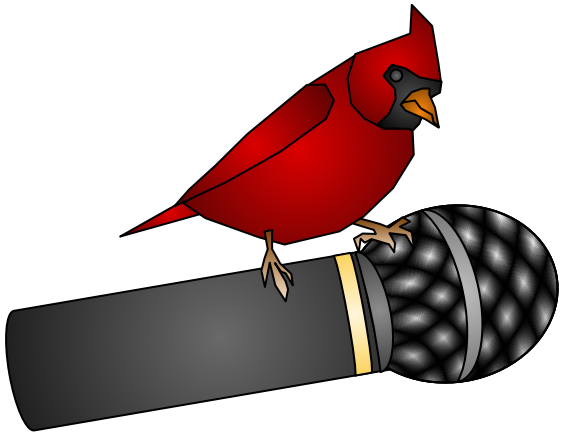
EEOB 5194 Bioacoustics of Ohio I: Practical Bioacoustics in the Field



Spectrograms

23 March 2022

Lecture: Wednesdays 10:20 to 11:15 am, Cunz 180

Outdoor Lab: Fridays 8:30 am to 12:30 pm

Topic Outline

Last Week's Homework

Spectrograms

Raven Exercise

Borror and Reese 1953 Paper Discussion

Recording Quality Rubric

Schedule for This Week

Extra Resources

Last Week’s Homework

Field Notes 1 Common Mistakes

Recording settings

- Is your recording in mono or stereo?
- What is your sample rate and bit rate of your recorder?
- What is your gain knob set to?
- Did you standardize by noise levels? (Unlikely for our class).

Please ask me about this in lab this week if you have questions!

Habitat

- Description of the environment that you are in: *urban, grassland, marsh, coniferous forest, desert.*
- Major plantlife: *oaks, junipers, creosote, maples, pinyon pines.*

Not Habitat

- Bird's specific location: *on a pine tree, on the grass*. This goes in **Behavior**.

Field Notes 1 Common Mistakes

Location

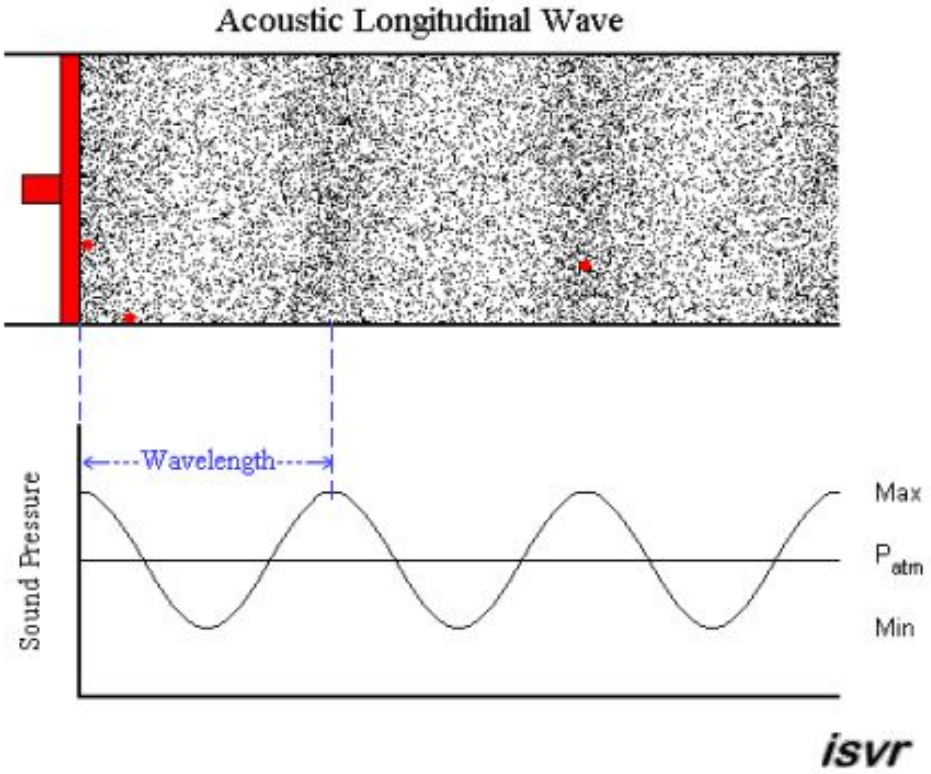
- Country, State, County, Town (or nearest town), Specific Locality (including Address if applicable), Latitude/Longitude
- *USA: Ohio; Franklin Co, Columbus, Whetstone Park of Roses (3901 N High St, 43214), 40.04404 °N, 83.02383 °W.*
- *USA: Arizona; Pima Co., 8.9 km S Ajo, 32.29166 °N, 112.85538 °W*

And in general:

When it doubt, write it down!

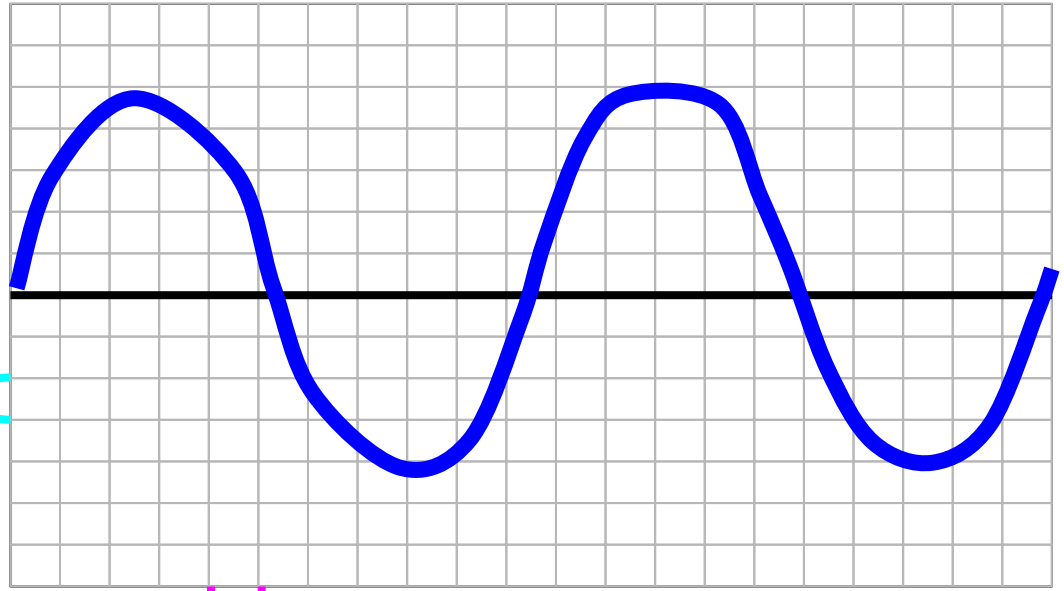
Spectrograms

How do we deal with sound as a wave?



