

Everything on Time Series Forecasting

Definition : A sequence of values or events where the next event is determined by events that precede it

Order of the Time Series : The number of steps

A time series reflects a process being measured. The process has certain components that affect its behaviour

Four types of behaviour

- 1) Level
- 2) Trend
- 3) Seasonality
- 4) Cycles

Level : The average value of a time series

If the average level is the same throughout its length, the time series is stationary

A stationary system might get pushed off its level by a sudden shock, but it returns back to it quickly

Trend : A process that produces values that get continually larger or smaller overtime. Also called non-stationary

The average level for such data is useless, since it's not constant

Seasonality : A season is any period of time that repeats through the data

All the seasons appear only once in a single epoch. Seasonality is always of a fixed and known period. It is associated with some aspect of calendar

Cycles : Smooth undulations of a process, often a physical one

Look similar to seasonality. Often add together to create complex waveforms like sound, images etc.

Cycles vs Seasonality

Cyclic pattern has no fixed period whilst seasonal has a fixed period

Average lengths of cycles is longer than average length of seasons

The magnitude/variation of cycles is higher than the one of seasonal patterns

Techniques

Data contains more than 1 component/behaviour

Techniques to predict the next step:

- The same as the previous one

- The average of the last few

- The weighted average of the last few

ARMA - Autoregressive Moving Average (For stationary/level)

Used to predict how quickly a process moves back to its level after being pushed off by a shock

AR shows how previous values affect future ones

MA shows how the shock affects future values

Trends

You can extract trend from a time series with respect to the number of time steps since the series started or with respect to the last value

Regression is used to find a trend → ARIMA - Autoregressive Integrated Moving Average

ARIMA is an extension of ARMA that incorporates trend

Seasonality

Seasonal factors may be additive or multiplicative

Seasonality Technique - Auto-Correlation

A method for finding the correlation between each value and the value before it (Can be applied to previous values of more than one step)

High correlation indicates seasonal effects

Cycles

Fourier Transform takes signal and decomposes it to sine waves. Replaces crisp value changes with smooth curves.

Recurrent neural networks are good at finding cyclical behaviour

Problems

1. Techniques can appear to work even if the time series is random.
2. A predictable time series can look random.
3. Technique needs to be tested to see if it works well.
4. Longer term trends are hard to capture

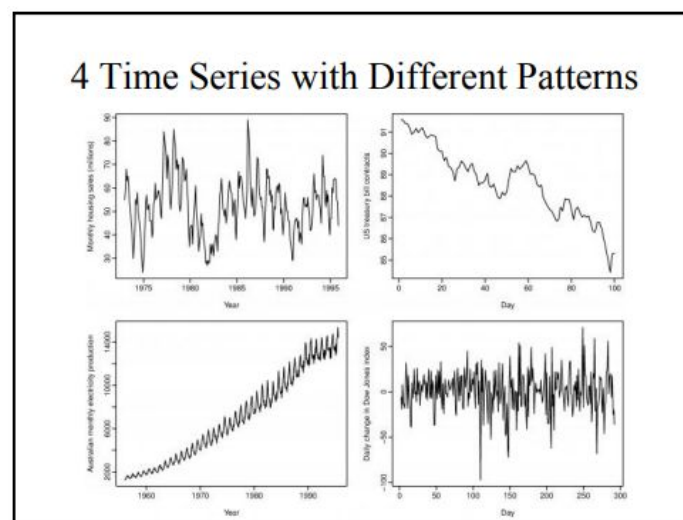
Time Intervals

A system is said to be temporally dependent if each step is predicted by previous ones.

Certainty

Outside forces can affect a system if not completely closed, they are measurable and can be included in the model

Any part of the series you cannot account for is called Residual. If residual not random, something is wrong



4 Time Series with Different Patterns

- **The monthly housing sales (top left)** show strong seasonality within each year, as well as some strong cyclic behaviour with period about 6–10 years. There is no apparent trend in the data.
- **The US treasury bill contracts (top right)** show results from the Chicago market for 100 consecutive trading days in 1981. Here there is no seasonality, but an obvious downward trend.
- **The Australian monthly electricity production (bottom left)** shows a strong increasing trend, with strong seasonality. There is no evidence of any cyclic behaviour here.
- **The daily change in the Dow Jones index (bottom right)** has no trend, seasonality or cyclic behaviour. There are random fluctuations which do not appear to be very predictable, and no strong patterns that help with developing a forecasting model.