HW3

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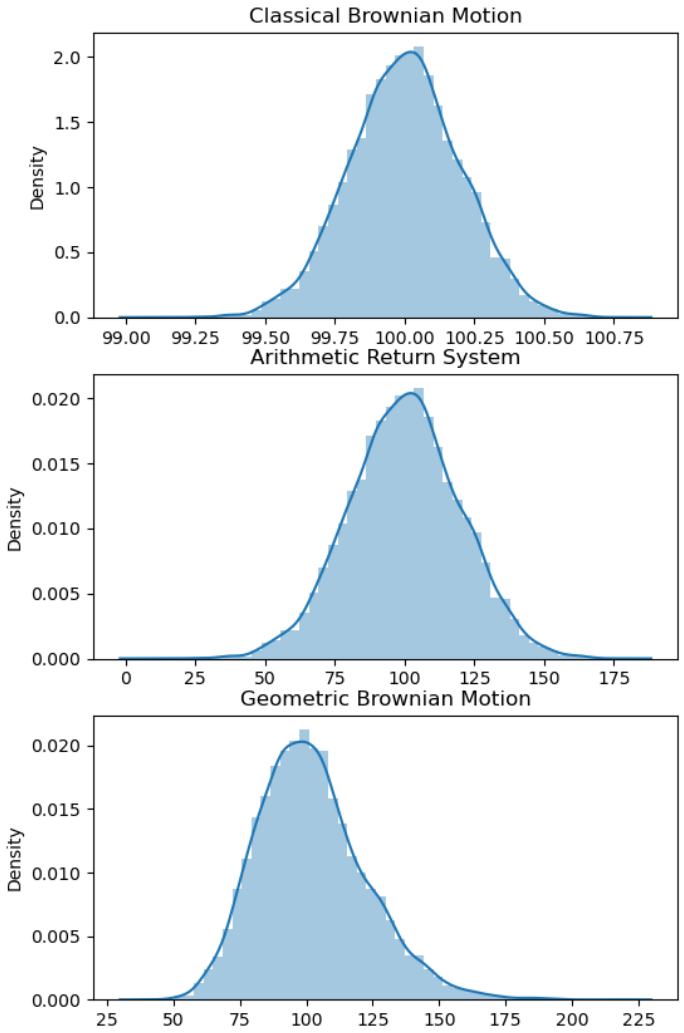
JT393

Problem 1

- **Question:**
- Calculate and compare the expected value and standard deviation of price at time t P , given t ( ) each of the 3 types of price returns, assuming r . Simulate each return equation $t \sim N$ 0, σ 2 ( ) using r and show the mean and standard deviation match your expectations.



Problem 1

- **Ans:**
- In this case, I assumes sigma = 0.2 and price_0 = 100.
- As what we can see, the actual number is very close to the expected value of mean and standard deviation.

Classical Brownian Motion: Mean = 100.00186644195438, Std Dev = 0.1990203973662266, theoretically_value = 100, theoretically_std = 0.2

Arithmetic Return System: Mean = 100.18664419543774, Std Dev = 19.902039736622662, theoretically_value = 100, theoretically_std = 20.0

