MANUAL STRATEGY

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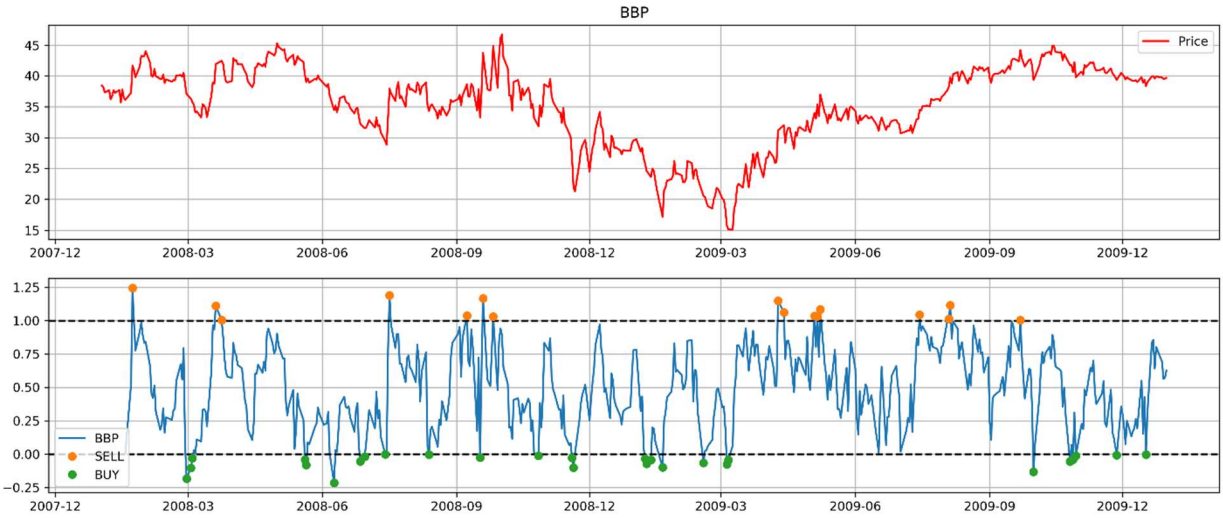
Part 1

BBP[1][2]

Bollinger Bands® are volatility bands placed above and below a moving average. Volatility is based on the standard deviation, which changes as volatility increases and decreases. The bands automatically widen when volatility increases and narrow when volatility decreases. One common strategy is to sell when the price touches the upper Bollinger Band® and buy when it hits the lower Bollinger Band®.
BBP is the percentage of BB, meaning, BBP > 1 indicate passing the upper band, while BBP < 0 indicate passing the lower band.
I think that since it checks for abnormalities of the mean, the assumption that that abnormality will return to normal, can predict the change of price.
Calculation:
Middle Band = 14-day simple moving average (SMA)
Upper Band = 14-day SMA + (14-day standard deviation of price x 2)
Lower Band = 14-day SMA – (14-day standard deviation of price x 2)

$$BBP = \frac{Price - lowerBand}{upperBand - lowerBand}$$



We can see in the figure the possible signals for buy/sell, based on our strategy to buy below 0 and sell when above 1.

[1] https://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:bollinger_bands
[2] https://www.investopedia.com/walkthrough/forex/intermediate/level4/bollinger-bands.aspx

RSI[3]

The Relative Strength Index - RSI is a momentum indicator that measures the magnitude of recent price changes to analyze overbought or oversold conditions. The RSI provides a relative evaluation of the strength of a security's recent price performance, thus making it a momentum indicator. RSI values range from 0 to 100. The default time frame for comparing up periods to down periods is 14, as in 14 trading days. Traditional interpretation and usage of the RSI is that RSI values of 70 or above indicate that a security is becoming overbought or overvalued, and therefore, may be primed for a trend reversal or corrective pullback in price. An RSI reading of 30 or below is commonly interpreted as indicating an oversold or undervalued condition that may signal a trend change or corrective price reversal to the upside.

