EE386 Digital Signal Processing Lab **Jul-Dec 2021**

5: Experiment

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1 Solution

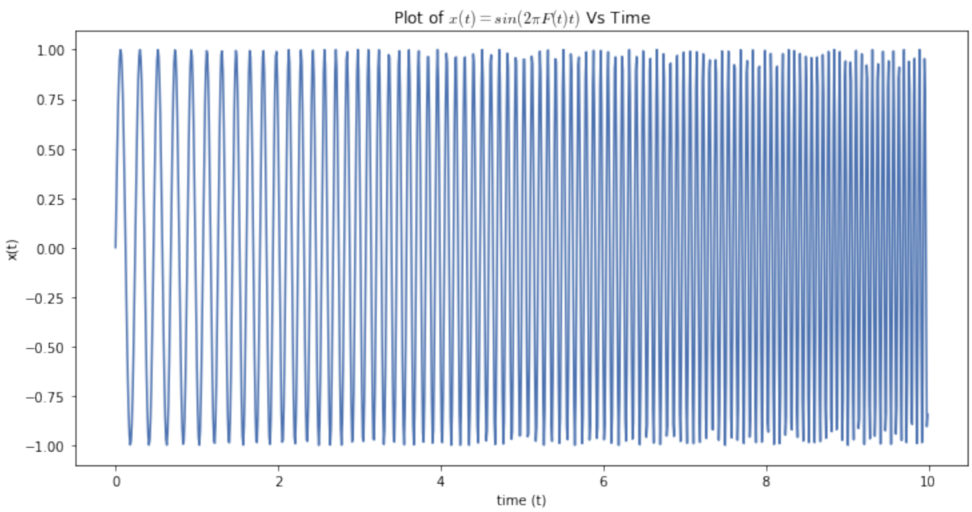
Wherever relevant, $\alpha = 1 + mod(x, 3)$ where x is the last three digits of registration number. Since $x = 114$,

$$\alpha = 1 + mod(114, 3)$$
$$\therefore \alpha = 1$$

Spectrogram of Chirp Signal

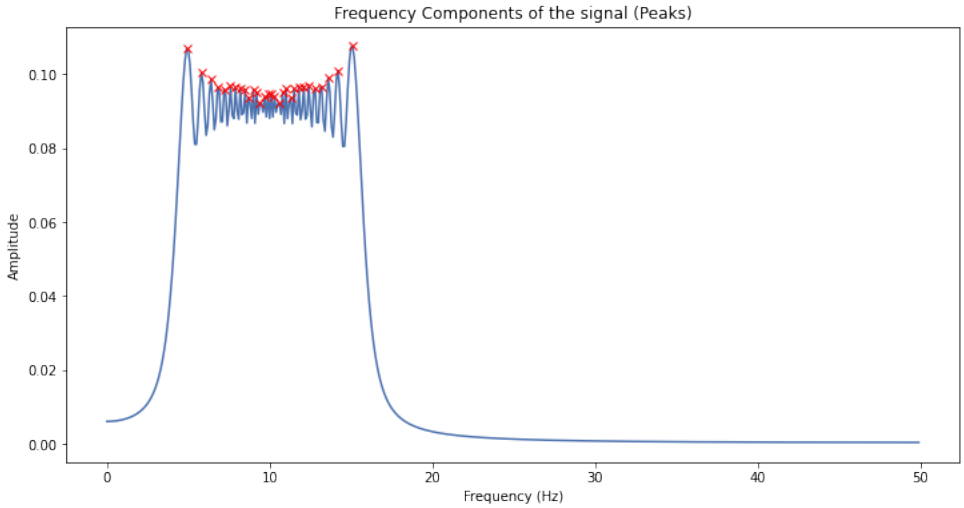
According to the problem statement, we are supposed to generate a chirp signal $x(t) = \sin 2\pi F(t)t$ with F(t) increasing linearly from 4Hz$(2 + 2\alpha)$ to 10Hz$(5 + 5\alpha)$ at a sampling rate of 100 samples per second for duration of 10 seconds.

(Subproblem 1) Plot of the signal $x(t) = \sin 2\pi F(t)t$ as a function of time.
(Solution)



It can be observed from the plot that the frequency of the signal is increasing linearly with time.

