PORTFOLIO OPTIMIZATION

MUKESH S BENGALURU
DUSHYANTH S NANDEESH
SUMIT GUPTA

CONTENTS

- SHARPE RATIO
- PORTFOLIO ALLOCATION
- PORTFOLIO OPTIMIZATION
- EFFICIENT FRONTIER

PORTFOLIO

- PORTFOLIO IS JUST A SET OF ALLOCATIONS IN A VARIETY OF SECURITIES.

- FOR EXAMPLE,

  1) 20% in APPLE
  2) 30% in FACEBOOK
  3) 50% in GOOGLE

  - THESE PERCENTAGES SHOULD ADD UP TO 100% OR IF DEFINED AS WEIGHTS THEY SHOULD ADD UP TP 1.

KEY STATISTICS FOR A PORTFOLIO

- **DAILY RETURNS** – THE PERCENT RETURNED FROM 1 DAY TO THE NEXT FOR A STOCK.

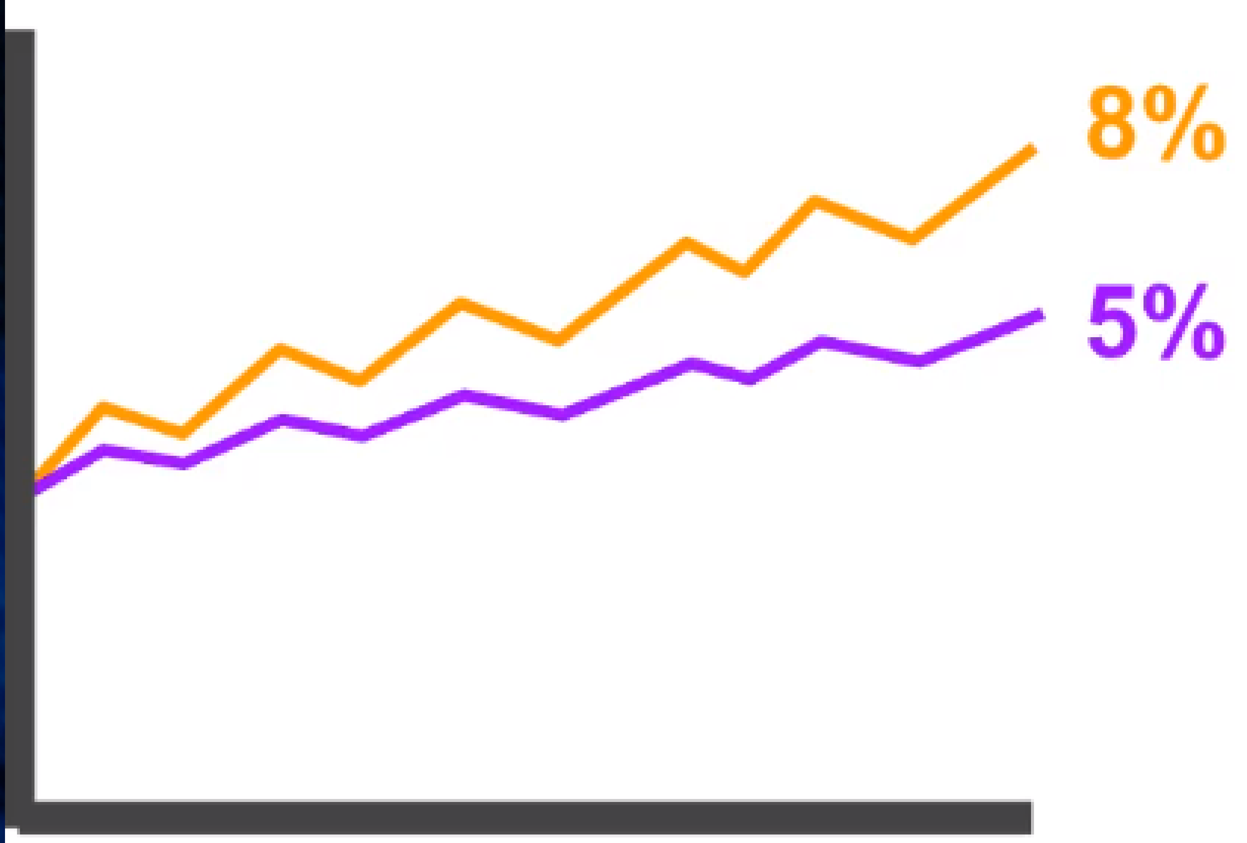
- **CUMULATIVE RETURN** – THE AMOUNT RETURNED AFTER AN ENTIRE TIME PERIOD.

- **AVERAGE DAILY RETURN** – MEAN OF DAILY RETURNS.

- **STANDARD DAILY RETURNS** – STANDARD DEVIATION OF DAILY RETURNS.

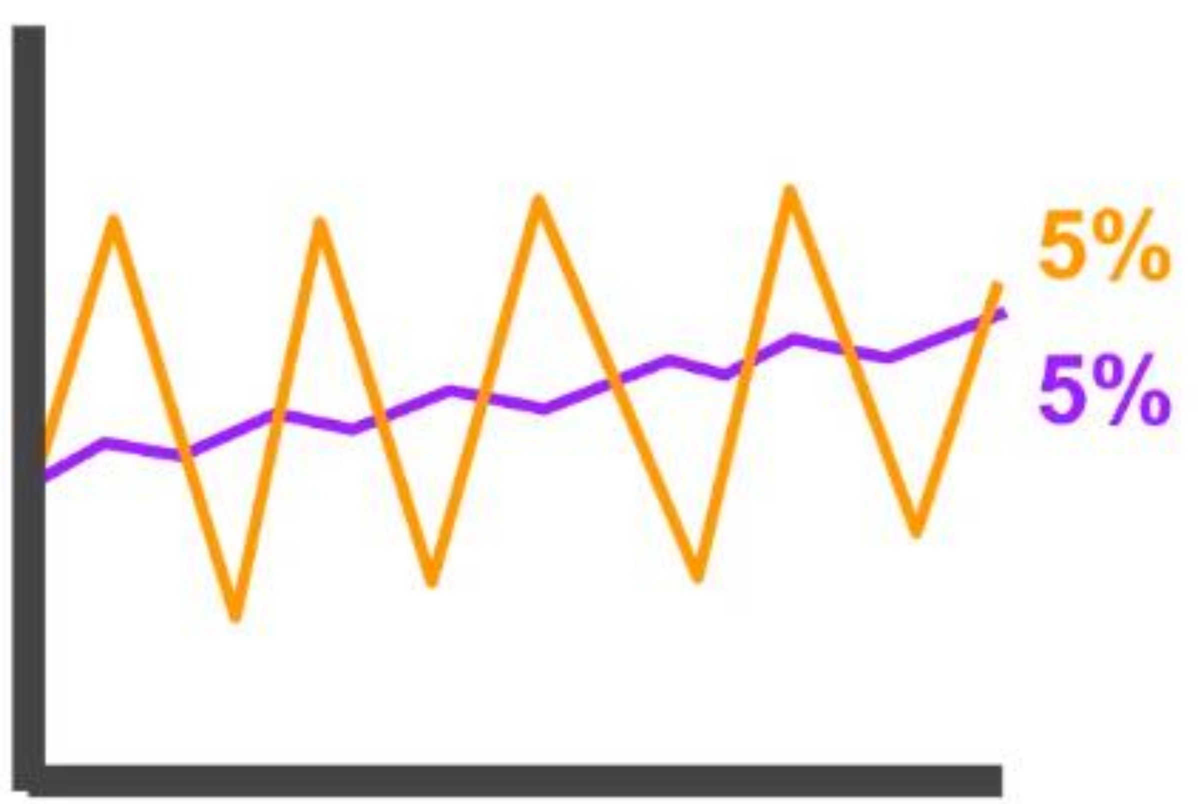
WHICH PORTFOLIO IS BETTER?

