Spectrogram of bird song

FizziQ activity · High school · 30-45 min

Scan to open in FizziQ

A nightingale recording analysed in the online FizziQ Web spectrogram: students read frequencies and sequence timing, then compare species by spectral signature.

Learning objectives

- Use the FizziQ Web spectrogram to visualize a complex sound signal
- Identify and measure characteristic frequencies of a bird song
- Measure the duration and periodicity of sound sequences
- Compare spectral signatures of two different species
- Understand the principle of automated acoustic recognition

Instruments and sensors

Sound spectrum analyzer (spectrogram / spectrum at cursor) · Microphone

Materials

- Computer with browser and access to FizziQ Web
- Bird song audio file (personal recording or downloaded from xeno-canto.org)
- Headphones or speakers (recommended)
- FizziQ experiment notebook
- Note: the protocol remains adaptable to any comparable spectral analysis tool.

Protocol

1. Obtain a bird song recording. Two options: record a bird directly in nature with your smartphone microphone, or download an audio file from a specialized site like xeno-canto.org. The common nightingale is an excellent choice for beginners.
2. Open FizziQ Web in a browser at fizziqweb.web.app.
3. Access the Audio Analysis module by clicking Experiment in the left sidebar, then selecting Audio Analysis.
4. Load the audio file: click the Audio Source button, select File, then choose the prepared audio file.
5. Select the Spectrogram visualization mode to display the time-frequency representation of the song.
6. Adjust the frequency range with the Scale button to visualize the entire song. For the nightingale, a range of 0 to 10,000 Hz is recommended.
7. Adjust detection sensitivity with the Sensitivity button to highlight song patterns.
8. Identify different sequences of the song, i.e., groups of sounds separated by silences. Measure each sequence's duration using the time cursor.
9. Observe if certain sequences repeat and measure the periodicity of these repetitions.
10. Switch to Spectrum at cursor mode to measure minimum and maximum frequencies used by the bird at different moments of the song.
11. Return to Spectrogram mode and describe the shape of observed patterns: rising frequency, falling, rapidly oscillating, or stable.
12. Export the spectrogram to the experiment notebook by clicking Add to notebook. Choose image export.
13. Repeat steps 4-11 with a recording of a second species (e.g., great tit) to compare spectral signatures.
14. Record comparative observations in the experiment notebook: frequency range, sequence duration, pattern complexity, periodicity.

Expected results

The nightingale spectrogram shows complex patterns in curves and arabesques extending from about 1,000 to 8,000 Hz, with rapid frequency modulations. Song sequences typically last 0.5 to 2 seconds, separated by brief silences. Some sequences repeat at regular intervals.

The great tit spectrogram shows a much simpler pattern: two or three narrow horizontal bands around 3,000 to 5,000 Hz, repeated regularly with very stable period.

Visual comparison between the two spectrograms highlights striking differences in complexity, frequency range, and temporal structure.

Questions

- Why is the spectrogram more suitable than a simple spectrum for analyzing a bird song?
- How do you explain that the nightingale's song covers a much wider frequency range than the great tit's?
- What information does a recognition algorithm extract from the spectrogram to identify a species?
- How does ambient background noise affect spectral analysis quality?
- Why is there a trade-off between temporal and frequency resolution in the spectrogram?

Going further

- Compare spectrograms of three or more species to build an acoustic identification key
- Record the same bird at different times of day and compare spectrograms to observe possible variations
- Use Fundamental Frequency mode to follow pitch evolution during the song
- Make the recording directly outdoors and analyze background noise influence on spectrogram readability
- Compare a bird song spectrogram with that of a musical instrument playing in the same frequency range