Problem 1

This problem is to simulate the classic brownian motion, arithmetic return, and the geometric brownian motion return processes. For this problem I chose the volatility to be 0.5, initial price to be 100, and randomly drew 10000 normal samples with mean 0 and 0.5 volatility. The mean and standard deviation and the graph of each simulation are shown below.

	Mean	Standard Deviation
Classic Brownian Motion	99.999	0.5017
Arithmetic Return	99.893	50.1706
Geometric Brownian Motion	4.604	0.5017

Table 1: Statistics for Simulated Return Process

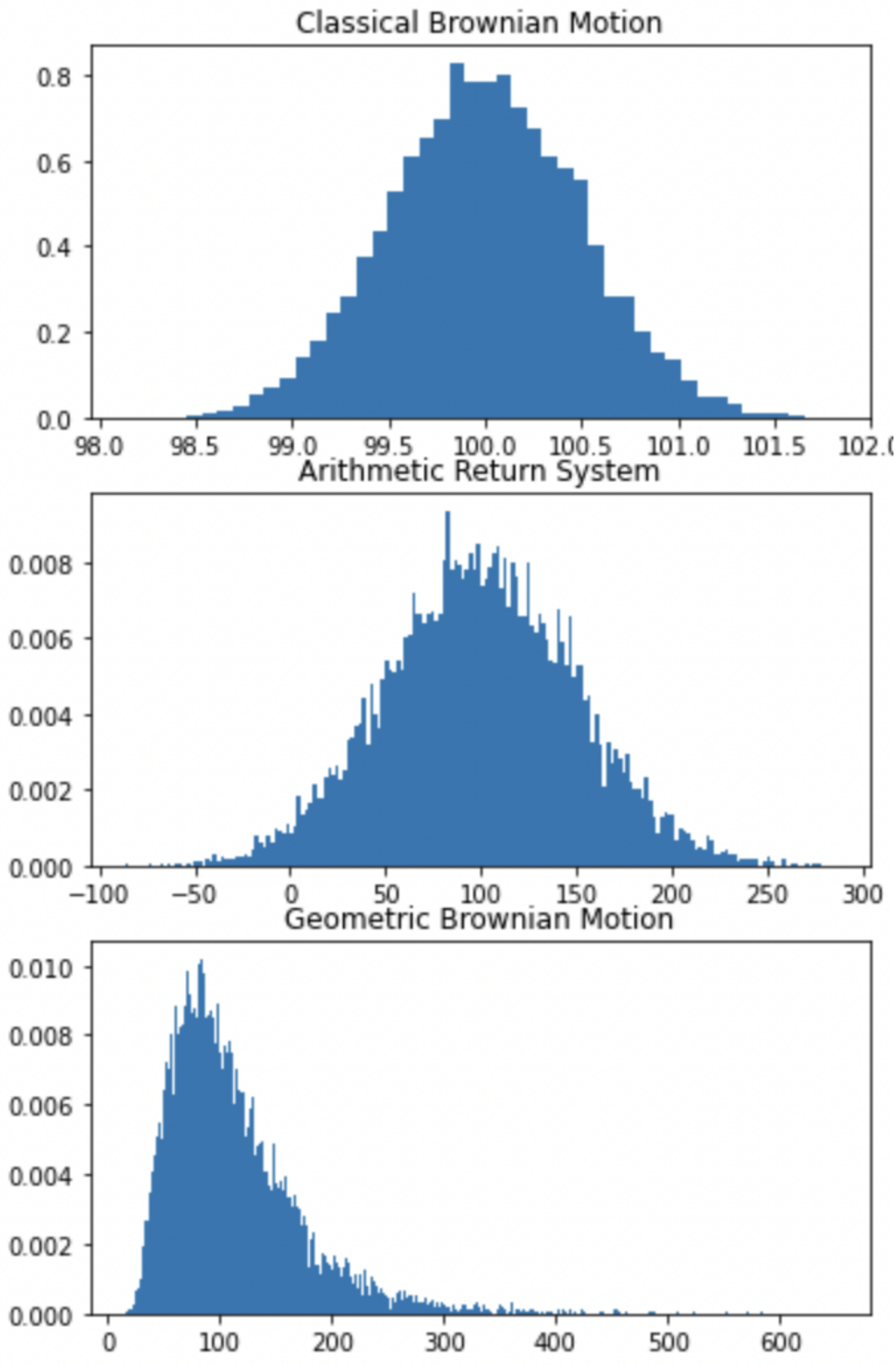


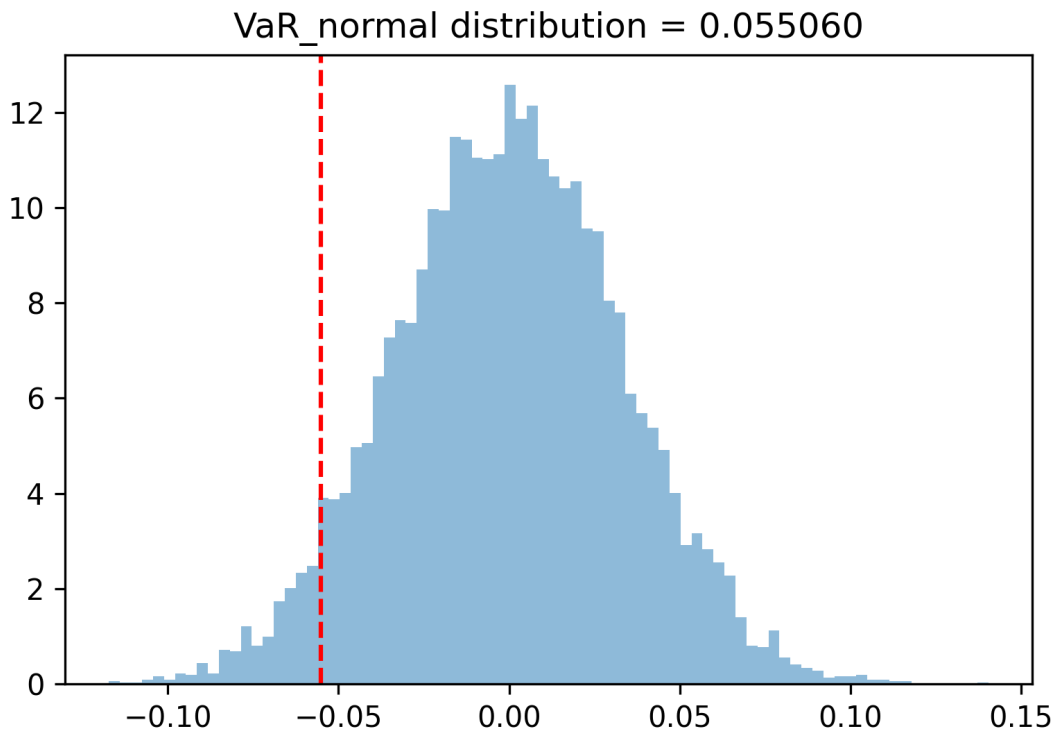
Figure 1: Simulated Return Process

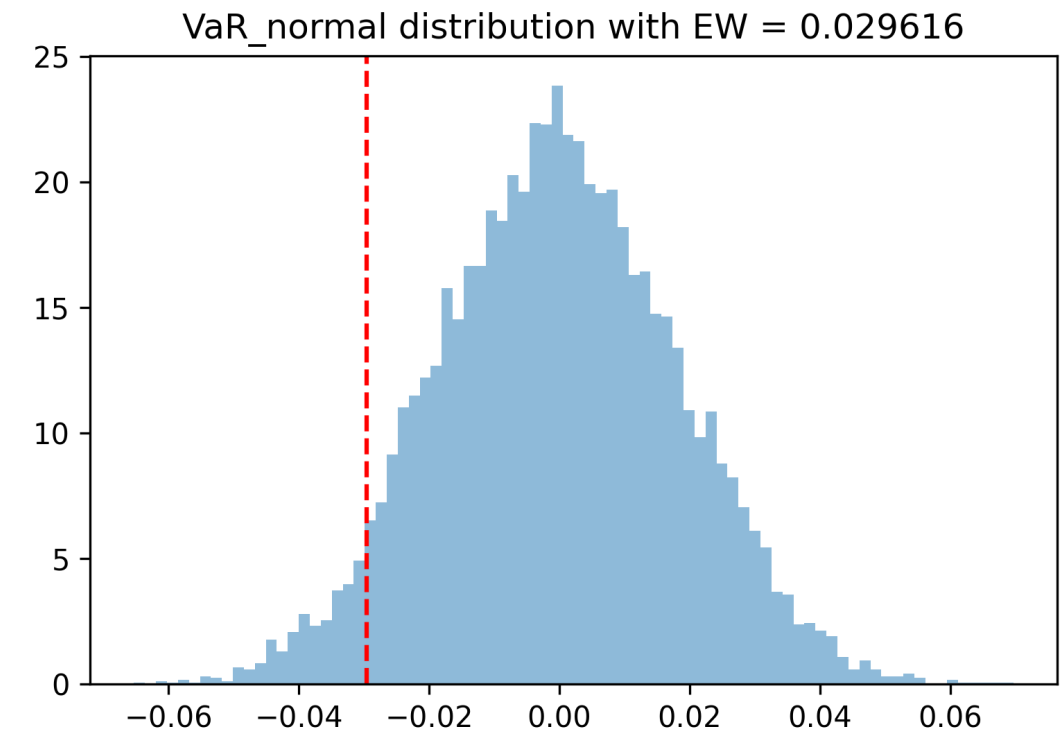
