

Physics of Music PHY103 In Class Worksheet

Exploring the shapes of sound spectra using Rave-Lite or Audacity

Set up for Triangle/Square wave lab, FFT measurement and midterm

Account on Mac Minis

usr: phy103 (when you log in select "Other")

passwd: given in class (Prof. Wolfs is responsible for the password)

Sound files of interest can be downloaded from

<http://astro.pas.rochester.edu/~aquillen/phy103/Sounds/Workshop1/>

(user: phy103, pw: music)

To download and not play a sound file: option/left click

Both Audacity and Raven are free software. Both run on Mac as well as Windows platforms.

Notes on using Audacity:

Showing spectral view: Click on the the drop down symbol ▼ and choose spectrum.

Expanding the x axis (time). You can use the magnifying glass button with the + sign. To zoom out you can use the magnifying glass with the – sign.

Expanding the y-axis (frequency or amplitude). Right or left click on the axis (on the left) or left click and hold to select

To adjust the FFT window size: Under Audacity choose Preferences then choose spectrogram. You can adjust the window size and the window type.

You can plot a spectrum by clicking on Analyze but there is no way to adjust the axes.

Notes on using Raven Lite:

It is a pain to find files as you have to know the complete path. I found that

Downloads was in

/Network/Servers/xserve407.pas.rochester.edu/Users/phy103/Downloads/ If you can find your files in the finder you can right click and choose "Get info" to find the full path of your directory

Expanding axes: Use magnifying glass buttons for both vertical and horizontal axis zooms

Adjusting the FFT window size: There is a horizontal slider on upper right.

Nice features: The ability to adjust the contrast of the spectrogram and look at the spectrogram and waveform views at the same time

1. RAVEN Lite and Measurement with FFTs (Fast Fourier Transforms)

Look at the file DarkToneBrightTone.aif

- a) Zoom in on the waveform view at the center of the file where the change in sound takes place. Look at the difference in the shape of the waveforms. You should notice that the brighter or sharper tone has more wiggles or more high frequency content.
- b) Look in spectral view. By adjusting the gray scale brightness and contrast try to determine which sound (the dark one or the bright one) has stronger higher frequency power.
- c) Look in spectral view. Adjust the length of the FFT (slider on top right). How short can you make the FFT before you stop being able to see that the sound file is composed of individual tones.
- d) Zoom out in time. Now increase the length of the FFT while looking at the midpoint of the sound file. As you increase the length the FFT you should be able to more accurately measure the frequencies of the tones. However then the FFT gets so long that the two sounds are blurred together.

2) What do the spectra of different sounds look like?

When you look at these spectra: Vary the horizontal and vertical scales. Vary the contrast of the grayscale (if using Raven). Vary the width of the window used to create the spectrum. Note that if you use a larger width of time to create the spectrum, the spectrum will be more precise (finer frequency precision) but will smooth out the spectrum over a larger time (notes can run together).

Play the sounds while looking at the waveform and spectral view of the sounds. Try and identify the notes, overtones, different instruments. Try to understand what the spectrum of the different sounds looks like.

The list of sound files to look at:

1. noise.mp3 This is what we would call noise. It has no pitch, favors no particular frequencies. There is power at all frequencies. We call it "broad spectrum" or "flat spectrum."
2. Debussy_Syrinx_clip.mp3 Flute playing. This should look quite different than the noise spectrum. An example of a very pure musical sound. Only a few overtones are bright
3. Guitar_harmonic3.mp3 A guitar string is plucked and then a finger put at a particular node letting only the harmonic ring afterwards. Note the difference in the spectrum before and after the string is damped. Which overtones are damped? Is there more than one harmonic sounding after the string is damped?
4. bell7.mp3 2 bell sounds. Note that the overtones are not evenly spaced the way they are for flutes and guitars.
5. Hendrix_clip.mp3 : Jimmy Hendrix Star Spangled banner. See if you can figure out at what frequency the distortion is strong.

6. BK_Beat_That_clip.mp3 and stompingtubes_clip.mp3 and framedrum_clip.mp3 These illustrate spectra of different drum/percussion
7. Zorn_Maskil_clip.mp3 John Zorn Maskil clean spectra of electric guitar and bass. See if you can figure out which part of the spectrum is from each instrument
8. digi_kanghop.mp3 Didgeridoo illustrating interesting variations in timbre
9. Human_Voice.aif, swift_clip.m3 Compare the variations seen in the digi sound to that illustrated by the vowel sounds and an example of singing. In the song, look at the large vibrato in the soprano. Can you tell from the spectrum which voice is soprano or bass?
10. kokhoomei_clip.mp3 An example of Tuva throat singing. Look at the variation in the brightness of the overtones of the voice
11. DarkToneBrightTone.aif An illustration of timbre change by varying the strength of overtones of a computer generated tone.
12. abhogi_clip.mp3 Flute and tablas. See if you can figure out what features corresponds to the flute, the small tabla and the large tabla.
13. gunxsword_clip.mp3 What gives that sliding sword sound its character?
14. bigslide.mp3 An example of a sliding whistle. Note that odd integer overtones are much louder than even ones.