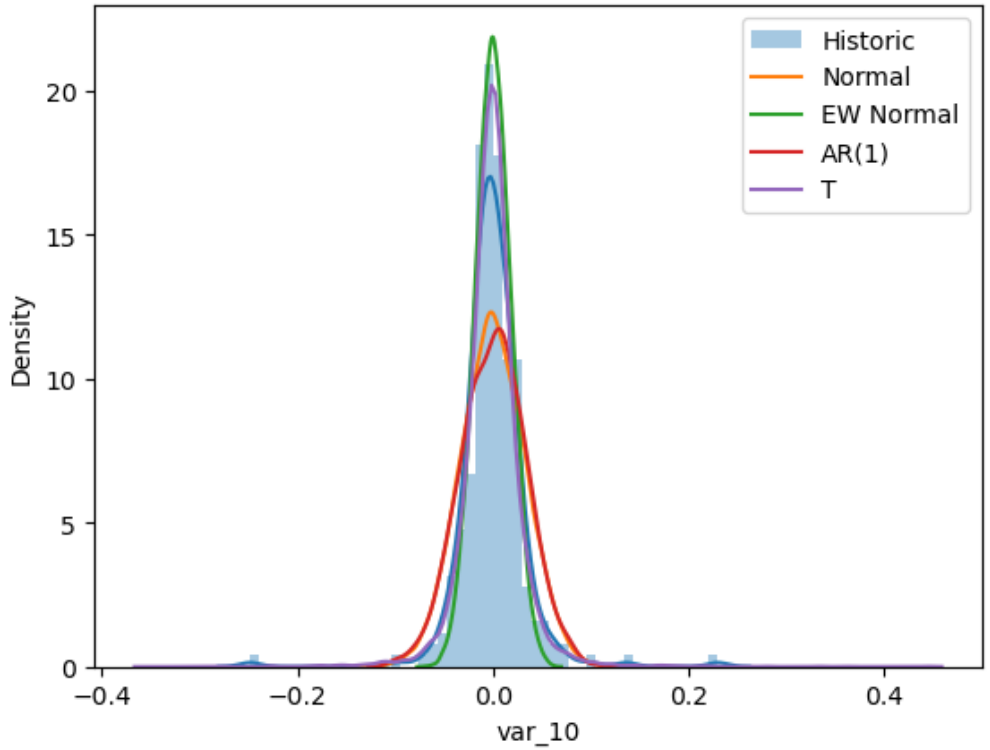
Log Return (Geometric Brownian Motion): Mean = 102.189409343997, Std Dev = 20.525731088730932, theoretically_value = 102.02013400267558, theoretically_std = 20.609777651049587

Problem 2

- **Question:**
- Implement a function similar to the “return_calculate()” in this week’s code. Allow the user to specify the method of return calculation. Use DailyPrices.csv.
- Calculate the arithmetic returns for all prices. Remove the mean from the series so that the mean(META)=0 Calculate VaR
- 1. Using a normal distribution.
- 2. Using a normal distribution with an Exponentially Weighted variance ($\lambda = 0.94$)
- 3. Using a MLE fitted T distribution.
- 4. Using a fitted AR(1) model.
- 5. Using a Historic Simulation.
- Compare the 5 values.

Problem 2

- **Ans:** As we can see, normal distribution with an Exponentially Weighted variance can best describe the data.




```
Normal distribution: 0.05476901350462931
Normal distribution(with ewv): 0.030560832544206933
T distribution: 0.0431554855341995
AR(1) model: 0.054645034268075
Historic Simulation: 0.03948424995533789
```

Problem 3

- **Question:**
- Using Portfolio.csv and DailyPrices.csv. Assume the expected return on all stocks is 0. This file contains the stock holdings of 3 portfolios. You own each of these portfolios. Using an exponentially weighted covariance with lambda = 0.94, calculate the VaR of each portfolio as well as your total VaR (VaR of the total holdings). Express VaR as a $.
- Discuss your methods and your results.
- Choose a different model for returns and calculate VaR again. Why did you choose that model? How did the model change affect the results?

Problem 3

- **Ans:**
- I used Shapiro-Wilks test on the data to check if the percentage of stocks follow normal distribution so that I can determine if normal distribution can be assumed and use corresponding methods.
- However, I find out that percentages of normally distributed returns for each portfolio are all around 5%, which is not enough. So, we shouldn’t choose methods that based on assumption of normal distribution.

Problem 3

- **Historic VaR:**

```
Portfolio A: 16987.478467068402
Portfolio B: 10980.358676761738
Portfolio C: 22143.33464394696
Portfolio Total: 47461.54180059675
```

The reason why I choose historic method is that it is a practical way to solve problem when the other methods are not working even though there is no exactly the same history. Since using a KDE to smooth the VaR estimation is highly recommended, I also tried to use KDE method as well. The model change did not affect much of the results.

Historic VaR smoothed by KDE:

```
Portfolio A: 18971.409620089922
Portfolio B: 11658.000403395738
Portfolio C: 24127.74499538215
Portfolio Total: 51558.929609780665
```