```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

1. Create portfolio for the given stocks:Google, amazon and tesla for the last 10 years.

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```
pip install --upgrade pandas-datareader
```

```
Requirement already satisfied: pandas-datareader in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: pandas>=0.23 in /usr/local/lib/python3.7/dist-packages
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Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-pa
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Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-pac
```

```
from pandas_datareader import data as dr
```

```
stocks = ['TSLA', 'GOOGL','AMZN']
```

```
stock_data = pd.DataFrame()
for s in stocks:
    stock_data[s] = dr.DataReader(s, data_source = 'yahoo', start = '2012-01-01',end='2022
```

```
stock_data.head()
```

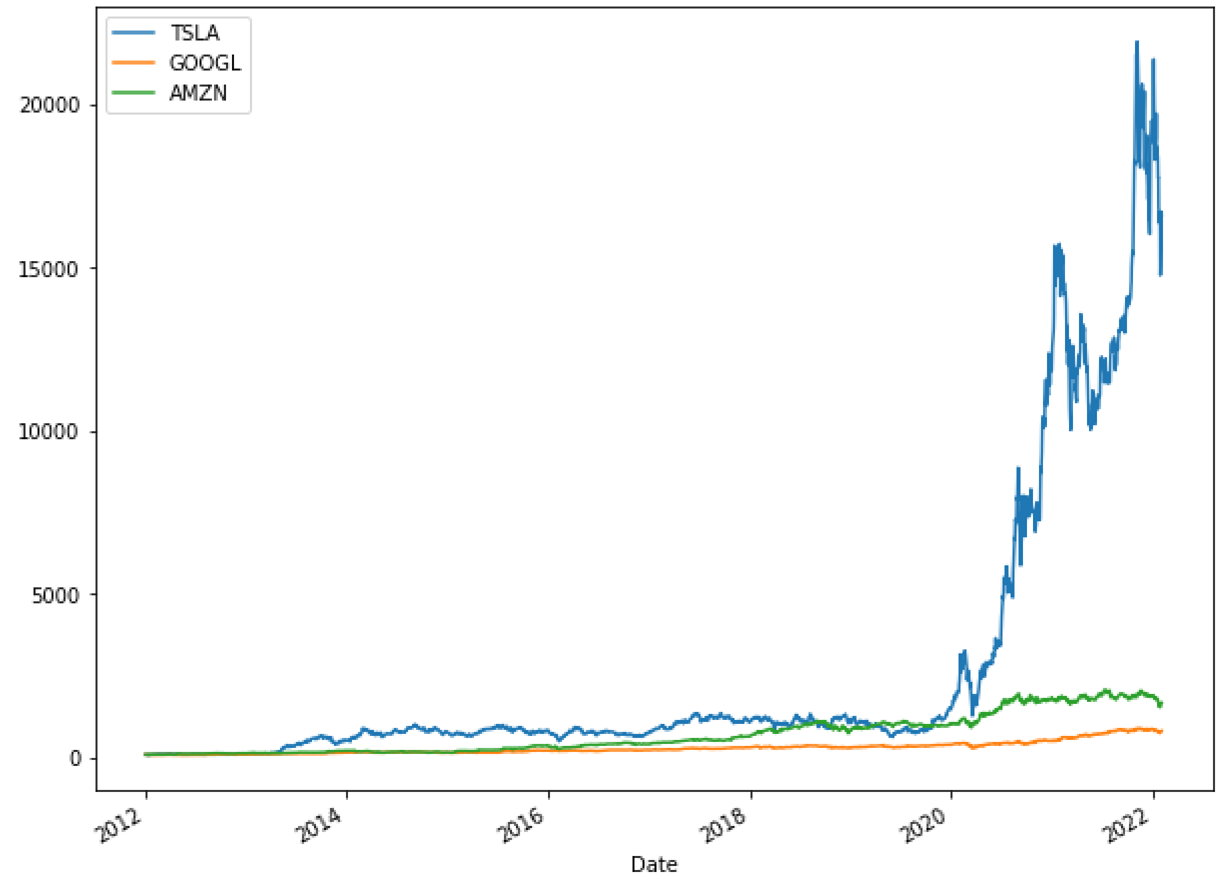
Date	TSLA	GOOGL	AMZN
2012-01-03	5.616	333.038025	179.029999
2012-01-04	5.542	334.474487	177.509995
2012-01-05	5.424	329.834839	177.610001
2012-01-06	5.382	325.335327	182.610001
2012-01-09	5.450	311.541534	178.559998

```
stock_data.tail()
```