http://resource.isvr.soton.ac.uk/spcg/tutorial/tutorial/Tutorial_files/Web-basics-nature.htm

Measuring sound pressure through time



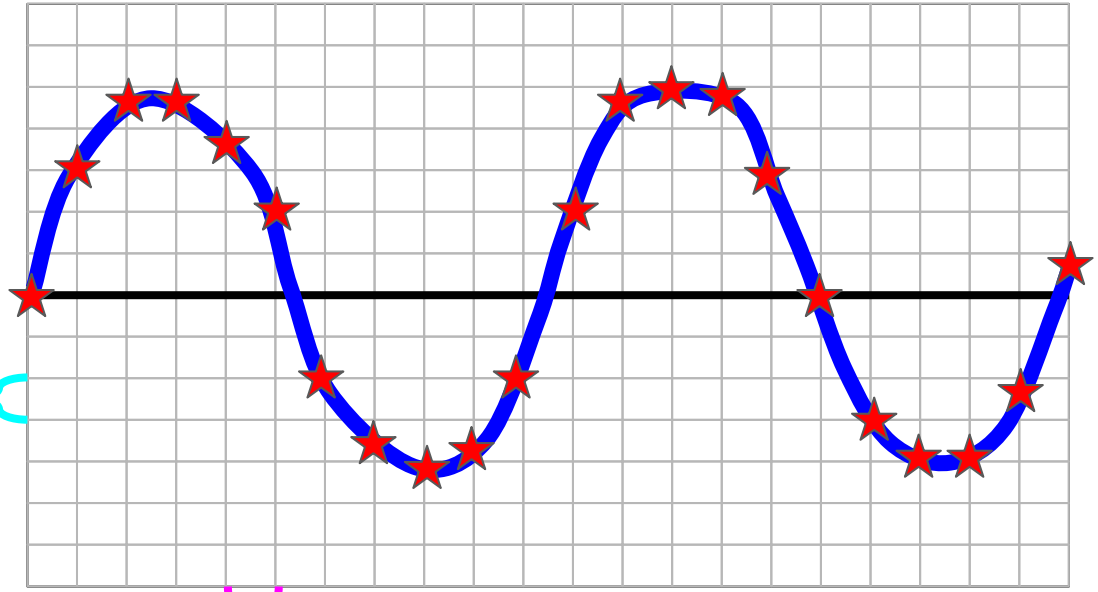
Pressure of Sound Wave

Bit Depth: how many different frequencies can be detected

Time

Sampling rate: how many measurements are taken per time

Measuring sound pressure through time



Pressure of Sound Wave

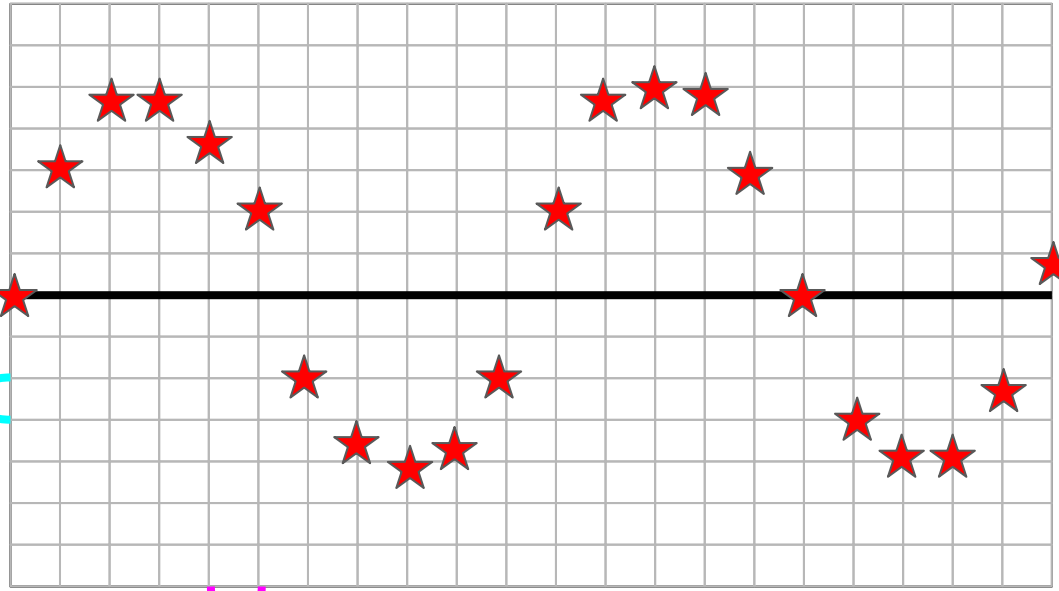
Time

Bit Depth: how many different frequencies can be detected

Sampling rate: how many measurements are taken per time

A sample: at an intersection between the bit depth and sampling rate

Measuring sound pressure through time



Pressure of Sound Wave

Time

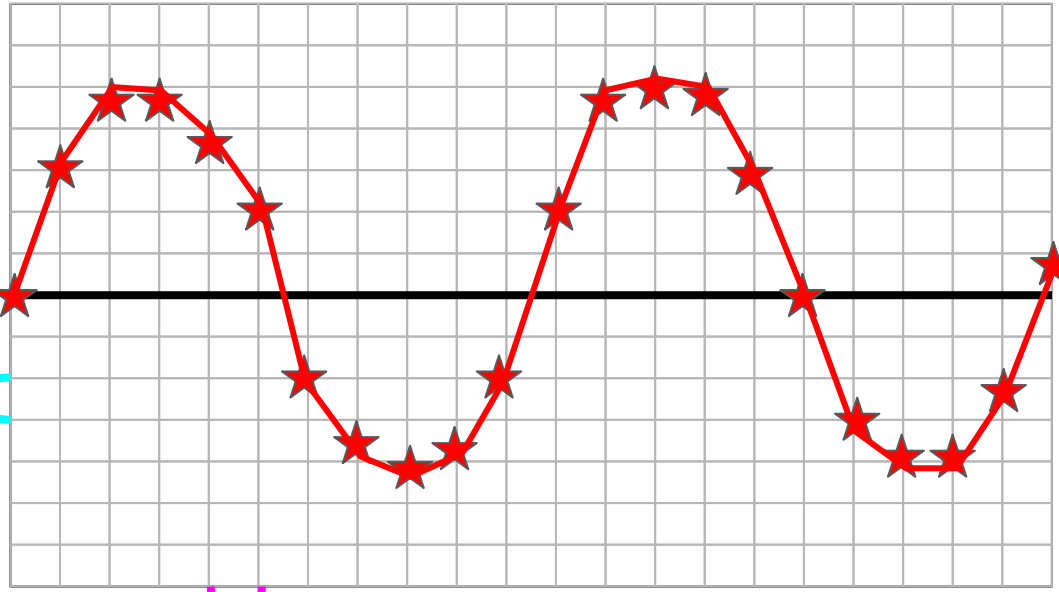
A sample: at an intersection between the bit depth and sampling rate

Bit Depth: how many different frequencies can be detected

Sampling rate: how many measurements are taken per time

We only get the samples taken when we make digital recordings!

