Homework#5

I. (70pts)

Price time series exercise. Please use NumPy array.

A. Process the historical price history in attached 'adj_close_hist.csv'. There are some missing values in the history, fill these missing values with its previous closing price.
B. Implement the following technical trading strategies. For the purpose for this exercise, you can initiate a stock position from either long or short side.
    a. Short term:
        i. Buy when stock closes above its 5-day SMA (simple moving average)
        ii. Sell when stock closes below its 5-day SMA
    b. Medium term:
        i. Buy when 15-day SMA moves above 50-day SMA
        ii. Sell when 15-day SMA moves below 50-day SMA
    c. Long term trend following:
        i. Buy when 50-day SMA moves above its 200-day SMA
        ii. Sell when 50-day SMA moves below its 200-day SMA
C. Compare the following performance statistics for the above trading strategies:
    a. Average position turn-over per annum
    b. Average position holding period
    c. Average annualized return
    d. Average annualized return volatility

II. (30pts)

In preparation to numerical solution to PDE (sharpen your math skills and use them here), please complete the following derivations

Given a parabolic partial differential equation (Black-Scholes equation belongs to this category):

$$\frac{\partial u(x,t)}{\partial t} = D\frac{\partial^2 u(x,t)}{\partial x^2}$$

Discretize notations:

a. Discretize space-time plane into grid points of size $N \times M$:
   i. $x \in \{x_0, x_1, \dots, x_{N-2}, x_{N-1}\}$, where $x_{n+1} - x_n = \Delta x$
   ii. $t \in \{t_0, t_1, \dots, t_{M-2}, t_{M-1}\}$, where $t_{j+1} - t_j = \Delta t$

b. Discretize the 2D function $u(x,t)$ into a function that live on these grid points:
   i.e. $u_{n,j} \equiv u(x_n, t_j)$

A. Use finite-difference method to express the partial derivatives in the above PDE and therefore express the PDE into its finite-difference form (write your answer below).

B. Move all the terms related to time slice $(j+1)$ to the left-hand-side and all terms related to time slice j to the right-hand-side (write your answer below).

C. Express your answer above in matrix form (remember what you learned in linear algebra)

Submit your (I) source code and performance statistics, and (II) the above derivation online

Happy coding and deriving!