CS 7646 - Project 6 Report:

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Technical Indicators:

I have chose 6 technical indicators namely: Price/SMA, Bollinger Band, Commodity Channel Index, Price/EMA, Momentum and Volatility.

Price/SMA:

The Simple Moving Average (SMA) of a stock is the mean value of the stock's price over a defined period (in the last x days). For example, in my implementation, I took the 10 day as lookback period and thus a 10-day SMA in my implementation was calculated by:

SMA = (Sum of prices over last 10 days) / 10

The value range of the SMA can be set up differently for different stocks, and therefore is not a very meaningful indicator by itself for a trading rule. A better indicator can be Price/SMA ratio.

Price/SMA represents the prices of the stock relative to its mean value. Figure below shows the normalized price, 10-day SMA, and Price/SMA ratio.

Ratio greater than 1 means that the current price is higher than the average price, and this might help us in predicting if there might be an expected drop back to the SMA. Likewise, a ratio less than 1 indicates that the current price is lower than the SMA and may help us in making a selling decision, and price might increase back to the average which may help us in making a buying decision.

normalized price and SMA
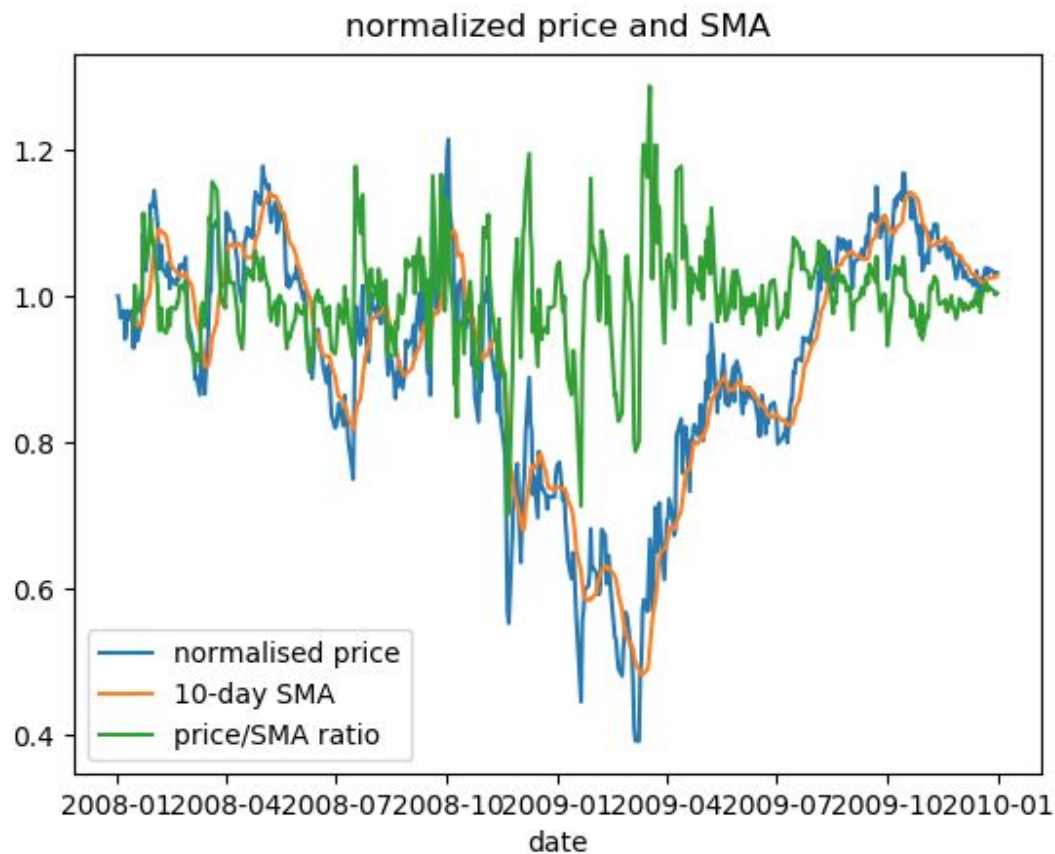
Bollinger Band

Bollinger Band can be calculated by first calculating the SMA as explained above. We then add two standard deviations above and below the SMA. Example, in our case given a 10-day SMA, at any particular point in time:

std = standard deviation over last 10 days.

