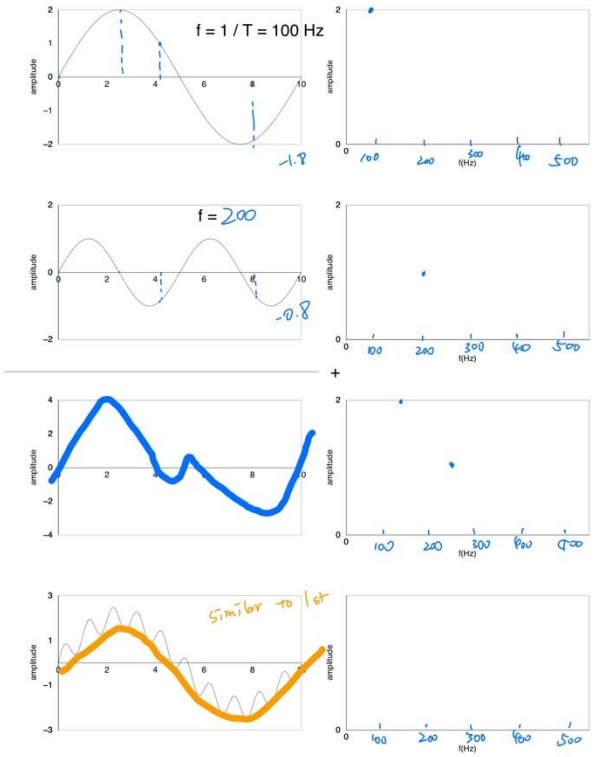
Drawing spectrum by hands
Combine two oscillograms:

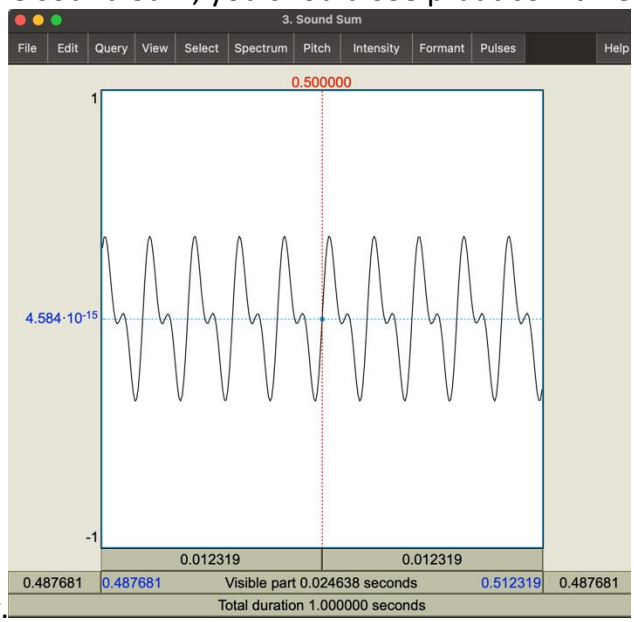
1. Combine the air pressure values, for example, they both start from 0, so the new oscillogram starts with 0 as well.
2. The second dot, the first oscillogram has a peak at 2, the second has approximately 0 at the same place, so 2 + 0 = 2, then you need to draw a dot at 2 for the combined oscillogram.
3. Then we take a point to look at where they go at 4 for each oscillogram, the first one has almost the same amplitude as the second one but one positive one negative, so they combine together we have 0 again.
4. Just repeat these steps to locate the dots, then line them up.
5. To draw the spectrum, as the first oscillogram indicates, the frequency is 100Hz, and we know the highest amplitude is 2. We draw 100 – 500 on the f(Hz) axis, then draw the dot on the top, where 2 stands. Same theory for drawing other spectrums.