- CASE 1



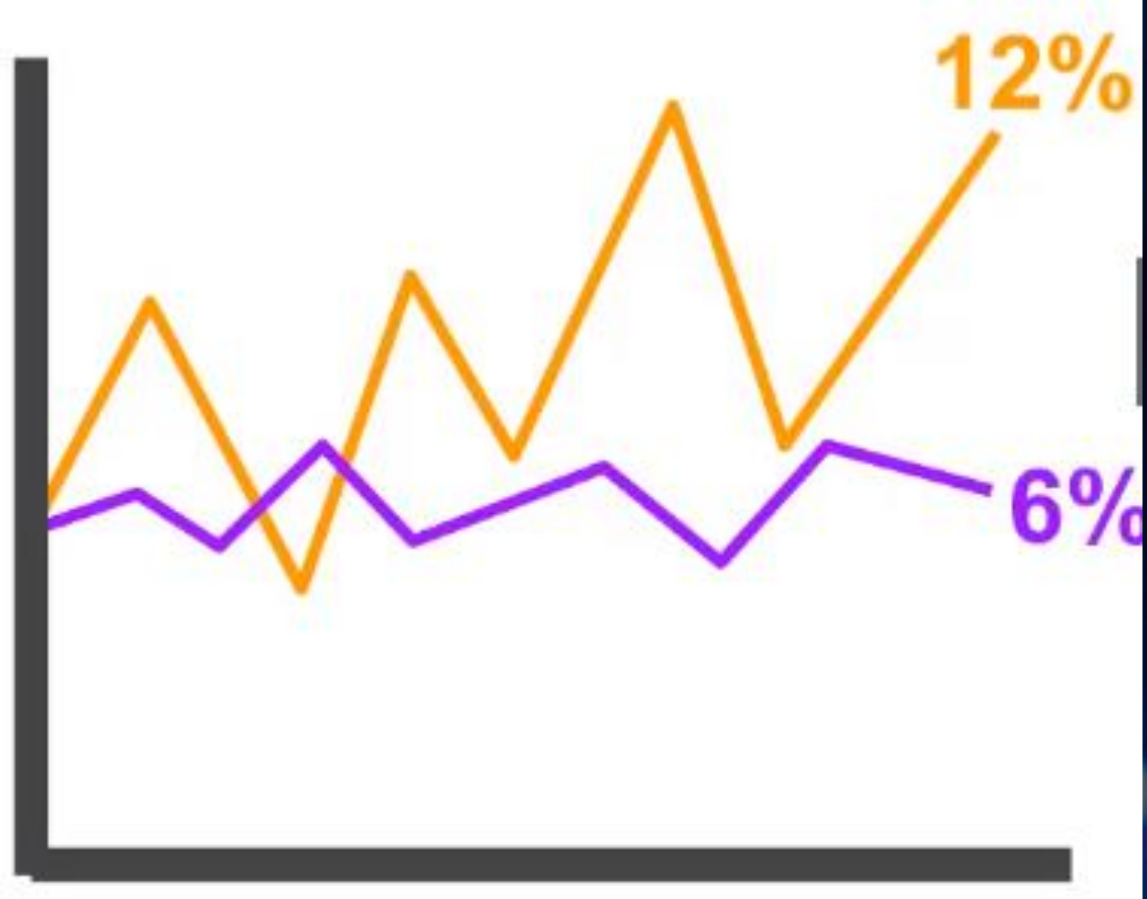
WHICH PORTFOLIO IS BETTER?

- CASE 2



WHICH PORTFOLIO IS BETTER?

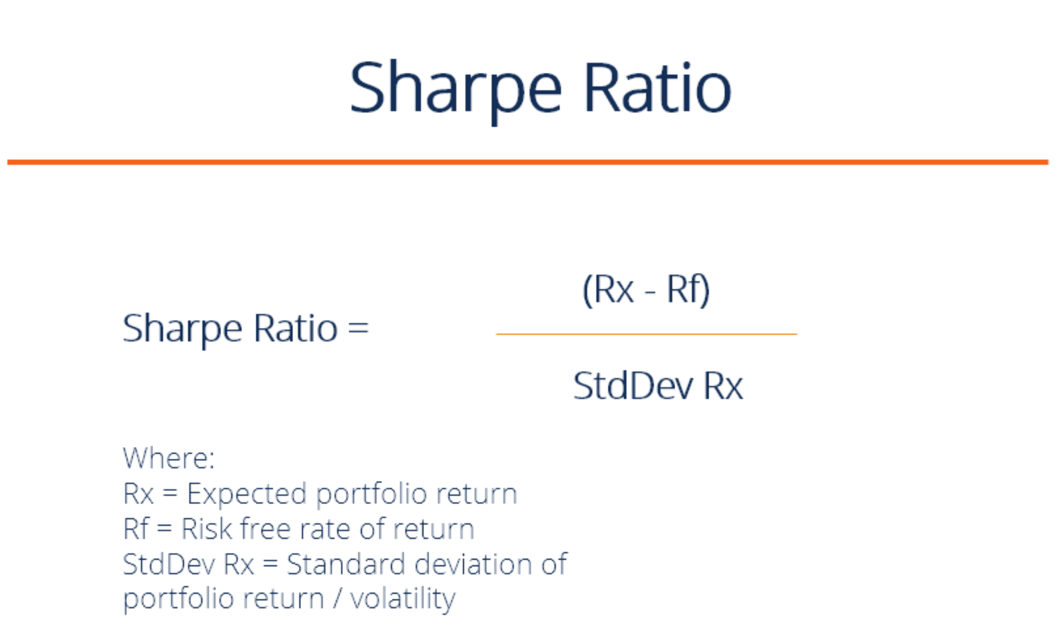
- CASE 3



SHARPE RATIO

- SHARPE RATIO IS A MEASURE FOR CALCULATING RISK-ADJUSTED RETURN, AND THIS RATIO HAS BECOME THE INDUSTRY STANDARD FOR SUCH CALCULATIONS.

- IT WAS DEVELOPED BY NOBEL LAUREATE WILLIAM F. SHARPE.

