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Project week 06 Solutions

Problem 1
At first, I calculated the time to maturity using the following code below. It gave me a maturity date of 14 days. In order to do so, I used the current date and expiration dates provided in the problem as:

Current Date: 03/03/2023
Expiration Date: 03/17/2023

The time to maturity is the difference between them, i.e. 14 days.

```python
# Given data
current_stock_price = 165
current_date = datetime(2023, 3, 3)
expiration_date = datetime(2023, 3, 17)
risk_free_rate = 0.0525
coupon = 0.0053  # Continuously Compounding Coupon

# Calculate time to maturity in calendar days
time_to_maturity = (expiration_date - current_date).days

print(f"Time to maturing: {time_to_maturity} days")
```

```
Time to maturing: 14 days
```

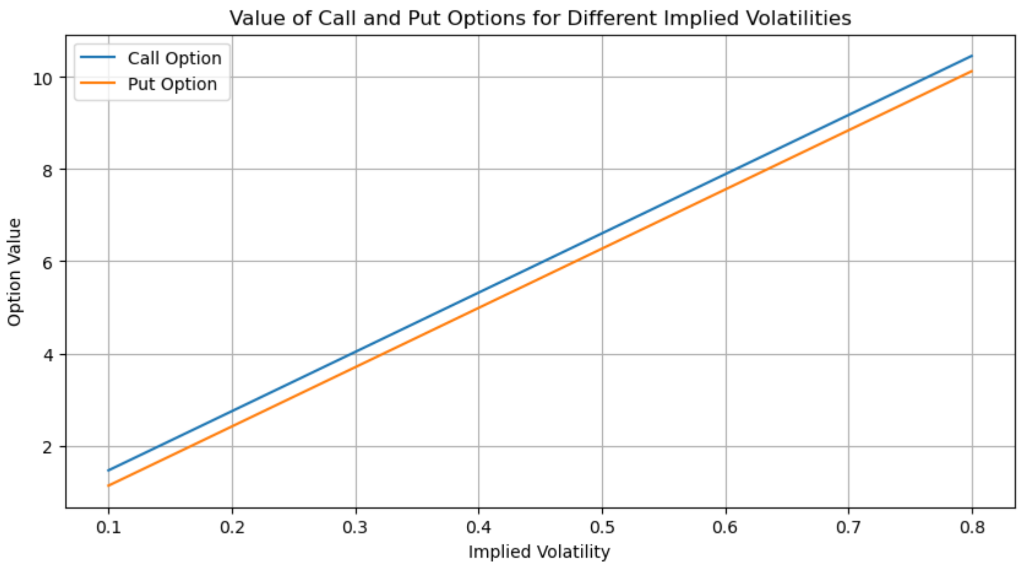
For the second part of the question, I was asked to plot the value of call and put options for a range of implied volatilies between 10% and 80%. The value of options (both call and put) are highly dependent on implied volatility. As implied volatility increases, the value of both cvall and put options also increases. This can be seen in the graph below.
In order to create these graphs, I used the black scholes pricing model to calculate the values of the options for varying implied volatilies. Then, I plotted the values for call and put options against the range of implied volatilities from 10% to 80%.

Regarding how supply and demand affect implied volatility:

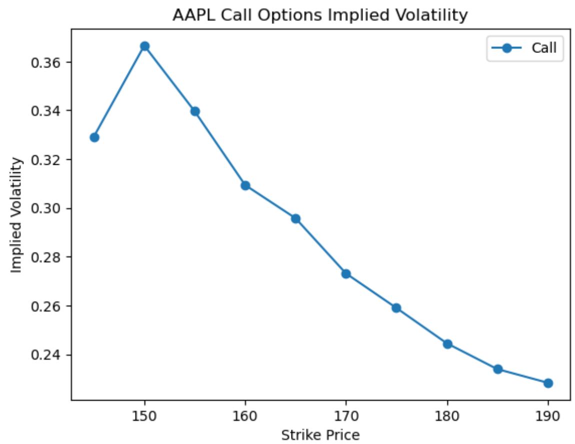
Implied volatility is derived from option prices and reflects the market's expectation of future volatility. If demand for options increases (for example, due to uncertainty or a market event), their prices will rise, which in turn increases implied volatility. Similarly, if there's higher supply (perhaps due to reduced market uncertainty), option prices drop, leading to a decrease in implied volatility.

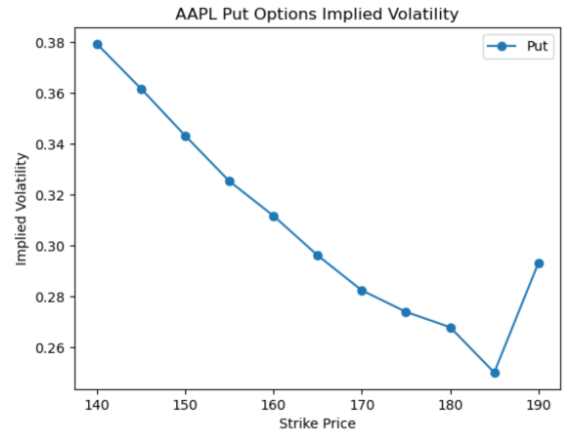
This relationship is somewhat circular: higher demand or supply for options affects their prices, subsequently affecting the implied volatility, and changes in implied volatility then impact option prices again. It's a dynamic relationship influenced by market sentiment, news, and various economic factors.

In the options market, changes in supply and demand directly influence option prices and consequently impact implied volatility, reflecting traders' perceptions of potential future market movements.



Problem 2





The relationship between implied volatility and strike prices differs for call and put options, resulting in distinct patterns on the implied volatility vs. strike price graphs.

In the case of call options, the graph often displays a "smile" or "skew" pattern, as shown above. This pattern shows higher implied volatility for both out-of-the-money (OTM) and in-the-money (ITM) strikes, while at-the-money (ATM) strikes tend to have lower implied volatility. This trend indicates that traders are more willing to pay a premium for options that offer protection against significant market movements. The higher demand for both OTM and ITM options contributes to increased implied volatility levels, resulting in the smile pattern.

Conversely, put options tend to exhibit a "frown" or "reverse skew" pattern on the implied volatility vs. strike price graph. In this pattern, in-the-money (ITM) strikes have higher implied volatility, while out-of-the-money (OTM) strikes show lower implied volatility. This scenario suggests that traders place a higher value on protection against potential downside risks for ITM options, leading to increased implied volatility levels. The increased demand for ITM options results in the frown pattern, while a relatively higher supply of OTM options contributes to lower implied volatility levels.

Market dynamics, including the differing demand and supply dynamics for call and put options, contribute to these distinct patterns. The demand for protection against market fluctuations, coupled with variations in supply across different strike prices, influences the implied volatility levels for various options, resulting in these observable smile and frown patterns in the implied volatility vs. strike price graphs.

Problem 3

For problem 3, I was only able to calculate up to the option value for the portfolio values. I also calculated the implied volatility values for the portfolio unfortunately, I could not solve the simulation successfully. I further went to calculate the portfolio values but was unsuccessful in doing so in python.