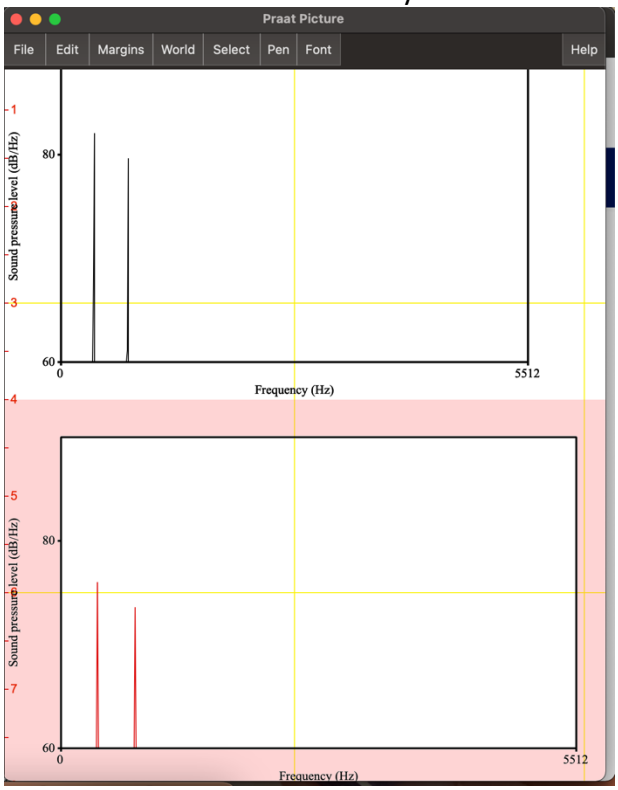
Use Praat to draw:

1. Click new > sound > create a new sound from formula. We are going to draw two. Setting the sampling frequency as 11025Hz.
2. First one: name it sine400, the 400 indicates the frequency, formula: ½ (the 2 indicates the amplitude) * sin(2*pi*400*x)
3. Second one: name it sine800, formula: 1/3 * sin(2*pi*800*x)
4. Then we need to sum these two. Open a new praat script > copy and paste the code from brightspace. Run the script, then you should see a sound sum in your list.

5. View the sound Sum, you should see praat combined these two oscillograms already.

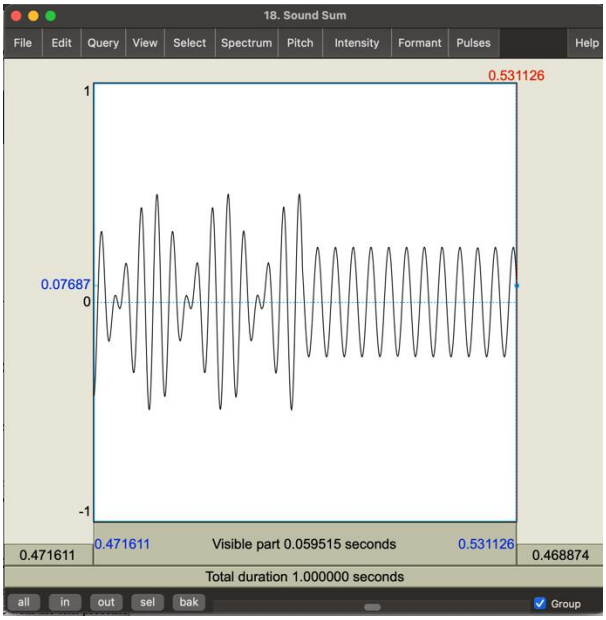


6. Creating a spectrum: select two sounds sine400 and sine800 > analyse spectrum, to spectrum, then you should see two spectrum entries on the list
7. Draw these two spectrums: select spectrum sine400 > change the setting minimal power to 60, maximum power to 90. Same for sine800. Then you should see two spectrums have been drown in one. Then select spectrum sum, same setting, but choose a different color. Then you should see this:

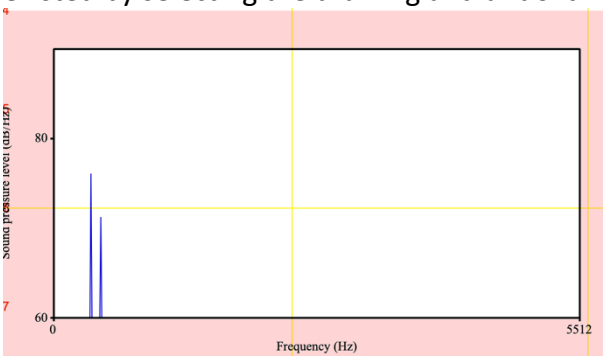


8. Creating a new sound with 500Hz. Formula > change the name to sine500, formula *500 and 1/2 > select half of the sound > edit > set the selection to zero. Now we have a sine500 on the list

9. Now we sum up the sine400 with the sine500 by selecting two sounds (command + touchpad) > open the praat script > run. Now you should see a new Sound Sum > view it



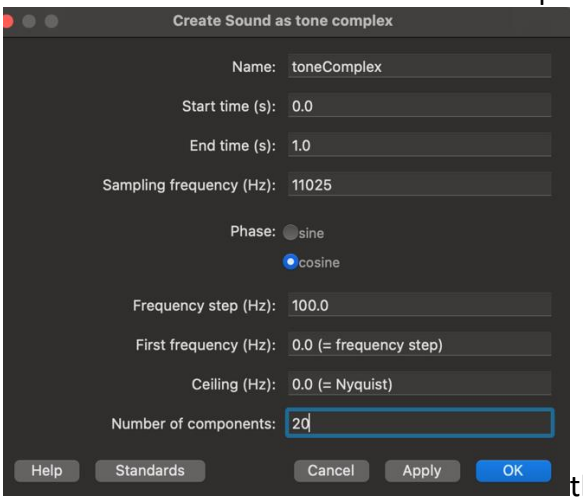
10. Create a spectrum, then draw it. But before drawing we can delete one of the existed by selecting the drawing and undo it



It is different than the other one because it has combined with two sounds with distinctive frequency and pitches. The first one has obviously higher frequency.

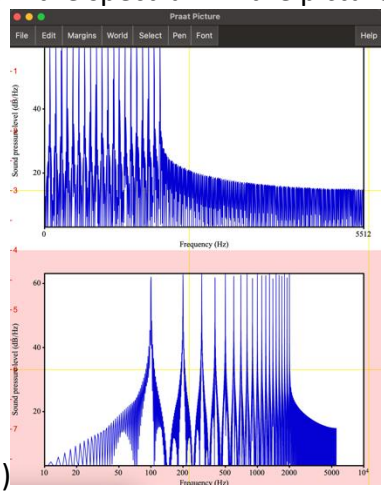
Add 20 sinusoides:

1. New > sound > create sound as tone complex



the setting should be like this > analyse

spectrum > draw the spectrum in the picture window > one with draw, one with draw (low freq)



Formants:

1. Analyze the spectrum of vowels you extracted from the sound + textgrid, find the two formants and make a plain text document

formants.dat

	F1	F2
1. ʊ	242	645
2. ɔɪ	443	1014
3. ɪ	555	1384

2. Then copy and paste the R code from the website, run in R (not R studio), then you should be able to see a formants graph. However, it is not my case even though I make sure the R data and the format DAT file are in the same working directory, but in theory it should have worked.

R Console

~/Downloads/formants ofzo

Help Search

```
> xlab = "<< front         F2 log(Hz)          back >>"
> ylab = "<< open          F1 log(Hz)          close >>"
>
> # to save the graph in a file, uncomment the desired file type and dev.off
>
> #bmp("Formants.bmp")
> #png("Formants.png")
> #setEPS()
> #postscript("Formants.eps")
> #pdf("Formants.pdf")
>
> plot(formants$F2, formants$F1, main="Formant value's", log="xy",
+   xlim=c(2500,500), ylim=c(1200,300), xlab=xlab, ylab=ylab, type="n")
Error in plot(formants$F2, formants$F1, main = "Formant value's", log = "xy",
  object 'formants' not found
> text(formants$F2, formants$F1, formants$Vowel)
Error in text(formants$F2, formants$F1, formants$Vowel) :
  object 'formants' not found
>
> #dev.off()
>
> source('~/Downloads/formants ofzo/R Console.R', chdir = TRUE)
Error in source("~/Downloads/formants ofzo/R Console.R", chdir = TRUE) :
  ~/Downloads/formants ofzo/R Console.R:2:3: unexpected symbol
1:
2: R version
```

