Sensing the Forest: A Multidisciplinary Exploration of Sound Data

Dr Anna Xambó Sedó

Jean Golding Institute - Turing Seminar - University of Bristol - December 10, 2025

Outline

sensing the forest

- About the project
- Key Methodologies
- WP1: Artistic audio ecology intervention concerning forests and climate data
- WP2: Community science intervention with forests and climate data
- Reflections & Future Work

AHRC
Sensing the Forest
Project overview

Sensing the Forest:
Let the Forest Speak

how can the use of artistic and community science research methods help to inform and educate people about climate change?

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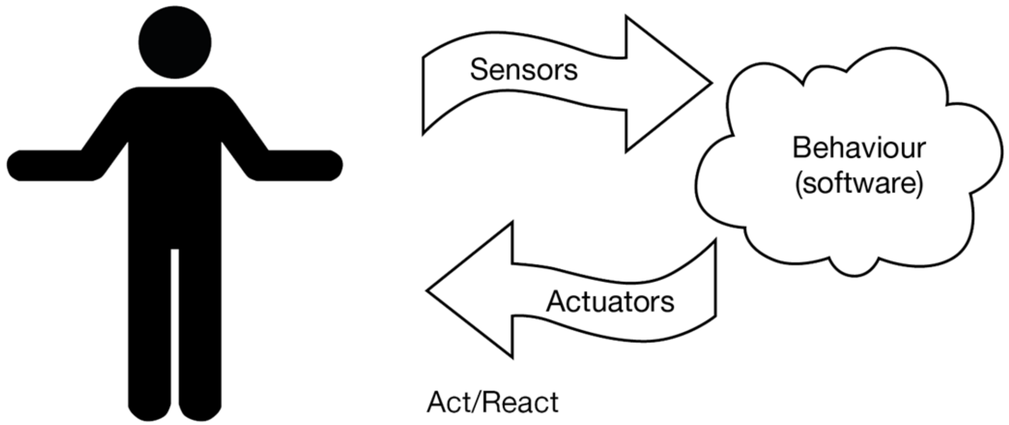
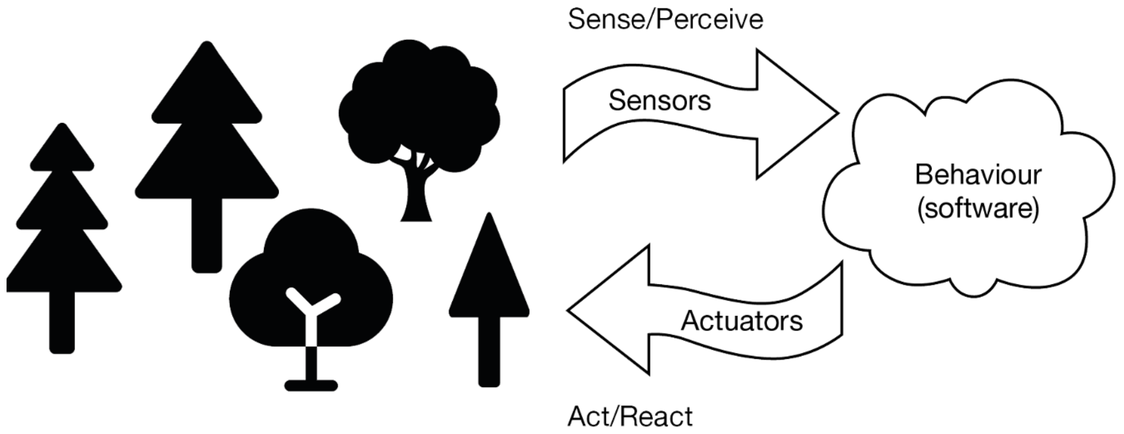


sensing the forest



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Nature and artistic creation in harmony

César Manrique

Jameos del Agua

StF Team

The team (1/3)

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Senior Climate Scientist, Forest Research

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Johana Knowles
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The team (2/3)

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Advisory Board

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Prof Mark Plumbley
Professor of Signal Processing,
EPSRC Fellow in “AI for Sound”,
University of Surrey

Louise Fedotov-Clements
Director of Photoworks,
National Curator at Forestry England

Prof Leigh Landy
Professor of Contemporary Music,
Director of MTI^2,
De Montfort University

Key Methodologies

Acoustic ecology

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- Study of **soundscapes** and the relationships between living beings and their sonic environments.
- Rooted in Canadian work of R. Murray Schafer and the *World Soundscape Project*.
- Listens to **biophony** (living sounds), **geophony** (natural forces), and **anthrophony** (human-made sounds).

Sonification

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- Systematic, reproducible transformation of **data into sound** with the goal of communicating information, revealing patterns, or supporting action.
- Sonification uses sound to **make data understandable**.
- A common approach (e.g. Hermann et al. 2011) is to map data to sound parameters (pitch, loudness, timbre, spatialization) in a meaningful and perceptible way and serve a functional purpose, such as analysis, monitoring, or exploration.

Live coding

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- **Creative practice** in which performers write and modify code in real time to generate sound, music, visuals, or interaction.
- Exploration of **soundscapes** via live coding can shape sonic environments in a live context.
- Soundscapes can be composed, manipulated, or reimagined in real time.

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WP1

Artistic audio ecology intervention concerning forests and climate data

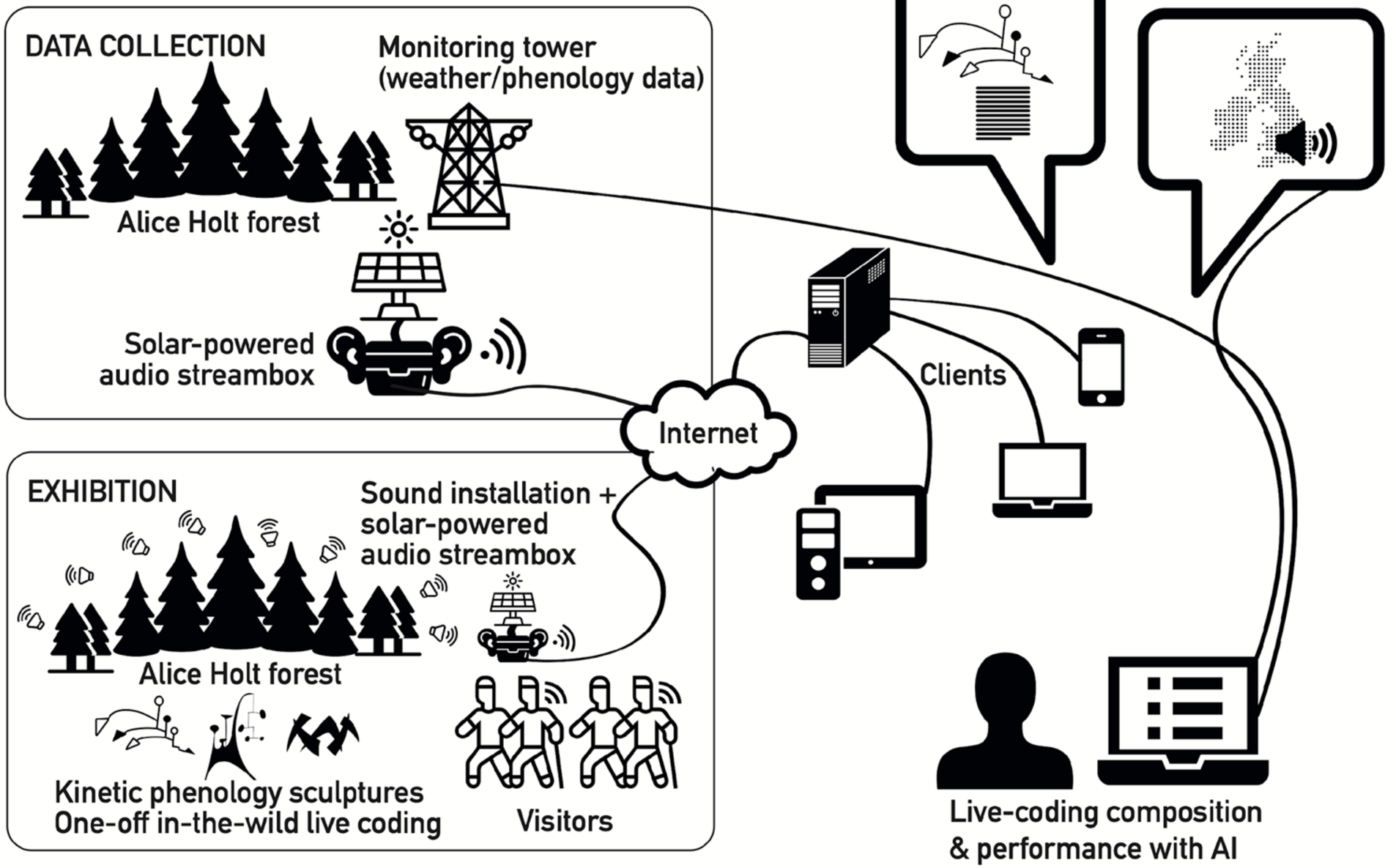
AHRC Sensing the Forest

Objectives

Objective 1 (WP1): Artistic audio ecology intervention concerning forests and climate data *(18.9.2023-29.6.2025)*.

