Discovering and evaluating trend patterns in Financial Time Series

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Abstract

Over the decades of stock price analysis, a number of heuristics have been developed. One such heuristic is the "head and shoulders" pattern; conventional wisdom has it that a large peak surrounded by two smaller peaks, at the end of a long upward trend, predicts a long downward trend afterwards. We developed a program to automatically find and evaluate such patterns. Simulated data indicates that in random sequences of high and low points, approximately 0.4% to 0.6% of these sequences can be classified as head and shoulders, with small differences depending on the underlying distribution. We present results from processing stock prices between 2007 and 2014 and analyze the empirical accuracy of the head and shoulders rule.

Key Words: visualization, prediction, technical analysis, financial data

Introduction

The authors have been looking at patterns in time series data in general, and financial data in particular, for the past several years [1, 2]. In particular, we developed a heuristic algorithm in R for trendine determination and visualization. This algorithm plots positive and negative trendlines for specific time periods at different thresholds [2].

Recently we have been looking at different patterns in financial time series which are thought to indicate and predict trend changes. Some examples of this are triangles, double tops, saucers and wedges. Achelis lists many of these patterns in detail [3]. A pertinent question is whether these specific patterns have a verifiable relationship to future performance based on data from financial time series such as stocks.

Our attention was particularly caught by the "head and shoulders" pattern. This pattern is described as a long upward trend, leading to a small peak, followed closely by a larger peak and then a second small peak. This pattern has been used extensively as a predictive heuristic for stock prices. The heuristic is that this pattern predicts the end of an upward trend and the beginning of a long-term downward trend [4, 5]. How accurate is this heuristic? What is its true predictive ability?

Research from the late 1990s was skeptical of the accuracy of the head and shoulders pattern [6, 7]. Lo et al have also looked at the accuracy of the head and shoulders pattern [8]. We looked at the basic head and shoulders pattern shown in Figure 1 and determined some basic rules for a series of break points (points where the data trend changes). We adapted our existing graphics algorithm to detect these patterns and display them

visually. We then evaluated these patterns to see how often they preceded a long-term downward trend and thus made a head and shoulders pattern a good predictor. Details of the algorithm are described in the next section.

