Analysis through Fourier Transforms

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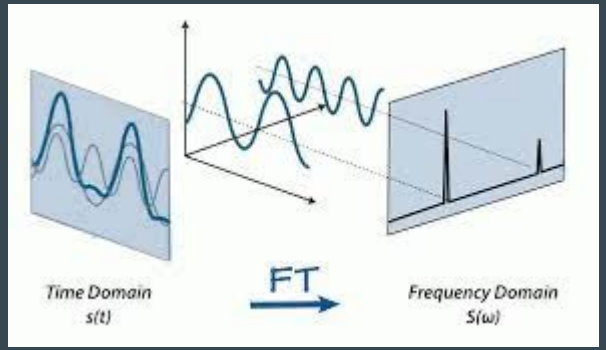
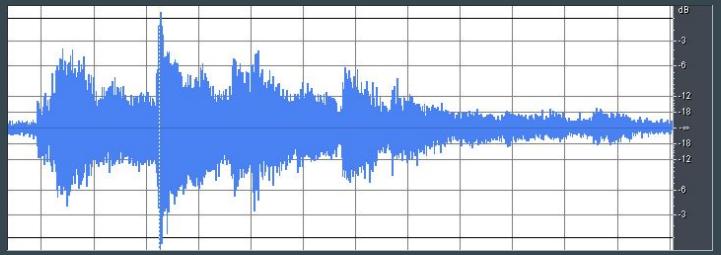
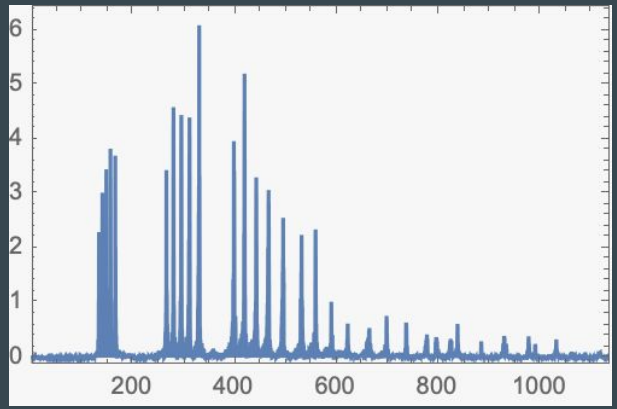
Fourier Transforms

Fourier transforms can break down a wave (such as from a sound file) into a combination of many sine and cosine waves of different frequencies. The resulting graph shows the amplitude of each frequency.







Comparing different sounds

Basic idea: what similarities or differences can we see in the fourier transforms of related sounds?

- For example: when viewing the fourier transforms of various animals we expect to see similarities in the transforms of similar animals, such as two different birds, that are distinct from other groups of animals. Could we even predict what group an animal belongs to from viewing the fourier transform?
- Kind of like a guess that animal game but instead of sounds we have graphs!
- We also decided to do the same comparison for various instruments, believing there might be clearer differences and similarities.
- Possible comparisons: Do they have a similar range of frequencies? Similar shape? Defined peaks or more of a cluster?

Expected Results

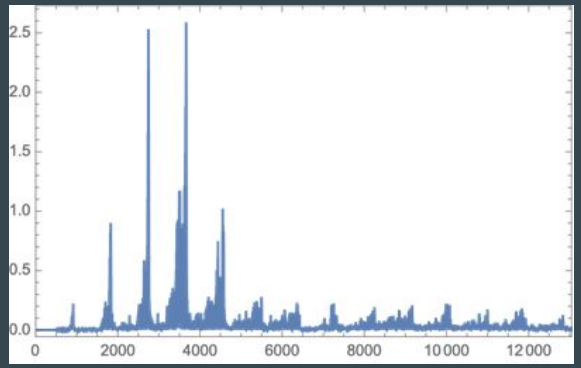
We expected to find visual patterns in the overall shape and peaks in frequencies between different animal groups - Bird sounds were expected to be more higher pitched with distinct peaks compared to growls that would have a wider range of frequencies.

