**Problem 1**

* ●  Current Stock Price $151.03
* ●  Strike Price $165
* ●  Current Date 03/13/2022
* ●  Options Expiration Date 04/15/2022
* ●  Risk Free Rate of 4.25%
* ●  Continuously Compounding Coupon of 0.53%

Implement the closed form greeks for GBSM. Implement a finite difference derivative calculation. Compare the values between the two methods for both a call and a put.

Implement the binomial tree valuation for American options with and without discrete dividends. Assume the stock above:

● Pays dividend on 4/11/2022 of $0.88  
Calculate the value of the call and the put. Calculate the Greeks of each. What is the sensitivity of the put and call to a change in the dividend amount?

**The result is shown as following:**

Price of call option with no dividend: 4.27 Price of call option with dividend: 4.12

Price of put option with no dividend: 3.68 Price of put option with dividend: 4.11

The value of call options decrease with dividend while the put value increase in this situation.

The change rate of call is (4.12 – 4.27) / 4.27 = -0.035

The change rate of put is (4.11 – 3.68) / 3.68 = 0.117 the put option is more sensitive.

**Graphical user interface

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**Problem 2**

Using the options portfolios from Problem3 last week (named problem2.csv in this week’s repo) and assuming :

* ●  American Options
* ●  Current Date 03/03/2023
* ●  Current AAPL price is 165
* ●  Risk Free Rate of 4.25%
* ●  Dividend Payment of $1.00 on 3/15/2023

Using DailyPrices.csv. Fit a Normal distribution to AAPL returns – assume 0 mean return. Simulate AAPL returns 10 days ahead and apply those returns to the current AAPL price (above). Calculate Mean, VaR and ES.

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Calculate VaR and ES using Delta-Normal.

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Present all VaR and ES values a $ loss, not percentages. Compare these results to last week’s results.

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From the result we can see that as the delta normal compare with last week’s result, the result is quite similar as using the normal distribution. But after using the delta normal, the VaR and ES reduce a lot. The smallest change is the straddle as it is an options trading strategy that involves buying both a call option and a put option on the same underlying asset .

**Problem 3**

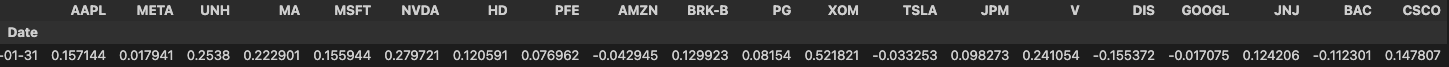
Use the Fama French 3 factor return time series (F-F\_Research\_Data\_Factors\_daily.CSV) as well as the Carhart Momentum time series (F-F\_Momentum\_Factor\_daily.CSV) to fit a 4 factor model to the following stocks.

|  |  |  |  |
| --- | --- | --- | --- |
| AAPL | FB | UNH | MA |
| MSFT | NVDA | HD | PFE |
| AMZN | BRK-B | PG | XOM |
| TSLA | JPM | V | DIS |
| GOOGL | JNJ | BAC | CSCO |

Fama stores values as percentages, you will need to divide by 100 (or multiply the stock returns by 100) to get like units.

Based on the past 10 years of factor returns, find the expected **annual** return of each stock. Construct an annual covariance matrix for the 10 stocks.  
Assume the risk free rate is 0.0425. Find the super efficient portfolio.

the expected **annual** return of each stock is shown as following:



the super efficient portfolio is:



And The Portfolio's Sharpe Ratio is: 1.65