Measuring sound pressure through time



Pressure of Sound Wave

Time

Bit Depth: how many different frequencies can be detected

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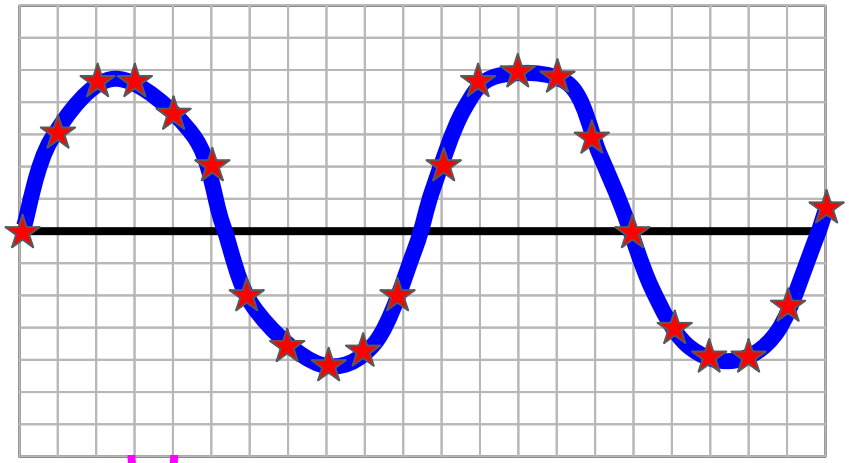
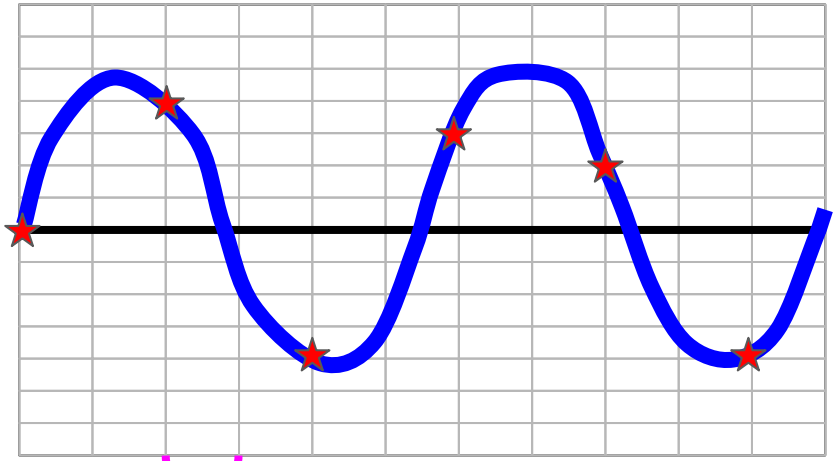
We only get the samples taken when we make digital recordings!

Sampling Rate Differences

Higher Sampling Rate (48,000 hz)



Lower Sampling Rate (12,000 hz)



Sampling rate: how many measurements are taken per time

Sampling Rate Differences

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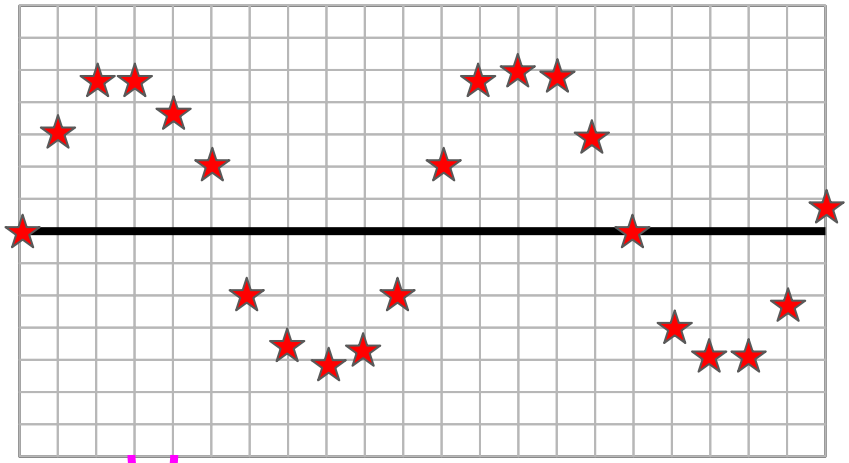

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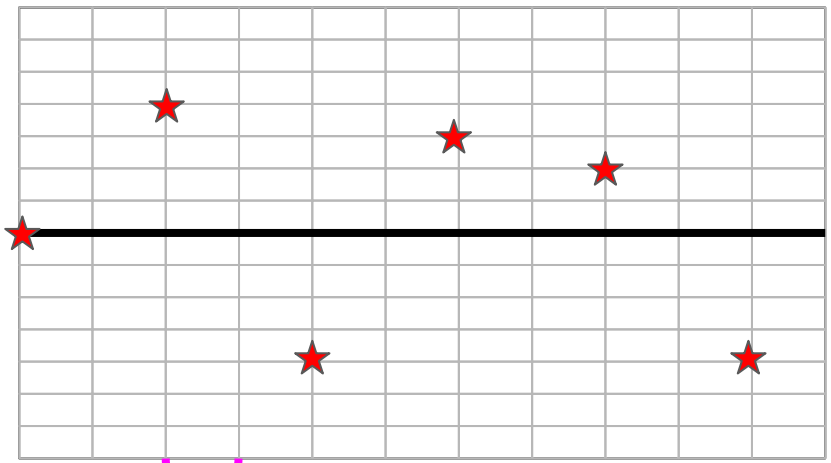

