

# Time Series Decomposition

# Time Series Patterns

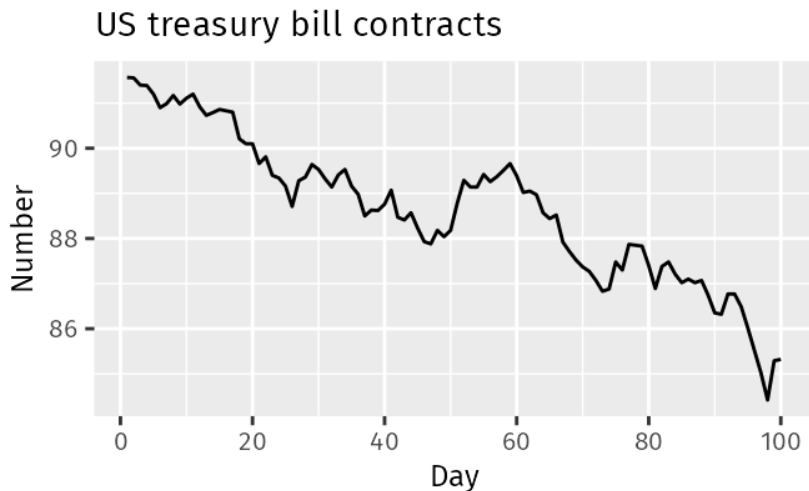
A time series may consist of

- ▶ trend,
- ▶ seasonality and
- ▶ cycles

# Trend

- ▶ A trend is a long-term increase or decrease in the data.
- ▶ Trend does not have to be linear.
- ▶ Sometimes we will refer to a trend as “changing direction”, when it might go from an increasing trend to a decreasing trend.

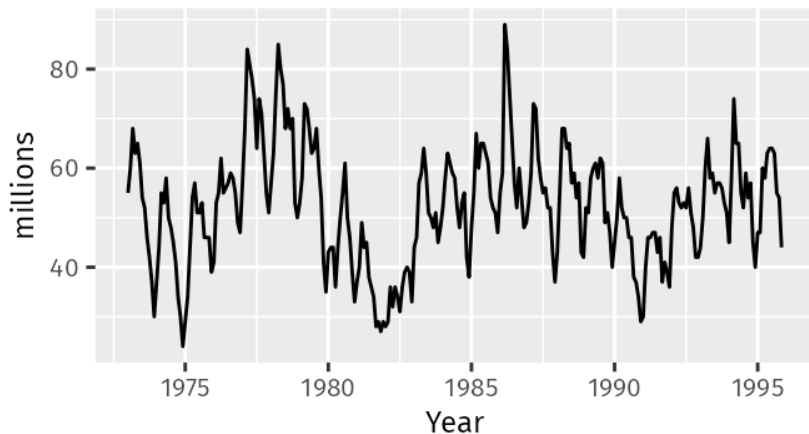
## Examples



- ▶ The US treasury bill contracts show results from the Chicago market for 100 consecutive trading days in 1981. There is a downward trend

## Examples

Sales of new one-family houses, USA



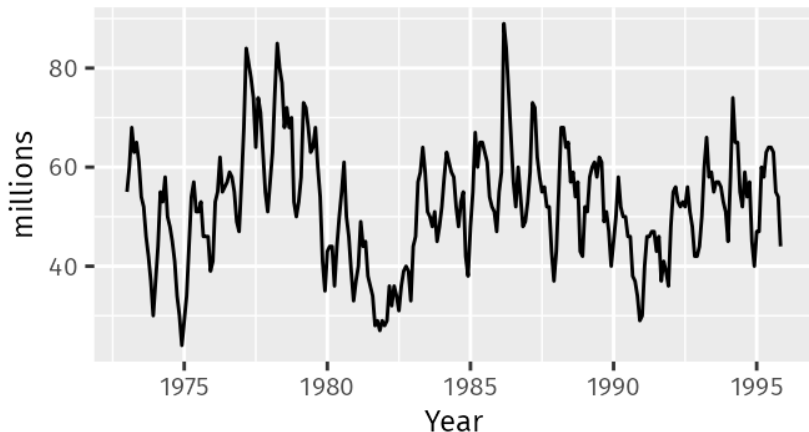
- ▶ There is no apparent trend in the data over this period

# Cycle and Seasonal

- ▶ cycle: repeated events over time that are not equally spaced
- ▶ seasonal: repeated events over time that are equally spaced

