

8T1: Spectral-based sound transformations (1 of 2)

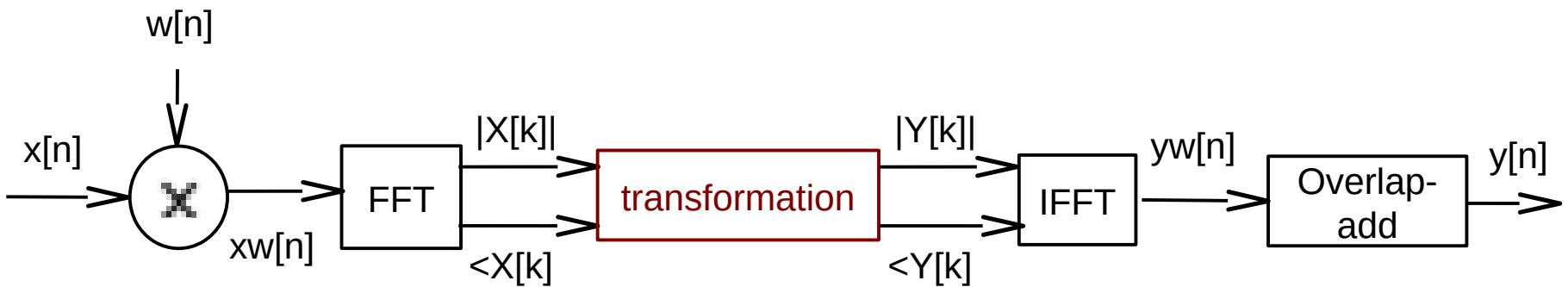
Xavier Serra

Universitat Pompeu Fabra, Barcelona

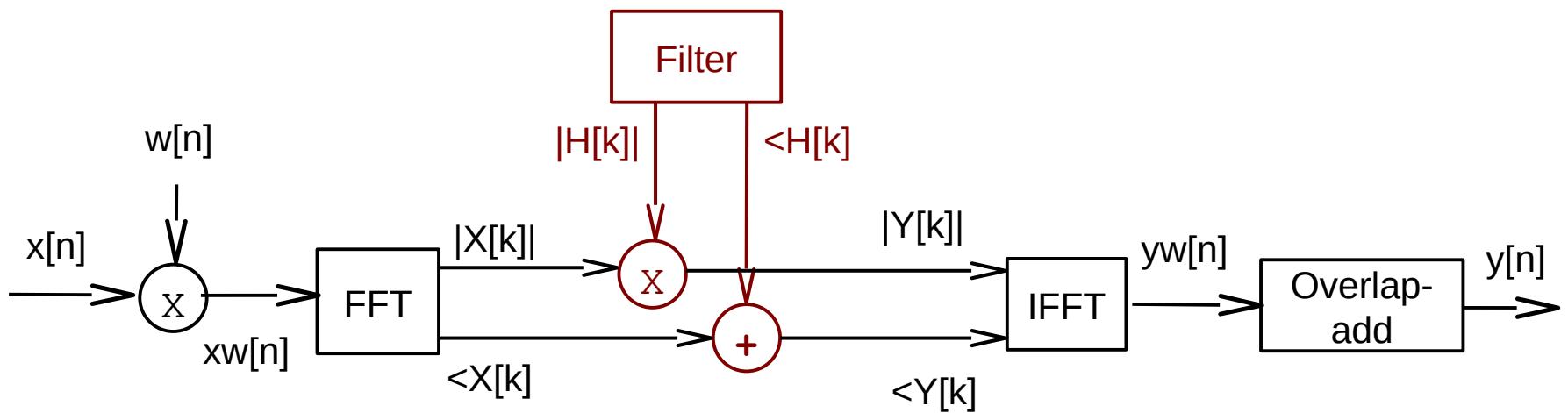
Index

- Short-time Fourier transform
 - Filtering
 - Morphing
- Sinusoidal model
 - Frequency scaling
 - Time scaling

Short-time Fourier transform

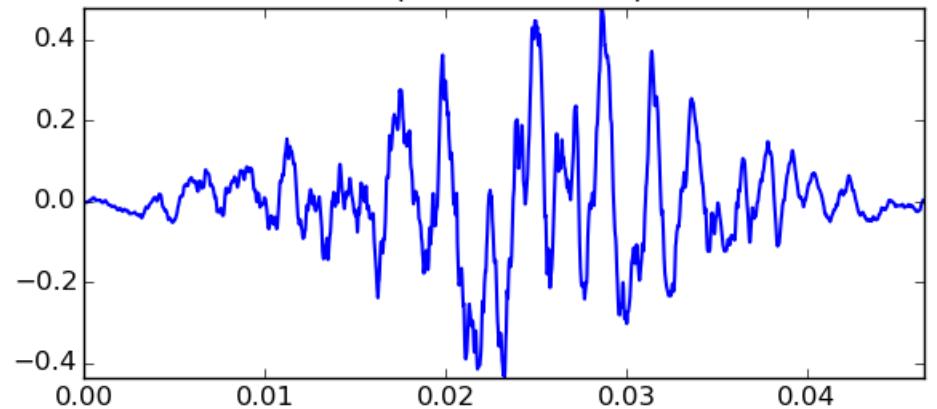


Filtering with STFT

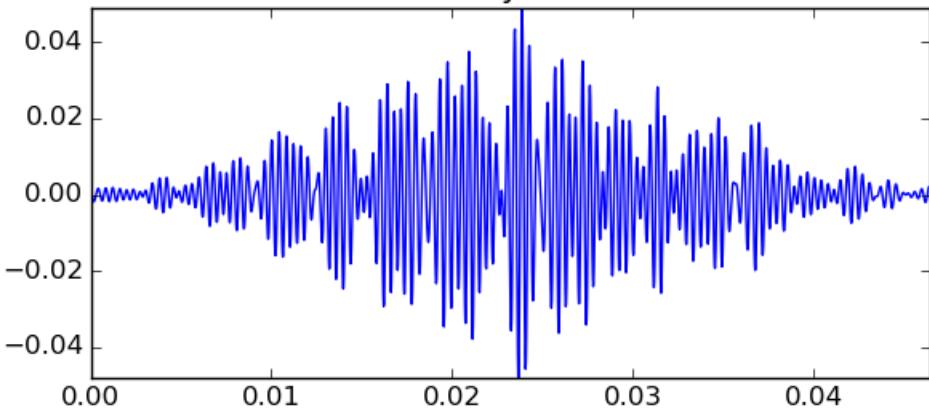


$$Y_l[k] = |H[k]| |X_l[k]| e^{j(\angle H[k] + \angle X_l[k])}$$

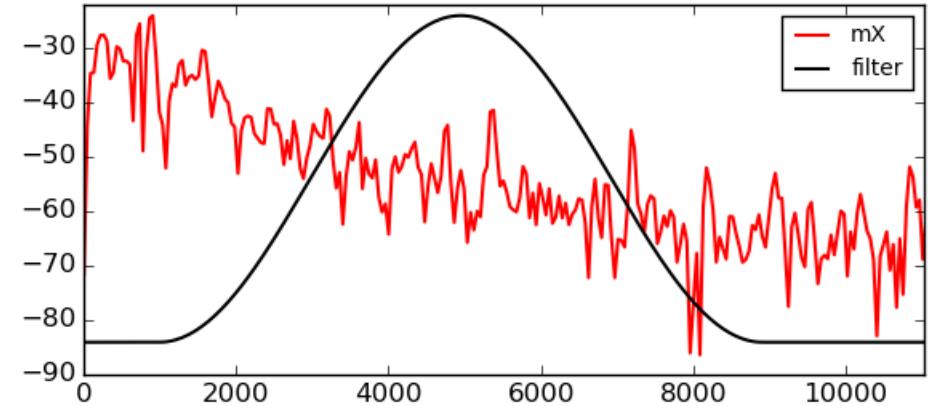
x (orchestra.wav)



