the efficient frontier are sub-optimal because they do not provide enough return for the level of risk. Portfolios that cluster to the right of the efficient frontier are sub-optimal because they have a higher level of risk for the defined rate of return.

In this plot, we use 100,000 sets of random weights to calculate the portfolio volatility and portfolio returns

Develop Max Sharpe Ratio Scenario



The Sharpe ratio was developed by Nobel laureate William F. Sharpe and is used to help investors understand the return of an investment compared to its risk. The ratio is the average return earned in excess of the risk-free rate per unit of volatility or total risk. Volatility is a measure of the price fluctuations of an asset or portfolio.

Maximum Sharpe Ratio is the portfolio selection has the best return/volatility ratio.

In this case (red star in the plot), maximum Sharpe Ratio is 0.1, portfolio return is 0.0027 (daily) and portfolio volatility (daily) is 0.025.

And weights distribution of each stock is listed in the table on left.

https://www.investopedia.com/terms/w/william-f-sharpe.asp

Develop Min Volatility Scenario

Minimum Volatility Scenario defines and lowest risk portfolio selection

In this case (blue star in the plot), portfolio return is 0.00136 (daily) and portfolio volatility (daily) is 0.017.

And weights distribution of each stock is listed in the table on left.

Conclusion

Max Sharpe Ratio

Returns	0.002706
Volatilities	0.025209
Sharpe Ratio	0.107325

Weights	distribution
AMD	0.625769
AMZN	0.079345
FB	0.224718
PETS	0.065794
CRM	0.004374

Maximum Sharpe Ratio scenario is recommended, since this is the best situation of maximize portfolio return while balancing volatility

Appendix

Programing notes

Python module used

- [ ] Pandas: for dataframes and calculations
- [ ] Numpy: for numerical maths
- [ ] Matplotlib: for statistics plots
- [ ] Seaborn : for heatmaps
- [ ] Datetime: for formalizing dates and times for stock queries
- [ ] Pandas- datareader: for reading stock portfolio information

Coding Editor: VScode

What can be done better

- [ ] Use log rate and annualize financial return
- [ ] More simplified and self explaining coding for efficient frontier calculation