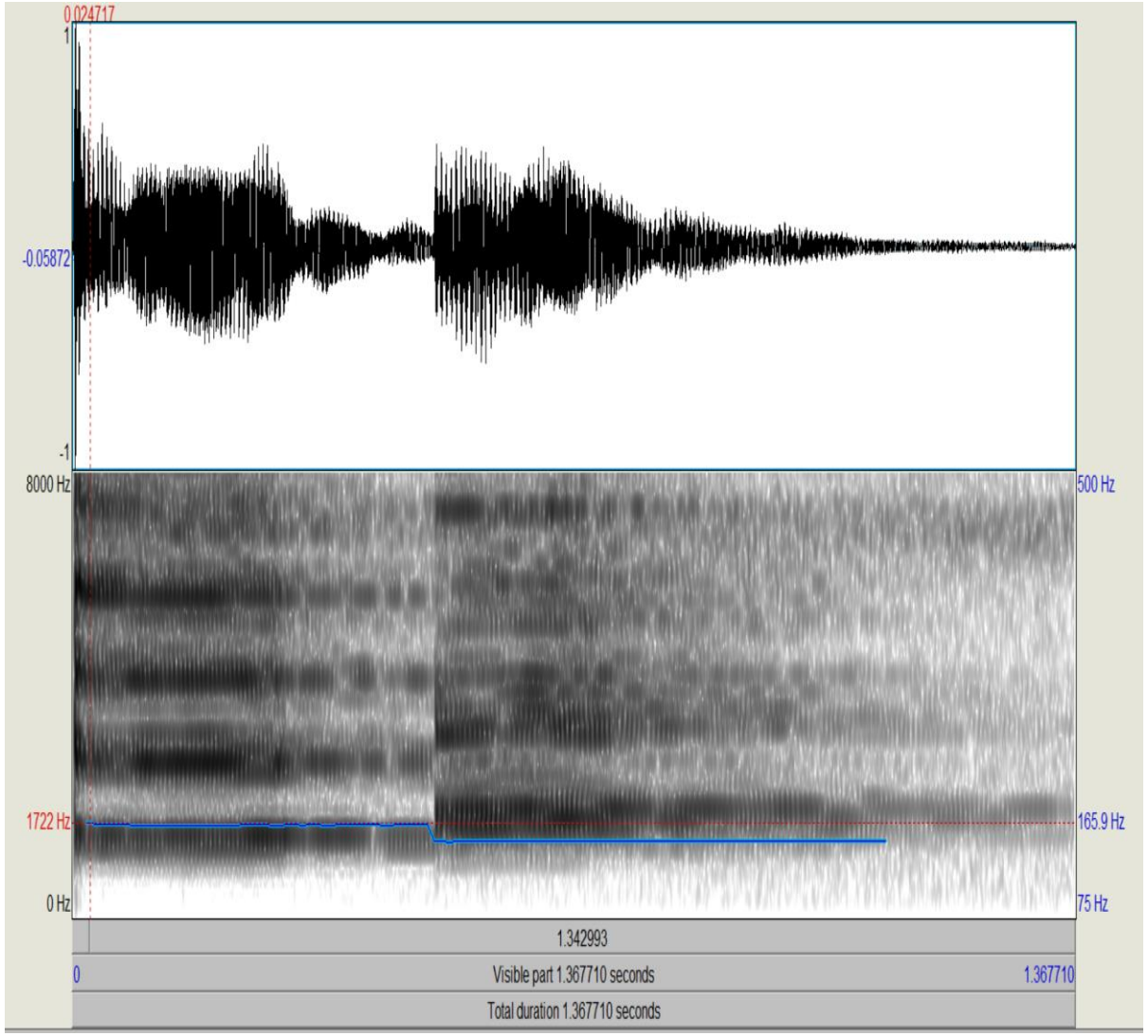
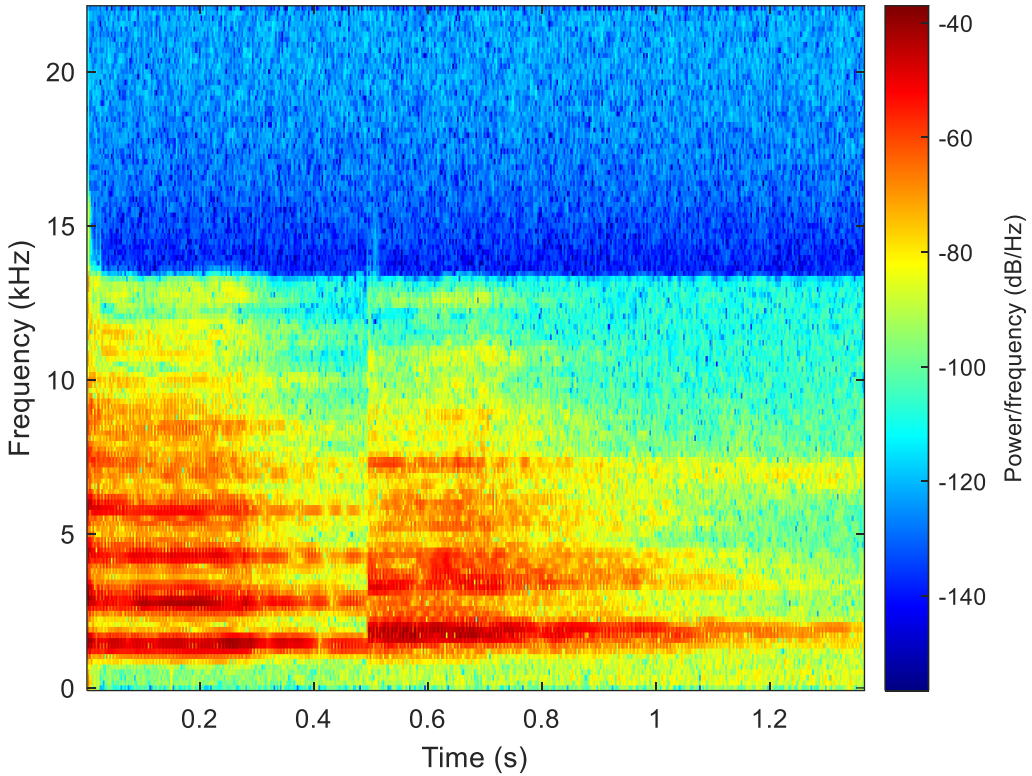
Analysis and synthesis of White bell bird call

