Lesson 4: Exercises

Learning goals

- Interpreting spectrograms. Broadband and narrowband spectrograms
- Formant analysis and plotting a formant chart (especially for students in phonetics)
- A better Praat script for measuring things from annotated speech

Exercises

1. Watch the video "What is sound?" by Mark Newman.

2. Read the background material *Spectrum and spectrogram*.

3. Try changing the spectrogram settings to display a *wideband* or *narrowband* spectrogram as needed.

   Note that the narrowband spectrogram helps you to see the harmonics of the sound and it is possible to use it as a "confirmation step" for pitch analysis. In this case, you should adjust the vertical frequency scale so that only a few of the lowest harmonics are shown in the spectrogram.

4. Read the background material *Formants*. Try to get an impression of what a formant is and how formants are reflected in spectrograms.

   The position of a vowel within a word and its phonological length can affect its acoustic-phonetic quality to a large extent. In the following exercises, you should preferably analyze rather clearly and slowly pronounced words that include a vowel in the first syllable. You can for instance try to compare the vowels [i], [a]/[ɑ] and [u] in Finnish or English speech, where the frequency differences between the two lowest formants should be clear. In the materials for this lesson, you can find some example sound files with isolated pronunciations of Finnish words (see the package *wav.zip*).

5. Switch on the formant analysis in the sound editor window. Red dots should appear on top of the spectrogram image. Try changing the formant analysis settings (check the background material to see what the different settings mean). Notice how the changes you make affect the measurement results. What needs to be considered in interpreting the results of your formant analysis?

6. Try plotting different **F1 / F2 formant charts** in the Picture window in Praat. There are two ways to do this. In the new Praat versions, you can do the following:

   Turn on the formants in the audio or TextGrid editor and adjust the settings as above.
   - Find a vowel segment in a speech sample and zoom in on the vowel, so that the vowel is displayed completely and part of the adjacent sounds is also included on both sides.
   - Select **Formant: Extract visible formant contour** to copy a new **Formant** object from the editor to the Object window. The Formant object will only contain the formant frequencies that are visible in the editor.
   - Select **Draw - Scatter plot…** in the Object list.

- Try drawing formant charts with different settings.
- You can also draw images from several different Formant objects on the same chart. After plotting the first vowel, remove the **Garnish** check mark. You can try switching the drawing color or the plotting character before plotting the next vowel.

7. Another way to start creating formant charts is to calculate a Formant object directly from an audio file in the Object list. This can be done by selecting **Analyse spectrum – To Formant (burg)…**

    - Tip: When drawing formant charts, it is a good idea to set the lower and upper limits quite wide apart, so that all the vowels fit in the picture (this is especially important in the case of a high-voiced speaker, since the formant frequencies also tend to be higher in this case).

    - The absolute frequencies of F1 and F2 tend to vary between different speakers, different vowels, different positions in words and utterances, etc. It often makes sense to include the vowels of a single speaker in one chart, or to indicate different speakers in different colours, for example. Examples of the center frequencies of formants in different isolated vowels pronounced by a male speaker can be found in the document *Average center frequencies of the two lowest formants*. (You might find some acoustically similar vowels in your data, or not.)

    - Even if the settings of your formant chart made perfect sense, some formant values may sometimes be plotted outside the map. If this happens, you need to consider whether you analyzed formants at the edges of vowel or consonant segments. If the articulation of the speaker happens to be rapidly changing at the point of measurement, the formant frequencies cannot be interpreted "traditionally" in the same way as in vowels, which often involve at least a brief "steady state".

    - You may want to first extract only one vowel segment from the original audio file and draw a formant map of just that segment.

    - Please note that the absolute frequencies of the formants can vary considerably between different speakers and different contexts! The values mentioned in the table in the course area should only be used as relative examples and you will probably not match the exact absolute values. For instance, you can observe on the table that in vowels of [i] type, the center frequency of the first formant is usually relatively low whereas the second formant is high **in relation to other vowels pronounced by the same speaker**.

    - The typical formant frequencies of vowels produced by a particular speaker are determined by the individual physiological characteristics (→ the typical resonant frequencies) of the vocal tract. The speaker cannot escape these: the longer the speaker's vocal tract, the lower the frequencies that tend to resonate. Within the physiological limits, each speaker also has an individual speaking style (i.e., "ways of articulating"), although it may vary. If studying vowels, it is useful to analyze as many different vowel sounds as possible in order to reveal the dimensions of the speaker's "personal vowel space".