To make a one-year on-site and online artistic intervention in a UK-based forest using live scientific data and fostering acoustic ecology experiences. This objective relates to making an artistic intervention in the Alice Holt forest in Hampshire, UK in collaboration with Forest Research (FR) and Forestry England (FE).

Forest Intervention WP1



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WP1

Custom data logger

sensingtheforest.github.io/exhibition/your-sonic-forest-data-logger-mike-bell-and-catrina-james/

Customised data logger

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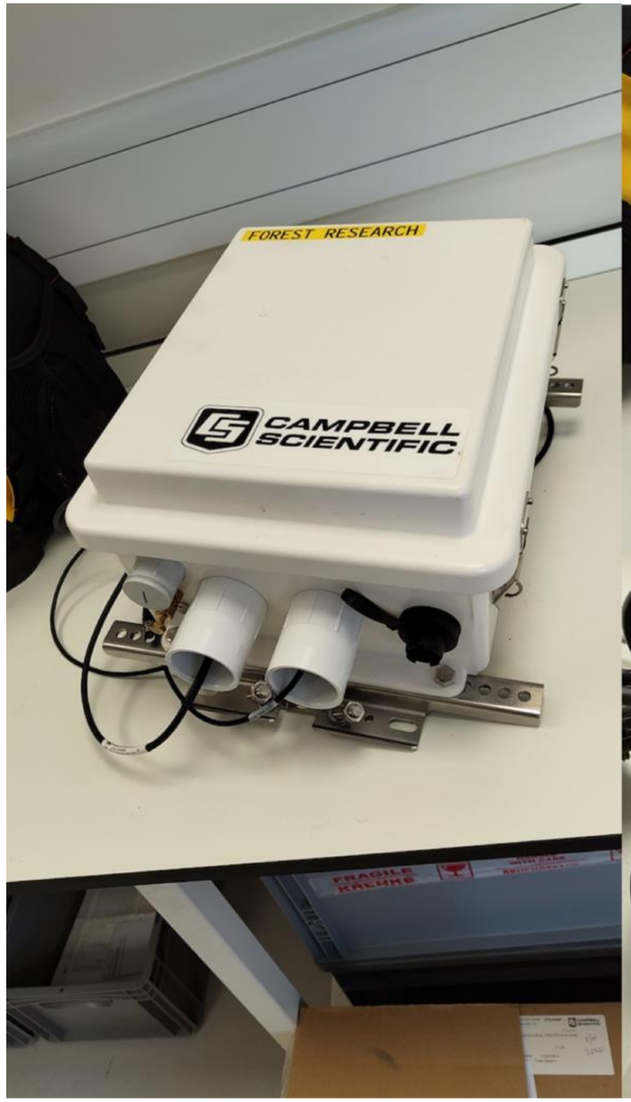
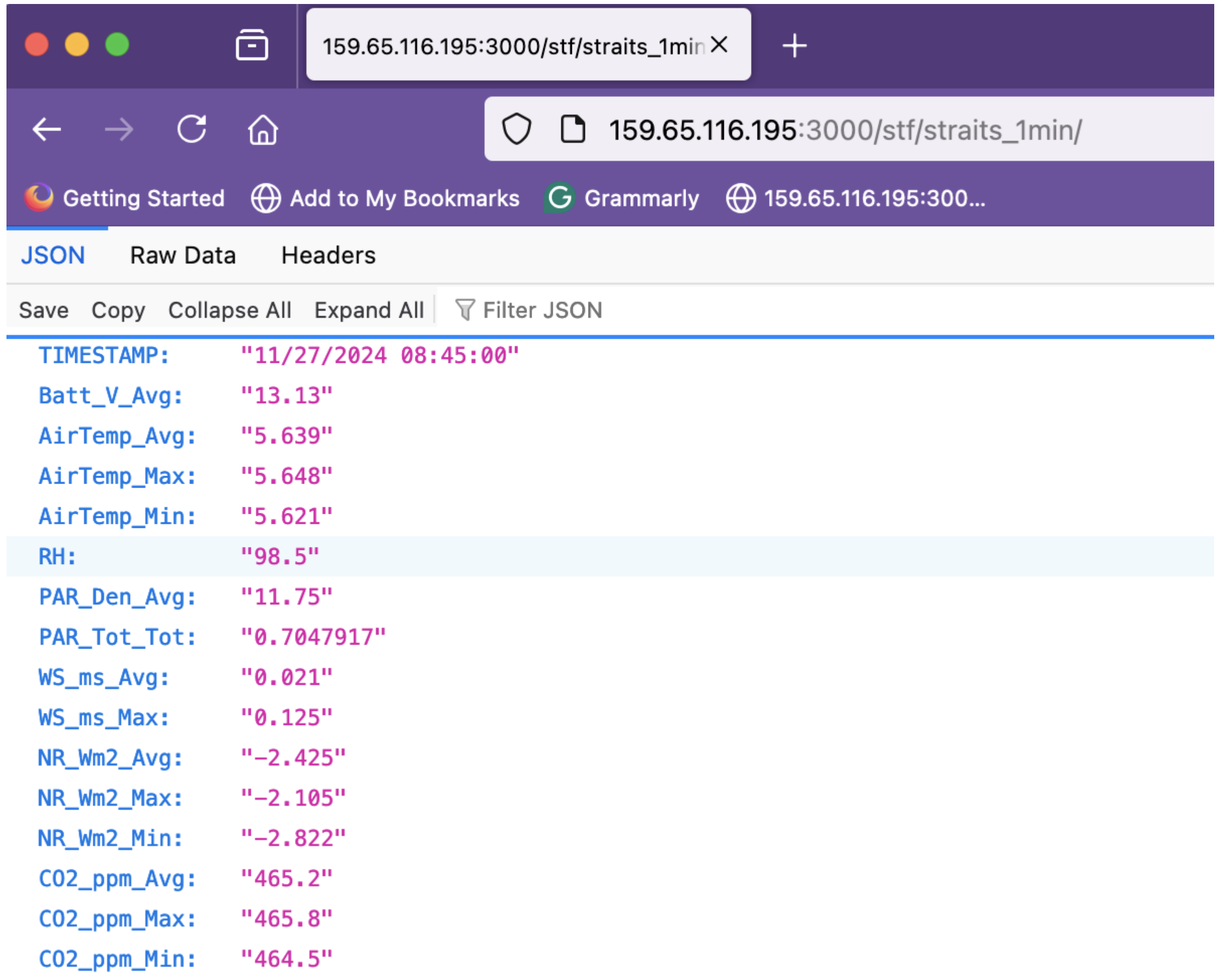


Customised web server & web client in PureData



http://159.65.116.195:3000/stf/straits_1min/

Customised web server & web client in PureData

0 TIMESTAMP Time of producing the JSON file with the below information. Format: DD/MM/YYYY HH:MM:SS

1 Batt*V*Avg

Air temperature

2 AirTemp_Avg - average value for the frequency measured (e.g. 1min) of air temperature in degrees celsius

3 AirTemp_Max - max value for the frequency measured (e.g. 1min) of air temperature in degrees celsius

4 AirTemp_Min - min value for the frequency measured (e.g. 1min) of air temperature in degrees celsius

Relative humidity measures water vapor relative to the temperature of the air (actual amount of water vapor in the air compared to the total amount of vapor that can exist in the air at its current temperature).

5 RH - relative humidity measured as % saturation ** Photosynthetically active radiation (PAR)** Solar radiation from 400 to 700 nanometers used by the photosynthetic organisms for the process of photosynthesis (active radiation).

6 PAR*Den*Avg - average value for the frequency measured (e.g. 1min) of the flux density in umol/s/m^2

7 PAR*Tot*Tot - total flux over period (mmol/m^2)

Wind speed (anenometer) measures the speed of the wind.

