

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

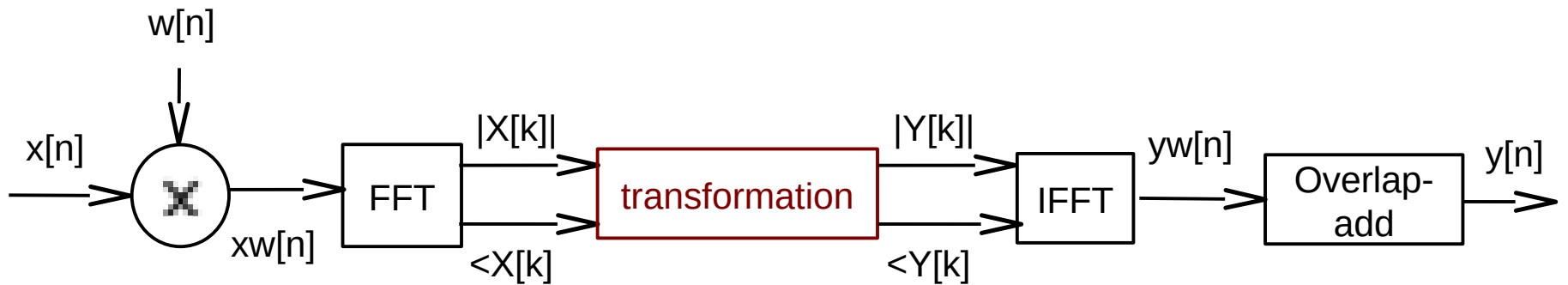
***Xavier Serra***

Universitat Pompeu Fabra, Barcelona

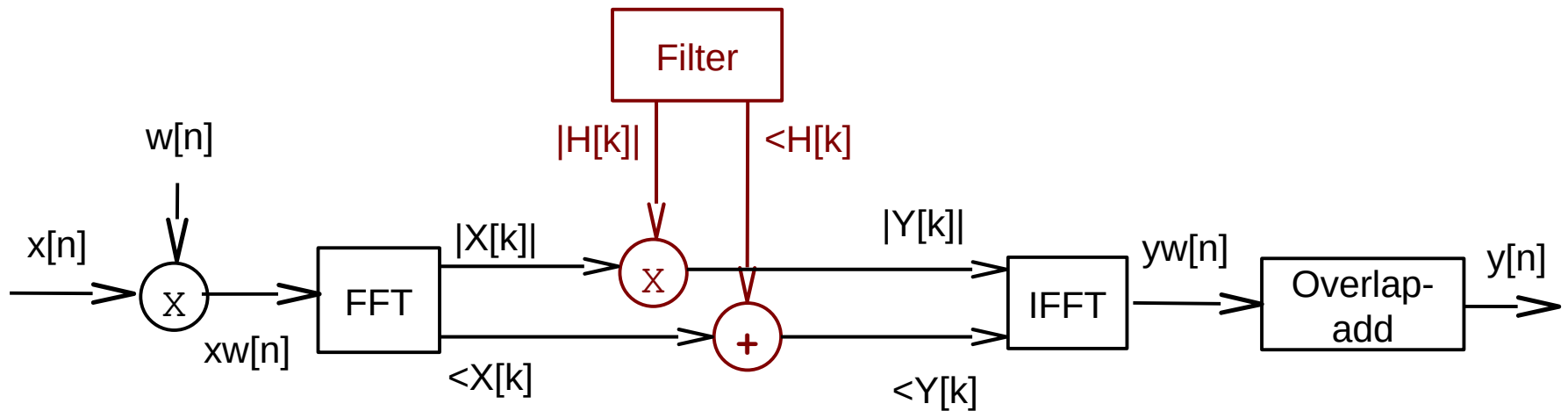
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# Short-time Fourier transform

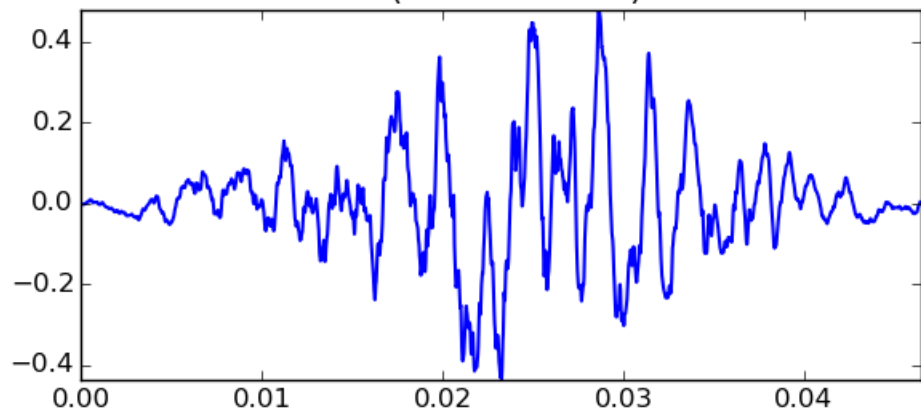


# Filtering with STFT

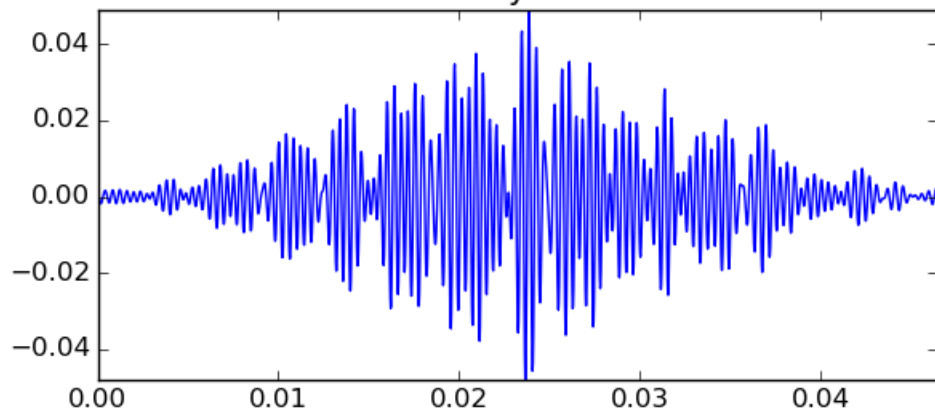


$$Y_l[k] = |H[k]| |X_l[k]| e^{j(\angle H[k] + \angle X_l[k])}$$

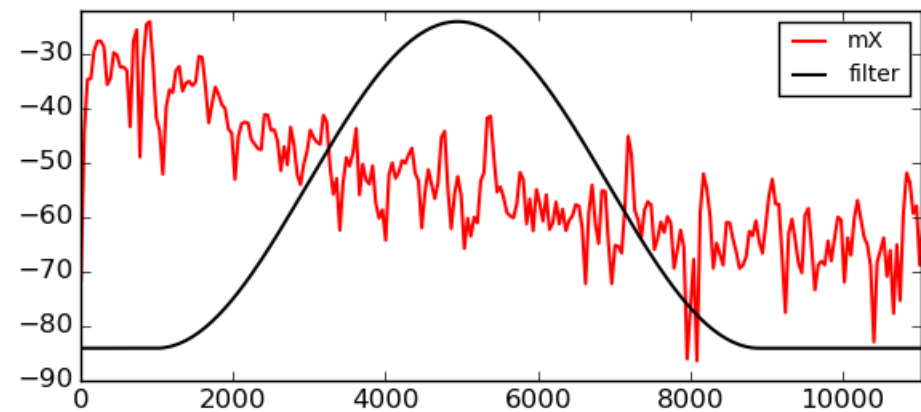
x (orchestra.wav)



