

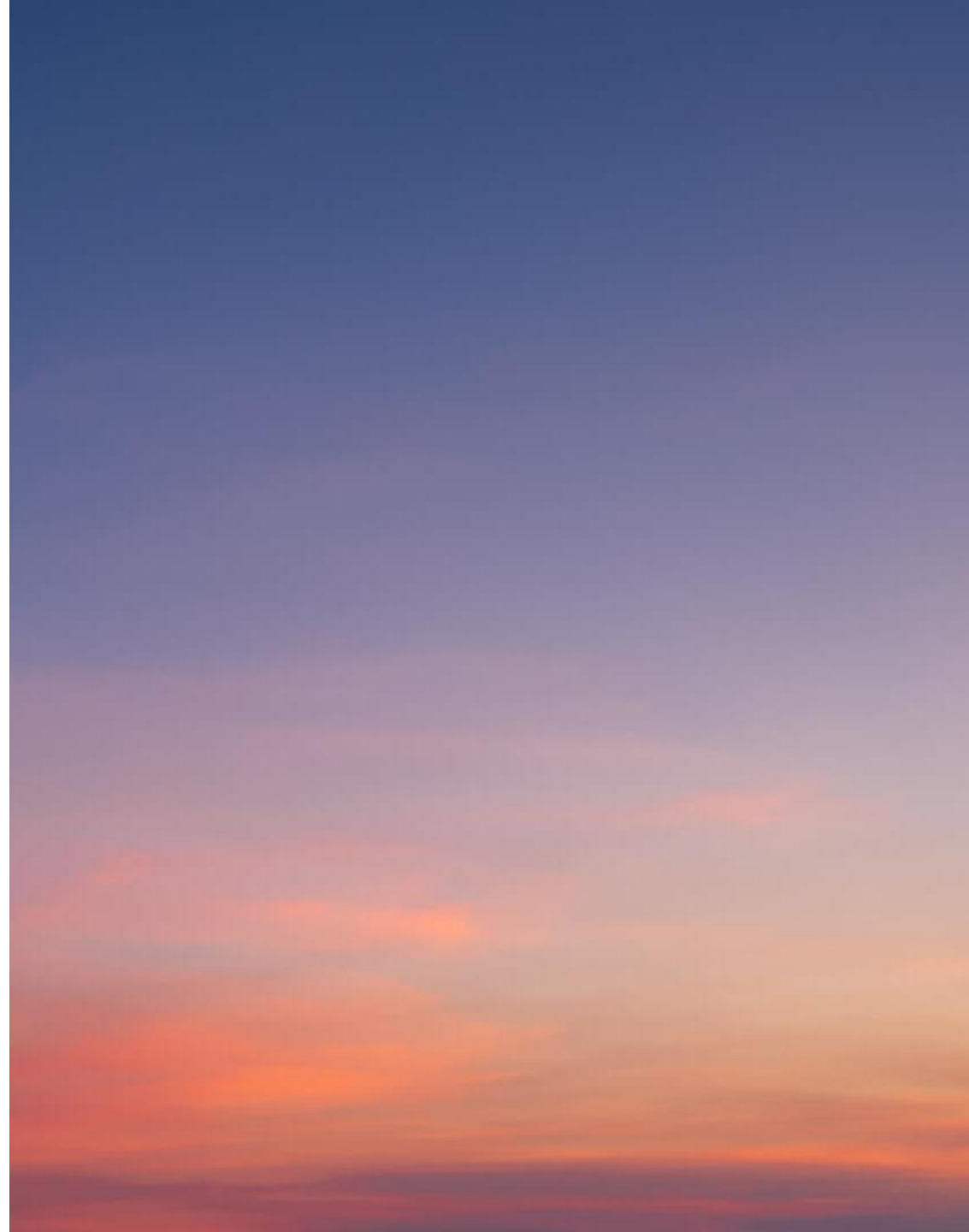
wood.