Upper Bollinger band = SMA + 2 x std.dev

Lower Bollinger band = SMA – 2 x std.dev

The range of the bands can be quite big and will vary for different stocks. A more meaningful measure is the relative ratio between the price and the band.

To be precise, below is the bollinger band percentage metric which is quite useful in making the buying and selling decisions.

Bollinger Band Percentage = (Price–Lower Band)/(Upper Band–Lower Band)

A high percentage (>100% or 1.0 in decimal) means that the price exceeds the upper band, and low percentage (< 0) means the price is less than the lower band. This can be used to show how much the price has deviated from the average.

In my implementation, I've used the exact formula outlined below with the lookback value of 10 days for calculating the std dev.

normalized price and bollinger band indicator
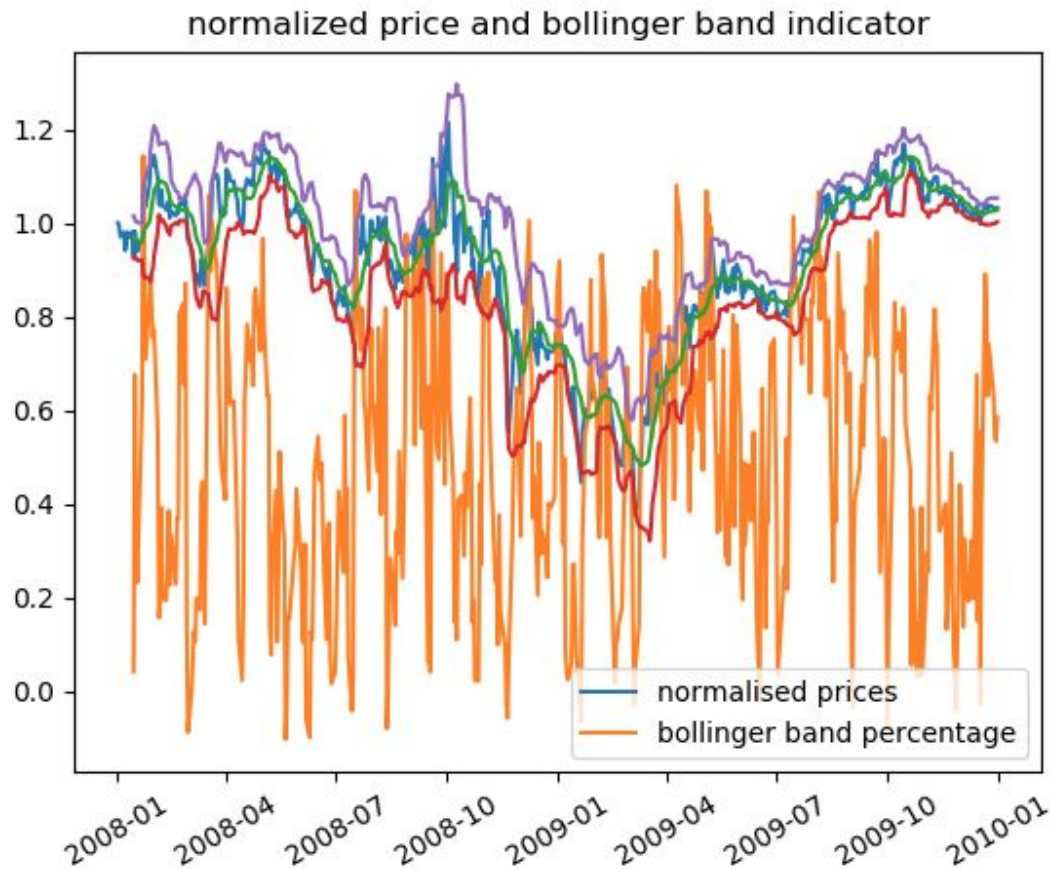
Commodity Channel Index (CCI):
CCI is an indicator that can be used to identify a new trend or can warn us of extreme conditions. CCI measures the current price level relative to average price level over a period of time. CCI is relatively high when the prices are above average and vice-versa. This metric can be used to identify overbought and oversold levels.
CCI measures the difference between a stock's price change and its average price change. High and positive value of CCI indicates that the price is well above the average which in turn shows

