Evaluation of time signals in a time domain

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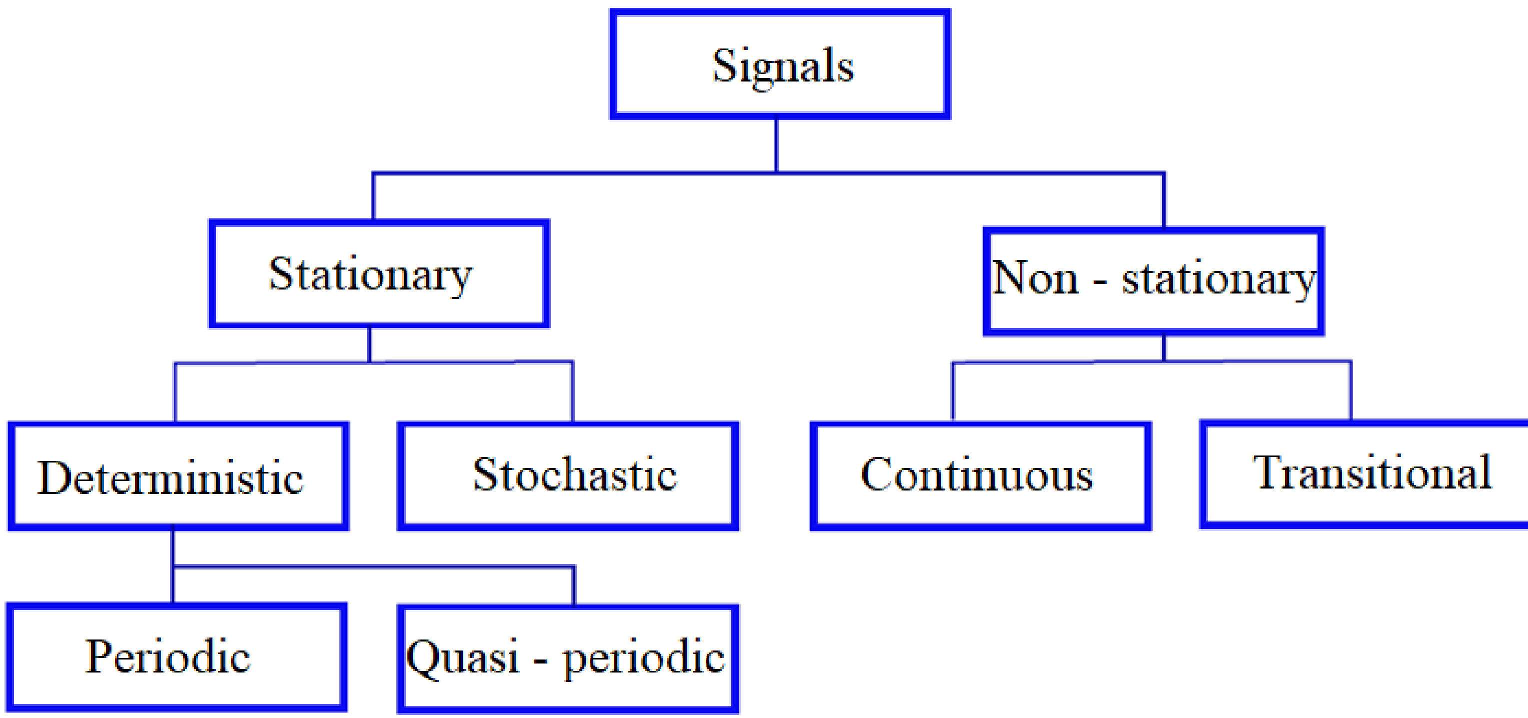
Fizika és Kémia Tanszék