Make a new sound with all the frequency components using stop hann filter:

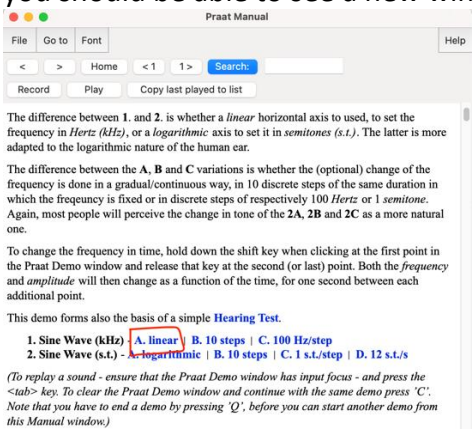
1. Select the sound with resampled frequency 11025 > filter > filter (stop Hann band) > set from frequency 0 to 200 > you should be able to see a new sound on the list
2. Repeat above, but this time we set the frequency from 0 to 1000 > then the first formant value has been filtered out of your recording

Make a new sound with all the frequency components using pass hann filter:

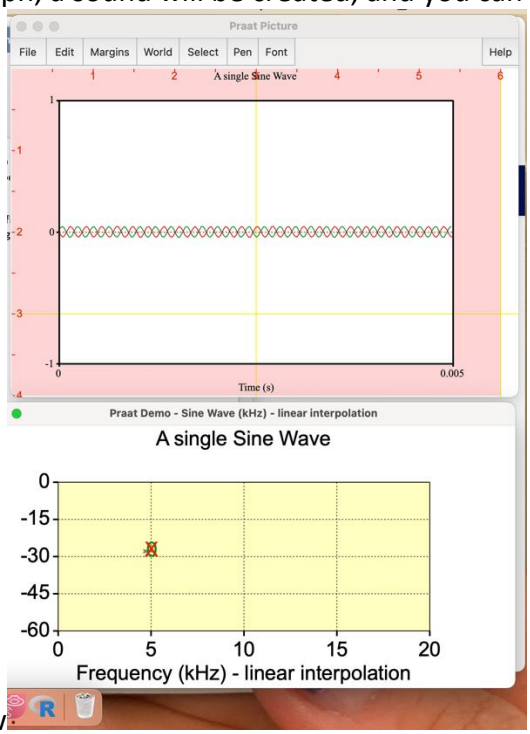
1. Select the sound with resampled frequency 11025 > filter > filter (pass Hann band) > set from frequency 0 to 250 > it should sound like overhearing conversation between walls, the high pitch sounds are not present
2. Repeat above but set the frequency from 0 to 1000 > then hear it. It should sound like someone speaking with a column, toilet roll. Speaking from a tunnel shaped thing.

How to use the spectra-2D demonstrations

1. Download the zip file from brightspace > open the file contents.man from praat > you should be able to see a new window > click single sine wave > linear