	TSLA	GOOGL	AMZN
Date			
2022-01-26	937.409973	2584.659912	2777.449951
2022-01-27	829.099976	2580.100098	2792.750000
2022-01-28	846.349976	2667.020020	2879.560059
2022-01-31	936.719971	2706.070068	2991.469971
2022-02-01	931.250000	2752.879883	3023.870117

```
(stock_data/stock_data.iloc[0] * 100).plot(figsize = (10,8))
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8851bdd310>
```




```
logReturns = np.log(stock_data/stock_data.shift(1))
logReturns
```

	TSLA	GOOGL	AMZN
Date			
2012-01-03	NaN	NaN	NaN
2012-01-04	-0.013264	0.004304	-0.008526
2012-01-05	-0.021522	-0.013969	0.000563
2012-01-06	-0.007773	-0.013736	0.027763
2012-01-09	0.012556	-0.043324	-0.022428
...	...	...	...
2022-01-26	0.020488	0.017942	-0.007986

```
#To obtain annual average returns!
logReturns.mean() * 250
```

```
TSLA     0.503637
GOOGL    0.208134
AMZN     0.278551
dtype: float64
```

```
#To obtain annual covariance
logReturns.cov() * 250
```

	TSLA	GOOGL	AMZN
TSLA	0.308315	0.045383	0.054215
GOOGL	0.045383	0.062747	0.043819
AMZN	0.054215	0.043819	0.089977

```
stock_data.corr()
```

	TSLA	GOOGL	AMZN
TSLA	1.000000	0.896469	0.818915
GOOGL	0.896469	1.000000	0.941772
AMZN	0.818915	0.941772	1.000000

```
expectedReturn = []
standardDeviation = []
weightList0 = []
weightList1 = []
weightList2 = []

# Running simulations for finding optimum weights
for i in range(1000):
```

```
    weights = np.random.random(numberOfStocks)
    weights = weights/ weights.sum()
    weightList0.append(weights[0])
    weightList1.append(weights[1])
    weightList2.append(weights[2])
    expectedReturn.append((weights * logReturns.mean()).sum() * 250)
    standardDeviation.append(np.sqrt(np.dot(weights.T, np.dot(logReturns.cov() * 250, weig

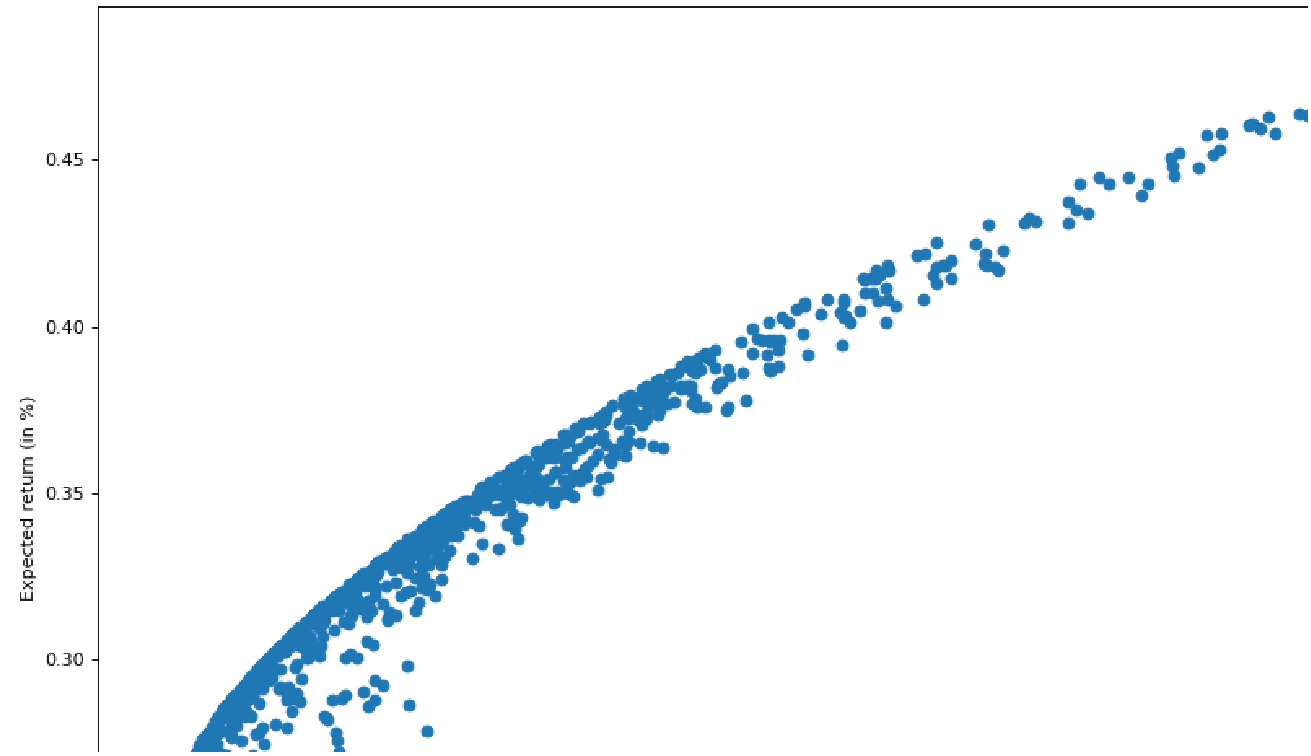
#Converting lists into arrays
weightList0 = np.array(weightList0) #Weights for PG
weightList1 = np.array(weightList1) #Weights for MSFT
weightList2 = np.array(weightList2) #Weights for MSFT
expectedReturn = np.array(expectedReturn)
standardDeviation = np.array(standardDeviation)

#Creating dataframe
df = pd.DataFrame({"Weight of TSLA": weightList0, "Weight of GOOGL": weightList1, "Weight
df.head()
```