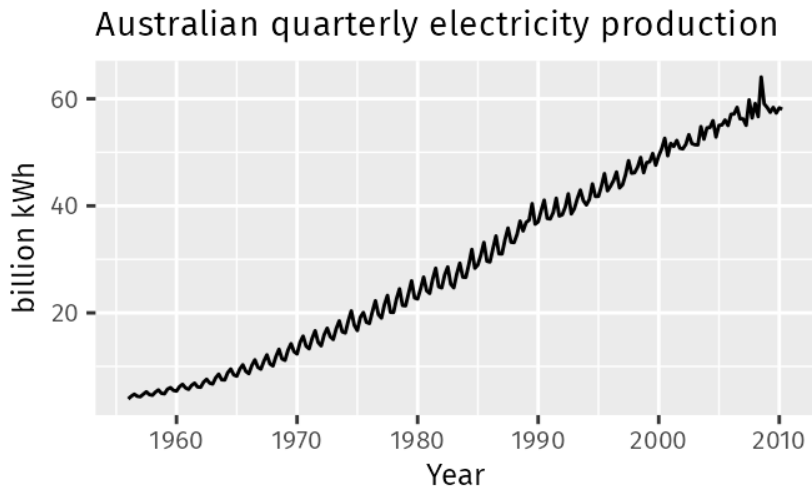
## Examples

Sales of new one-family houses, USA



- The monthly housing sales show strong seasonality within each year, as well as some strong cyclic behaviour with a period of about 6–10 years

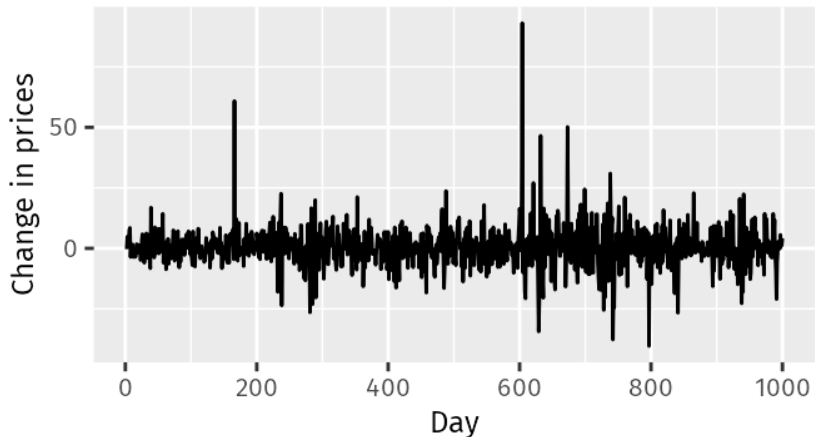
## Examples



The Australian quarterly electricity production shows a strong increasing trend, with strong seasonality. There is no evidence of any cyclic behavior here



## Google daily changes in closing stock price



- ▶ No trend, seasonality or cyclic behaviour. There are random fluctuations which do not appear to be very predictable, and no strong patterns that would help with developing a forecasting model.

# Time series decomposition

- ▶ When we decompose a time series into components, we usually combine the trend and cycle into a single trend-cycle component (sometimes called the trend for simplicity).
- ▶ Three components: a trend-cycle component, a seasonal component, and a remainder component (containing anything else in the time series).

# Two decompositions

- ▶ Additive Decomposition

$$y_t = S_t + T_t + R_t$$

- ▶ Multiplicative decomposition

$$y_t = S_t \times T_t \times R_t$$

## Relationship

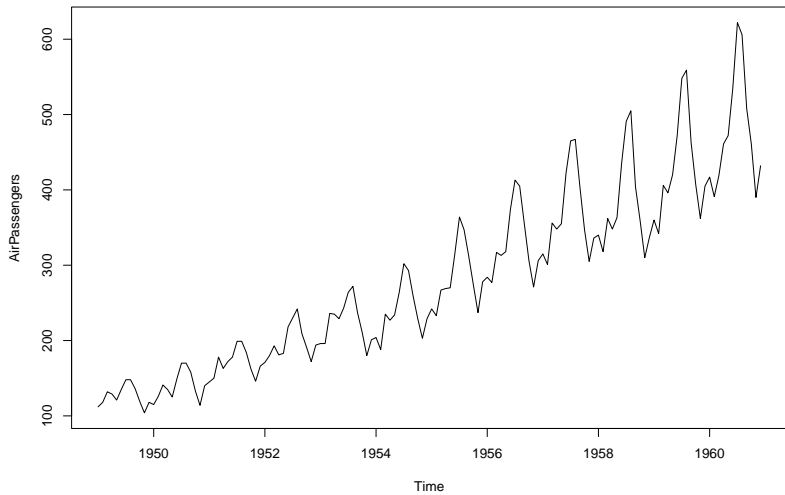
- ▶ The log transformation will turn a multiplicative model to additive model.