Prasad Madhava Kamath

Analysis of Spectrogram using Praat

Identify the pitches 165hz and 149hz based on praat's pitch analyser, pitch curve shown in blue

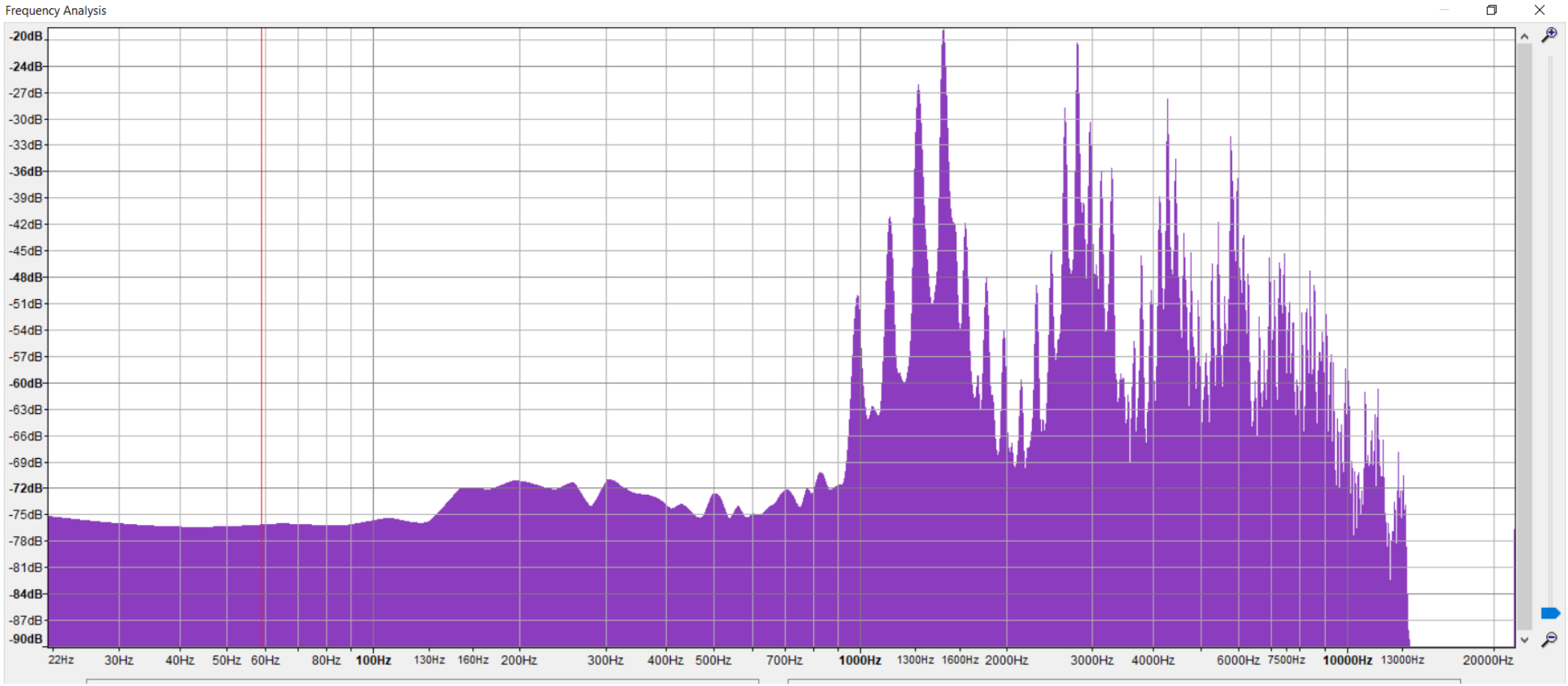




Analysis in MATLAB using STFT of length 1024,
50% overlap,
hann window

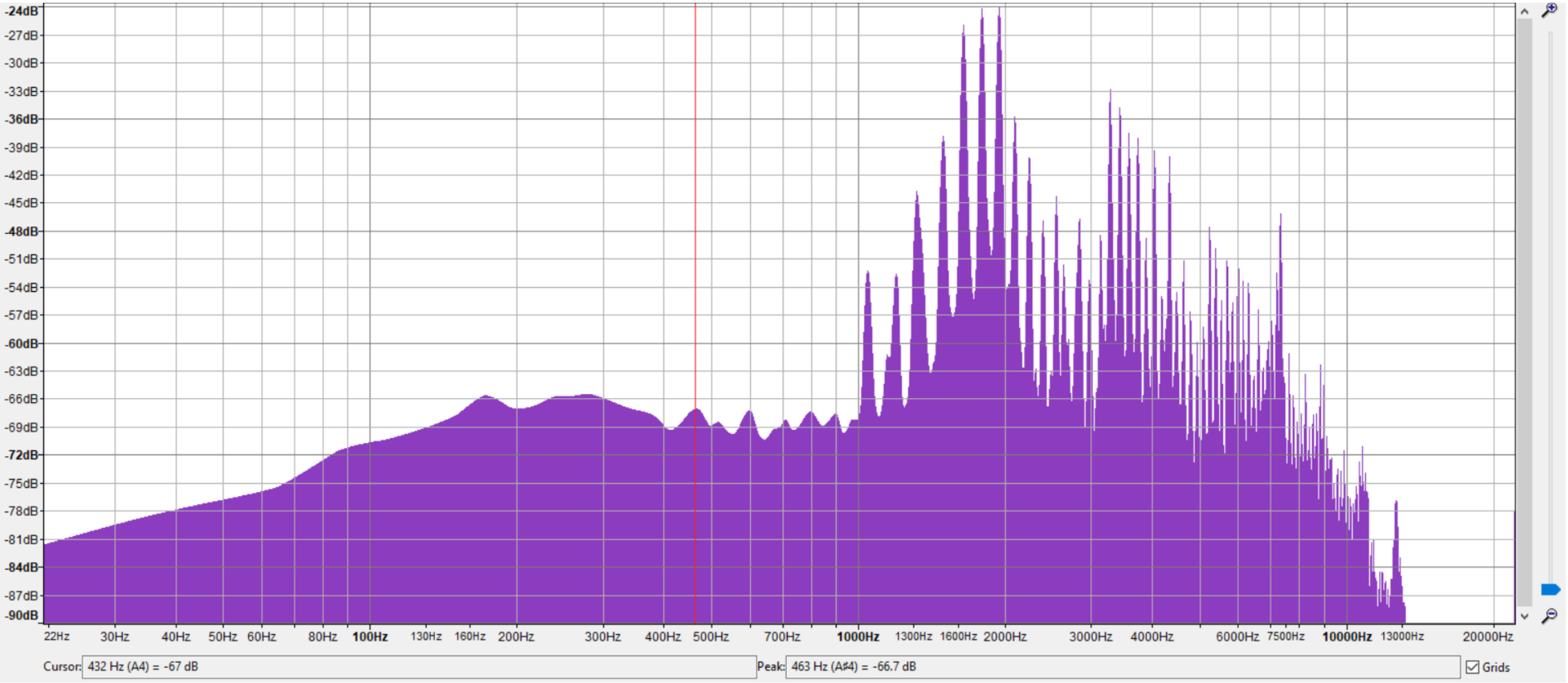
Spectrum of an initial section of white bell bird call as analyzed in audacity (hann window 1024 bins)

