

# 8T2: Spectral-based sound transformations (2 of 2)

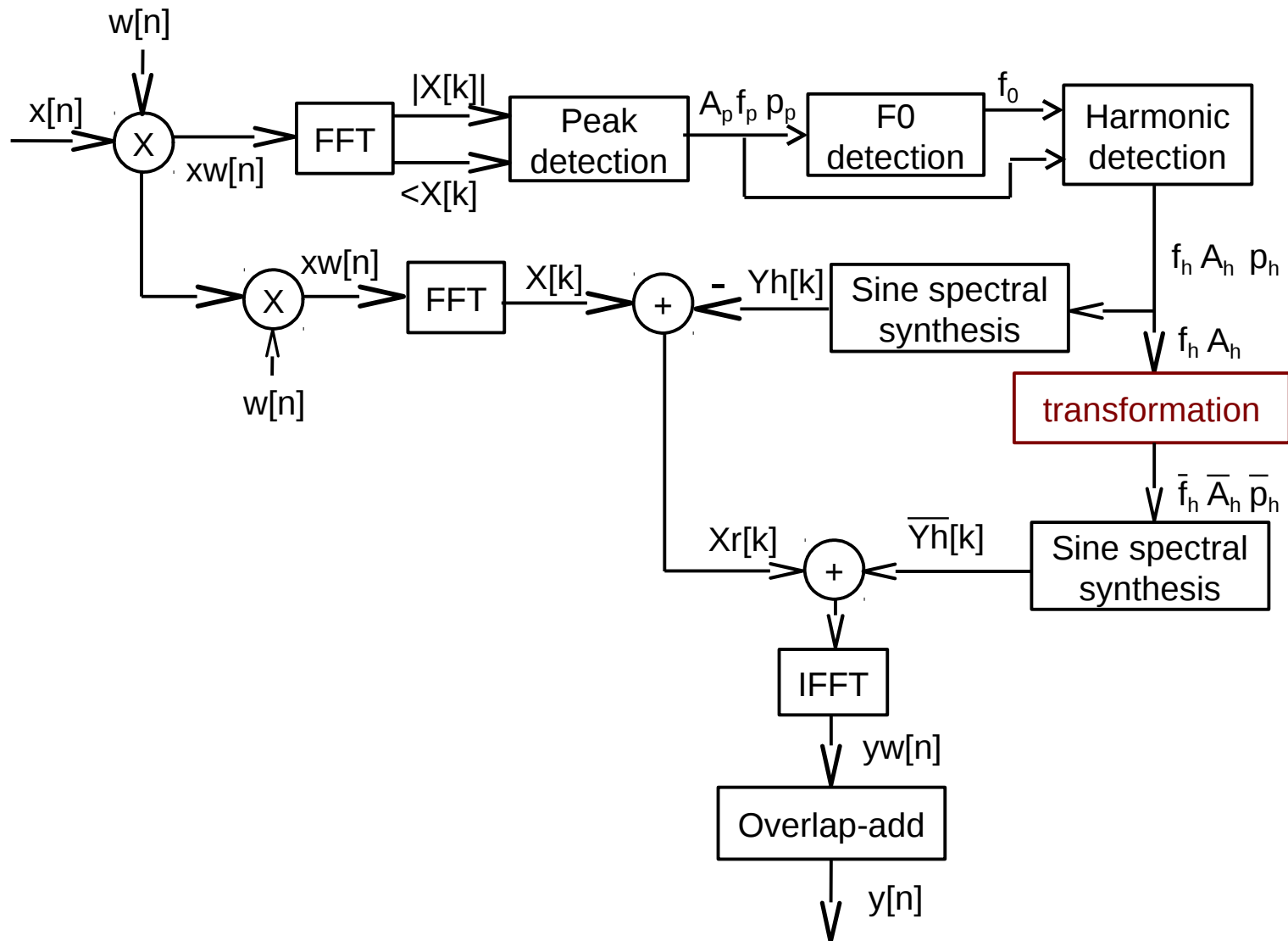
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Universitat Pompeu Fabra, Barcelona

# Index

- Harmonic plus residual model
  - Frequency transformations
- Harmonic plus stochastic model
  - Time scaling
  - Morphing