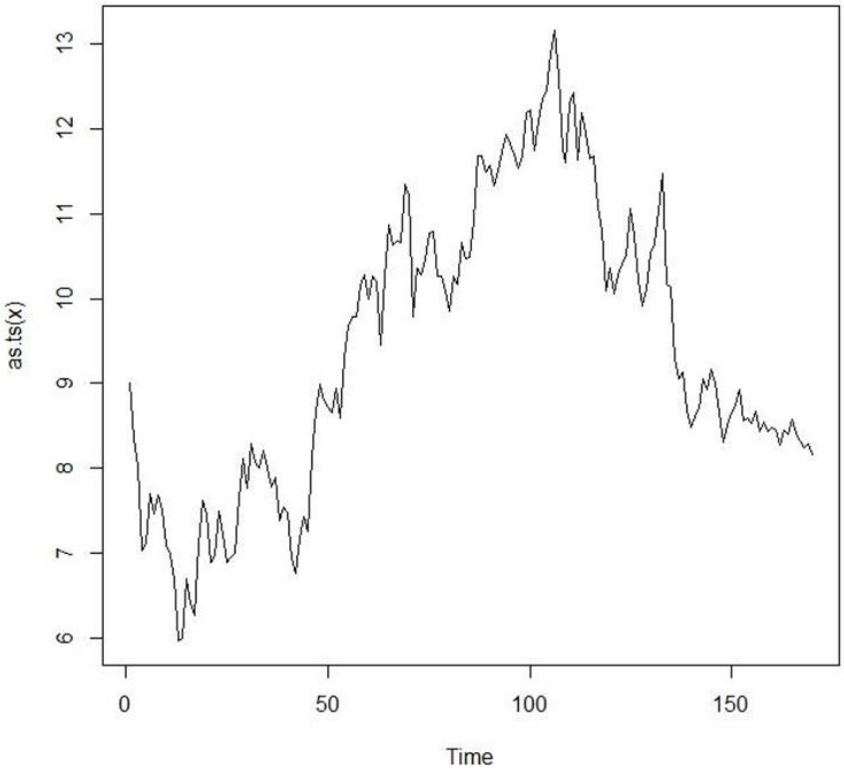

Figure 1: A head and shoulders example from real stock data

Algorithm

We first focused on rules for defining a head and shoulders pattern heuristically. Since our existing trendline algorithm provided lines with upward and downward slope, and points where the lines switched ("break points"), we adapted this algorithm for this effort. Figure 2 shows our basic rules graphically. Given a series of change points b1,b2, b3,b4,b5,b6,b7,b8 and b9 in a financial time series such as stock prices, a head and shoulders pattern is distinguished as follows:

1. b5 is the maximum value of the change points.
2. b4 is less than b7 and b6 is less than b3
3. The "neckline" is the line connecting b4 and b6. Both b1 and b9 must be below the neckline.

This definition is very similar to that of Lo et al [8].

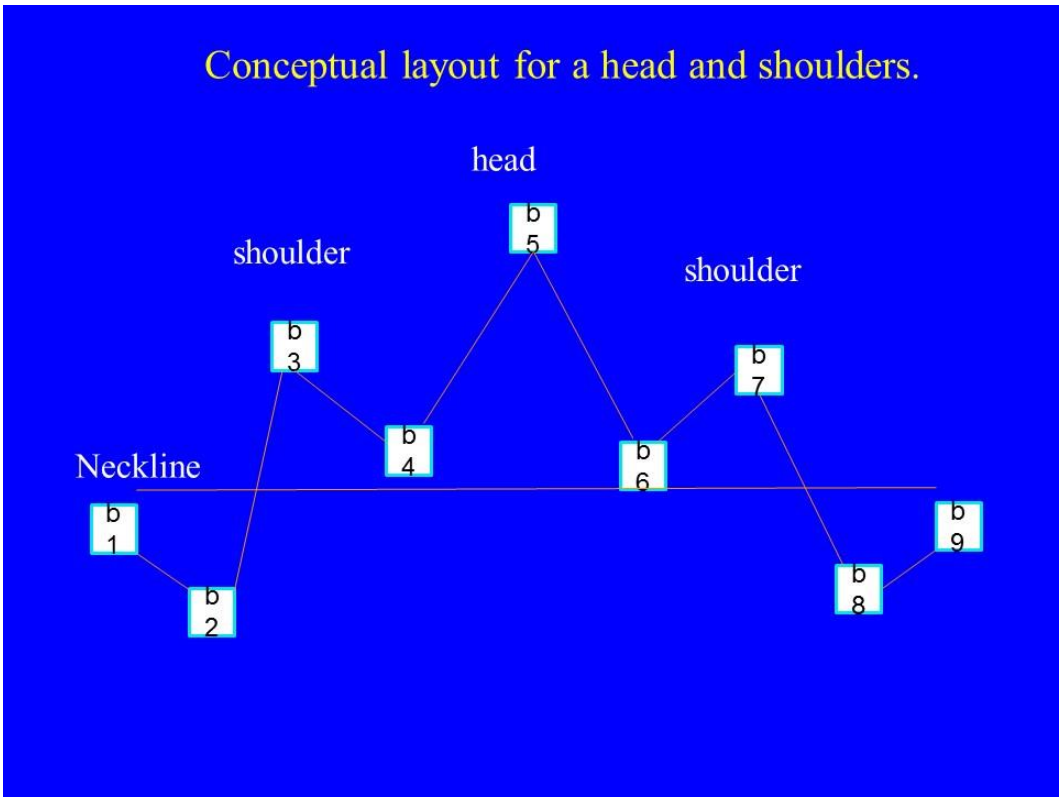

Figure 2: The break points used for our head and shoulders model

We used two smoothing parameters. The first was the step size used to compute the trendlines. This approach was described by the authors in 2014 [2]. When looking for the break points for the upward and downward lines, we can adjust the distance, or step, between points that we compare. We experimented with step sizes between 5 and 60. Since there seemed to be little empirical difference between results of step sizes of 35 and larger step sizes, we chose several values between 5 and 35. The second was a moving average parameter to smooth the data and remove some of the day to day volatility. We ran each of our data sets through multiple step sizes and multiple moving average windows.

