Week05 Project Report

Problem 1

Problem

Use the data in problem1.csv. Fit a Normal Distribution and a Generalized T distribution to this data. Calculate the VaR and ES for both fitted distributions.

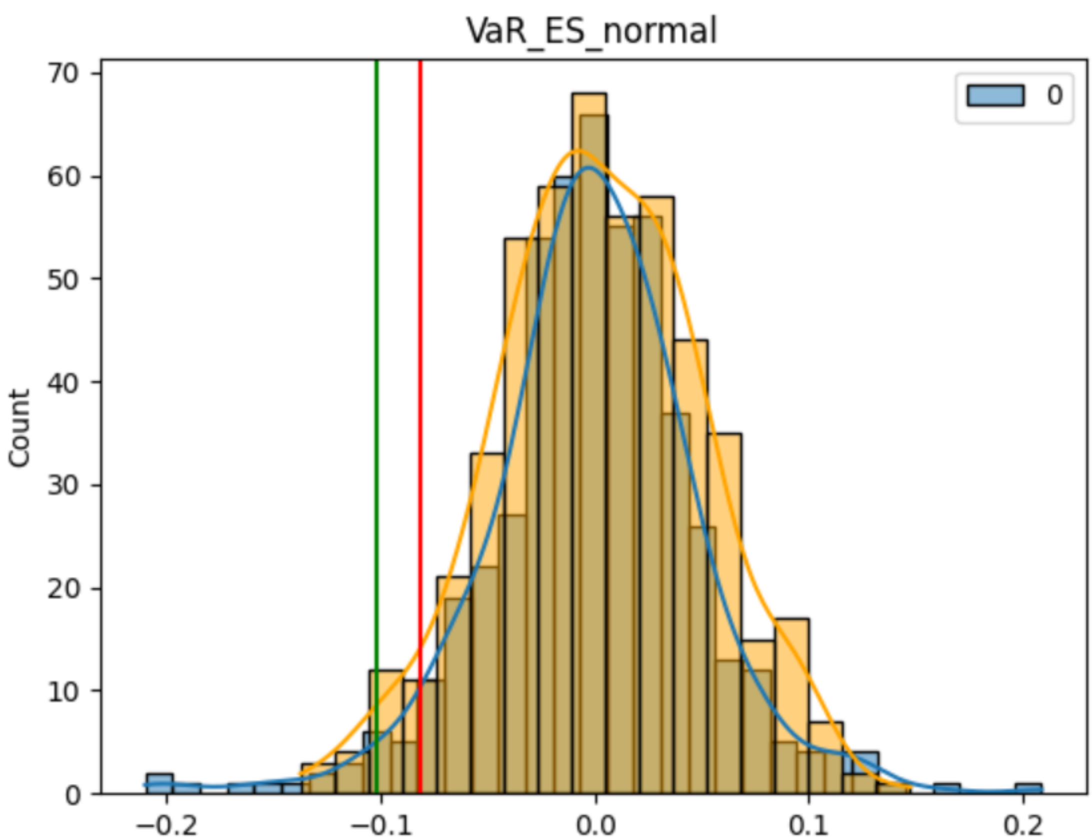
Overlay the graphs the distribution PDFs, VaR, and ES values. What do you notice? Explain the differences.