Identify the formants through visual inspection of peaks– 1481,2862,4224,5742 Hz



Spectrum of an initial section of white bell bird call as analyzed in audacity (hann window 1024 bins)

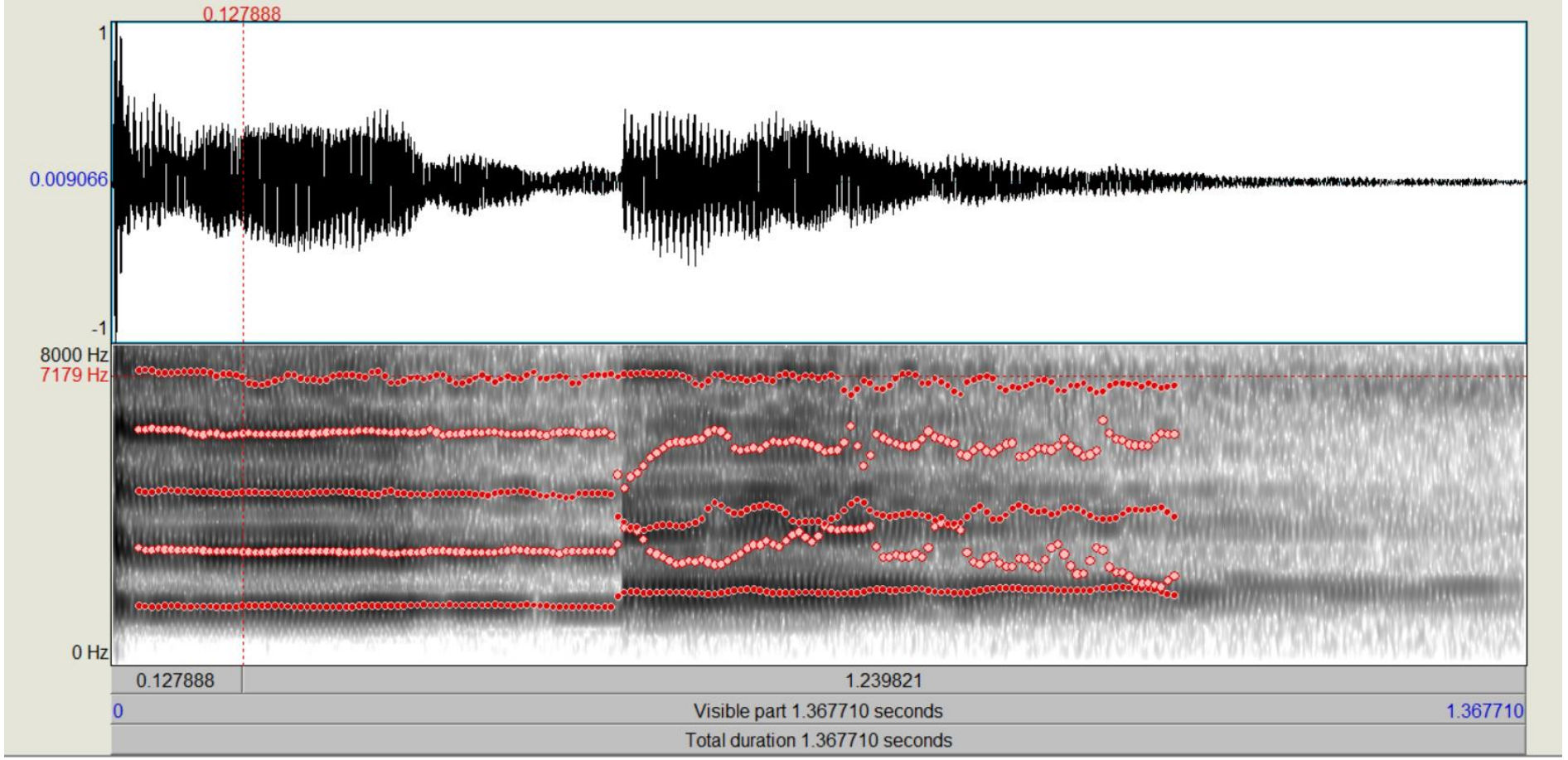
Identify the formants through visual inspection of peaks– 1791,3448,4322,5219 Hz



Synthesis

- Additive synthesis gives full control over adding sinusoids at formant frequencies and harmonics, both frequency and magnitude of each component can be specified
- The method is very laborious
- Subtractive synthesis is complex (use filters to obtain a shaped spectrum)
- I use a combination of additive synthesis and FM.
- This is based on literature survey and a book by Prof. Andy Farnell- Designing Sound

