Assignment

One of the difficult questions in linear regression is the size of the window W. In this assignment, we will build a linear regression model for stock prices and decide whether we want to hold a (long or short) position overnight. Specifically, we take a window of W days and given the (adj_close) prices P_1, P_2, \ldots, P_W for days $t = 1, 2, \ldots, W$ we estimate the closing price P_{W+1}^* for day W+1 using ordinary linear regression. We will choose W based on the profitability of our strategy.

We need to decide our investment at the end of day W and decide how to invest for day W + 1. Our trading strategy at the end of day W is the following:

- 1. if $P_{W+1}^* > P_W$ then we decide that tomorrow the price will rise (daily return for day W+1 will be positive). In this case we do the following:
 - (a) if we do not have a position, we buy \$100 of stock at the closing price P_W . We establish a long position with $100/P_W$ (fractional) number of shares.
 - (b) if we already have a long position (i.e. we bought yesterday or day(s) before), we keep the position. Since

- we expect the price to rise the next day, we expect to increase our profit
- (c) if we have a short position from yesterday, we close this position by buying the appropriate number of shares. If we established such a short position with x (possibly fractional) number of shares with price P_x , the profit/loss per share will be $P_x P_W$.
- 2. if $P_{W+1}^* < P_W$ then we decide that tomorrow the price will fall (daily return for day W+1 will be negative). In this case we do the following:
 - (a) if we do not have a position, we sell short \$100 of stock at the closing price P_W . We establish a short position with $100/P_W$ (fractional) number of shares
 - (b) if we already have a short position (i.e. we sold short yesterday or day(s) before), we keep the position. Since we expect the price to fall the next day, we expect to increase our profit
 - (c) if we have a long position, we close the position. If we established such a long position with x (possibly fractional) number of shares with price P_x , then the profit/loss per share is $P_W P_x$.
 - (d) if $P_{W+1}^* = P_W$, then we do nothing (this is a highly unlikely event) and we ignore trading costs

Questions:

- 1. take $W = 5, 6, \ldots, 30$ and consider your data for year 1. For each W in the specified range, compute your average P/L per trade and plot it: on x-axis you plot the values of W and on the y axis you plot profit and loss per trade. What is the optimal value W^* of W?
- 2. use the value of W^* from year 1 and consider year 2. For every day in year 2, take the previous W^* days, compute linear regression and compute the value of r^2 for that day. Plot the graph of r^2 for year 2. What is the average r^2 . How well does it explain price movements?
- 3. take the optimal value of W^* from year 1 and use it to implement the above trading strategy for year 2. How many "long position" and 'short position" transactions did you have in year 2?
- 4. what is the average profit/loss per "long position" trade and per "short position" trades in year 2?
- 5. what is the average number of days for long position and short position transactions in year 2?
- 6. are these results very different from those in year 1 for this value of W^* ?