STATIONARITY

→ Stationarity is an important thing in Time Series because it is an indicator that determines when we can use one model (or not) such as the AR model, MA model...

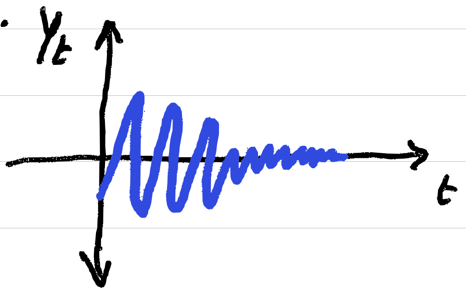
→ this models assume that the time series that we're trying to use <u>are</u> stationary.

- **What makes a time series Stationary?**

→ μ is constant
→ σ is constant
→ There is no seasonality

Let's see some examples:

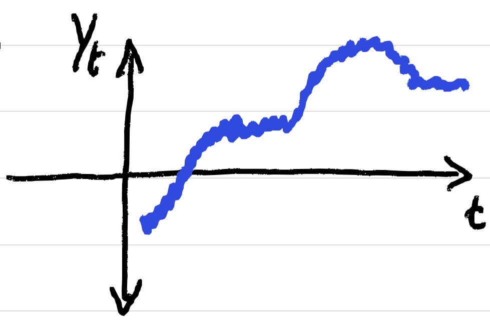
1.



✓ Constant mean

✗ σ is not constant, on the beginning of the time there is a lot of standard deviation and the it dies out

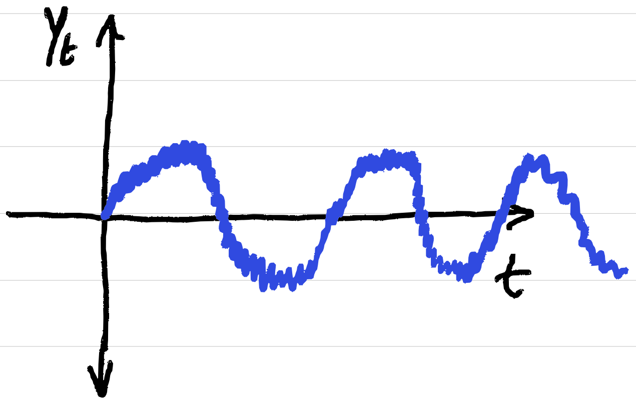
2.



✓ σ seems to be constant

✗ Obviously mean is not constant over time.

3.



✓ Mean is constant

✓ σ is constant

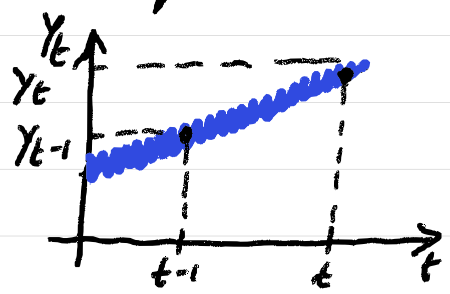
✗ There is seasonality

Checking for stationarity

1. Graphic way.
2. Local vs. Global tests.
3. Augmented Dickey-Fuller test (ADF)

Making a Time Series Stationary

Let's "move" a time series which is clearly non stationary into a stationary one.



$$y_t = \beta_0 + \beta_1 t + \varepsilon_t$$

$$z_t = y_t - y_{t-1} = (\beta_0 + \beta_1 t + \varepsilon_t) - (\beta_0 - \beta_1 (t-1) + \varepsilon_{t-1})$$

$$= \cancel{\beta_0} + \cancel{\beta_1 t} + \varepsilon_t - \cancel{\beta_0} - \cancel{\beta_1 t} + \beta_1 - \varepsilon_{t-1} = \beta_1 + (\varepsilon_t - \varepsilon_{t-1})$$

$$\iff \left[z_t = \beta_1 + (\varepsilon_t - \varepsilon_{t-1}) \right]$$

$\sigma(\varepsilon_t) = k^2$ $\quad \sigma(\varepsilon_{t-1}) = k^2$

$E(z_t) \equiv \mu = \beta_1 \Rightarrow$ Mean is constant

$Var(z_t) \equiv \sigma = 2k^2 \Rightarrow$ σ is constant

There is no seasonality obviously $\Rightarrow$

$\Rightarrow$ So we can use our models on z_t because it is stationary and then, once we have done our predictions we just simply substitute $z_t = y_t - y_{t-1}$