	Weight of TSLA	Weight of GOOGL	Weight of AMZN	Expected Return	Standard deviat
0	0.418767	0.198548	0.382685	0.358829	0.318
1	0.323880	0.184555	0.491565	0.338456	0.294
2	0.561024	0.396859	0.042117	0.376884	0.362
3	0.567295	0.259496	0.173209	0.387968	0.366
4	0.398175	0.428861	0.172964	0.337976	0.304

4. Formulate the Markowitz frontier.

```
plt.figure(figsize=(14, 10), dpi=80)
plt.scatter(df["Standard deviation"], df["Expected Return"])
plt.xlabel("Standard deviation")
plt.ylabel("Expected return (in %)")
plt.show()
```



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```
df["Expected Return"].mean()
```

    0.3299432805929543

```
df["Expected Return"].sort_values().median()
```

    0.33216667745773154

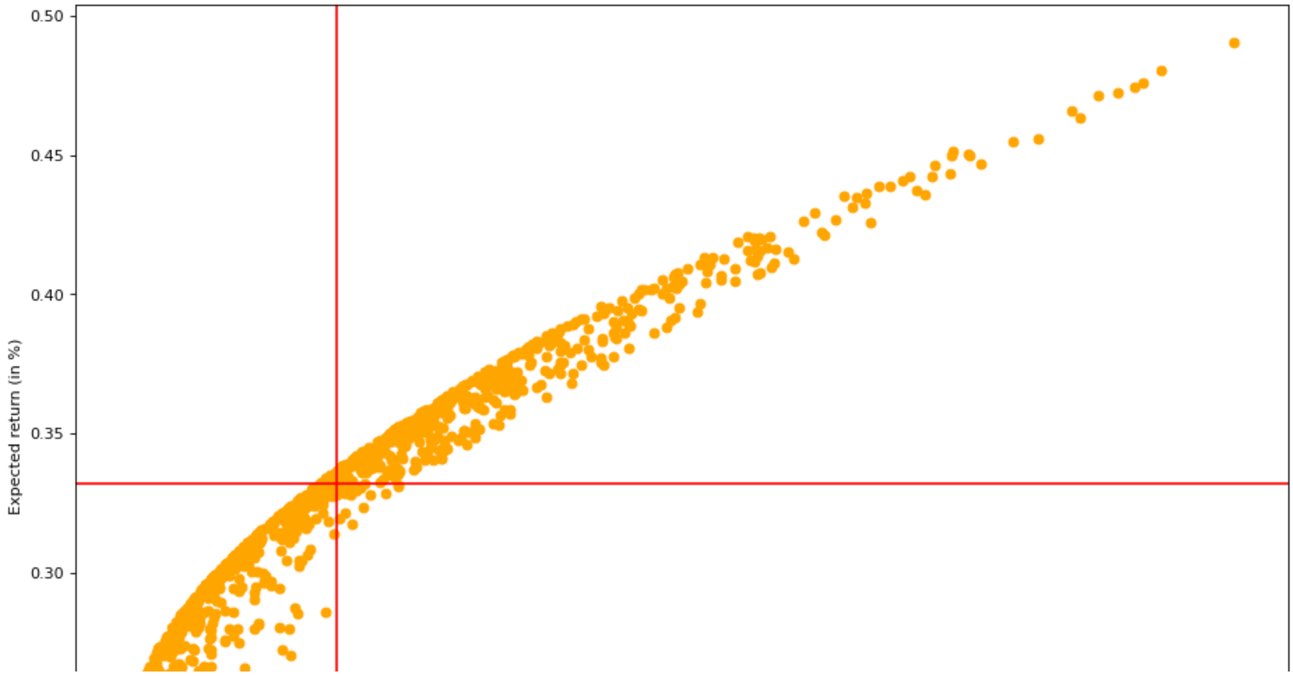
```
df[(df["Expected Return"]>0.3299432805929543) & (df["Expected Return"]< 0.3321666774577315
```

	Weight of TSLA	Weight of GOOGL	Weight of AMZN	Expected Return	Standard deviation
785	0.356957	0.380280	0.262763	0.332119	0.292950
220	0.343018	0.336718	0.320263	0.332049	0.290630
502	0.316501	0.252420	0.431078	0.332017	0.288418
223	0.302560	0.208201	0.489238	0.331992	0.288401
360	0.259136	0.070875	0.669989	0.331888	0.293364
578	0.386007	0.478025	0.135968	0.331775	0.300127
489	0.365850	0.415140	0.219011	0.331666	0.294683
763	0.411567	0.563474	0.024959	0.331511	0.309190
431	0.337581	0.328680	0.333739	0.331391	0.289546

```
df.loc[785]
```

```
Weight of TSLA         0.356957
Weight of GOOGL        0.380280
Weight of AMZN         0.262763
Expected Return        0.332119
Standard deviation     0.292950
Name: 785, dtype: float64
```

```
import matplotlib.pyplot as plt
df.reset_index()
plt.figure(figsize=(14, 10), dpi=80)