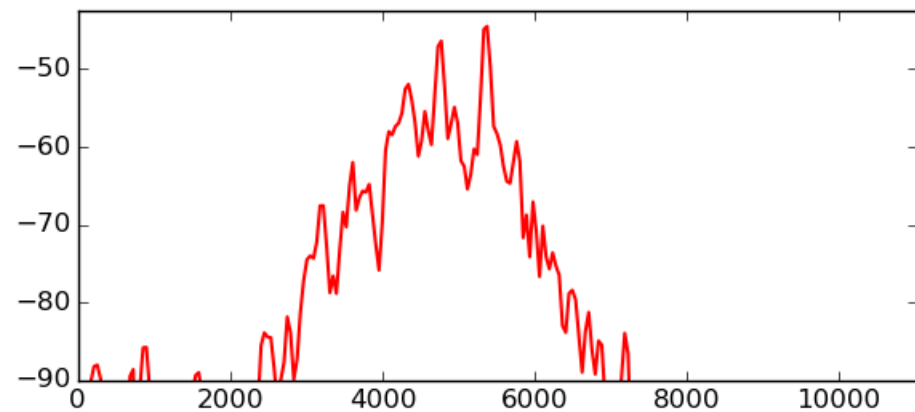
y



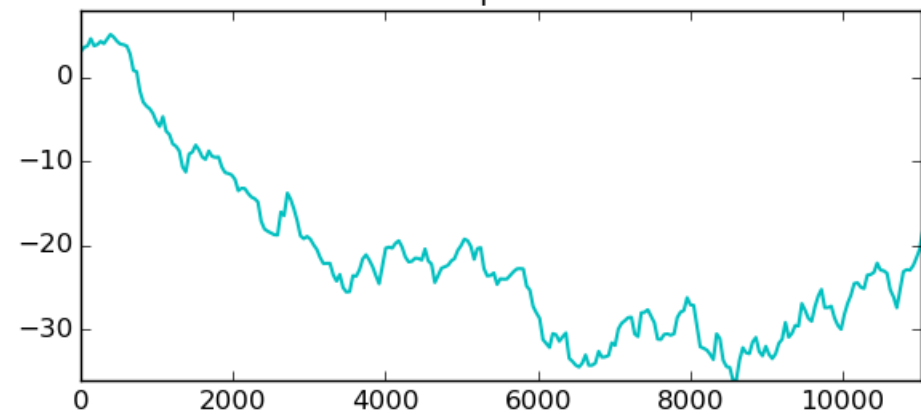
mX + filter



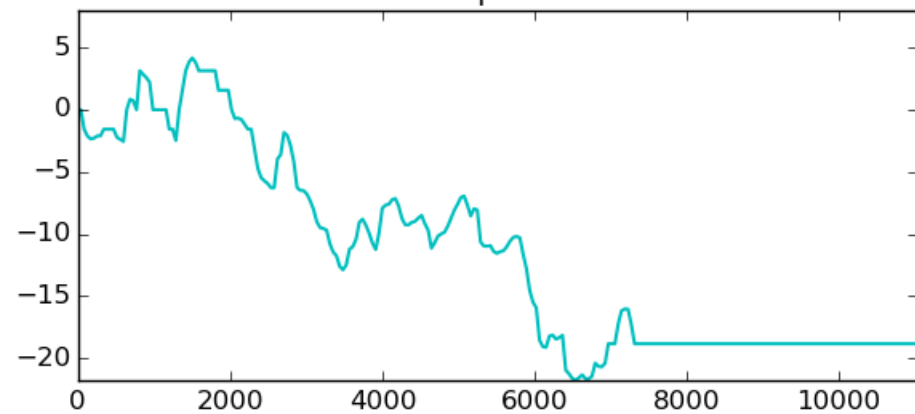
mY



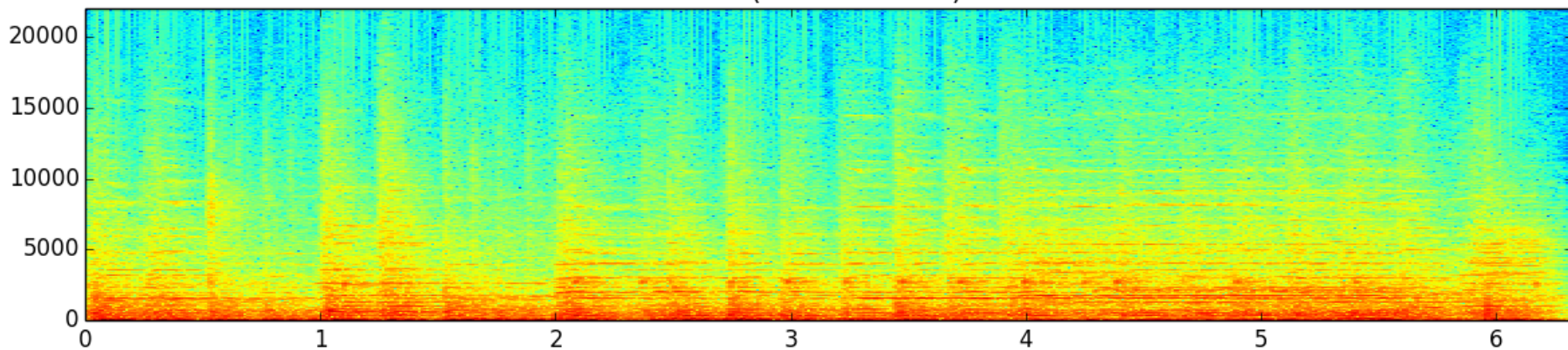
pX



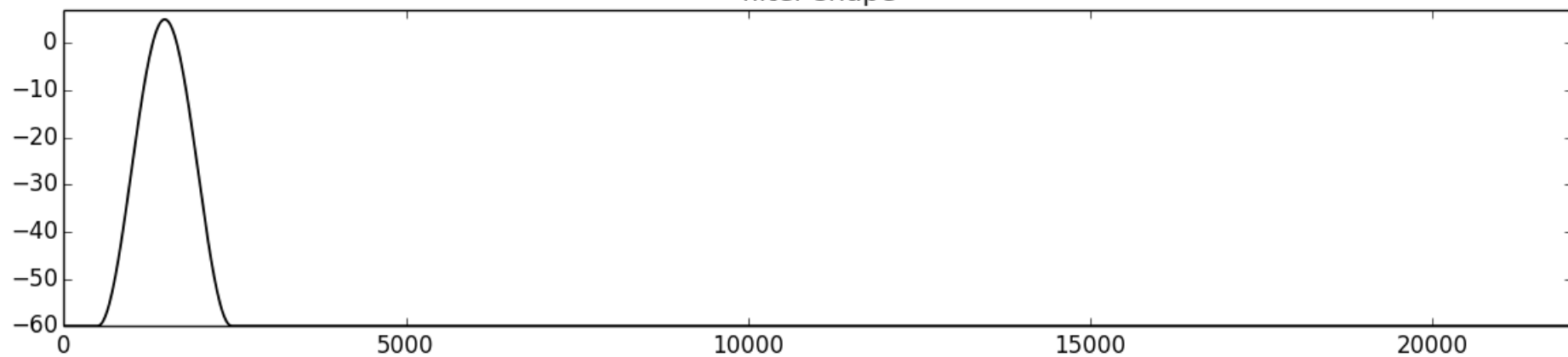
pY



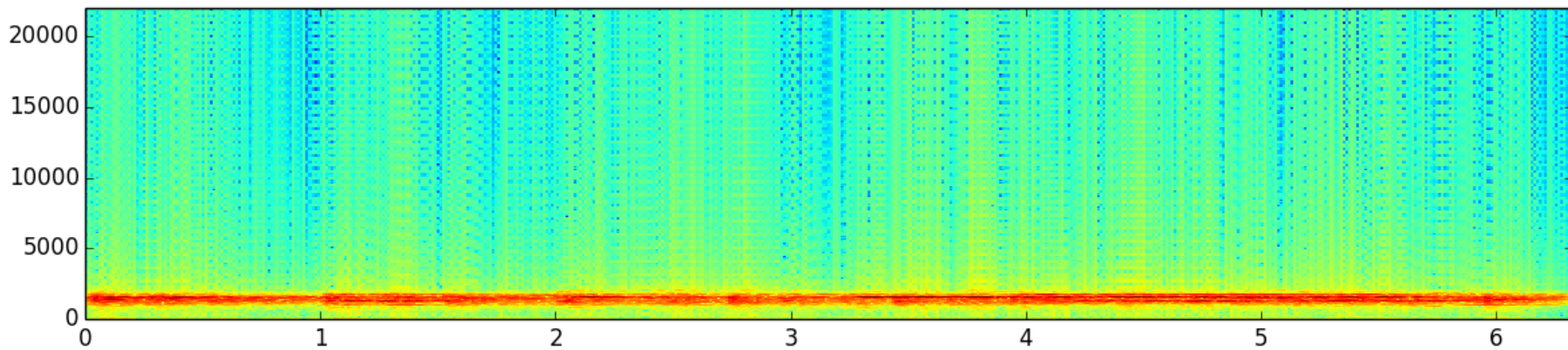
mX (orchestra.wav)