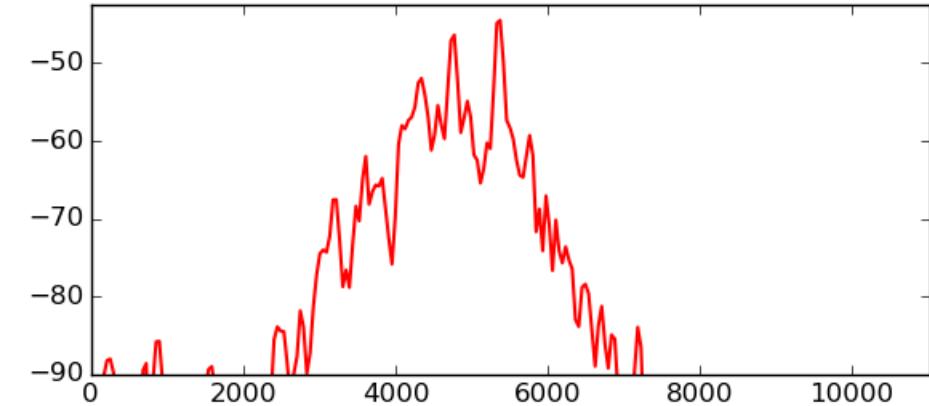
y



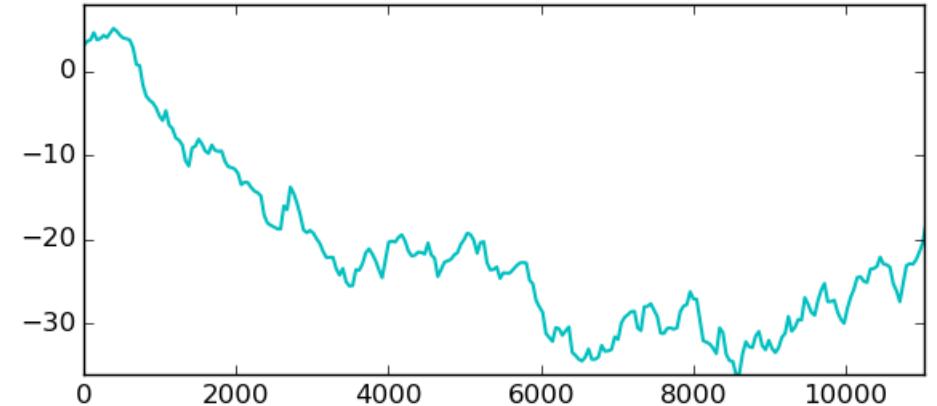
mX + filter



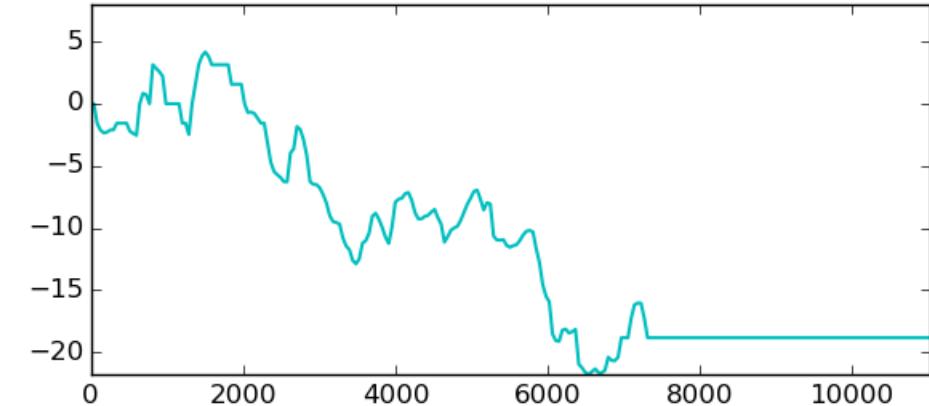
mY



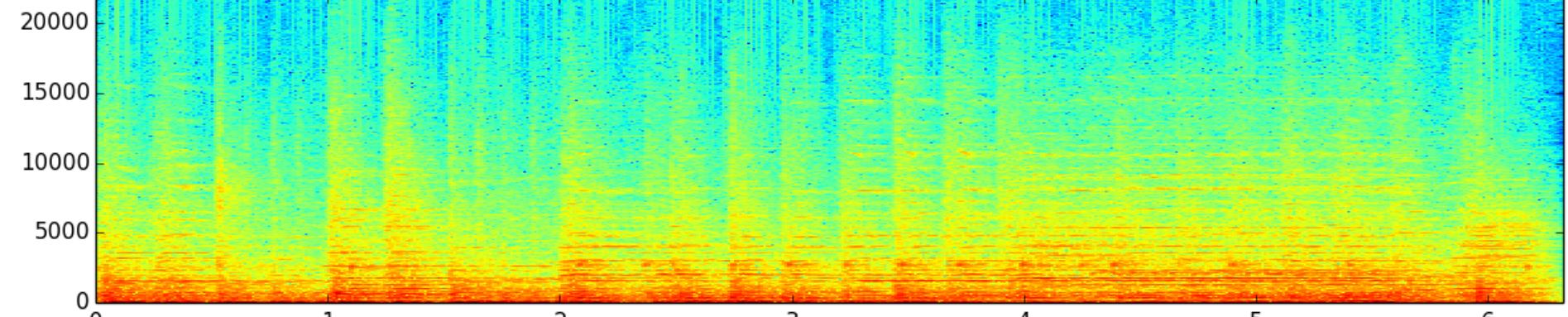
pX



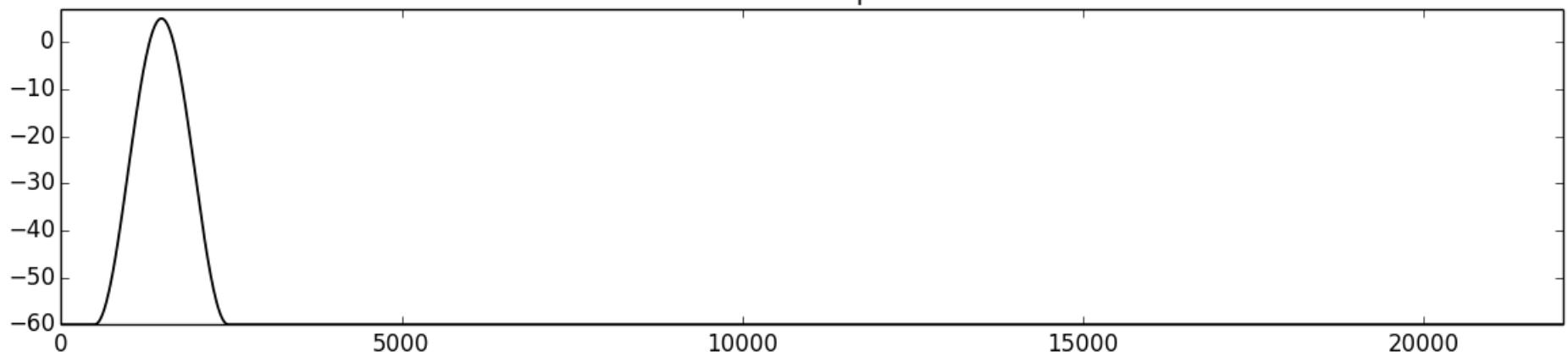
pY



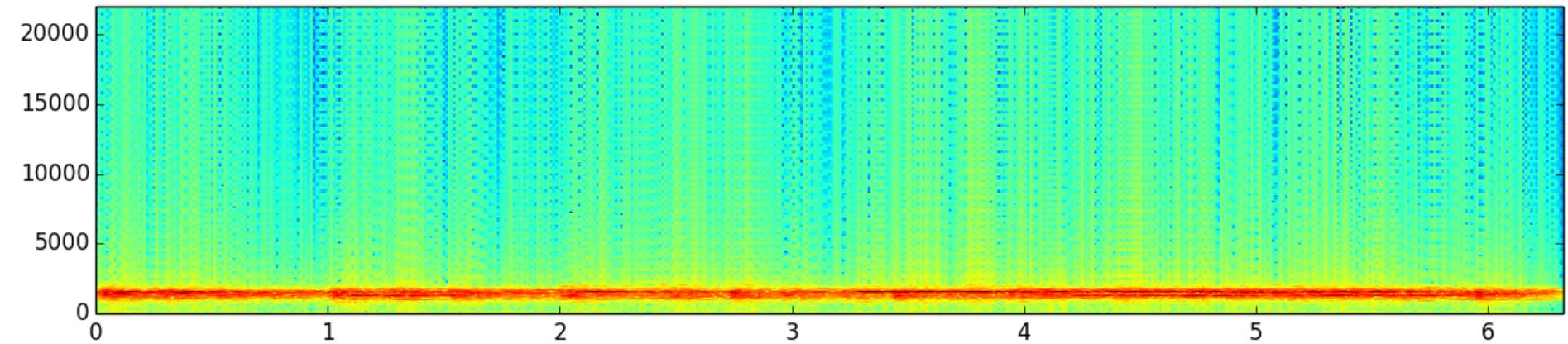
mX (orchestra.wav)