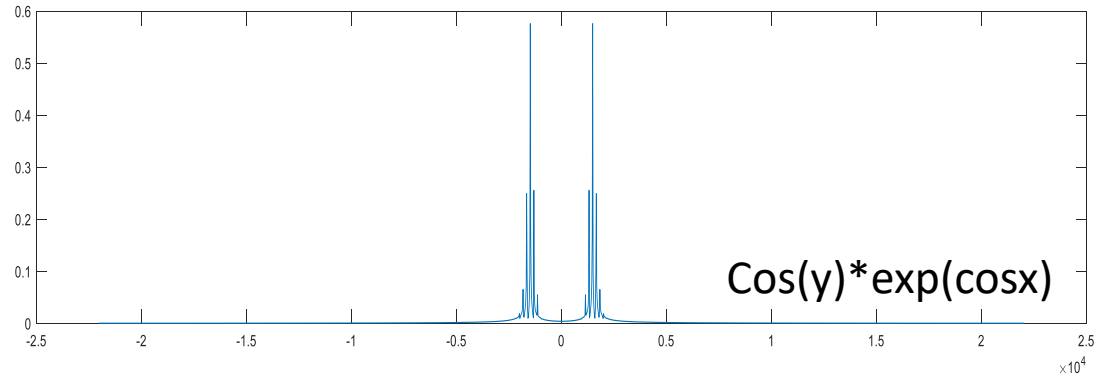
Formant tracking in Praat

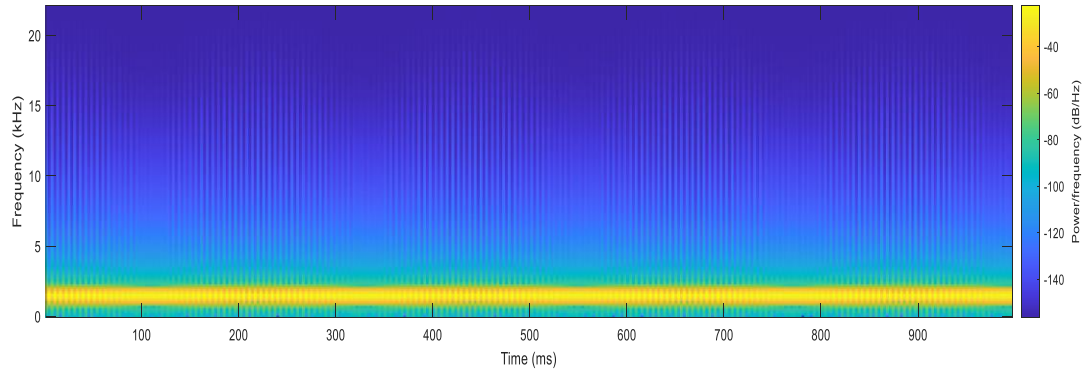


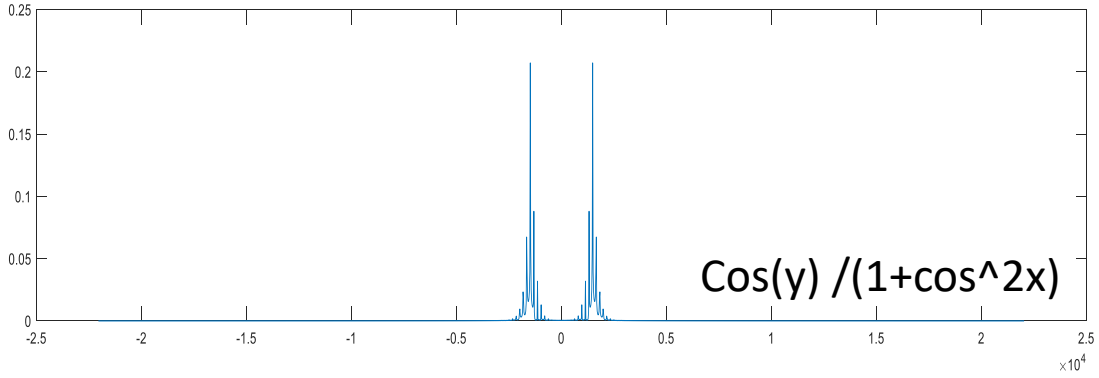
Additive synthesis + FM

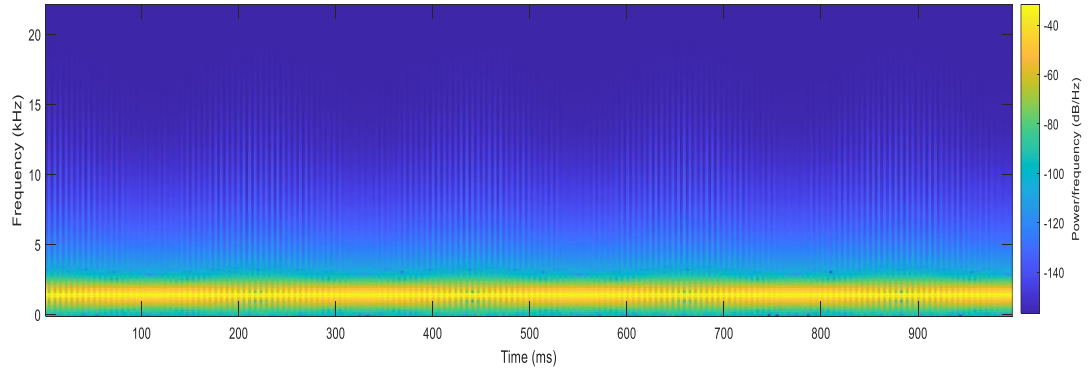
- Based on the detected formants, create 4 oscillators at formant frequencies
- Create a unipolar oscillator using exp(cos(2*pi*f)) where f is the fundamental frequency
- The harmonics are placed at f0±kf distance on either side of the formant, we can obtain this by ring modulation by multiplying the unipolar oscillator with each formant thus giving rise to the desired spectra
- The resultant formant + harmonics are weighed as per the reference spectrum and added together.

