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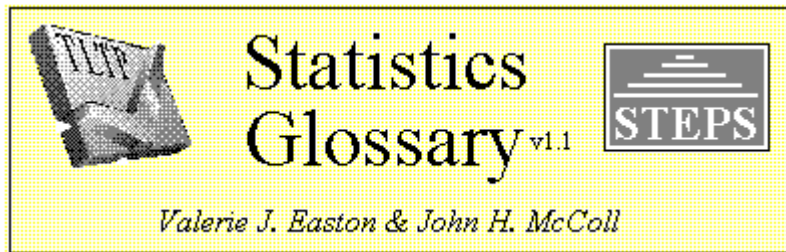
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STEPS Glossary Web version revised and updated Sep 97 by [Stuart G. Young](#).  
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## Time series data

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### Time Series

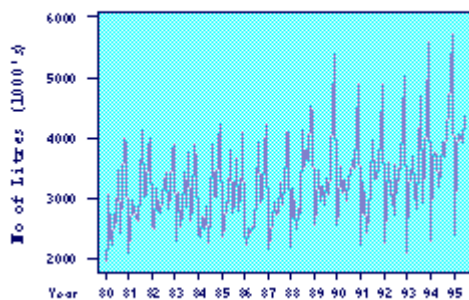
A time series is a sequence of observations which are ordered in time (or space). If observations are made on some phenomenon throughout time, it is most sensible to display the data in the order in which they arose, particularly since successive observations will probably be dependent. Time series are best displayed in a scatter plot. The series value  $X$  is plotted on the vertical axis and time  $t$  on the horizontal axis. Time is called the independent variable (in this case however, something over which you have little control). There are two kinds of time series data:

1. Continuous, where we have an observation at every instant of time, e.g. lie detectors, electrocardiograms. We denote this using observation  $X$  at time  $t$ ,  $X(t)$ .
2. Discrete, where we have an observation at (usually regularly) spaced intervals. We denote this as  $X_t$ .

*Examples*

Economics - weekly share prices, monthly profits  
 Meteorology - daily rainfall, wind speed, temperature  
 Sociology - crime figures (number of arrests, etc), employment figures

Time Series Plot  
 of Australian Sales of Dry White Wine



## Trend Component

We want to increase our understanding of a time series by picking out its main features. One of these main features is the trend component. Descriptive techniques may be extended to forecast (predict) future values.

Trend is a long term movement in a time series. It is the underlying direction (an upward or downward tendency) and rate of change in a time series, when allowance has been made for the other components.

A simple way of detecting trend in seasonal data is to take averages over a certain period. If these averages change with time we can say that there is evidence of a trend in the series. There are also more formal tests to enable detection of trend in time series.

It can be helpful to model trend using straight lines, polynomials etc.

See also [time series](#).

See also [cyclical component](#).

See also [seasonal component](#).

See also [irregular component](#).



## Cyclical Component

We want to increase our understanding of a time series by picking out its main features. One of these main features is the cyclical component. Descriptive techniques may be extended to forecast (predict) future values.

In weekly or monthly data, the cyclical component describes any regular fluctuations.

It is a non-seasonal component which varies in a recognisable cycle.

See also [time series](#).

See also [trend component](#).

See also [seasonal component](#).

See also [irregular component](#).



## Seasonal Component

We want to increase our understanding of a time series by picking out its main features. One of these main features is the seasonal component. Descriptive techniques may be extended to forecast (predict) future values.

In weekly or monthly data, the seasonal component, often referred to as seasonality, is the component of variation in a time series which is dependent on the time of year. It describes any regular fluctuations with a period of less than one year. For example, the costs of various types of fruits and vegetables, unemployment figures and average daily rainfall, all show marked seasonal variation.

We are interested in comparing the seasonal effects within the years, from year to year; removing seasonal effects so that the time series is easier to cope with; and, also interested in adjusting a series for seasonal effects using various models.

See also [time series](#).

See also [trend component](#).

See also [cyclical component](#).

See also [irregular component](#).



## Irregular Component

We want to increase our understanding of a time series by picking out its main features. One of these main features is the irregular component (or 'noise'). Descriptive techniques may be extended to forecast (predict) future values.

The irregular component is that left over when the other components of the series (trend, seasonal and cyclical) have been accounted for.

See also [time series](#).

See also [trend component](#).

See also [cyclical component](#).

See also [seasonal component](#).



## Smoothing

Smoothing techniques are used to reduce irregularities (random fluctuations) in time series data. They provide a clearer view of the true underlying behaviour of the series.

In some time series, seasonal variation is so strong it obscures any trends or cycles which are very important for the understanding of the process being observed. Smoothing can remove seasonality and makes long term fluctuations in the series stand out more clearly.

The most common type of smoothing technique is moving average smoothing although others do exist. Since the type of seasonality will vary from series to series, so must the type of smoothing.



## Exponential Smoothing

Exponential smoothing is a smoothing technique used to reduce irregularities (random fluctuations) in time series data, thus providing a clearer view of the true underlying behaviour of the series. It also provides an effective means of predicting future values of the time series (forecasting).



## Moving Average Smoothing

A moving average is a form of average which has been adjusted to allow for seasonal or cyclical components of a time series. Moving average smoothing is a smoothing technique used to make the long term trends of a time series clearer.

When a variable, like the number of unemployed, or the cost of strawberries, is graphed against time, there are likely to be considerable seasonal or cyclical components in the variation. These may make it difficult to see the underlying trend. These components can be eliminated by taking a suitable moving average.

By reducing random fluctuations, moving average smoothing makes long term trends clearer.



## Running Medians Smoothing

Running medians smoothing is a smoothing technique analogous to that used for moving averages. The purpose of the technique is the same, to make a trend clearer by reducing the effects of other fluctuations.

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