

Piecewise segmentation for financial data

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Abstract

Time series data is characterised as large in data size, high dimensionality and update continuously. Moreover, the time series data is always considered as a whole instead of individual numerical fields. As a consequence, in order to analyse and mine time series data, segmentation and dimensionality reduction are essential. In particular, in the following pages we are going to collect and study some segmentation methods, applied in particular to stock market data. Stock time series has its own characteristics over other time series.

1 Introduction

The tasks of segmentation and dimensionality reduction, as well as identification of trends, are fundamental to allow a number of time series analysis and mining tasks. As a matter of fact, the fields of application of such procedures are numerous (ECG, exchange rates, sensor detections of any kind, ...) and methods differ from application to application, due to the characteristics of data. As a consequence, literature regarding these issues is vast.

In particular, our focus is on stock market data, which is inherently large in size, noisy and continuously updated. In this paper we are going first to list some of the main research papers where dimensionality reduction and piecewise segmentation are studied, in section 2. Then, in section 3 we are going to present some implementations of the methods.

2 Methods

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2.1 Yin, Si, and Gong. “Financial time series segmentation based on Turning Points”

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3 Implementations

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3.1 Turning points in Matlab

Here we are presenting our implementation of the method to find *turning points*, as it was presented in [YSG11].

The method is developed and tested over CSV files downloaded from Yahoo! Finance website¹. Should another source be used, basic adaptations may be necessary, mostly in the handling of temporal data² (i.e., dates).

After importing the aforementioned CSV file (we suggest to use the graphical interface provided by Matlab itself), the user should issue the following command, in order to compute and plot the results:

```
| y = TurningPoints(Date, Close, 1);
```

¹<http://finance.yahoo.com/market-overview/>

²Due to our limited knowledge of Matlab language, we may have dealt with this kind of data in a naïve way.

`TurningPoints()` function is implemented as shown in listing 1, with the support of some side functions. We will not analyse the theoretical details of the algorithm, as they are covered in our reference document.

```

%% Actual TP function
function tp = TurningPoints(time, value, n)

x = TP_prepareData(time, value);
tp = TP_preprocess(x);

while n > 0

    n = n-1;
    y = tp;
    clear tp;

    i = 1;
    while i < (length(y)-3)

        p0 = y(i+0,2);
        p1 = y(i+1,2);
        p2 = y(i+2,2);
        p3 = y(i+3,2);

        condUT = p0 < p1 && p0 < p2 && p1 < p3 && p2 < p3 ... % uptrend
            && abs(p1 - p2) < abs(p0 - p2) + abs(p1 - p3);

        condDT = p0 > p1 && p0 > p2 && p1 > p3 && p2 > p3 ... % downtrend
            && abs(p2 - p1) < abs(p0 - p2) + abs(p1 - p3);

        eps = 0.05 * mean([p0 p1 p2 p3]);
        condST = abs(p0 - p2) < eps && abs(p1 - p3) < eps; % same trend

        if condUT || condDT || condST
            tp(i,:) = y(i,:);
            tp(i+3,:) = y(i+3,:);
            i=i+3;
        else
            tp(i,:) = y(i,:);
            i=i+1;
        end % end if

    end % end while i < (length(y)-3)

    tp(length(y),:) = y(length(y),:);
    tp = TP_cleaning(tp);
    TP_output(y,tp)

end % end while n > 0

plot( datetime ( x(:,1), 'ConvertFrom', 'datenum'), x(:,2), ...
    datetime ( tp(:,1), 'ConvertFrom', 'datenum'), tp(:,2));

end % end TurningPoints()

```

Listing 1: TurningPoints() function.

The main supporting function is `TP_preprocess()`, which implements the very first part of the algorithm in [YSG11], and is presented in listing 2. The other supporting functions are of secondary importance, so we are not presenting them here. Basically we have:

- `TP_prepareData()` takes in input raw Yahoo! Finance data and prepares it for being processed;
- `TP_cleaning()` cleans data matrix after processing;
- `TP_output()` shows information about the processing (i.e., the number of deleted elements).

```
%% Data preprocessing
function y = TP_preprocess(x)

% Boundary elements
y(1,:) = x(1,:);
y(length(x),:) = x(length(x),:);

% Core
for i=2:(length(x)-1)

    prec = x(i-1,2);
    curr = x(i,2);
    succ = x(i+1,2);

    condMIN = curr < prec && curr < succ; % curr: local minimum
    condMAX = curr > prec && curr > succ; % curr: local maximum
    if condMIN || condMAX
        y(i,:) = x(i,:);
    end % end if
end % end for

y = TP_cleaning(y);
TP_output(x,y)

end % end TP_preprocess()
```

Listing 2: `TP_preprocess()` supporting function.