Problem 2

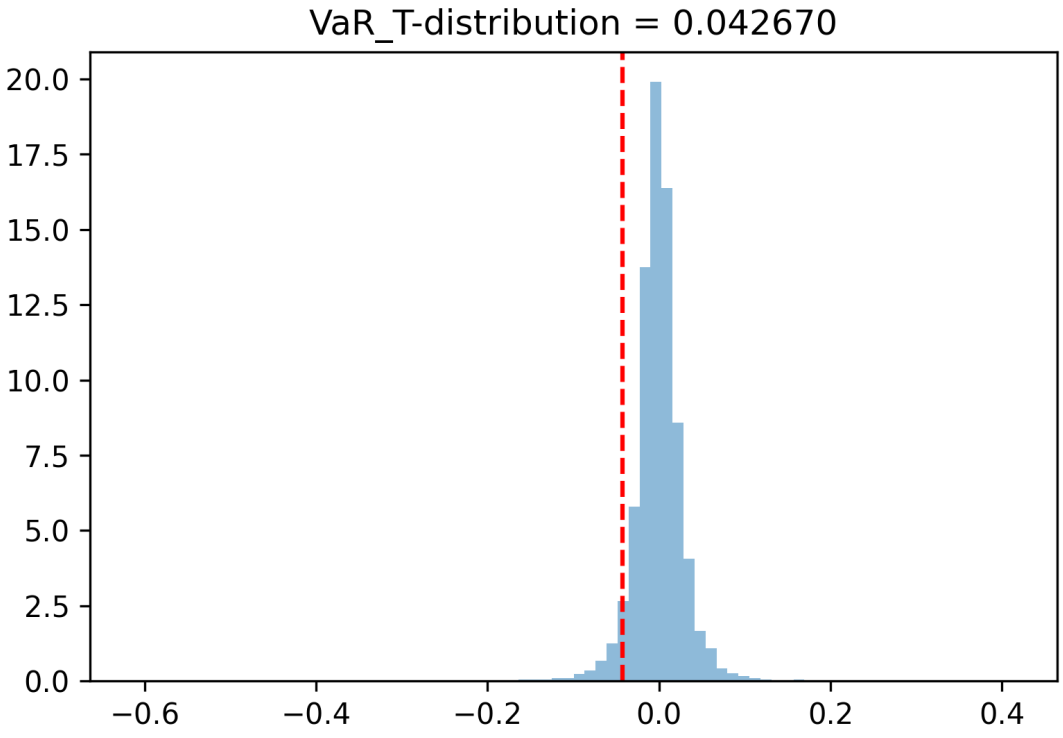
This problem is to use the META stock prices and returns to calculate five types of VaRs. The META stock prices are mean-centered and the 1-day lagged return rate is calculated. Then the five types of VaRs are calculated and are summarized in the following table, so are the graphs.