FM modulated formant using Unipolar oscillator vs Pulse oscillator (analyzed in matlab)





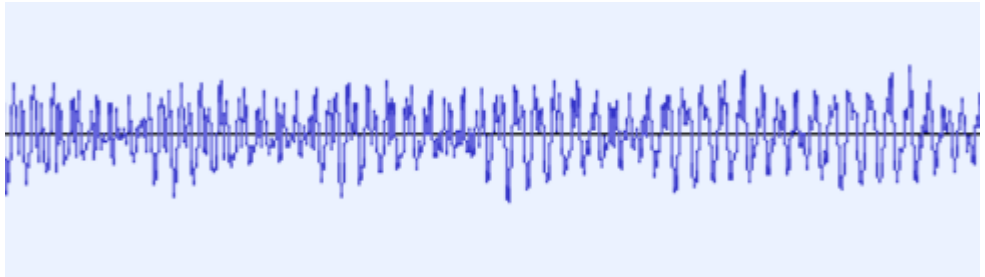




Has more spread around the formant frequency

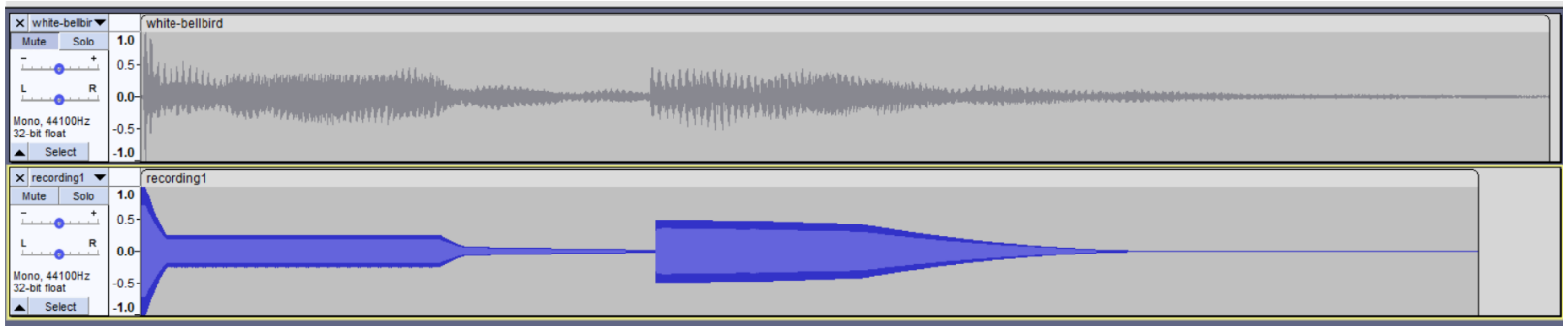
Amplitude Modulation

- The original bird call is amplitude modulate using a sinusoidal modulation signal of fm Hz
- Fm is identified by envelop tracking
- A cosine oscillator at fm hz and amplitude m is used to modulate the output of the weighted sum of the fm modulated formants



Envelop shaping

- I created a custom patch using vline in pure data to mimic the overall amplitude envelop seen in the actual bird call. The designed envelop is as shown below