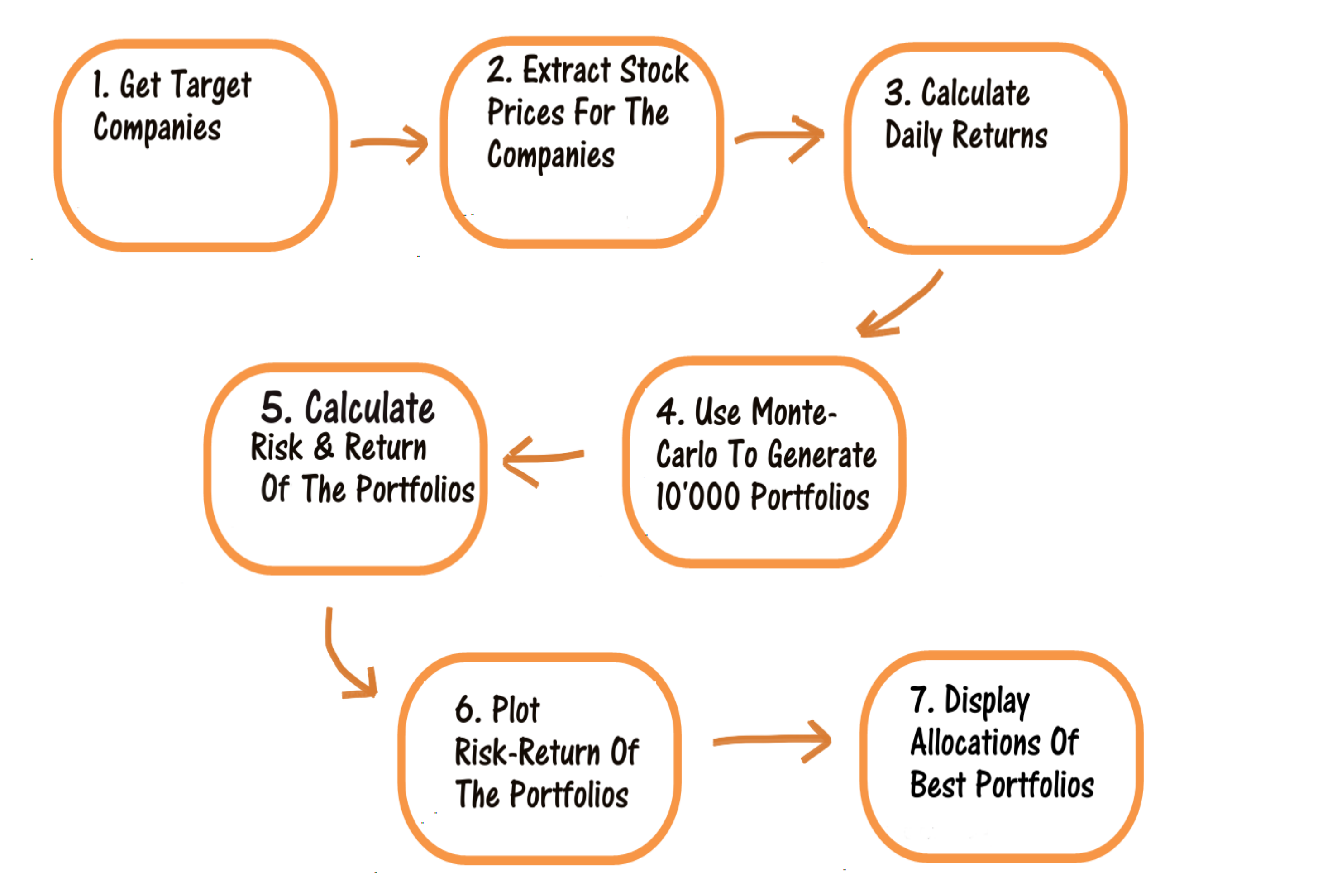


Sharpe Ratio

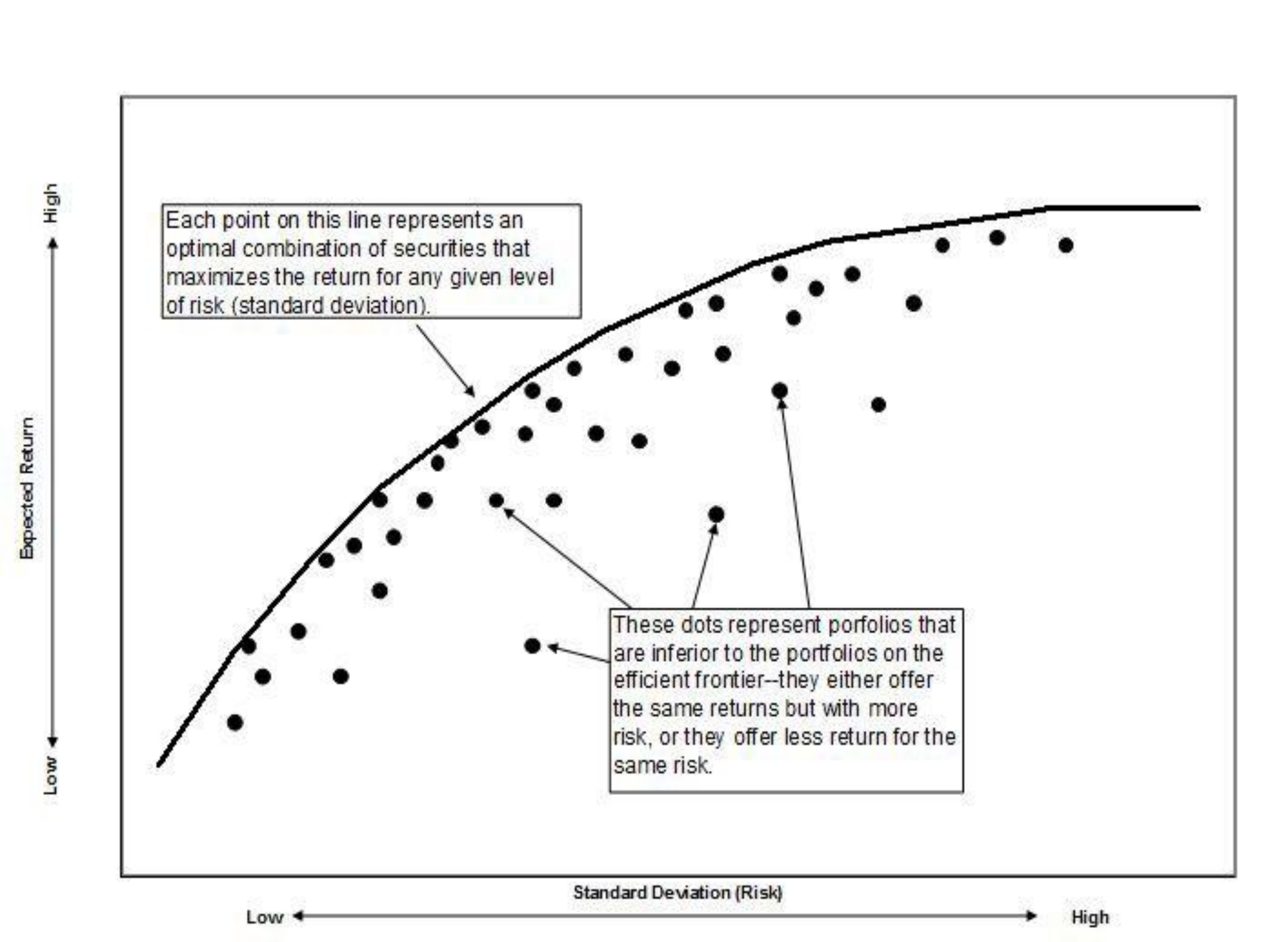
$$\text{Sharpe Ratio} = \frac{(Rx - Rf)}{\text{StdDev } Rx}$$

Where:
Rx = Expected portfolio return
Rf = Risk free rate of return
StdDev Rx = Standard deviation of portfolio return / volatility

MONTE CARLO SIMULATION


1. Get Target Companies
2. Extract Stock Prices For The Companies
3. Calculate Daily Returns
4. Use Monte-Carlo To Generate 10'000 Portfolios
5. Calculate Risk & Return Of The Portfolios
6. Plot Risk-Return Of The Portfolios
7. Display Allocations Of Best Portfolios

MODERN PORTFOLIO THEORY

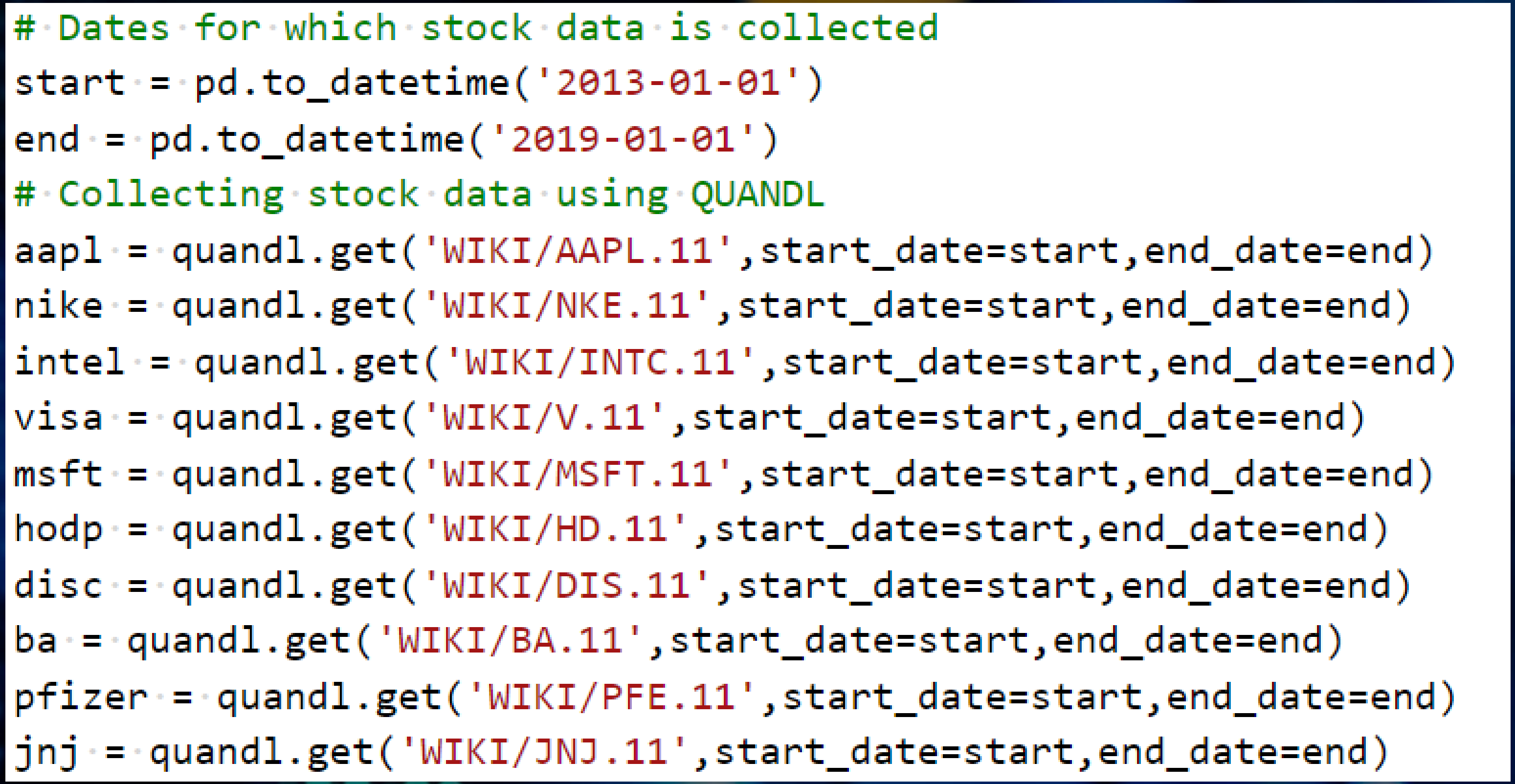


Each point on this line represents an optimal combination of securities that maximizes the return for any given level of risk (standard deviation).

These dots represent porfolios that are inferior to the portfolios on the efficient frontier--they either offer the same returns but with more risk, or they offer less return for the same risk.