Method

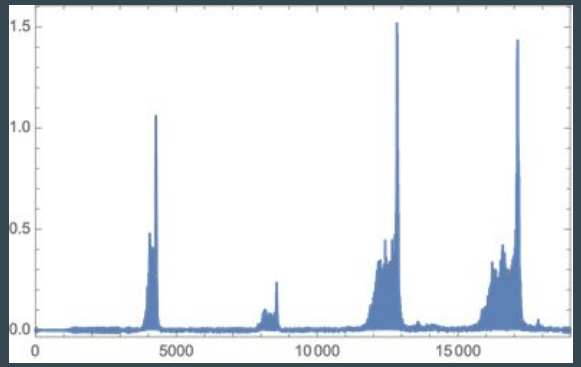
- First we imported sound files from our computer or used Mathematica's database to obtain different sound files.
- From labs used in Physics 123, we have some code to help us turn these sound files into fourier transforms. We also wrote code to find the largest frequencies from the graph.
- We gathered sound files from various animals and instruments. After running our code on these files, we compared the transforms and looked for similarities that could be used to distinguish the animals using only the frequencies.

Results

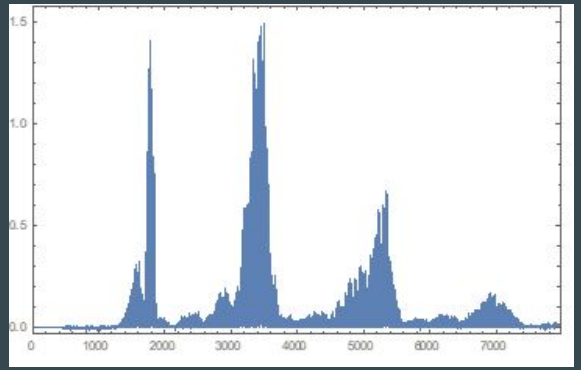
Birds



Cockatoo



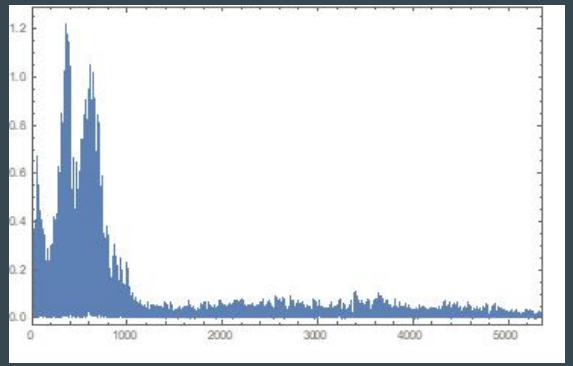
Baby bird

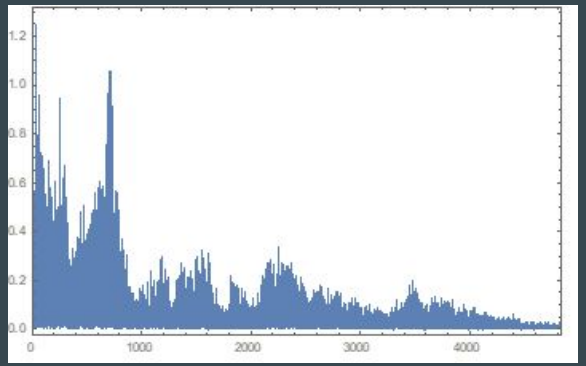


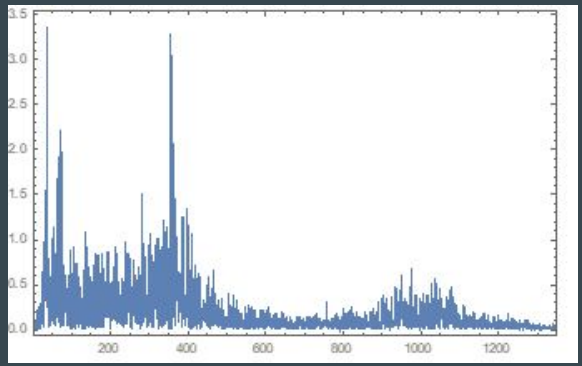
Eagle

Each have a few defined peaks. Not very wide. Higher frequencies. Range varies greatly from about 2kHz to over 10kHz