noiseAI

Automated Analysis of Sound

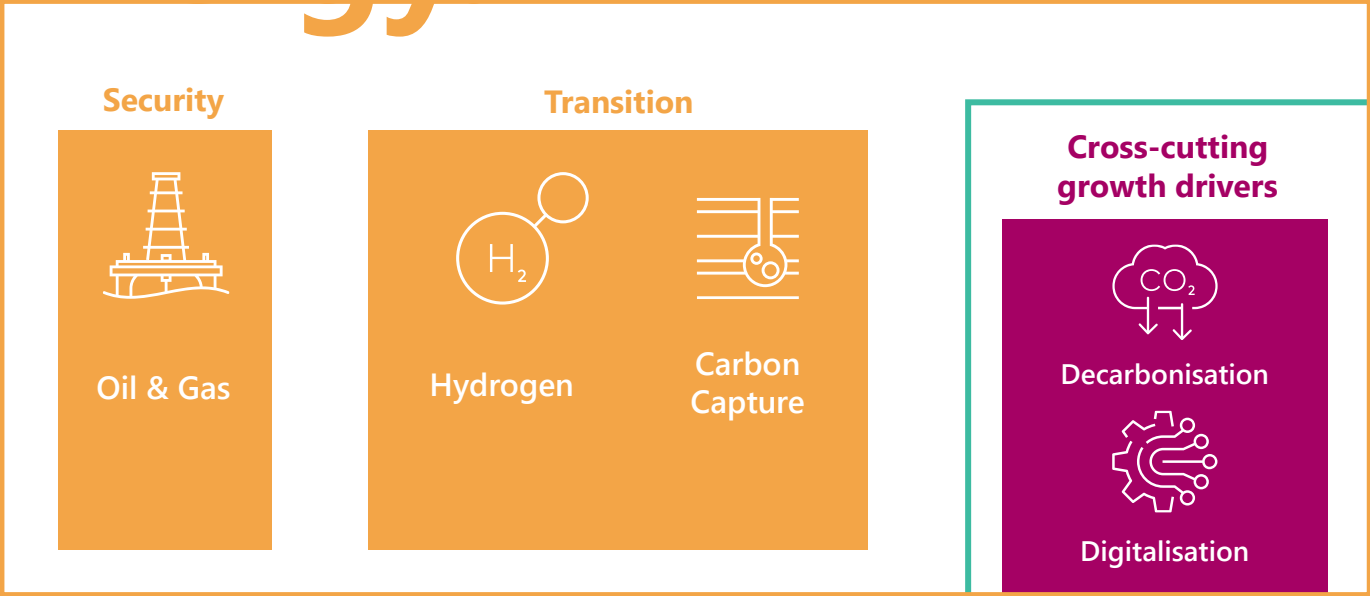
Matthew Pettersson

October 2023

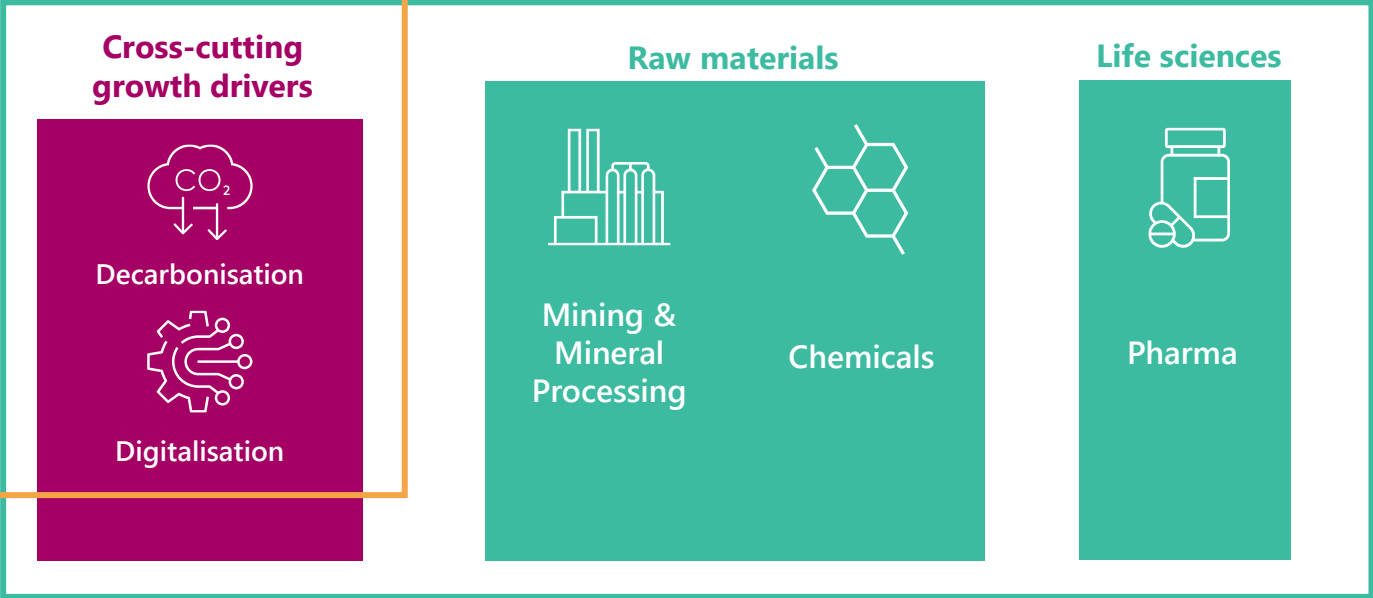


Wood

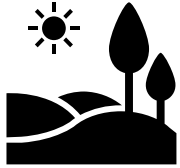
Energy.



Materials.



noiseAI Products



noiseAI/community

- Classifies types of environmental noise
- Enables proactive management of noise emissions
- Improves productivity



noiseAI/fauna

- Classifies calls of animal species
- Delivers timely data from remote locations
- Enables biodiversity monitoring programs to scale



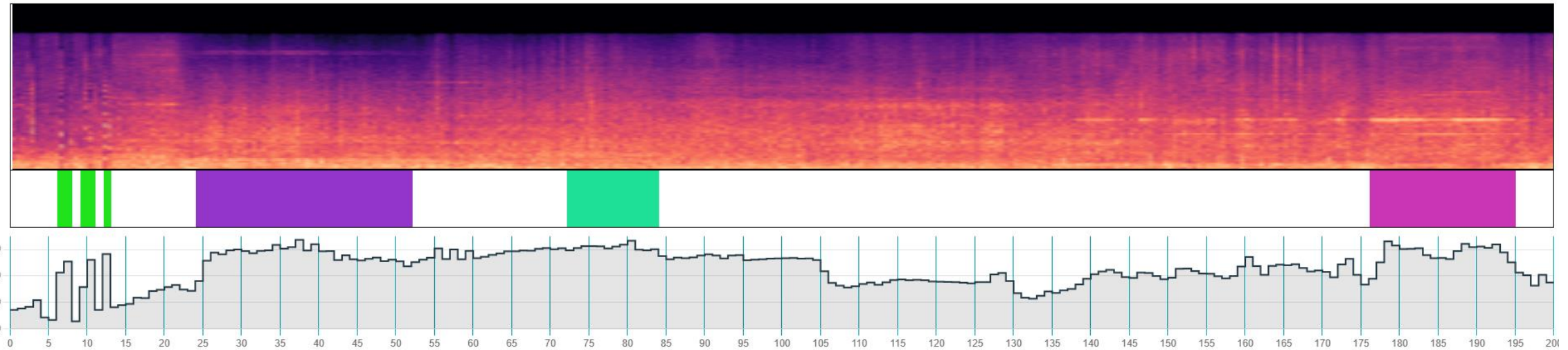
noiseAI/workplace

- Classifies sources of workplace noise exposure
- Enables transformation from noise monitoring to noise control

If a human can hear an event noise AI can see it in the data

Noise.ai WP (2).SVL_27_01_2023 8_15_55_27600_28200 is selected!