8 WS*ms*Avg - average value for the frequency measured (e.g. 1min) of wind speed in metres per second

9 WS*ms*Max - max value for the frequency measured (e.g. 1min) of wind speed in metres per second

Net radiation measures the balance between incoming and outgoing radiation under outdoor conditions

10 NR*Wm2*Avg - average value for the frequency measured (e.g. 1min) of net radiation in watts per square metre

11 NR*Wm2*Max - max value for the frequency measured (e.g. 1min) of net readiation in watts per square metre

12 NR*Wm2*Min - min value for the frequency measured (e.g. 1min) of net readiation in watts per square metre

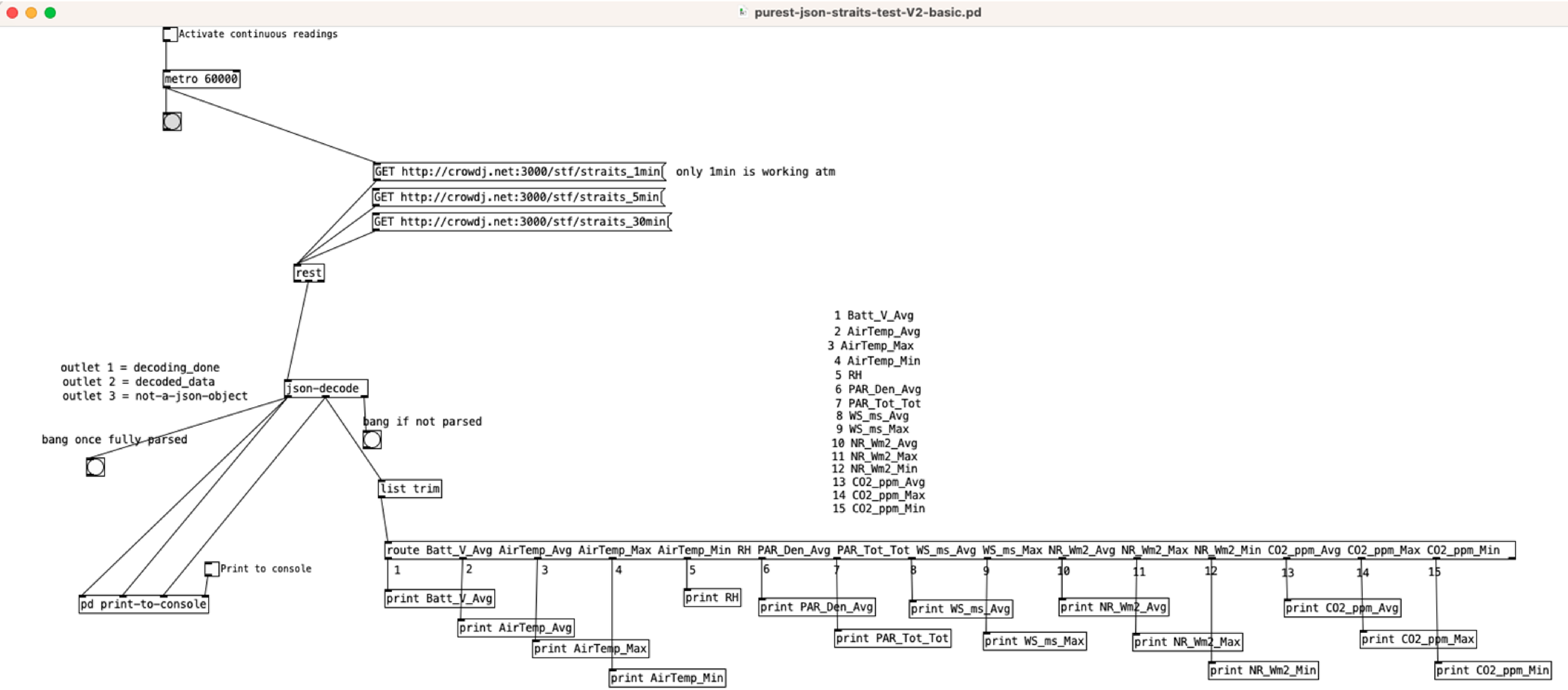
Carbon dioxide (CO2) concentration measure the level of CO2 as a percentage of a volume of air

13 CO2*ppm*Avg - average value for the frequency measured (e.g. 1min) of CO2 concentration in parts per million

14 CO2*ppm*Max - max value for the frequency measured (e.g. 1min) of CO2 concentration in parts per million

15 CO2*ppm*Min - min value for the frequency measured (e.g. 1min) of CO2 concentration in parts per million

Customised web server & web client in PureData



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WP1
Dendrophone

Featured sound installation

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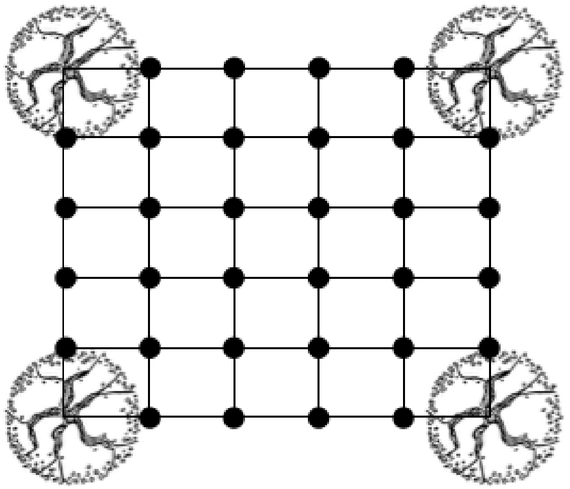
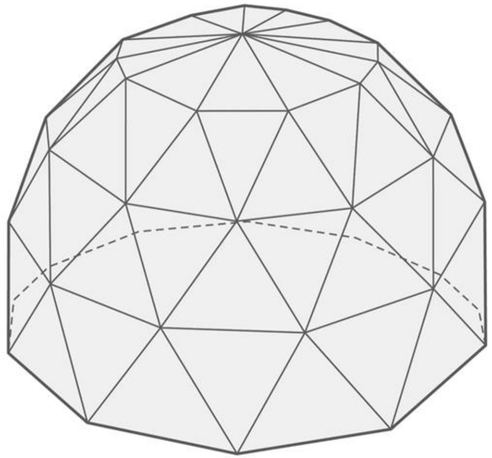
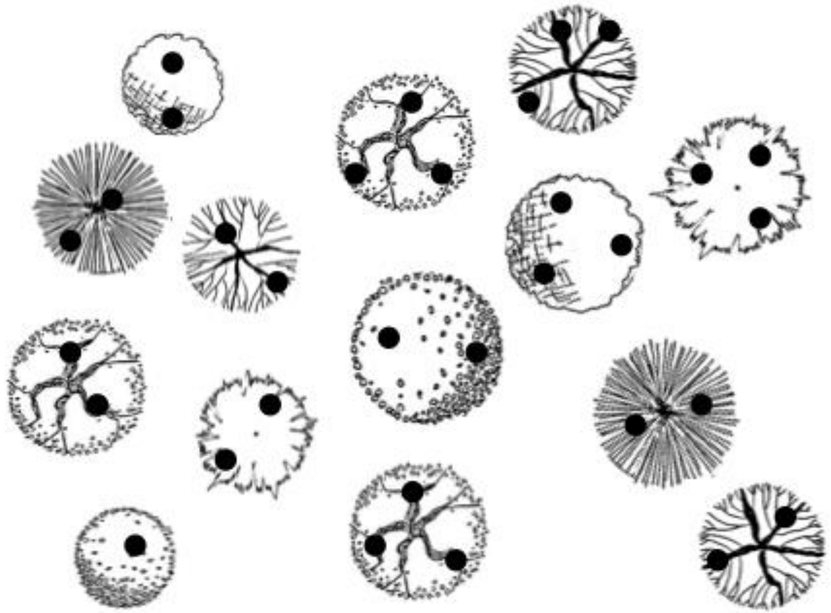
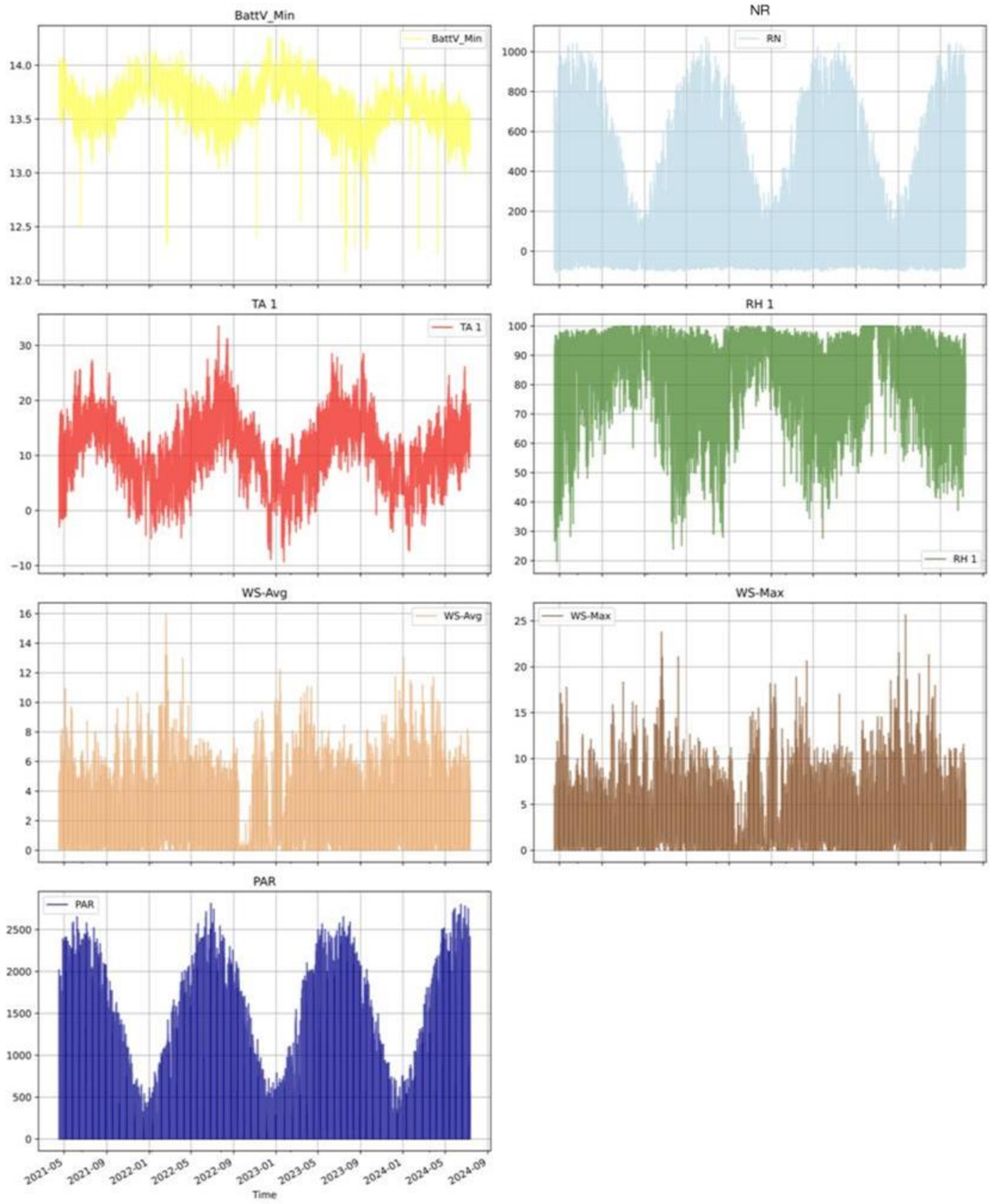


