

# Black-Scholes Option Pricing Model Web Application

## Overview

This project involves an interactive web application developed using **Streamlit** that implements the **Black-Scholes Option Pricing Model**. The application allows users to calculate and visualize the theoretical pricing and Greeks of European options. It also provides tools for evaluating Profit and Loss (PnL) and generates heatmaps for option prices and PnL across different parameters.

## Features

- Option Pricing and Greeks Calculation:**
  - Computes the theoretical price of both call and put options using the Black-Scholes formula.
  - Calculates the Greeks, which include Delta, Gamma, Vega, Theta, and Rho. These are essential metrics for understanding the sensitivity of option prices to various factors.
- Interactive User Interface:**
  - Current Price:** Input for the current market price of the underlying asset.
  - Underlying Asset Price (S):** The price of the underlying asset.
  - Strike Price (K):** The option's strike price.
  - Time to Maturity (T):** Time remaining until the option's expiration, entered in days and automatically converted to years.
  - Volatility ( $\sigma$ ):** The expected volatility of the underlying asset.
  - Risk-Free Rate (r):** The risk-free interest rate used in pricing.
  - Purchase Price:** The price at which the option was purchased.
  - Current Market Price:** The current market price of the option for PnL calculation.
- Results Display:**
  - Option Pricing and Greeks:** Displays calculated values for call and put options, including price, Delta, Gamma, Vega, Theta, and Rho in a tabular format.
  - Profit and Loss (PnL):** Computes and displays the PnL based on the current market price and purchase price of the option. The result is color-coded to indicate profit or loss.
- Visualizations:**
  - Option Price Heatmap:** Visualizes how the price of a call option varies with different underlying asset prices and times to maturity. This helps in understanding the sensitivity of option prices to changes in these parameters.
  - PnL Heatmap:** Shows how the PnL varies with different underlying asset prices and times to maturity. Positive PnL is indicated in green and

negative PnL in red, providing a clear visual representation of profitability.

## Usage

The web application provides a user-friendly interface for calculating and visualizing the Black-Scholes Option Pricing Model. Follow these steps to make the most out of the application:

### 1. Input Parameters

#### 1.1 Current Price

- **Description:** Enter the current market price of the underlying asset.
- **Purpose:** This is used to calculate the Profit and Loss (PnL) of the option.

#### 1.2 Underlying Asset Price (S)

- **Description:** Input the current price of the underlying asset.
- **Purpose:** This value is used in the Black-Scholes formula to determine the theoretical price of the option.

#### 1.3 Strike Price (K)

- **Description:** Enter the strike price of the option.
- **Purpose:** The strike price is crucial for calculating the option's payoff and theoretical price.

#### 1.4 Time to Maturity (T) in Days

- **Description:** Input the time remaining until the option expires, specified in days.
- **Purpose:** This is converted to years and used to calculate the option's price and Greeks. The time to maturity impacts the option's sensitivity to various factors.

#### 1.5 Volatility ( $\sigma$ )

- **Description:** Enter the expected volatility of the underlying asset, expressed as a decimal.
- **Purpose:** Volatility affects the option's price and sensitivity measures, with higher volatility generally increasing option prices.

#### 1.6 Risk-Free Rate (r)

- **Description:** Input the risk-free interest rate, expressed as a decimal.
- **Purpose:** This rate is used in the Black-Scholes formula to discount the option's payoff.

## 1.7 Purchase Price

- **Description:** Enter the price at which the option was bought.
- **Purpose:** This is used to calculate the Profit and Loss (PnL) by comparing it with the current market price of the option.

## 1.8 Current Market Price

- **Description:** Enter the current market price of the option.
- **Purpose:** This value is used to calculate the PnL by comparing it with the purchase price of the option.

## 2. View Results

### 2.1 Option Pricing and Greeks Table

- After entering all parameters, the application calculates and displays the following metrics in a table:
  - **Call Option Price:** Theoretical price of the call option.
  - **Put Option Price:** Theoretical price of the put option.
  - **Delta:** Sensitivity of the option price to changes in the underlying asset price.
  - **Gamma:** Rate of change of Delta with respect to the underlying asset price.
  - **Vega:** Sensitivity of the option price to changes in volatility.
  - **Theta:** Rate of change of the option price with respect to time decay.
  - **Rho:** Sensitivity of the option price to changes in the risk-free interest rate.

### 2.2 Profit and Loss (PnL)

- **Calculation:** The application calculates the PnL based on the difference between the current market price and the purchase price of the option.
- **Display:** The result is color-coded:
  - **Green:** Indicates a profit (positive PnL).
  - **Red:** Indicates a loss (negative PnL).

## 3. Explore Visualizations

### 3.1 Option Price Heatmap

- **Purpose:** Visualizes how the theoretical price of a call option changes with different underlying asset prices and times to maturity.
- **Usage:** Helps users understand the effect of varying these parameters on the option price.

### 3.2 PnL Heatmap

- **Purpose:** Displays how the PnL varies with different underlying asset prices and times to maturity.
- **Usage:** Provides insights into how changes in underlying asset prices and times to maturity impact the profitability of the option. Positive PnL is shown in green and negative PnL in red.

## 4. Interacting with the Application

- **Adjust Parameters:** Modify the input fields to see how changes affect the option pricing, Greeks, and PnL in real-time.
- **View Updates:** As you adjust the parameters, the application will automatically update the results and visualizations.
- **Analyze Heatmaps:** Use the heatmaps to visually analyze how different scenarios impact option prices and profitability, helping in strategic decision-making.

## 5. Practical Applications

- **Trading Decisions:** Utilize the theoretical prices and Greeks to make informed trading decisions, understand market sensitivity, and manage risk.
- **Scenario Analysis:** Use the heatmaps to explore different market conditions and their effects on option pricing and PnL.