(Subproblem 2) Plot of frequency spectrum of the signal using FFT.
(Solution)



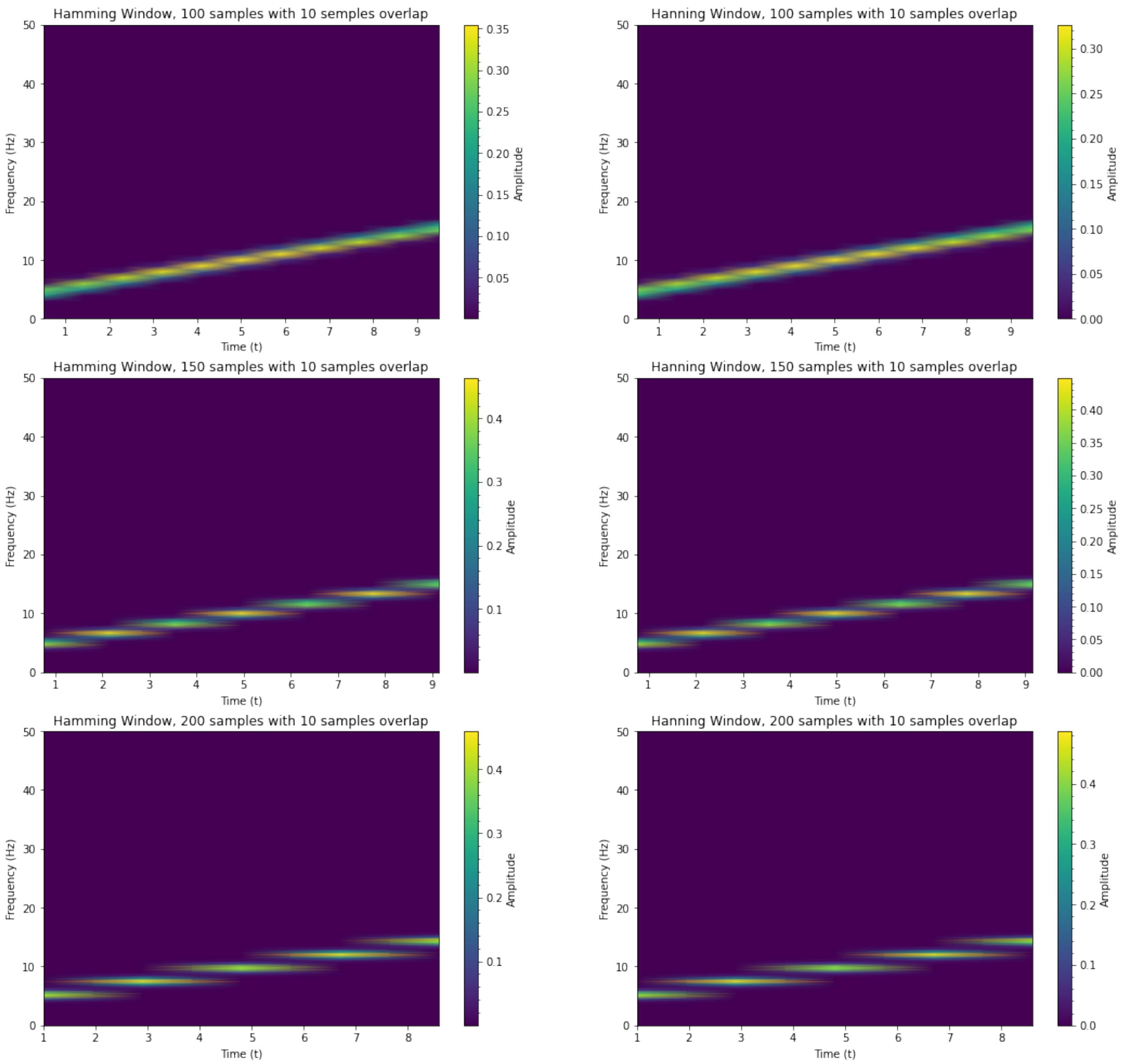
In the above figure, the red crosses indicates the peaks in the frequency spectrum of the given signal. The frequencies corresponding to these peaks are present in the given signal.