us the strength of the stock. Low and negative value of CCI indicates that the prices are well below their average which in turn shows us weakness of the stock.

CCI is calculated using the below formula:

$$CCI = \frac{(prices - rm)}{\sigma(prices)}$$

In my implementation I have used 10 days of lookback period for calculating the CCI.
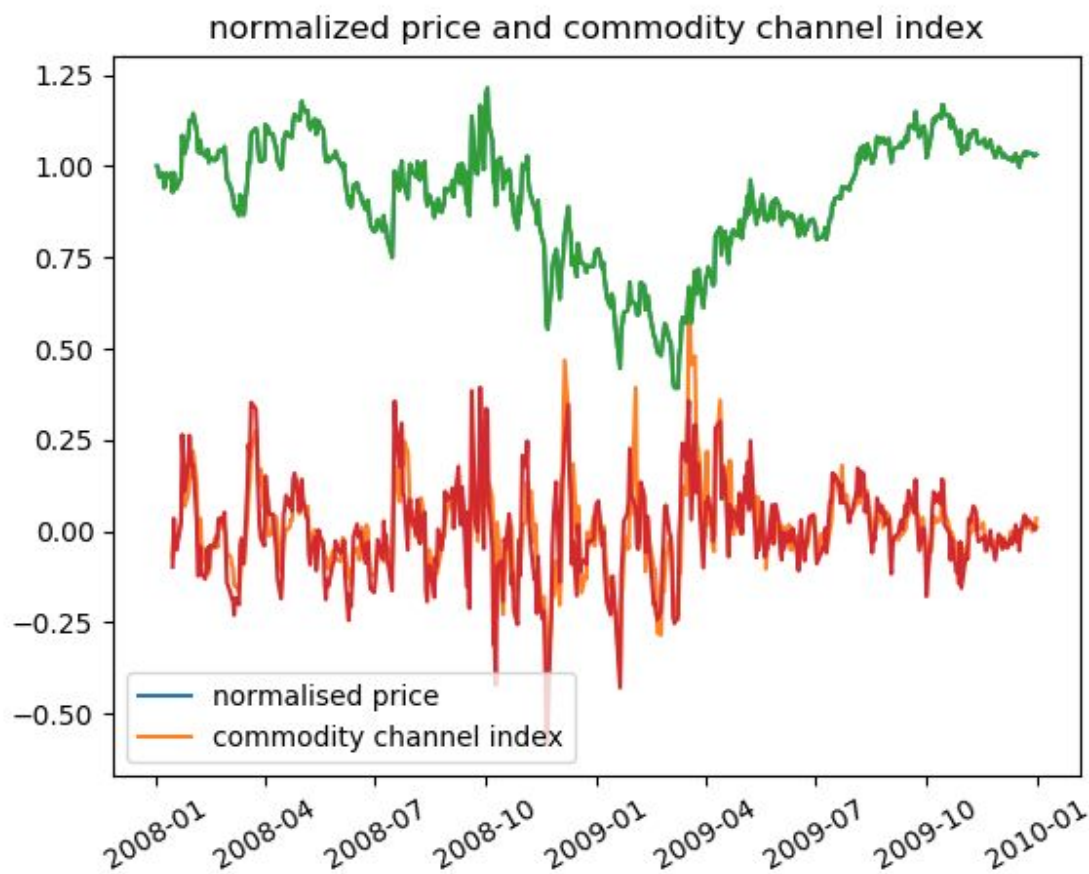
Price/EMA:

Current EMA = (current price - previous EMA) * multiplier + previous EMA

EMA focuses on recent prices rather than on a long series of data points.

