problem1

a

```
Arithmetic Returns (last 5 rows):
                 SPY      AAPL      NVDA      MSFT      AMZN      META     GOOGL      AVGO  ...       MDT        CB       LMT       KKR        MU       PLD      LRCX      EQIX
Date                                                                                        ...
2024-12-27 -0.011492 -0.014678 -0.025967 -0.018564 -0.016630 -0.009293 -0.016220 -0.018020  ... -0.010797 -0.002663 -0.002232 -0.020024 -0.014816 -0.015554 -0.009780 -0.006966
2024-12-30 -0.012377 -0.014699 -0.001596 -0.014502 -0.013045 -0.017714 -0.009586 -0.028829  ... -0.014254 -0.008718 -0.011623 -0.012392 -0.037776 -0.001448 -0.018836 -0.008064
2024-12-31 -0.004603 -0.008493 -0.028374 -0.009101 -0.010727 -0.013117 -0.011845 -0.019183  ...  0.003133  0.002688  0.005146 -0.005818 -0.015048  0.005591 -0.000698  0.006512
2025-01-02 -0.003422 -0.027671  0.024835 -0.008190  0.001688  0.020024 -0.001014 -0.002703  ...  0.003998 -0.014224 -0.007764  0.006071  0.036099 -0.013741  0.001101  0.000497
2025-01-03  0.011538 -0.003445  0.039438  0.010133  0.015932  0.005569  0.010758 -0.000850  ...  0.008842 -0.003442 -0.001062  0.016453  0.027517  0.013022  0.035052  0.015745

[5 rows x 100 columns]

Total Standard Deviation:
SPY     0.008077
AAPL    0.013483

[5 rows x 100 columns]
```

b

```
Total Standard Deviation:
SPY     0.008078
AAPL    0.013446
NVDA    0.031171
MSFT    0.014261
AMZN    0.019231
          ...
KKR     0.019898
MU      0.028072
PLD     0.015998
LRCX    0.025299
EQIX    0.015270
Length: 100, dtype: float64
PS D:\Study\FinTech545_Spring2025\Projects\Project02>
```

problem2

a

Current Portfolio Value: $251862.50

b

VaR & ES at 5% alpha level:
Normal VaR: $0.02, ES: $-0.02
T-distribution VaR: $0.02, ES: $-0.03

Historical Simulation VaR: $0.02, ES: $0.02

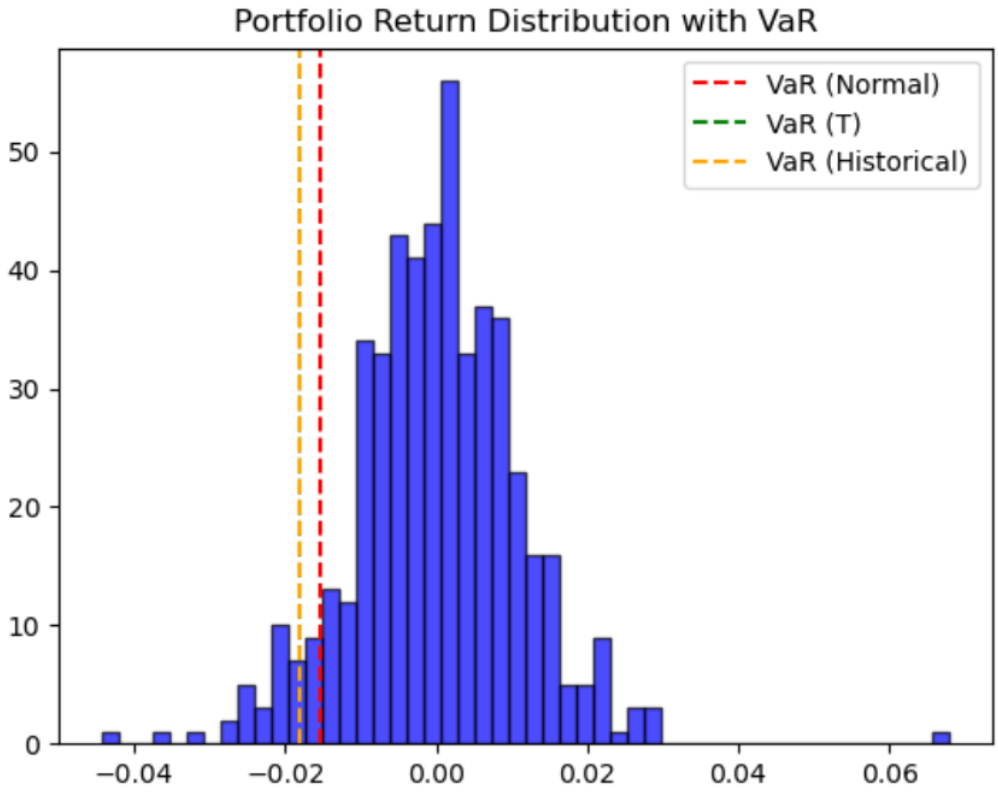
c

The three VaR methods have distinct strengths and weaknesses. **Normal VaR** assumes returns follow a normal distribution, making it simple to compute, but it tends to underestimate extreme risks.

