**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  demonstrated by [Fischer Black](https://en.wikipedia.org/wiki/Fischer_Black) and [Myron Scholes](https://en.wikipedia.org/wiki/Myron_Scholes), which gives a theoretical estimate of the price of [European-style](https://en.wikipedia.org/wiki/Option_style) [options](https://en.wikipedia.org/wiki/Option_(finance)) and shows that the option has a *unique* price given the risk of the security and its expected return (instead replacing the security's expected return with the [risk-neutral](https://en.wikipedia.org/wiki/Risk-neutral) rate)

**BSM tell about the following**:

* **S0** : The underlying stock price today (time t=0)
* **r** : The risk-free interest rate (Interest rate bonded by government)
* **σ2** : The Volatility of the underlying asset.
* **ST** : The underlying stock price at time T.
* **T** : Time to Expiration
* **K** : Strike price of the stock
* **Z** : A standard normally distributed random variable that represents the uncertain movement in the stock, up or down.



* **C0** : Call option price at time 0.
* **hT**  : The option payoff at time T.
* **r**  : The risk-free interest rate (Interest rate by government)
* **T** : Time to Expiration

The above formula talks the call option by fetching average of 100000 simulated stock price and the calculation of the risk-free interest rate (r) and (T) time to expiration.

**Monto Carlo Estimator Calculation:**

**hT(i)** is given by subtracting the maximum of stock price to the Strike price of the stock **ST (i)– K**,

**hT(i)= ST (i)– K**

where 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.

**Python Program:**

Using python programming we can do this calculation effectively by using only NumPy Library and random(), standard\_normal () function, and we just need to implement the formula mentioned above to solve the European call price. We used the example of Google stock dated 6th August 2021, referenced from Yahoo Finance.

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For the program we can see the European Call Option has the $ 390.617 (Google Stock)

**EX-2. Stock Visualisation Study**

For this assessment I have taken three different stocks (Google, Netflix, Facebook and undergone a couple of analysis with useful Visualizations.

For the Purpose of Interactive Visualisation (more user friendly and on click option, zoom, etc,) I have used the Plotly Library for this and another library namely matplotlib, Seaborn as well.

**Basic Visualisation**

Below is the few screenshot of Closing Stocks of Facebook, Netflix, and Google from November 1st, 2019, till the July 30th, 2021.

**Close Stocks Visualisation**

**Facebook:**

**Graphical user interface, chart

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**Netflix:**

**Graphical user interface, application

Description automatically generated**

**Google:**

**Graphical user interface, chart, line chart

Description automatically generated**

We can see that the google stocks are relatively higher than the other stocks such as the Facebook and Netflix,

**Open Stocks Visualization:**

**Facebook:**

**Chart

Description automatically generated with medium confidence**

**Google:**

**Graphical user interface, application

Description automatically generated**

**Percentage change :**

Daily percentage change is calculated based upon the percentage changes between the previous day closing price and the current day or 2 consecutive days

**Facebook Stock:**

Below is the percentage change of the Facebook stock, which has been visualised with plotly library (Line Plot and the Histogram ) Facebook has the mean percentage change of 0.17 %, Minimum is -14% and maximum is 10.23%

**Chart, histogram

Description automatically generated**

**Google Stock Percentage Change:**

Google stock has the mean change of 0.19556 and the Minimum is -11% and maximum are 9.4%, below is the visualisation of the percentage change

**Chart

Description automatically generated**

**Netflix Percentage change:**

Netflix has the Mean percentage change of 0.16%, minimum percentage change of -11.13%, maximum change of 16.85%. and Netflix has the maximum % change, when compared with other stocks.

**A screenshot of a computer

Description automatically generated with medium confidence**

**Volatility Analysis:**

Volatility measures the dispersion of returns for given security. It has a key role in options trading. Volatility can be measured by the standard deviation of returns for security over a chosen period.

**Facebook Volatility :**

For the Facebook stock we calculated the returns (from previous close day) and we did the standard deviation for it in order to calculate the Volatility and Facebook has the 39.43 %

**Chart, histogram

Description automatically generated**

**Google Volatility Analysis:**

**Chart, histogram

Description automatically generated**

**Netflix Volatility Analysis:**

**Chart, histogram

Description automatically generated**

**Moving Average Analysis:**

The moving average (MA) which is a technical analysis tool that smooths out price data by creating a constantly updated average price. The average is taken over a specific period, like 10 days, 20 minutes, 30 weeks, or any time the trader chooses.

In our analysis we have taken for the period of a week (7 days), and which is the simple moving average

**Facebook Stock:**

Moving average is calculated based upon the final close price of the stock here in the Facebook stock we have a variable called “Close” using the pandas rolling function we calculate the average window of 7 Days

**Chart, scatter chart

Description automatically generated**

**Google Stock:**

The 7 days moving average shows clearly how close, and we can find the cross as well in a 3-dimensional plot.

**Chart

Description automatically generated**

**Netflix Stock**

**Chart, radar chart

Description automatically generated**

**Trend Analysis;**

In the Trend analysis we are dividing the stock based upon the daily percentage change

Condition:

If the trend is less than negative 0.5 to positive 0.5 which is Slight or No change in stocks, when greater than 0.5 and less than equal to 1 then it’s a slight positive in the stock, like wise when stock is negative 1 to negative 0.5 which is the slight negative.

When stocks daily percentage change greater than 1 and less than equal to 3 then it is Positive, similarly when daily percentage greater than negative 3 to less than equal to negative 1, which is Negative trend.

When stock’s daily percentage change greater than 3 to less than equal to 7 it is among top gainers, similarly when the percentage change is greater than negative 7 to less than equal to negative 3 which is among top losers.

When the daily percentage exceeds negative 7 it is a Bull Drop and similarly when exceeds positive 7 it isa Bull Run

**Google Stock:**

Within the allocated time the trend of the google is Slight or No change which has 30.8% and it has only 21.5 % of positive that means (1 to 3 % increase of the base price) and it has very less bull drop and bull run.

**Graphical user interface, chart, application, pie chart

Description automatically generated**

**Facebook Stock :**

Facebook stock has shown good improvement in the past 2 years as we can see there is appositive trend remains from November 2019 until 2021 July 24% has been positive (1 to 3 % increase) and 23.3 % slight or No change and it has near equal in terms of Top losers and top Gainers and it has 19.25 % of negative.

**Netflix Stock:**

In Netflix stock we can see that the there is high portion of no change or slight change and high positive next to it with 22.8 % for the specified time and it has 8% of top gainers and we can tell that Netflix stock has a good pace and it’s withstanding the pandemic as it’s the entertainment social media platform as well, so it shows the good impact.

**Chart

Description automatically generated**

**Market Capitalization:**

Market Capitalization talks about the  total equity value of the company and is found by multiplying the current market price per share of the company with the total number of outstanding shares.

**Market Capitalization Formula = Current Market Price per share \* Total Number of Outstanding Shares.**

**Facebook Stock:**

**Facebook on average it has more than 5 billion of stocks, which has been traded over for the specified time from November 2019 until July 2021.**

Graphical user interface, chart

Description automatically generated

**Google Stock:**

Google stock Market Cap is lower than the Facebook stock, on average with 2.5 billion of trade volume of stocks

Graphical user interface, chart

Description automatically generated

**Netflix Stock:**

Netflix also has the less market cap on compared with Facebook.

Graphical user interface, chart

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