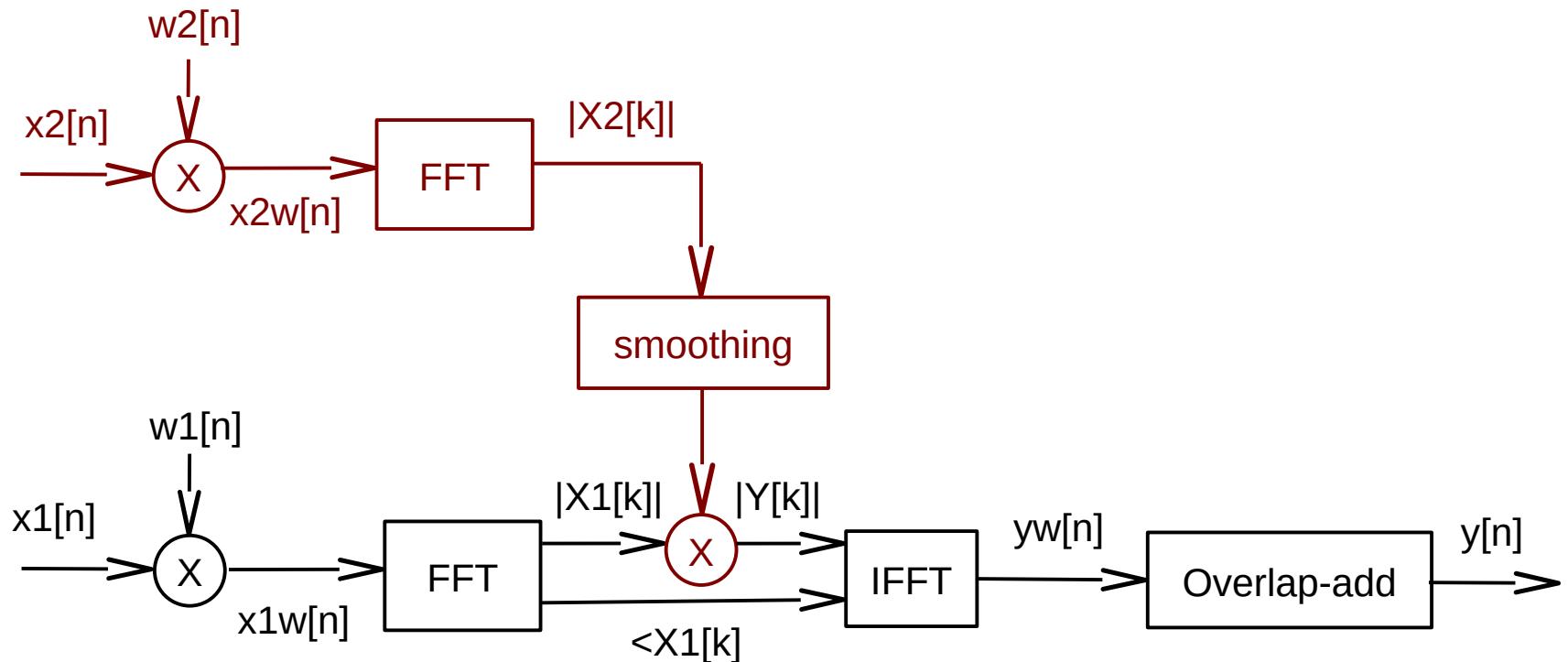
filter shape



mY

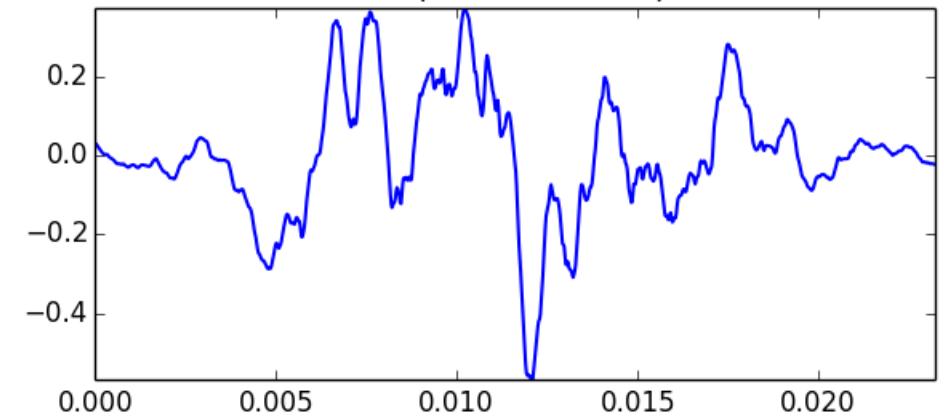


Morphing with STFT

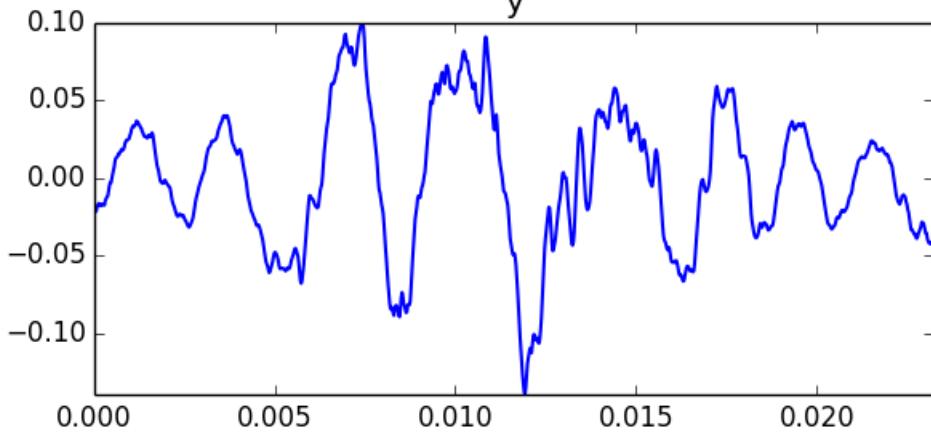


$$Y_l[k] = |X_2[l][k]| |X_1[l][k]| e^{j \angle X_1[l][k]}$$

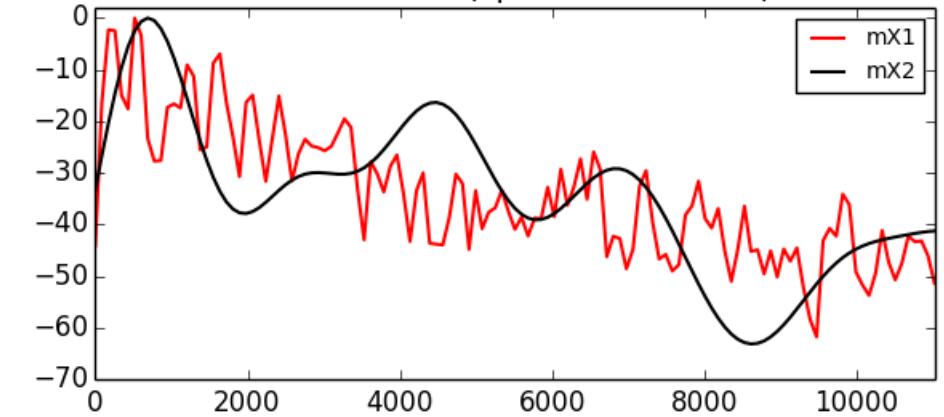
x1 (orchestra.wav)



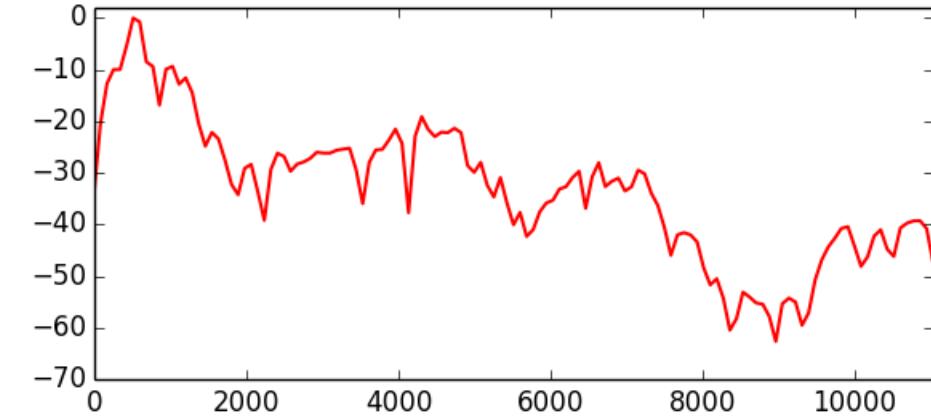
y



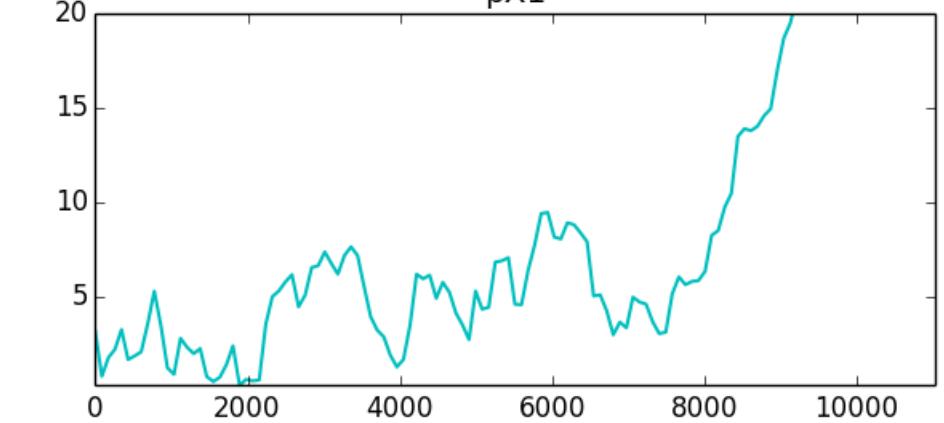
mX1 + mX2 (speech-male.wav)