T-distribution VaR accounts for fat tails, making it better suited for financial markets with high volatility, though it requires estimating the degrees of freedom.

Historical simulation VaR relies purely on past data without distributional assumptions, capturing real-world risk but failing to predict future black swan events.

In the histogram, all three VaR levels are close, but the **T-distribution ES is more conservative**, reflecting its ability to capture tail risks more effectively.



problem3

a

Implied Volatility: 0.3351

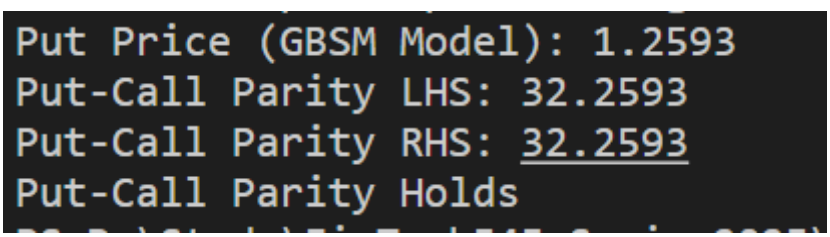
b

Delta: 0.6659
Vega: 5.6407
Theta: -5.5446

c

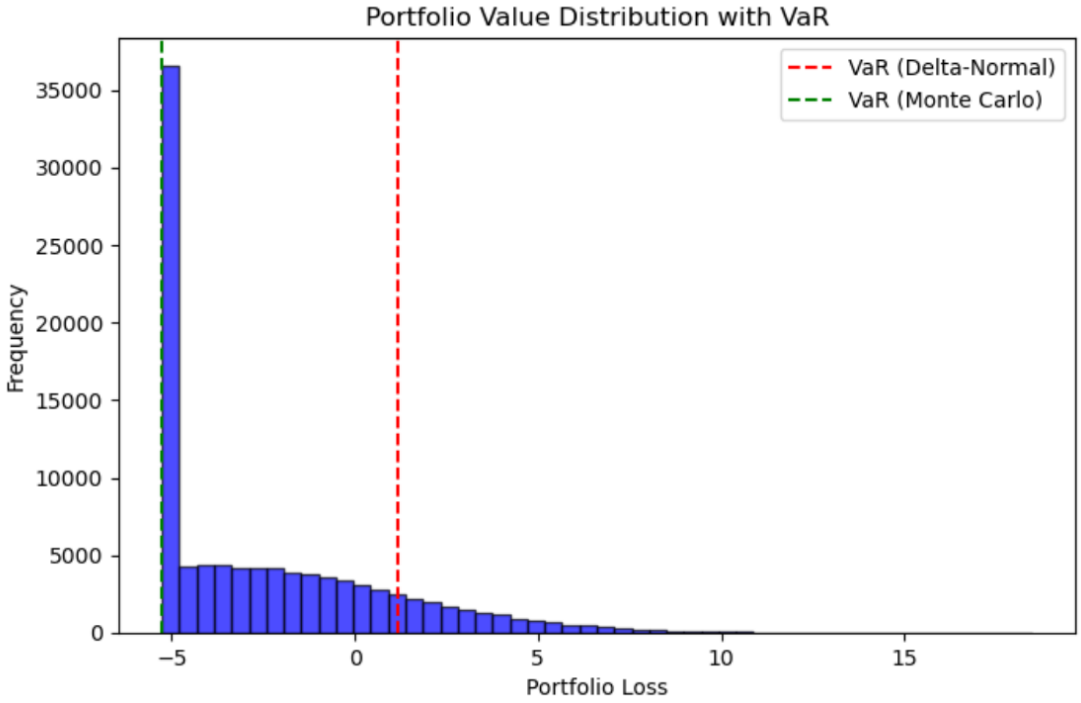
Estimated option price change for +1% volatility: 0.0564

d



Delta-Normal VaR: $-1.1848, ES: $-1.4857
Monte Carlo VaR: $5.2593, ES: $5.2593

e


Portfolio Value Distribution with VaR
VaR (Delta-Normal)
VaR (Monte Carlo)
Frequency
35000
30000
25000
20000
15000
10000
5000
0
−5
0
5
10
15
Portfolio Loss