(Subproblem 3)

Plot a spectrogram of the signal using a hamming window length of 100 samples and an overlap of 10 samples.
(Solution)

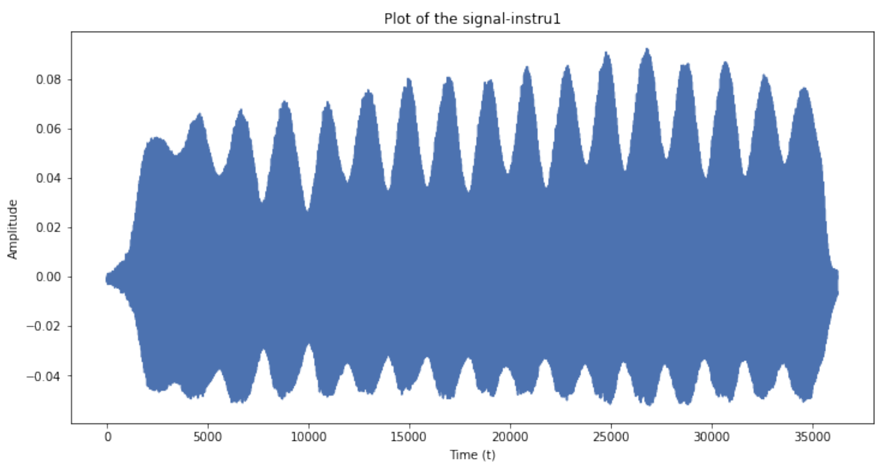
In the figure given below, it can be observed that the frequencies get concentrated to values at particular intervals as compared to the plot with lower number of samples where it appears that every frequency is present in a given range.

On the other hand, on comparing hanning and hamming window, it is observed that there isn't much difference in the plots with given samples and overlapping samples but the plots with hanning windows appears to have higher resolution.



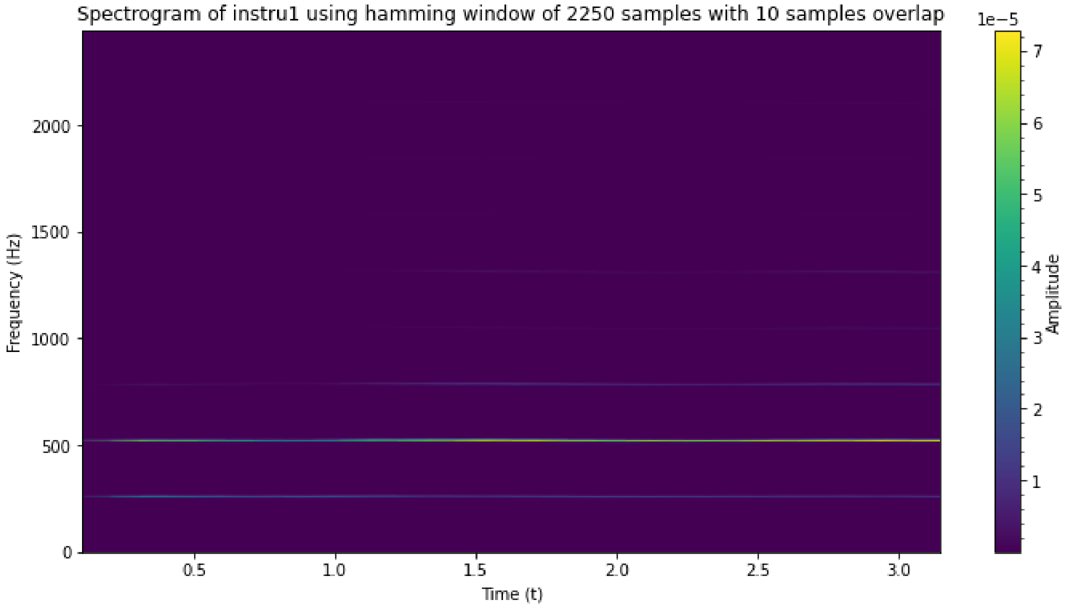
Pitch Extraction

According to the problem statement, here we need to plot the spectrogram of istru1.wav ($\alpha = 1$).