- multi-channel installation (spatial)
- one year duration (technical / aesthetic)
- autonomous system | self-sustaining | low impact
- robust but affordable / reproduceable (DIY)
- respond to data: real-time environmental
- public!





sensingtheforest.github.io/exhibition/your-sonic-forest-dendrophone-peter-batchelor/



DATA & Mappings

- **Relative Humidity** — mapped to multichannel soundscapes suggestive of forest ‘dryness’ vs ‘wetness’
- **PAR & Temperature**— mapped to drones which suggest ‘energy’ / photosynthesis activity
- **CO2** — mapped to ‘breathing’ sound — slower breathing = greater CO2 uptake

Personal Reflections on Dendrophone

15 Aug 2025 by Daniel Gill

Many autistic people experience challenges with managing sensory inputs. While the autistic people are constantly bombarded with such sensory information, for me, Dendrophone provided a sweet relief.
(...)
While laying down below a mighty beech, taking in all these sounds, I felt grounded—quite literally—with the forest. I knew from my lousy GCSE Biology that trees do, in-fact, "breath", and that they do so with tiny holes under the leaves (to prevent water getting in – perhaps not lousy after all); but it's not until you hear them breath that you fully realise that they are living things with a job to do and needs to fulfil, like us.
(...)
Dendrophone allowed me to connect to the forest like never before, and in doing so, provided a space for a clearer and more coherent mind.

Exploring Dendrophone - A day at Alice Holt Forest

27 Aug 2025 by Nico García

I do not exaggerate when I say that Dendrophone had a profound impact on me on that Friday afternoon.
(...)
I have found that meaningful sound sources and mappings are integral to any application of a data sonification process. It can make or break the delivery and impact of the installation, and in the worst case, disrupt the ecosystem's soundscape in damaging ways if deployed in an ecological context.
(...)
This harmonious coexistence was facilitated by the choice of geophonic sound material. The three layers featuring sounds like wooden wind chimes, resonant drones, and noise gave breathing room for biophonic organisms, mainly birds, in the forest to sound on top of the installation.

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WP1
Streamers

2x Audio streamers

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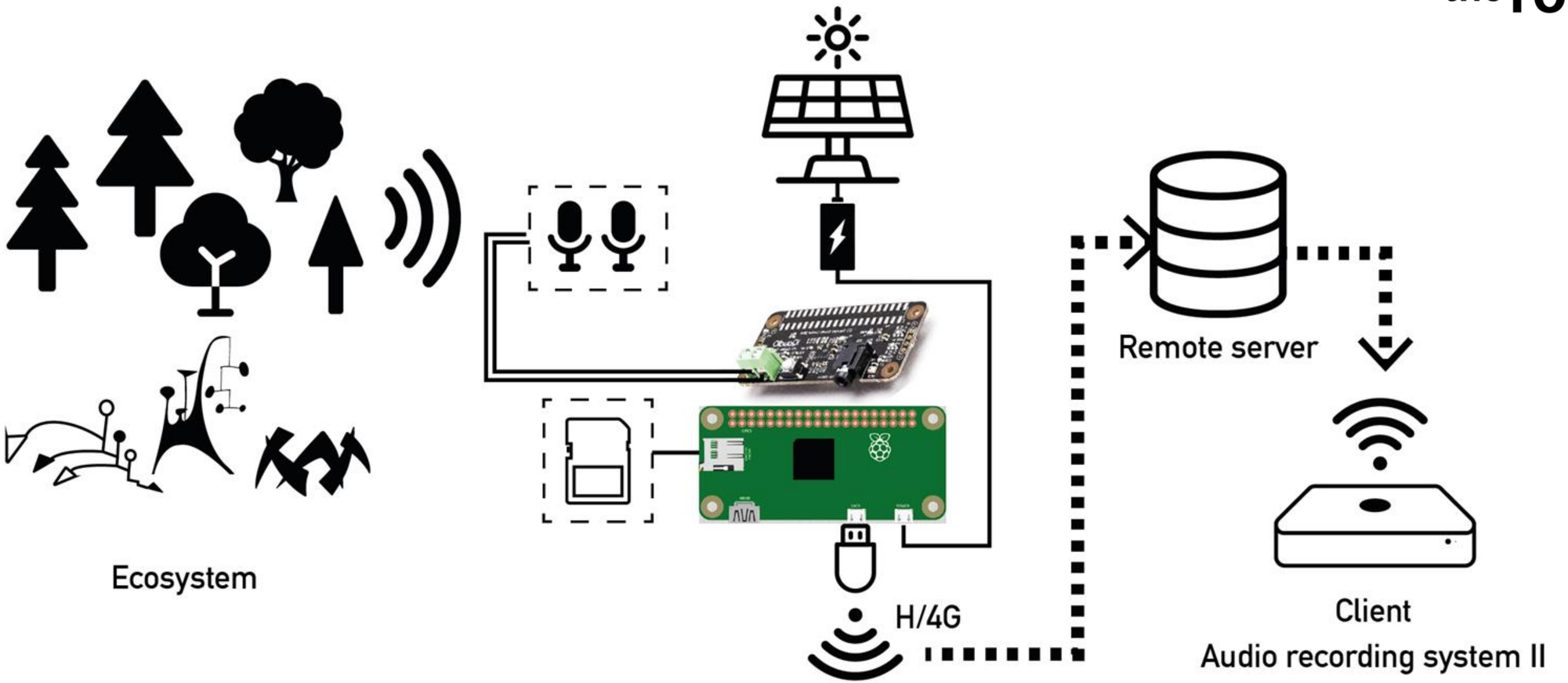


Map
Satellite
The Barn at Bury Court
Northbrook Park Wedding Venue
Wrecclesham
THE BOURNE
LOWER BOURNE
Waverley Abbey
Islamabad (Tilford)
Bourne Woods
Charles Hill
Charleshill
Lower Froyle
The Anchor Inn
Bentley
A31
A325
B3384
B300
Birdworld
Rowledge
Rural Life Living Museum
Tilford
Upper Froyle
Isington
Boundstone
The Reeds Rd
Tilford Rd
Hankley Common Golf Club
FROYLE
Blacknest Rd
Shortfield Common
Millbridge
Alice Holt Forest
Bucks Horn Oak
Blacknest
Blacknest Country Club
River Hl
Dockenfield St
Frensham
Pitt Ln
Moat Pond
Hankley Common
London Rd
Binsted
Holybourne
Batt's Corner
Frensham Great Pond
Dockenfield
Neatham
Hay Place
ALDI
Mill Ln
Frensham Country Pk
Rushmoor
High Thicket Rd
Frensham Pond Hotel & Spa
Wheatley
Frith End
Thursley Rd
Dyeho
Wyck
A287
Country Market : Garden Centre, Farm Shop &...
Pitch Place
lf Course
Caker Ln
Forge Rd
Kingsley
Hadeeqatul Mahdi (Jalsa Salana UK)
Green St
Churt
GREEN CROSS
Sleaford
Oakhanger Rd
BARFORD
PGL Marchants Hill
Cain Manor
West Worldham
Hartley Mauditt
d Golf Club
Beacon Hill
The Hange
Lindford
B3002
Headley
A3
sensingtheforest.github.io/listen/