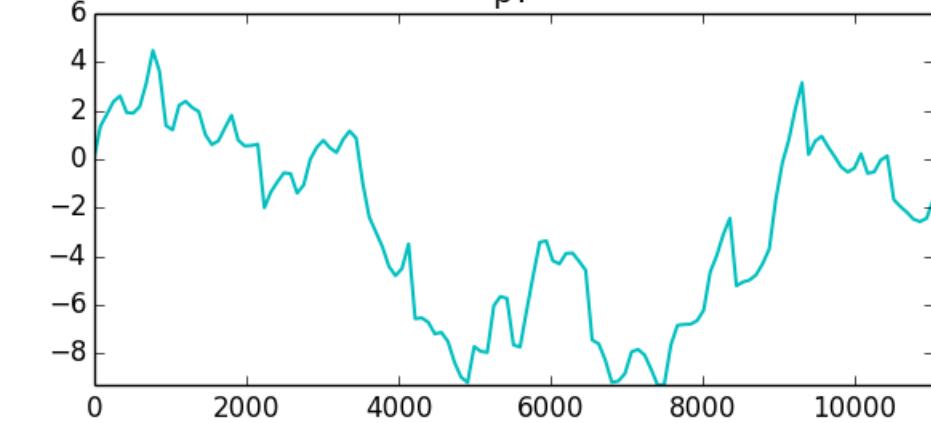
mY



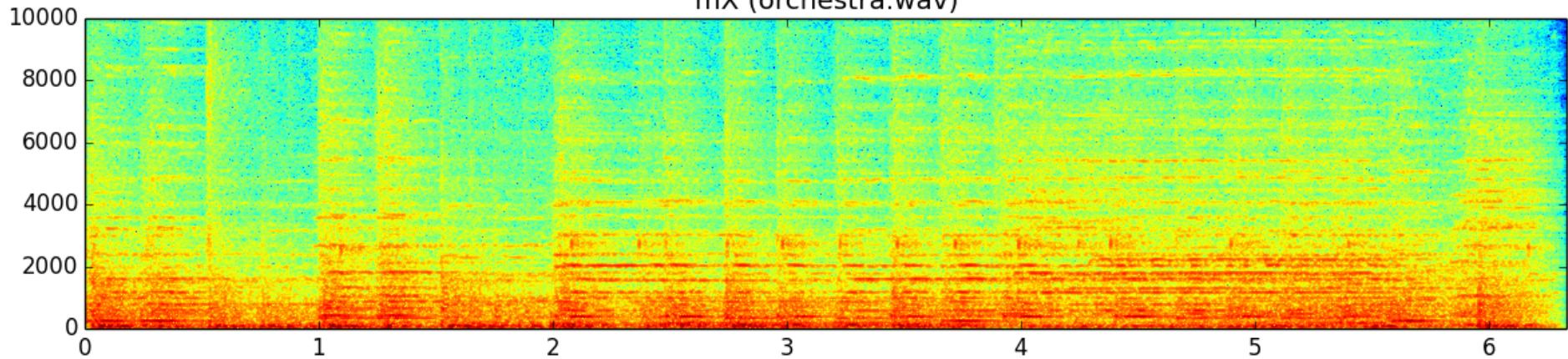
pX1



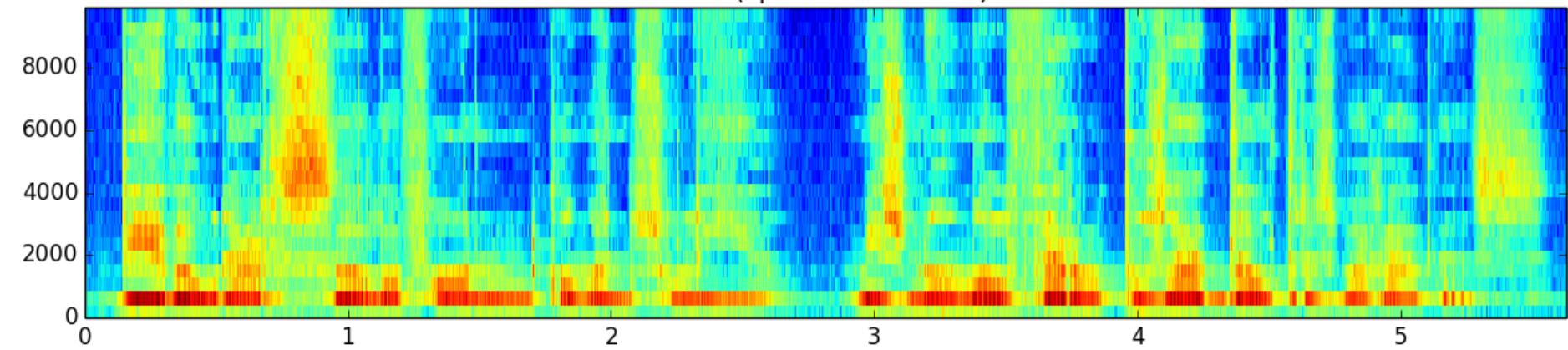
pY



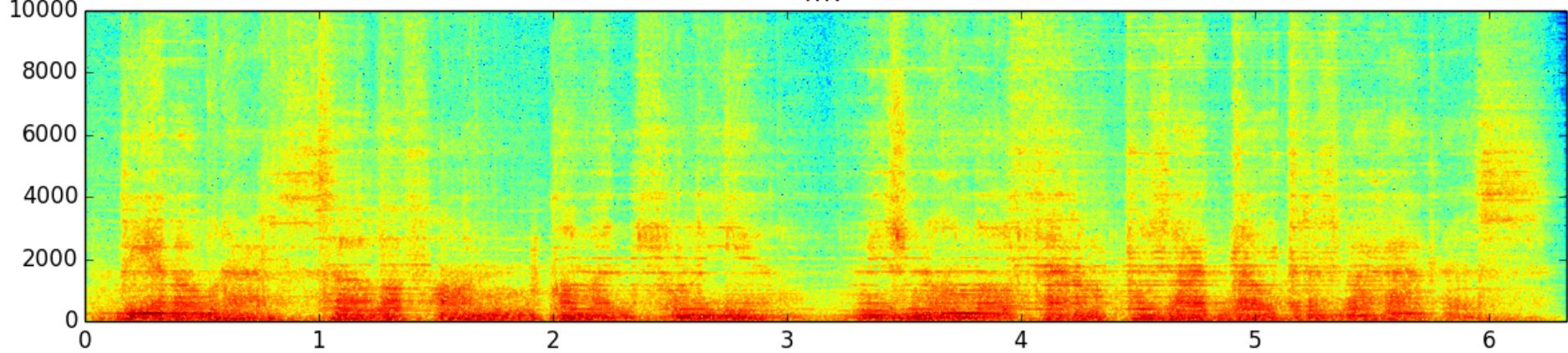
mX (orchestra.wav)



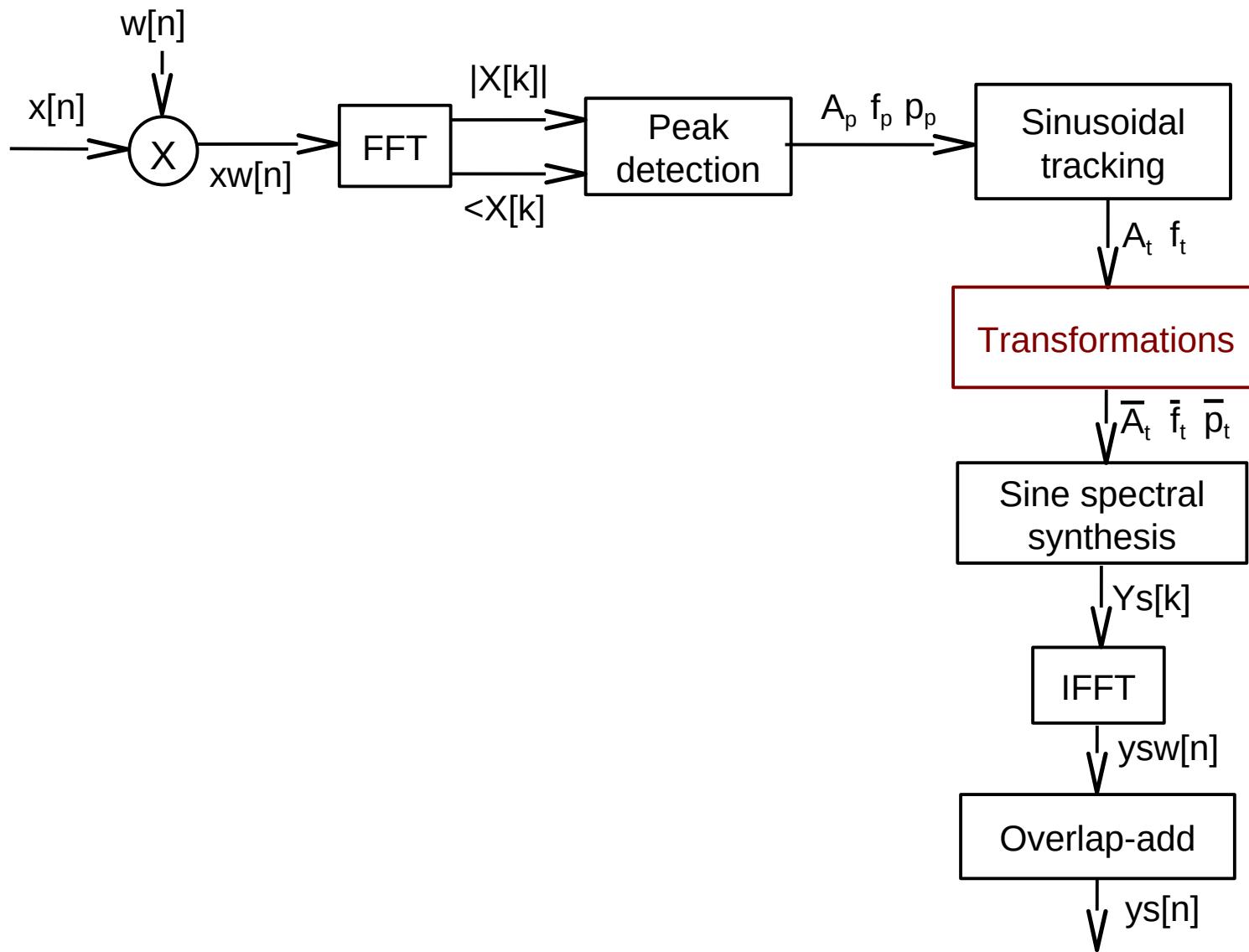
mX2 (speech-male.wav)