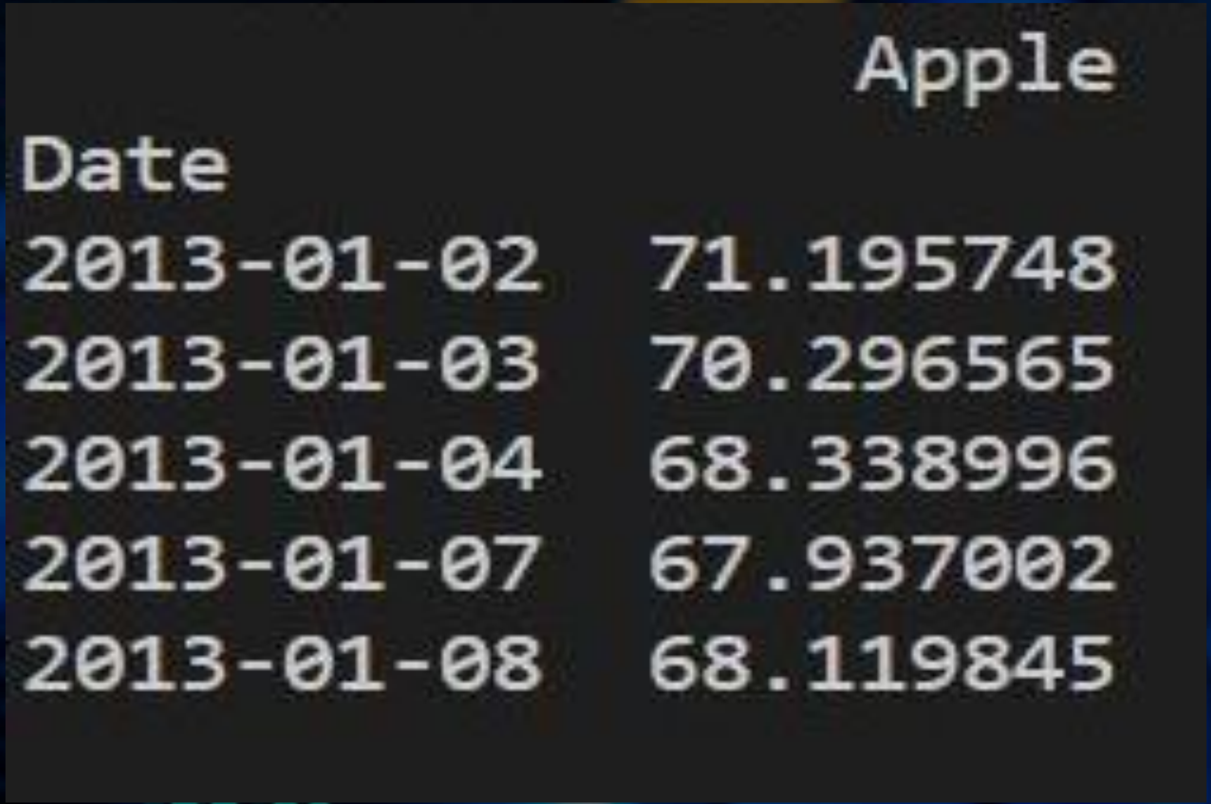
LIVE DEMO

DATA



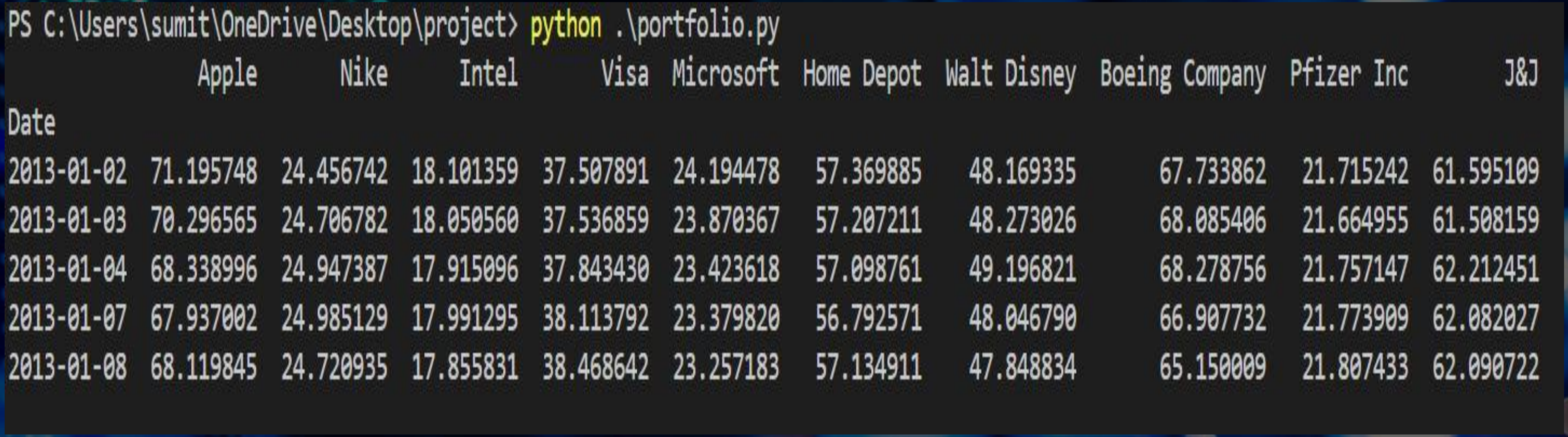
```
# Dates for which stock data is collected
start = pd.to_datetime('2013-01-01')
end = pd.to_datetime('2019-01-01')
# Collecting stock data using QUANDL
aapl = quandl.get('WIKI/AAPL.11',start_date=start,end_date=end)
nike = quandl.get('WIKI/NKE.11',start_date=start,end_date=end)
intel = quandl.get('WIKI/INTC.11',start_date=start,end_date=end)
visa = quandl.get('WIKI/V.11',start_date=start,end_date=end)
msft = quandl.get('WIKI/MSFT.11',start_date=start,end_date=end)
hodp = quandl.get('WIKI/HD.11',start_date=start,end_date=end)
disc = quandl.get('WIKI/DIS.11',start_date=start,end_date=end)
ba = quandl.get('WIKI/BA.11',start_date=start,end_date=end)
pfizer = quandl.get('WIKI/PFE.11',start_date=start,end_date=end)
jnj = quandl.get('WIKI/JNJ.11',start_date=start,end_date=end)
```

DATA



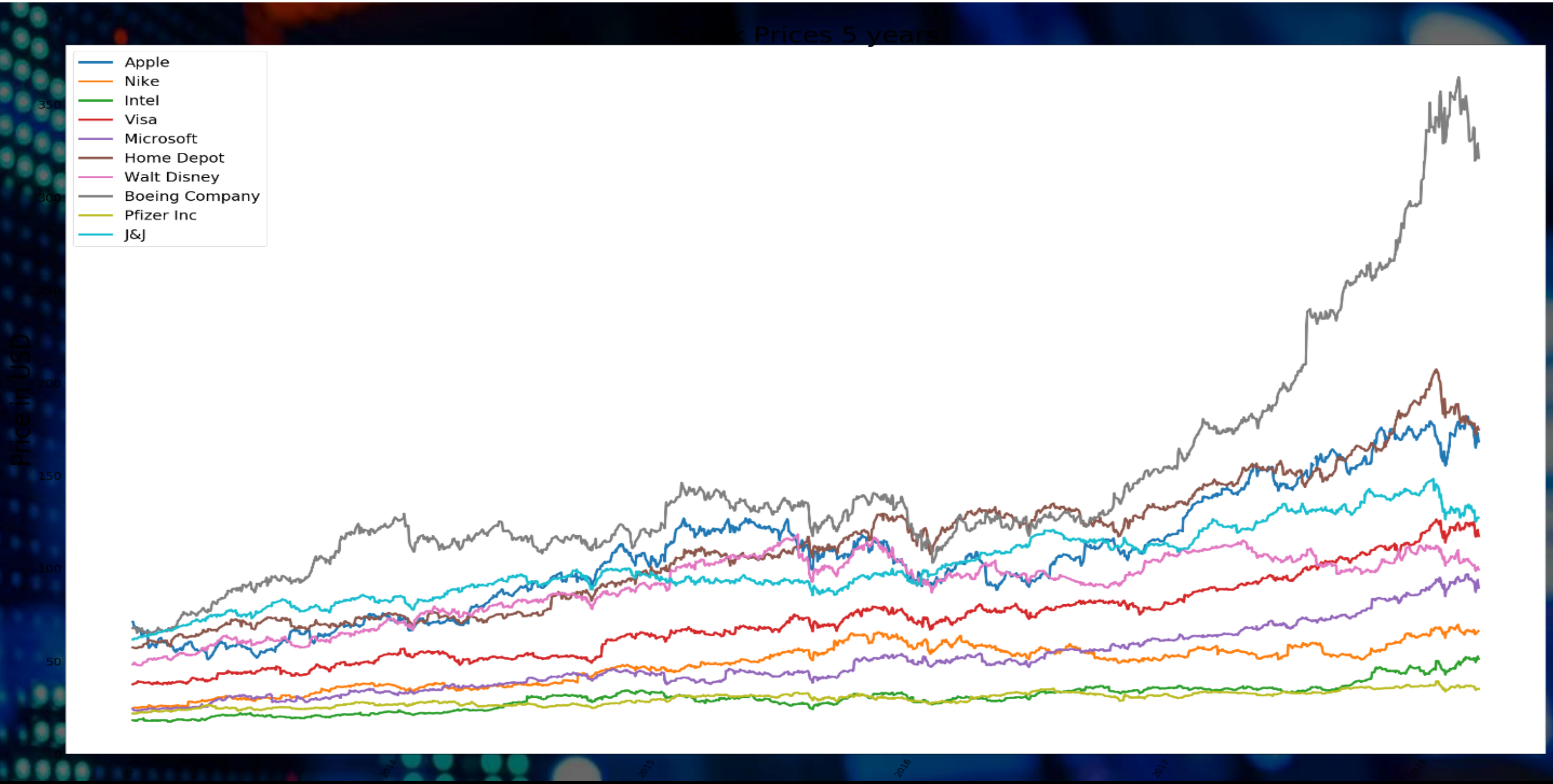
```
                 Apple
Date
2013-01-02  71.195748
2013-01-03  70.296565
2013-01-04  68.338996
2013-01-07  67.937002
2013-01-08  68.119845
```