# Harmonic plus residual model



# Frequency transformations

frequency transposition:  $\bar{f}_h[l] = sf[l] f_h[l]$

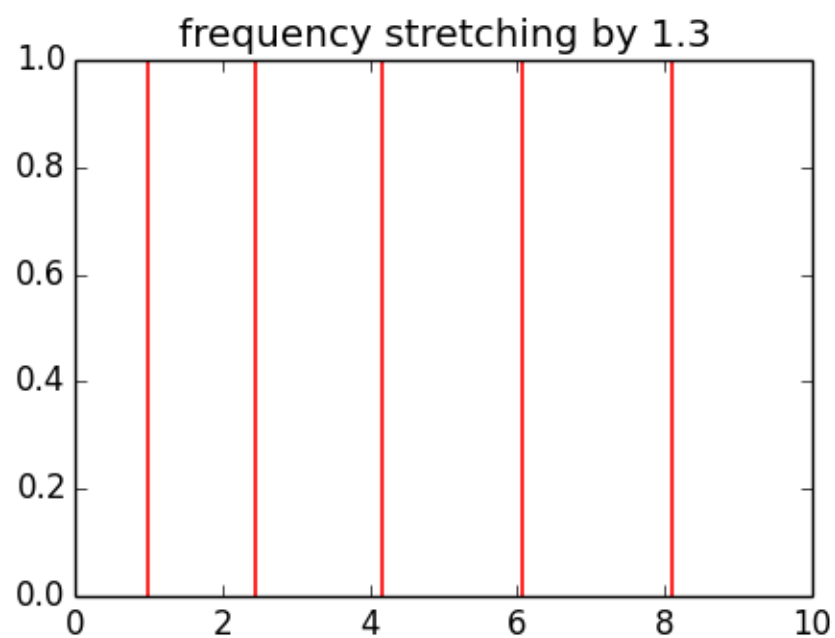
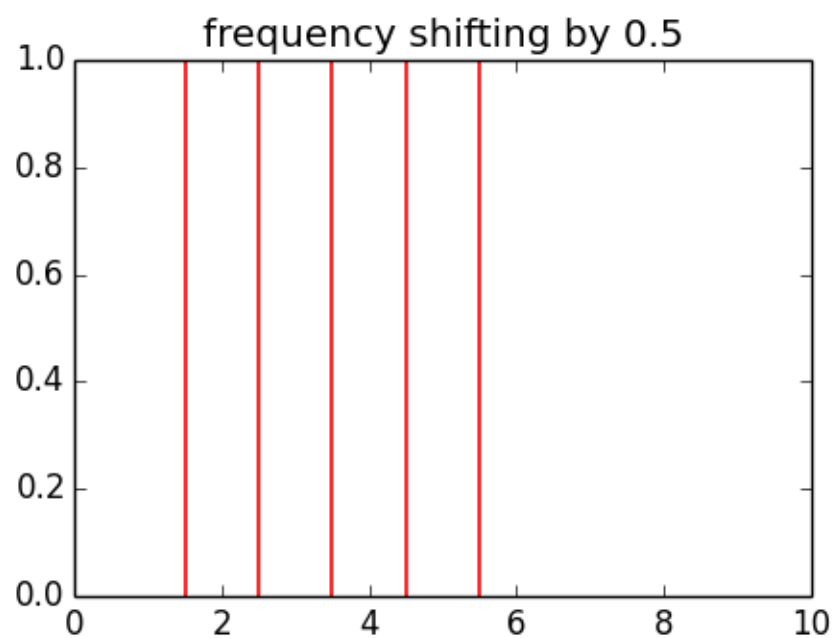
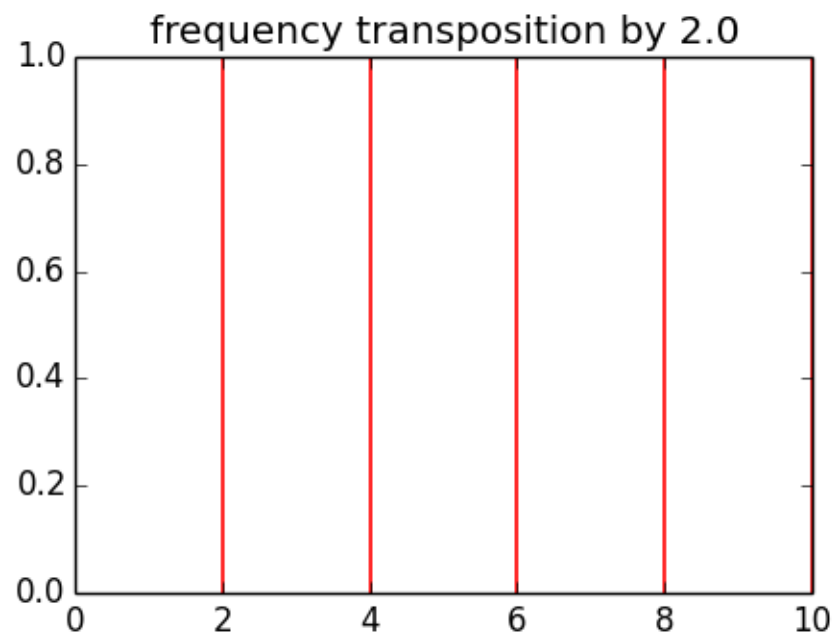
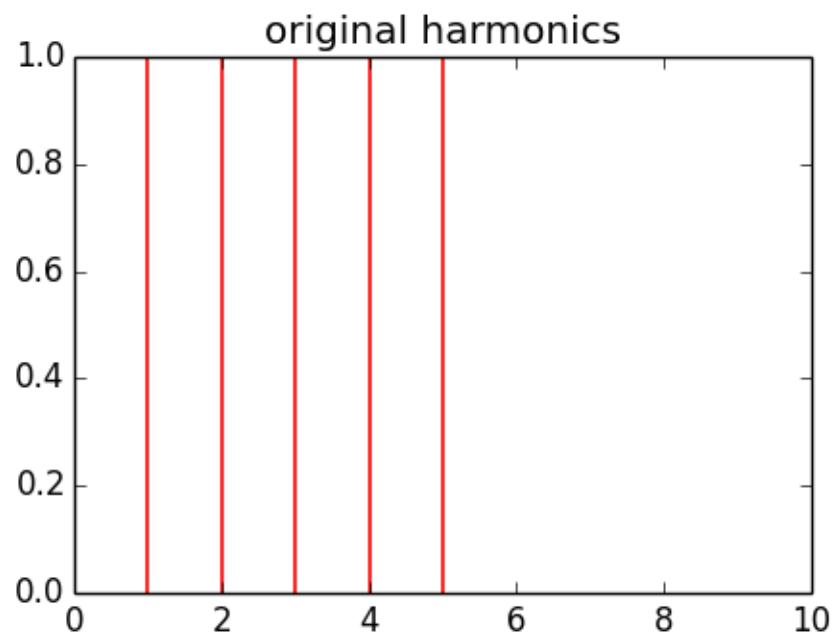
frequency shifting:  $\bar{f}_h[l] = sf[l] + f_h[l]$