Sampling rate: how many measurements are taken per time

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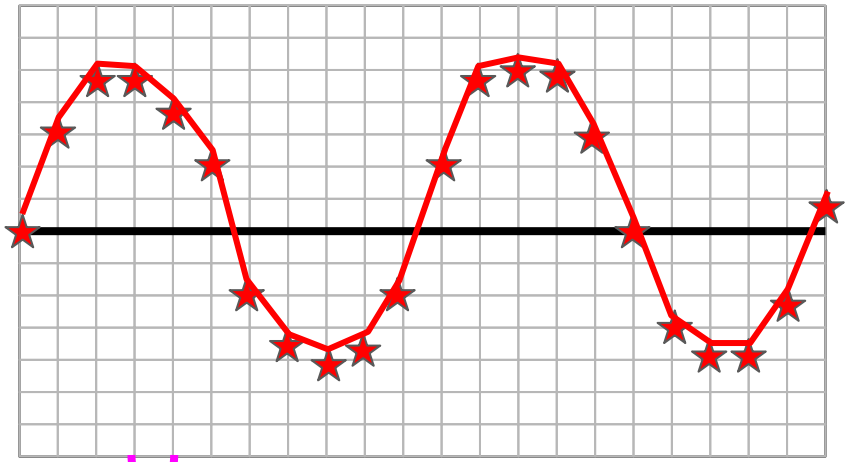

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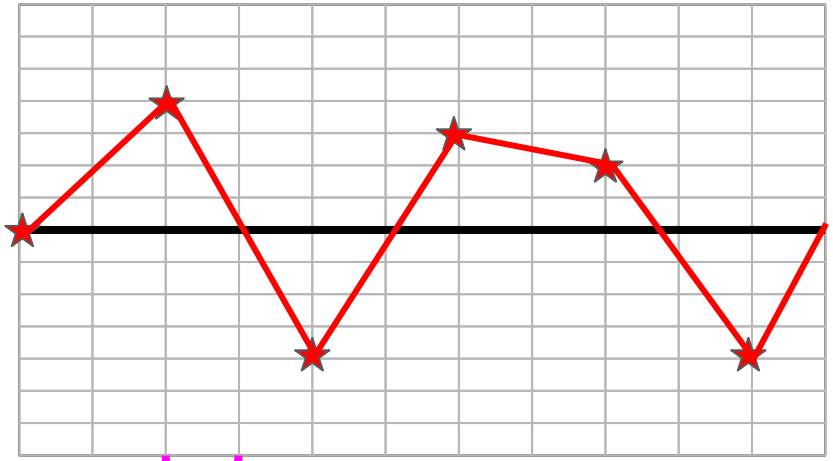
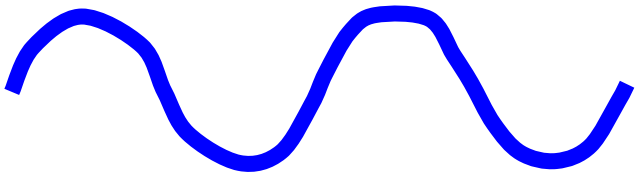


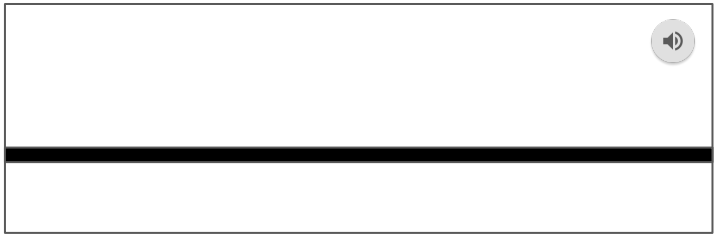
Sampling rate: how many measurements are taken per time

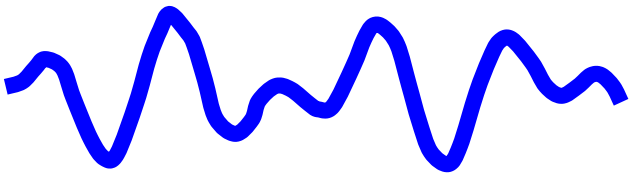
Complicated sounds = more complicated waves

Constant sounds of any number of tones can be described by sums of multiple sine waves according to the Discrete Fourier Transform or DFT.

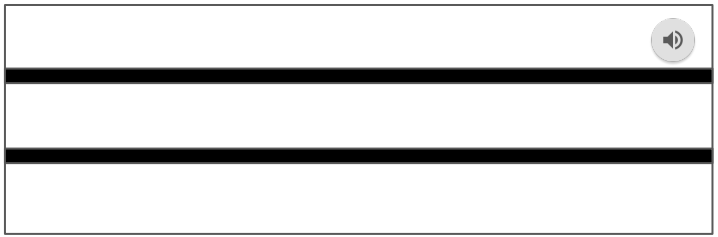


Frequency





Frequency



$$X(\omega_k) \triangleq \sum_{n=0}^{N-1} x(t_n) e^{-j\omega_k t_n}, \qquad k = 0, 1, 2, \ldots, N-1,$$

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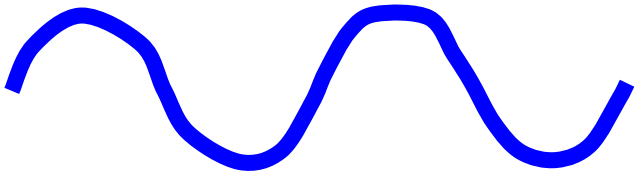
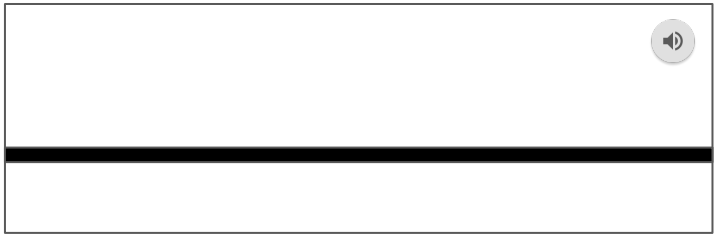
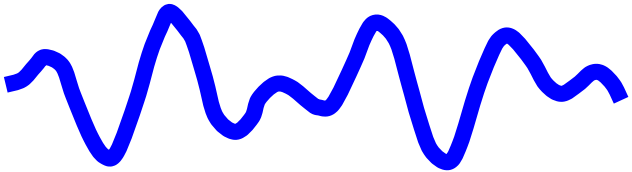
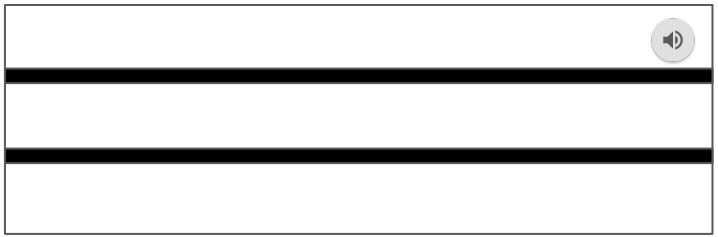