L: Soundscape streamer R: Installation streamer

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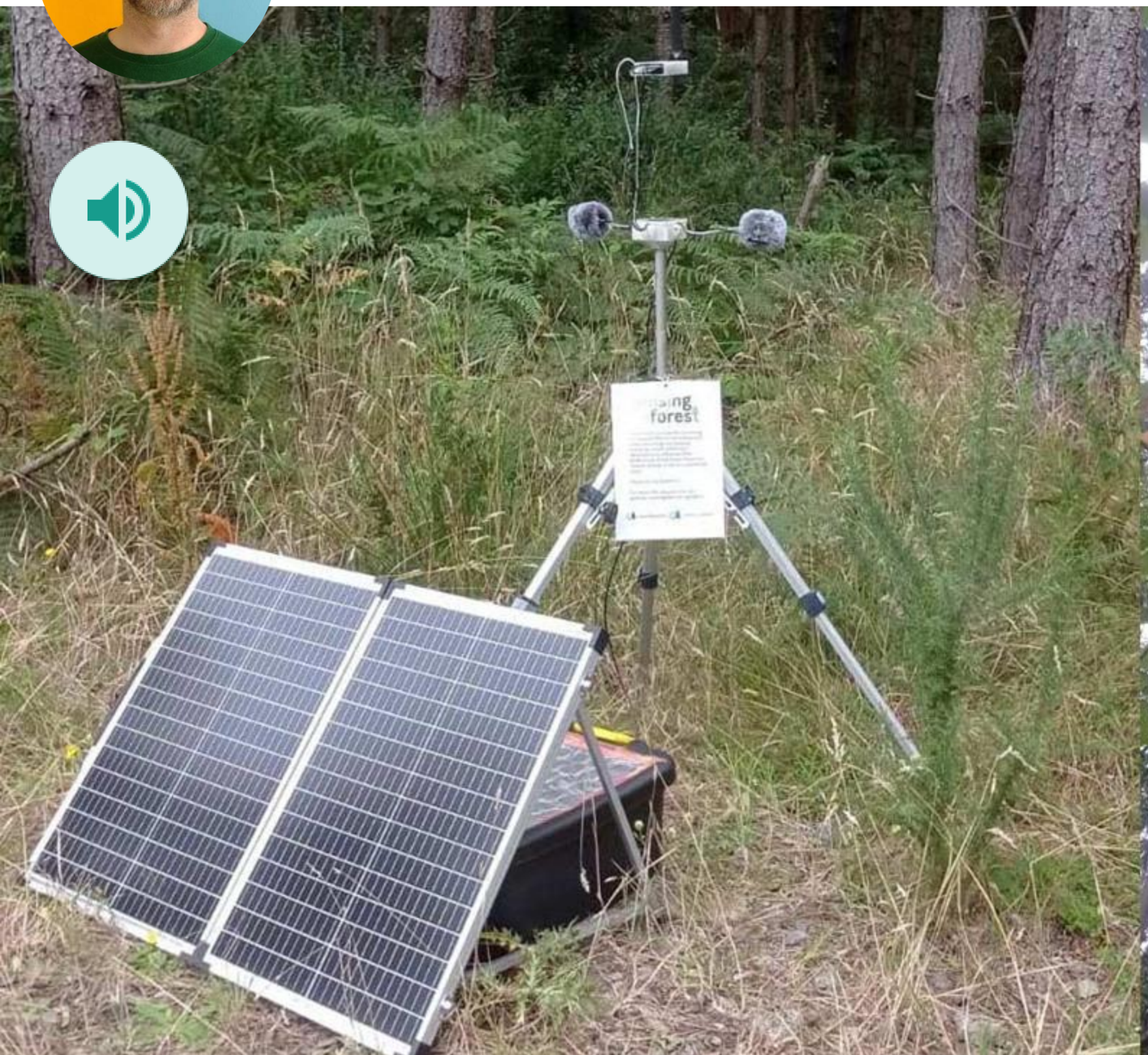
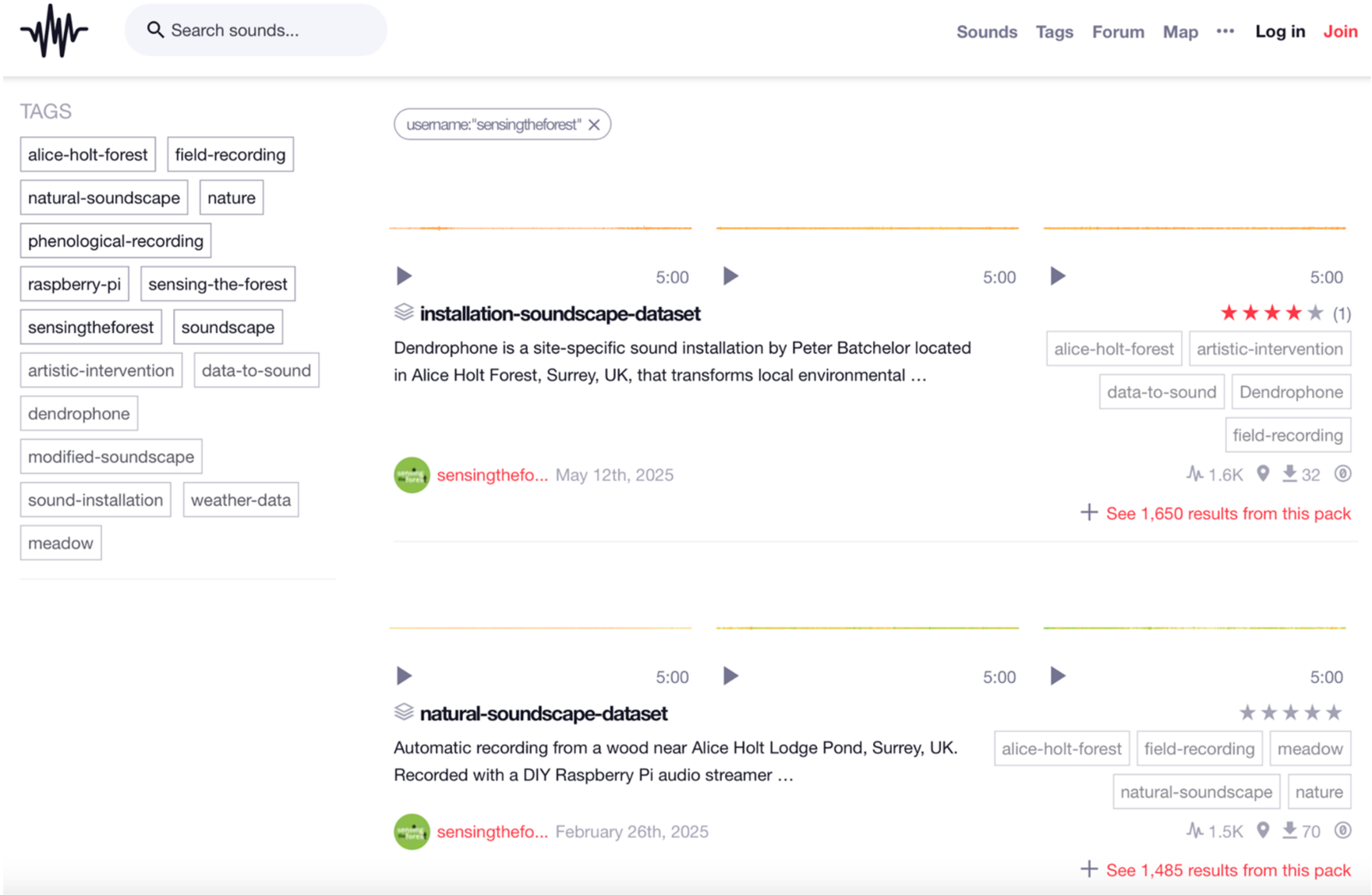