For the length of the input data set, we settled on an 8 year set of data: 2007 thru 2014.

Results

Synthetic data: We generated synthetic highs and lows with increments and decrements from three different distributions: uniform, exponential, and normal. We then ran the head and shoulders algorithm over the points generated by this data. We performed multiple runs of 10,000 data points for each of the distributions. This synthetic data generated random head and shoulders patterns an average of .45% for uniform data, .51% for exponential data, and .52% for normal data. This seems to indicate that a head and shoulders pattern will randomly occur about once every 200 peak or high point values.

Real data: We downloaded stock data from the New York Stock Exchange for stocks between 2007 and 2014. This data was downloaded from the Yahoo financial website. There are approximately 2,000 different stocks listed on the New York Stock Exchange that are available via Yahoo. We examined a subset of 145 of these stocks. The stocks were examined at step sizes of 5, 15 and 35, and with moving average data of 1 (the original), 5, 10 and 20. Head and shoulders patterns were plotted in red over an existing plot of the data, and the graphs were saved for further analysis. Several examples are shown below in Figures 3, 4, 5 and 6. While Figures 3 and 4 seem to show good head and shoulders predictors, Figures 5 and 6 do not.

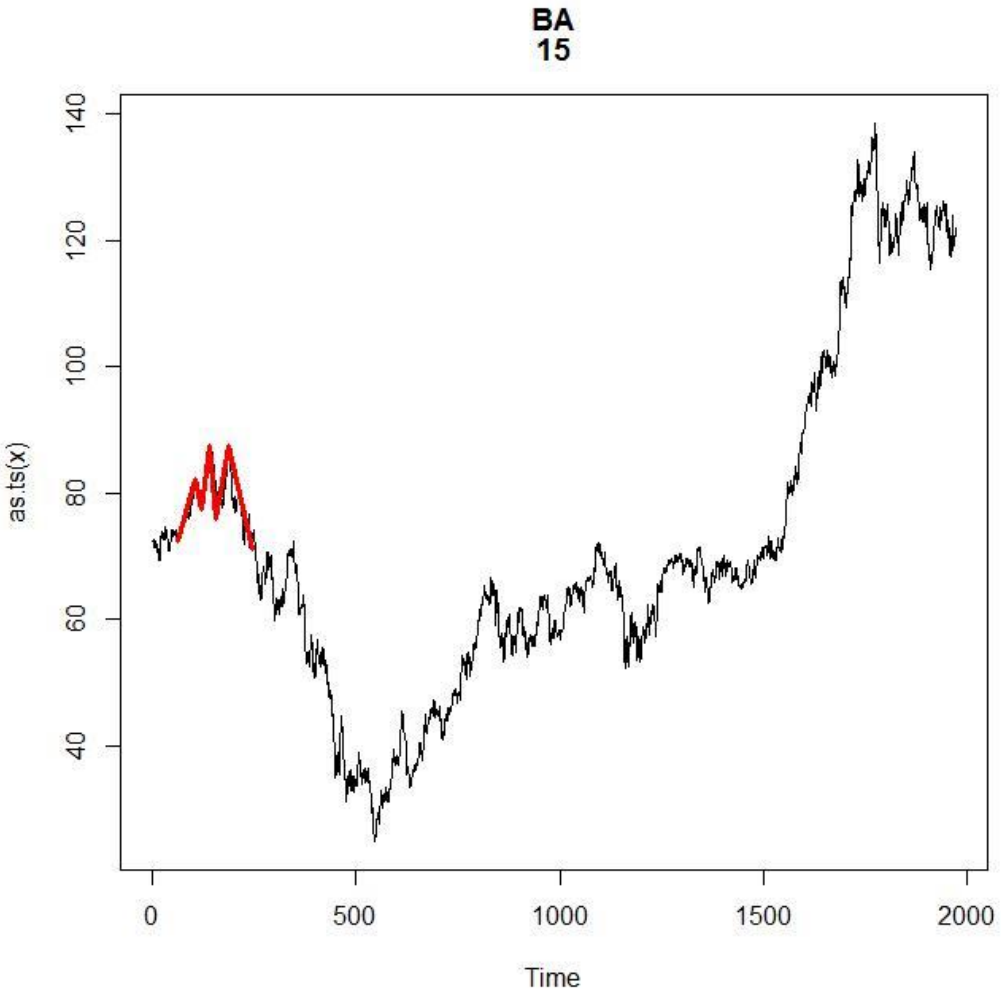

Figure 3: A head and shoulders for Boeing Airlines at a step size of 15 and a moving average of 1.

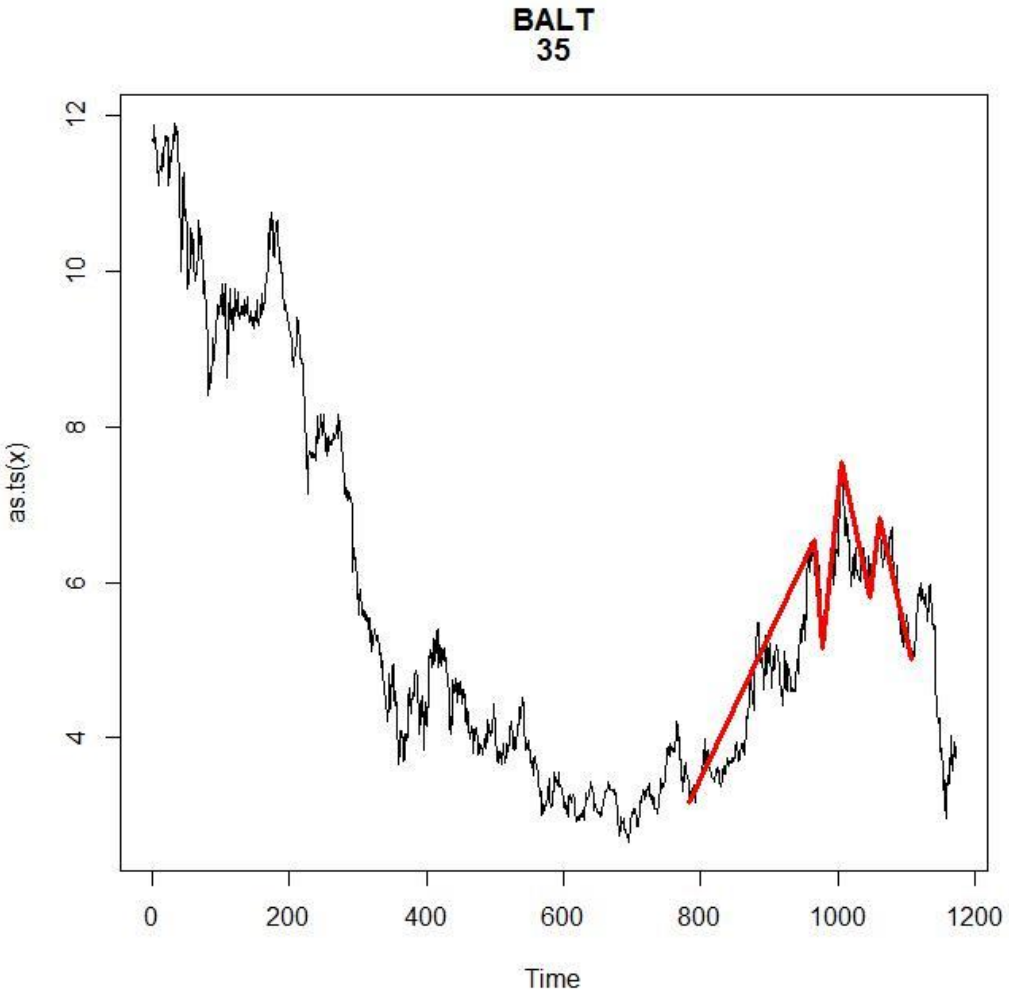

Figure 4: A head and shoulders for Baltic Trading at a step size of 35 and a moving average of 1.