To conclude our discussion, we are presenting some tests we performed. Weekly stock market data from A2A (A2A.MI) over the whole 2015 was used as source. In fig. 1 we show the original data in blue, the preprocessed data in orange and the data after one full run of the algorithm in yellow.

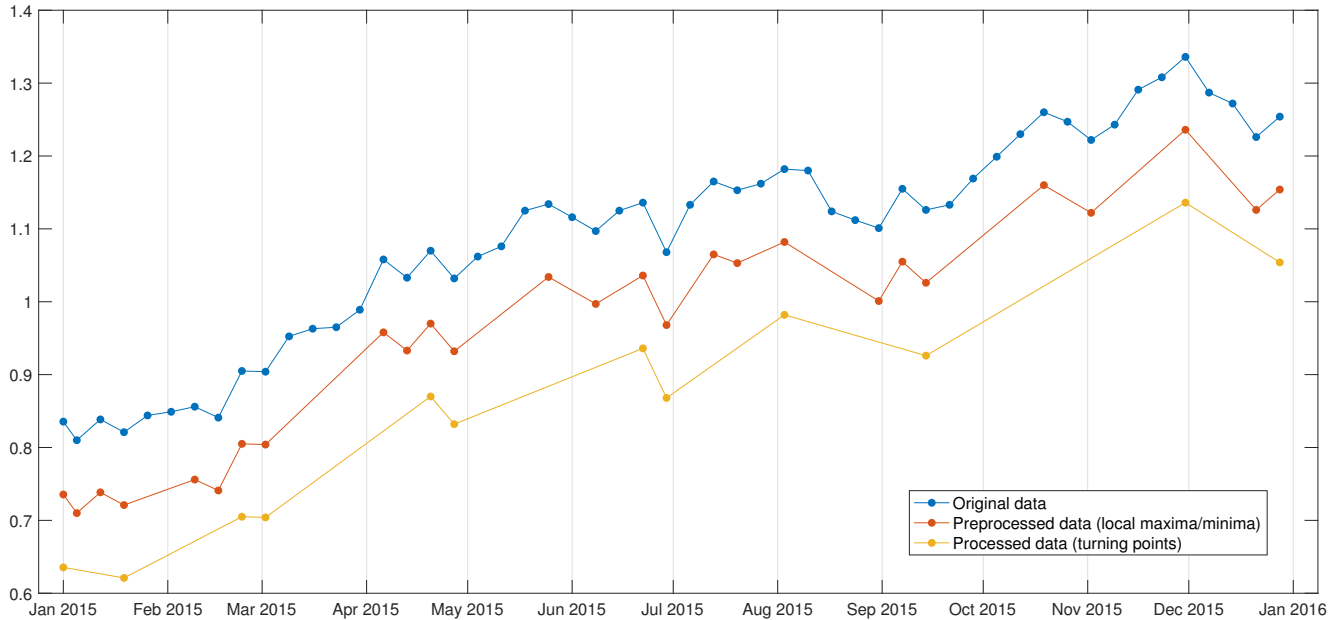


Figure 1: A2A.MI weekly 2015. Original data (53 samples) is in the correct position. The other two series (respectively 27 and 12 samples) are shifted down by 0.1 each.

3.2 Other implementations

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Bibliography

DOI, when defined, serves as URL to retrieve the document. Documents may be accessible only on institutional log in (e.g., academic credentials).

- [YSG11] Jiangling Yin, Yain-Whar Si, and Zhiguo Gong. "Financial time series segmentation based on Turning Points". In: *System Science and Engineering (ICSSE), 2011 International Conference on*. June 2011, pp. 394–399. doi: 10.1109/ICSSE.2011.5961935.