DATA PROCESSING

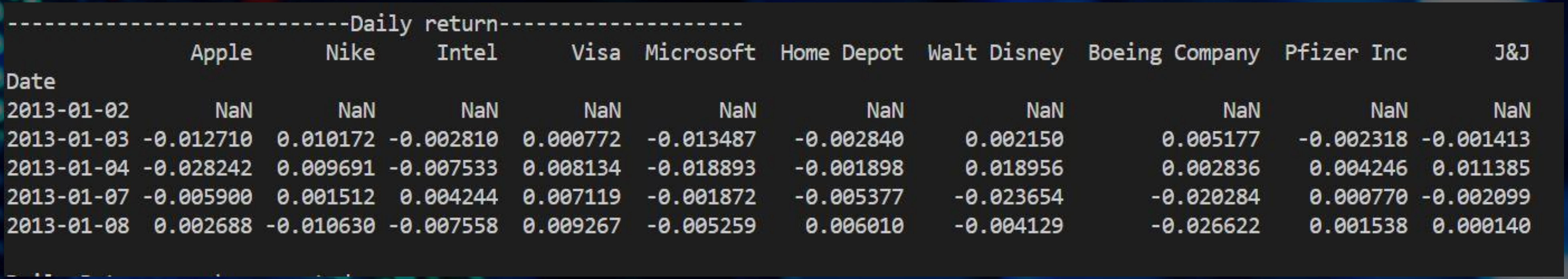


```
PS C:\Users\sumit\OneDrive\Desktop\project> python .\portfolio.py
                Apple       Nike      Intel       Visa  Microsoft  Home Depot  Walt Disney  Boeing Company  Pfizer Inc        J&J
Date
2013-01-02  71.195748  24.456742  18.101359  37.507891  24.194478   57.369885    48.169335       67.733862   21.715242  61.595109
2013-01-03  70.296565  24.706782  18.050560  37.536859  23.870367   57.207211    48.273026       68.085406   21.664955  61.508159
2013-01-04  68.338996  24.947387  17.915096  37.843430  23.423618   57.098761    49.196821       68.278756   21.757147  62.212451
2013-01-07  67.937002  24.985129  17.991295  38.113792  23.379820   56.792571    48.046790       66.907732   21.773909  62.082027
2013-01-08  68.119845  24.720935  17.855831  38.468642  23.257183   57.134911    47.848834       65.150009   21.807433  62.090722
```

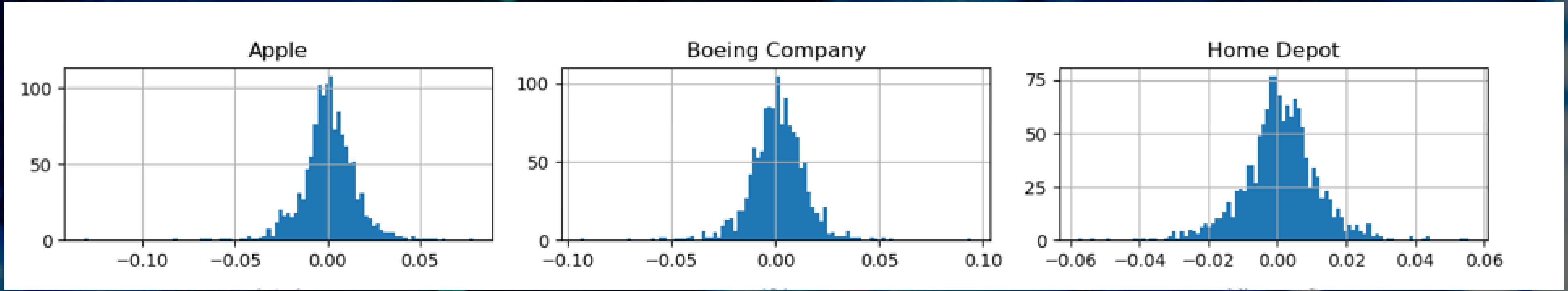
GRAPH


Prices 5 years
Apple
Nike
Intel
Visa
Microsoft
Home Depot
Walt Disney
Boeing Company
Pfizer Inc
J&J
Price in USD
350
300
250
200
150
100
50
0
2014
2015
2016
2017
2018

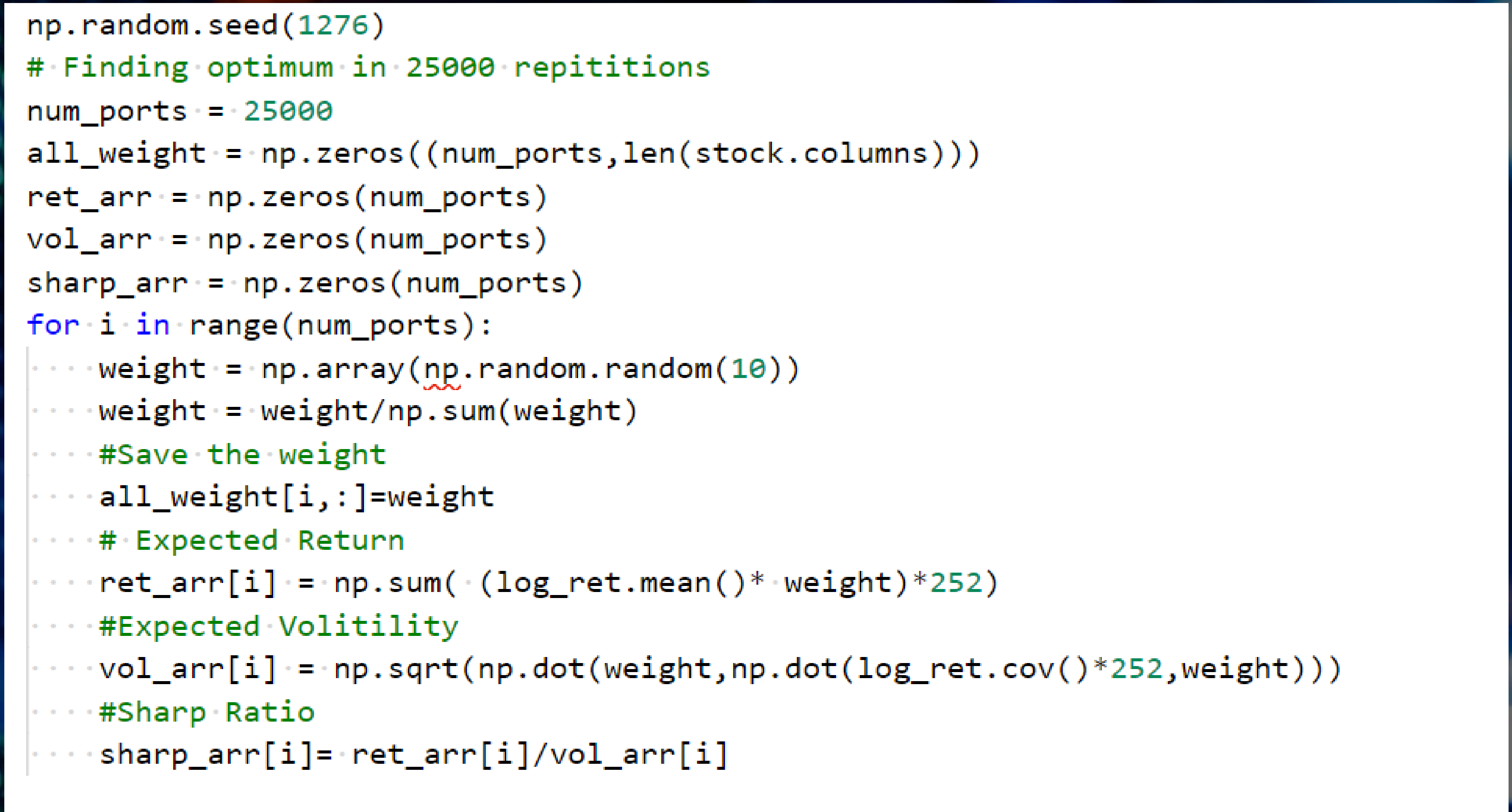
LOG RETURNS



```
----------------------------Daily return--------------------
                 Apple      Nike     Intel      Visa  Microsoft  Home Depot  Walt Disney  Boeing Company  Pfizer Inc       J&J
Date
2013-01-02         NaN       NaN       NaN       NaN        NaN         NaN          NaN             NaN         NaN       NaN
2013-01-03 -0.012710  0.010172 -0.002810  0.000772  -0.013487   -0.002840     0.002150        0.005177   -0.002318 -0.001413
2013-01-04 -0.028242  0.009691 -0.007533  0.008134  -0.018893   -0.001898     0.018956        0.002836    0.004246  0.011385
2013-01-07 -0.005900  0.001512  0.004244  0.007119  -0.001872   -0.005377    -0.023654       -0.020284    0.000770 -0.002099
2013-01-08  0.002688 -0.010630 -0.007558  0.009267  -0.005259    0.006010    -0.004129       -0.026622    0.001538  0.000140
```