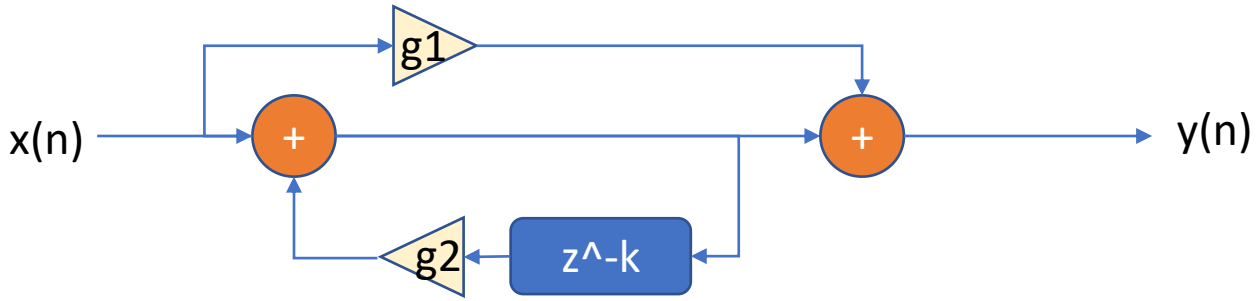
- Another method perhaps is to use side chain ducking and a compressor with fast attack 5ms, a hold time of 300ms, and long release time 200ms

High Pass filter

- As per literature survey, the beak of the bird acts like a high pass filter so I add a high pass filter post the am modulated output

Artificial Reverb (To be done)

- I plan to add synthetic reverberation using a simple feedback delay structure (comb filter) (a simple reverb algorithm), I'm yet to try this in PureData