Freesound


Search sounds...
Sounds
Tags
Forum
Map
Log in
Join
TAGS
alice-holt-forest
field-recording
natural-soundscape
nature
phenological-recording
raspberry-pi
sensing-the-forest
sensingtheforest
soundscape
artistic-intervention
data-to-sound
dendrophone
modified-soundscape
sound-installation
weather-data
meadow
username:"sensingtheforest"
5:00
5:00
5:00
installation-soundscape-dataset
(1)
Dendrophone is a site-specific sound installation by Peter Batchelor located in Alice Holt Forest, Surrey, UK, that transforms local environmental …
alice-holt-forest
artistic-intervention
data-to-sound
Dendrophone
field-recording
sensingthefo... May 12th, 2025
1.6K
32
See 1,650 results from this pack
5:00
5:00
5:00
natural-soundscape-dataset
Automatic recording from a wood near Alice Holt Lodge Pond, Surrey, UK. Recorded with a DIY Raspberry Pi audio streamer …
alice-holt-forest
field-recording
meadow
natural-soundscape
nature
sensingthefo... February 26th, 2025
1.5K
70
See 1,485 results from this pack

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WP1
Passive acoustic monitoring

Voice activity detection (VAD) models

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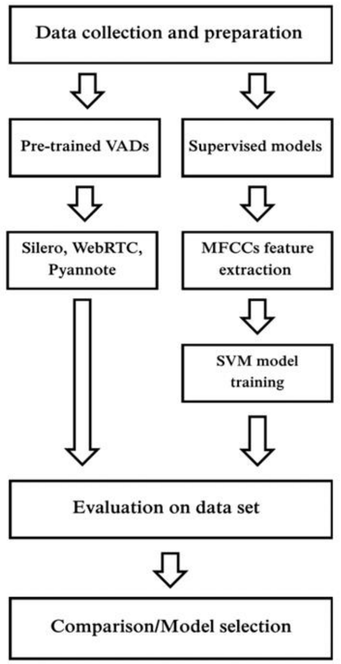
MSc James Shortland

- Binary classification problem: speech vs non-speech.
- Mel-Frequency Cepstral Coefficients (MFCCs) as input features to train models with Support Vector Machine classifier.
- SVM achieved high accuracy on a customised clean and balanced Freesound dataset but degraded when tested with real-world dataset.
- Pre-trained VAD systems (Silero, WebRTC, Pyannote) were also evaluated to conclude with a hybrid filtering approach.
- Future work: explore how to improve real-world datasets, alternative features, and models for more robustness.



https://jjshortland.github.io/masters-final/

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WP1
Sound analysis

Sound Analysis of Soundscapes

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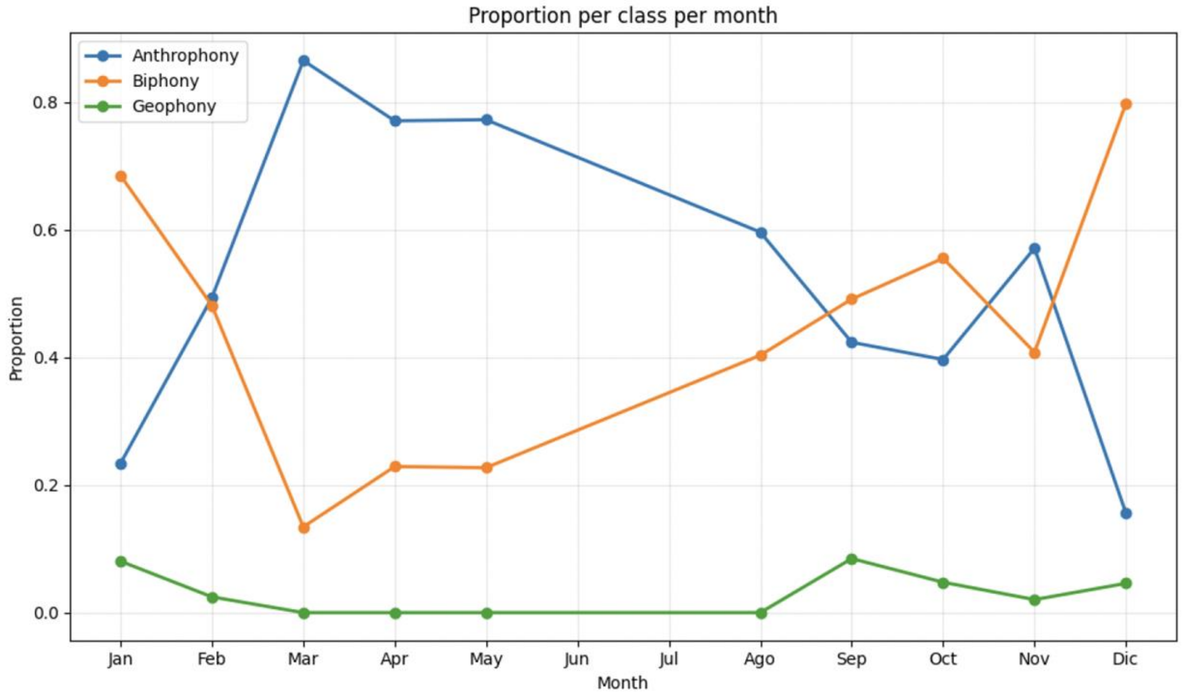
MSc Andrés Sanchez Castrillon

By applying deep learning classification models and statistical analysis techniques, the project demonstrates that soundscape composition, defined by the proportion of **biophony**, **geophony**, and **anthropophony**, varies in response to temperature, precipitation, and wind speed.



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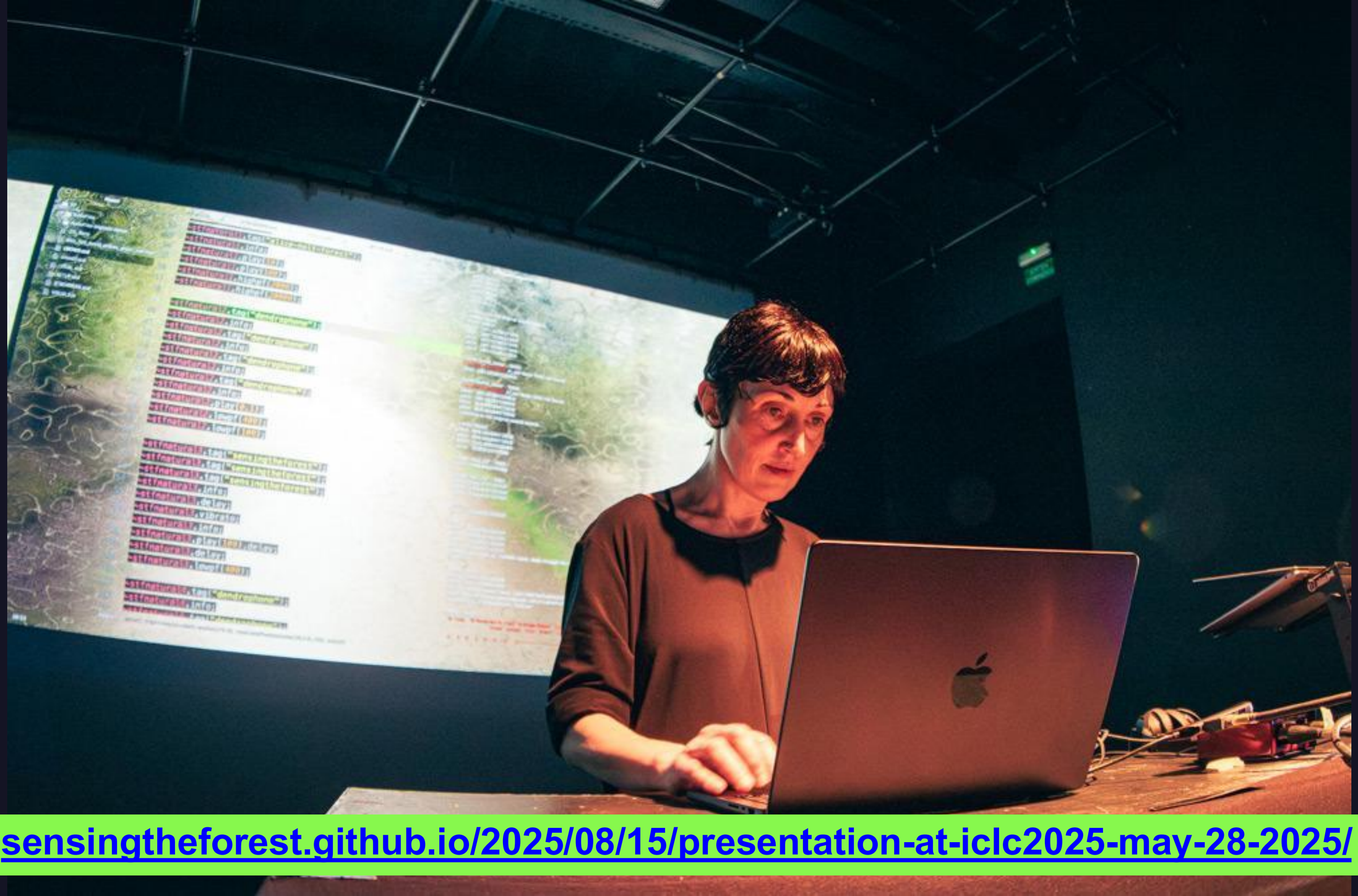
WP1
Live coding