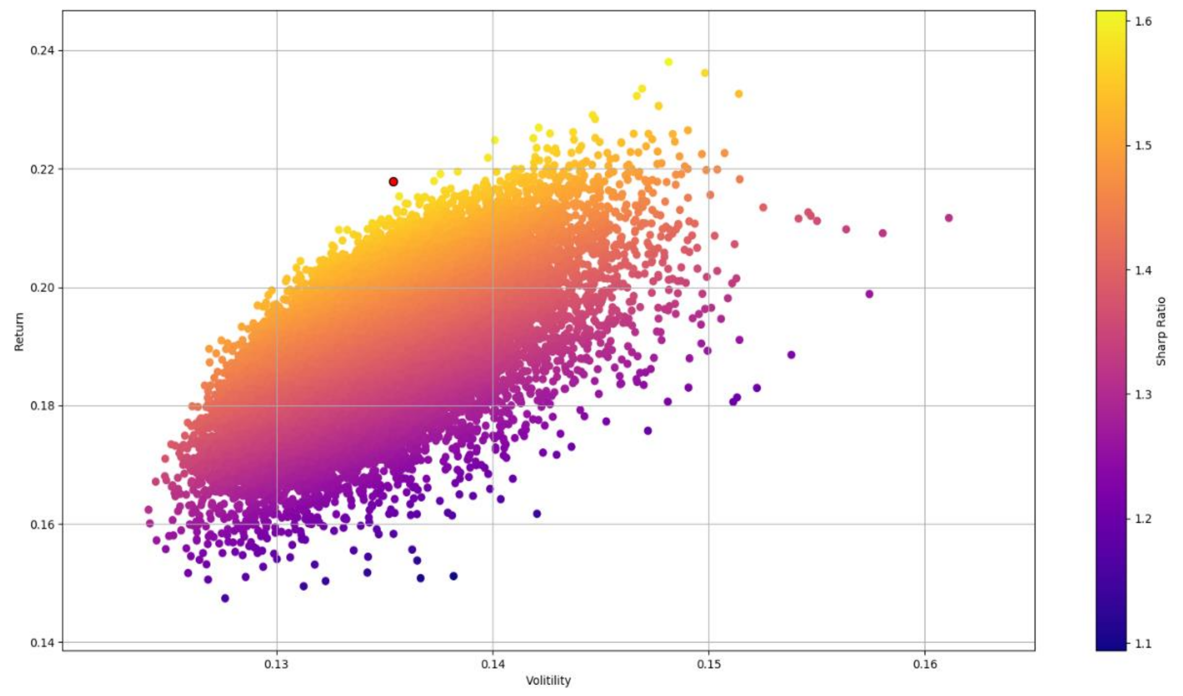


MONTE CARLO SIMULATION

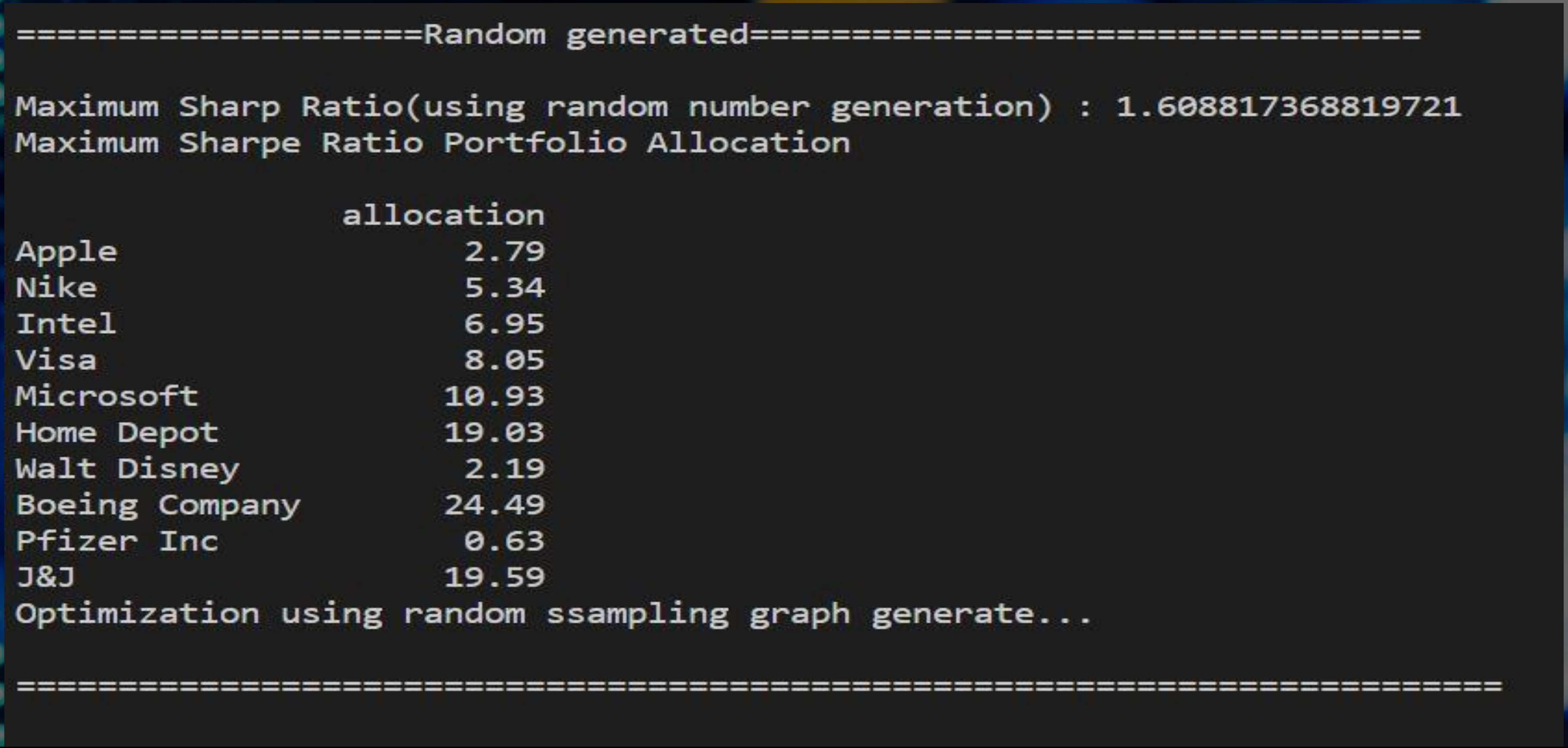


```python
np.random.seed(1276)
# Finding optimum in 25000 repititions
num_ports = 25000
all_weight = np.zeros((num_ports,len(stock.columns)))
ret_arr = np.zeros(num_ports)
vol_arr = np.zeros(num_ports)
sharp_arr = np.zeros(num_ports)
for i in range(num_ports):
    weight = np.array(np.random.random(10))
    weight = weight/np.sum(weight)
    #Save the weight
    all_weight[i,:]=weight
    # Expected Return
    ret_arr[i] = np.sum( (log_ret.mean()* weight)*252)
    #Expected Volitility
    vol_arr[i] = np.sqrt(np.dot(weight,np.dot(log_ret.cov()*252,weight)))
    #Sharp Ratio
    sharp_arr[i]= ret_arr[i]/vol_arr[i]
```

