SHS homework 7: formants

Study Weenink chapters 9 and 13.

Homework 7.1. Make one long recording of all your Dutch vowels (/u, oː, ɔ, ɑ, aː, ɛ, eː, i, ɪ, ʏ, y, øː/) in a /sVs/ context (V means vowel). That is, pronounce the following Dutch words at a monotonous pitch, with some pause in between "pief, paf, poef, soes, soos, sos, sas, saas, ses, sees, sies, sis, sus, suus, seus, pief, paf, poef" (the first and last three are there only to prevent list intonation on the 12 target words!). Save this sound on disk as `vowels.wav`. Make sure you have indeed recorded the 12 different vowels. Upload the sound to Canvas.

License. In your report, please copy one of the following sentences about the extent to which the teacher can use your recording:

a. "I allow the teacher to use my recording only for grading and analysis."

b. "I allow the teacher to use my recording for grading, analysis, and playback in class."

c. "I allow the teacher to use my recording for grading, analysis, playback in class, and distribution among all students of this course of the year 2019–2010 and later years as part of a dataset for purposes of education (e.g. training networks) later on in the course. I understand that although my name will not be mentioned in that dataset, my voice may be identifiable by others."

d. "My recording is open data. I allow the teacher to use my recording for grading, analysis, playback in class, distribution among all students of this course of the year 2019–2010 and later years as a part of a dataset for purposes of education (e.g. training networks) later on in the course, and for all actions that can be associated with open data, such as publication on a website under a CC0 license. I understand that although my name will not be mentioned in the dataset, my voice may be identifiable by others."

The teachers hope that you will agree to at least level **c**, because growing a Dutch vowel dataset will benefit the course, but there will of course be no consequences for you at all if you decline. Also, you can withdraw your consent at any time before distribution.

Homework 7.2. Annotate each vowel in the following way. Work through the **Annotation** part of the Praat Intro, and through Weenink chapter 9. Then select your Sound, choose **Annotate** > **To TextGrid**, creating only one tier labelled "vowel". Select Sound and TextGrid together and do **View & Edit**. Make sure that the *selection viewer* is visible in the TextGrid window (**File** > **Preferences** > **Show selection viewer**). Then mark the start and the end of each vowel (insert a boundary by clicking on the circle), and label each vowel interval with the corresponding IPA vowel symbol, which you can choose from the IPA chart at the right. The start of the vowel is where the noise ends and voicing starts; the end of the vowel is where the noise starts and voicing ends. Place boundaries at zero crossings (perhaps via selecting the boundary and choosing **Move to nearest zero crossing**). Do not label any of the six filler words. Save the TextGrid on disk as `vowels.TextGrid`, and upload this TextGrid file to Canvas.

Homework 7.3. Perform a formant frequency analysis on the sound file via **Sound: To Formant (burg)**. You want 5 formants, use pre-emphasis, and set the maximum formant's frequency depending on your estimated vocal tract length (typically, 5000 Hz for an average male, and 5500 Hz for an average female).

a. Explain (in your own words, of course) why we use pre-emphasis.

b. Explain the meaning of the **Maximum formant** in **To Formant (burg)**.

Homework 7.4. Use the vowel intervals in the TextGrid and write a script that queries for the first (F1) and second (F2) formant frequency of each vowel. The script should open your sound file, compute the formant contour for the Sound, open your TextGrid file, query the number of intervals in the first (and only) tier of the TextGrid, and then start a loop over all intervals in which for each interval that has a vowel label (or that is not empty) you query the Formant object for its median F1 and F2 frequency value and write a line to the Info window telling the reader the vowel and its two formants (you can round them to whole numbers in Hz).

Here is the frame of such a script:

```
sound = Read from file: ???
formant = ???
textgrid = Read from file: ???
numberOfIntervals = Get number of intervals: 1
writeInfo: ""
for i to numberOfIntervals
    ???
    label$ = Get label of interval: 1, i
    if label$ <> ""
        t1 = Get start time of interval: ???
        ???
        selectObject: formant
        f1 = ???
        appendInfoLine: ??? label$ ??? f1 ???
    endif
endfor
```

Include your script, and its output, in your report. (Note: you should name the script `formantAnalysis.praat` or so; giving a Praat script the extension `.praat` allows Praat to open it immediately in the script window when you double-click the script file or drag the script file on the Praat icon; it's also easier for the teacher than giving the script file no extension.)

Homework 7.5. You are now going to script a *vowel chart*. First you select a more or less rectangular area of 6 inches wide and 5.5 inches high in the Picture window via `Select outer viewport: 0, 6, 0, 5.5`. Then you do **World** > **Axes** and define the horizontal (F2) axis as running from 3000 Hz (left) to 500 Hz (right), and the vertical (F1) axis as running from 1000 Hz (bottom) to 200 Hz (top). Do **Margins** > **Draw inner box**, then use **Marks left every** (with a distance of 200) and **Marks bottom every** (with a distance of 500) to manufacture a grid. Run your script after every step so see the intermediate result (therefore, start your script with `Erase all`, and perhaps also `Times` and `Font size: 12`).

Now you are ready to plot the monophthongs. For instance, for /ɑ/, choose **World** > **Text special**. For the horizontal position, use your measured F2 for this vowel and for the vertical position, use your measured F1. The font size can be 18, and for the text you use either an ɑ symbol directly (e.g. copy–pasted from your TextGrid, or using any character insertion method available on your computer, or using an IPA website) or the digraph \as (see **Phonetic symbols: vowels** in the manual). Do the same for the other monophthongs. In your script you could either hard-code the formant values that resulted from **7.4**, or you could automate the result by including the script from **7.4**, which may be more challenging but is less error-prone.

Include the script and the picture in your report. You have created a visualization of your own Dutch vowel system!

Homework 7.6. Synthesize your /ɑ/ vowel with the F1 and F2 you have measured from your own production. You go through the following steps by hand.

1. Create a PitchTier (**New** > **Tiers** > **Create PitchTier**) of the right duration, i.e. perhaps 0.2 seconds.

2. Add pitch points via **View & Edit** to obtain a natural pitch contour.

3. Create a PointProcess from the PitchTier.

4. Create a source sound from the PointProcess (phonation). Use a sampling frequency of 10 kHz. Consult the manual on **PointProcess: To Sound (phonation)**. Show the spectrum of the source in your report.

5. Filter the source sound with the two formant filters. Use **Filter** > **Filter (one formant)**) so that you obtain a new Sound after each filtering. You may use a bandwidth that is 10% of the formant frequency value.

6. The two formants do not suffice: the result will sound dull. Therefore, you add some higher formants, at distances of 1000 or 1100 Hz. E.g. for a male voice use F3 = 2500 Hz, F4 = 3500 Hz, and F5=4500 Hz (no formants above the Nyquist frequency, please). Upload the resulting sound as `ah.wav`.

7. Report the slope of the spectrum in dB/octave. This is easiest to measure if you plot the spectrum on a log-frequency scale.