sensingtheforest.github.io/2025/08/15/presentation-at-iclc2025-may-28-2025/

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WP2

Community science intervention with forests and climate data

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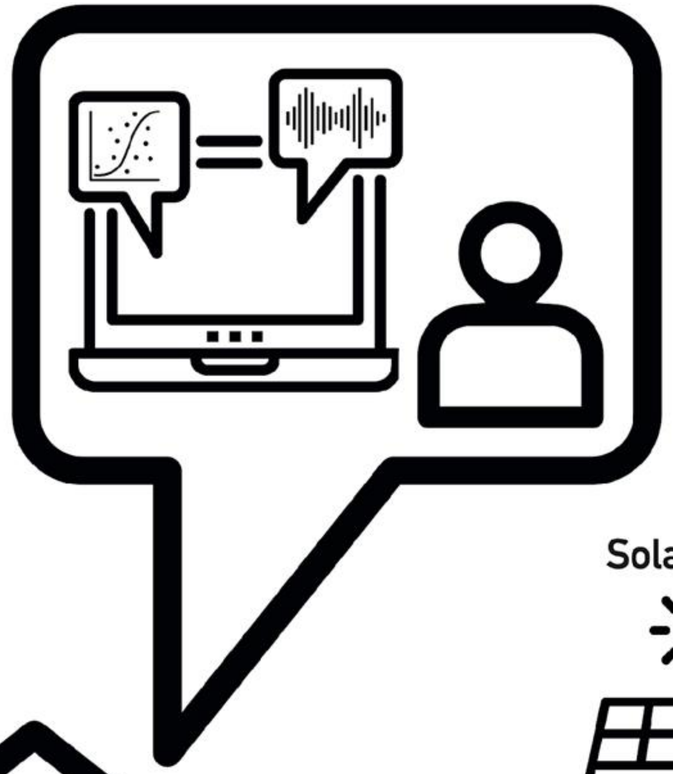
Objectives

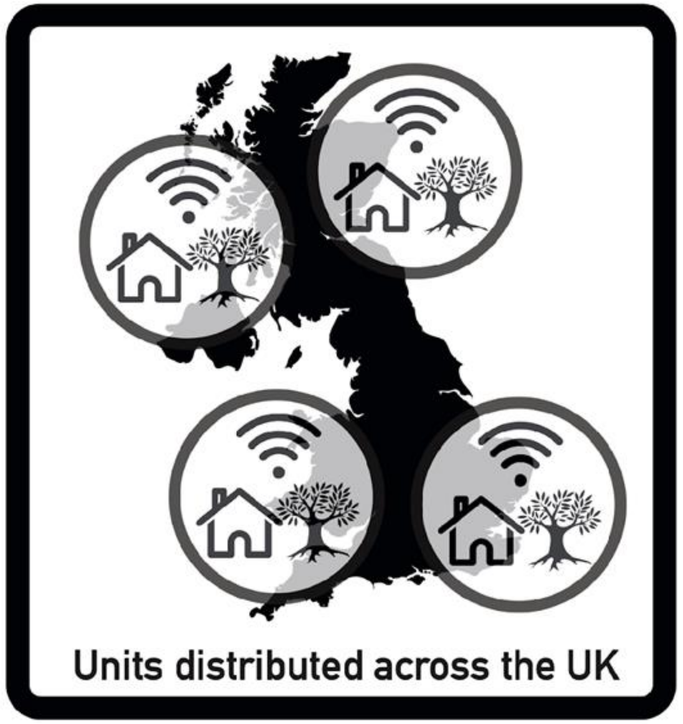
Objective 2 (WP2): Community science intervention with forests and climate data *(10.6.2024-11.5.2025)*.

To develop an in-house Internet of Things (IoT) prototype to measure variables related to tree stress, such as sap flow, air temperature, humidity and soil moisture to be piloted using community/citizen science methodologies connected to web applications for data analysis, visualisation and sonification. This objective relates to building a low-cost take-home prototype, inspired by commercial and expensive tree-talkers, to be used as a community/citizen science kit.

Prototype WP2

Dedicated web app (analysis, visualisation, sonification)





Units distributed across the UK

Solar panel

Household with Wi-Fi extender/powerline adapter

Box with RPi and sensors
(air temperature, soil moisture, sap flow)

Garden tree

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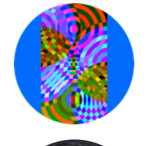

WP2
Tree talker (hardware)

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sensingtheforest.github.io/technologies/diy-tree-talker-hardware/

Customised tree talker


```
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  "sht40": {
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    "humidity": 53.24
  },
  "soil_moisture": -1
},
```


http://159.65.116.195:3000/stf/northern/


SENSING THE FOREST
UNIT 7
POWER
STREAMING
sensing the forest
SCAN ME

WP2
Tree talker (software)

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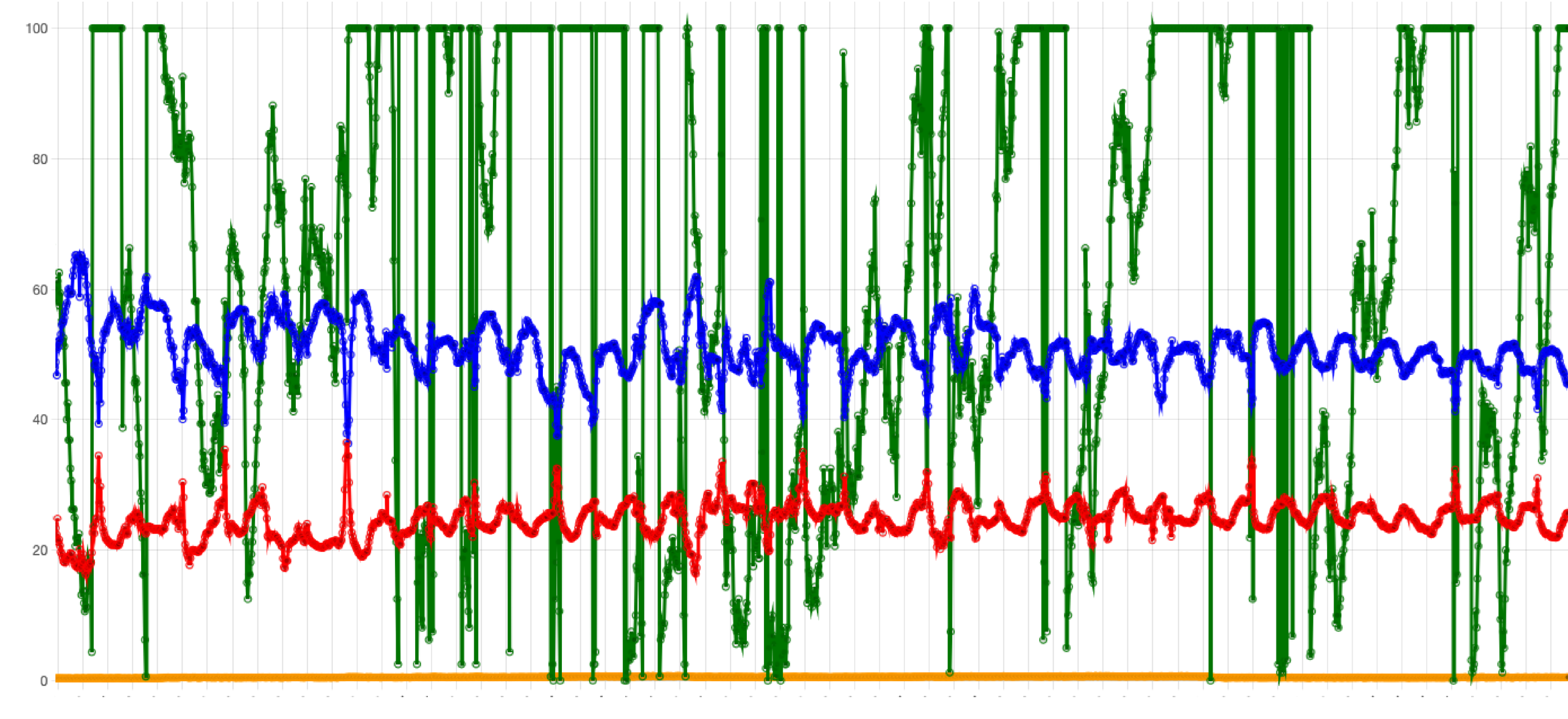
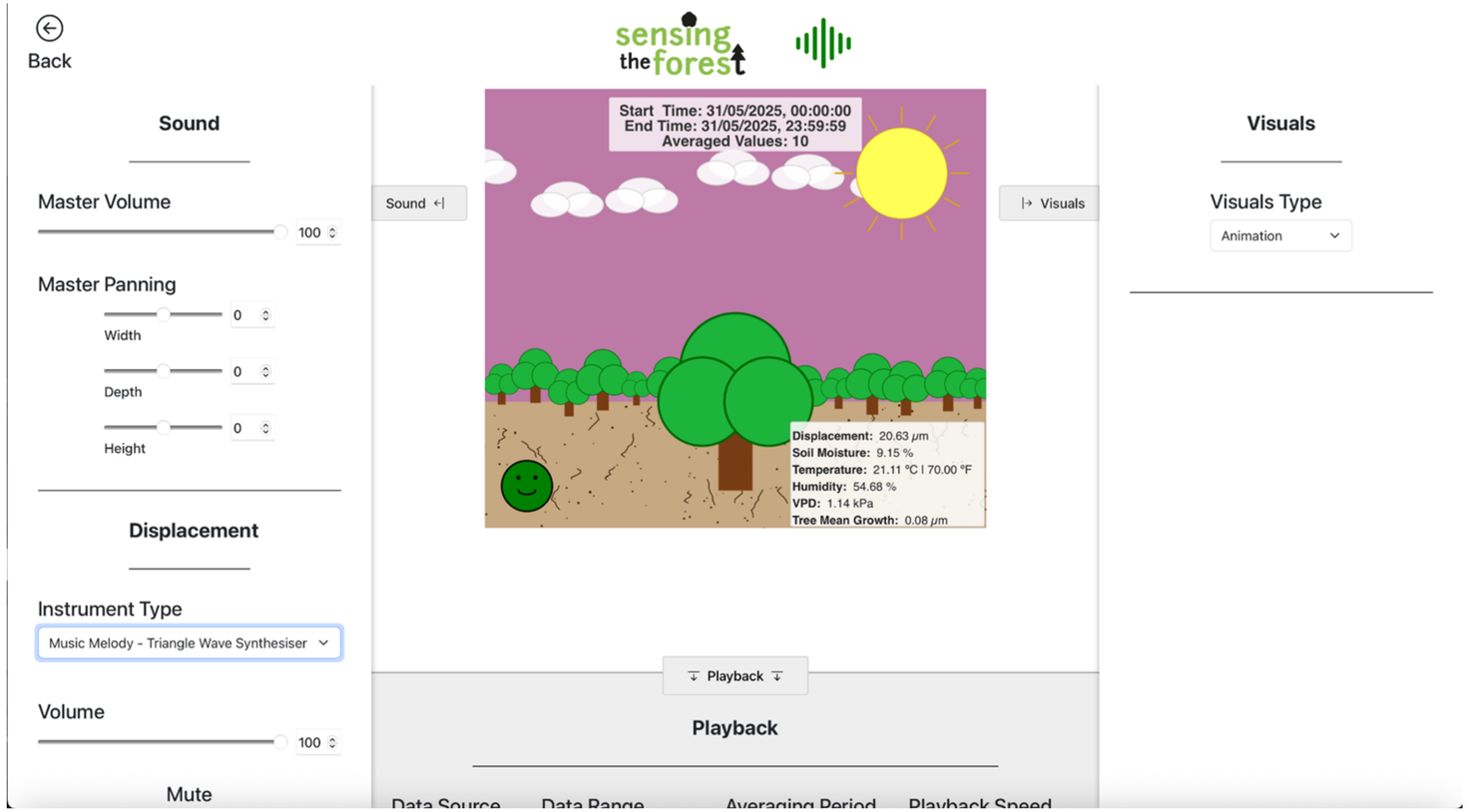