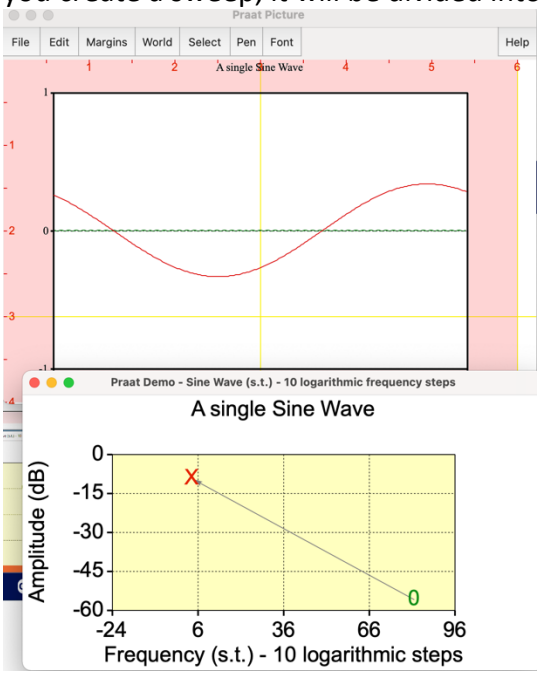


2. Click a random spot on the linear graph, a sound will be created, and you can see the drawing on the praat picture window:



More right, the higher frequency. If you press command then click the graph, you will get a sweep

3. Quit the current single sine wave, go to sine wave (s.t.) B.10 steps (same page) > if you create a sweep, it will be divided into ten parts like musical intervals



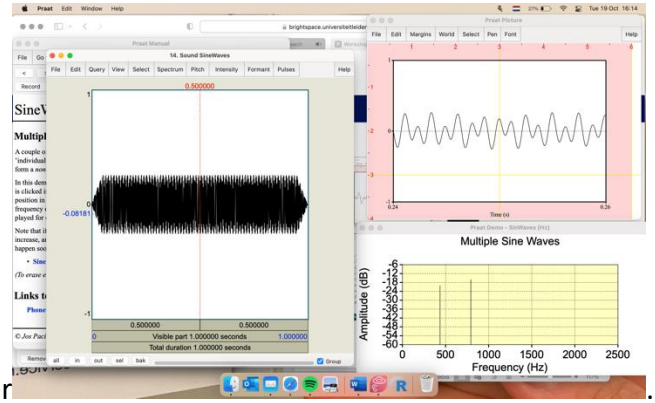
4. Move the cursor to the sine wave graph, press E to see the ocsillgram, press the S to see the spectrum.

Experience the logarithmic nature of your ears

1. Sine wave (kHz) B.10 steps > create a sweep > press Q > have a B.10 steps from (s.t.) > create a sweep from left to right (small interval, so you can hear the individual steps, when the interval is too large, it plays too fast to hear the individual sounds)
2. Try (s.t.) with c.1s.t./step, if you have large interval and it's been played in one second you will not hear the individual tones with a short interval
3. You can see with lower frequency you cannot hear the tones very clearly, but with higher frequency and larger intervals, the tones are more distinctive.

Adding sinusoids does not yield stationary signal

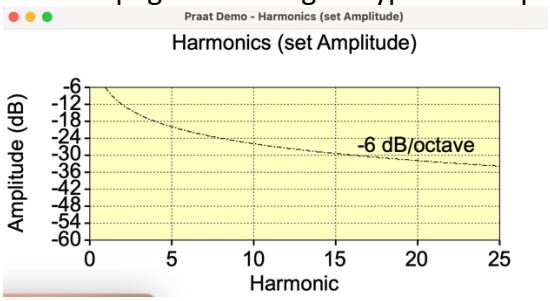
1. Go back to the content > basic signal types > multiple sine waves > click on the multiple sine waves graph, praat will generate the ocsilligram on the picture window, click another place on the waves graph > press E go to the edit window > zoom in closely

you will find out that the wave form changes from left to right, the wave doesn't stay the same frequency or whatsoever 

