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Time Series Components

Introduction

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What is a Time Series?

- A **time series** is a sequence of numerical **data** points in successive order, usually occurring in uniform intervals.
- **Time series *analysis*** comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data.
- **Time series *forecasting*** is the use of a model to predict future values based on previously observed values.

Courtesy: Wikipedia

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Components of Time Series

- **Trend**: Indicates a long term increase or decrease in the data. It may be linear or non-linear.
- **Seasonal**: Seasonality is a pattern observed with regular intervals of time. e.g. Sale of woolen clothes increases in winter and is relatively low in other seasons.
- **Cyclic**: Data exhibits rise and fall not in regular time intervals. e.g. Recession and Boom
- **Random**: This is an error component. Also called irregular component.

Classical Decomposition

- There are two types of classical decompositions:
  - Additive
  - Multiplicative
- We assume here that the seasonal component is constant from year to year.
- Suppose that we have *m* seasonal periods. Then there are m seasonal values which are called *seasonal indices*.

Notations

- y_t: Value in time series at time t
- $\widehat{T}_t$: Trend-cycle component (Moving Average) calculated for time t
- $\widehat{S}_t$: Seasonal Index for time t

Additive Decomposition

1. If m is even number, then centered MA is calculated otherwise non-centered MA is calculated.
2. Calculate the de-trended series, y_t-$\widehat{T_t}$
3. For estimating the seasonal component for each month, a simple average is calculated for detrended values for that particular month. It is denoted by $\widehat{S_t}$.
4. The random component is calculated by subtracting seasonal and trend-cycle components. $\widehat{E_t} = \hat{y}_t$-$\widehat{T_t}$-$\widehat{S_t}$

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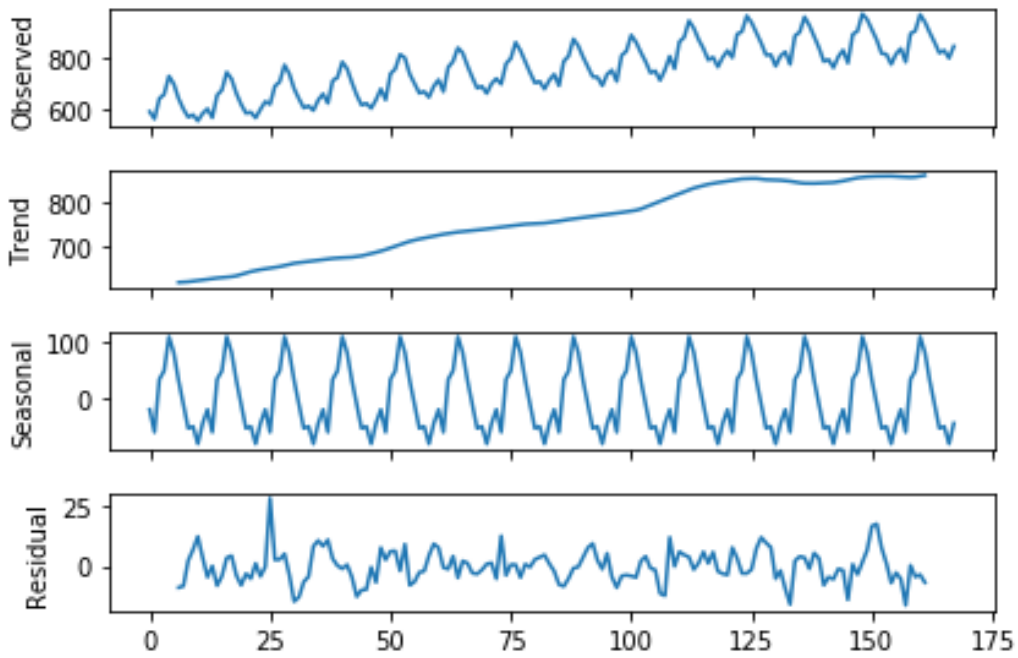
Example

```
In [55]: from statsmodels.tsa.seasonal import seasonal_decompose
    ...: from matplotlib import pyplot
    ...: series = df['Milk']
    ...: result = seasonal_decompose(series, model='additive',freq=12)

In [56]: result.plot()
    ...: pyplot.show()
```



Multiplicative Decomposition

1. If m is even number, then centered MA is calculated otherwise non-centered MA is calculated.
2. Calculate the de-trended series, $y_t/\widehat{T}_t$
3. For estimating the seasonal component for each month, a simple average is calculated for de-trended values for that particular month. It is denoted by $\widehat{S}_t$.
4. The random component is calculated by subtracting seasonal and trend-cycle components. $\widehat{E_t} = \hat{y}_t/(\widehat{T}_t\widehat{S}_t)$

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Example

```
In [57]: result = seasonal_decompose(series, model='multiplicative',freq=12)

In [58]: result.plot()
    ...: pyplot.show()
```