EE6641 Analysis and Synthesis of Audio Signals

Lab 6: Linear Prediction and Locating the formants

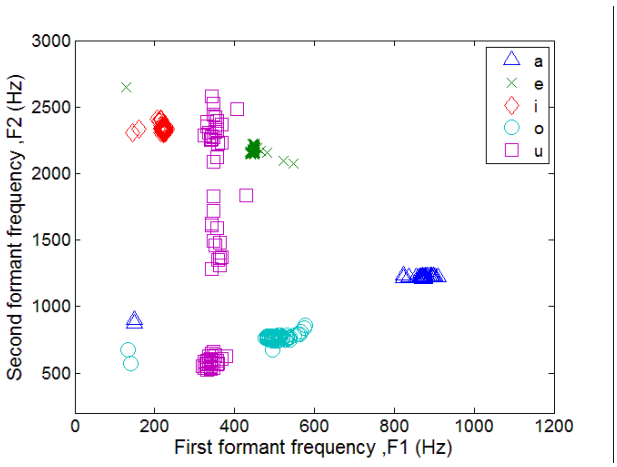
(created in Nov. 2011, modified Nov. 2015)

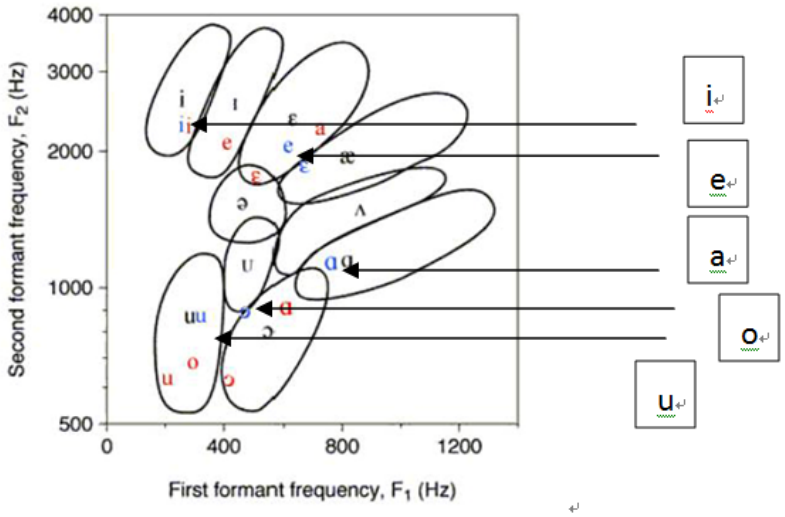
Due: December 1 **at noon, 2015**

1. In class, we talk about linear prediction (LPC) and we can use it to find the formants of vowels. Below are step-by-step guidelines. <u>You will need to turn in a plot and post it on our FB group by Dec. 1 at noon</u>.
   (a) Find a quiet room and record your own pronunciation of English vowels "/a/, /ɛ/, /i/, /ɔ/, /u/" (such as in pat, pet, peace, pot, and pooh) with 16 kHz/16 bits/mono. Pronounce them as steadily and clearly as possible.
   (b) Window the signal and do LP analysis for every frame.
   Reference: check `function A=lpc(frame,order)`, which returns a list of linear-prediction coefficients in A.
   (c) Find peaks in the magnitude spectrum of 1/A(z), which is the z-transform of the impulse response of the vocal tract filter.
   Reference: use H=`freqz(1,A,N,fs)`, then find local maxima in `abs(H)`.
   (d) Plot the frequencies of the first and second formants of every vowel. Note that they may vary a little bit but should look no worse than the figures below. The first plot shows results obtained by a former student, and the second plot illustrate where the formants should generally be located for native English speakers.

Questions to ponder or discuss with fellow students:

1. Do your results match with the second figure (for native English speakers generally)? Why or why not?
2. Based on this method, how well does each vowel cluster in the feature space (F1-F2)? Is it feasible to utilize this method for automatic recognition of the vowels?





Code Reference:

```
%step1: wave read
[y,fs]=wavread('YOUR_FILE_HERE.wav');
%step2: pre-emphasis
yPreEmp=filter([1 -0.95],1,X);
For ii=1 to nframes
     %windowing
     win = …; % DEFINE YOUR WINDOW HERE
     y_win=y.*win;
     % STFT and find peaks
     A=lpc(…);
     freqz(…);
     % find maxima of 1/A(z)
     …
     % save the formants
end
% Plot results
…
xlabel('First formant frequency, F1 (Hz)');
ylabel('Second formant frequency, F2 (Hz)');
title('formant frequencies');
```