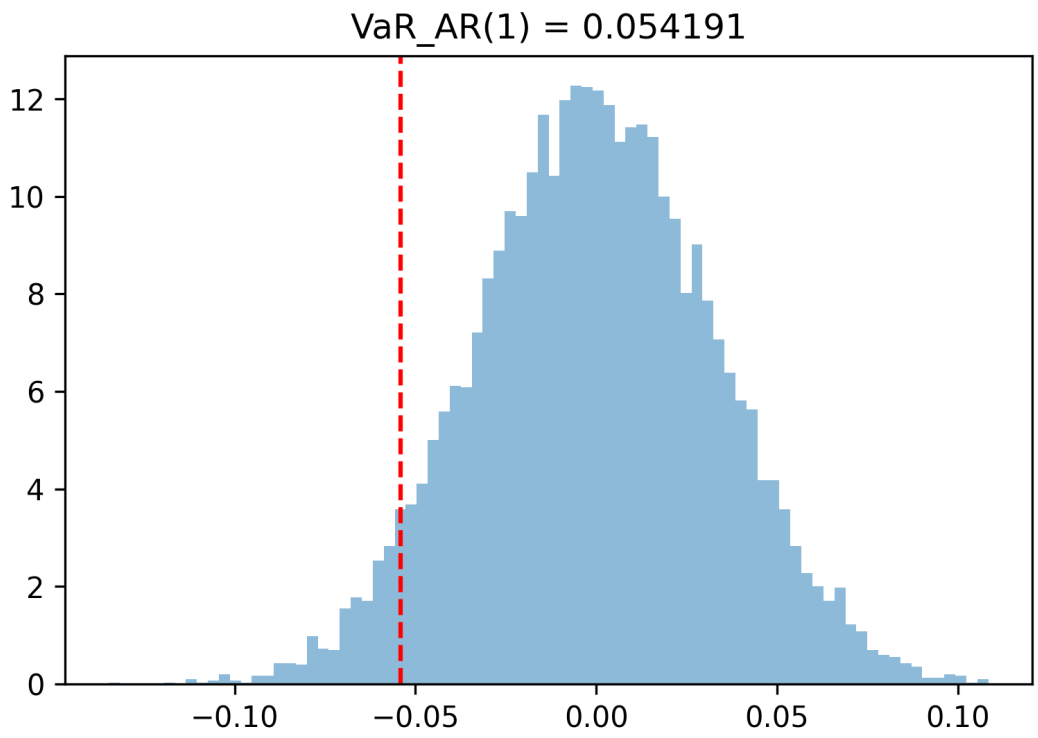
	VaR
Normal Distribution	5.51%
Normal Distribution with Exponentially Weighted Variances (lambda = 0.94)	2.96%
MLE Fitted T Distribution	4.27%
Fitted AR(1) Model	5.42%
Historical VaR	3.95%

