SHS homework 6: filtering

Study Weenink chapter 11.

6.1. Show the spectrum of the impulse response of the digital filter $y_n = x_n - 0.95\ x_{n-1}$. What kind of filter is this?

6.2. Make a script that queries for a formant frequency and its bandwidth and the sampling frequency. Calculate the *b* and *c* coefficients for a formant filter and display these values in the Info window. You can find information on how to create a form, i.e. how to communicate with the script from the outside, in Praat's Scripting tutorial, section 6.1.

6.3. Use the script to get *b* and *c* filter coefficients for a formant frequency of 300 Hz and a bandwidth of 60 Hz. Use a 10 kHz sampling frequency.

6.4. Calculate the impulse response of this filter and make a picture of the first 0.02 seconds. To calculate the impulse response, you can first create an empty sound and then use **Formula**. The formula is something like

```
b*self[col-1] + c*self[col-2] + (col=1)
```

where you have to supply values for *b* and *c*.

a. Explain at the sample level what this computation formula does, i.e. how it works.

b. Get the spectrum of the impulse response via **To Spectrum**.

c. What is the bandwidth (the width in Hz of the region that is less than 3 dB below the top in the spectrum; in other words, the frequency distance between the two –3 dB points)?

6.5. Create a linear sweep tone as explained in Weenink section 2.7.4. The tone should have a duration of 5 s, start with a frequency of 0 Hz, and end with a frequency of 5000 Hz. Its sampling frequency is 10000 Hz. Show a drawing of the narrow-band spectrogram. Filter this sweep tone with the filter from **6.4**, take *F* = 300 Hz and *B* = 60 Hz. Draw the spectrum of the filtered sound.

6.6. Create a sound with a duration of 2 seconds and a sampling frequency of 10000 Hz filled with white noise with uniformly randomly distributed amplitudes between -0.9 and 0.9 (use the `randomUniform` function). Filter this sound with a formant filter with a centre frequency of 300 Hz and a bandwidth of 60 Hz.

6.7. Create the impulse responses from the following two pairs of (*b*, *c*) filter coefficients: (1.93, -0.96) and (1.94, -0.96). What do the spectra of these two impulse responses look like? What are their centre frequencies and bandwidths?

6.8. We have two ways to represent a formant filter: as a (formant frequency, formant bandwidth) pair or as a pair of (*b*, *c*) coefficients. Which pair is more robust with respect to small variations in their values? Make a numerical example: increase for a given pair of (*b*, *c*) coefficients both values by 1%. How much do the formant frequency and bandwidth change?