Growls

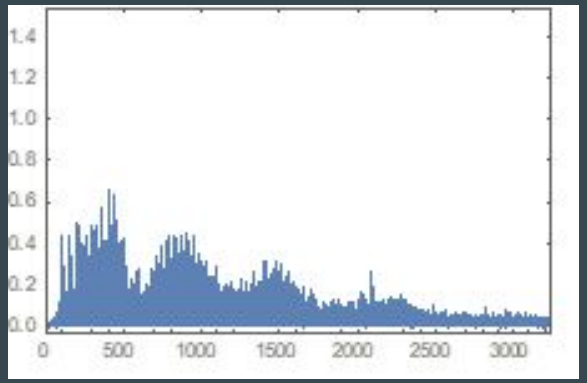




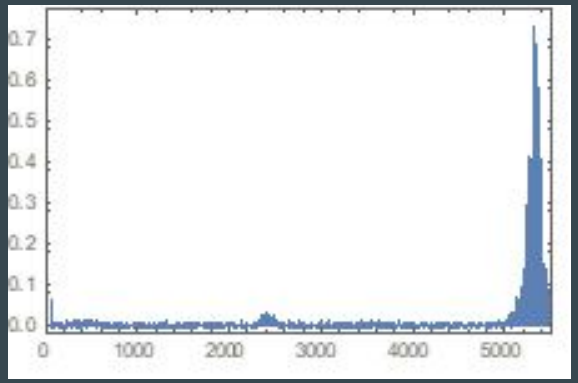


Sounds of growls from large cats had a similar shape with a wider range of frequencies while lower frequencies were the most distinguishing.