← Back



Z-Weighted Frequency Plot:

Progress Bar: **Total: 32.00%**

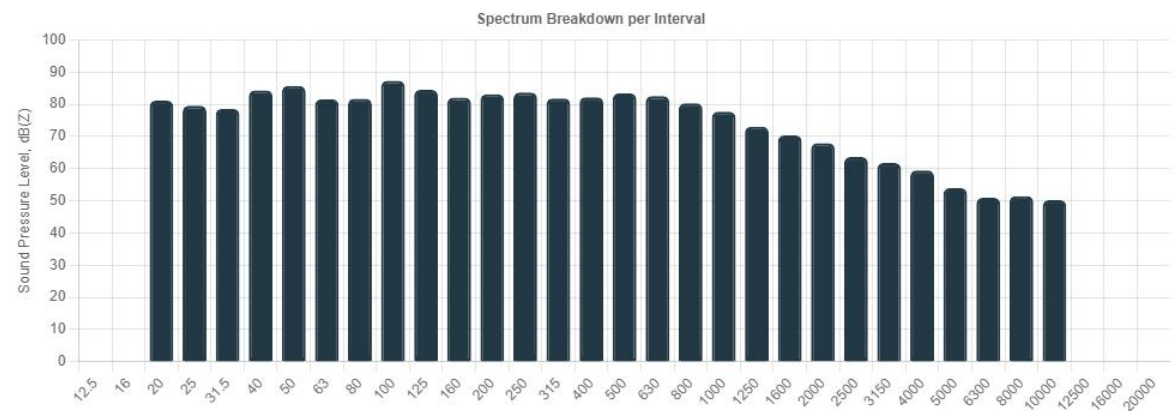
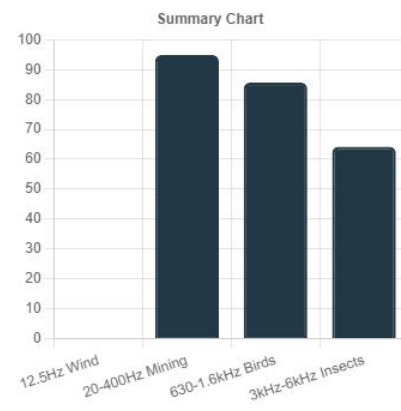


User Options:

More Options:

Weighting:

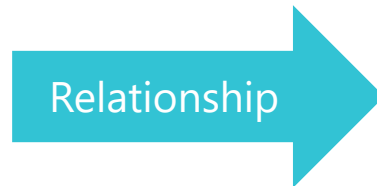
Needs Review



Machine learning extracts essential features



'Dog'



'Cat'

Big data



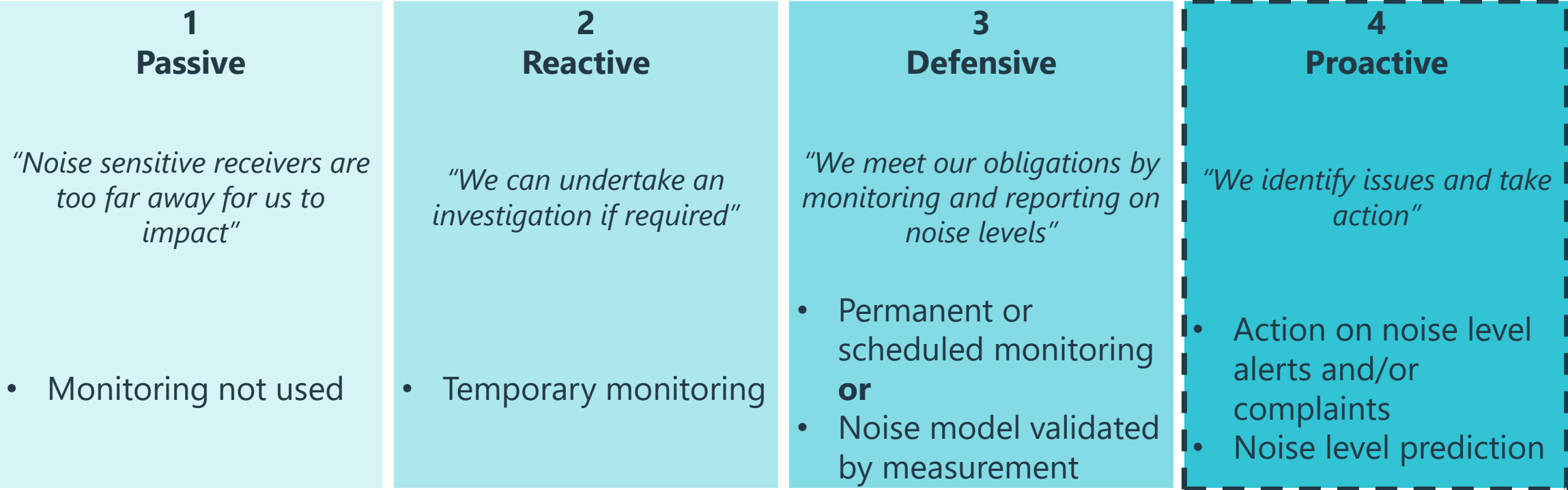
Small data

"Machine learning is the science of getting computers to imitate the way humans learn"