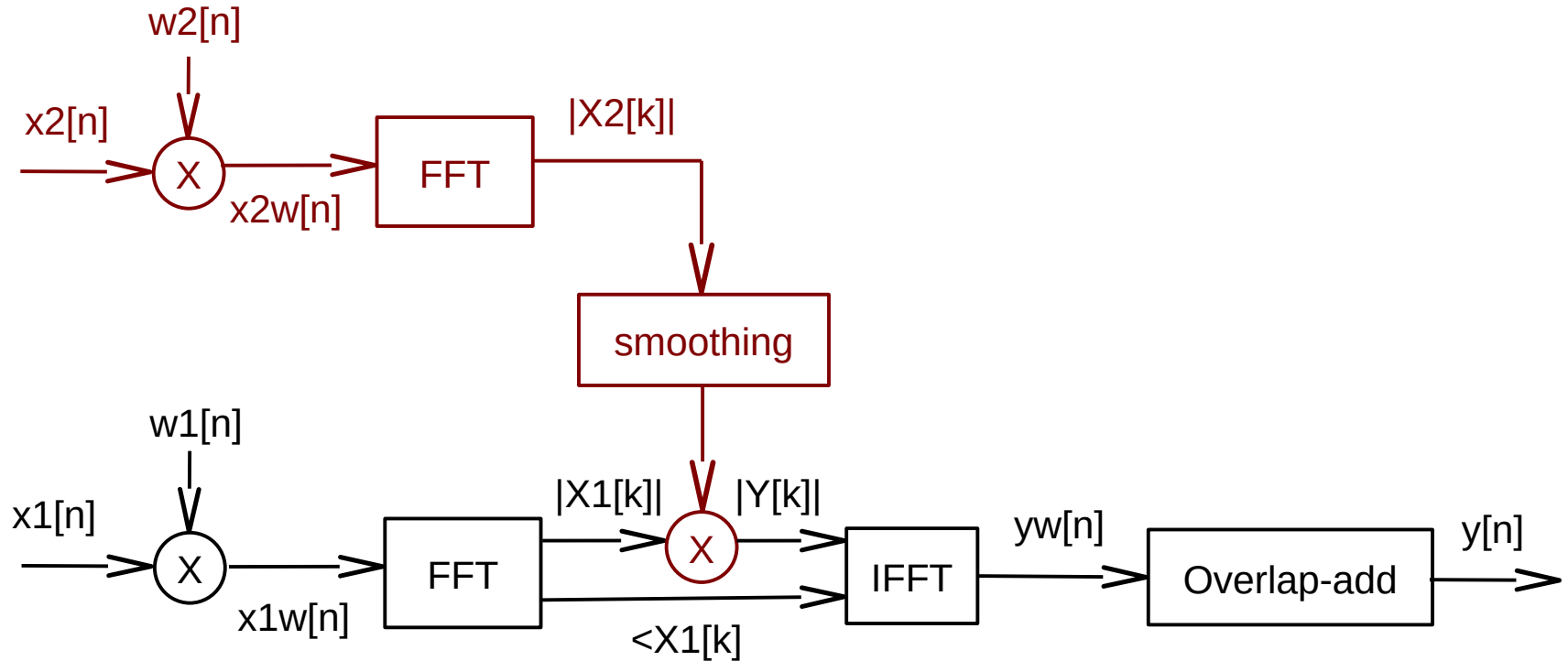
filter shape



mY

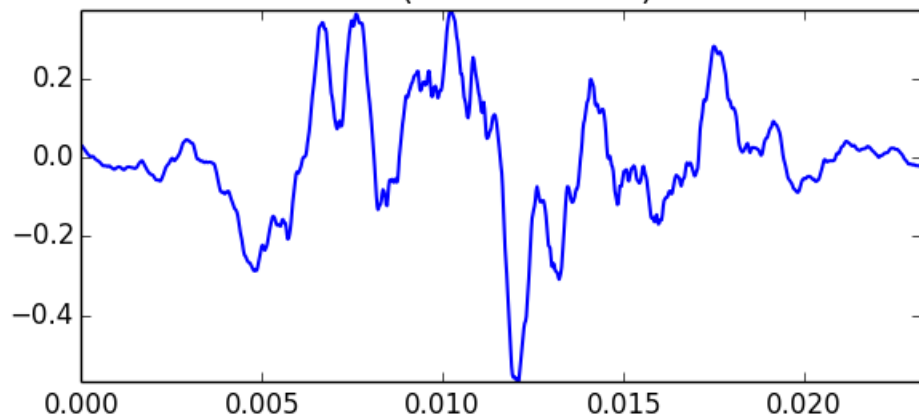


# Morphing with STFT

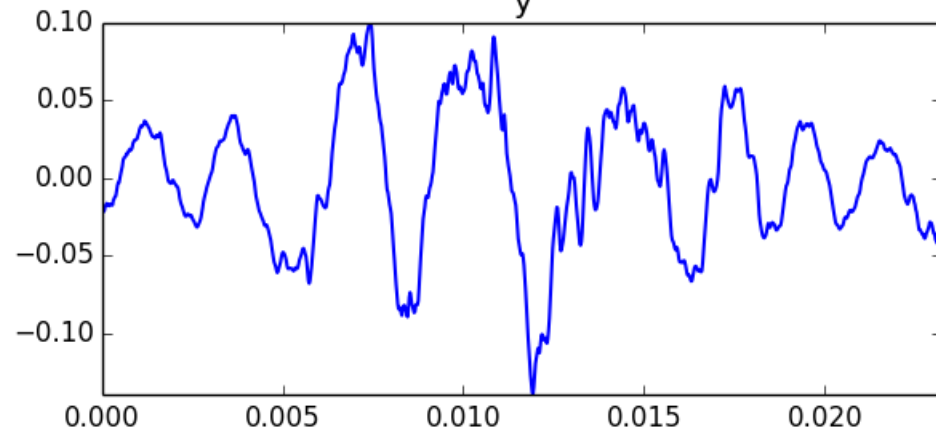


$$Y_l[k] = |X_{2_l}[k]| |X_{1_l}[k]| e^{j \angle X_{1_l}[k]}$$

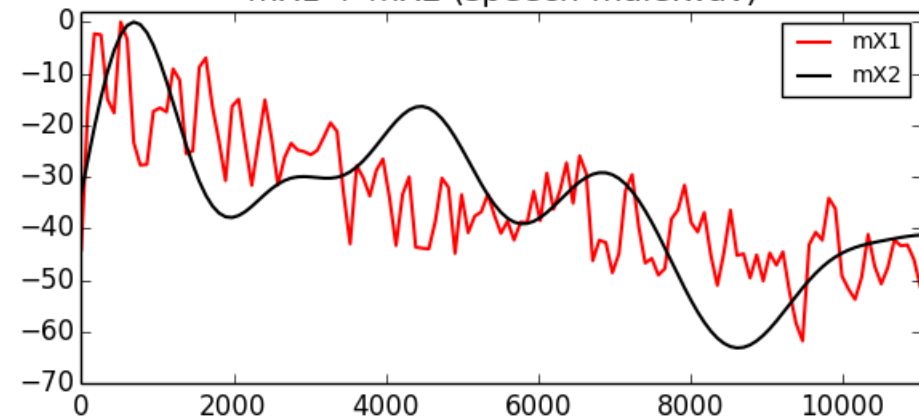
x1 (orchestra.wav)



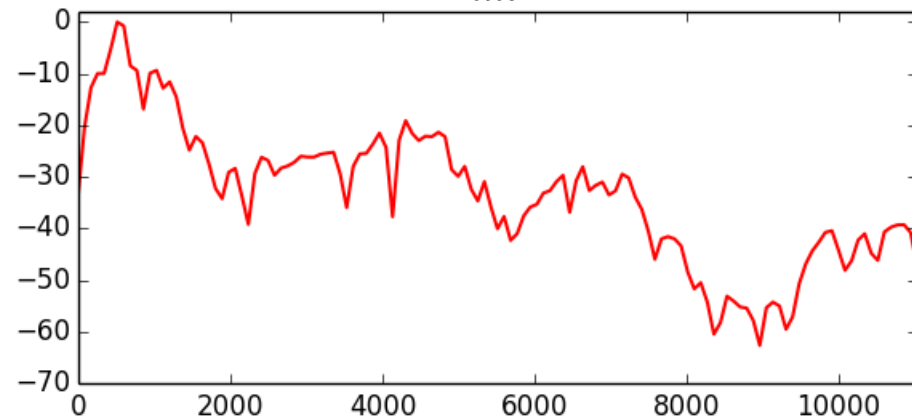
y



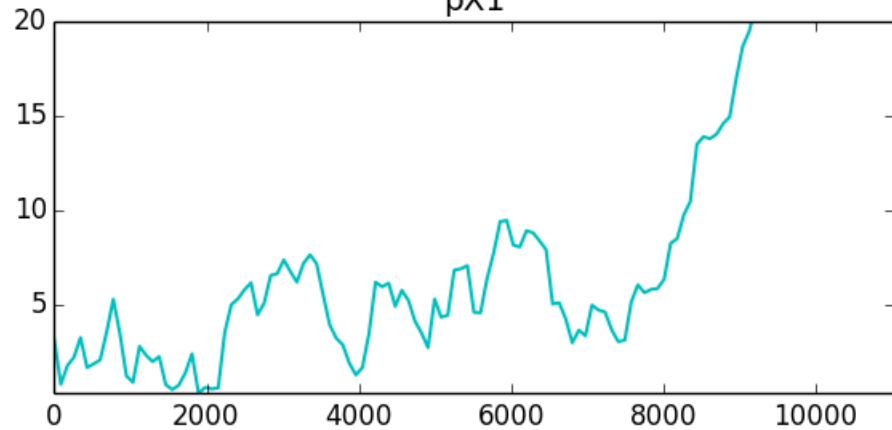
mX1 + mX2 (speech-male.wav)



