FAC-QuantWeb
Assignment 2

May 14, 2024

Instructions

- Submission deadline is 16th EOD.
- Use the ticker symbol 'AAPL' with a start date of 1st Jan, 2018 to 1st Jan 2022.
- For risk free rate the ticker symbol is '$\hat{\text{T}}$NX'. Use the same dates.
- The submission would be on GitHub classroom as stated in the meet. Submit separate .ipynb files for the problems you have attempted and most importantly **RUN ALL THE CELLS BEFORE SUBMITTING**
- In case of any query please feel free to contact the mentors.

The assignment is focused on making you familiar with the process of testing. The following are different parameters which are used in the process of testing a strategy:

- **Benchmark Return:**

  The benchmark return, also known as the buy-and-hold return, isn't directly dependent on your strategy but rather sets a standard for it.

  To put it simply, suppose you have 1000 dollars in your demat account and you're backtesting over a one-year period. If the starting price of the series is 100 dollars and the ending price is 200 dollars, the benchmark return denotes starting a long trade on the first day and exiting it on the last day.

  In other words, it signifies buying 10 stocks(1000/100=10) at the beginning, which then grow from 1000 dollars to 2000 dollars. Therefore, the benchmark return would be 1000 dollars or 100 percent.

- **Number of Closed Trades, Winning Trades and Losing Trades**

  In backtesting, trades are categorized into two types: Closed and Open. In our context, trades that commence with a 1 and are closed by a -1 (long

trades), and vice versa, those that start with a -1 and are closed by a 1 (short trades), are considered closed trades. Any other trades fall under the category of open trades.

Closed trades that result in a profit at the end are termed as winning trades, while those that result in a loss are referred to as losing trades.

- **Maximum Holding Time, Average Holding Time**

  Let's say your trade starts on the ith day and you square off your position on the ith+x day. The Holding time for this trade would be x. You would be trading on close mostly(atleast for this assignment) so we would not be counting the start day in the holding time as we would be holding the position for a very brief time, that is just as the market is about to close.

  After calculating the holding time for all of the closed trades, the maximum holding time would be the max of all the holding times and the average holding time would be the avg of all the holding times.

- **Gross Profit and Net Profit**

  Let's say you started with 1000 rupees, and at the end of the entire backtesting your capital grew to 2000 rupees, and this backtesting involved 10 trades. The Gross Profit is simply the final value of the capital- initial capital which would be 1000 rupees in this case.

  Net Profit subtracts the transaction cost from the gross profit which occur while dealing with a broker thereby simulating real-life conditions. For this assignement we would be taking a fixed brokerage or transaction cost as **20 rupees per trade**. So for the above example the net profit would be 1000-(20x10) which would evaluate to 800.

- **Max Drawdown and Average Drawdown**

  Drawdown denotes the maximum difference between a peak and the corresponding trough. Calculate the drawdown always using the portfolio value. Calculating the drawdown using the stock prices would require extra work as the definition of peak and trough would change for a short and long trade. A peak denotes profit and a trough denotes loss. For a short trade we want the market to fall while for a long trade we want the market to rise.

  For each trade calculate the drawdown in percent, the maximum of them would be the maximum drawdown and the average would be the avg drawdown.

  This is one method of calculating drawdown for a particular trade:

  Initiate a maximum variable to store the highest value encountered during iteration. Calculate the deviation from this maximum for each value in the list. The maximum deviation, represented as a percentage, indicates the maximum drawdown for that specific trade. The table below illustrates

Table 1: Drawdown example

Values	Day1	Day2	Day3	Day4	Day5	Day6	Day7
Portfolio Value	100	105	110	107	100	95	115
max	100	105	110	110	110	110	115
Drawdown	0	0	0	2.73	9.09	13.63	0

this calculation for a trade with portfolio values of 100,105,110,107,100,95,115], where drawdown is expressed in percentage.

So the drawdown is calculated by calculating the deflection of the portfolio value with respect to max in percent. The max dradown for this trade would be 13.63 percent.