noiseAI/community

Reduce noise management effort
Avoid unnecessary production deferral
Protect social licence to operate

noiseAI helps operators who want to manage noise proactively



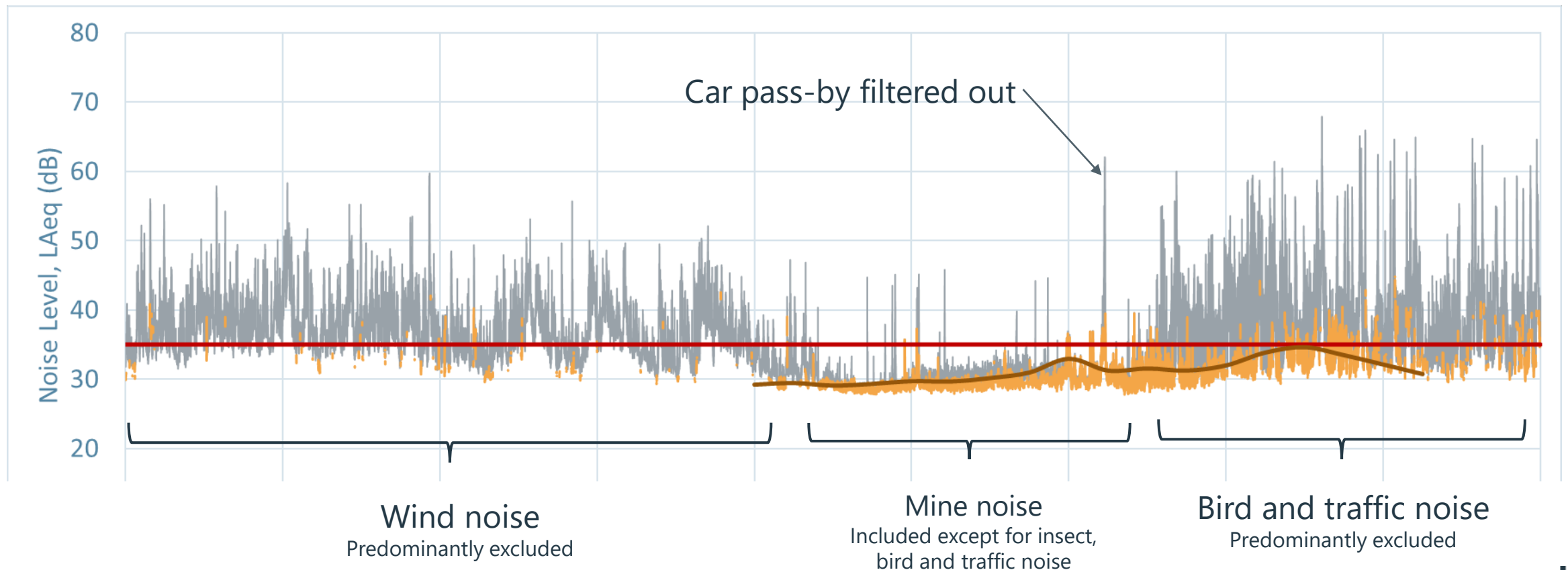
Noise Monitoring Challenges



Analysis of incoming noise data in near real time

- noiseAI filters out extraneous noise.
- Remaining data (in orange) indicates mine noise
- Includes frequency filtering for insect noise

— Overall unfiltered noise $L_{eq,0.5s}$
— noiseAI filtered noise level $L_{eq,0.5s}$
— **Assessed noise level**, $L_{eq,15m}$



