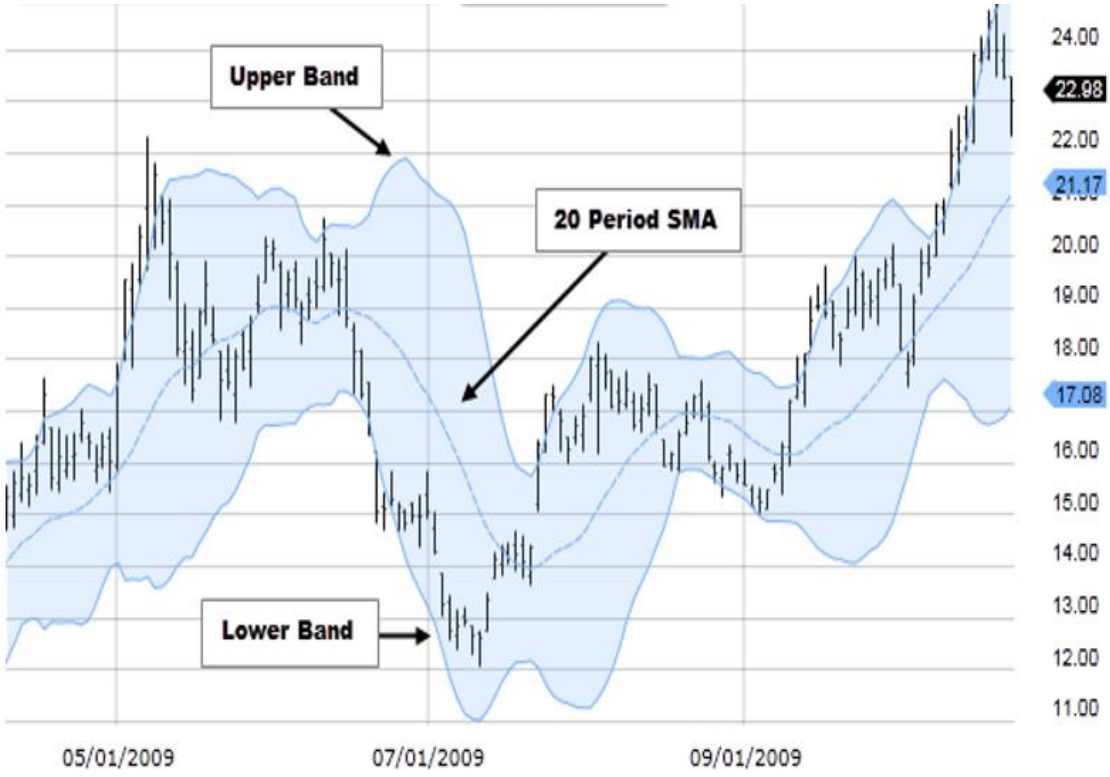
Assignment

One of the basic problems is computation of optimal hyper-parameters once you choose a prediction model. In this assignment, we will investigate the computation of optimal parameters for a popular trading strategy based on Bollinger bands.

Recall that for your stock we have computed the simple moving average MA of stock price and its volatility σ over W days. Around this average price, we compute the upper and lower bands as follows:

- upper band: $MA + k\sigma$ for $k = 2$
- lower band: $MA - k\sigma$ for $k = 2$

We consider the channel $C = (MA - k\sigma, MA + k\sigma)$ for $k = 2$. This is illustrated below:



Intutitively, most of the time the price will be inside the channel. if it falls below the lower band, we expect it to return (and therefore, we buy). If it goes above the channel, we expect it to decrease (and, therefore, we sell short). There are amny variations on Bollinger trading. We will consider the following (simplified) strategy:

- take $W = 20$ days, $k = 2$ and the time period - year 2017.
- consider each trading day just before the market close. Assume that the price will not change much during the last few

minutes of trading. In other words, assume that you know the closing price P for that day. Compute the Bollinger channel (using W days, including the current day). Our strategy is:

- if $P > MA + k\sigma$, then
  1. if you have no position, sell short \$100 at the closing price (this established a short position)
  2. if you have a short position already, keep it (do nothing)
  3. if you have a long position, sell all your shares at the closing price (close your position)
- if $P < MA - k\sigma$, then
  1. if you have no position, buy \$100 at the closing price (this establishes a long position)
  2. if you have a long position already, keep it (do nothing)
  3. if you have a short position, close it by buying shares at the closing price (close youur position)
- if $MA - k\sigma \leq P \leq MA + k\sigma$, then you do nothing (and keep your position if you have one)
- we ignore trading costs and assume that we can always execute our trades at the closing price

- a transaction is defined from the time you start a position (long or short) till you close it. A transaction always involves two trades: to opena position and to close it.

In the above strategy, there are two hyper-parameters: length of window W and the width of the channel determined by k. We ask the following question: which combination of W and k gives the best result (most profit) per transaction?

Questions:

1. write a function bollinger(W, k) that computes the average profit/loss per transaction. Take 2017. Take $k = [0.5, 1, 1.5, 2, 2.5]$ and take $W = range(10, 51)$. Plot the results as follows: on x axis you have W, on y axis you have k. For this combination of W and k, compute average P/L per transaction using your function bollinger(W, k). If the profit is positive, plot a "green" dot, if negative plot a 'red" dot. Use the size of the dot to indicate the size of profit or loss. (Hint: use "scatter" function in matplotlib - you can specify coordinates, color, size, etc.)

2. examine your points. are there any patterns? What is the best (highest profit per transaction) combination of W and k for 2017?

3. repeat the previous question for 2018. Are your results different?