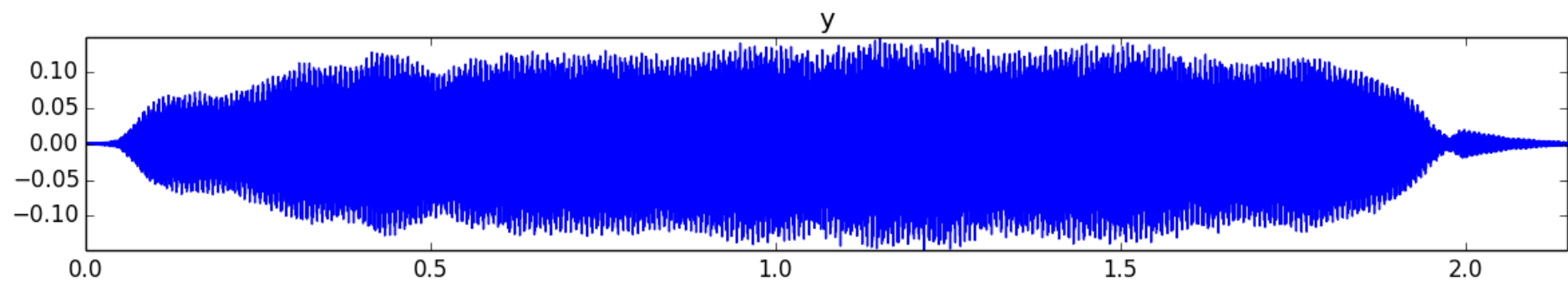
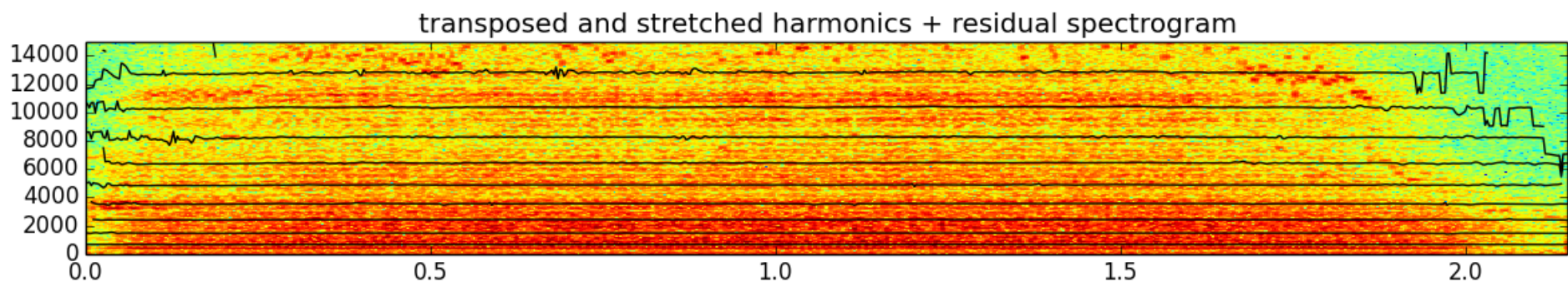
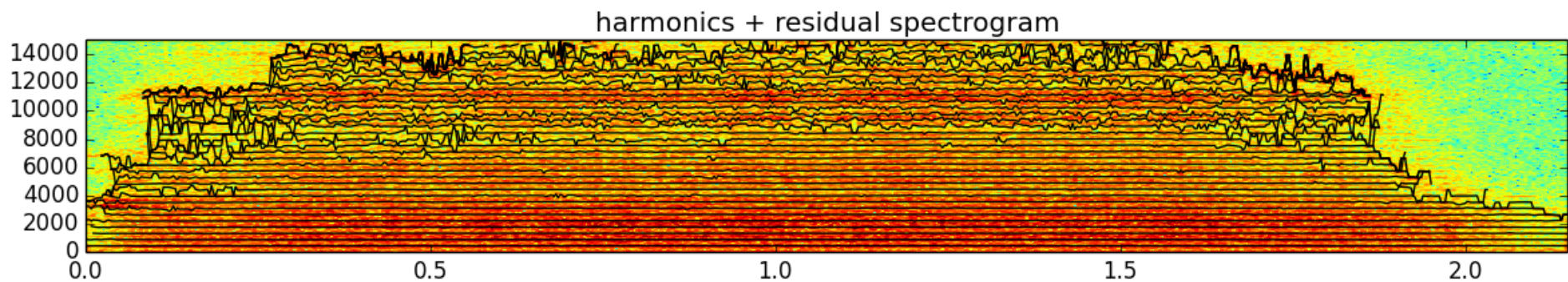
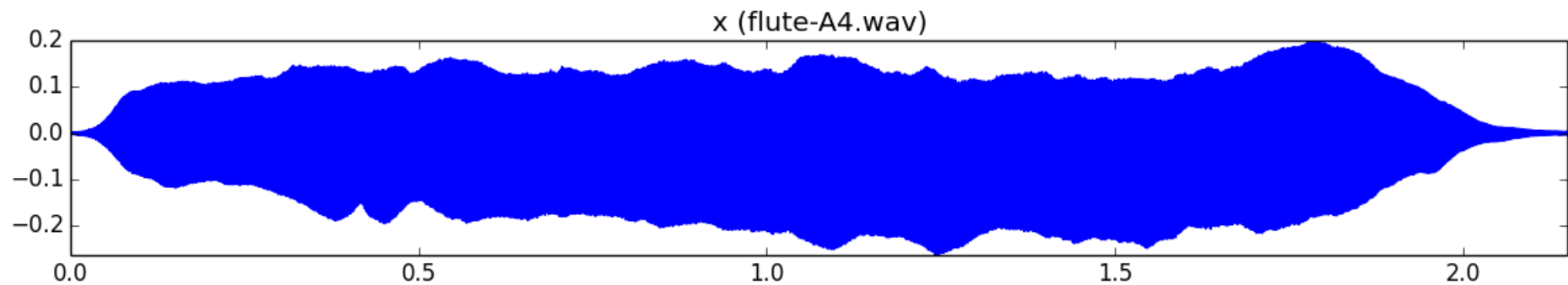
frequency stretching:  $\bar{f}_h[l] = (f_h[l]/h) \times h^{sf[l]}$