- Set a wet and dry gain and combine the wet signal with the original signal

bb_pulse_osc_env_shaped2.pd - C:/Users/prsdk/OneDrive/MUS270B/Pd/myPatches

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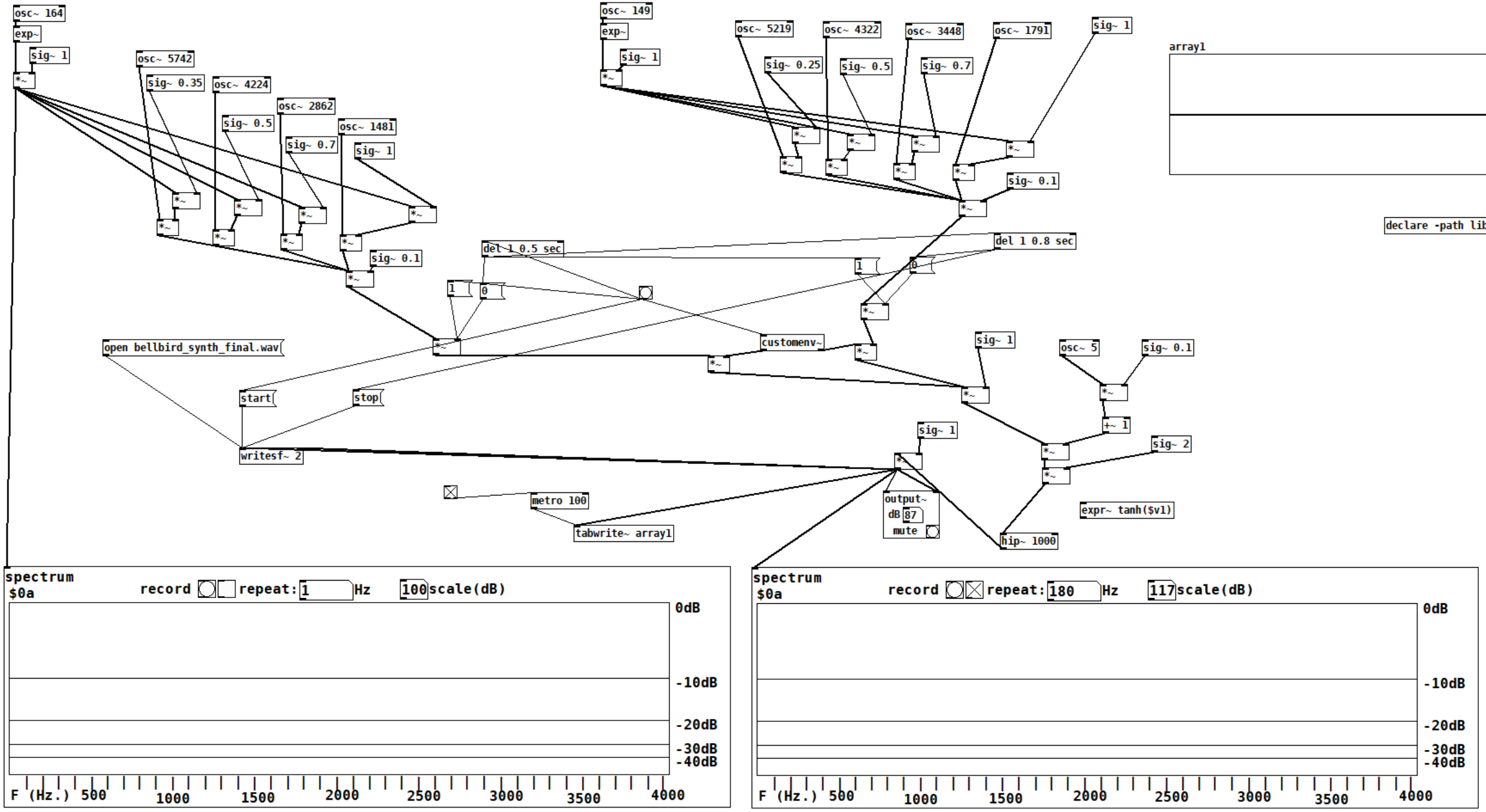