MONTE CARLO SIMULATION

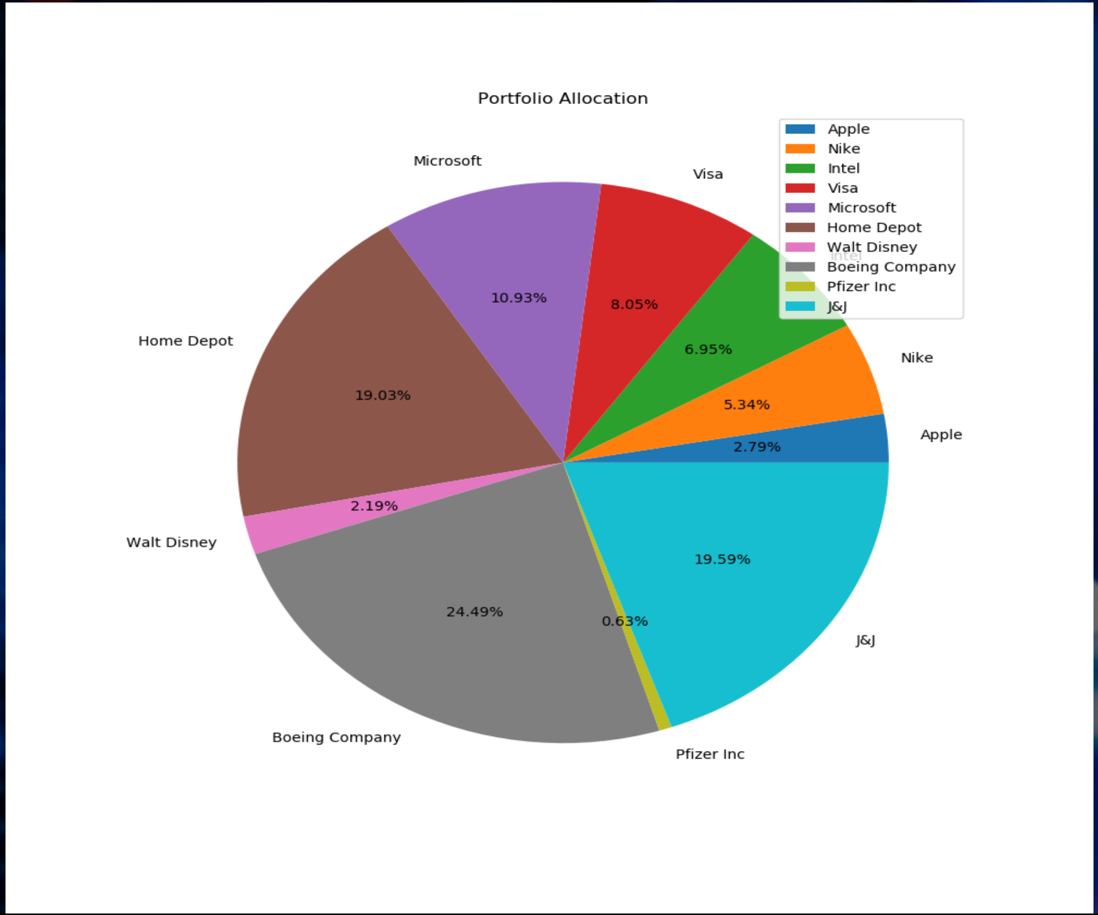


MONTE CARLO SIMULATION

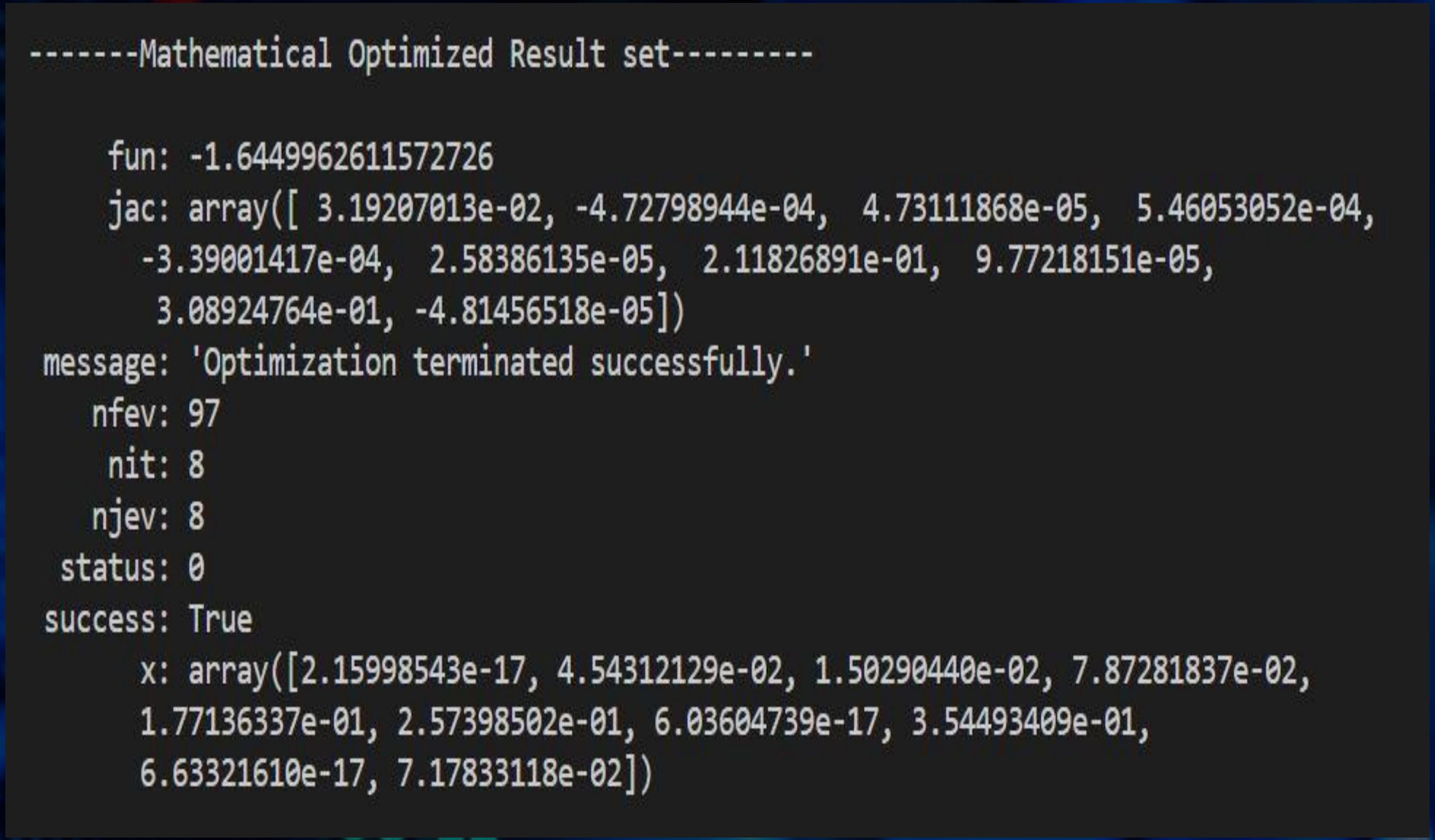


```
====================Random generated=================================

Maximum Sharp Ratio(using random number generation) : 1.608817368819721
Maximum Sharpe Ratio Portfolio Allocation

                allocation
Apple                 2.79
Nike                  5.34
Intel                 6.95
Visa                  8.05
Microsoft            10.93
Home Depot           19.03
Walt Disney           2.19
Boeing Company       24.49
Pfizer Inc            0.63
J&J                  19.59
Optimization using random ssampling graph generate...

=========================================================================
```