$f_h$ : input frequency of harmonic h

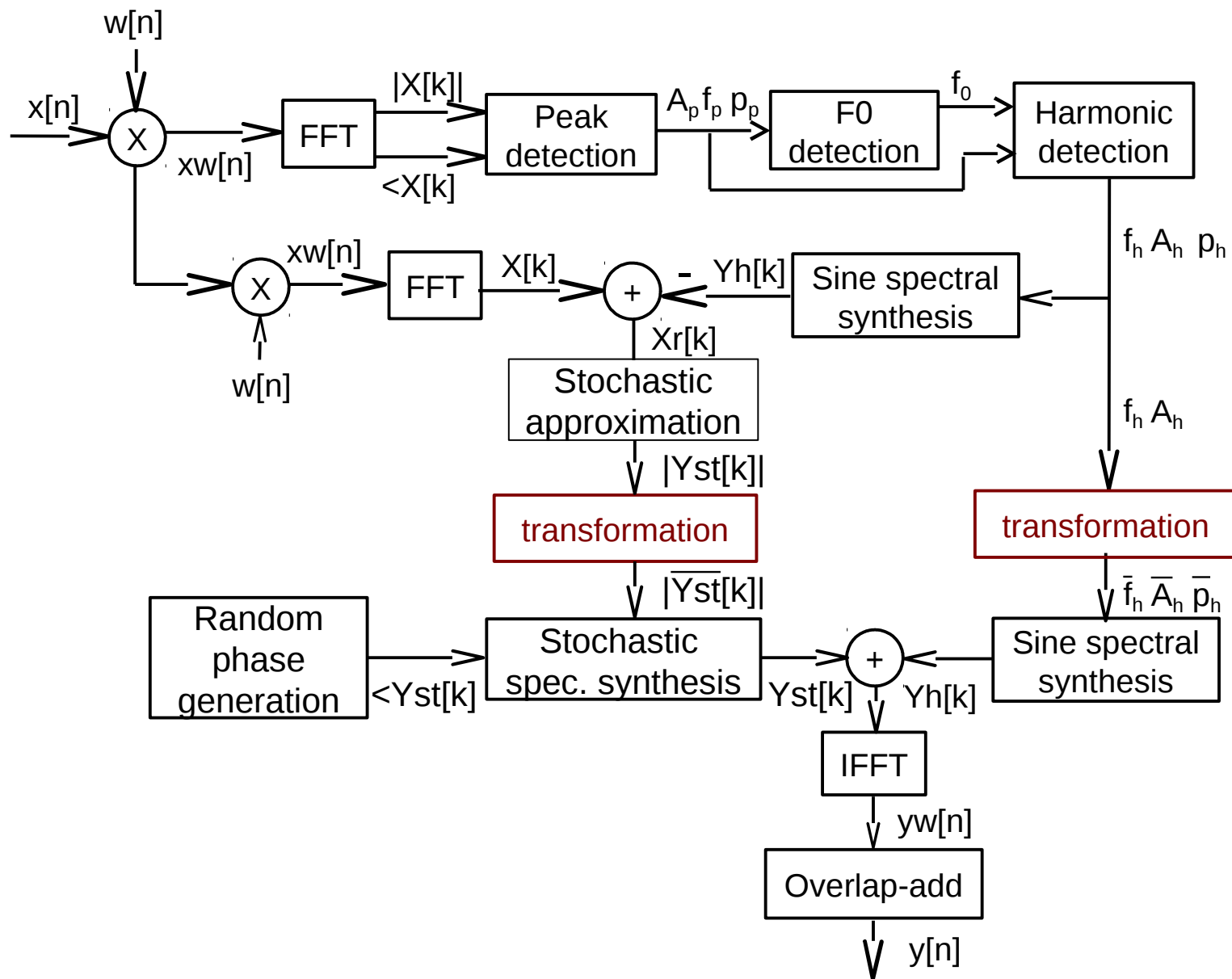
$sf$ : scaling frequency

$\bar{f}_h$ : output frequency of harmonic h





# Harmonic plus stochastic model



# Scaling amplitude, frequency and time

$$\bar{f}_h[q] = sf_h[l] f_t[st_h[l]l]$$

$$\bar{A}_h[q] = sA_h[l] + A_t[st_h[l]l]$$

$$\bar{\phi}_h[q] = \phi_h[q-1] + f_h[q]$$

$$\bar{st}_k[q] = sst_k[l] st_k[st_k[l]l]$$

$q$ : output frame ;  $l$ : input frame ;  $h$ : harmonic

$f$ : input frequency ;  $A$ : input amplitude ;  $st$ : input stochastic envelope

$sf$ : scaling frequency ;  $sA$ : scaling amplitude ;  $st$ : scaling time ;

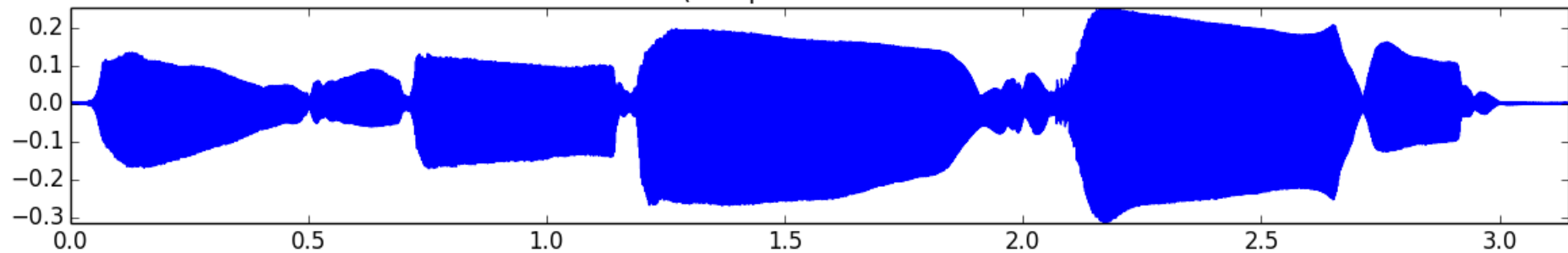
$sst$ : scaling stochastic

$\bar{f}$ : output frequency ;  $\bar{A}$ : output amplitude ;  $\bar{\phi}$ : output phase ;

