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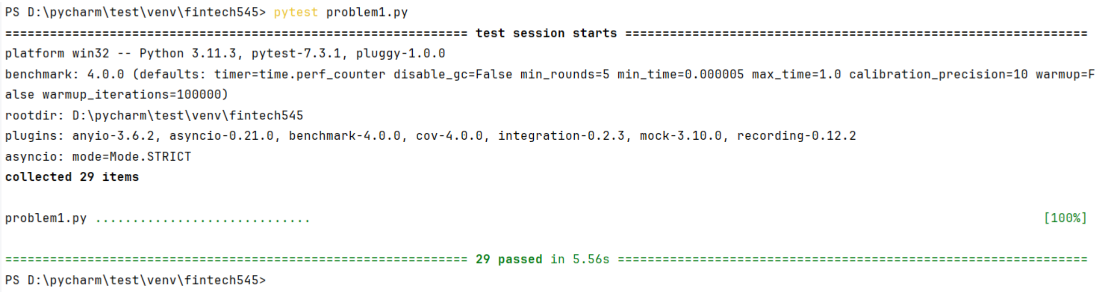
Prob1

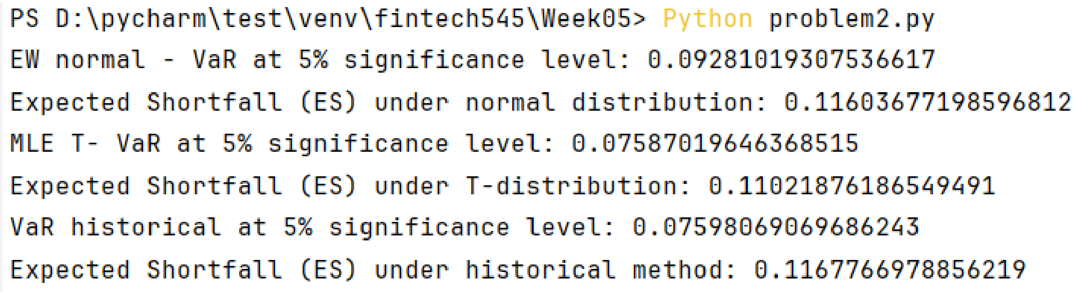


```
PS D:\pycharm\test\venv\fintech545> pytest problem1.py
============================================================= test session starts =============================================================
platform win32 -- Python 3.11.3, pytest-7.3.1, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 warmup=F
alse warmup_iterations=100000)
rootdir: D:\pycharm\test\venv\fintech545
plugins: anyio-3.6.2, asyncio-0.21.0, benchmark-4.0.0, cov-4.0.0, integration-0.2.3, mock-3.10.0, recording-0.12.2
asyncio: mode=Mode.STRICT
collected 29 items

problem1.py .............................                                                                                                  [100%]

============================================================= 29 passed in 5.56s ==============================================================
PS D:\pycharm\test\venv\fintech545>
```

This shows all the 29 tests have passed with pytest.

Prob2

With the following output,



```
PS D:\pycharm\test\venv\fintech545\Week05> Python problem2.py
EW normal - VaR at 5% significance level: 0.09281019307536617
Expected Shortfall (ES) under normal distribution: 0.11603677198596812
MLE T- VaR at 5% significance level: 0.07587019646368515
Expected Shortfall (ES) under T-distribution: 0.11021876186549491
VaR historical at 5% significance level: 0.07598069069686243
Expected Shortfall (ES) under historical method: 0.1167766978856219
```

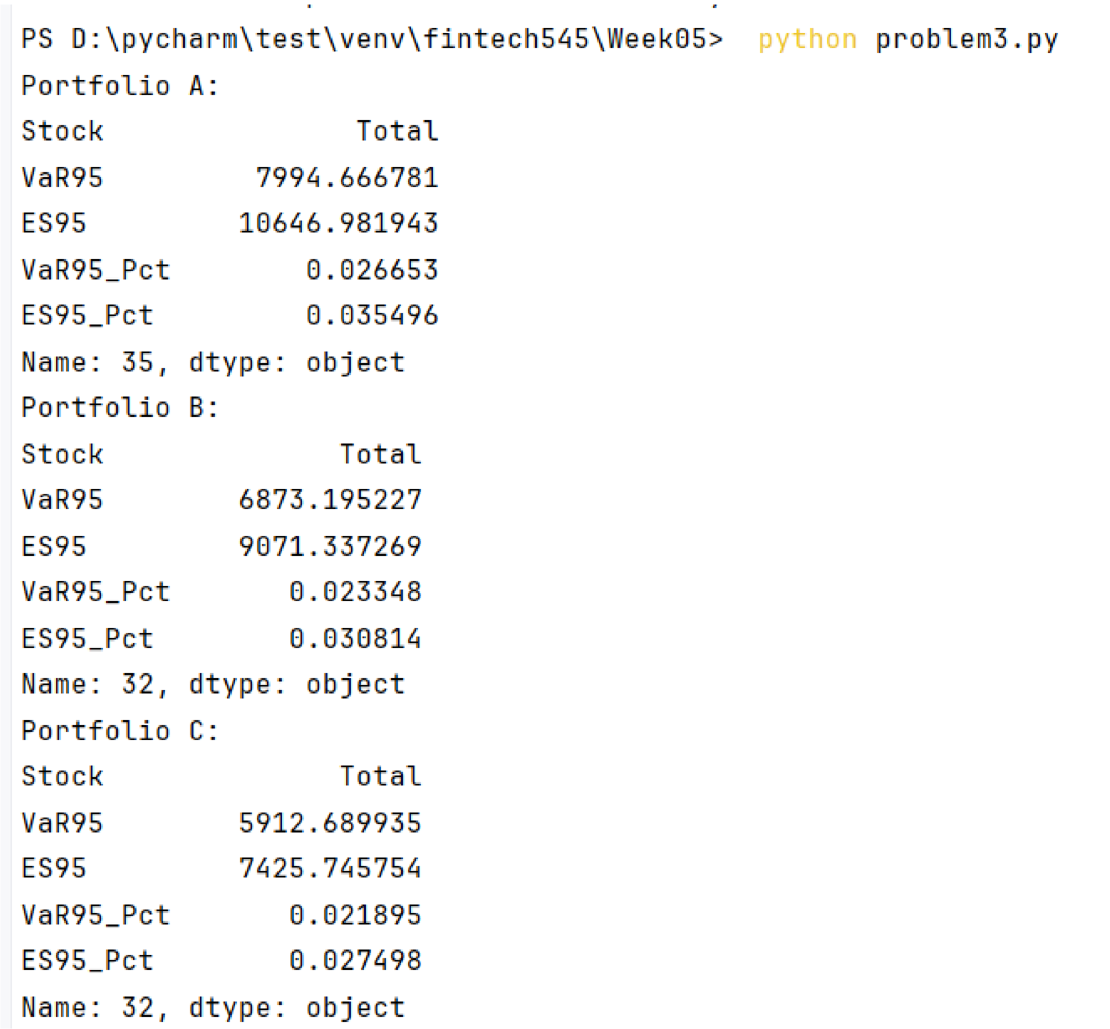
It can be concluded that EWMA's utilization within the normal distribution framework results in the highest observed VaR. This could be attributed to the model's inherent assumption of returns being symmetrically distributed, which overlooks the 'fat tails' commonly seen in the distribution of financial returns.

