Week 3 Project

Question 1

In this problem, we will simulate three calculations of returns: Classic Brownian, Arithmetic, and Geometric Brownian.

1. Classical Brownian Motion

$$P_t = P_{t-1} + r_t$$

2. Arithmetic Return System

$$P_t = P_{t-1}\left(1 + r_t\right)$$

3. Log Return or Geometric Brownian Motion

$$P_t = P_{t-1}e^{r_t}$$

For each simulation, we assume $r \sim N(0, \sigma^2)$, and run 25,000 simulations to get the result below.

	Name	Mean	Std
0	Original	70.495078	11.174723
1	Classic_Brownian	70.493406	0.161613
2	Arithmetic	70.365064	11.371942
3	Geometric_Brownian	73.667078	12.010054

We can see that the Classic Brownian has the most biased standard deviation because the standard deviation of the rate of return is low, and it will remain low since it uses addition.

We can also see that the Geometric Brownian has the most biased mean because the logarithm will change the curve of the distribution.

Therefore, since the Arithmetic method has the most accurate mean and std, it is the most widely used method.

Question 2

In this question, we first implement the methods to calculate the rate of return, and we get the mean and std of the INTC stock.

```
daily_price = pd.read_csv(r'DailyPrices.csv')
daily_price = daily_price.iloc[: , 1:]
INTC = daily_price["INTC"]
INTC = INTC-INTC.mean()
```

```
ret = return_calculate('Arithmetic', INTC)
ret_mean = ret.mean()
ret_std = ret.std()
print(ret_mean)
print(ret_std)
```

```
-0.522582198776928
3.440057420436574
```

For the next part, I calculated the VaR for the whole portfolio because it makes no sense that I buy 100% of INTC stock. The calculation is based on the assumption that the weight of 101 stocks are the same.

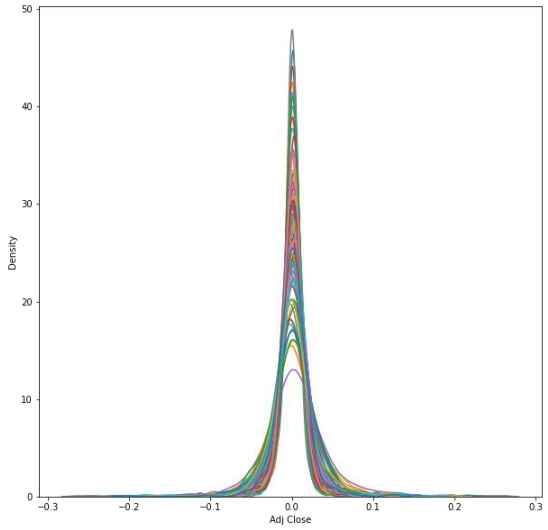
```
weights = np.full((101,1), 1/101)
```

After implement four ways to calculate the VaR, I got the result below:

	Name	VaR
0	Norm_dist	-0.012997
1	Norm_dist with EW_VAR	-0.010999
2	T_dist	-0.014601
3	Historical_sim	-0.022949

The difference is small, and we can conclude that the minimum loss on a 5% percent bad day is about 1.3%, which is reasonable because we have 101 best stocks equally distributed.

For the historical simulation, I imported the data from 1/1/2019 until 2/12/2022, and simulated through the “Adj Close”, and got the KDE plot.



Question 3

In this question, I calculated the VaR for 3 portfolio and a total portfolio using normal distribution, because since we have a lot of data and from Q2 we get that the difference between 4 methods is not significant, the normal distribution is the fastest way to get the result.

	Name	VaR
0	Port_A	-0.016521
1	Port_B	-0.015009
2	Port_C	-0.011269
3	Tot_Port	-0.013936