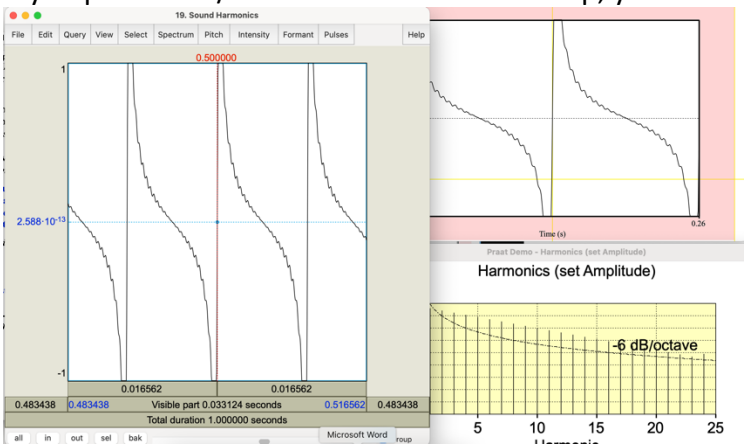
. Therefore, we can say it is not a complex wave form because it is not stationary.

Periodic sounds:

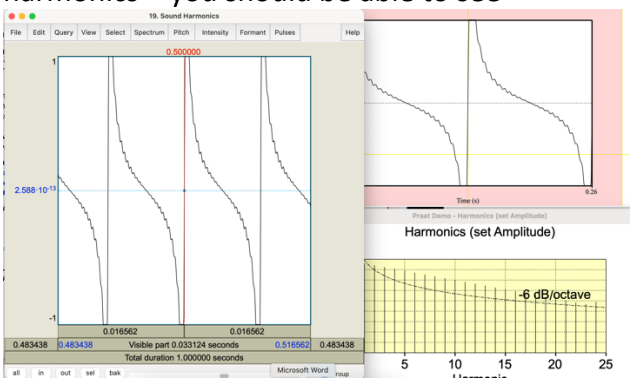
1. Content page > basic signal types > complex wave form > harmonics (set amplitude)



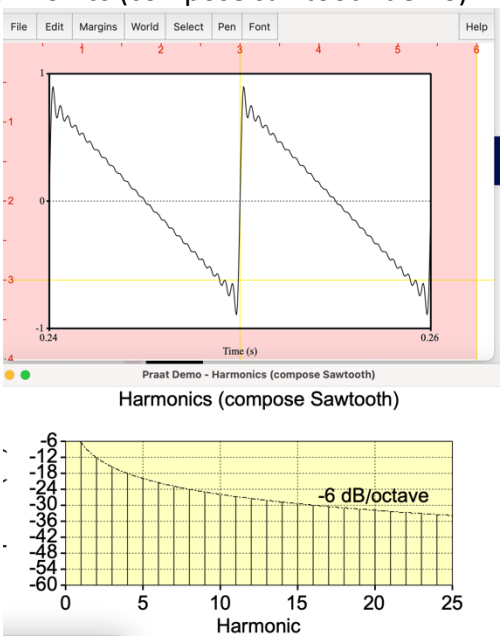
2. Click on 400Hz and 800Hz, the press E to go to edit window, you will see the wave form stays the same from the beginning to the end. At the certain point you will recognize a wave form that repeating.
3. If you press shift/command to create a sweep, you will see



4. If you make the frequency few hundreds more by click on two individual lines on the harmonics > you should be able to see

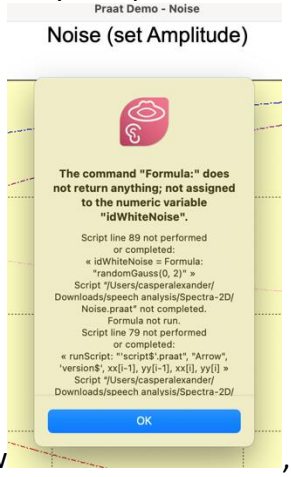


5. Quit the current one > go to harmonics (compose sawtooth demo) > create a sweep from the beginning to the end



Non-period signals:

1. Go to content page > colors of noise > noise (amplitude)
   However my computer runs errors when I am trying to operate on the harmonics window



, I think it is a coding problem which I have no idea how to solve that.