

3.9 Exercises

Solutions to these exercises are in `chap03soln.ipynb`.

Exercise 3.1 Run and listen to the examples in `chap03.ipynb`, which is in the repository for this book, and also available at <http://tinyurl.com/thinkdsp03>.

In the leakage example, try replacing the Hamming window with one of the other windows provided by NumPy, and see what effect they have on leakage. See <http://docs.scipy.org/doc/numpy/reference/routines.window.html>

Exercise 3.2 Write a class called `SawtoothChirp` that extends `Chirp` and overrides `evaluate` to generate a sawtooth waveform with frequency that increases (or decreases) linearly.

Hint: combine the evaluate functions from `Chirp` and `SawtoothSignal`.

Draw a sketch of what you think the spectrogram of this signal looks like, and then plot it. The effect of aliasing should be visually apparent, and if you listen carefully, you can hear it.

Exercise 3.3 Make a sawtooth chirp that sweeps from 2500 to 3000 Hz, then use it to make a wave with duration 1 s and framerate 20 kHz. Draw a sketch of what you think the spectrum will look like. Then plot the spectrum and see if you got it right.

Exercise 3.4 In musical terminology, a “glissando” is a note that slides from one pitch to another, so it is similar to a chirp.

Find or make a recording of a glissando and plot a spectrogram of the first few seconds. One suggestion: George Gershwin’s *Rhapsody in Blue* starts with a famous clarinet glissando, which you can download from <http://archive.org/details/rhapblue11924>.

Exercise 3.5 A trombone player can play a glissando by extending the trombone slide while blowing continuously. As the slide extends, the total length of the tube gets longer, and the resulting pitch is inversely proportional to length.

Assuming that the player moves the slide at a constant speed, how does frequency vary with time?

Write a class called `TromboneGliss` that extends `Chirp` and provides `evaluate`. Make a wave that simulates a trombone glissando from C3 up to F3 and back down to C3. C3 is 262 Hz; F3 is 349 Hz.

Plot a spectrogram of the resulting wave. Is a trombone glissando more like a linear or exponential chirp?

Exercise 3.6 Make or find a recording of a series of vowel sounds and look at the spectrogram. Can you identify different vowels?