plt.scatter(df["Standard deviation"], df["Expected Return"], color='orange')
plt.xlabel("Standard deviation")
plt.ylabel("Expected return (in %)")
plt.axvline(x=0.292950,color='red') ##Mean Value
plt.axhline(y=0.332119, color='red') #Median Value
plt.show()
```




```
returns = (stock_data/stock_data.shift(1)) - 1        #calculating simple rate of return
returns.head()
```

	TSLA	GOOGL	AMZN
Date			
2012-01-03	NaN	NaN	NaN
2012-01-04	-0.013177	0.004313	-0.008490
2012-01-05	-0.021292	-0.013871	0.000563
2012-01-06	-0.007743	-0.013642	0.028152
2012-01-09	0.012635	-0.042399	-0.022178

```
weightsDifferent = np.array([0.356957,0.3802800, 0.262763])  #Note: the sum of the weights
annualReturns = returns.mean()*250
```

```
np.dot(annualReturns, weightsDifferent)   # R*WT
```

```
0.4113501013979609
```

```
portfolioDifferentWeights = str(round(np.dot(annualReturns, weightsDifferent)*100, 5)) + '
```

```
print("The cumulative return for portfolio with different weights is ", portfolioDifferent
```

```
The cumulative return for portfolio with different weights is  41.13501 %
```

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```
!pip install quandl
```

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Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/
```

```
import quandl
```

```
start = '2012-01-01'
end='2022-02-01'

TSLA=quandl.get('WIKI/TSLA.11',start_date=start,end_date=end)
GOOGL=quandl.get('WIKI/GOOGL.11',start_date=start,end_date=end)
AMZN=quandl.get('WIKI/AMZN.11',start_date=start,end_date=end)
```

```
for stock_df in (TSLA,GOOGL,AMZN):
    stock_df['Normed Return']=stock_df['Adj. Close']/stock_df.iloc[0]['Adj. Close']
```

