QF 302 Final Project Report
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Technical Analysis Using Bollinger Bands

Background

The objective of our project was to use Bollinger bands to create signals for when to buy and sell stocks in order to optimize our portfolio's returns. Bollinger bands are a useful tool for analyzing trend strength and monitoring when a reversal may be occurring. The simple moving average (middle band), and two standard deviations above (upper band) and below (lower band) the moving average make up the three main bands of this type of analysis. The movement between these bands then signal buy and sell strategies to traders. These bands move with the price and will contract and widen with volatility. When the closing price moves towards the upper band, it shows that the price level is statistically high or expensive. As the closing price moves towards the lower band, it means the price level is statistically low or cheap.

Methodology

Our algorithm imports the price data of the following five stocks from the SHIFT system: Apple (AAPL), Amazon (AMZN), British Petroleum (BP), ConocoPhillips (COP), and Exxon Mobil (XOM). The Bollinger bands for each stock are calculated using a moving window of ten periods. The program calculates the ten period moving average of the stock prices and the ten period standard deviation of those stock prices. It uses these to calculate the upper and lower bands, which are the moving average plus or minus two standard deviations. We also use these to compute the upper mid and lower mid bands, which are the moving average plus or minus one standard deviation.

Using the four bands created, we are able to formulate buy and sell signals for a momentum strategy that our algorithm will trade off of. The signals are as follows:
- Long (1) when Last Price ∈ [Upper Mid, Upper Band]
- Neutral (0) when Last Price ∈ [Lower Mid, Upper Mid]
- Short (-1) when Last Price ∈ [Lower Mid, LowerBand]

We determined that our portfolio would be an equally weighted portfolio. Thus, we assume a portfolio of $1,000,000 and divide this money equally amongst the five stocks. Every three seconds, our algorithm makes a decision of whether it should be long, neutral or short. The number of shares calculated is determined by taking this ⅕ of the total portfolio and dividing it by

the Last Price of the stock. After the signals and number of shares are calculated, the trades are executed. These trades then used to produce the profit and loss of the strategy.

Results

After running our algorithm multiple times for ten minutes, we are able to conclude that our strategy is profitable. In one of the simulations we ran, we generated a 0.63% return during the ten minute trading period. Below is the profit and loss breakdown for each of the five stocks, as well as the overall profit.

	Profit/Loss
AAPL	$1,598.31
AMZN	$1,763.62
BP	$361.28
COP	$1,404.54
XOM	$1,156.67
Total	**$6,284.42**

We can also analyze our results in a graphical format. To do this, we will look specifically at how Apple performed during the simulation.