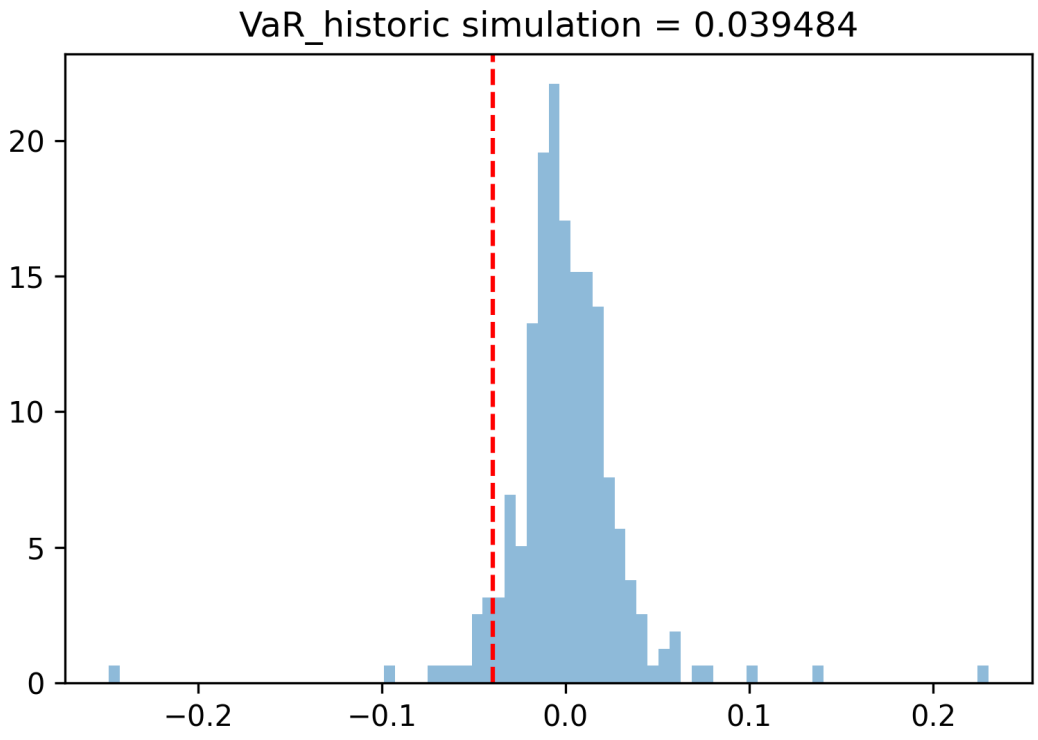
Table 2: Different Types of VaRs for META Stocks




VaR_normal distribution with EW = 0.029616
25
20
15
10
5
0
−0.06
−0.04
−0.02
0.00
0.02
0.04
0.06


VaR_T-distribution = 0.042670
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−0.6
−0.4
−0.2
0.0
0.2
0.4


VaR_AR(1) = 0.054191
12
10
8
6
4
2
0
−0.10
−0.05
0.00
0.05
0.10


VaR_historic simulation = 0.039484
20
15
10
5
0
−0.2
−0.1
0.0
0.1
0.2

From the results we can see that the VaR obtained from the normal distribution simulations (both classic normal and exponentially weighted variance) and AR(1) model are higher than the other two methods. This could be because the returns from simulated T-distribution and historical data are more centered and have a higher kurtosis.

Problem 3

This problem is to calculate the portfolio VaR for each of the given portfolios using both discrete and logarithm calculation for returns. The portfolio data consists of the portfolio name (A, B, or C), the stock included in the portfolio and the number of holdings of the stock. To compute the VaR, I used the daily prices data to extract the price for each stock in the corresponding portfolio, multiplied by the number of holding to obtain the present value, and finally divided by the total present value of the specific portfolio to get the weight of each stock in the portfolio in terms of the value. Finally, the exponentially weighted volatility and the historical method are used to calculate two types of VaRs.

	Portfolio A	Portfolio B	Portfolio C	Total
Exp Weighted Normal	1221192.8158	311765.6510	1432179.1876	2965137.6545
Historical VaR	290230.6066	168863.0105	673778.5791	1132872.1962

Table 3: VaR of Portfolios Under Two Return Measurement

The exponentially weighted normal VaR is in general much higher than the historical VaR. I think it’s because the historical VaR is calculated using merely on the past information that’s hugely different from a exponentially weighted normal simulation.