Frequency





Frequency



$$X(\omega_k) \triangleq \sum_{n=0}^{N-1} x(t_n$$

DFT MATH

$$), 1, 2, \ldots, N-1,$$

Complicated sounds = more complicated waves

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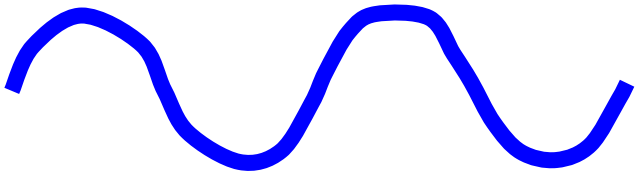
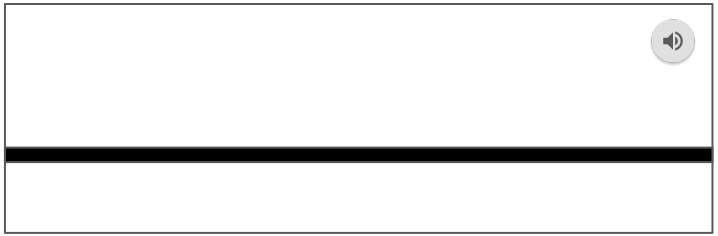
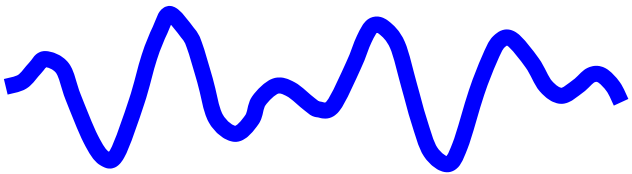
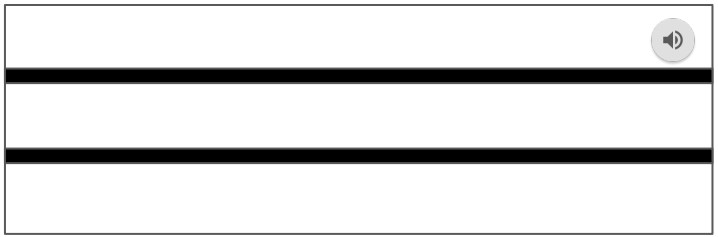


Frequency





Frequency



PROBLEM: Biological sounds are not constant! How do we deal with this?

$$X(\omega_k) \triangleq \sum_{n=0}^{N-1} x(t_n$$

$$), 1, 2, \ldots, N-1,$$

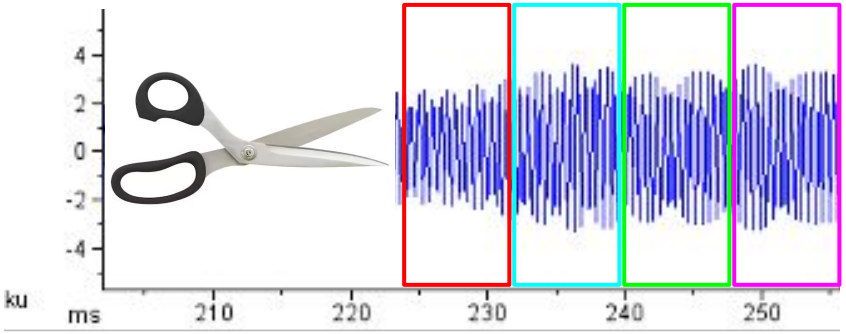
DFT MATH

Complicated sounds = more complicated waves

PROBLEM: Biological sounds are not constant! How do we deal with this?

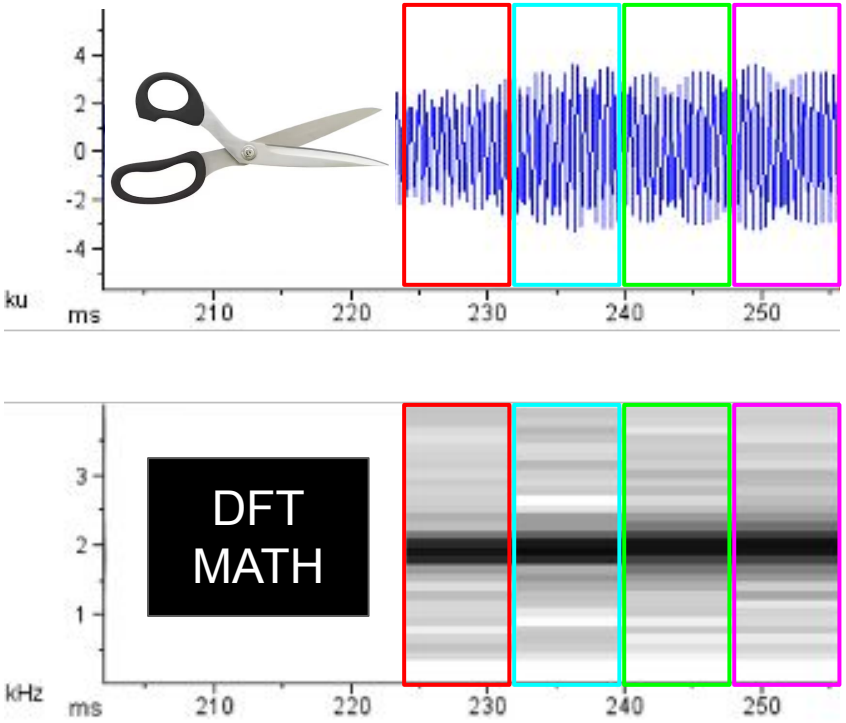
SOLUTION: Chop the sound up into sufficiently small pieces, then apply the math.

