

## Additional questions

Note the following table of  $\sin^{-1}$  values:

x	$\sin^{-1}(x)$	x	$\sin^{-1}(x)$
0	0	0.6	36.9
0.1	5.7	0.7	44.4
0.2	11.5	0.8	53.1
0.3	17.5	0.9	64.2
0.4	23.6	1.0	90.0
0.5	30.0		

Note also if  $\sin(\theta)=x$ , then  $\sin(-\theta) = -x$

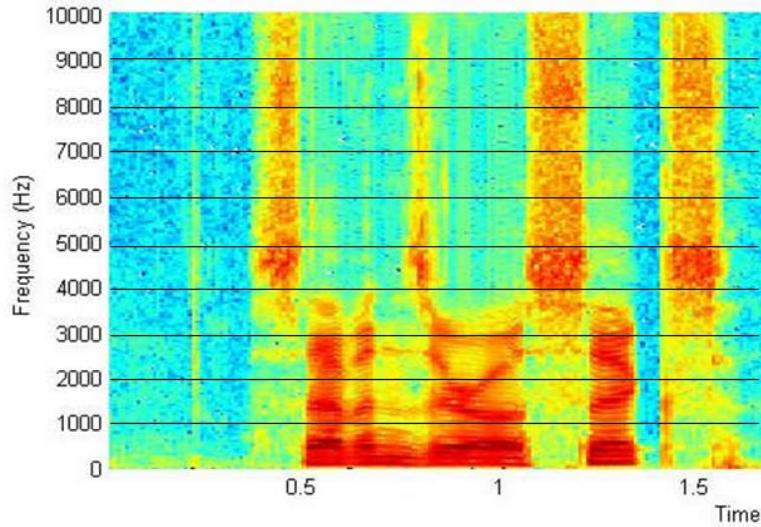
What is the location of the sound source for a typical head given the sound arrives at the left ear and the right ear at the specified times below. (You may estimate your answer based on the table above.)

(a)  $t_{\text{left}}=13.5\text{ms}$        $t_{\text{right}}=13.1\text{ms}$   
 $\sin^{-1}(343 \times 0.0004 / 0.2) = \sin^{-1}(0.686) = 43.3^\circ$  (a number between 37 and 44)

(b)  $t_{\text{left}}=24.2\text{ms}$        $t_{\text{right}}=24.4\text{ms}$   
(c)  $t_{\text{left}}=41.3\text{ms}$        $t_{\text{right}}=40.75\text{ms}$

If we increase our head size from 0.2m to 0.4 m, what happens to the range of possibly accepted sound timing differences  $\Delta t$ ?

- (a) Stays the same
- (b) Gets larger
- (c) Gets smaller



Identify the time intervals for at least three times the 's' or 'ch' sound occurs in the "spectrogram" above (plotting frequency vs time).

The letter 'r' is said at least once during this recording. Identify a time it may have been said.

What other sounds look like the letter 'r' in a spectrogram?  
**Other frequency slides include L, M, N (also Y and W).**

Identify the formants for the first vowel in this recording.

Identify the formants for the last vowel in this recording.

Let us suppose the spectrogram above (showing power of frequency over time) comes from a matrix called `soundRecording` with dimensions 10,000 x 1,700 (for information at 1-10,000Hz and 1-1700 ms).

What Matlab command would generate the colored figure shown above? (Don't worry about generating the x and y axis labels and the black lines)

What command(s) will let us know the largest and highest values in the `soundRecording` matrix?

```
min(soundRecording(:)) and max(soundRecording(:))  
or  
hist(soundRecording(:))
```

Let us say we want to extract the frequencies across time for `word2`, taking place from 751ms to 1100ms. Write code to define `word2Matrix` (a 10,000x350 matrix) to record the desired data.

**The following is more challenging, but it is possible the most challenging Matlab question be like this:**

What if measuring data at every single Hz frequency is too much? Instead, we'd prefer to take the average energy at every 50 Hz. Write code to define `soundRecordingSmall` that is a 200x1700 matrix containing the sounds at all 1700ms, but with frequency energy summarized for every 50 Hz. For example, `soundRecordingSmall(1,20)` will have the average values `soundRecording(1,20)`, `soundRecording(2,20)` through `soundRecording(50,20)`.

```
for k=1:200  
    soundRecordingSmall(k,:) = soundRecording((k-  
1)*50+[1:50],:);  
end;
```