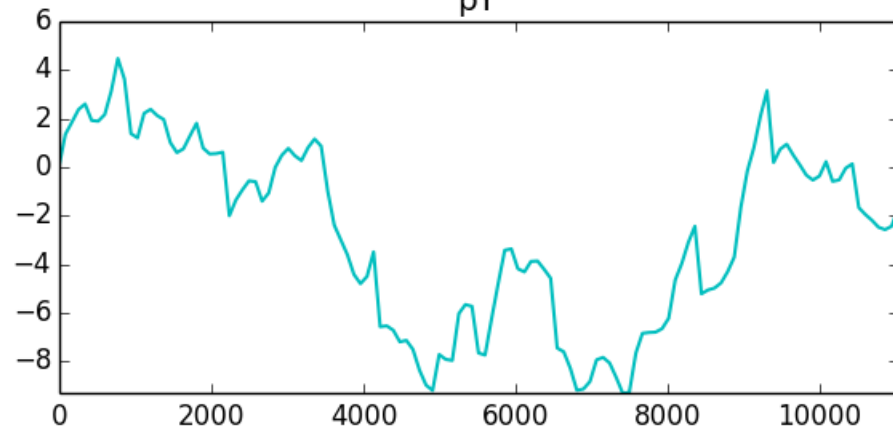
mY



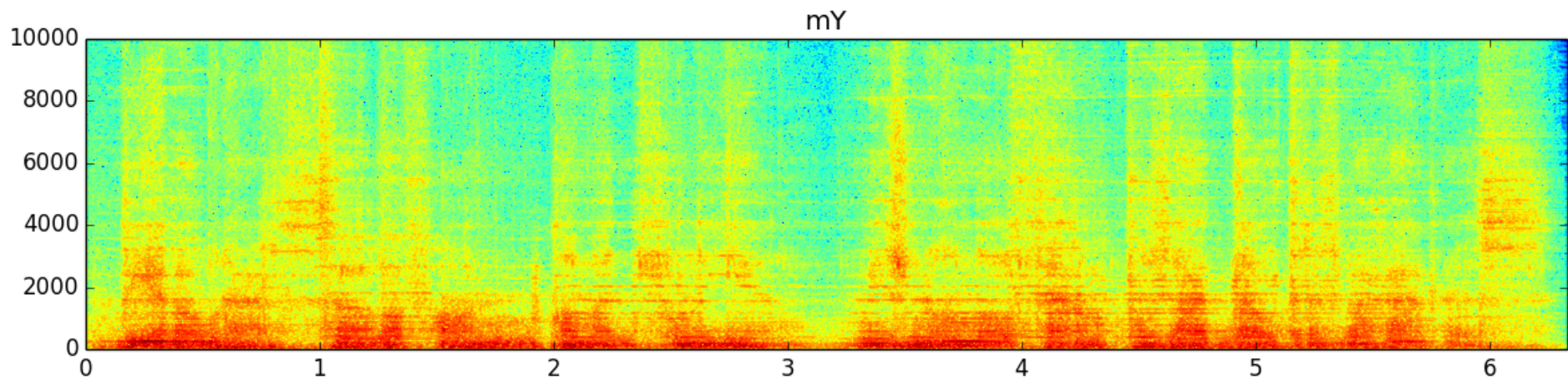
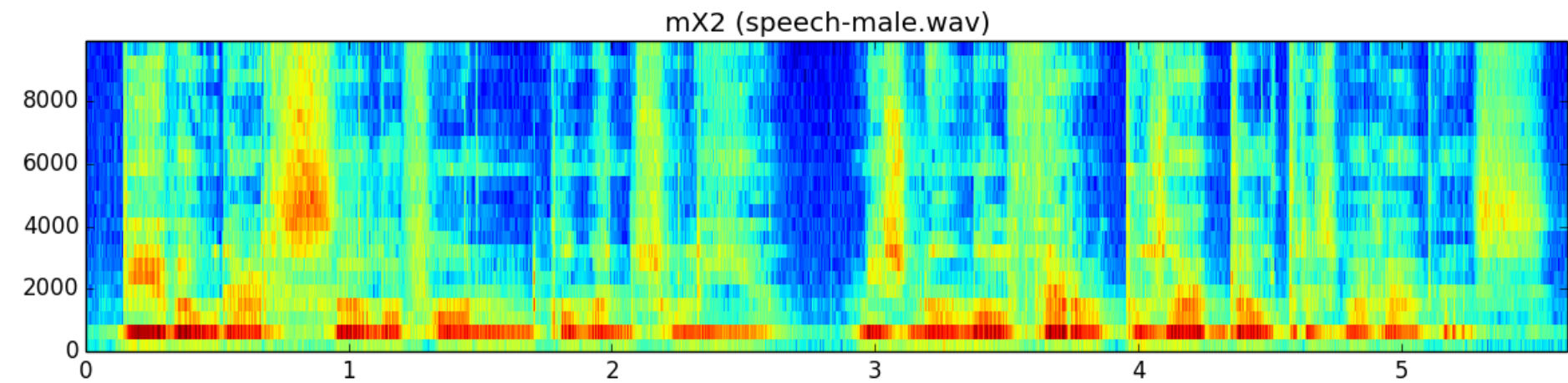
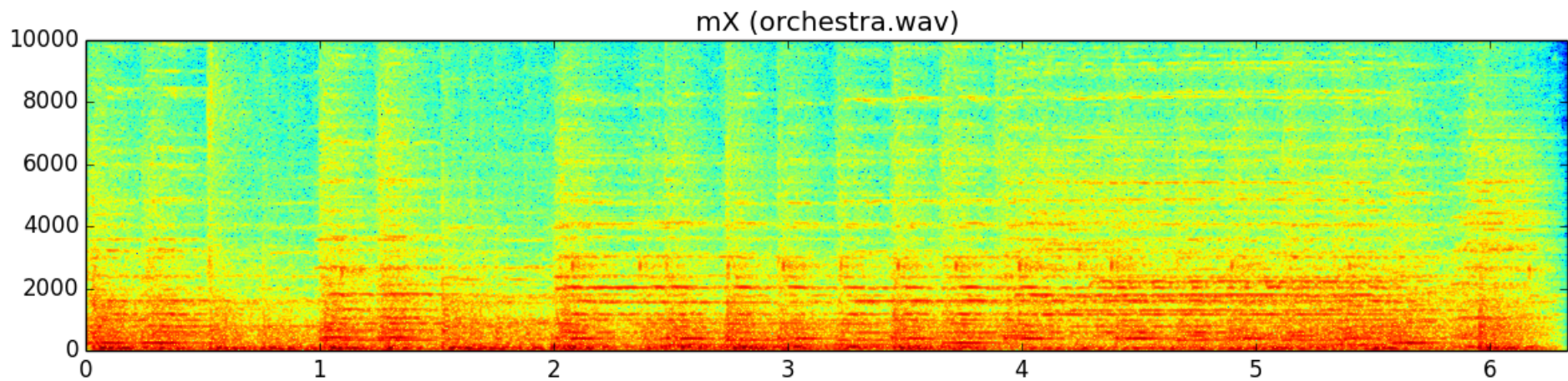
pX1



