QF302 Homework Assignment #2

Due Date: In class on May 1 (Wednesday).

Data Files: Datasets are available from the course website on Canvas. Instructions of the assignment: Your answers need to be typed using any document editing software (e.g. Word), but your final submission has to be saved in one single PDF file. Any supporting programs (Python) need to be submitted along with the PDF file with proper references.

Problem 1 [**40 points**] You are required to answer the following questions using the SHIFT system with Python programming. Consider the stock price for Apple INC (AAPL) in the SHIFT system. Implement a simple Technical Analysis (TA) trading system. Using the simple *filter* rule, one should buy/sell at the next period if the last closing price P_k is higher/lower than the highest/lowest price for a given past period of length n by a certain threshold $\delta > 0$. These rules can be formulated as the following:

$$\text{Buy: } P_k/M_k > 1+\delta$$
$$\text{Sell: } P_k/m_k < 1-\delta$$
$$\text{where}$$
$$M_k = \max(P_{k-1}, ..., P_{k-n}), m_k = \min(P_{k-1}, ..., P_{k-n})$$

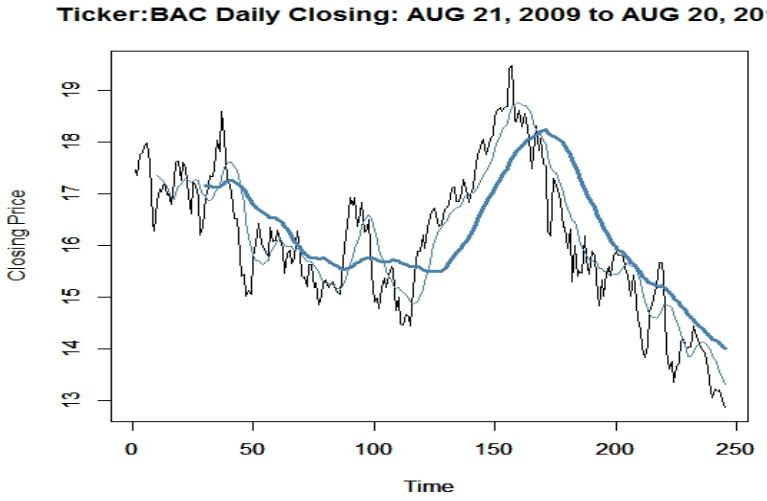
Note that there are two parameters that you need to decided on namely n and δ. For this assignment, please use $\Delta t = 5$ seconds for each period and $T = 120$ for the number of periods (or run the program for 10 minutes). The bid price P_t^B represents the highest priced buy order that's currently available in the market. The ask price P_t^A is the lowest priced sell order that's currently available or the lowest price that someone is willing to go short or sell at. To simplify the problem, we also assume that each time you buy or sell 100 shares of AAPL stock, and use **mid-price** to calculate the

filter rule i.e. $P_k = (P_k^A + P_k^B)$. All orders will be placed as **market order**, and all orders will be filled sequentially. Please do the following:

(1) Assuming $n = 10$ periods and $\delta = 0.2$, please implement a trading system in Python and run the system for T periods, and calculated your total profit/loss (P/L). Need to repeat the trading 10 times, and provide a summary statistics on the number of trades (count the number of buys or sells), and P/L.

(2) Please propose an optimal δ for the given $n = 10$ so that your P/L will be optimized. Please describe the process you use to reach the optimal δ. (Hint: use heuristic research/"try and error" method. There is no right or wrong as long as you can show that you improved the P/L with the new δ.)

Problem 2 **[30 points]** Consider the daily stock close price for Back of America (BAC) from August 21, 2009 to August 20, 2010 in the file sp500hst.txt.



(1) Build a momentum trading strategy based on the Moving Average Convergence/Divergence (MACD) method. Note that you need to use the fast EMA (11 days) and the slow EMA (22 days) for this assignment. Please present your results as a table of long and short signals and accumulative return along with dates. And also provide a plot of the prices and all the buy and sell signals on the plot. [15 points]

(2) Build a momentum trading strategy based on the Relative Strength Index (RSI) method. Note that you need to use N=14 days for this assignment, and use overbought and oversold market parameter of 80 and 20 respectively. Please present your results as a table of long and short signals and accumulative return along with dates. And also provide a plot of the prices and all the buy and sell signals on the plot. [15 points]

Problem 3 **[30 points]** Pair trading strategy can be simplified as: buy a portfolio consisting of long shares A with log return x_t and short shares B with log return y_t when

$$y_t - \alpha x_t = c - \Delta$$

and sell the portfolio when

$$y_t - \alpha x_t = c + \Delta$$

The key is to find A, B and Δ. In this problem, you are given two stocks Exxon Mobile (xom) and Chevron (cvx) as A and B from 11/30/2015 to 11/27/2017. The historical data is provided in two separate files: XOM.csv and CVX.csv. You need to show there exists α and c such that the linear combination $z_t = y_t - \alpha x_t + c$ is I(0) i.e. stationary. Please follow a two step Engle and Granger procedure first, and then apply the trading rule for the two stocks (using logarithmic "Close" price to calculated log returns) provided:

1. Estimate the co-integrating relation (e.g. with a linear regression). Provide regression results.

2. Test for stationarity of the residual (z_t) using Augmented-Dickey-Fuller unit root test. Use a Python package "statsmodels.tsa.stattools" to perform the unit root test.

3. Use $\Delta = 2 * std(z_t)$ to identify long and short portfolio signals. Please present your results as a table of long and short signals and accumulative return along with dates.

Homework Honor Policy: You are allowed to discuss the problems between yourselves, but once you begin writing up your solution, you must do so independently, and cannot show one another any parts of your written solutions. The HW is to be pledged (that it adheres to this).