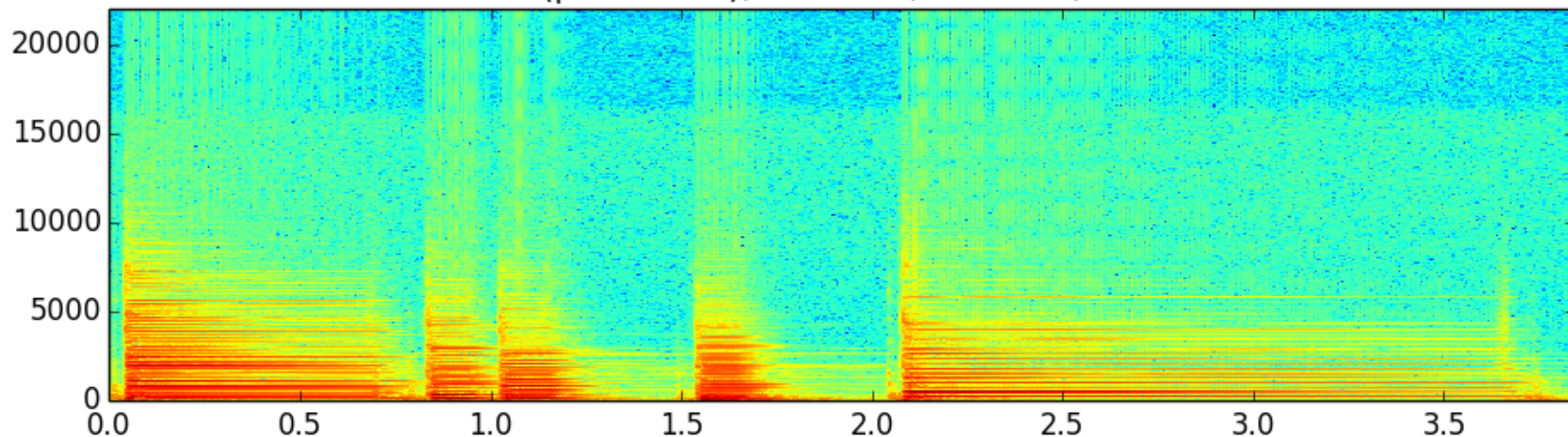# 10T2: Review

Xavier Serra
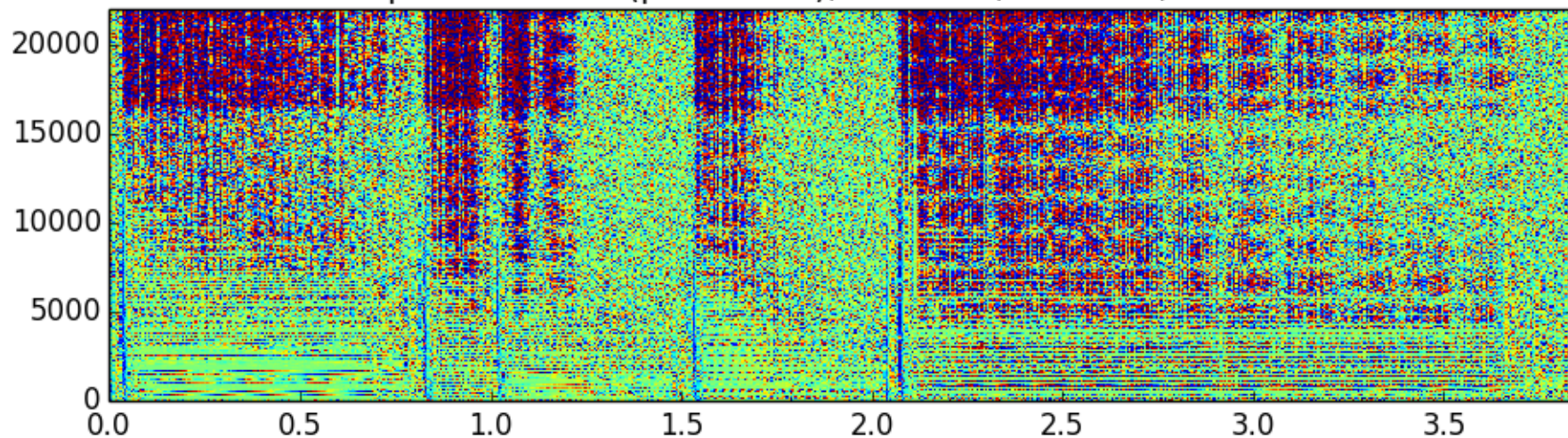
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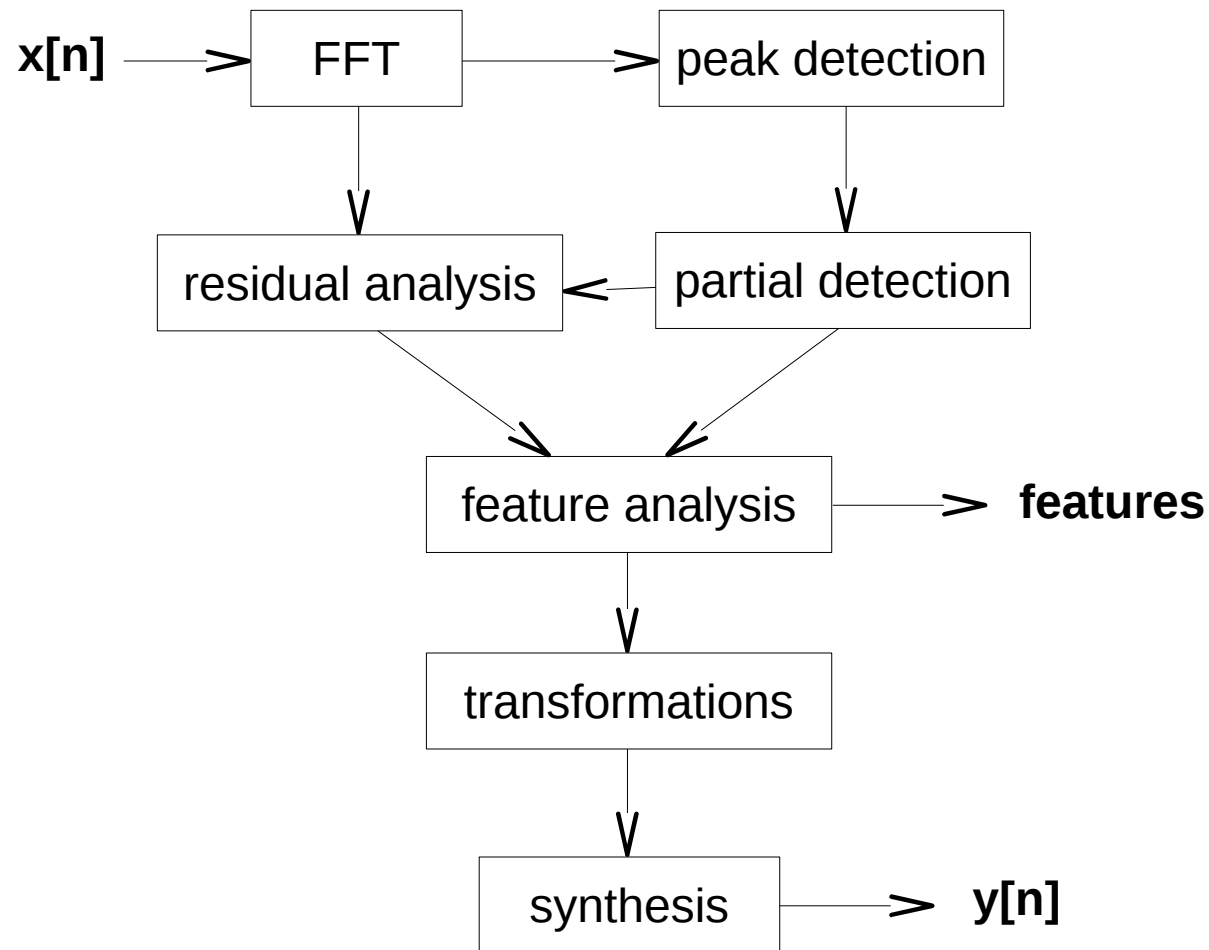
A spectral view of sound and music