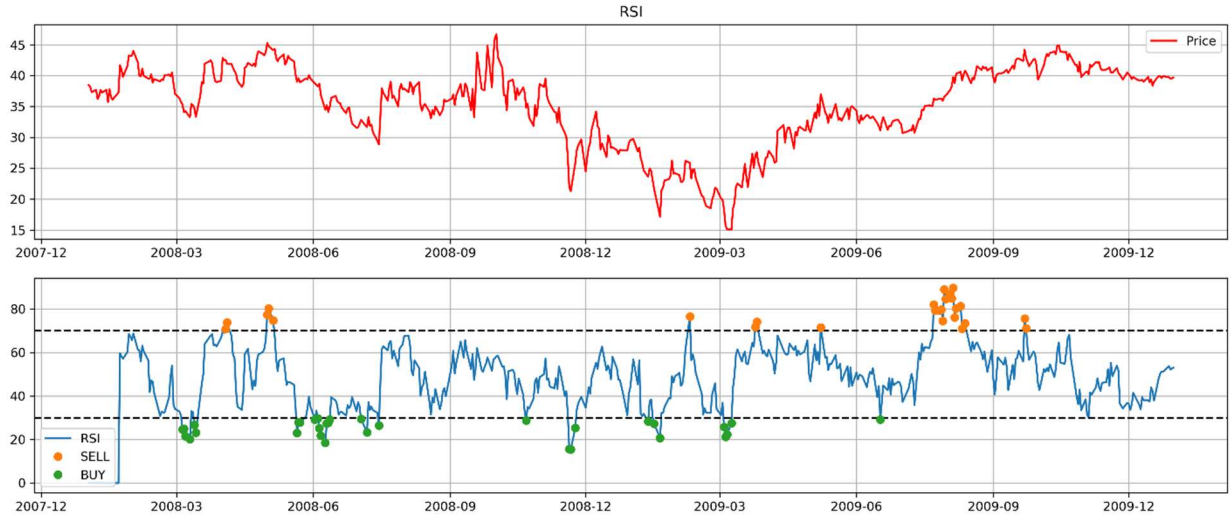
I think that adding a trend indicator to our strategy can give us a sense of the general change in price.

Calculation:

$$\text{RSI} = 100 - \frac{100}{1 + RS}$$

$$\text{RS} = \frac{Average\ Gain}{Average\ Loss}$$

Average gain/loss is the total sum of up/down days divided by the amount of days in our current window.



We can see in the figure the possible signals for buy/sell, based on our strategy to buy below 30 and sell when above 70.

[3] https://www.investopedia.com/terms/r/rsi.asp

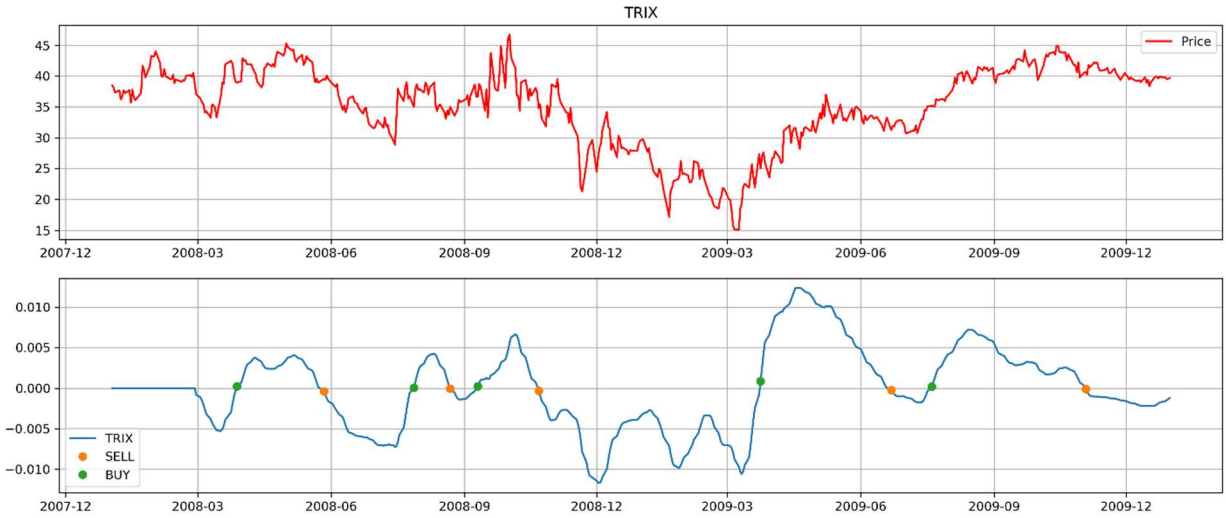
TRIX[4][5]

