Options Volatility Script: Documentation

Key Features:

- **Option Chain Data:** Fetches live call/put options from NSE.
- **Historical Data:** Retrieves daily OHLC data from NSE (last 90 days).
- **Historical Volatility (HV):** Calculates past stock price fluctuations.
- **GARCH Volatility:** Models future volatility based on past returns.
- **Implied Volatility (IV):** Derives market's expectation of future volatility from option prices.
- **Excel Output:** Saves all data into an organized Excel file.

Mathematical Formulas :

1. Historical Volatility (HV)

- **What it is:** Annualized standard deviation of daily log returns.
- **Formula:**
  1. Daily Log Return (Rt): ln(Pt/Pt−1)
  2. Daily StDev (σdaily): N1∑(Ri−R¯)2

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  3. Annualized HV (σHV): σdaily×252

- **Code Reference:** `calculate_hv` function.

2. GARCH(1,1) Volatility

- **What it is:** Conditional volatility modeling, accounting for volatility clustering.
- **Formula:** σt2=α0+α1ϵt−12+β1σt−12

- σ_t^2: Conditional variance at time t.
- ϵ_{t-1}^2: Squared past return (lagged error).
- σ_{t-1}^2: Past conditional variance.
- $\alpha_0, \alpha_1, \beta_1$: Model parameters (estimated by the model).

- **Code Reference:** `estimate_garch` function. Result is then divided by 100 for decimal.

3. Black-Scholes Option Pricing (for IV Calculation)

- **What it is:** Model to price European options, inverted to find IV.
- **Call Price (C):** $SN(d1) - Ke^{-rT}N(d2)$
- **Put Price (P):** $Ke^{-rT}N(-d2) - SN(-d1)$
- **Where:**
  - $d1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$

  - $d2 = d1 - \sigma\sqrt{T}$

  - S: Spot Price
  - K: Strike Price
  - T: Time to Expiration (years)
  - r: Risk-Free Rate
  - σ: Volatility
  - N(x): Standard Normal CDF
- **Code Reference:** `black_scholes_price` function.

4. Implied Volatility (IV)

- **What it is:** The σ that makes the Black-Scholes price match the `market_price`.

- **Method:** Numerical optimization (minimizing the squared difference between Black-Scholes price and market price).
- **Objective:** $\text{minimize}(BS(S,K,T,r,\sigma,\text{option\_type}) - \text{MarketPrice})^2$
- **Code Reference:** `implied_volatility` function (uses `scipy.optimize.fmin`).