sensingtheforest.github.io/technologies/diy-tree-talker-software/

Dendrostream: Exploring Tree Stress and Climate Change Through Sonification and Visualisation

MSc Tug O'Flaherty



https://stf-sv-tool.pages.dev

Back

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Start — Sounds — Refine — Tone — Beat — Pitch — Layers — Effects — Done

Customise the pitch of the selected sounds or instruments:

Key Signature for Musical Instruments

Key

C

Scale

Major

Displacement: Drone

Frequency Range (Hz)

16.35 — 4186.01

Minimum — Maximum

Soil Moisture: Drone

Frequency Range (Hz)

16.35 — 4186.01

Minimum — Maximum

Frequency Range (Hz)

sensingtheforest.github.io/2025/12/23/dendrostream/

WP2
User study

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Participatory Design User study

Sensing the Forest at Northern Station: Participatory design of a tree talker prototype

4 participants + 2 researchers

Test a custom-made tree-talker prototype from home

June-August 2025

We met online four times (1h/session) via a Zoom call with the group.

Gain essential insights that could shape the future implementation of the tree talker.






Category	Principle	Actionable Guidelines
Design	1. Minimise barriers to entry (accessibility & reliability)	Design plug-and-play sensors, provide step-by-step guides, build error detection and recovery mechanisms, ensure durable casing and simple maintenance.
	2. Balance creativity with credibility (multimodal and integrated data)	Support multiple modes of data representation, integrate modes so that visual and auditory outputs reinforce each other, enable user customisation, use creative elements to improve interpretation and engagement of scientific data.
	3. Embed learning and participation (educational and social features)	Present contextualised data insights, layer educational resources, provide community dashboards, support feedback loops highlighting participants' contributions.
	4. Build trust in the data (transparency and richness)	Improve sensor accuracy and stability, present uncertainty transparently, enable longitudinal tracking and historical comparisons, allow richer datasets to be integrated.
Climate	5. Make climate connections visible	Design hardware and software to translate tree stress and environmental data into understandable insights, showing how local tree health reflects broader climate processes.
	6. Provide guidance and interpretation	Embed clear explanations, annotations, and narrative scaffolds to help users make sense of the data and relate it to ecological and climate phenomena.
	7. Support long-term engagement	Facilitate sustained participation through longitudinal data collection, progress tracking, seasonal or yearly comparisons, and reminders to ensure meaningful learning and awareness.
	8. Foster motivation and community action	Encourage personal and social engagement by enabling sharing, collaborative projects, creative applications of data (e.g., sonification, visualisation), and highlighting the impact of participants' contributions on environmental understanding.
Future	9. Ensure data credibility and scientific rigour	Design systems that provide reliable, reproducible, and longitudinal tree data to build participant trust and support meaningful scientific contributions.
	10. Integrate multimodal and extensible functionality	Develop modular, cohesive platforms that combine visualisations, sonifications, sensors, and imaging tools to enrich user understanding and engagement.
	11. Provide guidance and accessible interfaces	Offer tutorials, interpretive scaffolding, and inclusive design to help users make sense of tree data and connect it to broader ecological and climate contexts.
	12. Foster collaboration, creativity, and community engagement	Enable social interaction, data sharing, co-creation, and creative outputs (visual, auditory, or narrative) to sustain participation and encourage environmental awareness and action.

sensing the forest

Reflections & Future Work

Exploring creative AI (UKAIRS 2025)

Soundscape-based music and creative AI: Insights and promises

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Figure 1: Bird boxes repurposed as speakers used in the sound installation Dendrophone by Peter Batchelor.

Abstract

Technological revolution and industrialisation are, sadly, disconnecting us, humans, from our natural environment. This loss of connection with nature is waning activities such as listening to natural sounds. Monitoring and understanding the natural sounds of our environment can help identify possible changes or anomalies, which in turn can inform the bigger picture of depletion of natural resources, loss of biodiversity, and climate change, among others. This position paper investigates the insights and promises of creative uses of AI applied to soundscape-based music in the form of musical instruments and practices. By looking at AI-enhanced bespoke DIY technologies for streaming and analysing live sound-

Keywords

Acoustic Ecology, Artificial Intelligence, Climate Change, Human Computer Interaction, Sonic Arts

1 Sensing the Forest

Sensing the Forest[1] (StF) is a project funded by the UKRI Arts and Humanities Research Council that aims to raise awareness among forest visitors, artists, scientists, and the general public about the connection between forests and climate change. The overarching research question is, *how can the use of artistic and community science research methods help to inform and educate people about climate change? In particular, what can we learn from using artistic*

ReX: Use of Causal Responsibility EXplanations for Image Classifiers and Tabular Data to understand our dataset of audio recordings seen as time series to see its patterns and evolutions.

Filters: Explore the weather dataset of 15 sensor values as filters of the audio recordings.

Agency: Look more into the philosophical aspect of agency in the project.

Complexity analysis: Use of complexity analysis to understand the large amount of data collected: one year of audio recordings and weather data.

Future directions

Towards new ways of listening to - and learning from - the living environment

- Expanding interventions to other UK and international forests.
- Applying approaches to urban environments as well as rural ones.
- Publishing pedagogical resources on DIY sensing technologies.
- Continuing to scale up participatory and artistic methods from a multidisciplinary perspective to engage broader audiences with climate change.


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Thank you!

Partners

UKRI Arts and Humanities Research Council

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centre for digital music

De Montfort University Leicester

MTI² Institute for Sonic Creativity

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