1. Descriptive Techniques

Descriptive Techniques

Types of Variation

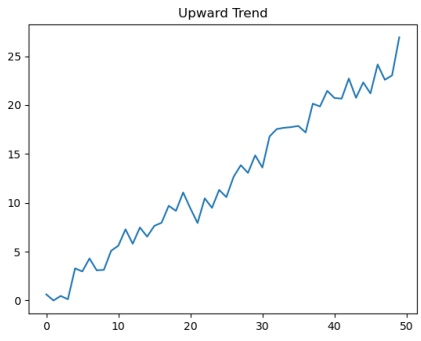
When the graph of a time series is plotted, we observe some haphazard changes in the graph over time. A part of this change, called the **systematic part** and can be accounted for while the remaining part is irregular. The systematic parts consist of :

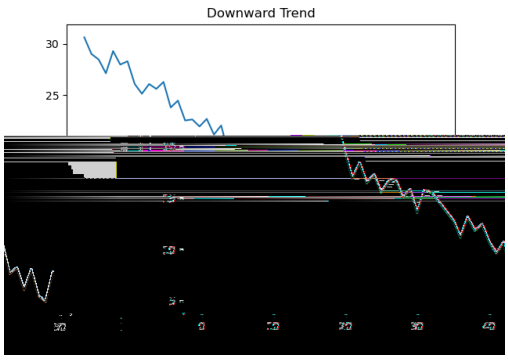
- Secular Variation / Trend
- Seasonal Variation
- Cyclical Variation

Thus the value of the time series at time t, Y_t is the resultant of the combined effect of trend (T_t), seasonal variation (S_t), cyclical fluctuations (C_t) and irregular variations (I_t).

Trend

The smooth, regular, long-term movement of a series observed over a long period of time is called **trend**.



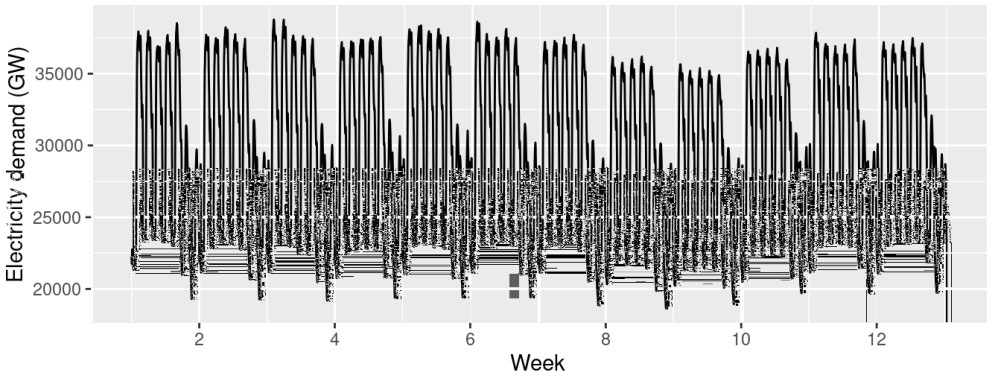


A series may change its course after some time but sudden or frequent changes are quite inconsistent with the idea of trend.

A series may show an upward or downward trend or may remain at more or less a constant level.

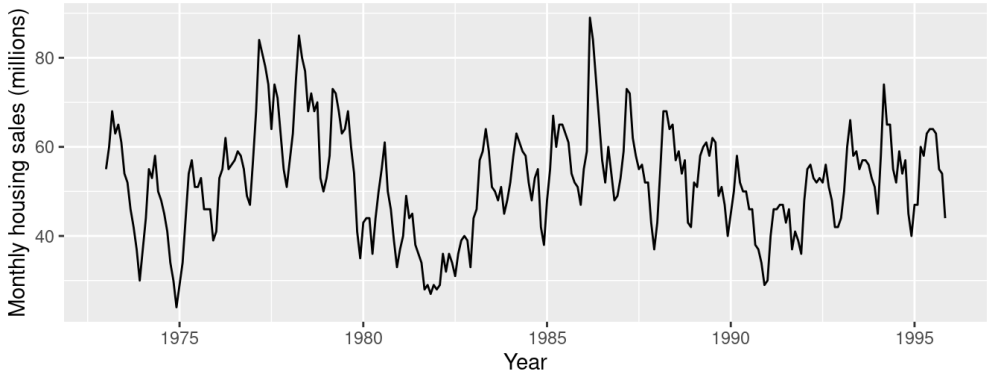
Seasonal Effect

Periodic movement (i.e. movement that repets itself at regular time intervals) of a series where the period is not larger than a year is called **seasonal variation** or **seasonality** or **seasonal effect**. e.g. climatic changes, increase in sale of certain consumer goods during festivals.



Cyclic Changes

The kind of oscillatory movement in a time series with period of occilation being more than a year is called **cyclic change** or **cyclic variation** or **cyclicity**. One complete period is called a **cycle**. These variations though more or less regular are note necessarily periodic.



Irregular Fluctuations

Apart from regular variations, all series contain a random / irregular factor which is not accounted for by trend, seasonal and cyclic variations. These variables are purely random or are completely unaccounted for or are caused by unpredectible events.

Models for Expressing Y_t

There are two approaches by which we can express Y_t.

Additive Model / Sum Model

Here, Y_t is expressed as,

$$Y_t = T_t + S_t + C_t + I_t$$

Here, all the components have the same unit as Y_t.

Multiplicative Model / Product Model

Here, Y_t is expressed as,

$$Y_t = T_t \cdot S_t \cdot C_t \cdot I_t$$

Here, T_t has the same unit as Y_t whereas S_t, C_t, I_t are unit free.

> **Note**
> In additive model, all the components are assumed to be independent but in multiplicative model, no such assumption is made. However in reality, these four components are highly inter-related and hence cannot be independent. So generally, multiplicative model is preferred over additive model.

> **Note**
> To convert a multiplicative model into an additive model, we take the logarithm of it.

$$\begin{aligned} \ln Y_t &= \ln(T_t \cdot S_t \cdot C_t \cdot I_t) \\ \Rightarrow \ln Y_t &= \ln T_t + \ln S_t + \ln C_t + \ln I_t \\ \Rightarrow Y_t' &= T_t' + S_t' + C_t' + I_t' \end{aligned}$$