Algorithmic Trading

03 August 2018

Abstract

For financial time series data analysis, support and resistance are very popular concepts among traders. These help a trader to anticipate quantitatively the price movements in near future. The support and resistance are represented by straight lines. This text, after a brief introduction to support and resistance, presents an algorithm to find those, and obtain an empirical distribution of the time interval in the future for which the the support and resistance are obeyed by the data. We illustrate these using an example.

1 Introduction

Support A support level is a level where the price tends to find support as it falls. The traders believe that the price is more likely to bounce off this level rather than break through it. At this price level, demand is thought to be strong enough to prevent the price declining further. However, once the price breaches this level, by an amount exceeding some noise, traders redefine a new support from the recent lag data. Buyers buy shares of a stock near the support level, since it is thought that the prices of a stock will not decrease beyond the support level.

Resistance Resistance is, in some sense, a complement to the support. Resistance refers to the historically observed upper bound of the price of a stock, so the resistance is rarely breached. At this price level selling is thought to be strong enough to prevent the price from rising further. However, once the price has breached this level, by an amount exceeding some noise, traders redefine a new resistance from the recent lag data. Both resistance and support are characterized by straight lines. Sellers sell shares when a stock is at its resistance level, since prices rarely go above the resistance level.

Support and resistance are used in technical analysis of stock prices (where the focus is on the observing the trends and patterns instead of looking at the qualitative and quantitative features of the company). Together, support and resistance forecast a range where the stock price would stay in the near future.

In this experiment, given a time series data of stock prices observed at discrete points in time (equally spaced from each other), firstly we try to find out the equations of the straight lines representing support and resistance, respectively, using l units of the data as lag. Once we have determined the equations of the straight lines, we try to find out the time intervals in the near future till which the given support and resistance levels are obeyed by the data. We determine these time intervals for different values of t, where t is the present time. We recall that l is the number of data points prior to t used to calculate the support and resistance equations. We then use all these values to find out an empirical distribution of the time intervals till which the stock prices stay within the support and resistance levels.

2 Theory

2.1 Determining the equations of support and resistance

Suppose we have data points $\{S_t | t = 0, 1, 2, \cdots, n\}$ which represent the stock prices as observed at time points $t = 0, 1, 2, \cdots, n$ which are equally spaced. Let the present time be denoted by $t(\geq l)$ and let l denote the units of lag data. Therefore, we will be using $\{S_{t-l}, S_{t-l+1}, \cdots, S_t\}$ as lag data. Thus we obtain a set X of $l+1$ points given by $\{(t-i, S_(t-i)) | i = 0, 1, ..., l\}$. For finding support and resistance line, we would first consider the collection of straight lines passing through any pair of points from X such that the whole set X lies on one side of the line. There could be many such straight lines. For the sake of unique selection we bring in a minimization problem. We minimize the cost functional that gives the distance of the CG of X from the straight line. We want to find out the equations of support and resistance by minimizing the perpendicular distance between the center of gravity and the straight line representing support/resistance.

The center of gravity $g = (g_1, g_2)$ is -

$$(g_1, g_2) = (t - \frac{l}{2}, \frac{1}{l+1} \sum_{s=0}^{l} X_s) \tag{2.1.1}$$

where $X_s = S_{t-l+s}, s = 0, 1, ..., l$

Now, we choose two points (s_1, X_{s_1}) and (s_2, X_{s_2}) in the set X. The equation of the line L passing through (s_1, X_{s_1}) and (s_2, X_{s_2}) is given by

$$L(s) = X_{s_1} + \frac{X_{s_2} - X_{s_1}}{s_2 - s_1}(s - s_1). \tag{2.1.2}$$

Thus $(s, L(s))$ is the locus of required line L. Let $J(s_1, s_2)$ be the perpendicular distance between the point (g_1, g_2) and the line. Then $J(s_1, s_2)$ is given by

$$J(s_1, s_2) = \frac{|X_{s_2} - X_{s_1}|\, g_1 - (s_2 - s_1)g_2 + (X_{s_1}s_2 - X_{s_2}s_1)}{\sqrt{(X_{s_2} - X_{s_1})^2 + (s_2 - s_1)^2}}. \tag{2.1.3}$$

Now for obtaining the equation of support, we consider the minimization problem :
$\min_{t-l \leq s_1 < s_2 \leq t} J(s_1, s_2)$ subject to $\{X_k \geq L(k; s_1, s_2)\ \forall\ 0 \leq k \leq l\}$.

Let (s_1', s_2') be a minimizer of the above problem.Then the equation of support is given by

$$L(s) = X_{s_1'} + \frac{X_{s_2'} - X_{s_1'}}{s_2' - s_1'}(s - s_1') \tag{2.1.4}$$

The equation of resistance is arrived at by a similar method.

2.2 Empirical distribution of $\delta^+(l)$ and $\delta^-(l)$

Given l, $\delta^+(l)$ is the length of time in the immediate future where resistance was obeyed. Similarly, $\delta^-(l)$ is the length of time in immediate future where support was obeyed.

For fixed l, $\delta^+(l)$ and $\delta^-(l)$ are random time series. To be more precise $\delta^+(l) = \{\delta^+(l)_l, \delta^+(l)_{l+1}, ..., \delta^+(l)_{n-l}\}$.

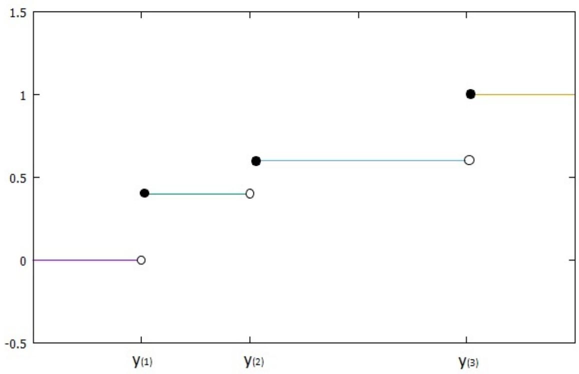
Empirical Distribution

If we have a sequence of independent and identically distributed sample from a population $(y_1, y_2, ..., y_n)$, then

$$\hat{F}(y) = \frac{\#\{i|y_i \le t\}}{k}$$

$t \ge 0$
$\hat{F}(y)$ estimates the probability $P(Y \le y) = F_Y(y)$.

Let $\left\{y_{(1)}, y_{(2)}, ..., y_{(n)}\right\}$ be an ordered set.



This graph shows the empirical distribution of $\{y_{(1)}, y_{(2)}, ..., y_{(n)}\}$.