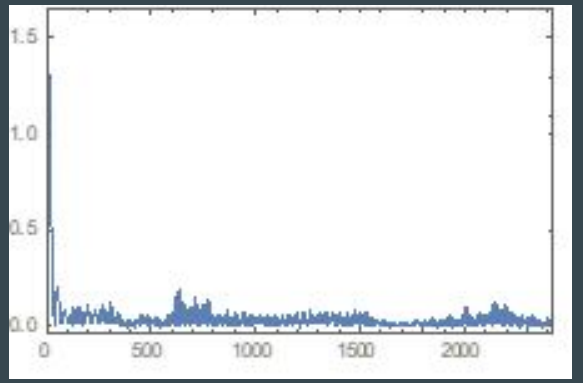
Unusual Sounds



Gorilla



Cricket

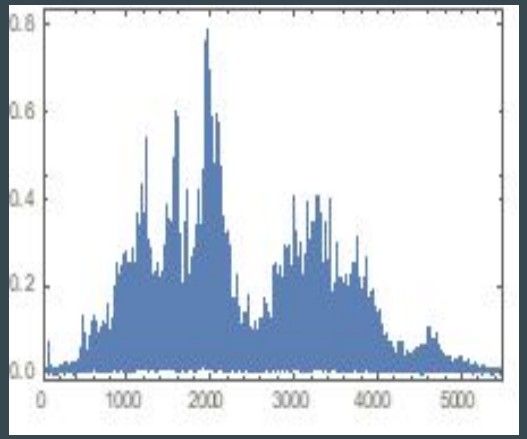


Lamb

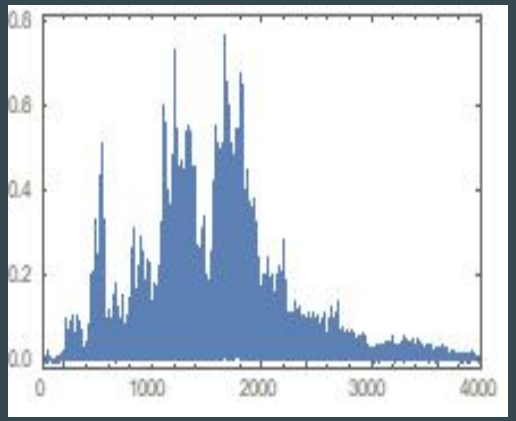
The gorilla sound had a very large range with no distinct peaks. Instead the frequencies have more rounded peaks at 500, 1000, 1500 2300Hz.

The cricket sound had the highest frequency of any sound we tested above 5000Hz. The bah of the lamb had the least distinguishing features.

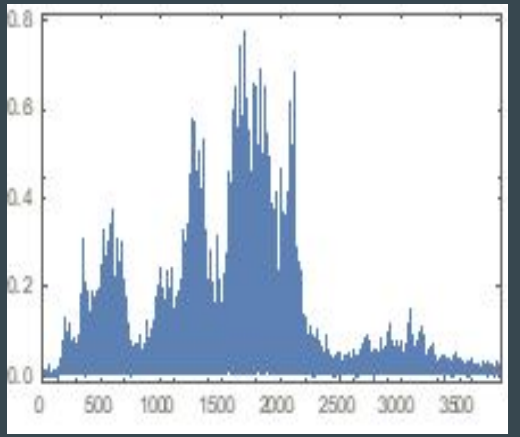
Similar - pig squeal, duck, horse neigh



Pig Squeal



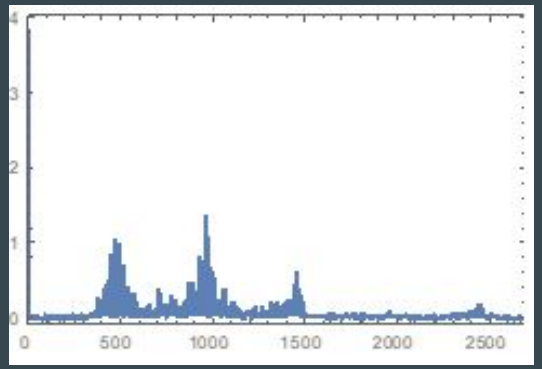
Duck Quack

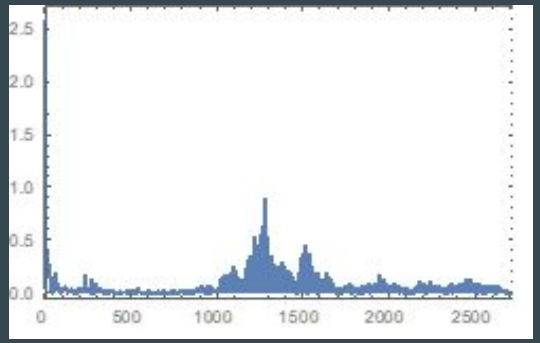


Horse Neigh

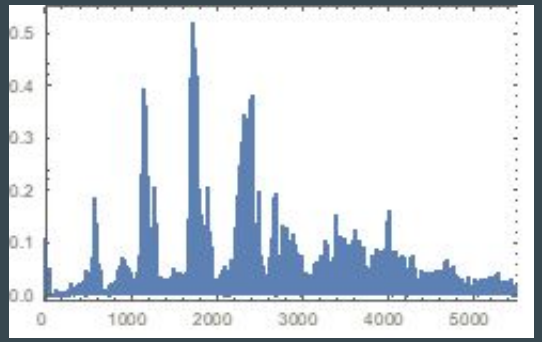
These sounds all had a transform shape that somewhat mimicked a normal distribution with the most distinguishing feature roughly in the middle.