Visualizing waves as frequencies



Images borrowed from Cornell Lab of Ornithology

Visualizing waves as frequencies



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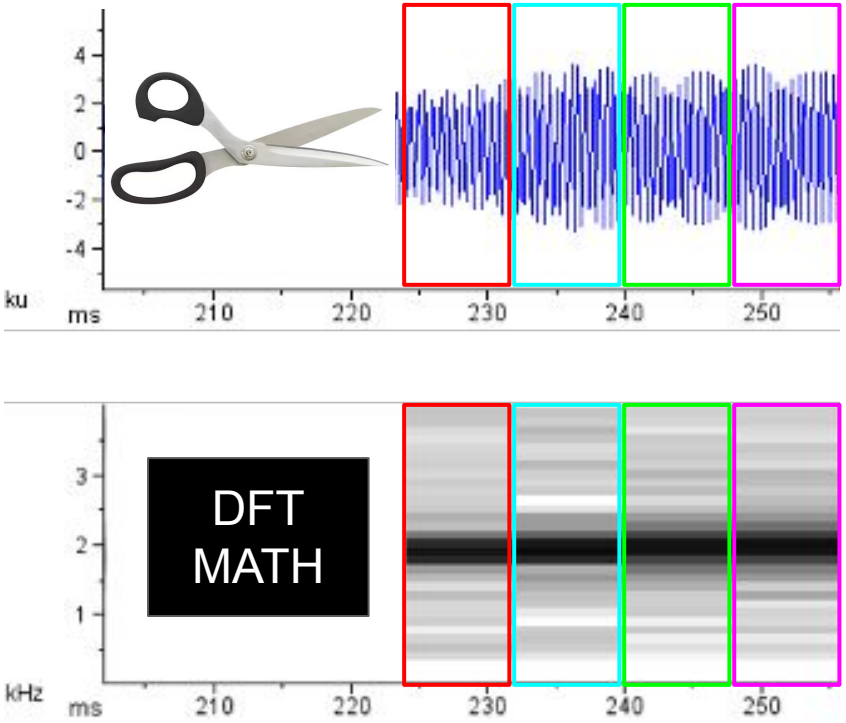
Visualizing waves as frequencies

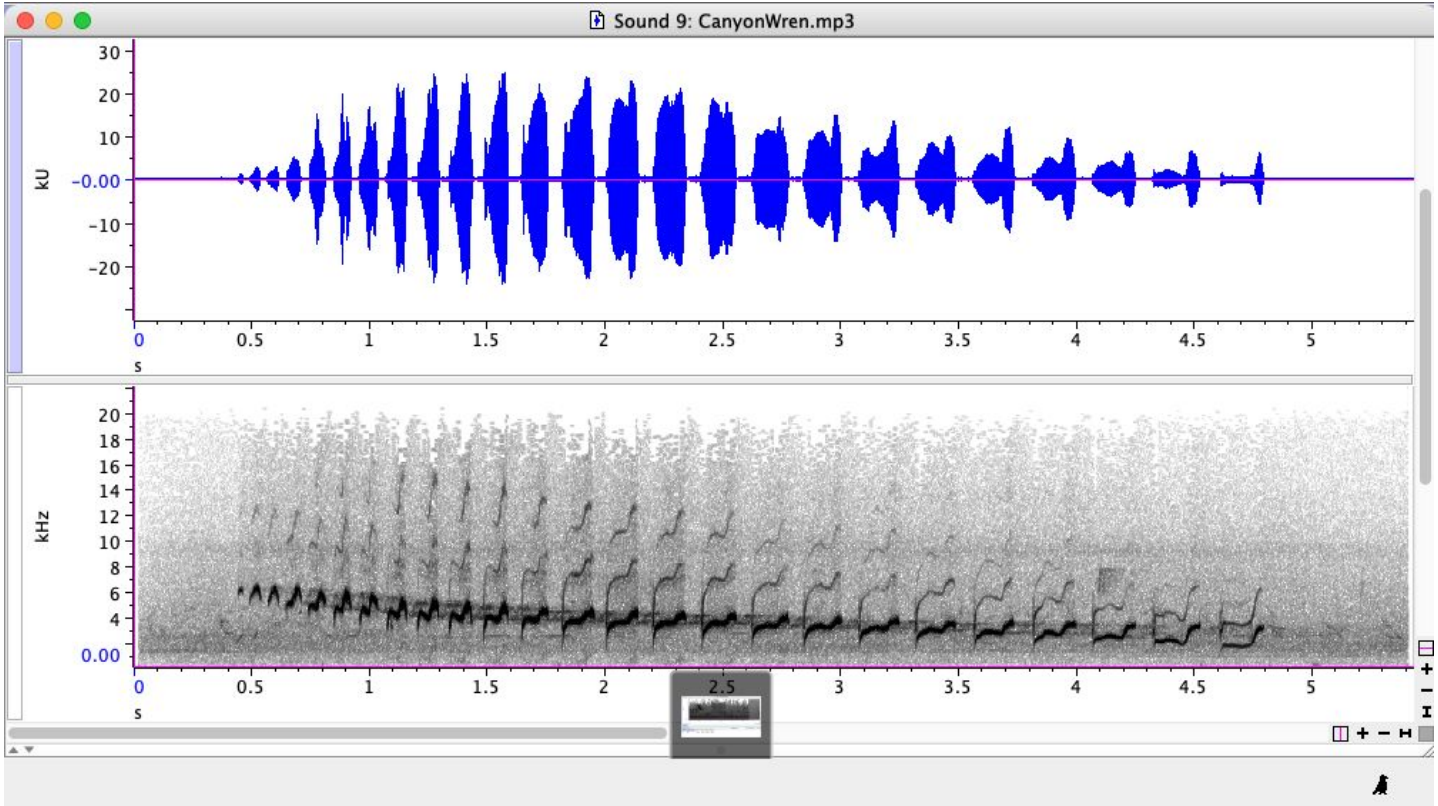


2	2	5	5
4	2	3	5
5	5	2	9
7	8	9	9
10	10	10	10
7	8	9	9
3	5	4	9
2	2	2	5
3	2	4	5
0	0	0	0

