Simple Spectrogram

- sample bird call audio

```
[channels, sample_rate] = audioread('../datasets/XC403881.wav');
whos;
```

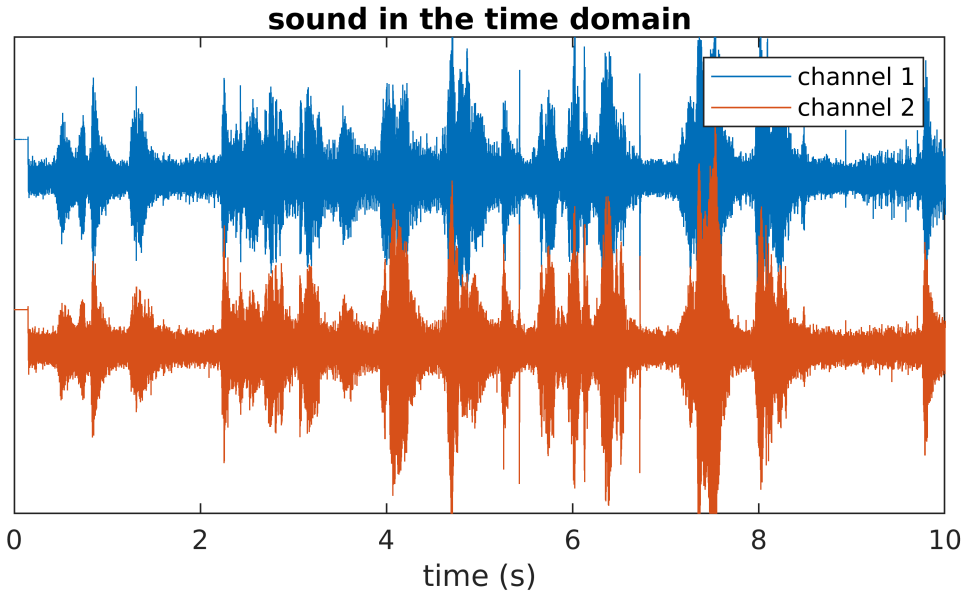
```
  Name                  Size              Bytes  Class     Attributes

  channels         450879x2            7214064  double
  sample_rate           1x1                  8  double
```

- note there are 2 channels
- play the audio

```
soundsc(channels, sample_rate);
N = length(channels);
t = (0:N-1)/sample_rate;
```

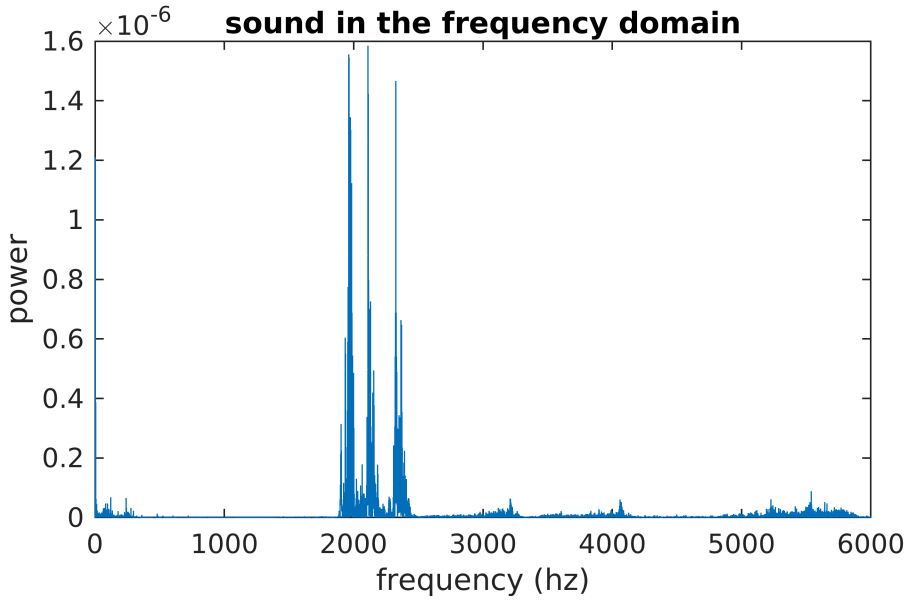
- plot the channels

```
f1 = figure(1); clf;
f1.Position = [0 0 600 300];
plot(t, bsxfun(@plus, channels, [.25 0])); %offset the channels
xlabel("time (s)");
title("sound in the time domain");
xlim([0 10]);
ylim([-.3 .4]);
yticks([]);
legend(["channel 1", "channel 2"]);
```