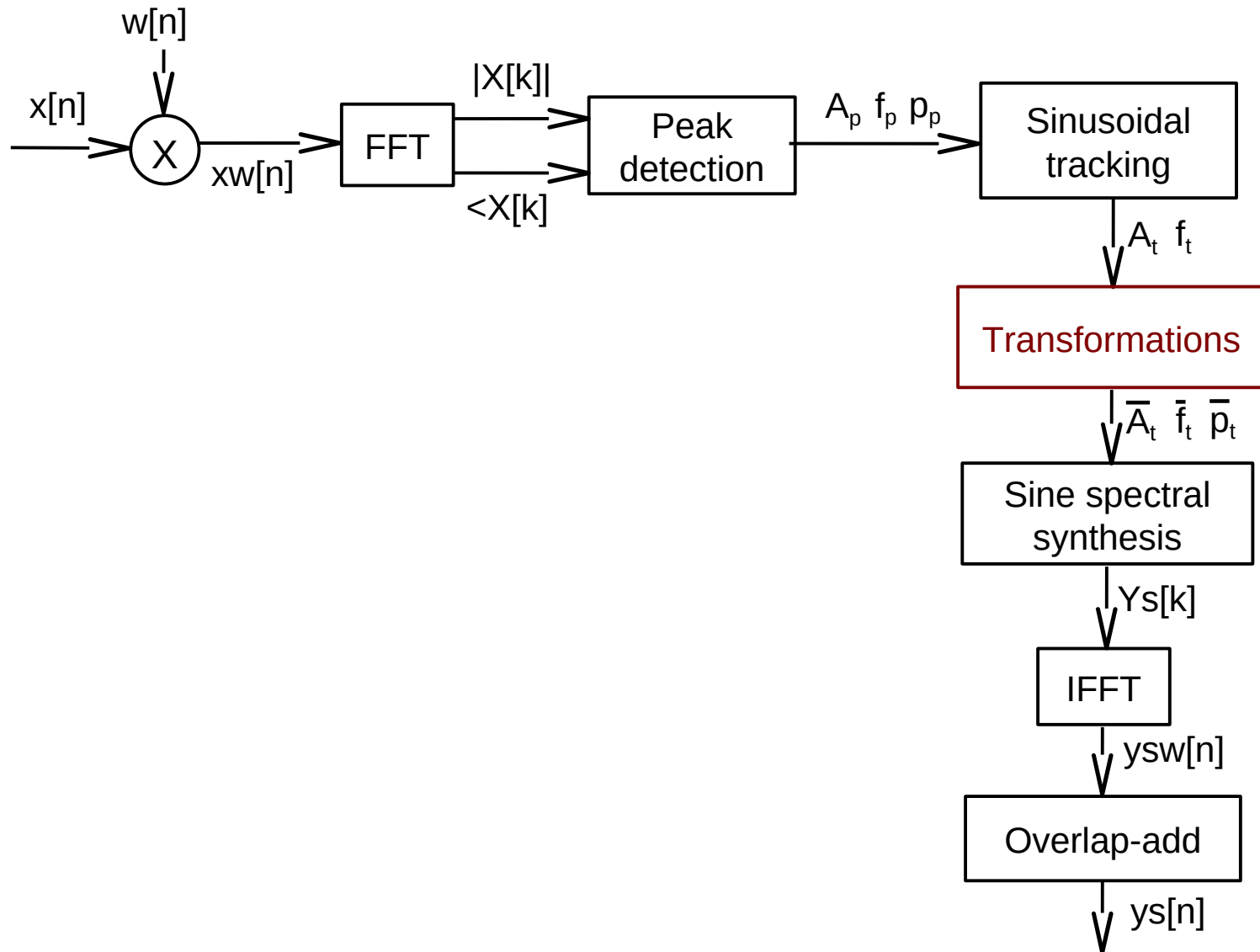
pY







# Sinusoidal model



# Scaling frequency, amplitude and time

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

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

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

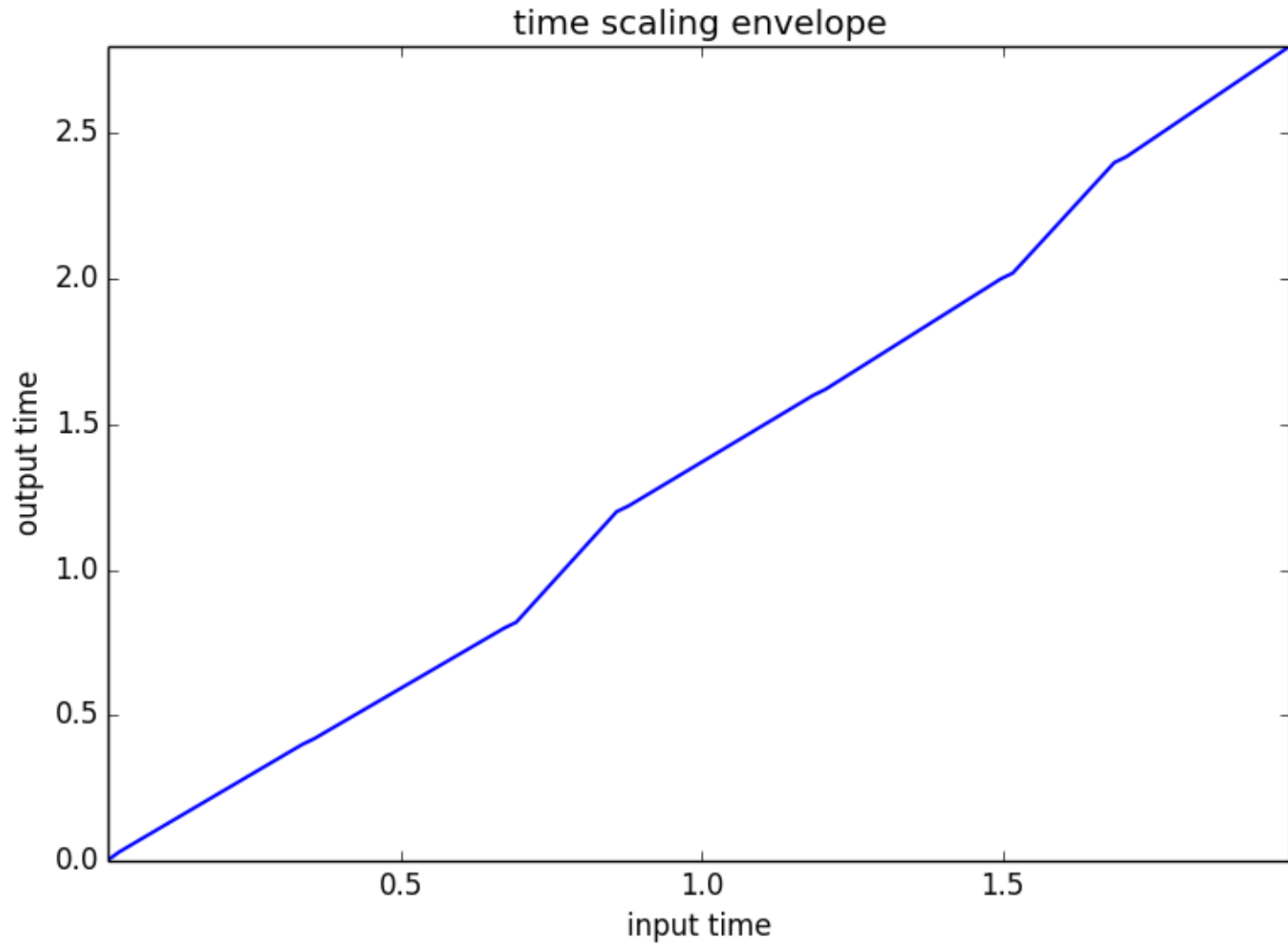
$q$ : output frame index ;  $l$ : input frame index ;  $t$ : sinusoidal track index