What noiseAI/community tells the operator



WHEN THE INDUSTRIAL NOISE OF INTEREST IS **NOT DETECTABLE**

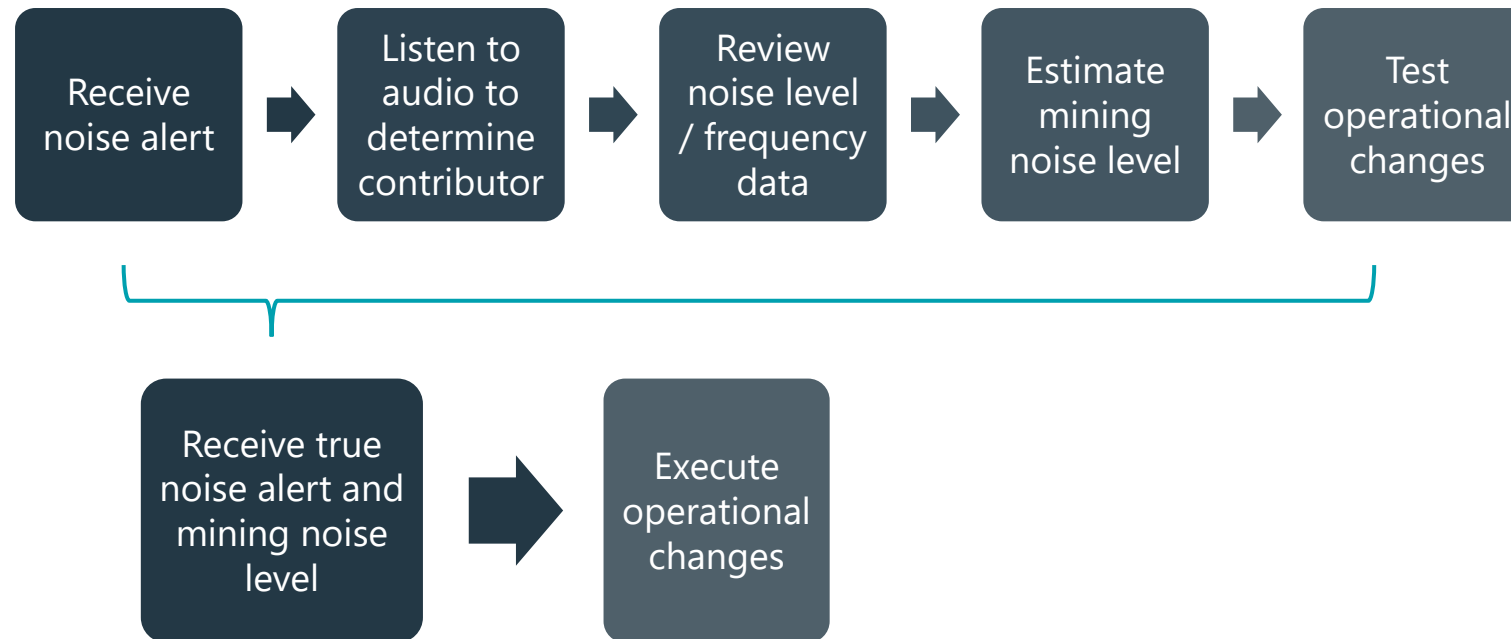


WHEN THE INDUSTRIAL NOISE IS DETECTABLE AND **ABOVE THE LIMIT**



WHEN THE INDUSTRIAL NOISE IS DETECTABLE BUT **BELOW THE LIMIT**

noiseAI replaces a manual and inconsistent process with a low touch system...