Time signal

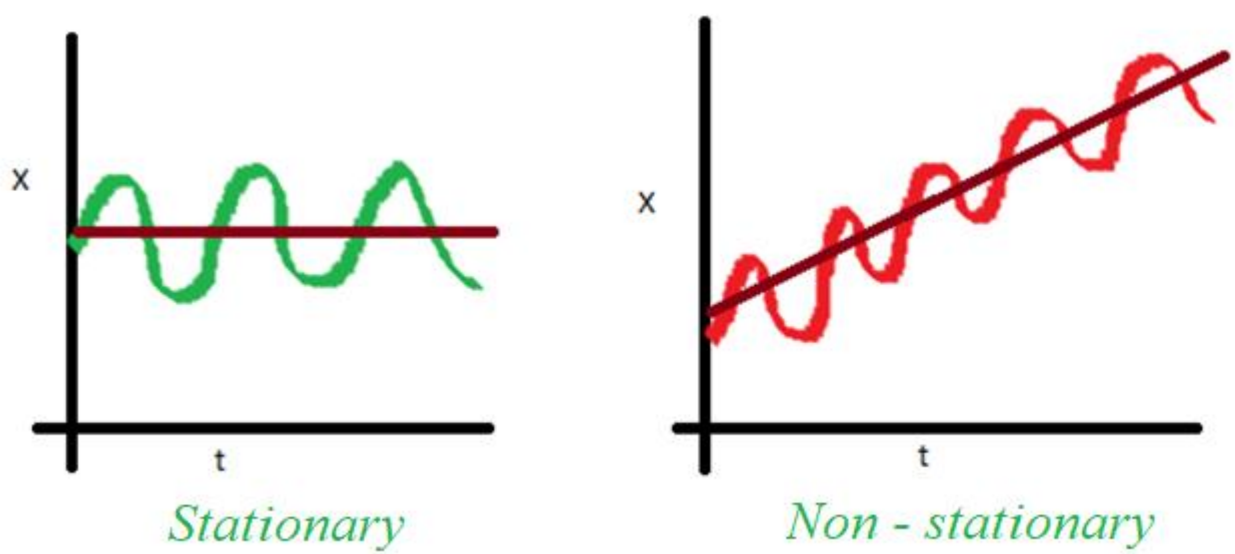
- Any time-dependent quantity is a *"time signal"!*
- If a time signal is sampled at intervals Δt, we speak of a *"sampled time signal"* or *"time series"*.
- *Δt – sampling time*
- *$F_s = 1/\Delta t$ – sampling frequency*

Classification of time signals



Stationary time series

- If the averages calculated for *"shorter periods"* compared to the length of the data series do not depend on time, then we speak of a *stationary time series*.



Trend in time series

- If in non – stationary time series the averages calculated for "shorter" time periods show *"characteristic" behavior in long term*, then a long – term *trend* can be observed in the time series.
- The recognized trend can always be removed from the data series by *detrending*.

A random component in the time series

- All measured data contains a random component! (measurement uncertainty – *noise*)
- In many cases, the measurement noise can be "*smoothed*" out of the signal.

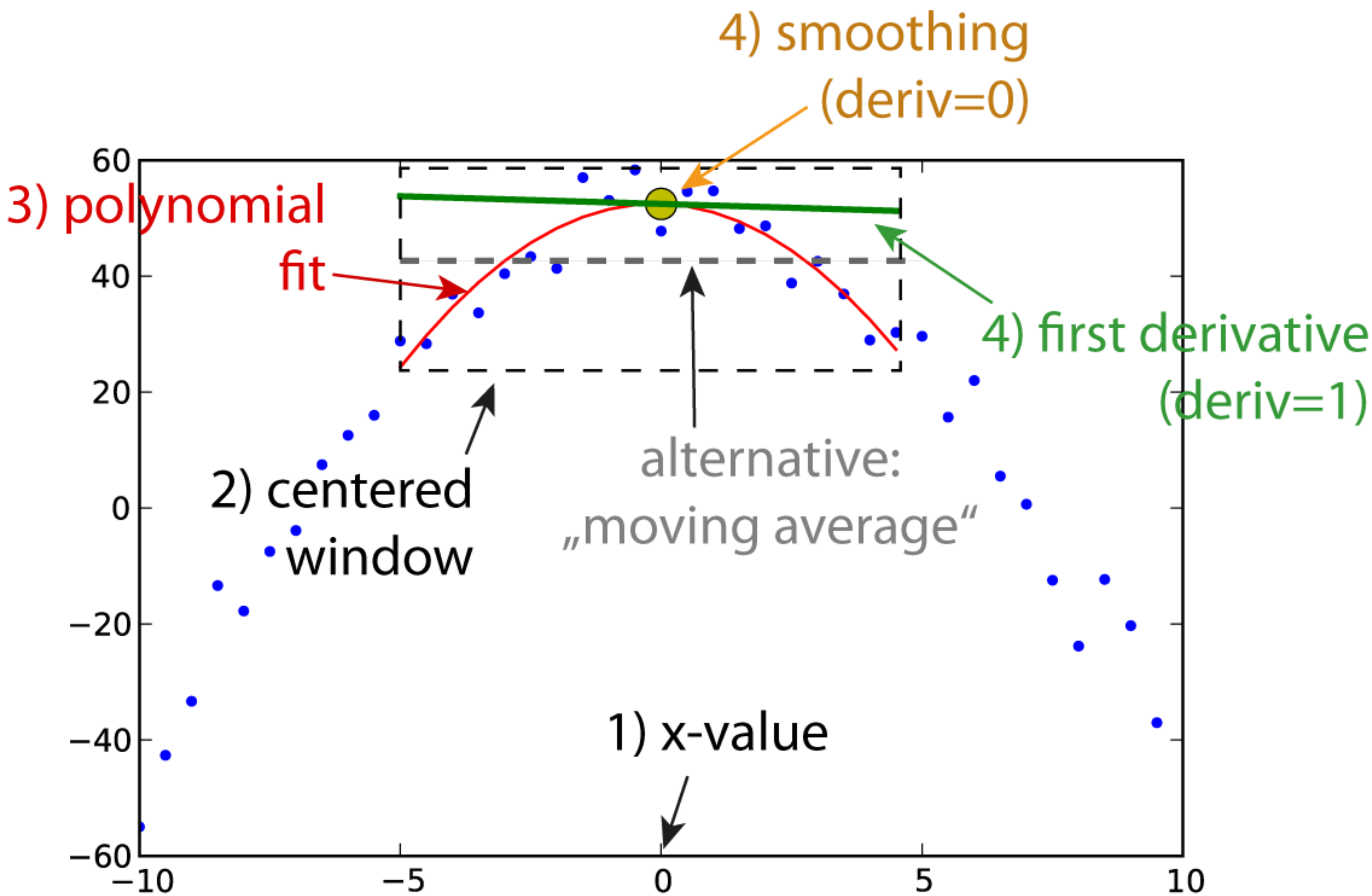
- Method of moving averages
- Golay – Savitzky filtration

