

Sonification Station Instructions: Would you like to hear a galaxy?

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I would be very grateful if anyone running the station could jot down a few notes about their experience talking to people while running the station, and any answers to questions below.

Learning outcome

Sonification is a new technique for interacting with data that requires minimal training but is a rich medium that allows us to experience data in a new way.

Suggested Script

The demonstration features galaxies that have been rendered as sounds accompanied by their images. The sounds are a *unique signature* of each galaxy, where the spatial frequency of the image is encoded as musical frequency: smaller features in the galaxies make higher notes.

The sonification strategy we are using here emphasises *symmetry* in galaxy images: symmetry means how you could ‘fold’ or ‘rotate’ a galaxy and it would look nearly the same. Most galaxies show some form of symmetry, which is the product of their formation history – we can learn about how galaxies evolve over time based on their symmetries.

Demonstration walkthrough (for context, $z=1$ is 7Gyr ago, $z=2$ is 10Gyr ago):

1. Sonification of a distant galaxy imaged by JWST. This galaxy is a simple ellipse in appearance; try listening for the pitch of notes (e.g. are they high or low?). When the notes start over the the lowest notes, we are hearing new symmetries in the galaxy.
2. Sonification of a distant barred spiral galaxy. For this demonstration, more high notes are played because the structure is more detailed – point out the spiral arms. As the sounds play, try focusing on the high notes. What happens? Finer structure is added as the notes get higher – it takes all the notes to resolve the arms.
3. Sonification of a perturbed (looking?) galaxy. This galaxy is difficult to classify by eye. Is it a disc? A merger? Something else? Ask the viewers if they notice anything different when looking at the image after hearing the sonification. I notice much more symmetry in the galaxy than I previously thought.
4. Audio-only version. Now the sonification is just the audio, while looking at galaxy images. Don’t be discouraged if you don’t get it ‘right’: the point is to listen to the sonifications and hear what is unique. The reason the right galaxy (bottom sound) has more high notes is *because the sonification is representing the strong bulge in this galaxy*. The reason the left galaxy (upper sound) sounds complex is because of the warped feature in the galaxy: it takes a lot of low structure to represent!

Key talking points:

- Sonification is a new technique with a goal to render *any type* of data in sounds
- Sonification can prompt us to experience the data differently and notice new features that we might not have otherwise seen. The human eye is biased towards low-density features in the galaxy images, which are not the most important parts for evolution.
- The human ear has a larger dynamic range than the human eye, and can register more than one frequency at once (multiple notes) – more data processing capacity!
- There are many ways to sonify a galaxy – we’ve chosen one possible representation that emphasises symmetries. Many other strategies are possible and being explored!
- Sonification can include the low-vision community in astronomical research.
- The images have been constructed from *templates* (the basis functions) that have been mapped to sounds.

Questions for engaged visitors: The italics are just clarifications for you, no need to ask

- What is the last song you listened to (or a song you have recently listened to, or a favourite song)?
 - o *This question is to coarsely gauge how well this particular harmonic sonification goes over with an audience, as well as to keep track of how many listeners and roughly an age range.*
- Do you notice the volume of notes changing?
 - o *The volume is in fact changing from note to note, reflecting the significance of the note, but this is subtle.*
- Do you notice any repeated notes?
 - o *The notes start over when a new symmetry starts; this is difficult to get at first (in my opinion), but then seems more obvious later.*
- Do you find the numbers in the images distracting? Are there any other annotations that would have been helpful?
 - o *The numbers correspond to the function number (harmonic and radial); this is basically a souped-up Fourier expansion*

FAQ (that I was asked while running the demo)

- Are these recordings of the galaxies? *These are not recordings of the sounds of galaxies – there is no sound in space!*
- Why are you doing this? *Refer to bias of human eye towards low-density features, data processing capacity of human ear, low-vision community.*
- Have you worked with any musicians? *No, but we'd really like to!*
- Does sonification help with quick identification of structure? *Yes, and we'd like to use the sounds as a classification tool. If you've heard of Galaxy Zoo, this will be similar.*
- Can other people apply the sonification tools? *Yes! The tools are being developed to be available to everyone; please feel free to contact us.*
- Could we render drawn galaxies as sounds? *Yes! We're really interested in this project, please draw us a galaxy and leave your name.*
- Could you sonify multiple galaxies to make a symphony? *Yes! We've chosen a marimba here, but we could imagine creating a whole orchestra to represent the thousands of galaxies in a single JWST image.*

Troubleshooting instructions

1. The laptop has a specific open days user, 'Roe Open Days', with password 'roeopendays'.
2. To bring up the sonification demo, navigate to <https://michael-petersen.github.io/roe/sonification/tutorial/tutorial.html> (you can also give this out to viewers if they are interested).
3. The magic mouse is connected to the laptop, but if it fails the trackpad on the laptop works fine.
4. Headphones can be used if the sounds get annoying. Check the volume first before giving to any visitors.
5. Volume control for the external speakers is on the iPad near the central screen (this instruction is specific to the rooftop gallery).
6. If the screen shuts off, open the laptop to reconnect (you can then close the laptop again once the TV screen wakes up).

I also recommend playing the sounds every five minutes or so if people are around and not visiting, it adds nice ambiance to the goings-on!