8. **Let's get back to Praat scripts!**

   This task is for Windows users and should be done before trying the following scripts: There is a default preference in the Windows operating system that hides file name extensions, and we need to change it. When using scripts, you need to be able to see the exact name of each file. Sometimes Windows automatically inserts a file name extension for files downloaded from the web, and this may come as a surprise to the user. For example, if you download a file with the name *myannotation.TextGrid*, it may become *myannotation.TextGrid.txt*, even if the file name appears as *myannotation.TextGrid* in Windows Explorer. Confusing…

   Fortunately, the setting can be changed in the file manager (Windows Explorer): menu **Tools: Folder Options**, tab **View**, then make sure that there is no check mark under **Hide extension for known file types**. Then click **Apply to all Folders** or **Like current folder** from the same point. After this, Windows always agrees to display the full names of all files, so there will be no more hassle when scripting.

9. Try using the script **calculate_segment_durations.praat** again.

10. With this script, you can basically analyze as many TextGrid as you want in a row, and the results will be inserted at the end of the same text file. However, you must always manually open each TextGrid in Praat, and you can easily make mistakes or accidentally calculate durations from the same TextGrid multiple times.

    - Wouldn't it be easier if there was a script that analyzes all the files in directory in one go? Next, let's try analyzing an entire folder:

11. First, you need to gather a set of files to analyze on your own computer.

    Download and uncompress the package called *questions.zip* that contains Finnish audio files starting with "*kysymys*" (*kysymys1.wav*, etc.) as well as the corresponding TextGrid files (*kysymys1.TextGrid*, etc.). Make sure the uncompressed folder *questions* is located in a place where it is easy for you to find it, for example in the same directory where you keep your Praat scripts. Avoid spaces in the names of the parent folders, since this can sometimes cause trouble when using scripts.

    You should then hopefully be able to run the next new analysis script on your *questions* folder without modifications. (Of course, you can also experiment with some sound and annotation files you edited yourself - just make sure that all of them have some sort of segments marked in annotation layers that have the same name.)

    Now you have a test corpus from which you can analyze the annotated vocal segments!

12. Download the new Praat script called **collect_pitch_data_from_files.praat.** Place the script file on your computer in a suitable location, for instance in the same directory that you created during the second lesson for the duration script.

    The purpose of the script you just retrieved is to measure the maximum pitch values from all the annotated speech sound segments within each audio file in a given

directory and to save the results in a text file.

In Praat, open the script file **collect_pitch_data_from_files.praat**. Run the script.

13. When you start the script, you will need to
    - select the directory path where the audio files are
    - select the directory path where the TextGrid files associated with the audio files are (= same as above if you have saved everything in the same directory)
    - select a text file to save the results to (the file does not need to exist yet)
    - provide the extension for audio files, which is **.wav** for the Finnish question files
    - provide the extension of the TextGrid files, which is **.TextGrid** for the Finnish question files
    - provide the name of the annotation tier from which the fundamental frequency maxima are to be measured (the tier is named "äänteet" in the Finnish question files)
    - provide the pitch analysis settings.

    Once you have entered the information and pressed OK, the script will open all the files one at a time, calculate the pitch, find the maximum pitch values within all labeled sound segments based on the TextGrid, and save the results to a text file.

14. In the Script Editor window, try to find a line in the Praat script that specifies that the value to be measured is the *pitch maximum*. Just for fun, calculate a Pitch object from any audio files in the Object window, and make sure the Pitch object is selected in the Object list. You should be able to find the same command in the object list dynamic menu that the script applies to extract the maximum pitch…

15. If you like, you can try opening some of the result files you created (with either the previous two Praat scripts or with **Log** commands) in a spreadsheet program, such as MS Excel. When importing a tabulated text file in Excel, you must remember to specify that the ***field delimiter*** is the *space* character, so the pieces of information in each line will end up in their corresponding columns on the spreadsheet. In addition, you probably also need to specify that the decimal separator for numeric values is a **dot** . and not a **comma** , (when importing in Excel, click **Advanced** and select ***decimal separator*** **= .**). If the field type ends up being incorrect, Excel will treat numeric values as text, and nothing can be calculated from the duration values until the field type has been changed. – However, this exercise is turning into a spreadsheet tutorial instead of a speech analysis course, so let's stop here for now…