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

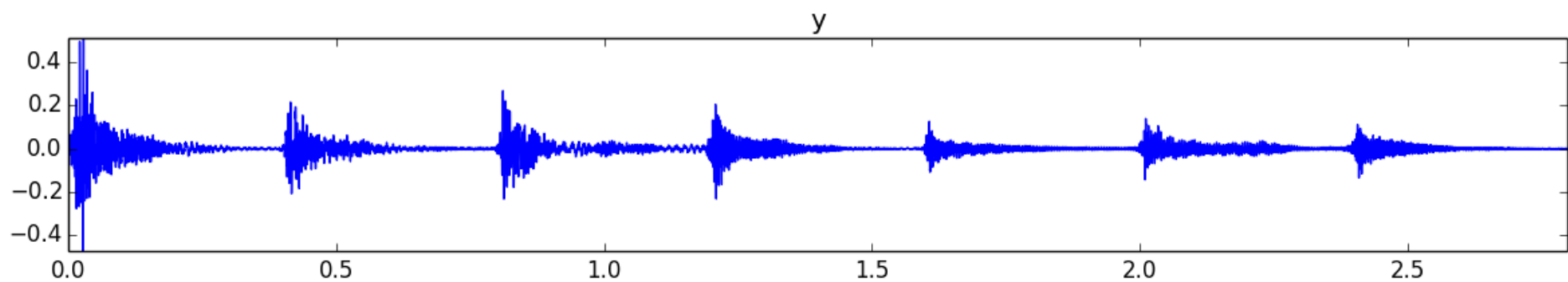
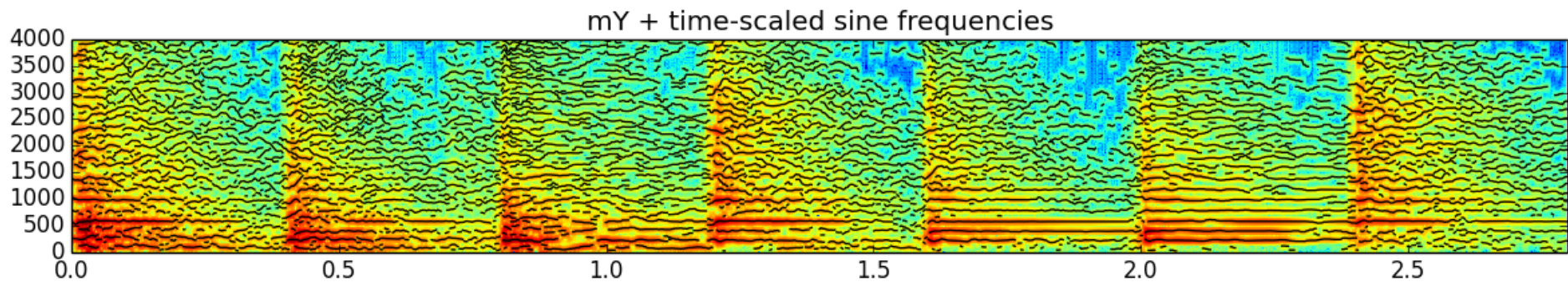
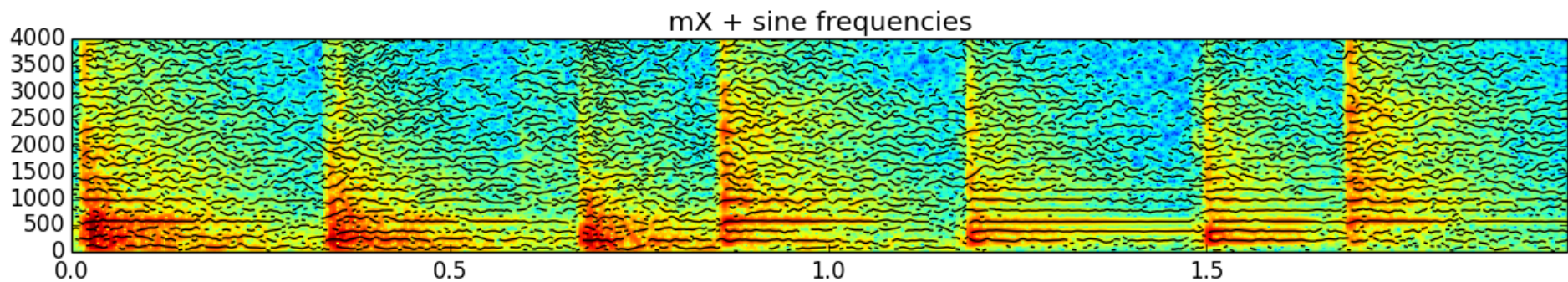
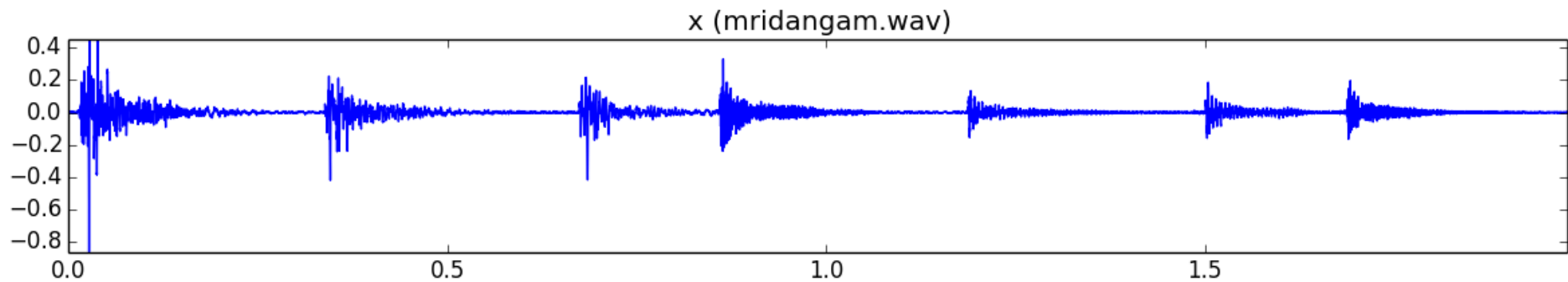
$sf$ : scaling frequency ;  $sA$ : scaling amplitude ;  $st$ : scaling time