Images borrowed from Cornell Lab of Ornithology

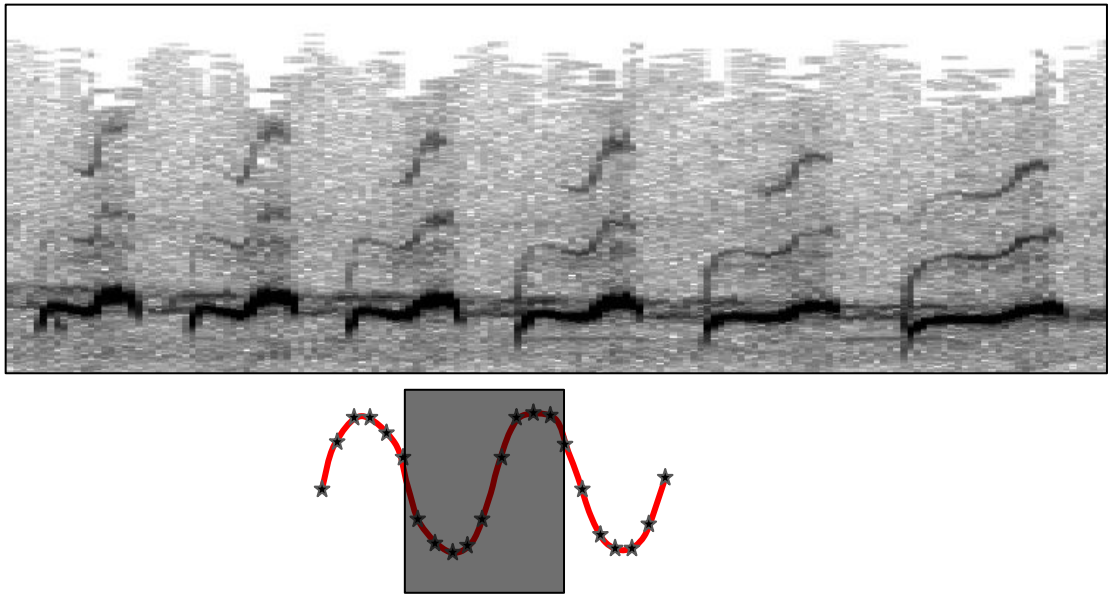
Example spectrogram and waveform

Canyon Wren
Catherpes mexicanus



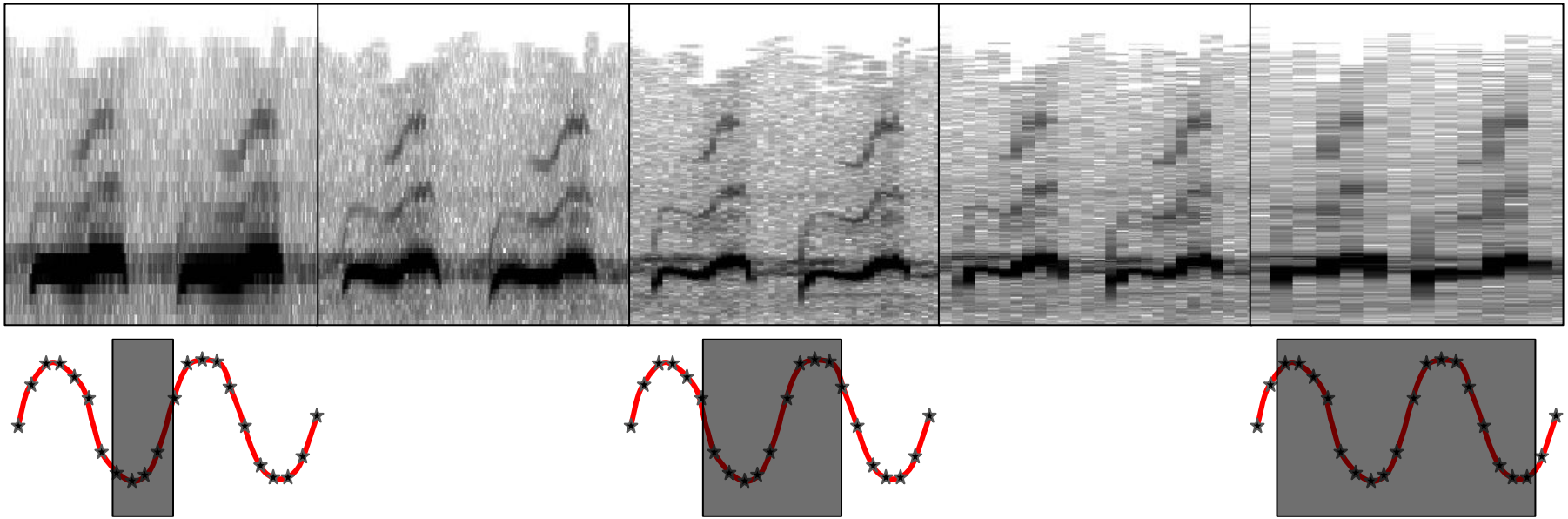
There is no single “correct” spectrogram

516 Samples
per Slice



There is no single “correct” spectrogram

64 Samples per Slice | 128 Samples per Slice | 516 Samples per Slice | 1024 Samples per Slice | 2048 Samples per Slice



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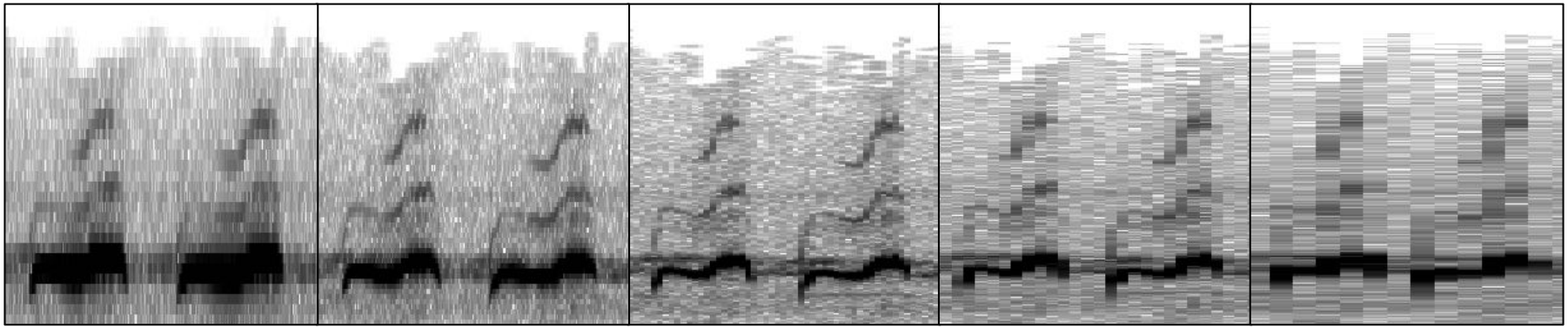

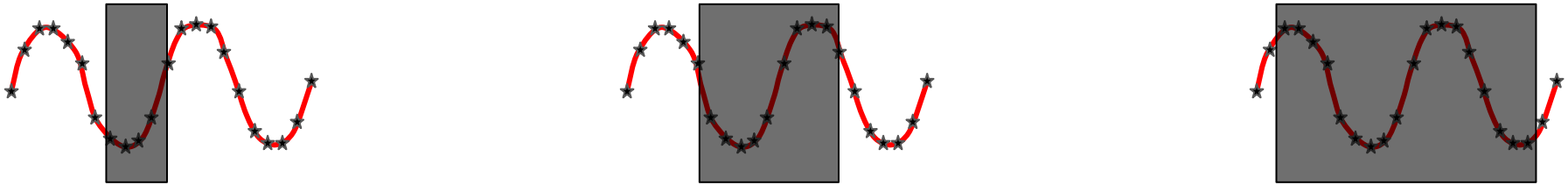

Good time resolution, bad frequency resolution

Bad time resolution, good frequency resolution

Raven Exercise

Raven Exercise Instructions

1. Open Raven Lite / Raven Pro
2. Find the “Examples” Folder in Raven
   (Mine: “/Users/kprovost/Raven Pro 1.6/Examples/”)
3. In Raven: Open > Open Sound Files and open the following:
   a. 2000Hz.aif
   b. CanyonWren.wav
   c. Noise.wav
   d. Raven.aif
4. Examine and listen to the sounds! How are they different from each other?
5. What settings can you play with to adjust the spectrogram parameters? Color? Brightness? Contrast? Spectrogram size?