...enabling operators to focus on safety and production

noiseAI solution overview



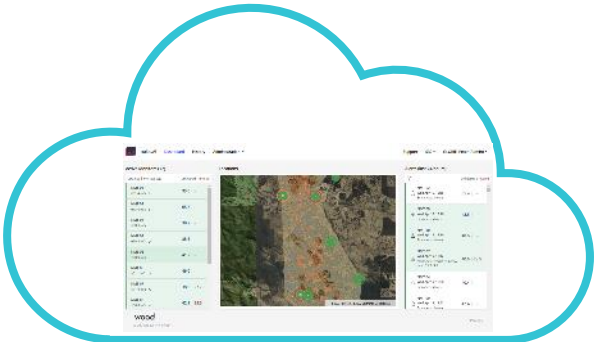
Hardware support

By others



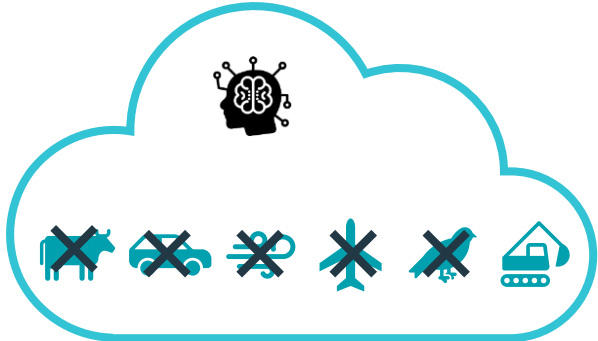
Hardware*

By Wood or others



Noise management platform

Wood: noiseAI/Community



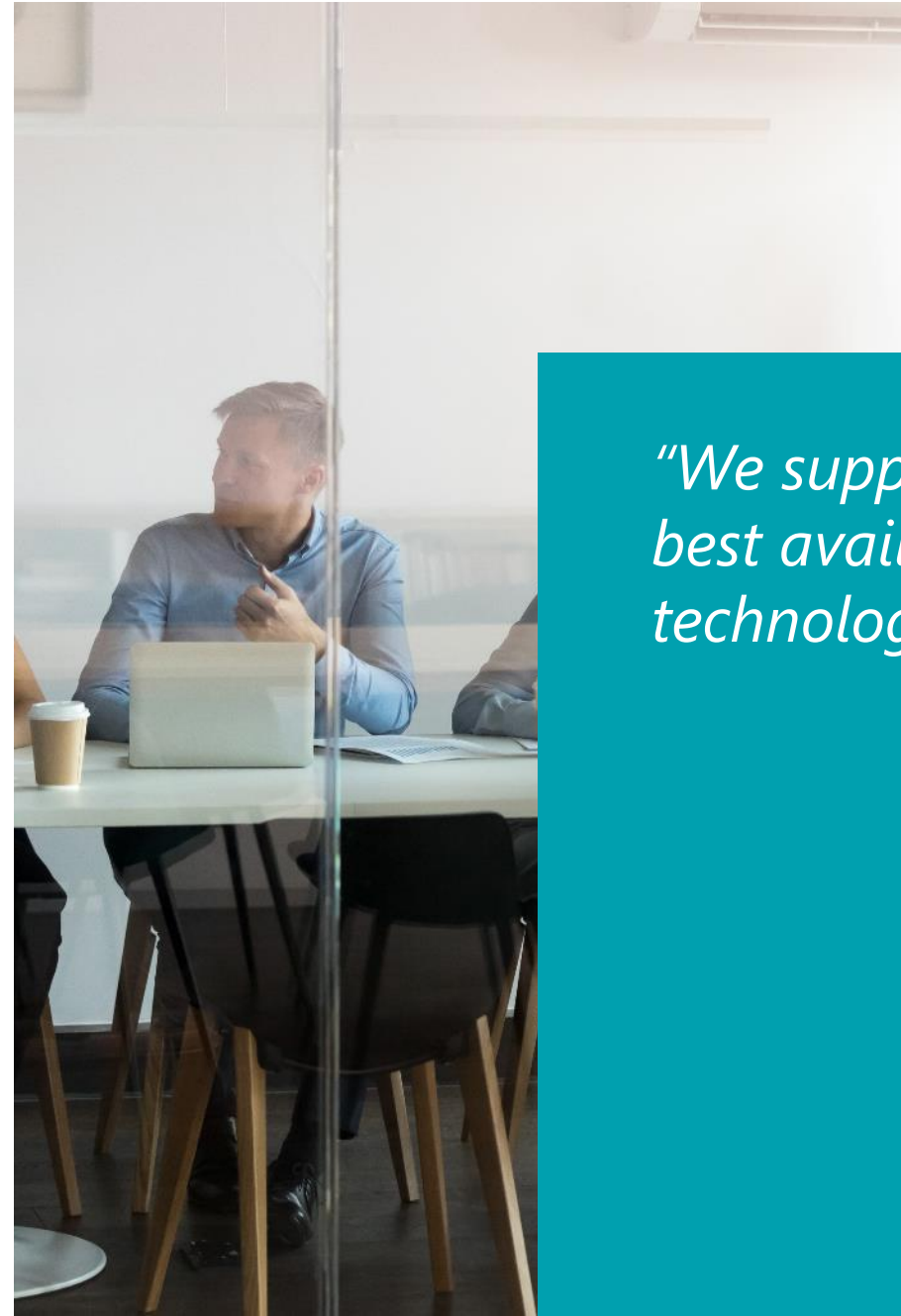
AI filtering

- Advisory and technical support by subject matter experts
- Responsive support underpinned by service level agreement

* Wood provides ECU (Edge Computing Unit) to enable connectivity

A regulator's perspective

- Noise monitors must meet applicable standards
- noiseAI ML technology is an enhancement of conventional screening techniques
- Immediate assessment enables better outcomes for the community



"We support use of best available technologies"

noiseAI/fauna

Enable timely action

Reduce monitoring effort

Protect social licence to operate

Solution Overview

- Solution required for monitoring bat activity to:
 - Provide data in a more-timely manner which enables management action
 - Reduce cost and safety issues associated with field work
- Challenges:
 - Large data
 - High precision required
 - Limited network bandwidth
 - Remote and hostile environment



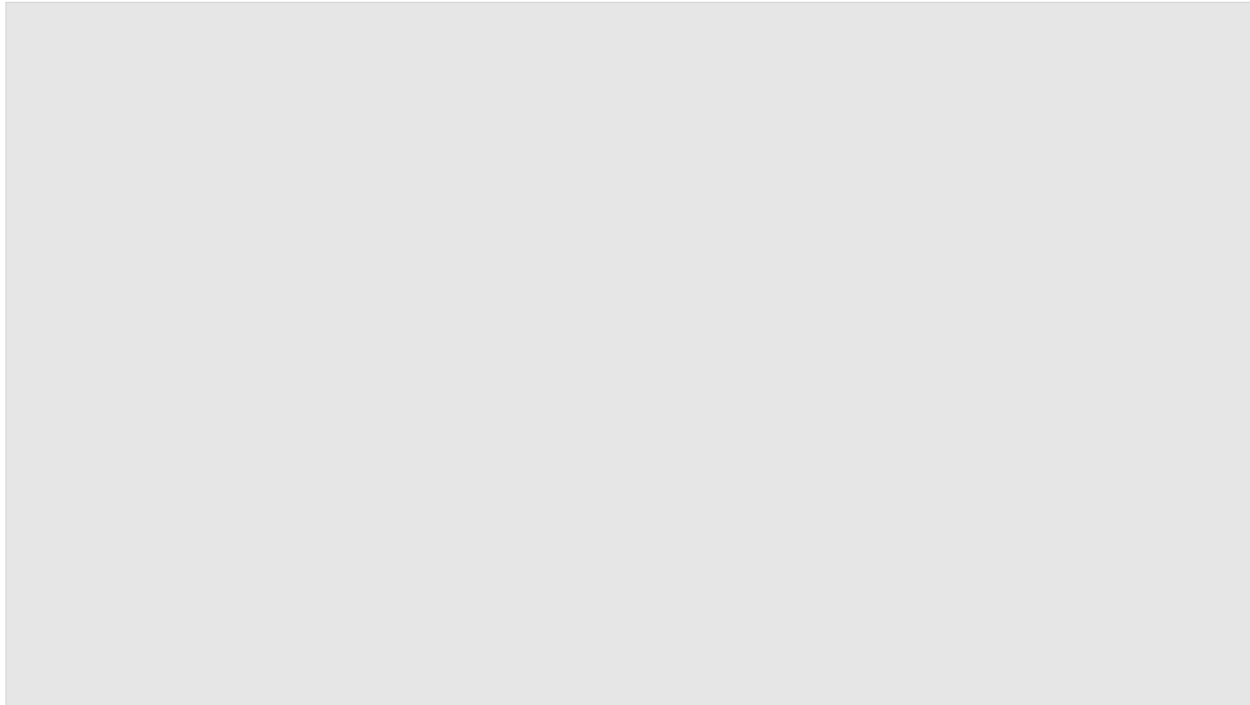
Pilbara Leaf Nosed bats (PLNb)



Pilbara Ghost Bats (PGb)

Model Objectives

- Objective is to accurately identify PLN/Ghost bat calls
- Prioritise *precision* over *recall*, although achieving high performance on both are important



Predicted Class	Negative	False Negative (Few accepted)	True Negative
	Positive	True Positive	False Positive (Undesirable)
		Positive	Negative
		True Class	