mX (piano.wav), M=1001, N=1024, H=256

pX derivative (piano.wav), M=1001, N=1024, H=256

Framework covered in this course

x[n] → FFT → peak detection

FFT → residual analysis

peak detection → partial detection

partial detection → residual analysis

residual analysis → feature analysis

partial detection → feature analysis

feature analysis → **features**

feature analysis → transformations

transformations → synthesis

synthesis → **y[n]**

Sound spectra

Discrete Fourier Transform:

$$X[k] = \sum_{n=0}^{N-1} x[n] e^{-j2\pi kn/N} \quad k = 0, \ldots, N-1$$

Short-time Fourier Transform:

$$X_l[k] = \sum_{n=-N/2}^{N/2-1} w[n] x[n+lH] e^{-j2\pi kn/N} \quad l = 0, 1, \ldots,$$

Sinusoids and harmonics

Sinusoidal model:

$$y[n] = \sum_{r=1}^{R} A_r[n] \cos\left(2\pi f_r[n]n\right)$$

Harmonic model:

$$yh[n] = \sum_{r=1}^{R} A_r[n] \cos\left(2\pi r f_0[n]n\right)$$

Residual and stochastic components

Sinusoidal plus residual model:

$$y[n] = \sum_{r=1}^{R} A_r[n] \cos(2\pi f_r[n]n) + xr[n]$$

Sinusoidal plus stochastic model:

$$y[n] = \sum_{r=1}^{R} A_r[n] \cos(2\pi f_r[n]n) + \sum_{k=0}^{N-1} u[n] h_l[n-k]$$

Transforming sounds

manipulating sinusoids and stochastic component:

$$\bar{f}_h[q] = sf_h[l]f_t[st_h[l]l]$$
$$\bar{A}_h[q] = sA_h[l] + A_t[st_h[l]l]$$
$$\bar{\phi}_h[q] = \phi_h[q-1] + f_h[q]$$
$$\bar{st}_k[q] = sst_k[l]st_k[st_k[l]l]$$

Describing sounds and music

cognitive	emotion, music style, semantic concepts			
formal	melody, key, tonality	rhythmic patterns, tempo, meter	instrument, voice	articulation
perceptual	successive and simultaneous intervals	time (beat)	timbre (spectral envelope)	dynamics
sensorial	pitch	time	timbre	loudness
physical	frequency	duration (onset)	spectrum (centroid)	intensity

...and beyond

...audio signal processing is more than this

...sounds and music is more than audio

References and credits

- Slides released under CC Attribution-Noncommercial-Share Alike license and available from https://github.com/MTG/sms-tools

10T2: Review

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