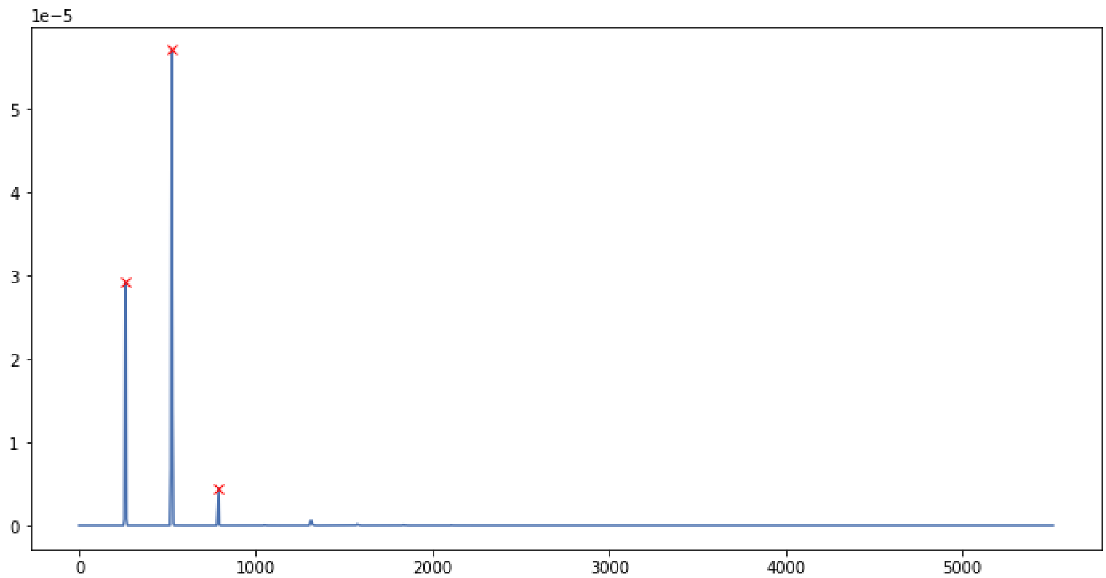


(Subproblem 1) Plot of spectrogram of instru1.wav using hamming window of 2250 samples with an overlap of 10 samples.

(Solution)

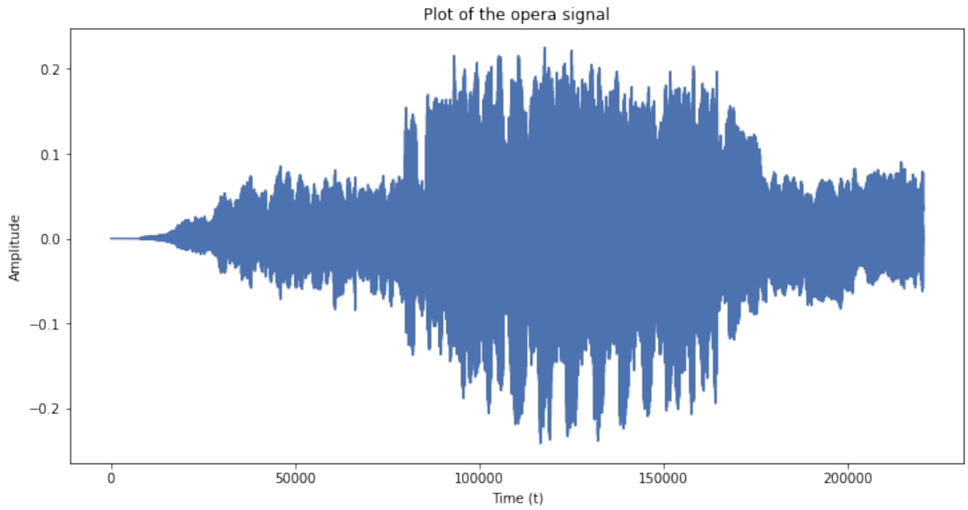


Given below is the plot of the frequencies at which the spectrogram shows a bright yellow lines(peaks).