PLN bat detection

- High precision ensures low false positives
- High recall ensures few calls are missed

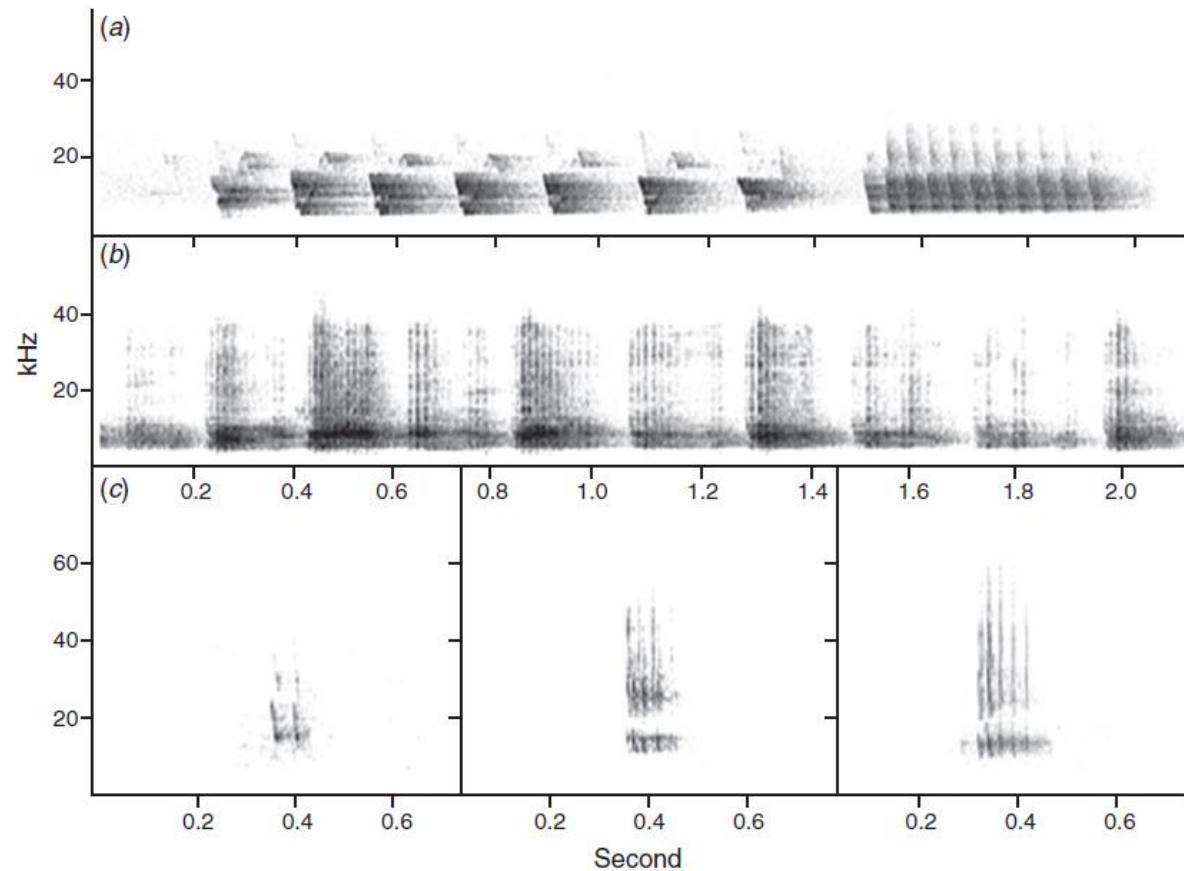


Audio file



Ultrasonic model		
Ultrasonic frequency analysis	98.7% precision	96.1% recall

Ghost bat Social Calls



Chirp Trill

Squabble

USV (Ultrasonic Social Vocalisation)

Fig. 1. Spectrograms of the three target vocalisations: (a) Chirp-trill, (b) Squabble, and (c) Ultrasonic Social vocalisation (three variants).

Ref: Hanrahan 2019

Ghost bat detection

- Ghost bat detected if either model returns positive result
- High precision on both models ensures low false positives
- Lower recall in each model due to cross over
- Models compensate for each other to reduce false negatives



