

Time Series

When bivariate data has the I-V as time it is called a "time series".

We consider 4 characteristics when looking at patterns in time series.

TREND

When considering trend, we look at whether there is an overall upward or downward trend for the data plot.

If a line was placed on the plot to ignore the fluctuations this would be called a trend line.

Note: There can be more than 1 trend across a range of data.

SEASONAL VARIATION

This is where you observe patterns or fluctuations repeating within one year.

Examples include:

- ① icecream sales data - higher in summer every year
- ② visitor numbers to mountain regions with ski resorts - higher during ski season - higher over weekends

These variations are more predictable. Identify by looking for ups and downs within 1 year.

SMOOTHING PROCESS

CYCLIC VARIATION

These are variations are longer term fluctuations and are less predictable than seasonal variations.

They do not have a fixed duration or size.

* If you observe more than 1 trend, assume cyclic *

RANDOM VARIATION

As the name suggests this is unpredictable and irregular variation about a constant mean. All time series exhibit this.

Many time series plots show a combination of the above patterns.

When constructing the plot on your CAS follow all the usual steps for bivariate data.

- ① enter data in lists and spreadsheets
- ② add data & stats
- ③ connect the data points

**ALL TIME SERIES HAVE
RANDOM VARIATION (OR ERROR)**

SMOOTHING PROCESS

We have seen that there are 4 components to a time series.

$$\text{observed data} = \text{trend at the time} + \text{seasonality at the time} + \text{cyclic variation at the time} + \text{random var.}$$

It can be quite difficult to see an overall pattern so we use a process called **SMOOTHING** to reduce the random, local fluctuations

moving median } 2 methods you
moving mean } need to know.

Moving median smoothing

- take the median value of the required number of points

* Can be 3, 4, 5 etc median

* Eliminates impact of outliers

* Can be done graphically with odd size smoother i.e. 3, 5, 7 etc.

The larger the number of points you smooth over, the greater the smoothing effect.

When conducting an even numbered smoothing, you need an extra step called centring.

This is because the median of 1 2 3 4 is 2.5 and that is not an original x value

The median of 1 2 3 is 2

The median of 1 2 3 4 5 is 3
and these are original x values
so do not need to centre.

- Sometimes you are just interested in one point in time NOT the whole series.
- To find the required answer you must complete the appropriate steps for that point and the method requested.

e.g. for 3 median smoothing at time = 6
use values 5, 6 and 7

for 5 median use values 4, 5, 6, 7, 8

e.g. for centred 4 median smoothing at time = 6 you will need the 4 median value for time 6.5 and time 5.5
Then take the centre median to give you the value for time = 6.

Moving Average or Mean Smoothing

The process is similar to that for median, except now use the mean of the data values.

- For quarterly data use moving average of multiples of 4 so 4, 8 etc.
- For daily data use multiples of 7
- For monthly data use multiples of 12
- Will be affected by outliers.