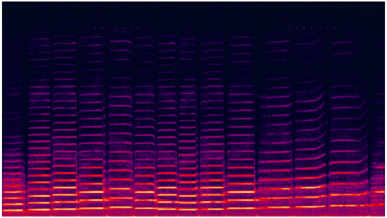
EDISP (Inst. Spectrum - STFT)
(English) Digital Signal Processing
Instantaneous spectrum
or
Short Time Fourier Transform lecture

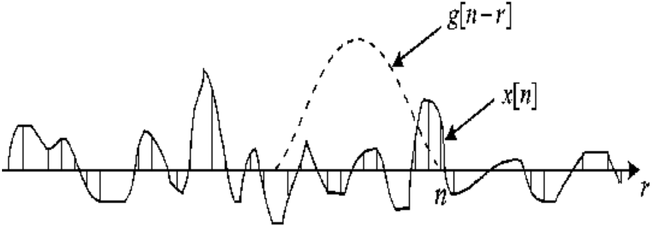
November 19, 2007

Signal properties changing in time

- FT/DFT etc: signal properties assumed constant in a whole analysis time
- True signals (e.g. speech, music, video): main information content in the **changes** of the signal properties
- (A simple idea) how to analyse such signals:
  - get a small section of a signal
  - assume properties stable inside section
  - analyze section (calculate spectrum)
  - move to next section (and repeat the procedure)
  - Finally draw a 2d-picture (abs() spectrum vs. time) $\longrightarrow$ *spectrogram*



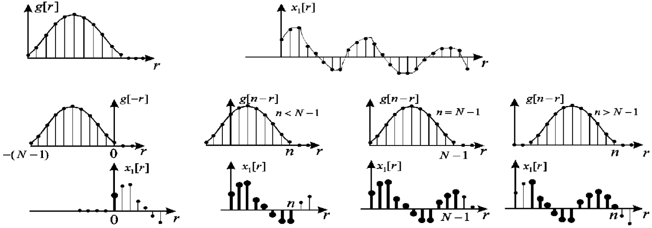
Formulation



$$X(n,\theta) = \sum_{r=-\infty}^{\infty} x[r]g[r-n]e^{-j\theta r}$$

- A window $g(n)$ of length L is non-zero if $n = 0,\ 1,\ \ldots,\ L-1$ (beware - others may define symmetrical windows)
- so n in $X(n,\theta)$ is the *end* of window
- The result depends on L and window type (recall windows lecture)

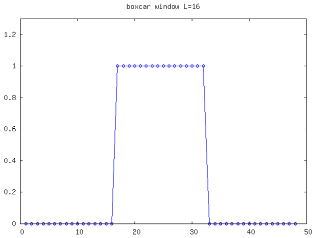
Sliding a window

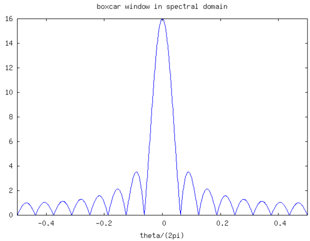


- edge effects
- resolution

Resolution in time or in frequency?

Can't have both :-)





- Resolution in time $\approx L$ (window length)
- Resolution in frequency $\approx \frac{4\pi}{L}$
- And we also want low sidelobes (= "good" windows)
- $\longrightarrow$ good windows (with low sidelobes)
  are bad windows (have wide mainlobe and are effectively shorter in time)

Hint: choose your window carefully to your application!

Wider wiev of the problem

Other names for the same:

- Short-Time Fourier Transform (STFT)
- Short-Term Fourier Transform (STFT)
- Time-Dependent Fourier Transform (TDFT)

Other approaches: Time-Frequency Transforms in general

- Vigner-Ville transform $W_x(n,\theta) = \sum_{r=-\infty}^{+\infty} x(n+r)x^*(n-r)e^{-j\theta 2r}$
- Wavelet transform (use time-concentrated basis functions)
- Chirplet transform
- ...