## Central MA vs. MA

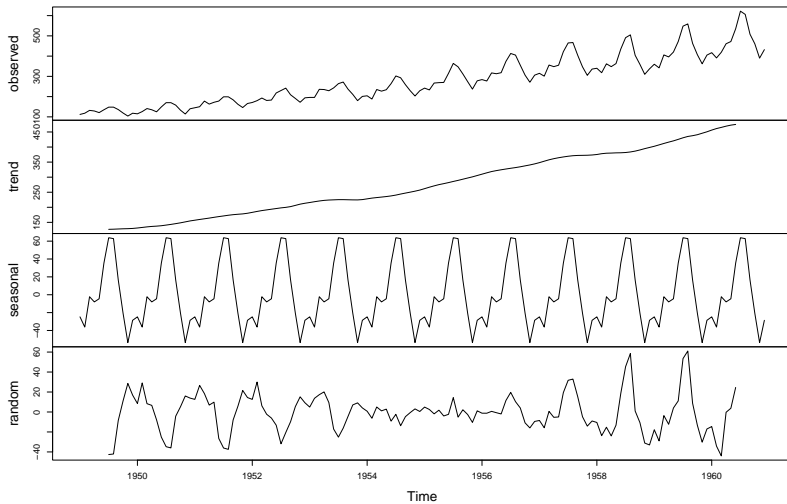
Link.

# Classical Decomposition

- ▶ Trend Estimate: Smooth the data using centred moving average (CMA) of the order equal to the periodicity of the data
- ▶ Detrend the data: calculate the detrended series by subtracting/dividing the trend estimate
- ▶ Seasonal Estimate: Average value for each period is calculated based on the de-trended series.
- ▶ Random/Remainder: subtract from the series the trend and seasonal component estimations

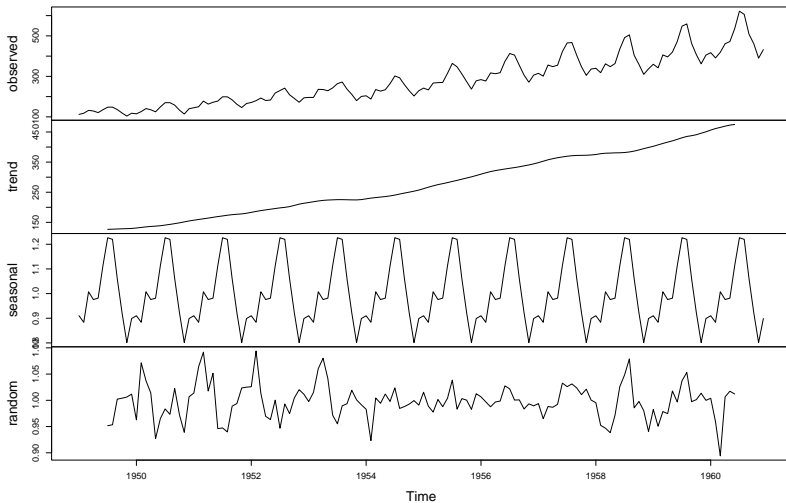


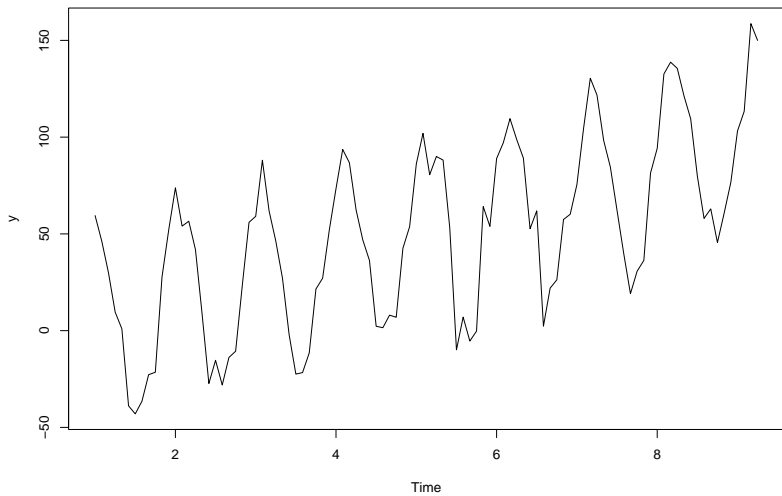
**Decomposition of additive time series**





**Decomposition of multiplicative time series**





**Decomposition of additive time series**