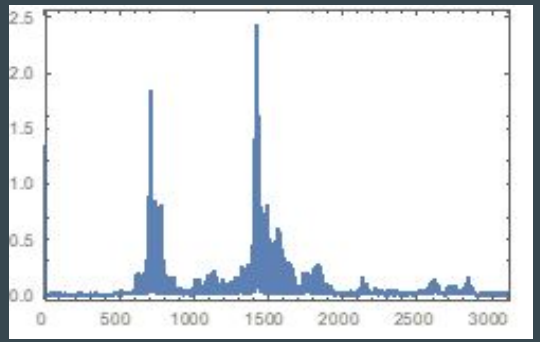
Some Similar Shapes Dog & Parrot





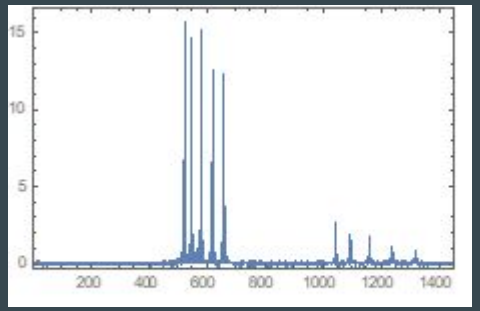
Cat, Rooster



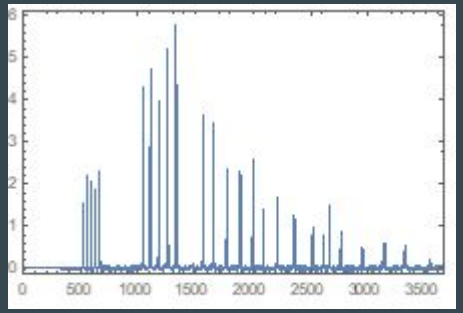


Instrument Scales

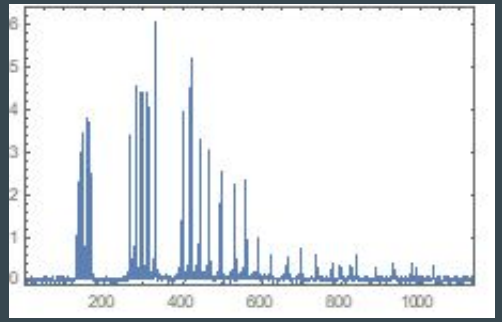
All very defined frequencies. Notice harmonics.