- compute and plot the power spectrum

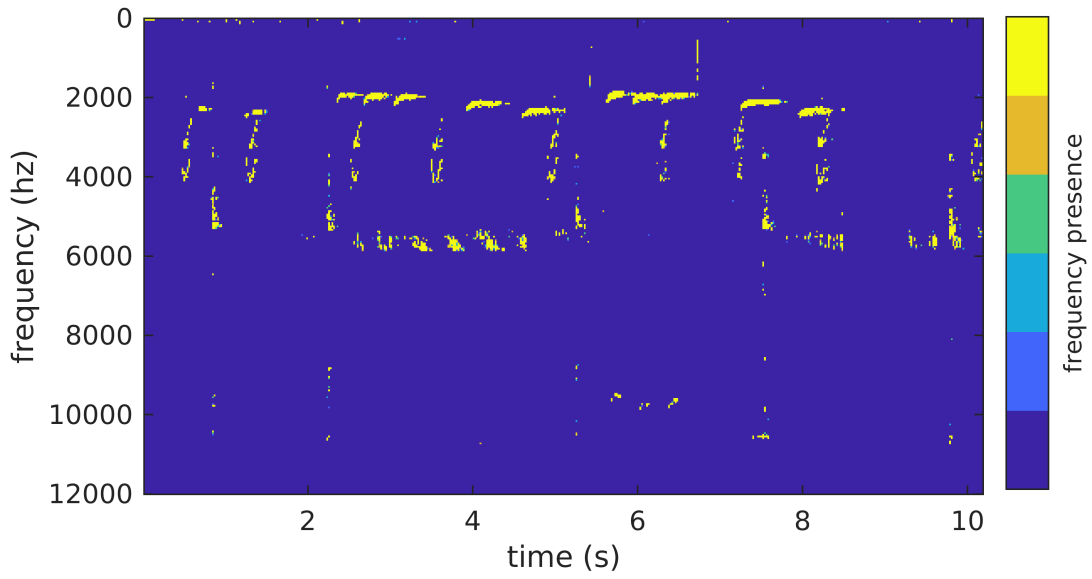
```
hz_vals = linspace(0, sample_rate/2, floor(N/2)+1);
powers = abs(fft(detrend(channels(:,1)))/N).^2;

f2 = figure(2); clf;
f2.Position = [0 0 500 300];
plot(hz_vals, powers(1:length(hz_vals)));
xlabel("frequency (hz)");
ylabel("power");
title("sound in the frequency domain");
xlim([0 6000]);
```



Now Apply spectrogram

- use function in signal processing tool box

```
[spectrum, frequency, time] = spectrogram(detrend(channels(:,1)), hann(1000), 100, [],

f3 = figure(3); clf;
f3.Position = [0 0 600 300];
imagesc(time, frequency, abs(spectrum).^2);
ax = gca;
ax.CLim = [3 4];
ax.YLim = frequency([1 dsearchn(frequency, 12000)]);
ax.XLim = time([1 end]);
colormap(parula(6));
c = colorbar();
c.Label.String = "frequency presence";
set(c, 'YTick', []);
xlabel("time (s)");
ylabel("frequency (hz)");
```



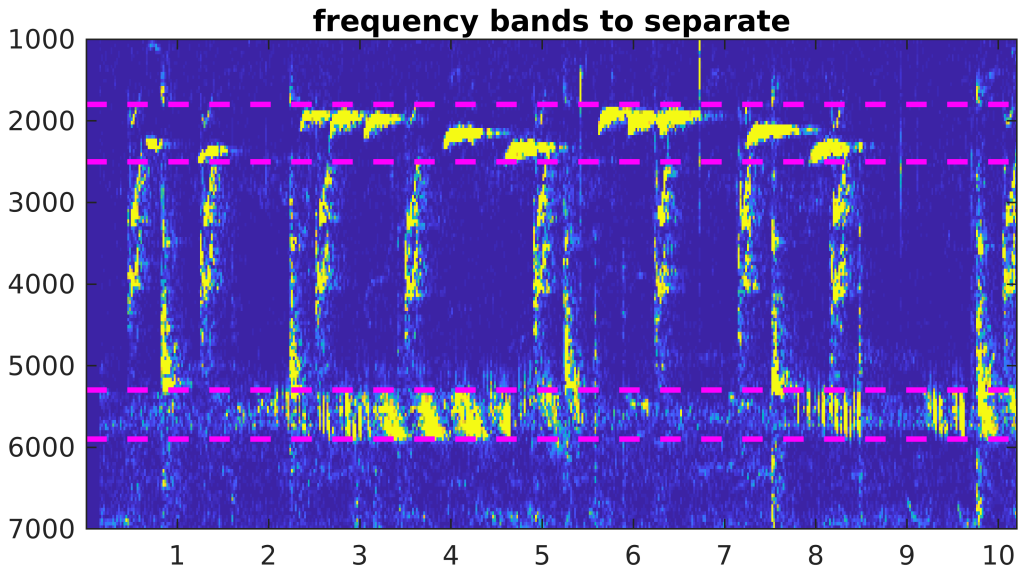
Separate the sources

- visually inspect the spectrogram to identify frequencies of interest

```
freq_{1} = [1800 2500];
freq_{2} = [2501 5299];
freq_{3} = [5300 5900];
```

Plot

```
colorz = 'kk';
f4 = figure(4); clf;
f4.Position = [0 0 600 300];
imagesc(time, frequency, abs(spectrum).^2);
ylim([1000 7000]);
ax = gca;
ax.CLim = [0 2];
hold on;
for k = 1:length(freq_)
    plot(get(gca,'xlim'), [1 1]*freq_{k}(1), 'm--', 'linew', 2);
    plot(get(gca,'xlim'), [1 1]*freq_{k}(2), 'm--', 'linew', 2);
end
hold off;
title("frequency bands to separate");
```



Filter both frequency ranges

```
filtered_freqs = cell(2,1);

for k=1:length(freq_)
    order = round(10*sample_rate/freq_{1}(1));
    kernel = fir1(order, freq_{k}/(sample_rate/2));

    for l=1:2
        chan = channels(:,l);
        filtered = filtfilt(kernel, 1, chan);
        filtered_freqs{k}(:,l) = filtered;

    end
end
```

Play the sounds

- original

```
soundsc(channels, sample_rate);
```

- lower frequency

```
soundsc(filtered_freqs{1}, sample_rate);
```

- higher frequency

```
soundsc(filtered_freqs{2}, sample_rate);
```