The first chart to analyze is the Bollinger bands generated for AAPL. As you can see, we have 200 observations during the 10 minute period. The blue line is the Last Price, which you can see bouncing around between the various bands we have created. Based on our strategy, we are long AAPL when the blue line is above the green line and below the yellow line. We are neutral when the blue line is between the purple line and the green line. Lastly, we are short AAPL when the blue line is between the brown line and the purple line. As you can see below, there are multiple times where the blue line crosses into new signal sections.
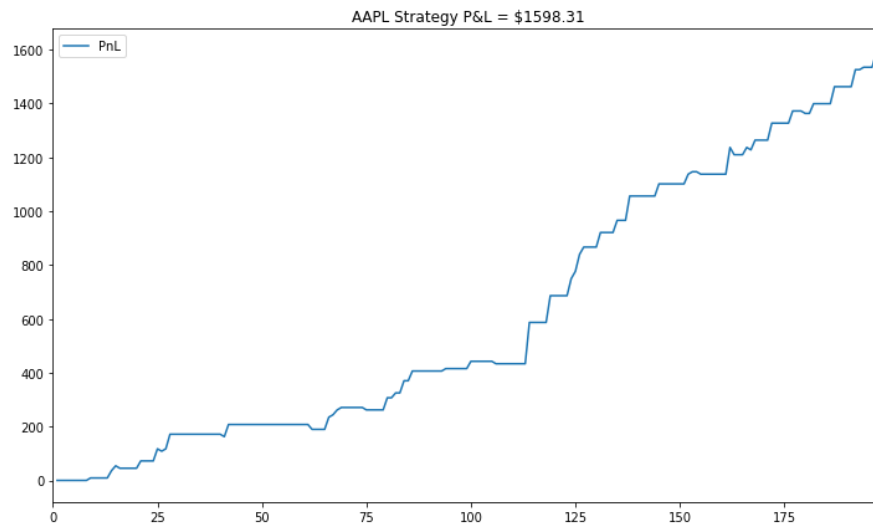
Bollinger Bands for AAPL
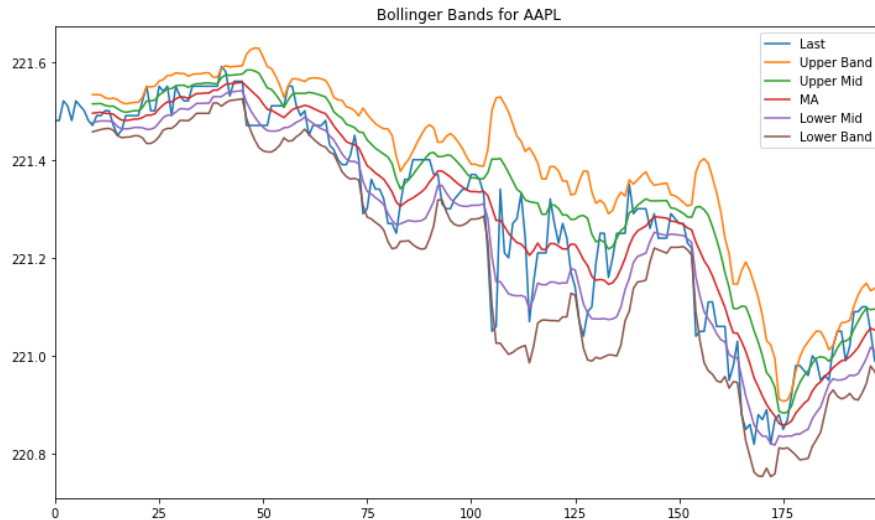
The next chart is the signal line for AAPL during the 10 minute simulation. As mentioned earlier, Apple's stock price was constantly bouncing between different signals based on the Bollinger bands chart. The chart below give an even better illustration of which signal we are in at various stages. As you can see, our trading strategy is extremely active in the market during the simulation period. On a quick visual analysis, it seems there is a roughly equal distribution between the three signals of long, neutral and short.

Signal Line for AAPL
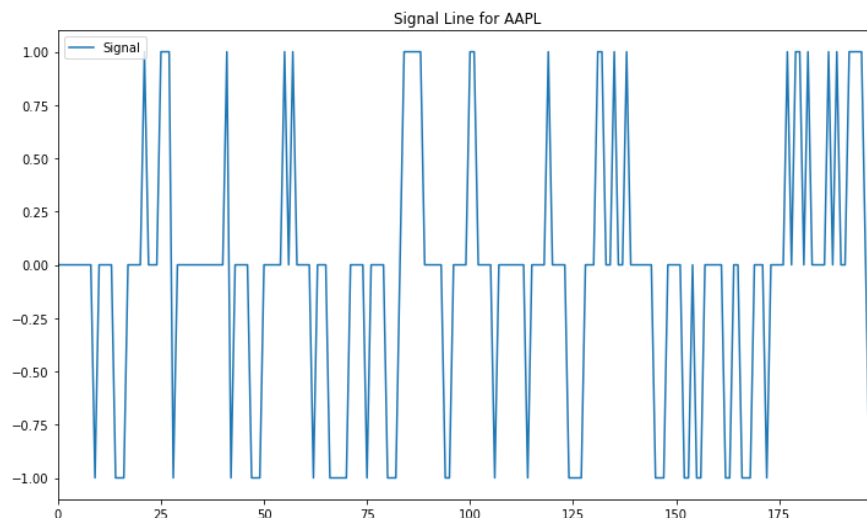
The final chart we will analyze is the profit and loss (PnL) for AAPL during the simulation. The chart below ties together the Bollinger band chart and the signal line chart. As you can see in the PnL chart, the strategy consistently generates profit during the trading period. In fact, the resulting chart shows that nearly every trade made is profitable, which is an excellent result to see. The results are similar for all other stocks as well, showing we have a strong,

