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import numpy as np
import math
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

def myBlackScholes(r, sigma, x_0, x_t, K, T, M, N):
    # Compute the parameters
    dx = (x_t - x_0) / M
    dt = T / N
    u = lambda p: 0.25 * dt * ((sigma**2 * p**2) - (r * p))
    v = lambda p: 0.5 * dt * ((sigma**2 * p**2) + r)
    w = lambda p: 0.25 * dt * ((sigma**2 * p**2) + (r * p))

    # Initialize matrices
    V = np.zeros((M+1, N+1))
    X = np.arange(0, M+1) * dx
    t = np.arange(0, N+1) * dt

    # Set boundary conditions
    V[:, -1] = np.maximum(X - K, 0)
    V[1, :] = 0
    V[-1, :] = np.max(X) - (K * np.exp(-r * (T - t)))

    # Initialize A as a zero matrix
    A = np.zeros((M-1, M-1))
    # Set diagonal elements
    A[np.arange(M-1), np.arange(M-1)] = 1 + v(np.arange(1, M))
    # Set elements below the main diagonal
    A[np.arange(1, M-1), np.arange(M-2)] = -u(np.arange(2, M))
    # Set elements above the main diagonal
    A[np.arange(M-2), np.arange(1, M-1)] = -w(np.arange(1, M-1))

    # Initialize B as a zero matrix
    B = np.zeros((M-1, M-1))
    # Set diagonal elements
    B[np.arange(M-1), np.arange(M-1)] = 1 - v(np.arange(1, M))
    # Set elements below the main diagonal
    B[np.arange(1, M-1), np.arange(M-2)] = u(np.arange(2, M))
    # Set elements above the main diagonal
    B[np.arange(M-2), np.arange(1, M-1)] = w(np.arange(1, M-1))

    # Loop for implicit option prices
    for n in range(N, 0, -1):
        # Boundary set for previous time
        b = np.zeros(M-1)
        b[0] = -u(1) * V[0, n]
        b[-1] = -w(M-1) * V[-1, n]

        # Boundary set for current time
        c = np.zeros(M-1)

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c[0] = u(1) * V[0, n]
c[-1] = w(M-1) * V[-1, n]

# Solve for previous time
V[1:M, n-1] = np.linalg.solve(A, np.dot(B, V[1:M, n]) + c - b)

return V, X, t

# Constant parameters
rate = 0.05;
volatility = 0.3;
X_grid = 80;
T_grid = 80;
Xmax = 200;
Xmin = 0;
expiry_time = 4;
strike = 100;

# Calculate call option prices given the parameters
V, X, t = myBlackScholes(rate, volatility, Xmin, Xmax, strike,
expiry_time, X_grid, T_grid)

# Create a meshgrid for t and X
T, X = np.meshgrid(t, X)
Z = V.T

# Create a 3D plot
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

# Plot the 3D mesh
ax.plot_surface(T, X, Z, cmap='viridis') # Transpose V to match the
dimensions

# Set labels
ax.set_xlabel('Time (t)')
ax.set_ylabel('Underlying Asset Price (X)')
ax.set_zlabel('Option Value (V)')

# Change the viewing angle to appear as if the x-axis is rotated
ax.view_init(elev=20, azimuth=-215) # Adjust the 'azim' value to change
the azimuth angle

plt.title('3D Mesh Plot of Option Value')
plt.show()

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3D Mesh Plot of Option Value