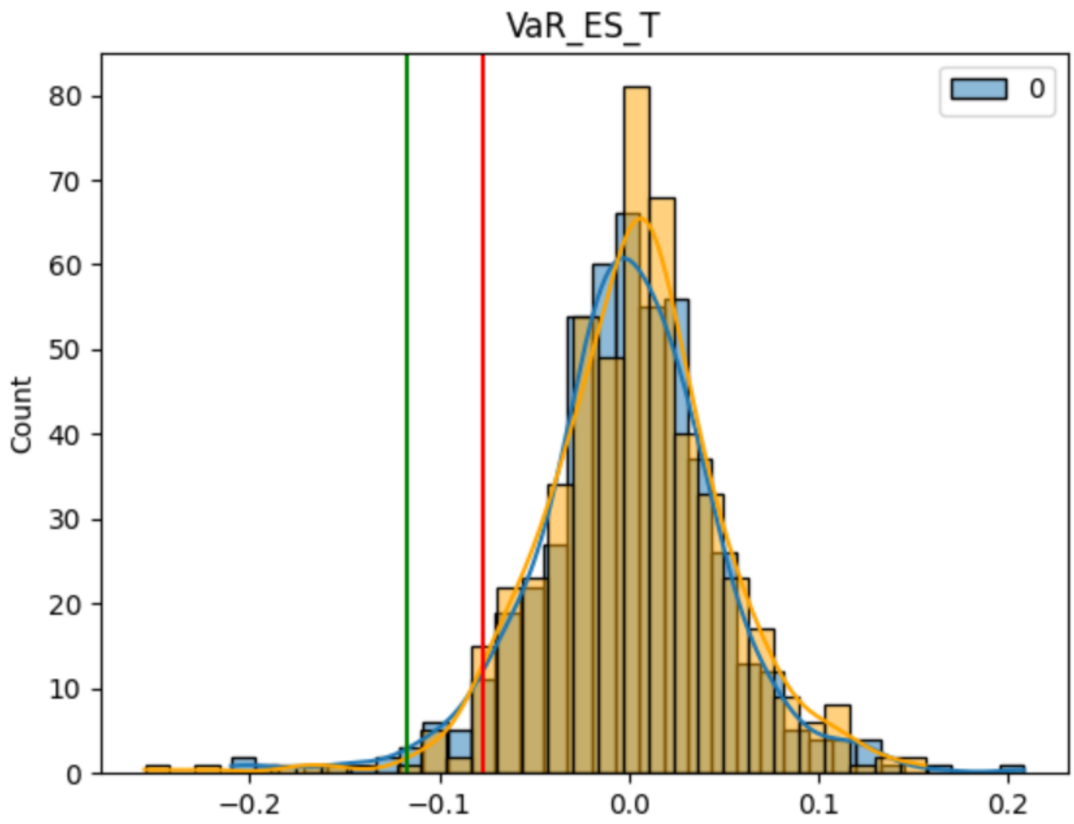
Answer

Calculate the VaR and ES for fitted Normal Distribution and a Generalized T Distribution, $\alpha = 0.05$.

	fitted Normal Distribution	Generalized T Distribution
VaR	8.1255%	10.3308%
ES	7.6476%	11.7208%

Here are the graphs of the distribution, VaR and ES values. The blue one is the original distribution, the orange is the fitted distribution, the red line is the VaR and the green line is the ES value.





It's obvious that the Generalized T Distribution fits the data better. Because it shows a fatter tail which fits the outliers of the data better. The normal distribution fitted data is more centered, with smaller kurtosis, which has higher peak than the real data.

The ES for Generalized T distribution is larger(by positive value), which means that the estimated risk should be higher than Normal Distribution one. It shows that the average of the left tail of the distribution is fatter, which resonates with the property of T distribution compared with the Normal Distribution.

When $\alpha = 0.05$, there is no quite big difference between the two VaR, the VaR for normal distribution fitted data is still smaller because the normal distribution is more centered, without outliers. If $\alpha = 0.01$, the VaR and ES of T distribution fitted data should be even larger, and the difference between the results obtained from the two distributions should be larger.

Problem 2

Problem

In your main repository, create a Library for risk management. Create modules, classes, packages, etc as you see fit. Include all the functionality we have discussed so far in class. Make sure it includes

1. Covariance estimation techniques.
2. Non PSD fixes for correlation matrices
3. Simulation Methods
4. VaR calculation methods (all discussed)
5. ES calculation

Create a test suite and show that each function performs as expected.

Answer

To create a Library, I used a file directory named `RiskMgmt` in my main repository, it contains `CovEstimation.py`, `NonPSDFix.py`, `Simulation.py`, `VaR.py` and `ES.py` , including all the functionality we have discussed so far. I also included functions like `return_calculte()`.

To test the library, I used five test suites written in `problem2.py`, which imported the modules in the `RiskMgmt` directory to finish the tests. Here are my samples of my results.

```
Standard Pearson covariance
[[7.84558898e-05 9.17763370e-05 1.01017869e-04 ... 1.20300592e-04
  8.61989926e-05 8.51534216e-05]
 [9.17763370e-05 2.57456530e-04 1.55775637e-04 ... 9.33624920e-05
  4.35999851e-05 7.83882823e-05]
 [1.01017869e-04 1.55775637e-04 2.54799921e-04 ... 7.14482749e-05
  2.49406759e-05 6.57722319e-05]
 ...
 [1.20300592e-04 9.33624920e-05 7.14482749e-05 ... 7.29692544e-04
  2.36122957e-04 1.94335713e-04]
 [8.61989926e-05 4.35999851e-05 2.49406759e-05 ... 2.36122957e-04
  3.01351185e-04 9.37728651e-05]
 [8.51534216e-05 7.83882823e-05 6.57722319e-05 ... 1.94335713e-04
  9.37728651e-05 2.77427464e-04]]
```

```
Exponentially Weighted covariance
[[8.41106879e-05 1.06945661e-04 1.21760868e-04 ... 1.25484459e-04
  8.11331553e-05 8.61130378e-05]
 [1.06945661e-04 2.68752310e-04 1.97531666e-04 ... 1.15658766e-04
  3.74977535e-05 8.22220867e-05]
 [1.21760868e-04 1.97531666e-04 2.91157501e-04 ... 8.30278938e-05
  3.31844931e-05 7.34713763e-05]
 ...
 [1.25484459e-04 1.15658766e-04 8.30278938e-05 ... 7.47889237e-04
  2.68371116e-04 2.00639597e-04]
 [8.11331553e-05 3.74977535e-05 3.31844931e-05 ... 2.68371116e-04
  3.08241684e-04 8.21009552e-05]
 [8.61130378e-05 8.22220867e-05 7.34713763e-05 ... 2.00639597e-04
  8.21009552e-05 2.62692776e-04]]
```

```
Original matrix is not psd
Near PSD matrix is psd
Higham PSD matrix is psd
```

```
VaR_Normal:  0.08037500222061399
VaR_Normal_exp_weighted:  0.09028951366738858
VaR_t_mle:  0.08014829618721435
VaR_AR_1:  0.07801637463732039
VaR_hist:  0.08357546777328072
ES_Normal:  0.10194756593293458
ES_T:  0.15122584336127903
```