relevant, and profitable trading strategy. All other stock charts can be found in the Appendix of this paper.

AAPL Strategy P&L = $1598.31

Conclusion

   Technical analysis using bollinger bands can be useful to retail investors who are interest in making investments using statistical measures. All in all, our approach to a Bollinger band trading strategy proved to be profitable in a market simulation using SHIFT data. We were able to obtain positive PnLs for all stocks and overall have a positive portfolio return.

   There are several ways in which we can add on and improve the efficiency of this trading algorithm. This strategy could include expanding to a larger or a more diverse basket of stocks, testing the strategy over a longer time period, and testing/deploying the strategy in a real market environment using real money. We can also combine other technical indicators to this trading strategy such as the Relative Strength Index (RSI) that we built in the previous assignment. This combination of technical indicators is commonly used to detect whether the RSI divergence is bearish or bullish. A bearish divergence is when the market makes a higher high, but the RSI indicator shows a lower high (a sign of weakness). A bullish divergence is when the market makes a lower low, but the RSI indicator shows a higher low (a sign of strength). If the price is at upper Bollinger Bands, then you can look for a bearish RSI divergence to indicate weakness in the underlying move and vice versa.
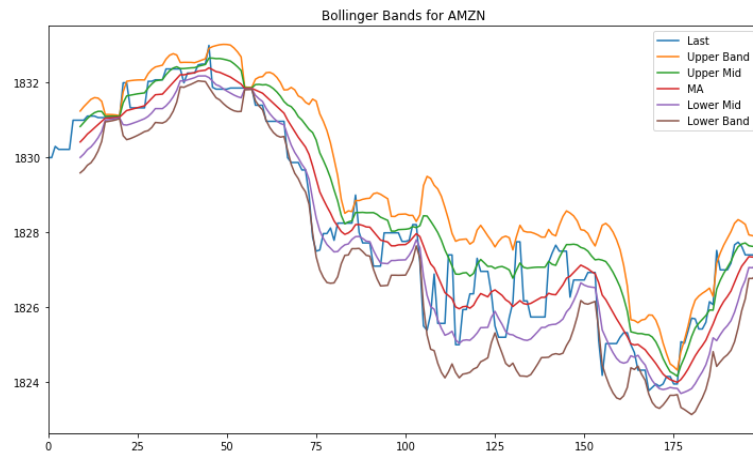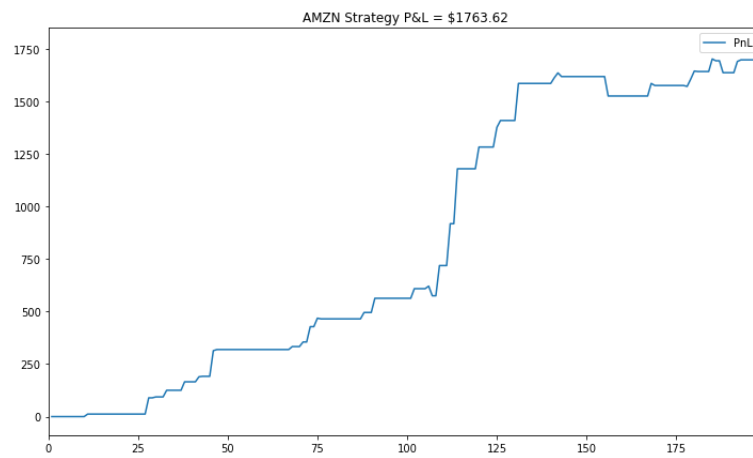
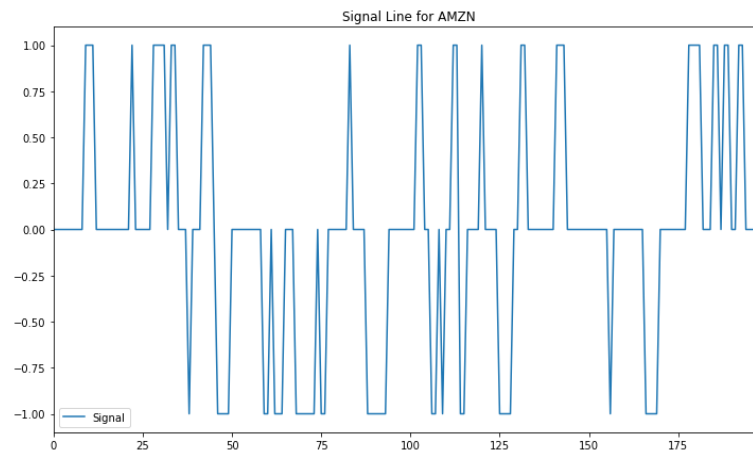# Appendix