MONTE CARLO SIMULATION

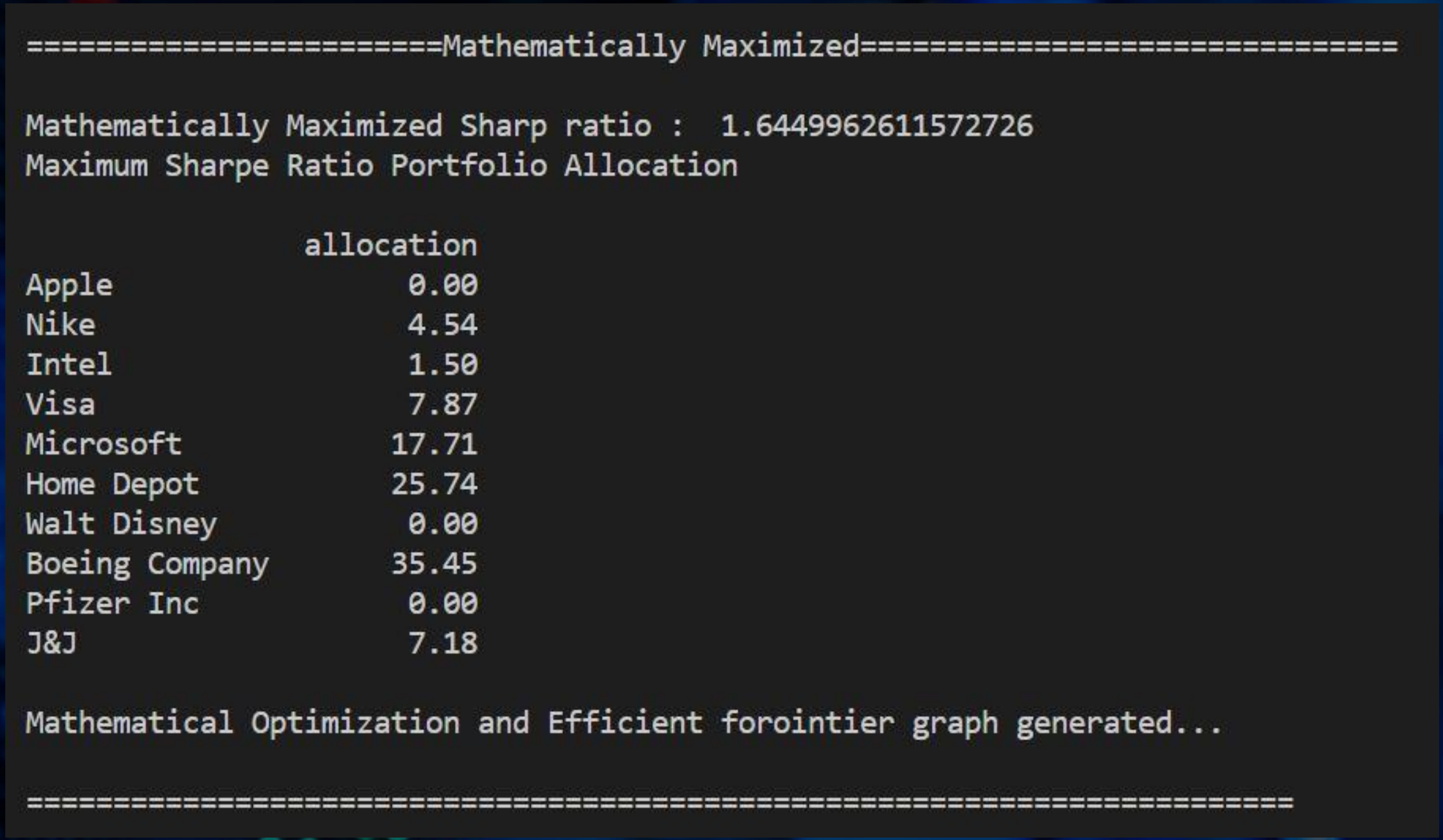


MARKOWITS OPTIMIZATION



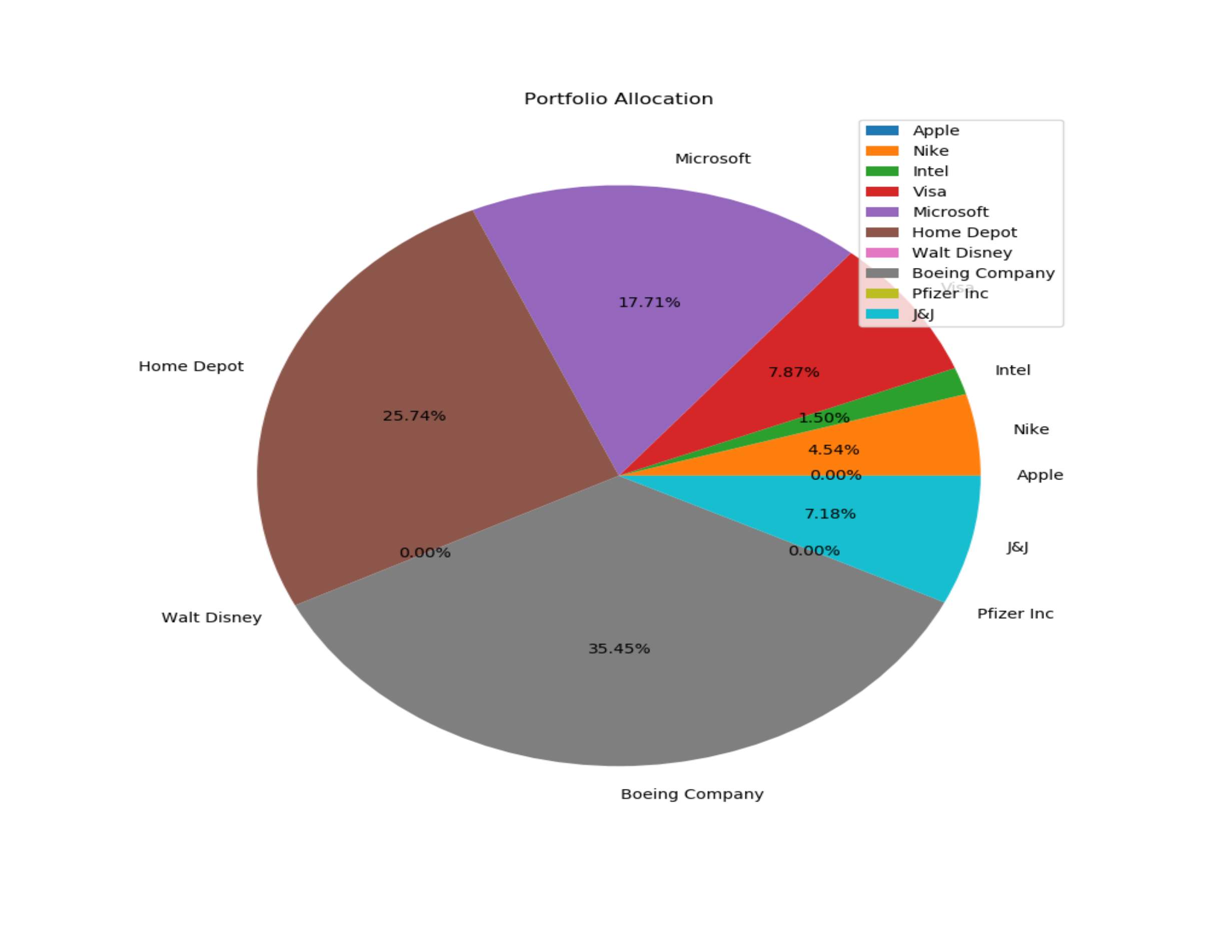
```
-------Mathematical Optimized Result set---------


     fun: -1.6449962611572726
     jac: array([ 3.19207013e-02, -4.72798944e-04,  4.73111868e-05,  5.46053052e-04,
       -3.39001417e-04,  2.58386135e-05,  2.11826891e-01,  9.77218151e-05,
        3.08924764e-01, -4.81456518e-05])
 message: 'Optimization terminated successfully.'
    nfev: 97
     nit: 8
    njev: 8
  status: 0
 success: True
       x: array([2.15998543e-17, 4.54312129e-02, 1.50290440e-02, 7.87281837e-02,
       1.77136337e-01, 2.57398502e-01, 6.03604739e-17, 3.54493409e-01,
       6.63321610e-17, 7.17833118e-02])
```

MARKOWITS OPTIMIZATION

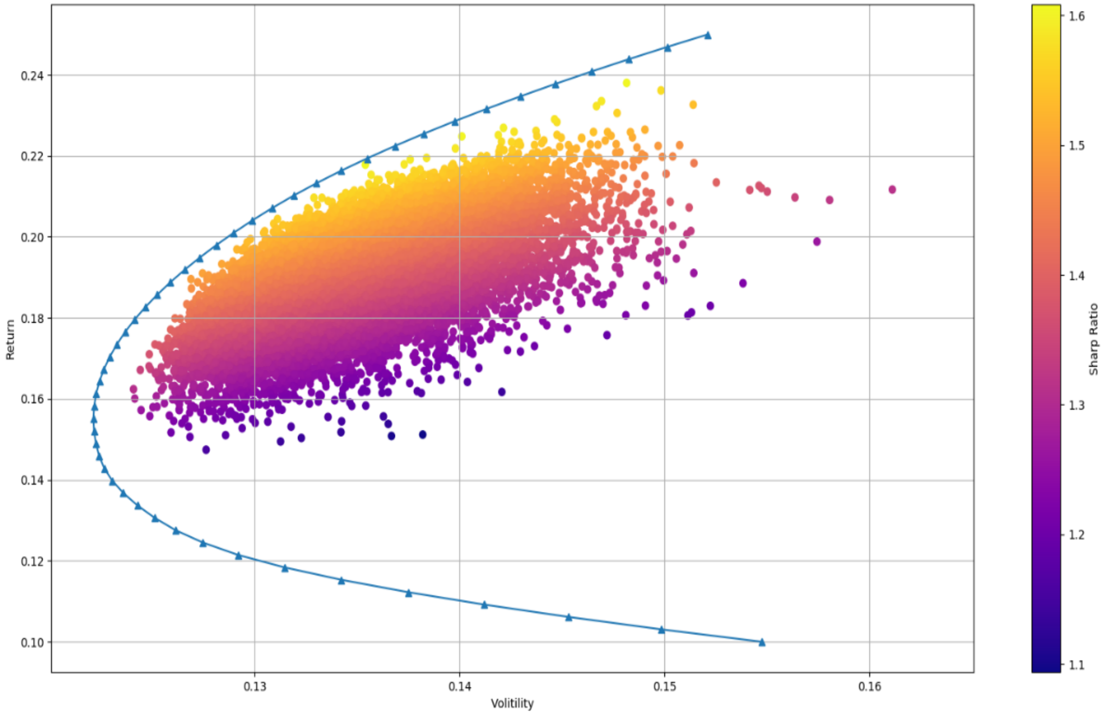


```
========================Mathematically Maximized===============================

Mathematically Maximized Sharp ratio :  1.6449962611572726
Maximum Sharpe Ratio Portfolio Allocation

                allocation
Apple                 0.00
Nike                  4.54
Intel                 1.50
Visa                  7.87
Microsoft            17.71
Home Depot           25.74
Walt Disney           0.00
Boeing Company       35.45
Pfizer Inc            0.00
J&J                   7.18

Mathematical Optimization and Efficient forointier graph generated...

=========================================================================
```

MARKOWITS OPTIMIZATION



ALL OPTIMAL PORTFOLIOS (EFFICIENT FRONTIER)



THANK YOU