Method of moving averages

Month	Sales	Moving Average
Jan-08	280	
Feb-08	356	
Mar-08	486	374
Apr-08	603	482
May-08	737	609
Jun-08	815	718
Jul-08	882	811
Aug-08	907	868
Sep-08	952	914
Oct-08	1004	954
Nov-08	1087	1014
Dec-08	1090	1060

- an effective method if used „well"
- we can lose important information if we don't use it „well"!

Golay – Savitzky filtering



Correlation functions

- Autocorrelation

$$ACF_s(\tau) = \int s(t).s(t-\tau)dt$$

$$ACF_s(m) = \frac{1}{N}\sum_{n=1}^{N} s(n).s(n-m)$$

The value of the autocorrelation function at $\tau = 0$ (*maximum of ACF*) gives the *signal power*!

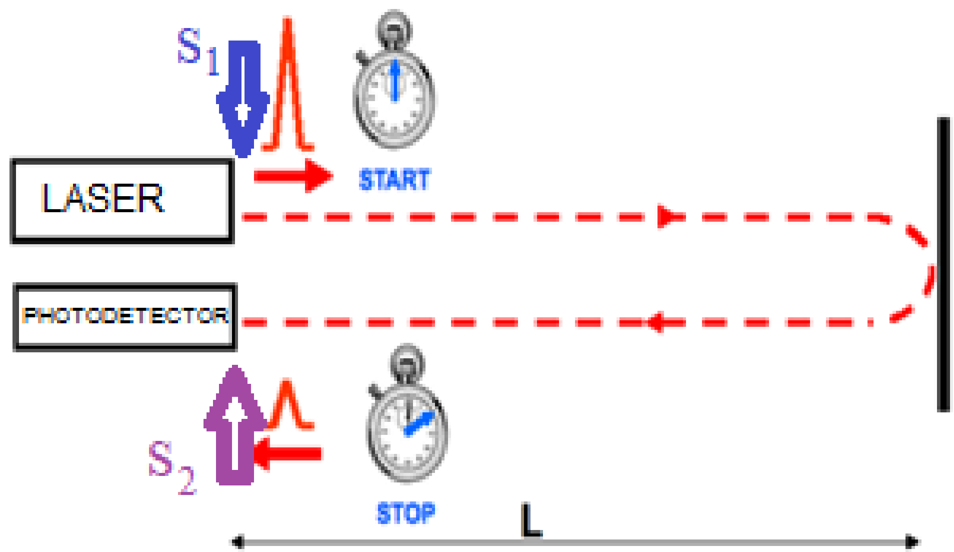
- Cross – correlation

$$CCF_{12}(\tau) = \int s_1(t).s_2(t-\tau)dt$$

$$CCF_{12}(m) = \frac{1}{N}\sum_{n=1}^{N} s_1(n).s_2(n-m)$$

- CCF is a measure of how well the time series s_1 and s_2 are „similar" to each other at a given time delay. (CCF has a maximum at the time delay for which the similarity is the greatest!)

Method of time of flight



$$TOF = \text{value of time delay where } CCF_{12} \text{ is maximal}$$

$$c_{flight} = \frac{2L}{TOF}$$