TRIX is a momentum oscillator that displays the percent rate of change of a triple exponentially smoothed moving average. With its triple smoothing, TRIX is designed to filter insignificant price movements and used to identify oversold and overbought markets.
I went by the centerline crossover - when the TRIX crosses above the zero line it gives a buy signal, and when it crosses below the zero line, it gives a sell signal.
I wanted to add a different moving average than the traditional one that can also eliminate head fakes. TRIX seems to fit, and give me another look on the price change.
Calculation:
First, the Exponential Moving Average of a price is derived from the expression:

$$\mathrm{EMA}(i) = \mathrm{EMA}(\mathrm{Price}, \mathrm{N}, \mathrm{i})$$

Where: $\mathrm{Price}(i)$= current price; N = EMA period; $\mathrm{EMA}(i)$ = the current value of the EMA.
The rest is as follow:

$$\mathrm{EMA1}(i) = \mathrm{EMA}(\mathrm{Price}, \mathrm{N}, \mathrm{i})$$
$$\mathrm{EMA2}(i) = \mathrm{EMA}(\mathrm{EMA1}, \mathrm{N}, \mathrm{i})$$
$$\mathrm{EMA3}(i) = \mathrm{EMA}(\mathrm{EMA2}, \mathrm{N}, \mathrm{i})$$
$$\mathrm{TRIX}(i) = \frac{\mathrm{EMA3}(i)}{\mathrm{EMA3}(i-1)} - 1$$



We can see in the figure the signals for buy/sell, based on our strategy to buy when TRIX crosses above the zero and sell when crosses below.

[4] https://www.investopedia.com/terms/t/trix.asp
[5] https://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:trix

OBV[6][7]

On Balance Volume (OBV) measures buying and selling pressure as a cumulative indicator that adds volume on up days and subtracts volume on down days. It is believed that when volume increases sharply without a significant change in the stock's price, the price will eventually jump upward, and vice versa.

The absolute value of OBV is not important. I wanted to check the trend on OBV, and since I have an indicator that measures the magnitude of recent changes (RSI) I used that on the OBV

I wanted another aspect of the portfolio besides price, and the simplicity of OBV add another dimension to it.

Calculation: (All volumes were calculated based on adjusted price)

If the closing price is above the prior close price, then:

Current OBV = Previous OBV + Current Volume

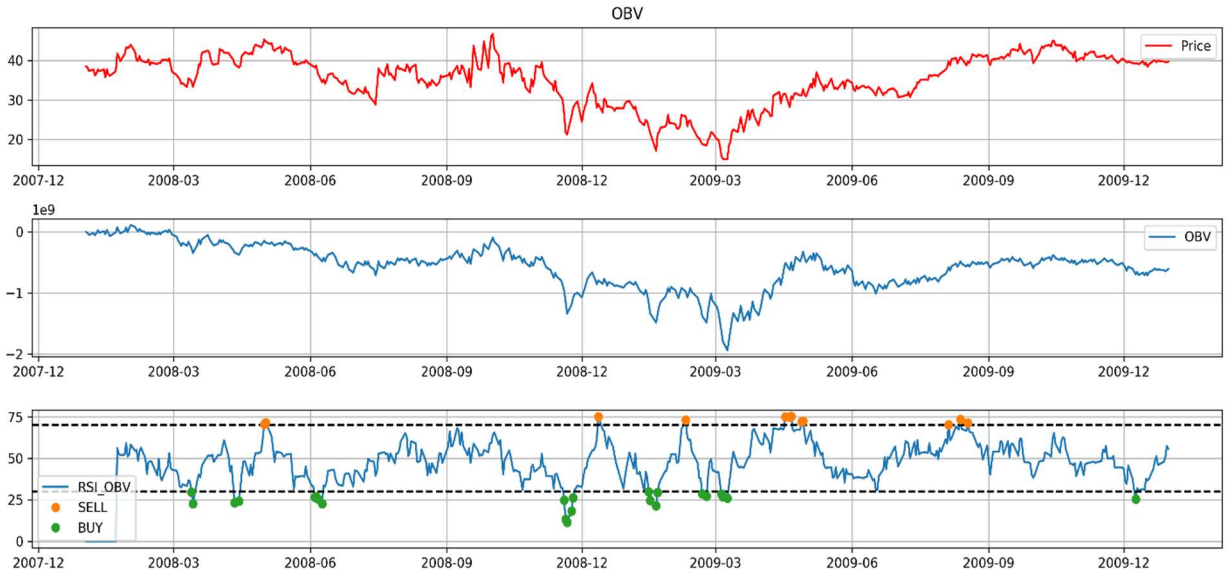
If the closing price is below the prior close price, then:

Current OBV = Previous OBV - Current Volume

If the closing prices equals the prior close price, then:

Current OBV = Previous OBV (no change)

$$\text{RSI\_OBV} = \text{RSI(OBV)}$$



We can see in the second graph the OBV itself as it behaves similarly to the price changes and even precede it in some occasions.

The third graph represent our strategy to buy when our RSI of OBV is bellow 30 and sell when above 70.