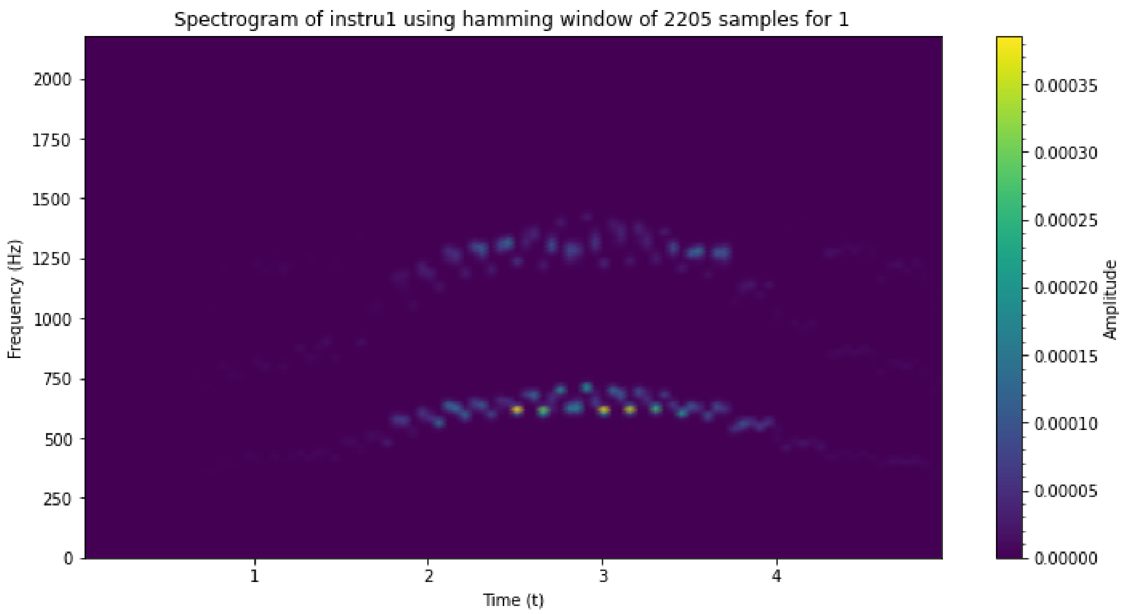


After using the scipy function $find_peaks$ for finding the frequencies corresponding to the peaks in the spectrogram, the fundamental frequency is found to be 264Hz(note C4) with 524.3Hz and 788.9Hz as harmonics.

(Subproblem 2) Plot of spectrogram of opera.wav using hamming window of 2250 samples with an overlap of 10 samples.
(Solution) Given below is the plot of the given opera signal.

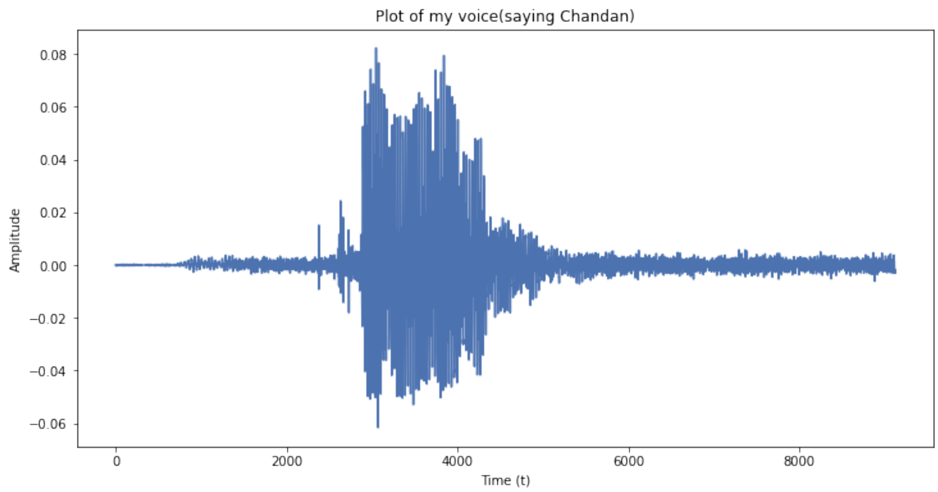


In the spectrogram given below, it can be observed that the frequency of the singer first increases and then decreases as can be heard in the audio as well. These are termed as crescendos(increase in frequency) and decrescendo(decrease in frequency)