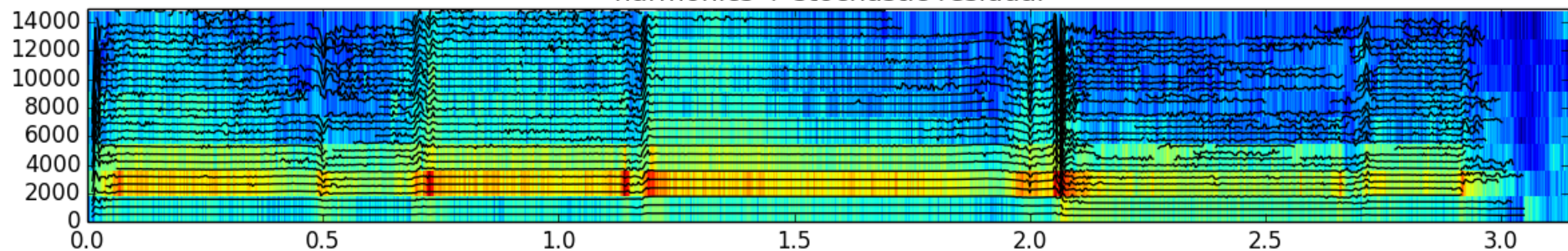
$\bar{st}$ : output stochastic



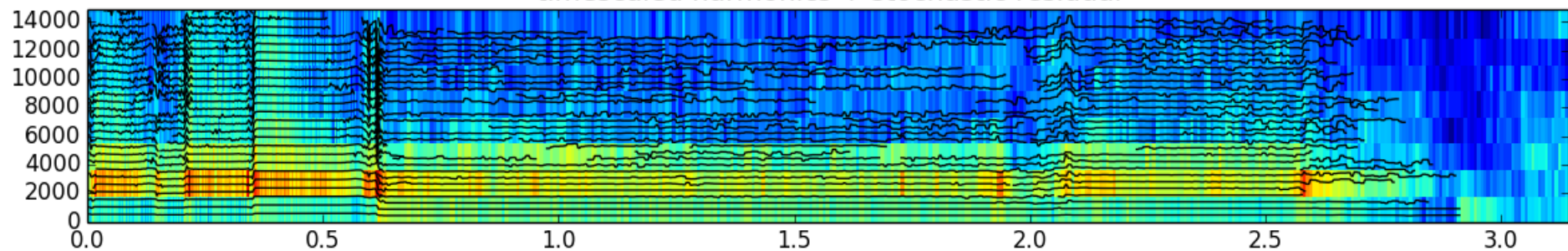
x (sax-phrase-short.wav)