```
for stock_df,allo in zip([TSLA,GOOGL,AMZN],[0.356957,0.3802800, 0.262763]):
    stock_df['Allocation']=stock_df['Normed Return']*allo
```

INVESTMENT

```
for stock_df in (TSLA,GOOGL,AMZN):
    stock_df['Position Values']=stock_df['Allocation']*1000000
```

```
portfolio_val=pd.concat([TSLA['Position Values'],GOOGL['Position Values'],AMZN['Position V
```

```
portfolio_val.columns=['TSLA Pos','GOOGL Pos','AMZN Pos']
```

```
portfolio_val.head()
```

	TSLA Pos	GOOGL Pos	AMZN Pos
Date			
2012-01-03	356957.000000	380280.000000	262763.000000
2012-01-04	352253.506766	381920.197172	260532.090320
2012-01-05	344753.341880	376622.417457	260678.860694
2012-01-06	342083.791667	371484.656978	268017.379378
2012-01-09	346405.920584	355734.192152	262073.179244

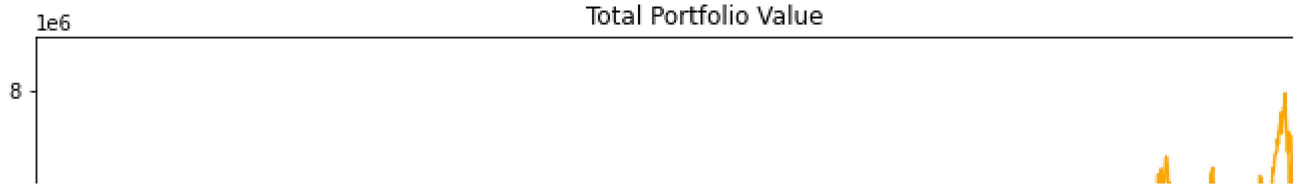
```
portfolio_val['Total Pos']=portfolio_val.sum(axis=1)
```

```
import matplotlib.pyplot as plt
%matplotlib inline
```

2. Visualize the expected returns on the 10 years series.

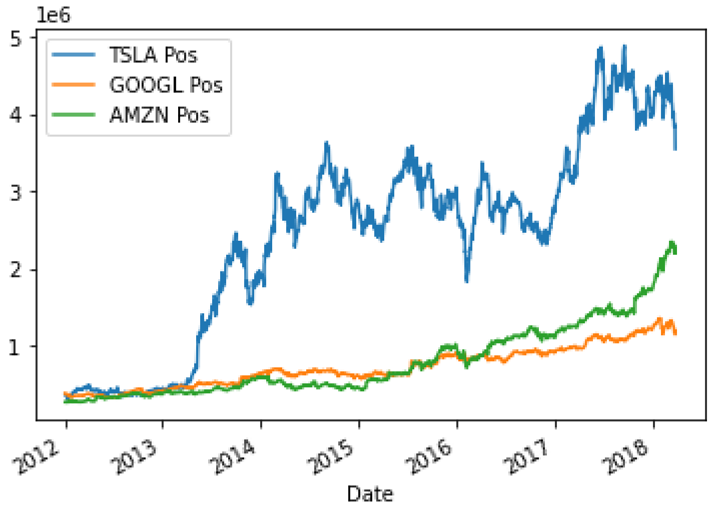
```
portfolio_val['Total Pos'].plot(figsize=(12,10),color='orange')
plt.title('Total Portfolio Value')
```

```
Text(0.5, 1.0, 'Total Portfolio Value')
```




```
portfolio_val.drop('Total Pos',axis=1).plot(kind='line')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f883caacc10>
```




```
portfolio_val['Total Pos'].pct_change(1)
```

```
Date
2012-01-03         NaN
2012-01-04   -0.005294
2012-01-05   -0.012719
2012-01-06   -0.000477
2012-01-09   -0.017698
                ...
2018-03-21    0.008923
2018-03-22   -0.025872
2018-03-23   -0.026726
2018-03-26    0.021318
2018-03-27   -0.062280
Name: Total Pos, Length: 1567, dtype: float64
```