mY



Sinusoidal model



Scaling frequency, amplitude and time

$$\bar{f}_t[q] = sf_t[l] f_t[st_t[l]l]$$

$$\bar{A}_t[q] = sA_t[l] + A_t[st_t[l]l]$$

$$\bar{\phi}_t[q] = \phi_t[q-1] + f_t[q]$$

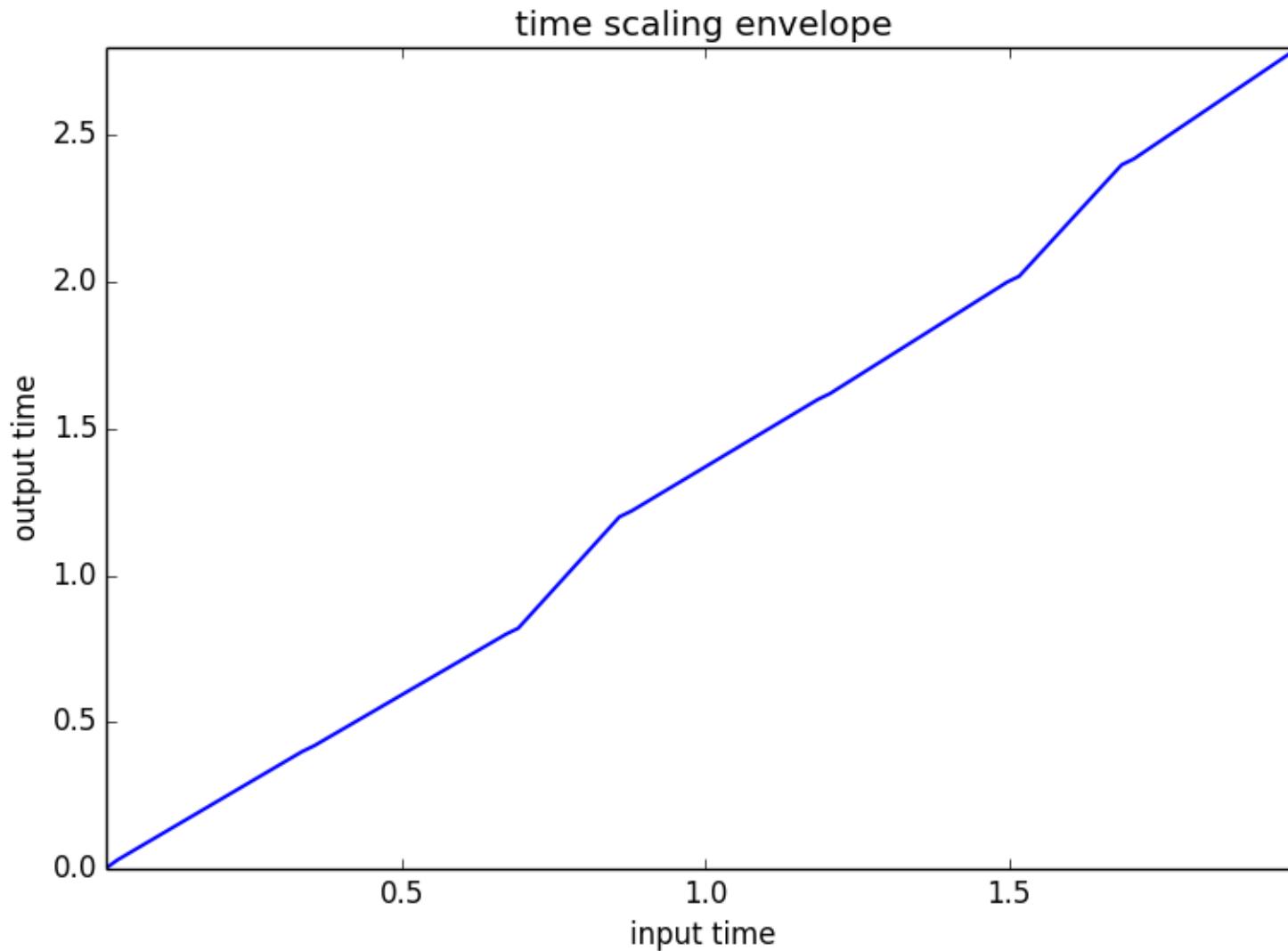
q :output frame index ; l :input frame index ; t :sinusoidal track index

f :input frequency in Hz ; A :input amplitude in dB

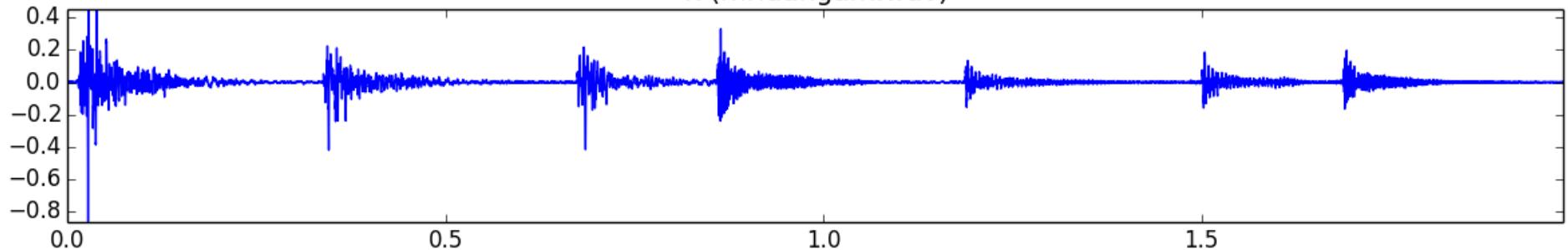
sf :scaling frequency ; sA :scaling amplitude ; st :scaling time

