SHS homework 5: spectrum

Study the spectrum: Weenink chapters 7 and 8 and appendices A.9 and A.16.2, and Boersma sections 5 and 6.

Given the sampled sound that comes with this assignment, you have to find out how strong the frequency components in this sound are. You have to do this by performing a Fourier analysis by hand, i.e. you do this with a Praat script. The sound, *s*(*t*), was constructed as a linear combination of 5 cosines and 5 sines with harmonically related frequencies as follows:

$$s(t) = b_0 + a_1 \sin(2\pi f t) + b_1 \cos(2\pi f t) + a_2 \sin(2\pi 2 f t) + b_2 \cos(2\pi 2 f t) + \cdots + a_5 \sin(2\pi 5 f t) + b_5 \cos(2\pi 5 f t)$$

Now determine the (relative) strengths of the individual components $a_1 \cdots a_5$ and $b_0 \cdots b_5$ (the value b_0 is the result of a multiplication with a cosine of frequency 0 and equals the average value of the signal *s*(*t*)). The components a_k can be found by multiplying the sound by a sine $\sin(2\pi k f t)$, which has a frequency that is *k* times the frequency *f* that is the inverse of the sound's duration *T* (i.e., $f = 1/T$), and integrating the product:

$$a_k = \int_0^T s(t) \sin(2\pi k f t)\, dt$$

In appendix A.9 you will find that the integral of a sampled function is proportional to the average value of the function. Notes:

• Script 7.4 in chapter 7 provides a skeleton.

• You can multiply a selected sound by a sine of frequency *kf* by using a formula:

```
Formula: ~ self * sin(2*pi*k*f*x)
```

• You can get the mean amplitude of a selected sound with

```
mean = Get mean: 1, 0, 0
```

which tells Praat to assign the output of the **Get mean** query command to the variable *mean*. You can find **Get mean** in the **Query** menu if you have a Sound object selected.

• You can print values from the script into the Info window via `appendInfoLine`, for example if you have calculated the values of variables *a* and *b*:

```
appendInfoLine: "a = ", a, "; b = ", b
```

• Draw a picture of the sound from the script. You have to

  • Select the viewport where you are going to draw via **Select outer viewport** (a command in the Picture window), where you fill out the horizontal and vertical range in inches (the origin is at the top left);

• Use the Sound > **Draw** to draw the sound into the viewport.

• Extra: if you really feel adventurous, you may try to script a more complicated picture, for example a simplified version of picture 7.13 in the book, that shows your decomposition. For each separate graph you have to use **Select outer viewport** with different horizontal and vertical ranges.

• Hints: use **selectObject** to select an object. Use `Copy: "name"` for duplicating a sound and giving the copy a new name.

Hand in the script and the 5 a_k and 6 b_k values.