The multiplier factor is calculated as:
2/(1+N) where N is the number of days.

Initial EMA is calculated as: N-period sum/N(same as SMA).

This formula makes EMA quicker to react to price changes, helping the trader to get out of a trade during a market hiccup, resulting in an even bigger profit once the hiccup is finished. The faster moving EMA signal any trouble quicker than the SMA, and thus allows the trader to get out of harming the situation fast, leading to loss avoidance for the traders.

A high value to Price/EMA ratio indicates that the price is overestimated, and thus helps in making a selling decision. On the other hand, a low value of Price/EMA ratio indicates that the price is underestimated and thus helps in making a buying decision.
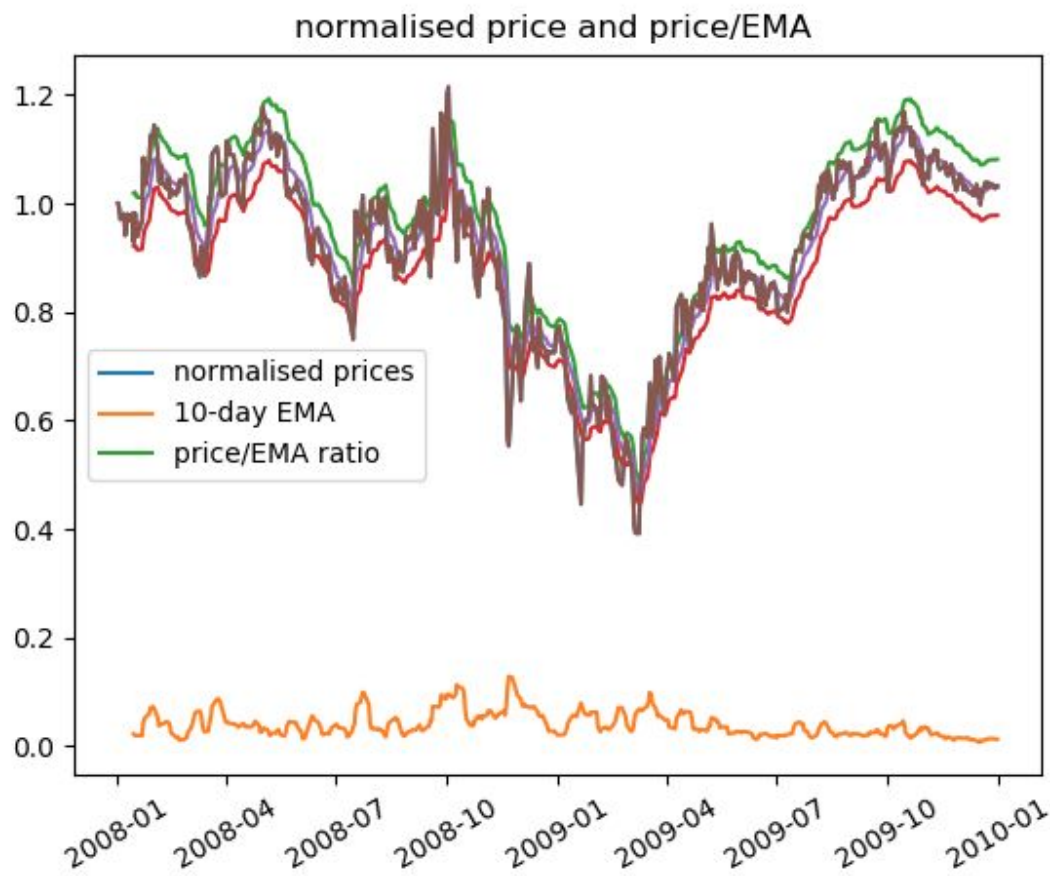

Momentum:

Momentum of a stock over n days is the return of a certain day compared to n days before, specifically:

Momentum (N days) = (current price/price N days ago) – 1

The below figure shows the 10-day momentum of JPM and normalized price.