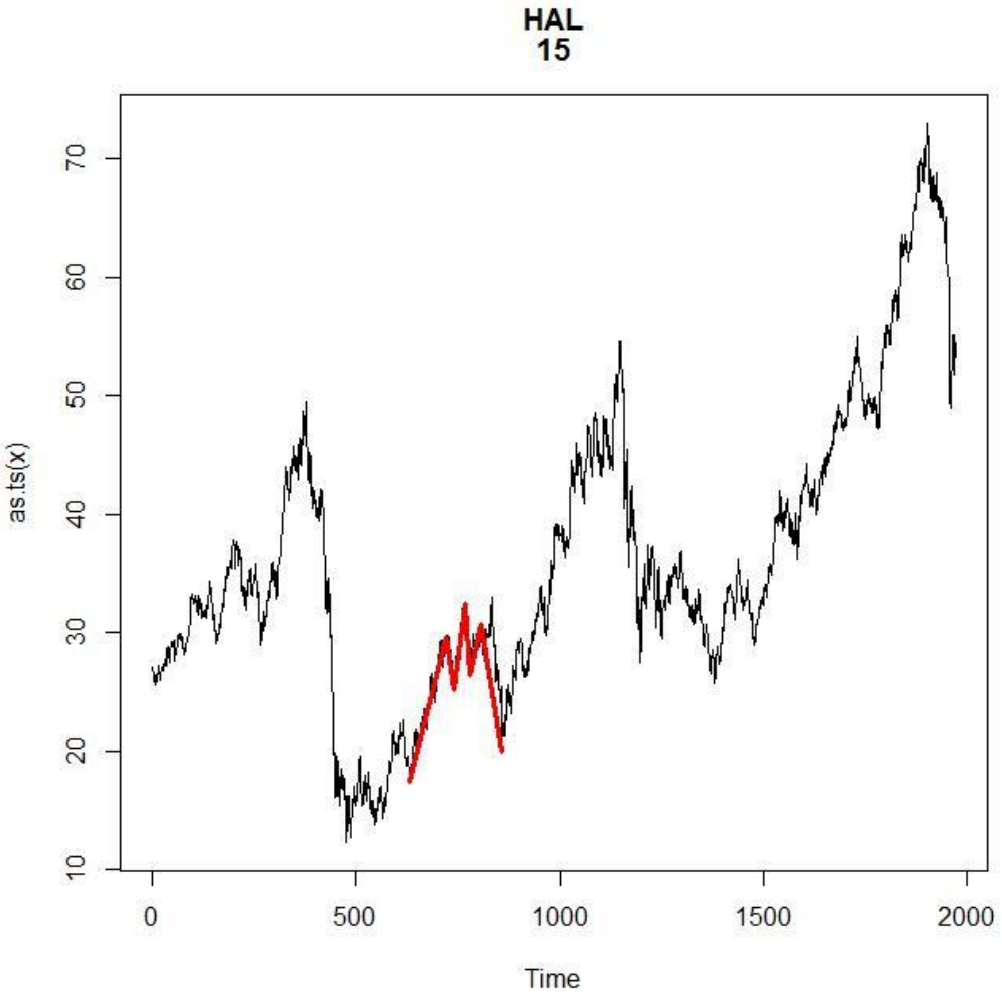

Figure 5: A head and shoulders for Halliburton at a step size of 15 and a moving average of 1.