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

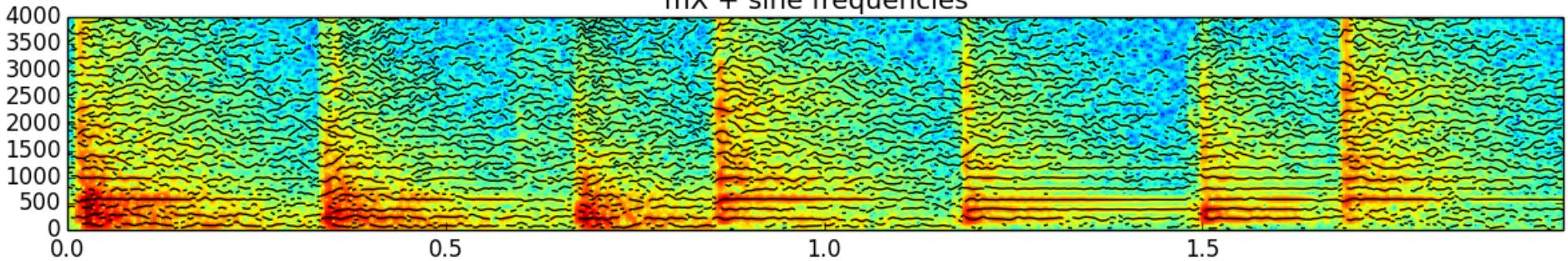
Time scaling



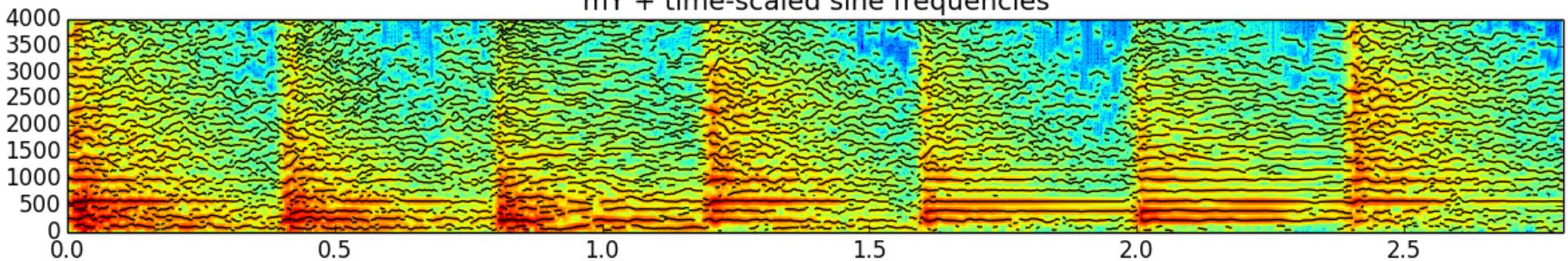
x (mridangam.wav)