- **Max Dip and Avg Dip**

  Dip is very much similar to drawdown but differs in how we calculate the deviation. While drawdown compares each value to the peak within a particular trade, dip measures the deviation from the entry portfolio value. It's essential to utilize portfolio value to maintain simplicity and ensure accuracy, especially considering the differing market movements desired for short and long trades.

  In the given example, the entry value is 100, and the maximum dip occurs on day 6 when the value drops to 95, resulting in a maximum dip of 5 percent.

  To compute dips for each trade, calculate the deviation from the entry portfolio value. The maximum deviation represents the max dip, while the average is termed the average dip.

- **Sharpe Ratio**

  The Sharpe Ratio, or risk-adjusted return, is a valuable metric for assessing strategy effectiveness. It's calculated using the formula:

$$\text{Sharpe Ratio} = \text{Annualization Factor} \times \frac{\text{mean}(returns) - \text{risk-free rate}}{\text{std dev}(returns)}$$

  Here, the Annualization Factor is typically taken as the square root of 252, representing the number of trading days in a year. This adjustment scales the Sharpe Ratio to provide an annualized perspective, suitable for comparing strategies.

  The Risk-Free Rate is determined by the 10-year US Treasury bond interest rate, which fluctuates over time. To obtain this rate, you can download data from Yahoo Finance using the ticker symbol $\hat{\text{T}}$NX, considering the closing values corresponding to your backtesting period. Ensure that the backtesting period is same as the risk free rate timeframe.

The formula can also be expressed as:

$$\text{Sharpe Ratio} = \text{Annualization Factor} \times \frac{\text{mean}(returns - \text{risk-free rate})}{\text{std dev}(returns - \text{risk-free rate})}$$

as mean(x+a)=mean(x)+a and std(x+a)=std(x) for a constant 'a'. Using this information compute the sharpe ratio.

Question 1

Your Job in the below question is to implement the MACD strategy. Start with the standard EMA12 and EMA26, whose difference would give you the MACD line.Signal Line is computed by taking a 9 day EMA of MACD. The point where MACD line crosses above the Signal Line is a bullish indication and similarly the point where the MACD line crosses below the Signal line is a bearish indication.
In simpler words:

- **Buy Signal**

  If ith index is a buy signal(1) then MACD[i] > SignalLine[i] and MACD[i-1] < SignalLine[i-1] to indicate a crossover.

- **Sell Signal**

  If ith index is a sell signal(-1) then MACD[i] < SignalLine[i] and MACD[i-1] > SignalLine[i-1] to indicate a crossover.

- **Zero Signal**

  When ith and (i-1)th have same direction of inequality append a 0 for that day in the signals column.

Change this strategy so that you have no open trades and are holding only one position at a time in the same way as the previous assignment.Follow a compounding approach implying that in each iteration you invest all the amount that you currently have. Start with an initial capital of **10,00,000**.

Keep caution that the number of stocks can only be integer. The left over amount is termed as non investment capital and is not invested in the trade. Try to Code a backtesting engine which is able to calculate the above backtesting parameters given in the signals column in the dataframe and utputs the following dataframes:

- **Trade Wise DataFrame**

  The trade wise dataframe is a trade log and should be containing the following columns for each trade:

    * **Entry Index**
    * **Exit Index**
    * **Entry Date**
    * **Exit Date**
    * **Trade Duration**
    * **Returns for the trade in percent**
    * **Type of Trade: long or short**
    * **Max Drawdown for the Trade**
    * **Max Dip for the Trade**
    * **Quantity or number of stock traded**

- **Daily DataFrame**

  The daily dataframe would be containing a daily log of the following parameters.

    * **Portfolio Value**: Also plot this
    * **Number of Stock or Quantity hold**
    * **Profit from initial capital till now in percent**

Add Graphs to gain valuable insights and mark the entry and exit points on the graph using upper and lower triangles.
A good strategy has a higher return percent and a minimum drawdown. Try to tweak the parameters 12,26 and 9 to arrive at an optimal strategy with a good return percent and a minimum drawdown.

NOTE: It might be possible that you do not beat the benchmark, but that is fine as you are just utilizing a very simple strategy that too without any risk management measure. Focus on the backtesting engine more for this assignement.