**EX-1 : Critically evaluate the use of Python to implement the Black Scholes Merton formulae for calculating the value of a call option.**





The Black -Scholes-Merton (BSM) formula was created in 1973 , Black-Scholes-Merton (BSM), it was the first widely used model for the  option pricing. To calculate the theoretical value of options using current stock prices, expected dividends, the option's strike price, expected interest rates, time to expiration, and expected volatility.

The formula is expanded such as below,

**S0 -** The stock price at time t=0.

**r** - The risk-free interest rate (Govt Interest rate)

**σ2** - The Volatility of the asset.

**ST** - The stock price at time T.

**T** - Time to Expiration, in (Months or Years)

**K** - Strike price of the stock

**Z** - A standard normally distributed random variable that represents the uncertain movement in the stock, up or down.

Monto Carlo Estimator for the European Call formula explains below,

**C0** - Call option price at time 0.

**hT**  - The option payoff at time T.

**r**  - The risk-free interest rate (Govt Interest rate)

**T** - Time to Expiration in (Months or Years)

**Calculating using Python**:

**A live example of Amazon stock on 8th August 2021.**

Strike Price (**k**) = $5,500.00 , Sourced on a Finance Web Portal.

Stock Price(**So**)= $3,344.94 , Sourced on a Finance Web Portal.

Interest Rate(**r**)= 1.31% - Sourced from Us Govt website for the latest interest rate.

Volatility (**σ2** )= 0.17- Sourced on Finance Web Portal

Time in Years(t) =1.0

**Calculation:**

We have set the random seed of 1000, and I as 100000 simulated stock price, and we imported the NumPy library, Math library, SciPy and Sqrt library for the calculation. In which we have used the standard normal deviation,

hT(i) is the maximum of stock price – Strike price of the stock => hT(i)= ST (i)– K

ST (i) is the ith value in the vector of stock,

hT(i) is theith value of the option payoff at time T,

K is the Strike Price of the stock.

Text

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Graphical user interface, text

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From the Calculation we can understand the European call option which has the price of $ 1859.244 USD.

**EX-2: Stock Visualization Study (Amazon, Apple, Microsoft)**

For the Stock Visualization Assessment i have chosen three different stocks namely “Amazon”, “Microsoft”, “Apple” and used the Yahoo Finance to pull and retrieve historical data and have made in the Google Colab.

**Introduction:**

As the data is fetched using the yahoo Finance, data is Filtered based upon the specified dates such as the November 1st, 2019, Until July 30th, 2021, respectively, the stock data has the following variables such as the “Open”, “High”, “Close”, “Adj Close”, “Volume”. Whereas the Open is the opening session rate of the stocks in USD $, High in the Highest increase of the stocks in a particular day, Close is the Closing price of the Stock, Adj Close is the Adjusted Close price of the stock on a particular day, Volume is the Total Number of the Stocks outstanding .

**Basic Analysis Visualisation:**

For the three Stocks I have performed basic Analysis such as the Rolling Statistics (finding Mean, Minimum, Maximum, Standard Deviation and Median) , Daily Percentage change, Intra day Changes and the Visualization of each stocks (Open, Close, Volume)

**Rolling Statistics:**

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Rolling Statistics talks about the Mean, Median, Standard Deviation, Minimum, Maximum o the stocks in the specified time. Where amazon has the highest price per share compared with other stocks(Apple, Microsoft)

**Daily Percentage Change:**

Daily percentage change is calculated among the Three different stock by calculating the percentage change from the previous day close to the current day close. By this we can understand the change of the rates and the percentage which hold them.

Chart

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Above Is the percentage change for all three different stocks (Amazon, Apple, Microsoft) where we can see the x axis as the respective dates ( in month wise) and y axis is the daily percentage change from positive 16 % to negative 15% which tells that the within specified time limit stocks have been volatile in the positive and negative bounds. Since the other stocks between them overlap, let’s have a separate change plots for each stocks .

**Amazon:**

Amazon is the most heavily priced stocks which we have chosen, let see the percentage difference, from the graph we can tell that the amazon stock price continues to increase, and the percentage change is above 2 % from the specified time limit with the highest change of 15 % in the first 3 quarters of 2020.After that there is a steady decrease in the Stock prices. One reason we can make it as because of the Pandemic we can see that stocks are moving dull until now. But overall, we can tell that the there is no negative percentage of the changes, and it maintains a positive change.

Chart, line chart, histogram

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**Apple:**

When compared with Amazon Apple stock has less percentage of increase in the specified time limit, and it has been severely fallen after the start of Pandemic and other crisis

Chart, line chart, histogram

Description automatically generated

**Microsoft:**

Microsoft has the worst in number as their percentage increase is around maximum of 1% and the lowest of the 0.2%

Chart, line chart, histogram

Description automatically generated

**Intra Day Change:**

The intra day changes is calculated based upon the open and close price of the same day, to find how much increase and decrease, when traders trade on a intra day basis stock.

**Amazon:**

**Chart, line chart

Description automatically generated**

**Microsoft:**

**Chart, line chart

Description automatically generated**

**Apple:**

**Chart, line chart

Description automatically generated**

**Advanced Analysis :**

To advanced analysis, I have performed Moving Average , Simple Moving Average, Market Capability, Volatility Analysis

**Moving Average:**

Moving Average is used to calculate and analyse the data points by creating a series of average of subsets of the full data.

Moving Average in Financial Analysis is used to calculate the moving average of stocks to smooth out the price data by creating a constant updated average price.

**Amazon:**

In Amzon stock which I, have representyed by “0” for Amzon and have calculated the 20, 50, 100 rolling days for the stock moving avergae.

Where we can see the multiple spots of the death cross and the golden cross

A [golden cross](https://www.investopedia.com/terms/g/goldencross.asp) and a [death cross](https://www.investopedia.com/terms/d/deathcross.asp) are exact opposites. A golden cross indicates a long-term bull market going forward, while a death cross signals a long-term bear market. Both refer to the solid confirmation of a long-term trend by the occurrence of a short-term [moving average](https://www.investopedia.com/terms/m/movingaverage.asp) crossing over a major long-term moving average.

**Golden Cross:** When short-term moving average crosses the long-term moving average, in our case we can look for the amazon stock 20 days moving average crosses the 100 days moving average in multiple times(2021-11)

**Death Cross :** which is exactly opposite when short-term moving averages moves below long-term moving average it’s a death cross and in Amazon stock (time period from 2021-03 till 2021- 05 there is a heavy death cross)

Chart, histogram

Description automatically generated

Microsoft:

Chart, histogram

Description automatically generated

**Apple:**

Chart, histogram

Description automatically generated

**Simple Moving Average :**

**Amazon:**

**Chart, line chart, histogram

Description automatically generated**

**Microsoft:**

**Chart, line chart, histogram

Description automatically generated**

**Apple:**

**Chart, line chart

Description automatically generated**

**Market Capital**

Market Capital explains about the price per share time the total outstanding amount of shares in volume

Market Capital = Price per stock \* total outstanding stock

**Chart, line chart

Description automatically generated**

**Volatility Analysis:**

Volatility is the key important concept of the financial stock markets , they are classified into two types

1. High Volatility : Changes Dramatically within short period of time.
2. Lower Volatility: Stock tends to be relatively steady over a certain period.

These Movement are majorly due to the several factors such as the demand , supply, sentiment, corporate actions, greed, fear, famine, etc

In maths its measured using the Standard Deviation : Measures an asset’s departure value from its average value.

In python it done using the rolling() function and Std() to calculate the volatility analysis.

**Chart, histogram

Description automatically generated**

From this we can tell that Microsoft has high Volatility