Paper Discussion

Borror and Reese 1953

THE ANALYSIS OF BIRD SONGS BY MEANS OF A VIBRALYZER

BY DONALD J. BORROR AND CARL R. REESE

TO analyze a bird's song one needs to determine its loudness, rhythm, and frequencies. Since these characteristics cannot be accurately determined by the ear alone, most published accounts of bird songs are merely subjective descriptions and not accurate analyses. Attempts have been made (*e.g.*, Arleton, 1949, and Mathews, 1904) to represent bird songs with the

One example from the paper

Possibly BLB87?

Pipilo erythrophthalmus, the Eastern Towhee (prev. Red-eyed Towhee)

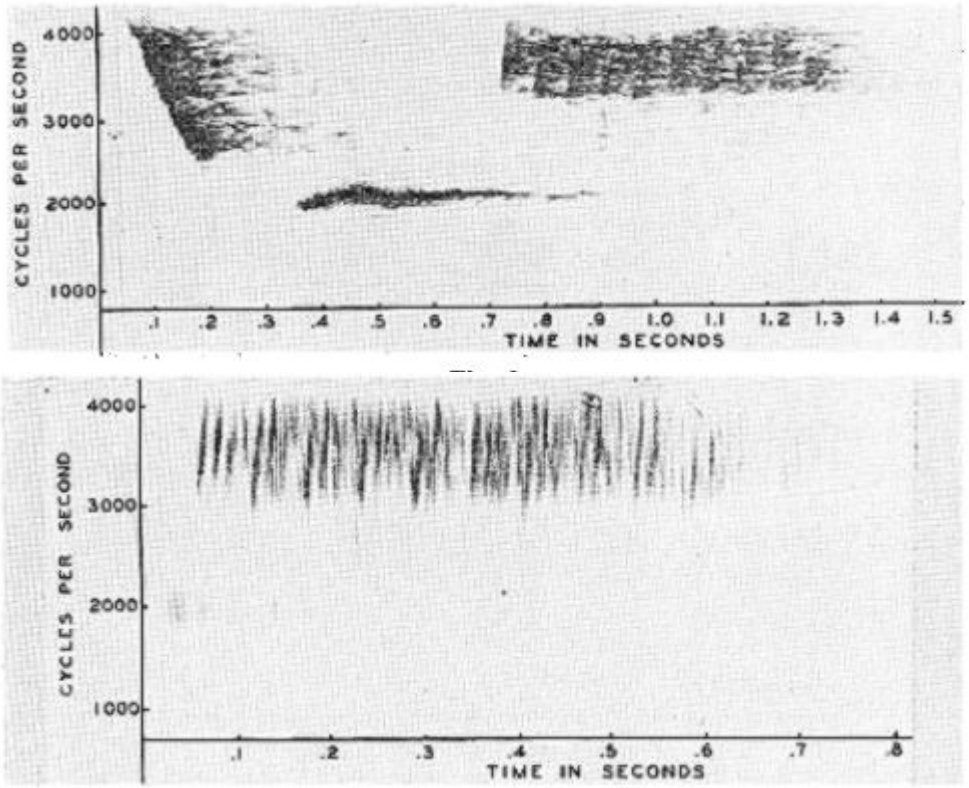

Fig. 4

Discussion

Why was this paper important?

What was the main move forward for this paper?

How do we use this paper today?

Recording Quality Rubric

Recording Quality Rubric

Criterion	Points per Recording	Points per assignment	Points per semester
Recording is turned in	3	30	90
Recording has metadata at the end	2	20	60
Recording is normalized	2	20	60
Recordings is good quality	1	10	30
Recording has field notes	2	20	60
TOTAL	10	30	300

Extra credit recordings use the same rubric, but are worth a total of 1 point instead of 10.

Schedule for This Week

Field Trip Sign Ups

Sign up for one or both of the following by **TODAY**

Saturday March 26th 2022: Hocking Hills State Park (Day Trip)

Saturday April 16th - Sunday April 17th 2022: Stone Lab (Overnight Camping)

This Friday March 25th

Blendon Woods Metro Park

** different from syllabus before today **

https://www.metroparks.net/parks-and-trails/blendon-woods/

Meet at 9:00 AM in front of the Nature Center. (~26 minute drive from Museum).

Expected weather: High 48 F, Low 26 F, rain all morning.

DRESS WARM. DRESS WATERPROOF. Bring some plastic bags.

This Saturday March 26th

Saturday March 26th 2022: Hocking Hills State Park + Clear Creek (Day Trip)

https://www.hockinghillsstatepark.com/

https://ohiodnr.gov/static/documents/parks/parkmaps/hockinghillsparkmap.pdf

Rough schedule:

- Leave Columbus ~8 am
- Arrive at HH ~9 am, eat packed breakfast
- Bird and record ~9:30-12:30 pm
- Eat packed lunch ~12:30-1 pm
- Bird and record ~1-3 pm
- Drive to Clear Creek, arrive ~3:30 pm
- Bird and record ~3:30-5 pm
- Half-hour wrap-up
- Drive back to Columbus, arrive ~6:30 pm

This Saturday March 26th

Meet at 7:40 AM at the museum (1315 Kinnear Rd) or 8:00 AM at the Ohio Union on campus. Let me know which: we are carpooling in my car.

I'll drop you off ~6:30 pm at one of these locations afterward.

This Saturday March 26th

Bring: recording gear, breakfast, lunch, snacks, water, coffee if you need it.

Suggested: portable cell phone chargers, extra socks, daily medications, emergency medications, etc.

Do not bring: nice clothes, non-essential valuables.

Expected weather: High 43 F, Low 26 F, snow and rain.

DRESS WARM. DRESS WATERPROOF. Bring some plastic bags.

Homework for This Week

Homeworks Due **TODAY** by 11:59 pm

1. Field Notes from last lab and independent work
2. Field Trip Sign-Up
3. 300 Word Summary/Comments on Borror and Reese 1953 Paper

Homeworks Due **March 30th 2022** by 11:59 pm

1. Field Notes from This Friday lab, Field Trip, and any Independent Work
2. First 10 Songs are Due

Extra Resources

Further Reading

Bird Song Hero:
https://academy.allaboutbirds.org/features/bird-song-hero/bird-song-hero-tutorial

Physics of Waves:
http://resource.isvr.soton.ac.uk/spcg/tutorial/tutorial/Tutorial_files/Web-basics-nature.htm

Raven software training from Cornell: https://ravensoundsoftware.com/training/