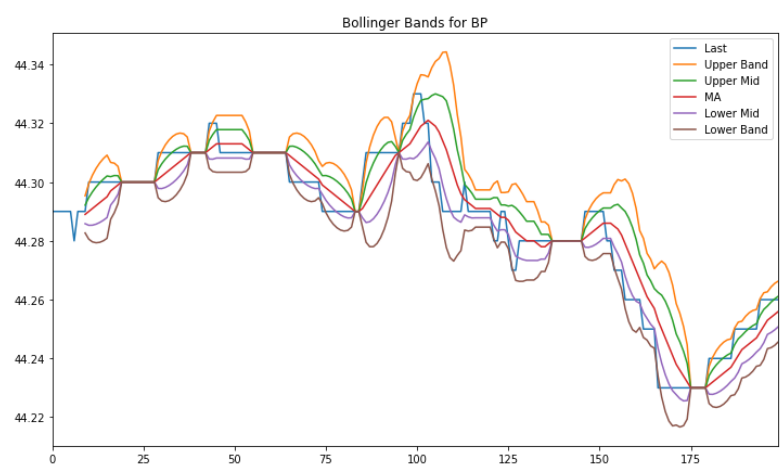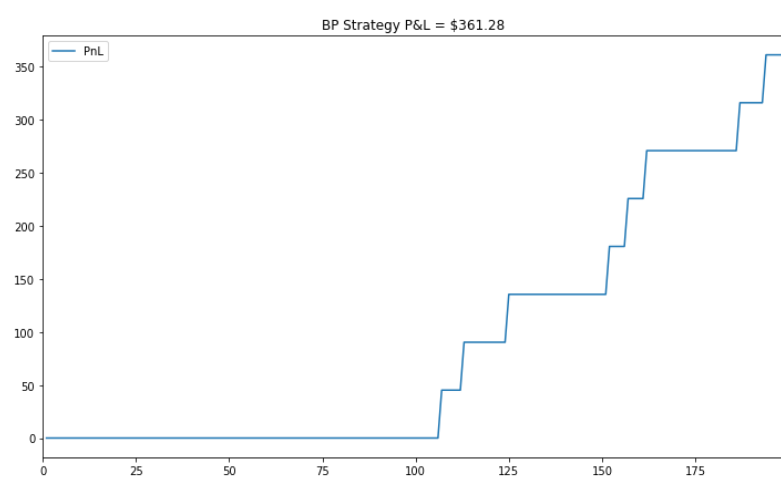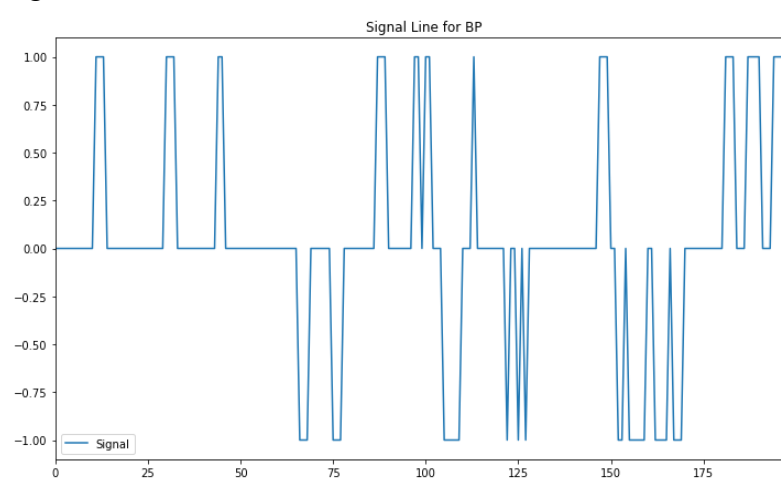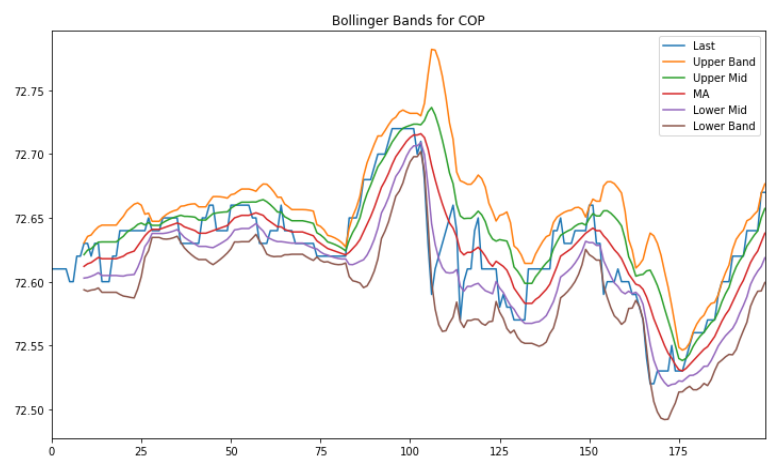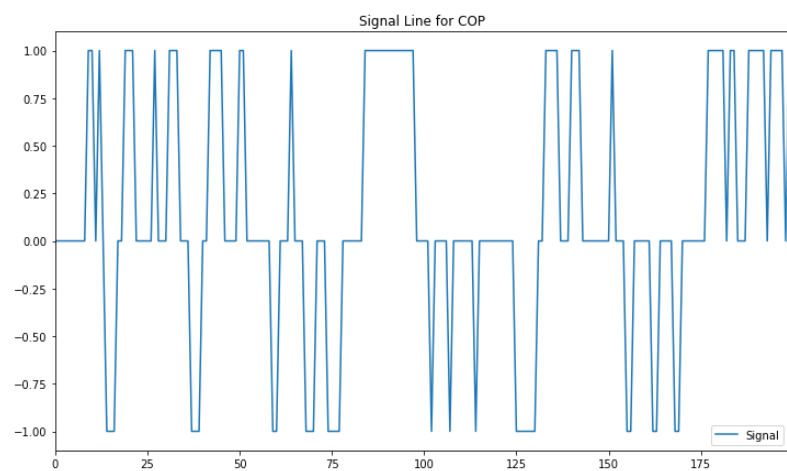Figure 1

Figure 2

Figure 3

Figure 4

Bollinger Bands for BP

Figure 5

BP Strategy P&L = $361.28

Figure 6

Signal Line for BP

Figure 7

Bollinger Bands for COP

Figure 8

COP Strategy P&L = $1404.54

Figure 9

Signal Line for COP

Figure 10

Bollinger Bands for XOM

Figure 11

XOM Strategy P&L = $1156.67

Figure 12

Signal Line for XOM