Momentum helps filter out price fluctuation over the N-day period and thus shows the overall movement over those days. In this example, a positive momentum shows that price has increased compared to 10 days ago, and vice versa.

This indicator can be used to show the trend in price movement over a defined period. If a short period is used, it can help predict whether the price will continue to increase or decrease.

normalized price and momentum
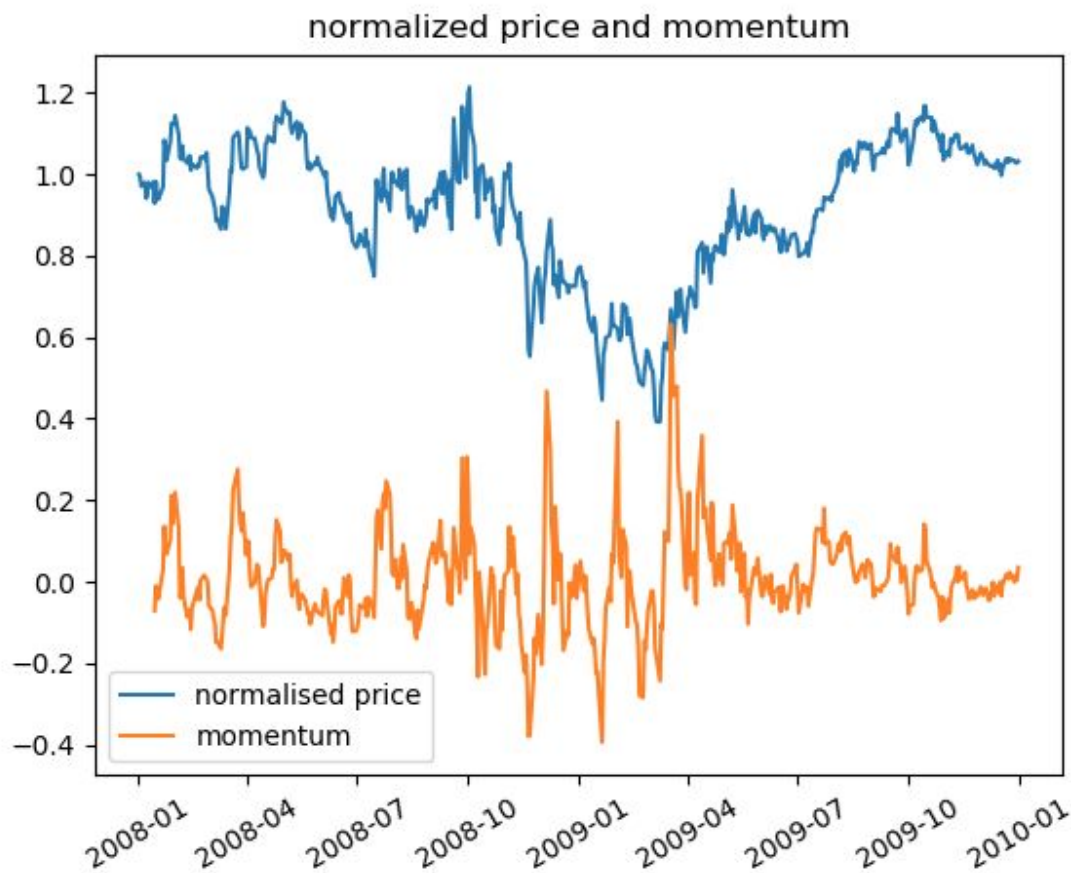
Volatility:
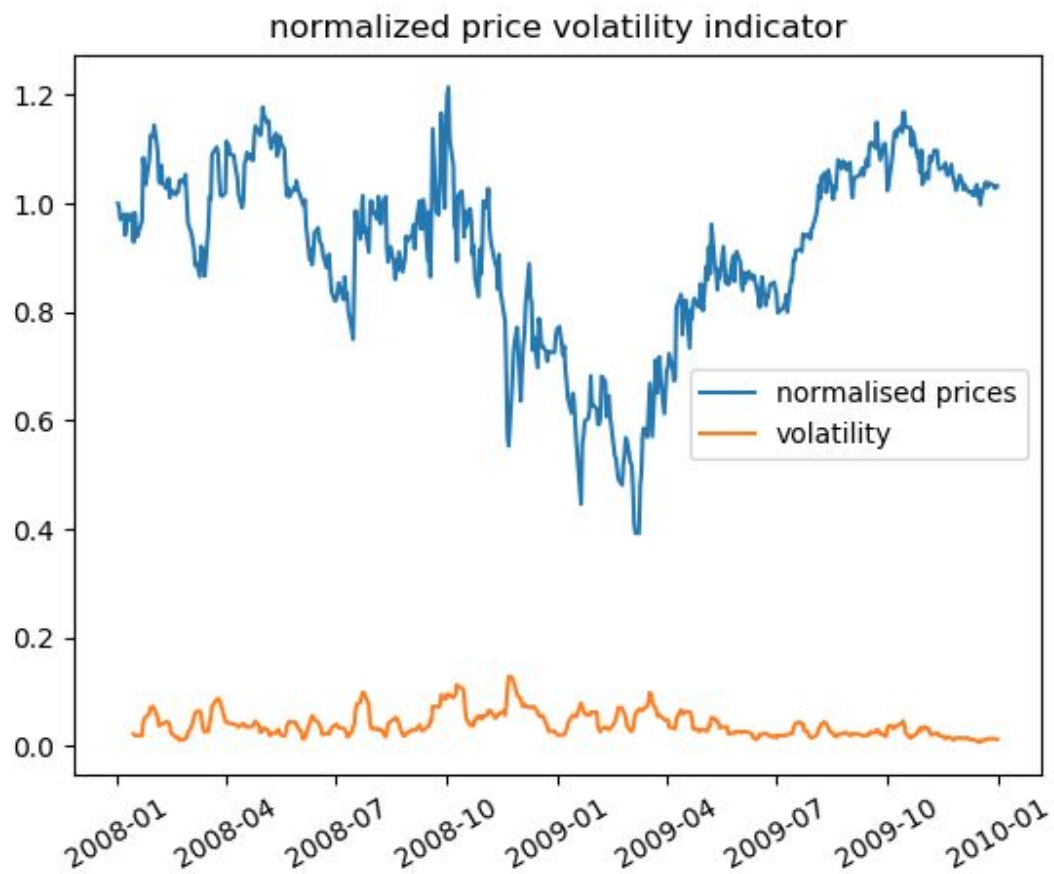I have calculated it using the below formula:

$$Volatility = \sigma = \sqrt{prices}$$

Volatility is a statistical measure of the dispersion of returns for a given security or market index.

It is measured using the std deviation between the returns. The higher volatility implies that there is higher risk for a market index/stock.

I refer to the amount of risk about the size of changes in a security or market index. A higher volatility means that a stock/market index/security is spread out over a large range of values. This in turn means that price can dramatically fluctuate over a short period of time period in either direction. On the other hand, a lower volatility implies that the price won't change dramatically within a short period of time but can change value at a steady pace over a period of time.
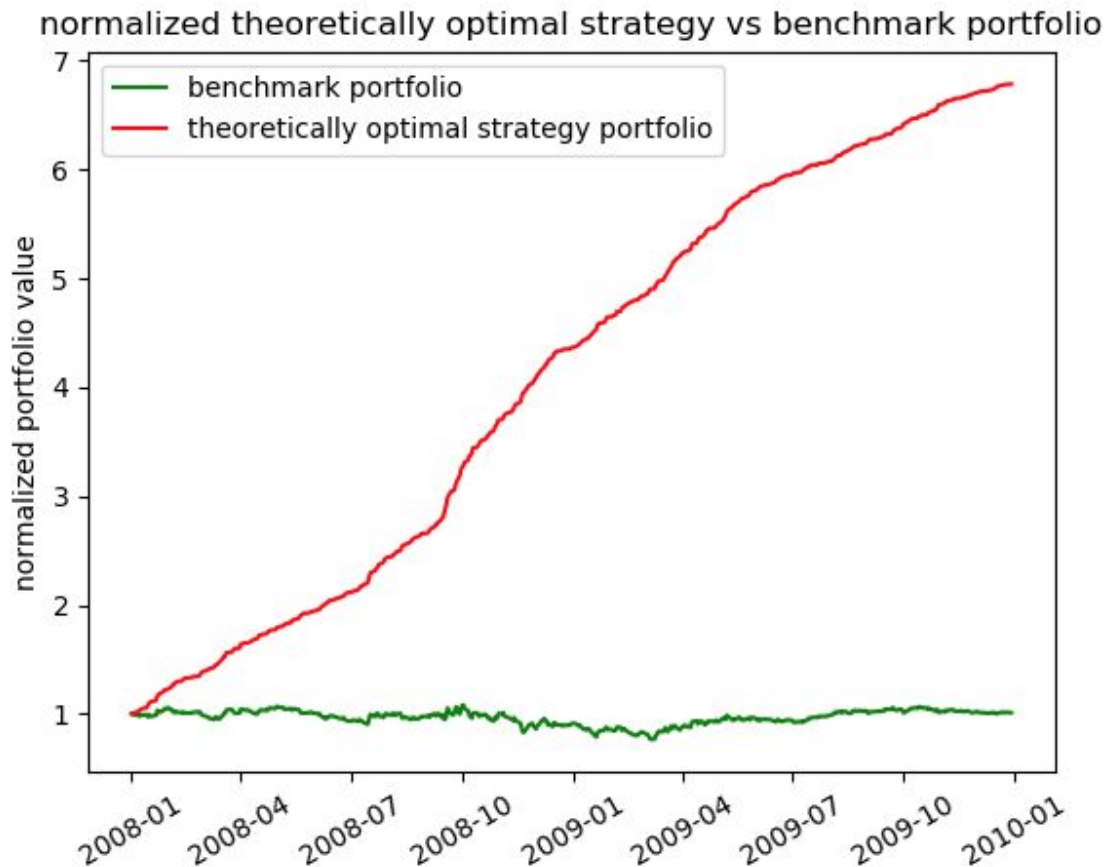
Standard deviation is the most common way of calculating volatility. In my implementation, I have considered volatility to be the standard deviation of prices of JPM stock over a window of 10 days.

Theoretical optimal strategy vs benchmark

normalized theoretically optimal strategy vs benchmark portfolio

The above figure shows the theoretical optimal strategy vs benchmark strategy performance. The optimal strategy simply looks ahead at the next day prices for the JPM stock. If the prices of the stock go up, the program invokes the buying strategy on the other hand if the prices of the stock goes down, the program invokes the selling strategy. It looks at the future 1 day prices data and based on that it already knows if the prices goes up or down. The strategy also makes sure that it can have only one of three states: -1000 shares, +1000 shares, 0 shares. Therefore, it makes sure that if the current position is longing 1000 shares, it won't further buy more stocks. It also takes care of the case when the position is -1000 shares, and it can go ahead and buy 2000 stocks to go to the state with 1000 shares and similarly if the current position is 1000 shares, it can sell 2000 stocks if the next day prices go down and then will go back to the previous -1000 share position. It can't trade more than 2000 stocks.

The benchmark strategy buys 1000 shares and holds its position during the same time frame. It doesn't do any active trading.

Metric	Theoretical Optimal Strategy	Benchmark strategy
Cumulative return	5.7844	0.010599999999999943
Stdev of daily returns	0.004550893009106838	0.017038196884553946
Mean of daily returns	0.003831493339603475	0.00016540672698628993