[6] https://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:on_balance_volume_obv

[7] https://www.investopedia.com/terms/o/onbalancevolume.asp

Part 2

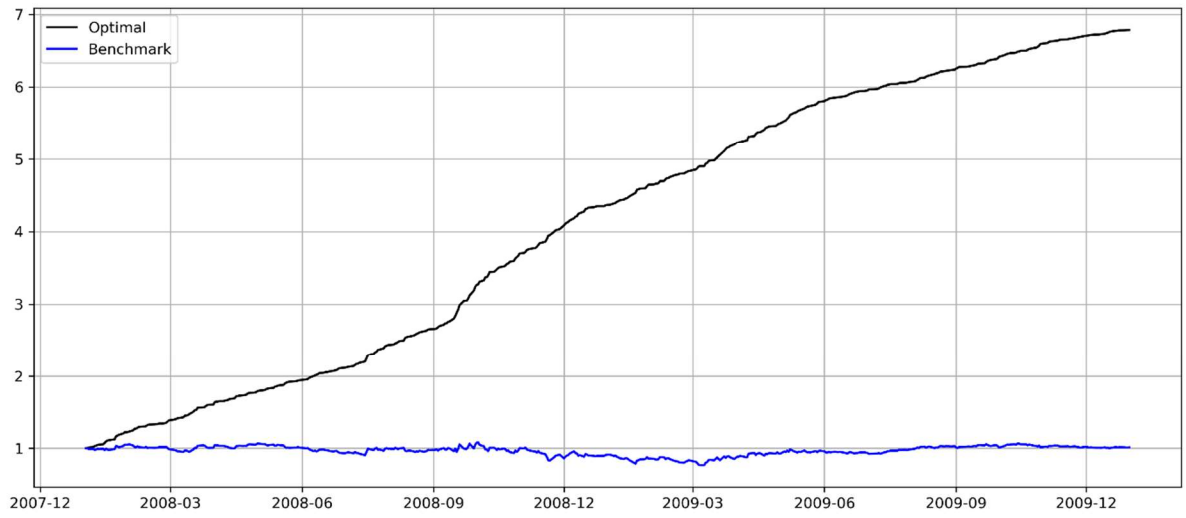
The strategy for optimal portfolio is to go long/short or buy/sell the maximum amount of shares we have if the next day price will change its current direction – since we don't care about the commission or the impact, we will want to do it for **every change** there is. That way we will maximize our profit from each trade we are doing. We are basically making every slope in the price chart positive.
For example: if the price has been dropping for a while, and we know that tomorrow it will rise, we are going to buy the maximum shares available.

Sharpe Ratio of Optimal: 13.3227698482
Sharpe Ratio of Benchmark: 0.156918406424

Cumulative Return of Optimal: 5.7861
Cumulative Return of Benchmark: 0.0123

Standard Deviation of Optimal: 0.00454782319791
Standard Deviation of Benchmark: 0.0170043662712

Average Daily Return of Optimal: 0.00381678615086
Average Daily Return of Benchmark: 0.000168086978191



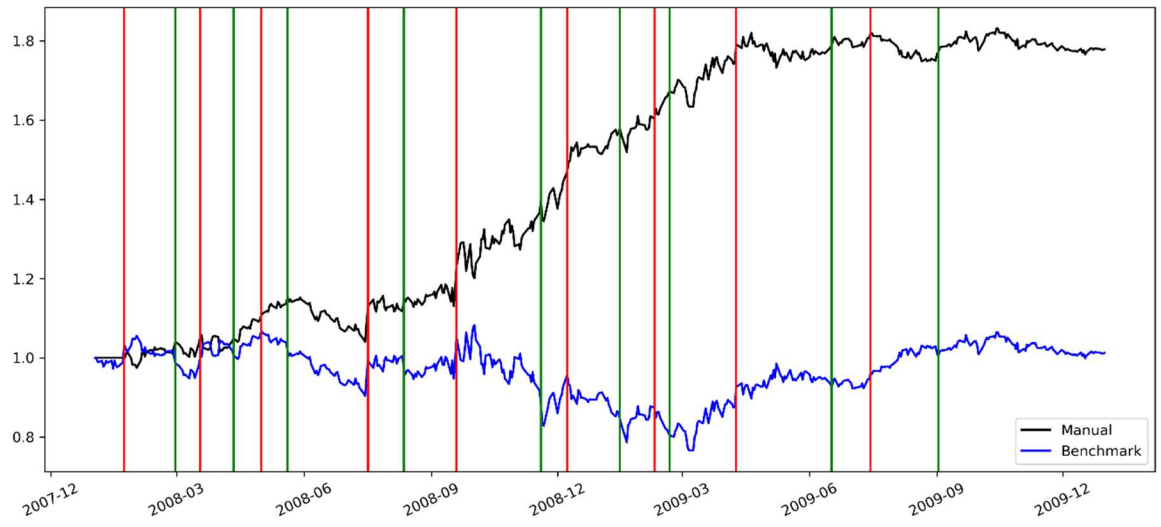
Part 3

I had 4 different indicators to choose from.
Each indicator strategy is as follow:

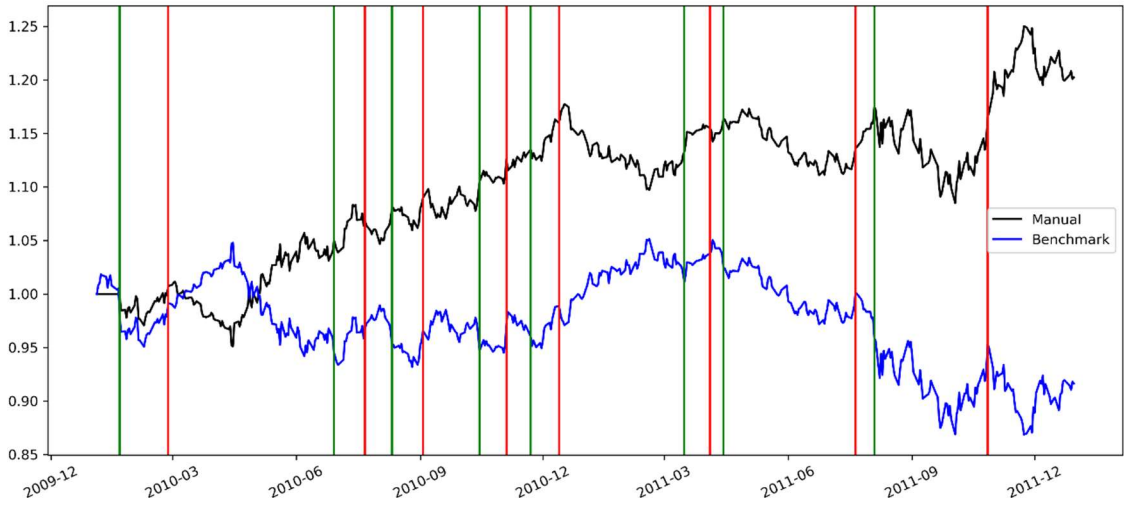
Buy	Sell
Bollinger Band % < 0	Bollinger Band % > 1
RSI < 30	RSI > 70
TRIX crosses 0 upwards	TRIX crosses 0 downwards
RSI_OBV < 30	RSI_OBV > 70

I have been trying several combinations, some were using TRIX as a close signal, some were using a combined state and some as separate state.
The best strategy I found was:
BBP (10) – meaning 10 days
RSI_OBV (14) – meaning RSI of 14 days.
Buy/Sell: when either BBP **or** RSI_OBV met the criteria – meaning going long or short for 2000 shares each time (besides the first 1000)
When I tried to combine (And operator) the strategies, I came out with very little transaction that didn't yield a good outcome. When I treated each separately (Or), I came out with more trades and more meaningful gains.
When I tested the outcome with 0 commissions and impact, I got the best results when TRIX was my closer. But since this is not the case, the multiple transaction hurt the portfolio which led me to minimize the amount of transactions by eliminating TRIX.
I think it turned out the best, since it has a moderate number of orders that doesn't get hurt from the commissions or impact, but at the same time is able to make meaningful transactions.

Sharpe Ratio of Manual: 1.63959799261
Cumulative Return of Manual: 0.779134
Standard Deviation of Manual: 0.0117371629261
Average Daily Return of Manual: 0.00121227246441



Part 4



In-sample period:

	Benchmark	Optimal	In-Sample
Sharpe Ratio	0.15691840	13.32276984	1.6395979
Cumulative Return	0.0123	5.7861	0.779134
Standard Deviation	0.01700436	0.004547823	0.0117371
Average Daily Return	0.00016808	0.003816786	0.0012122

Out-sample period:

	Benchmark	Optimal	Out-Sample
Sharpe Ratio	-0.25681	16.38974551	0.88079843
Cumulative Return	-0.0834	3.1202	0.2023825
Standard Deviation	0.008481	0.00273384	0.00705223
Average Daily Return	-0.0001372	0.00282258	0.00039129

So, for the out-sample my strategy got a better result from the benchmark, but less than the in-sample. The reason for that, is that I overfitted my strategy for the in-sample. I tried to get the best outcome for that period, without cross-validation. As we know from machine learning, when we are trying to get the best result for in-sample without any validation, we tend to overfit and get worst results for the out-sample.