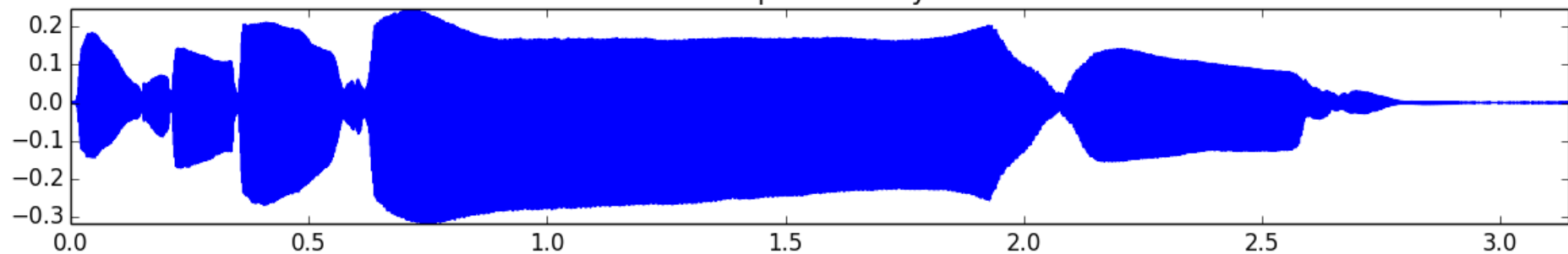
harmonics + stochastic residual



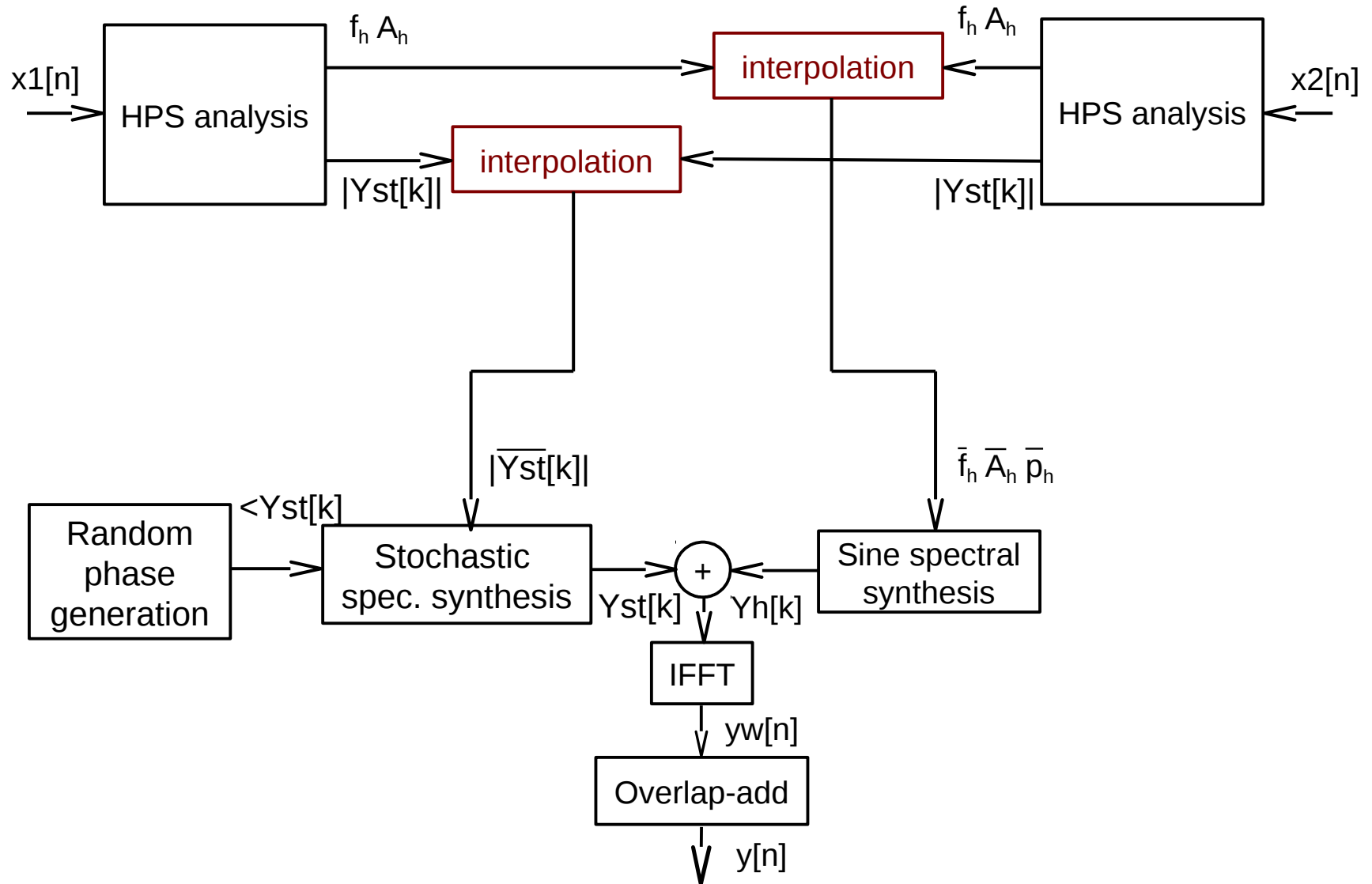
timescaled harmonics + stochastic residual



