

## Plotting your vowels

Ling 151 Fall 08

Due 11/12

Homework 3

For this assignment you record yourself saying some words illustrating vowels and then you produce a graph of your vowel space and answer some questions about the acoustics of vowels.

1. Digitize (at a sampling rate of 11025 Hz) directly into the computer your own productions of the vowels in the following English words:

heed hid aid head had odd awed hud herd owed hood who'd  
[i] [ɪ] [e] [ɛ] [æ] [ɑ] [ɔ] [ʌ] [ɚ] [o<sup>u</sup>] [ʊ] [u]

2. Make LPC (linear predictive coding) and FFT (fast Fourier transform) spectra from the approximate midpoint of the vowel.

3. Keep a table of vowel formant measurements for each of the vowels in the word list.

	heed	hid	aid	head	had	odd	awed	hud	herd	owed	hood	who'd
F1												
F2												
F3												

4. Plot the vowel formant measurements on an F1 vs. F2 chart, perhaps using Praat (as in lab), Microsoft Excel or some other graphics package (e.g. the free statistics package R [[www.r-project.org](http://www.r-project.org)] has a simple plot() command). Try plotting the vowel formant measurements on both linear and logarithmic axes, and be sure to label the points in the plot with the IPA vowel symbols – by hand is fine.

5. Questions:

*Q1:* Is there any advantage to the logarithmic scale? (if you have an intuitive or auditory/perceptual notion of the shape of the vowel space, which type of display conforms more to that intuition?)

*Q2:* Does omitting F3 in these plots cause any important vowel-specific information to be neglected? If so, specify what might be lost.

*Q3:* Which vowels have the most mouth movement over the duration of the vowel? To answer this you have to go back and stare at the spectrograms. In addition to answering these questions, turn in your table of formant values and the plots.

*Q4:* Looking at FFT and LPC spectra of [i] and [a], number the harmonics in the FFT spectrum, starting with the fundamental. Which harmonic corresponds to the second vowel formant in [i] and which harmonic corresponds to F2 in [a]? Why are these formant values different?

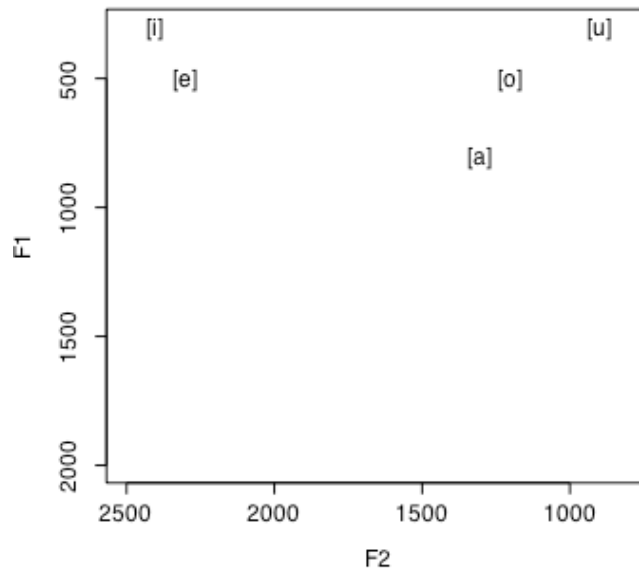
### Using the R package to make nice looking graphs (for the brave).

You won't like R because it is a command-line language - you have to type commands to it instead of point and click. But it does make nice graphs, and can do any statistical analysis known to humans. Download R for free from [www.r-project.org](http://www.r-project.org). Here are the commands that I used to make graphs of formant measurements.

```

# my data
> F1 = c(300,500,800,500,300)
> F2 = c(2400, 2300, 1300, 1200, 900)
> names = c("[i]","[e]","[a]","[o]","[u]")
# my linear plot
> plot(F2,F1,xlim=c(2500,800),ylim=c(2000,300),type="n")
> text(F2,F1,names)

```



```

# my logarithmic plot
> plot(F2,F1,xlim=c(2500,800),ylim=c(2000,300),type="n",log="xy")
> text(F2,F1,names)

```