In contrast, the T distribution, when fitted through Maximum Likelihood Estimation (MLE), presents both a lower VaR and ES compared to its normal counterpart. This suggests a more precise estimation of the likelihood of extreme loss occurrences, which in turn provides a reduced VaR in standard market environments.

The historical simulation approach yields a VaR that aligns closely with the T distribution but with an escalated ES. Typically, losses that surpass the established VaR threshold surpass the T distribution's average loss predictions. The reason for this is that historical simulation doesn't confine itself to a predetermined distribution model but instead is grounded in the actual historical returns distribution.

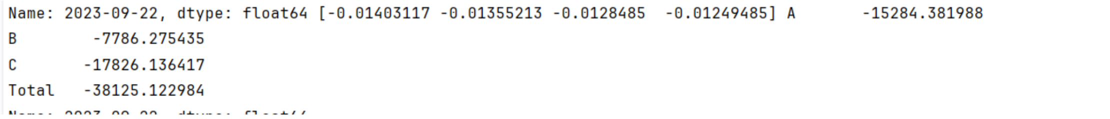
Prob3

Using the package from problem1, I got the following answers:

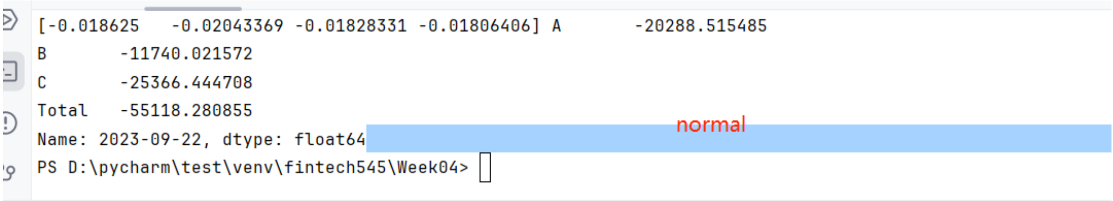


```
PS D:\pycharm\test\venv\fintech545\Week05>  python problem3.py
Portfolio A:
Stock                Total
VaR95          7994.666781
ES95          10646.981943
VaR95_Pct         0.026653
ES95_Pct          0.035496
Name: 35, dtype: object
Portfolio B:
Stock               Total
VaR95         6873.195227
ES95          9071.337269
VaR95_Pct        0.023348
ES95_Pct         0.030814
Name: 32, dtype: object
Portfolio C:
Stock               Total
VaR95         5912.689935
ES95          7425.745754
VaR95_Pct        0.021895
ES95_Pct         0.027498
Name: 32, dtype: object
```

The data below is from last assignment. A, B, C are respectively 15284, 7786, 17826.



```
Name: 2023-09-22, dtype: float64 [-0.01403117 -0.01355213 -0.0128485  -0.01249485] A       -15284.381988
B        -7786.275435
C       -17826.136417
Total   -38125.122984
```



```
[-0.018625   -0.02043369 -0.01828331 -0.01806406] A       -20288.515485
B        -11740.021572
C        -25366.444708
Total    -55118.280855
Name: 2023-09-22, dtype: float64
PS D:\pycharm\test\venv\fintech545\Week04> 
```

The outcome for this assignment is less than what was obtained in the Week04 assignment. This discrepancy could likely be due to the capacity of copulas to undertake a more nuanced construction of the assets' joint return distribution, especially regarding the dependence in the tails. The correlation among assets in the distribution tails tends to be lower; thus, the copula approach tends to report a diminished VaR, reflecting the reduced extreme co-movement that it can encapsulate, as opposed to models that hold the correlation as constant.