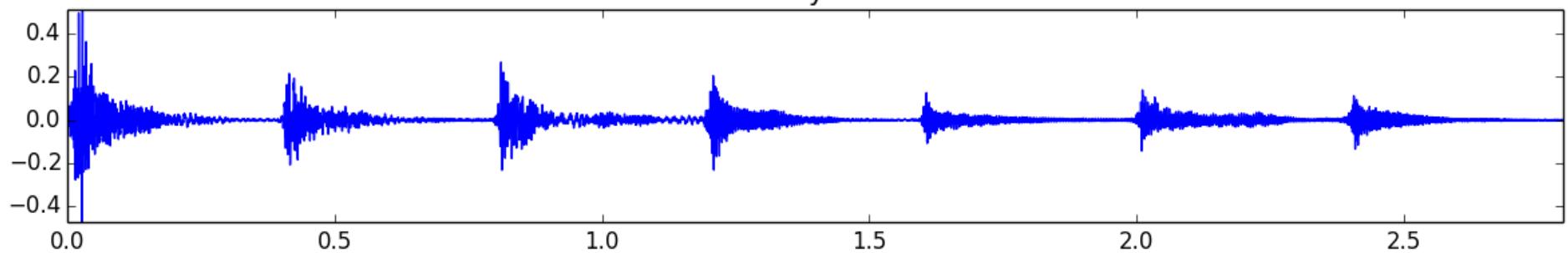
mX + sine frequencies



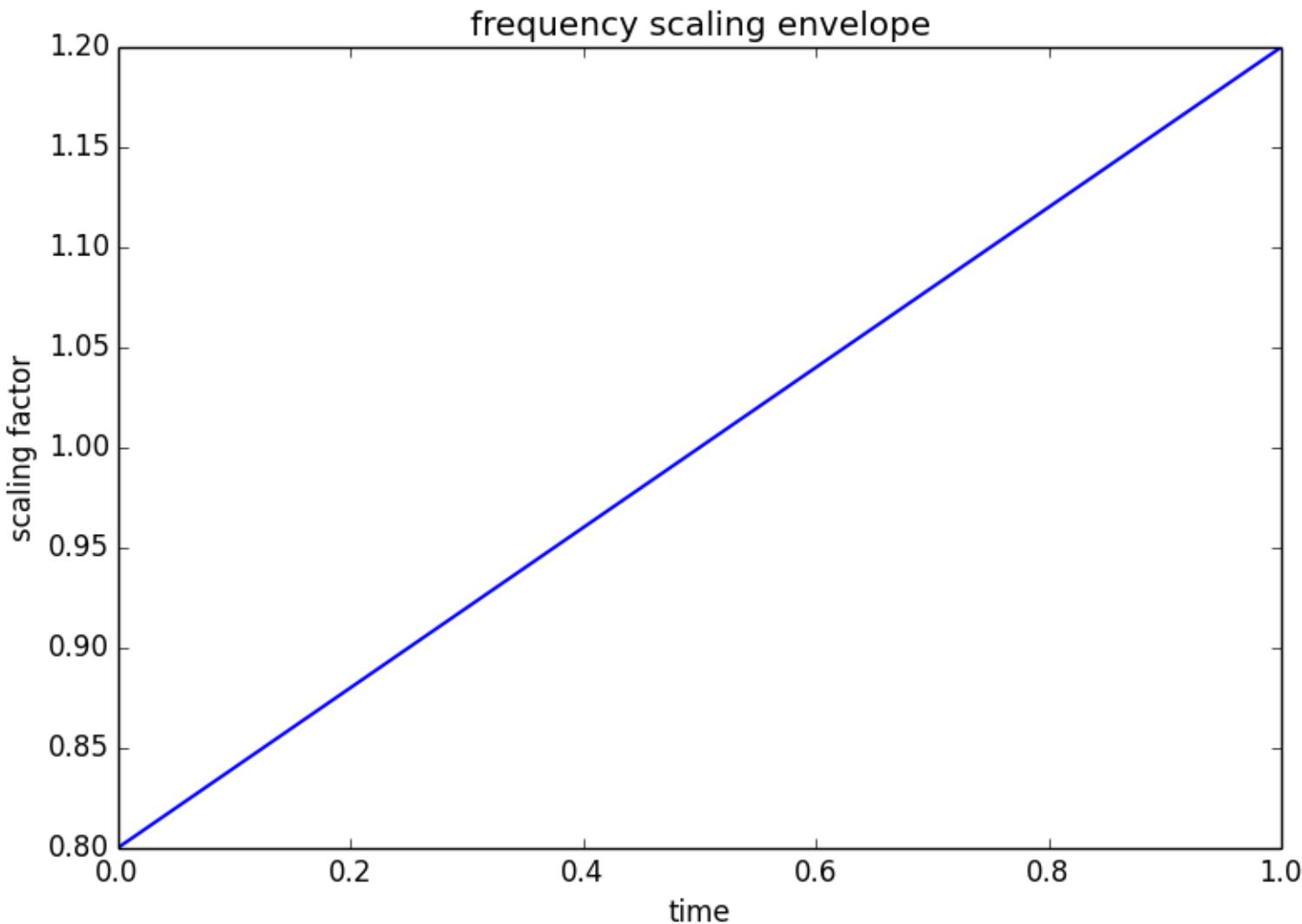
mY + time-scaled sine frequencies



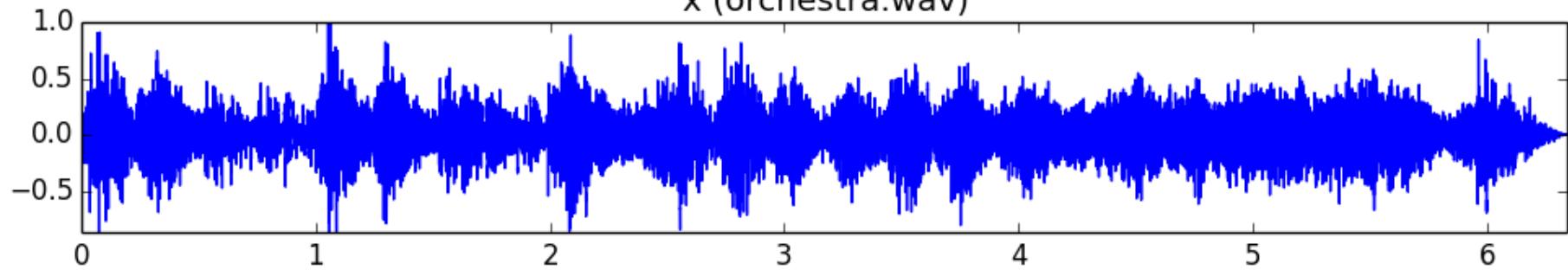
y



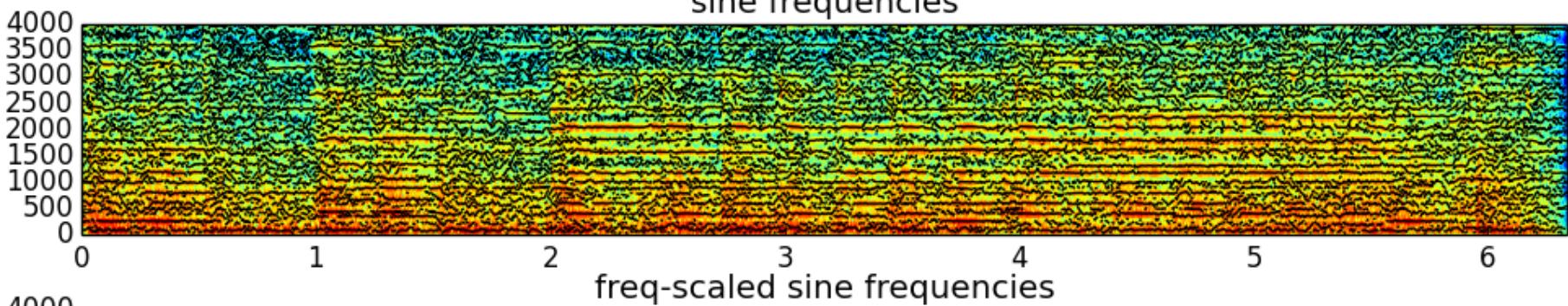
Frequency scaling



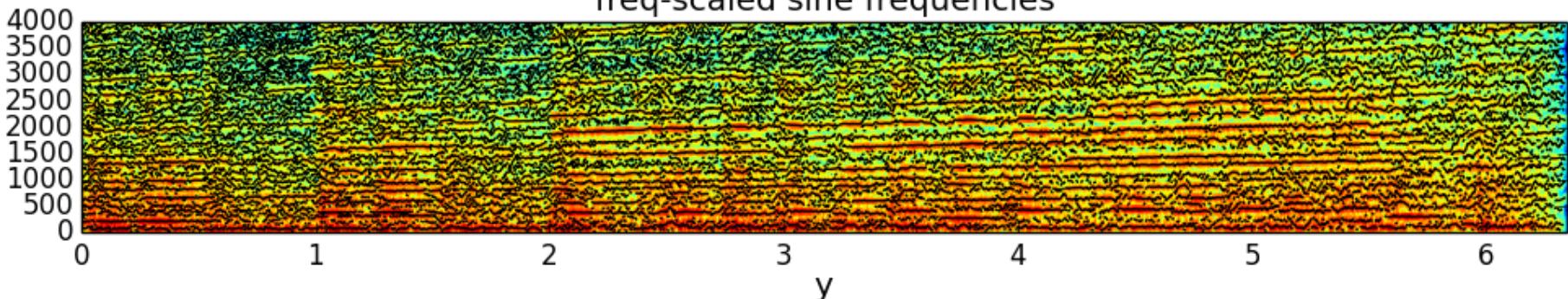
x (orchestra.wav)



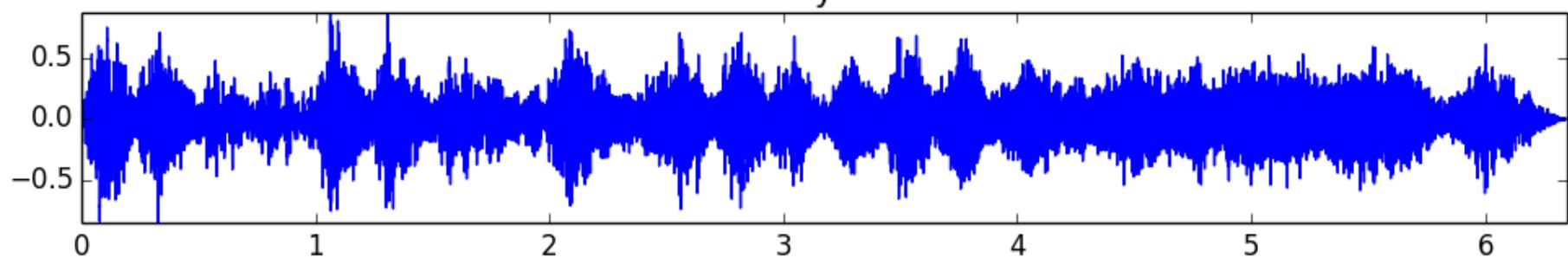
sine frequencies



freq-scaled sine frequencies



y



References

- More information on this topic from Wikipedia:
 - http://en.wikipedia.org/wiki/Sound_effects
 - http://en.wikipedia.org/wiki/Equalization_filter
 - 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>

8T1: Spectral-based sound transformations

(1 of 2)

Xavier Serra

Universitat Pompeu Fabra, Barcelona

&

Stanford University