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

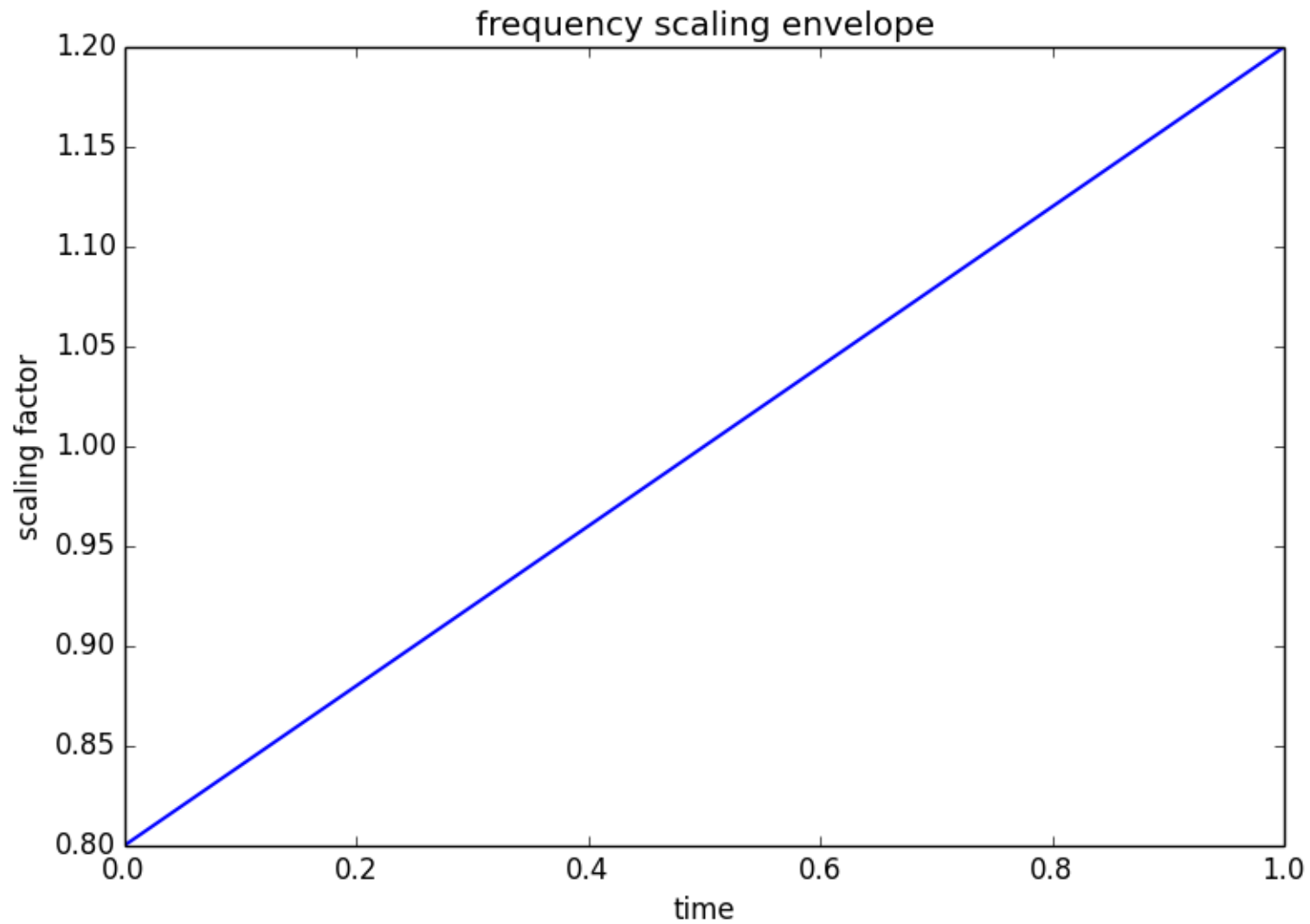
# Time scaling



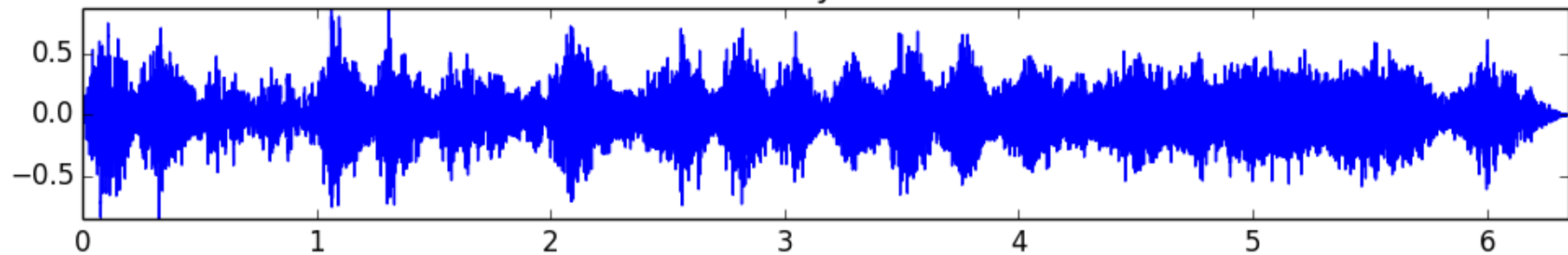
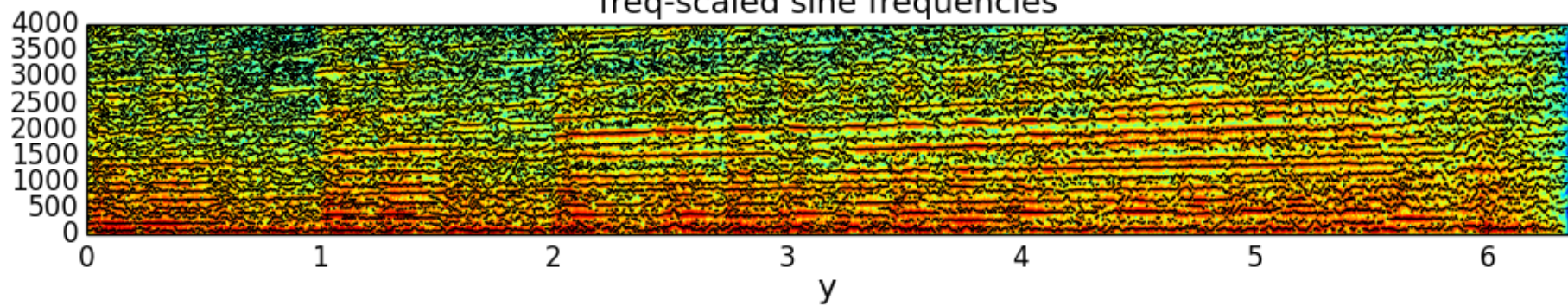
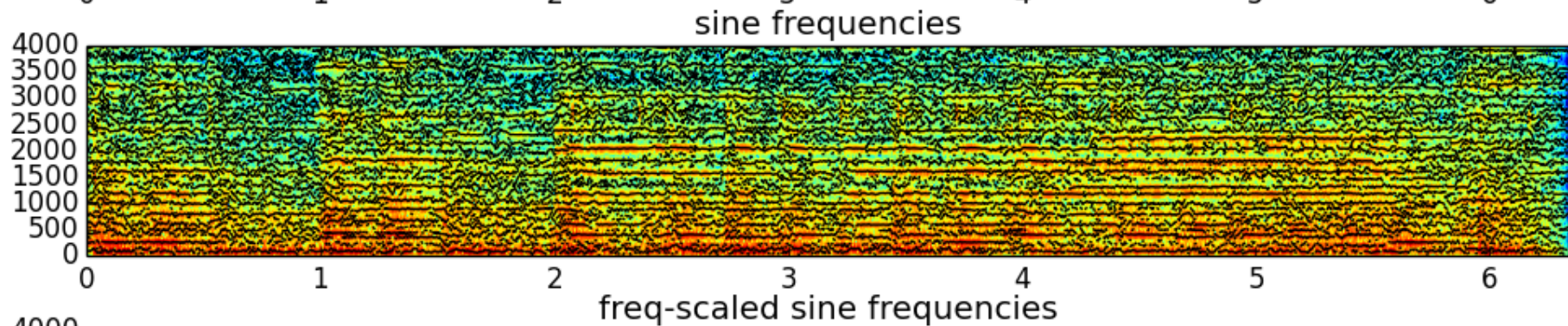
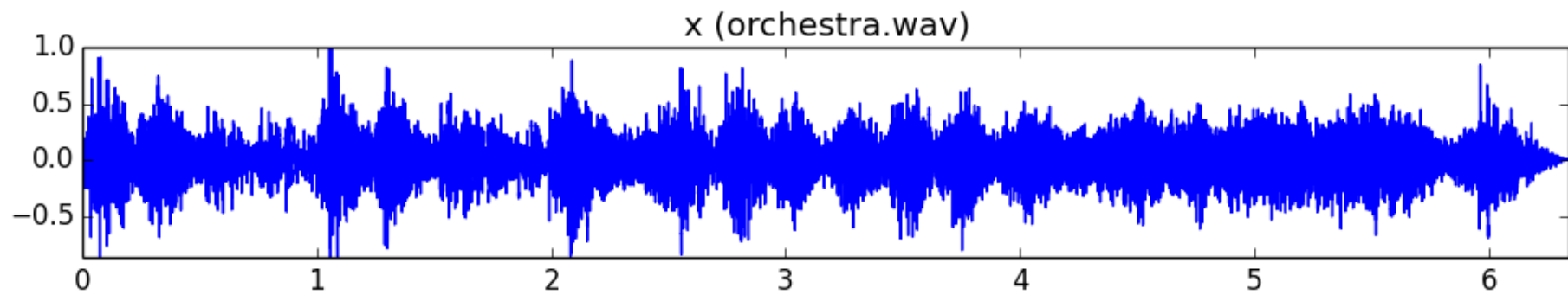




# Frequency scaling







# 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/Equalization\\_filter](http://en.wikipedia.org/wiki/Equalization_filter)
  - [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>



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

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