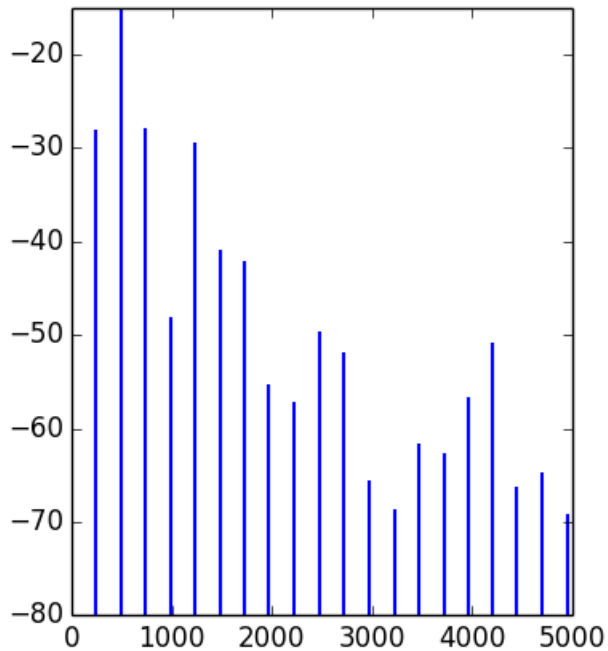
output sound: y



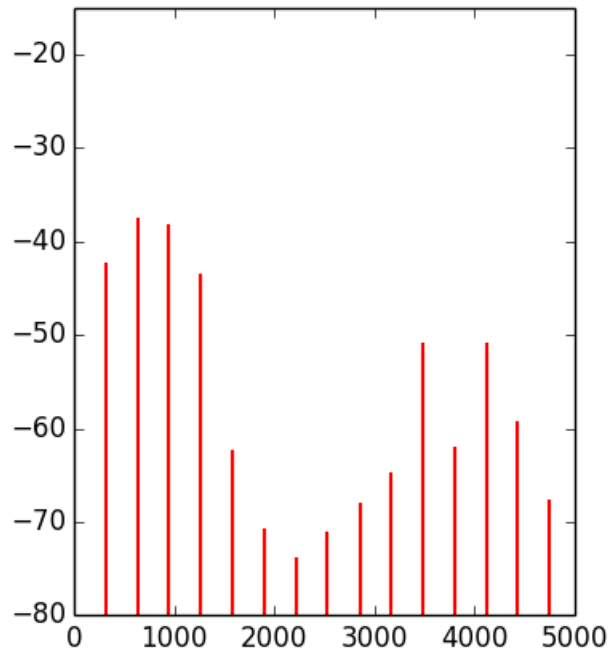
# Morphing



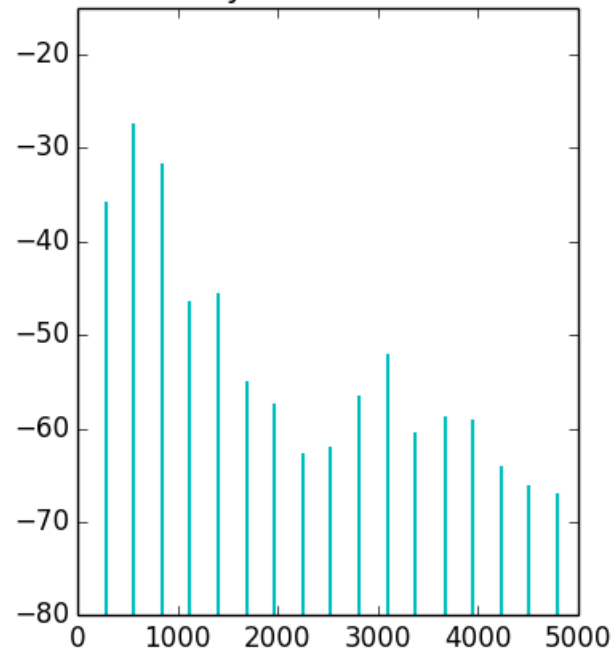
x1: harmonics



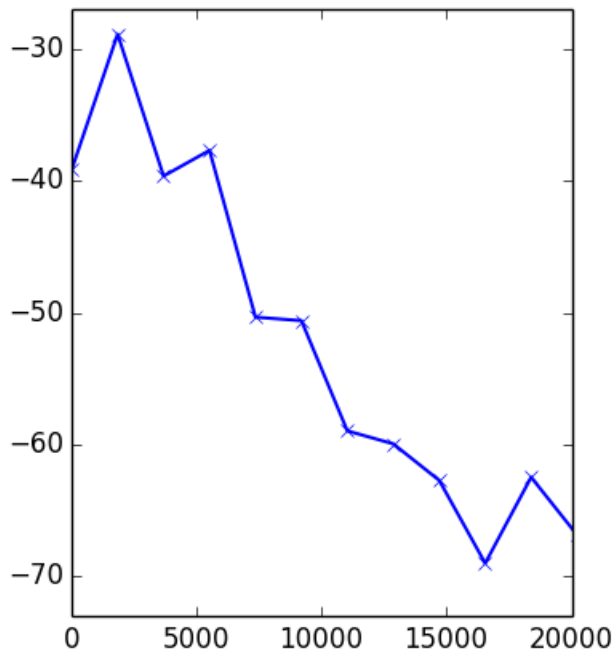
x2: harmonics



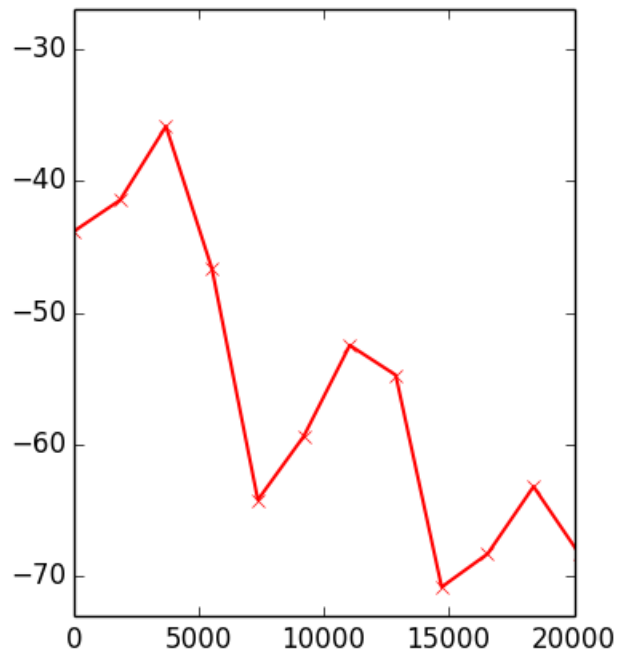
y: harmonics



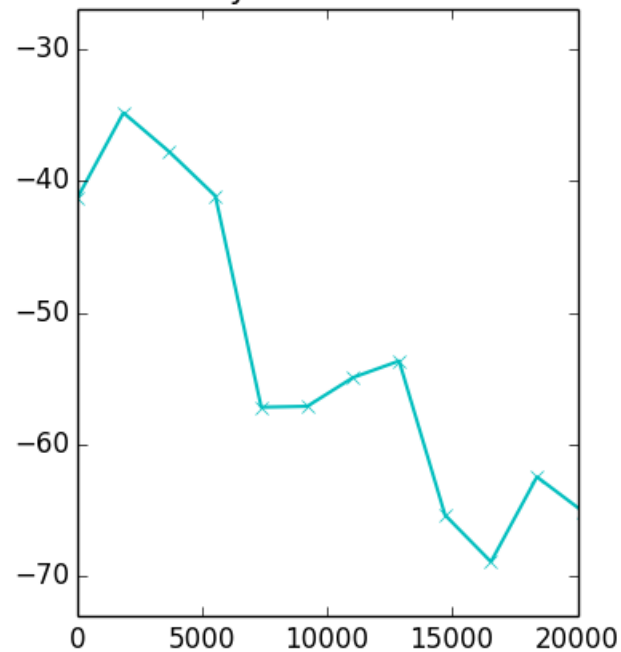
x1: stochastic



x2: stochastic

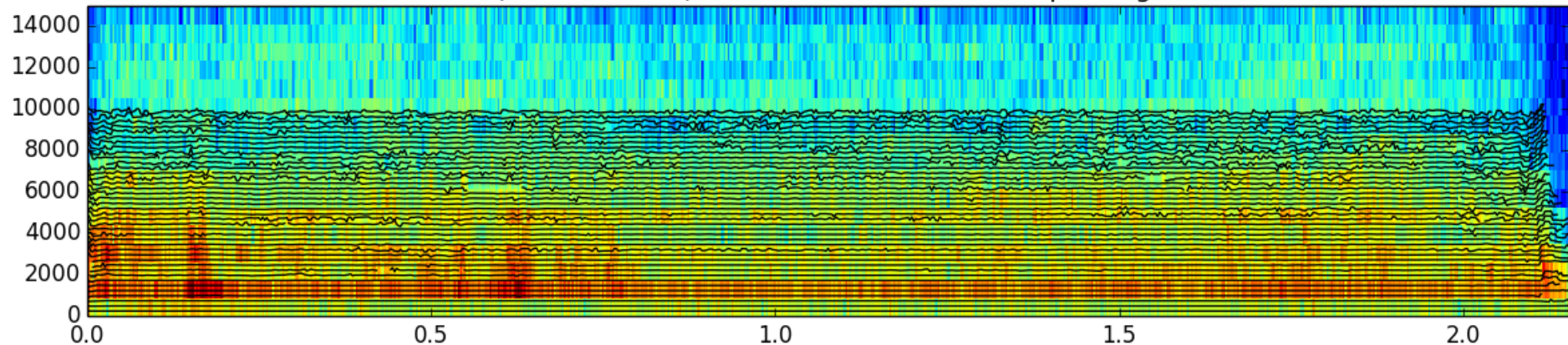


y: stochastic

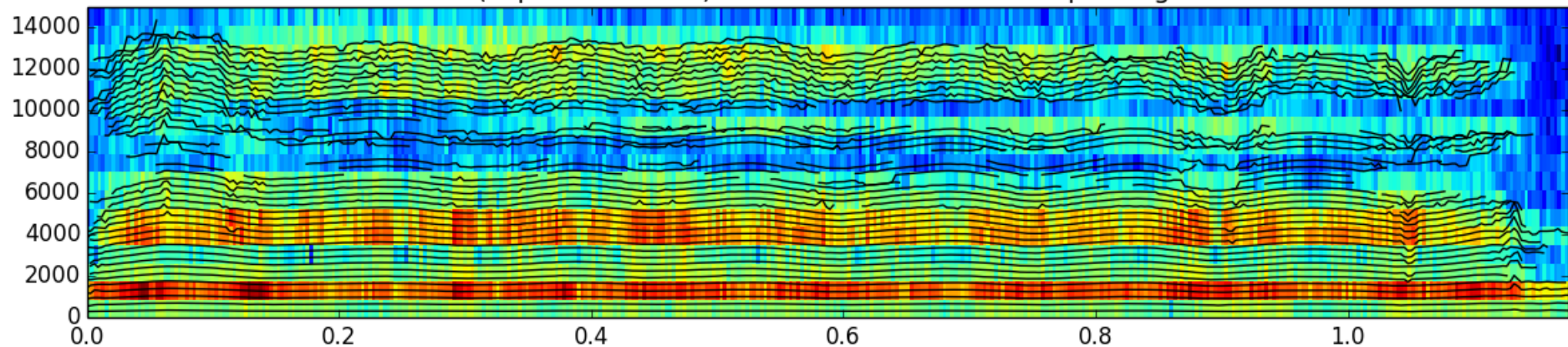




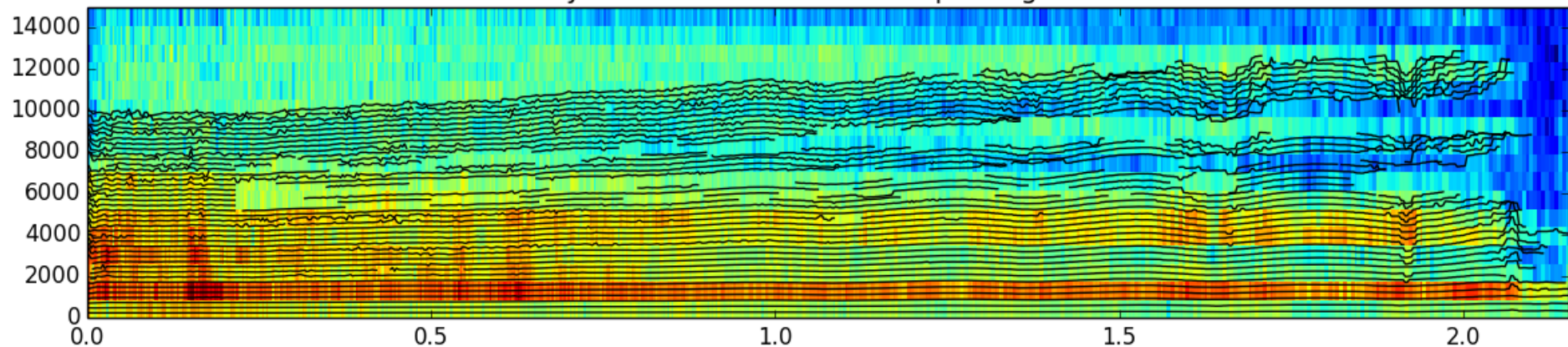
x1 (violin-B3.wav): harmonics + stochastic spectrogram



x2 (soprano-E4.wav): harmonics + stochastic spectrogram



y: harmonics + stochastic spectrogram



# References

- More information on this topic from Wikipedia:
  - [http://en.wikipedia.org/wiki/Sound\\_effects](http://en.wikipedia.org/wiki/Sound_effects)
  - [http://en.wikipedia.org/wiki/Audio\\_timescale-pitch\\_modification](http://en.wikipedia.org/wiki/Audio_timescale-pitch_modification)
- Sounds:  
<http://www.freesound.org/people/xserra/packs/13038/>
- Slides released under CC Attribution-Noncommercial-Share Alike license and code under Affero GPL license; available from <https://github.com/MTG/sms-tools>

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