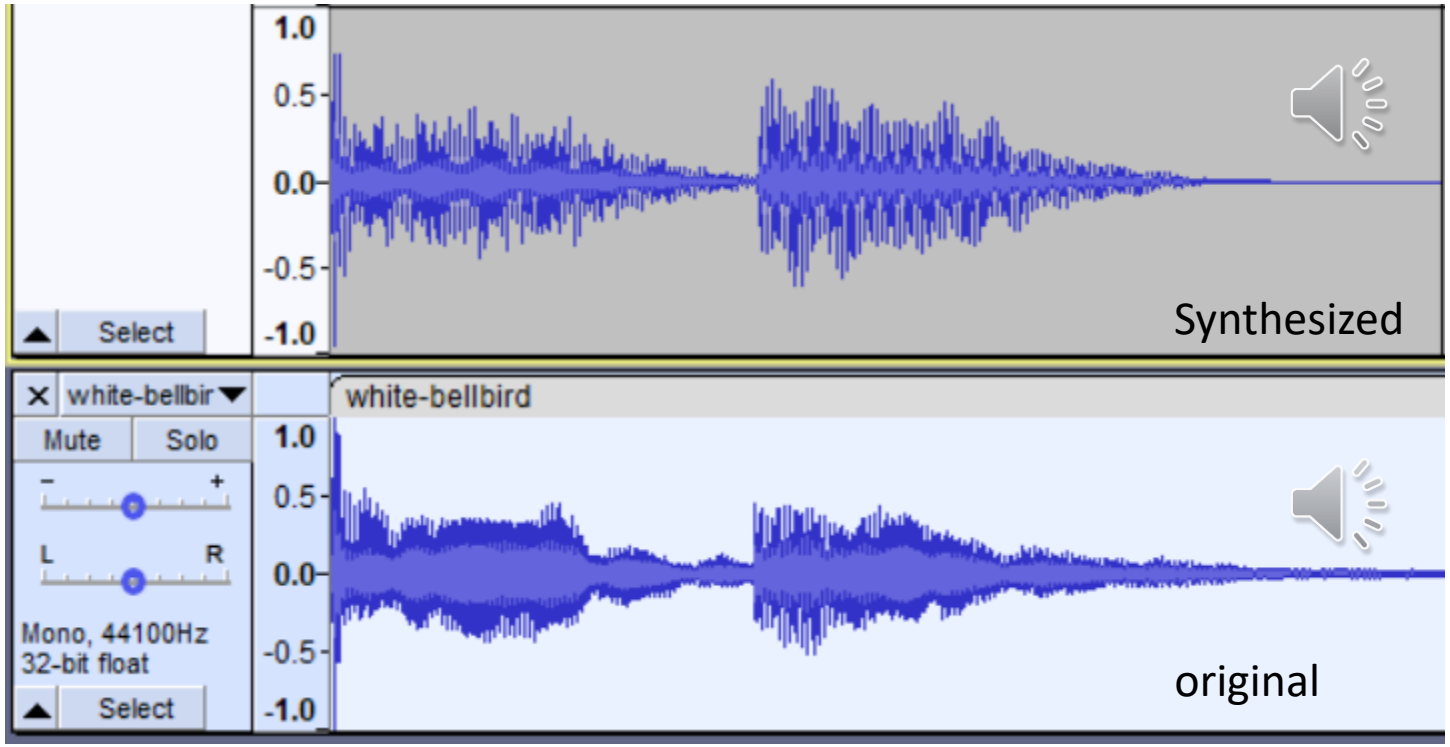


Results


1.0
0.5
0.0
-0.5
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Select
Synthesized
white-bellbir
white-bellbird
Mute
Solo
L
R
Mono, 44100Hz
32-bit float
Select
original