Problem 3

Problem

Problem 3: Use your repository from #2.

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.

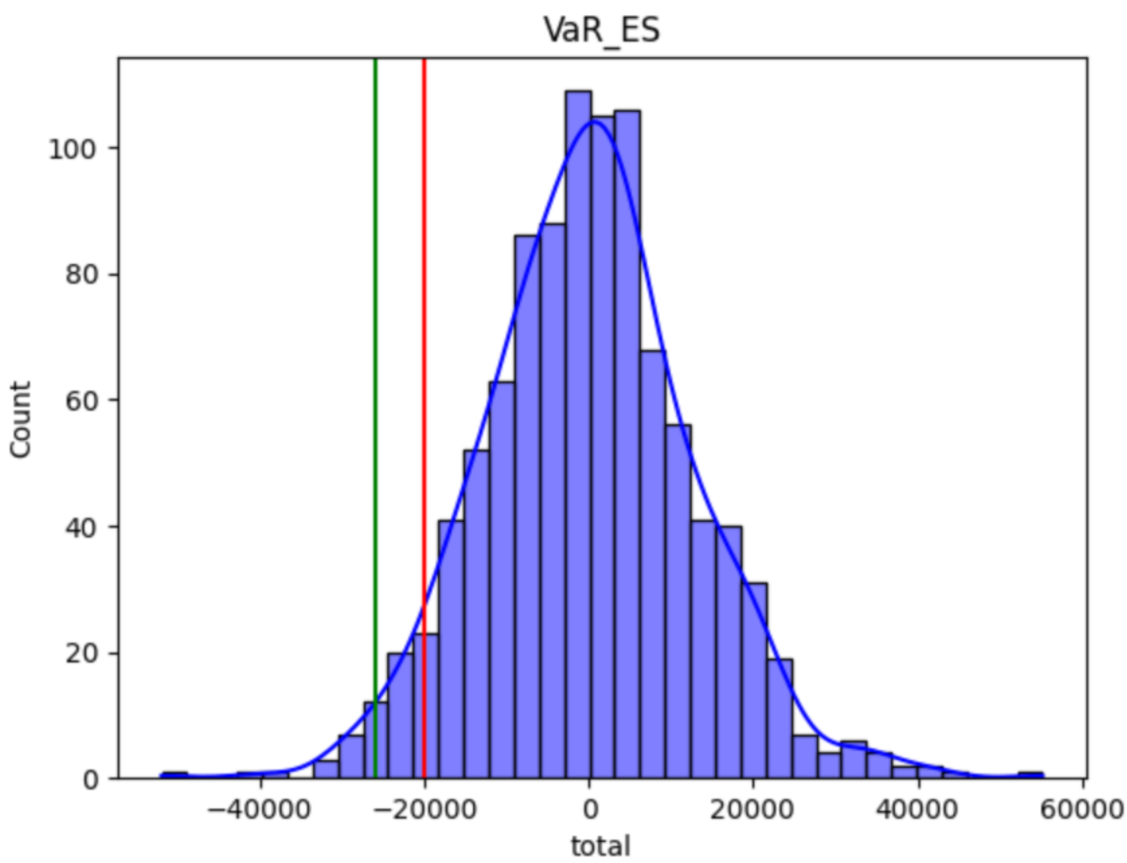
Fit a Generalized T model to each stock and calculate the VaR and ES of each portfolio as well as your total VaR and ES. Compare the results from this to your VaR form Problem 3 from Week 4

Answer

Fit a Generalized T Distribution to the arithmetic returns of each stock. I used Copulas to fit the stock returns to a generalized T distribution, with `nsim=1000`.