Spectro-Temporal Analysis of Speech

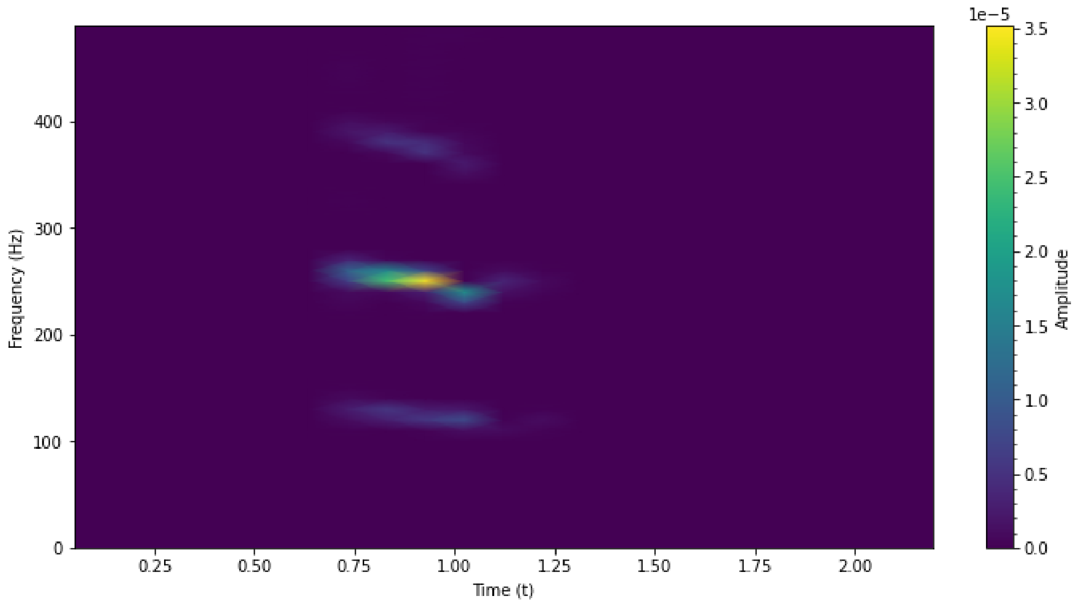
Plot of my voice saying "Chandan"



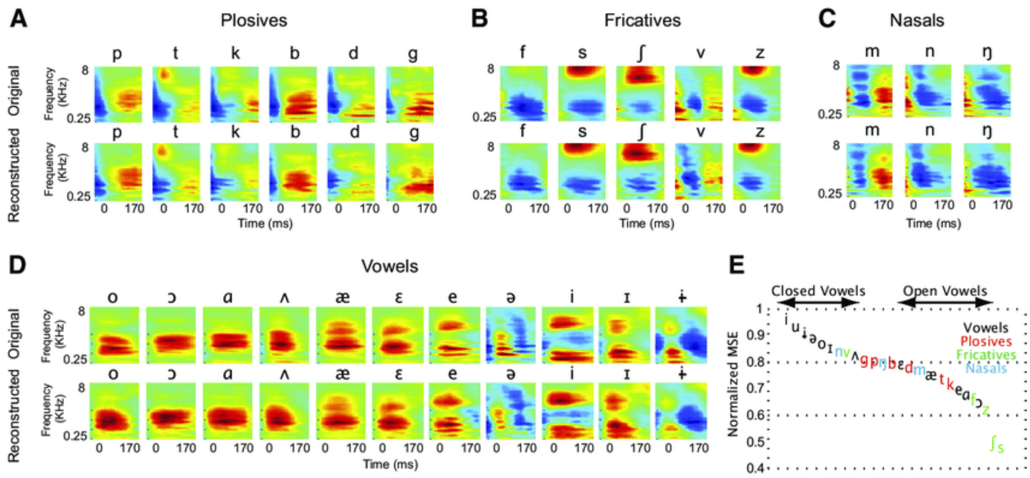
Below is the spectrogram of the my voice. My name consists of three phenomes named as degraph, consonant and long vovel phenomes.

Digraphs form when two consonants work together to create a completely different sound. The two consonants have different sounds on their own and are most often but not always seen at the start or end of a word.

- ch – watch and chime
- ā – day and eight
- d – doe and deal
- n – net and nip



Below is the spectrogram of the different vowels and consonants. Taking reference from this, one can observe similar patterns of a, n, d in the spectrogram of my voice.



A Code Repositories

Refrain from including any or all code in this document. Upload codes to your repository and include the links to executed nbviewer files here as – The codes to reproduce the results can be found in the GitHub repository `https://github.com/predator4hack/EE386_Digital_signal_processing`.

B Reference

`https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FAverage-phoneme-spectrograms-from-original-and-reconstructed-phonemes-A-D-top-the_fig1_26816996&psig=AOvVaw3-hTLZHusTiaqvwoAFlmj2&ust=1634234096621000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCKiYmcj6x_MCFQAAAAAdAAAAABAD`