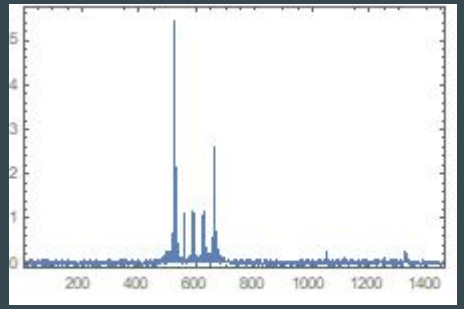
French Horn



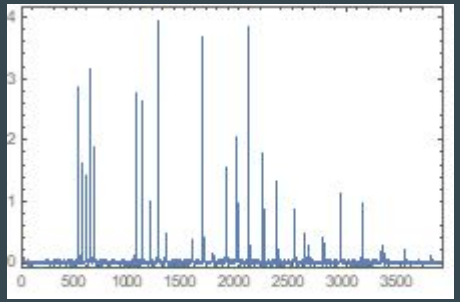
Trumpet



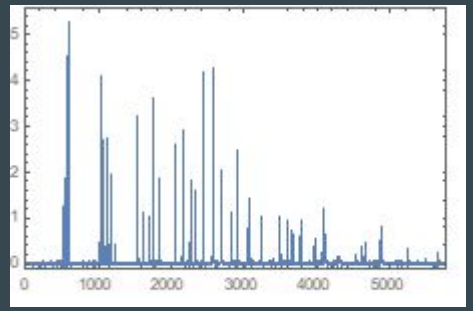
Tuba



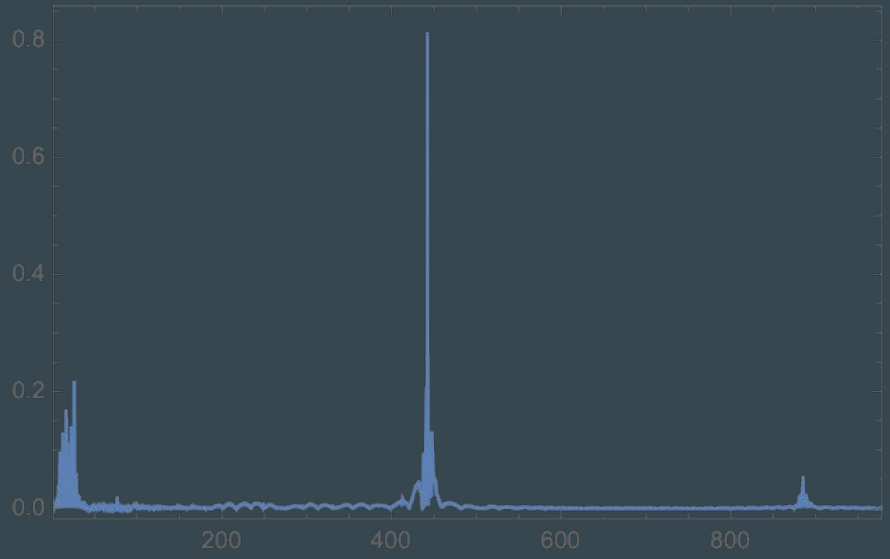
Piano



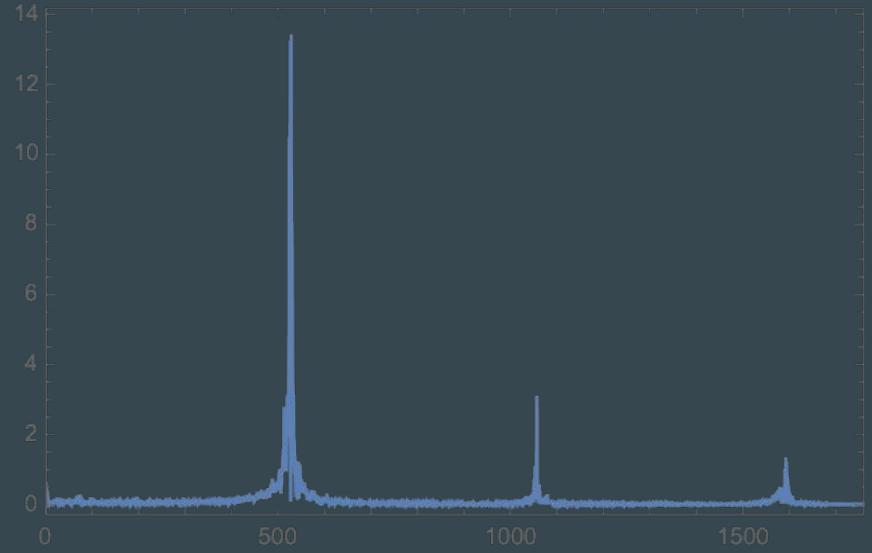
Viola



Violin



Guitar



Piano

Conclusion

Animals

Show some patterns. Possible to predict in simple situations such as groups of animals. Gets more complicated when viewing many animals and situations.

We were able to find some patterns among birds which had distinct peaks and lower ranges as we expected.

Growls and groups of sounds were able to be distinguished but individual animals were difficult to distinguish.

Instruments

All very similar shapes--clear peaks (as we might expect for instruments). Main differences come from key which causes a shift in frequency peaks.

Overall: Difficult to analyze by eye, but maybe some computer system could be used to see the similarities and make predictions.