I used the 1000 simulated returns and the current price of the stocks to get new prices and P&L to calculate the VaR and ES of each 3 portfolio and the total 3 portfolios. Here are my results and graph.

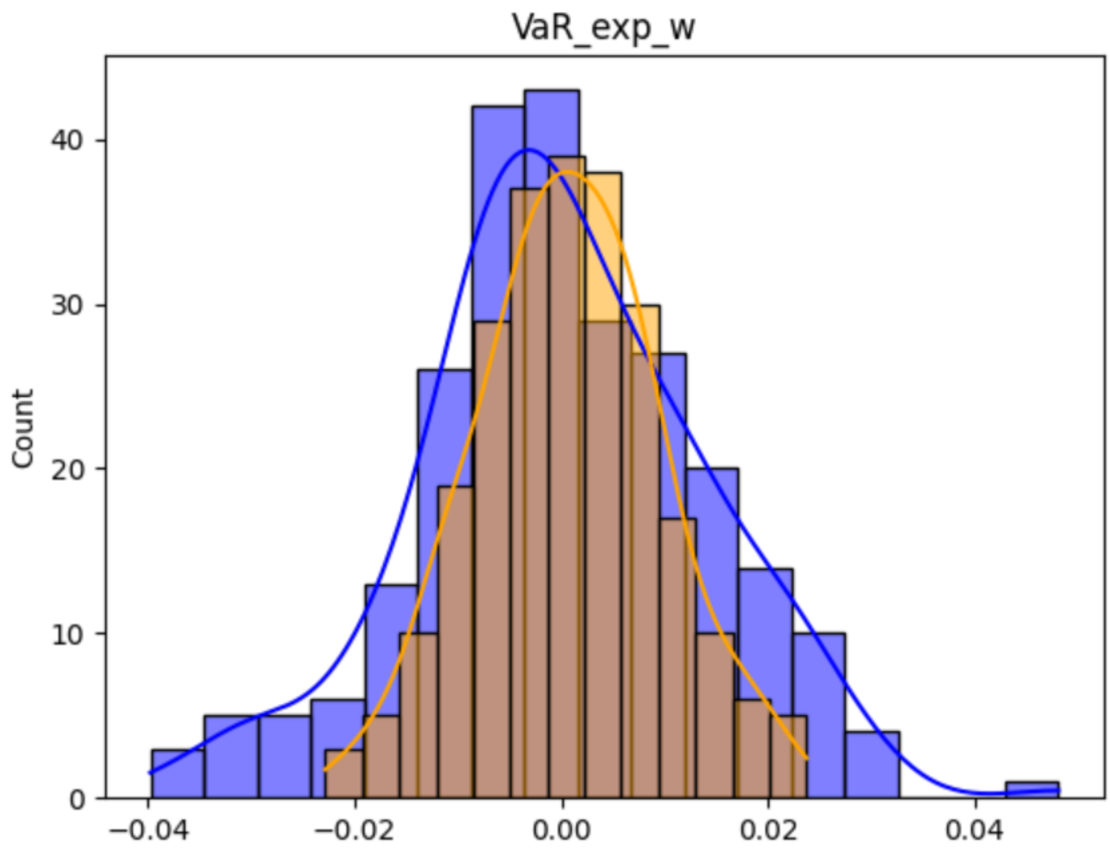
	Portfolio A	Portfolio B	Portfolio C	Portfolio A+B+C
VaR	$7905.01	$6568.74	$5405.48	$19855.03
ES	$10734.72	$9155.72	$7617.57	$27189.60



Compare with problem3 from week 4 with the normal distribution using exponentially weighted ($\lambda = 0.94$) method.

	Portfolio A	Portfolio B	Portfolio C	Portfolio A+B+C

	Portfolio A	Portfolio B	Portfolio C	Portfolio A+B+C
VaR	1.868241%	1.485023%	1.388189%	1.543658%
$	5603.79	4371.69	3748.70	13343.05



Generalized T distribution fits the data well, displaying the outliers of the return data, and the shape of the curve is close to the original return. Normal distribution is still centered, with much smaller excess kurtosis, and does not show the tail of the data well. Therefore, the VaR and ES calculated by fitted Normal Distribution data is underestimated.

Last week, I also tried log returns with AR(1) model, which fits the data best in all the models.

	Portfolio A	Portfolio B	Portfolio C	Portfolio A+B+C
VaR	2.618736%	2.169598%	2.028810%	2.246988%
$	7854.90	6386.98	5478.65	19422.48

It fits the tail very well and the fitted distribution is smoother than other models. We can see that the VaR is closer to the one I calculated using the simulated returns of Generalized T Distribution this week. When the value of the returns and prices gets larger, the difference of results among the models should be larger, Normal Distribution fitted data will performs worse than generalized T simulation and AR models.