

**Instructions:**

Be verbose. Explain clearly your reasoning, methods, and results in your written work. Write clear code that is well documented. With 99% certainty, you cannot write too many code comments.

Written answers are worth 18 points. Code is worth 2 points. 10 points total.

1. When finished, respond to the question in Canvas as “done.” We will record your grade there.
2. In your code repository, create a folder called “Project02.”
3. In that folder, include
  - a. a document (PDF) with your responses.
  - b. All code
  - c. A README file with instructions for us to run your code

Everything must be checked into your repository by 8am Saturday 3/1. A pull will be done at that time. Documents and code checked in after the instructors pull will not be graded.

Data for problems can be found in CSV files with this document in the class repository.

**Problem 1**

Given the dataset in DailyPrices.csv, for the stocks SPY, AAPL, and EQIX

- A. Calculate the Arithmetic Returns. Remove the mean, such that each series has 0 mean. Present the last 5 rows and the total standard deviation.
- B. Calculate the Log Returns. Remove the mean, such that each series has 0 mean. Present the last 5 rows and the total standard deviation.

**Problem 2**

Given the dataset in DailyPrices.csv, you have a portfolio of

- 100 shares of SPY
  - 200 shares of AAPL
  - 150 shares of EQIX
- A. Calculate the current value of the portfolio given today is 1/3/2025
  - B. Calculate the VaR and ES of each stock and the entire portfolio at the 5% alpha level assuming arithmetic returns and 0 mean return, for the following methods:
    - a. Normally distributed with exponentially weighted covariance with  $\lambda=0.97$
    - b. T distribution using a Gaussian Copula
    - c. Historic simulation using the full history.
  - C. Discuss the differences between the methods.

**Problem 3**

You have a European Call option with the following parameters

- Time to maturity: 3 months (0.25 years)
- Call Price: \$3.00

- Stock Price: \$31
- Strike Price: \$30
- Risk Free Rate: 10%
- No dividends are paid.

- Calculate the implied volatility
- Calculate the Delta, Vega, and Theta. Using this information, by approximately how much would the price of the option change if the implied volatility increased by 1%. Prove it.
- Calculate the price of the put using Generalized Black Scholes Merton. Does Put-Call Parity Hold?
- Given a portfolio of
  - 1 call
  - 1 put
  - 1 share of stock

Assuming the stock's return is normally distributed with an annual volatility of 25%, the expected annual return of the stock is 0%, there are 255 trading days in a year, and the implied volatility is constant. Calculate VaR and ES for a 20 trading day holding period, at  $\alpha=5\%$  using:

- Delta Normal Approximation
  - Monte Carlo Simulation
- Hint: Don't forget to include the option value decay in your calculations
- Discuss the differences between the 2 methods. Hint: graph the portfolio value vs the stock value and compare the assumptions between the 2 methods.