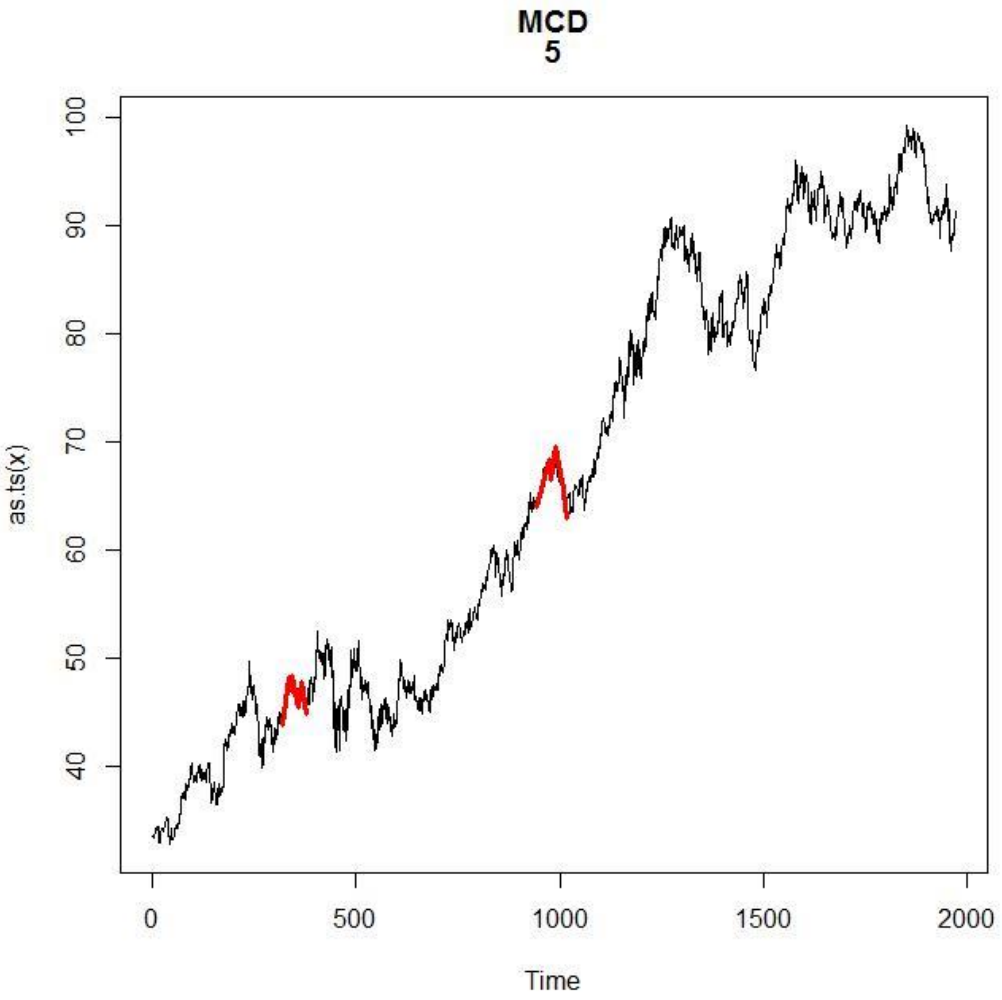

Figure 6: Two head and shoulders patterns for McDonalds Corporation at a step size of 5 and a moving average of 1.

Our analysis of head and shoulder graphs seem to indicate that this is not a good predictor of a downward trend. Out of the 145 stocks examined, we detected 136 head and shoulder patterns; after eliminating duplicates and patterns too close to the end of the data, we analyzed 130 patterns. Of the analyzed patterns, we only found 12 that we considered to be followed by the predicted downward trend.

Conclusions and Future Work

We are working on additional data points and our basic algorithm, but our results so far seem to indicate that the head and shoulders pattern is not a good predictor when applied to actual data from stock prices from the New York Stock Exchange.

For future work, we hope to examine the slopes of the "neckline" (the line connecting the two bottoms). Our current version only allows for a horizontal slope, but it is possible that other patterns will be discovered if the slope is allowed to deviate slightly from the horizontal (say, 10 or 20%). We also wish to experiment with the distance allowed between the peaks for the head and two shoulders. There are currently no restrictions on the two distances, but some sort of metric to keep these distances at least somewhat similar seems desirable. We also hope to combine the step sizes and moving averages and only flag those patterns which occur in more than one of these permutations.

Acknowledgements:

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