```
portfolio_val['Daily Returns']=portfolio_val['Total Pos'].pct_change(1)
portfolio_val
```

Date	TSLA Pos	GOOGL Pos	AMZN Pos	Total Pos	Daily Returns
2012-01-03	3.569570e+05	3.802800e+05	2.627630e+05	1.000000e+06	NaN
2012-01-04	3.522535e+05	3.819202e+05	2.605321e+05	9.947058e+05	-0.005294
2012-01-05	3.447533e+05	3.766224e+05	2.606789e+05	9.820546e+05	-0.012719
2012-01-06	3.420838e+05	3.714847e+05	2.680174e+05	9.815858e+05	-0.000477
2012-01-09	3.464059e+05	3.557342e+05	2.620732e+05	9.642133e+05	-0.017698
...	...	...	...	...	...

3. Evaluate the annual daily mean, correlation, Sharpe ratio and daily standard mean.

AVG Daily Return

```
portfolio_val['Daily Returns'].mean()
```

```
0.0014690953537660981
```

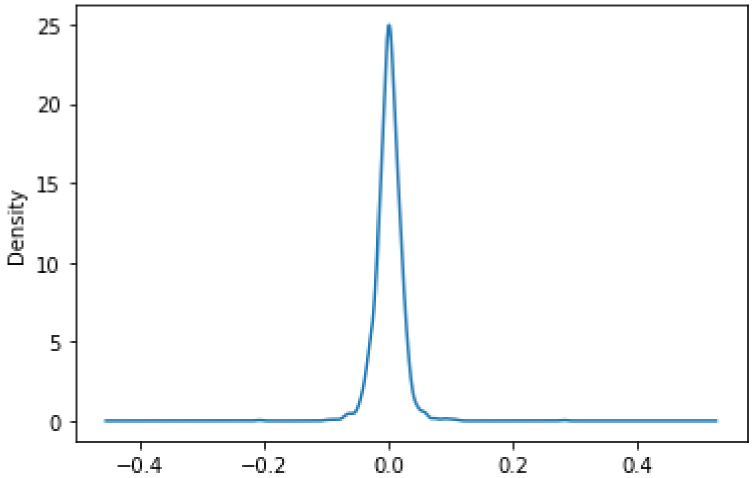
STD Daily Return

```
portfolio_val['Daily Returns'].std()
```

```
0.02179874900915436
```

```
portfolio_val['Daily Returns'].plot(kind='kde')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f883c9fa390>
```



SHARPIE Ratio

```
SR=portfolio_val['Daily Returns'].mean()/portfolio_val['Daily Returns'].std()
SR
```

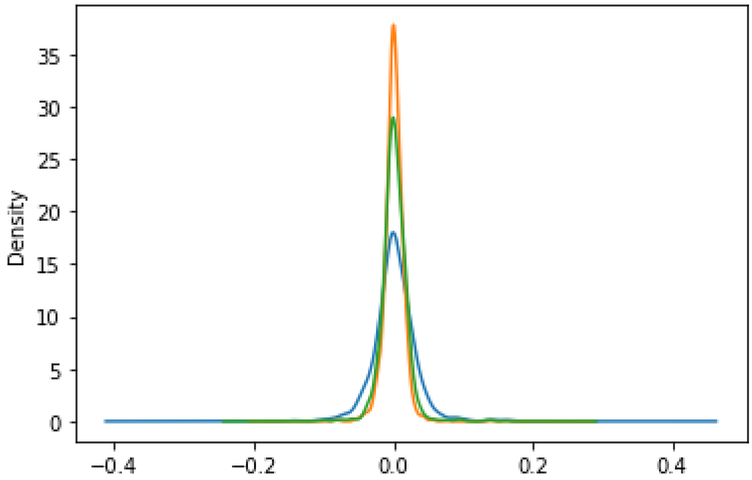
```
0.0673935624998092
```

```
ASR=(252**0.5)*SR
ASR
```

```
1.0698396380471018
```

```
TSLA['Adj. Close'].pct_change(1).plot(kind='kde')
GOOGL['Adj. Close'].pct_change(1).plot(kind='kde')
AMZN['Adj. Close'].pct_change(1).plot(kind='kde')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f883c9f1c50>
```



5. Discuss on the optimal portfolio and the different parameters evaluated for the portfolio.

To create an optimal portfolio, we evaluated parameters like, mean and median of the expected returns and then we chose the portfolio where the Expected Returns were between mean and median. An optimum portfolio is where the risk and reward ratio is less.