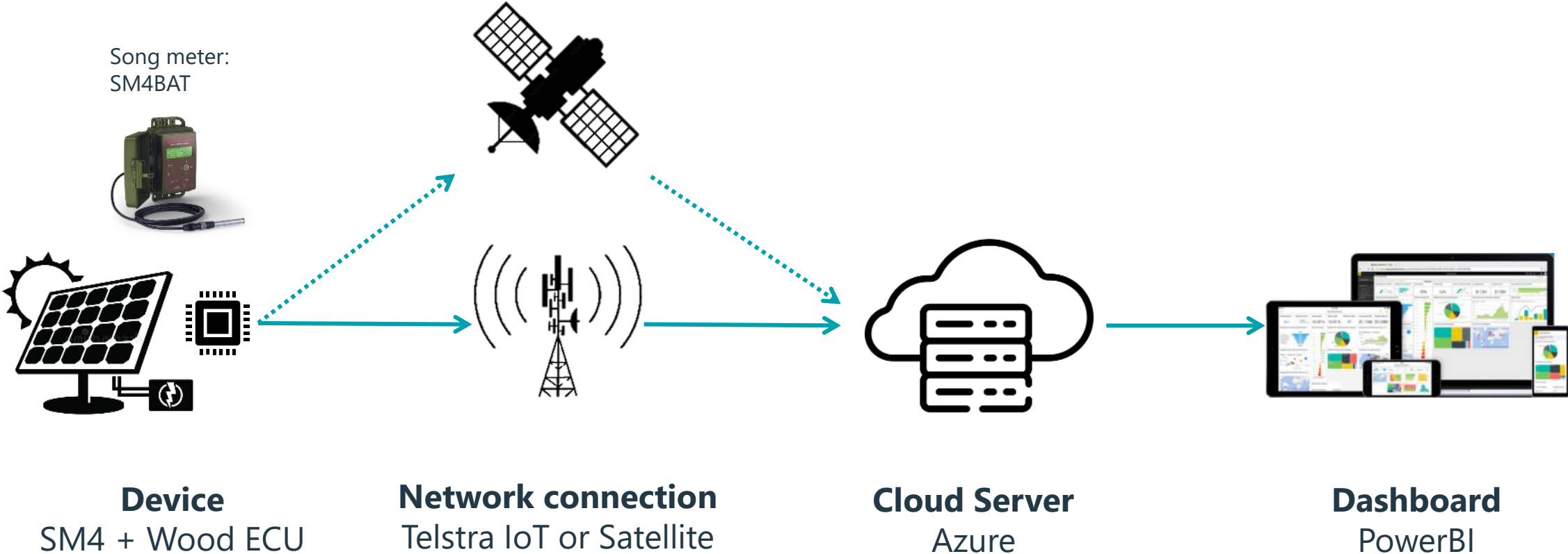
Audio file



Ultrasonic model		
Ultrasonic frequency analysis	99.4% precision	92.7% recall

Social call model		
High frequency analysis	99.6% precision	97.2% recall

Solution Overview



Hardware

- Portable and adaptable to suit various situations



noiseAI/workplace



Quantify exposure contributions

Prioritise noise controls

Demonstrate benefits

How to identify which sources should be controlled?

Comparison of Methods

Dosimetry



- ✓ Accuracy
- ✓ Immediate results
- ✓ Standardised
- ✗ Identification of sources
- ✗ Prioritisation for control

Exposure Estimations

Noise hazard	Measured noise level, L_{Aeq,T_i} dB(A)	Duration of exposure, T_i h	Partial exposure, E_{A,T_i} Pa^2h
Planer	102	0.5	3.17
Circular saw	98	4.0	10.1
Hammering	92	2.0	1.27
Power drill	89	2.5	0.79

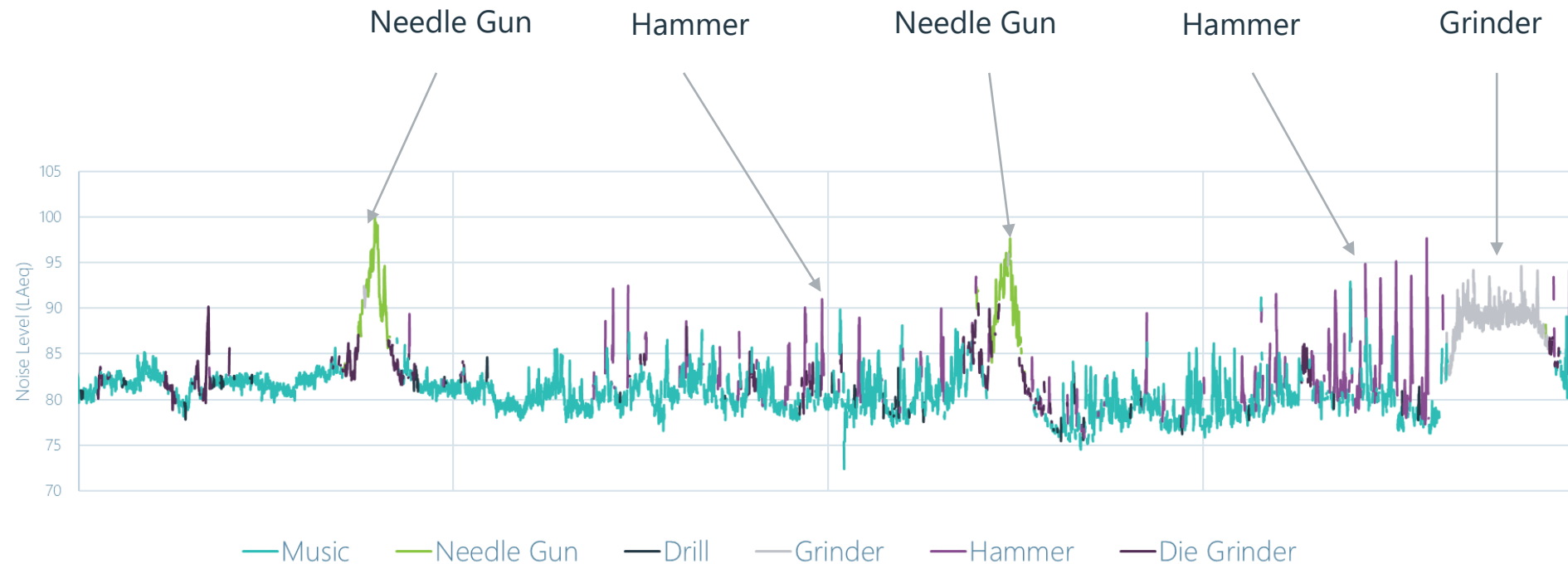
- ✓ Identification of sources
- ✓ Prioritisation for control
- ✓ What-if investigation
- ✗ Less repeatable
- ✗ Takes time
- ✗ Requires experience

Dosimetry + noiseAI



- ✓ Derived from dosimetry
- ✓ Accuracy
- ✓ Immediate results
- ✓ Identification of sources
- ✓ Prioritisation for control
- ✓ What-if investigation

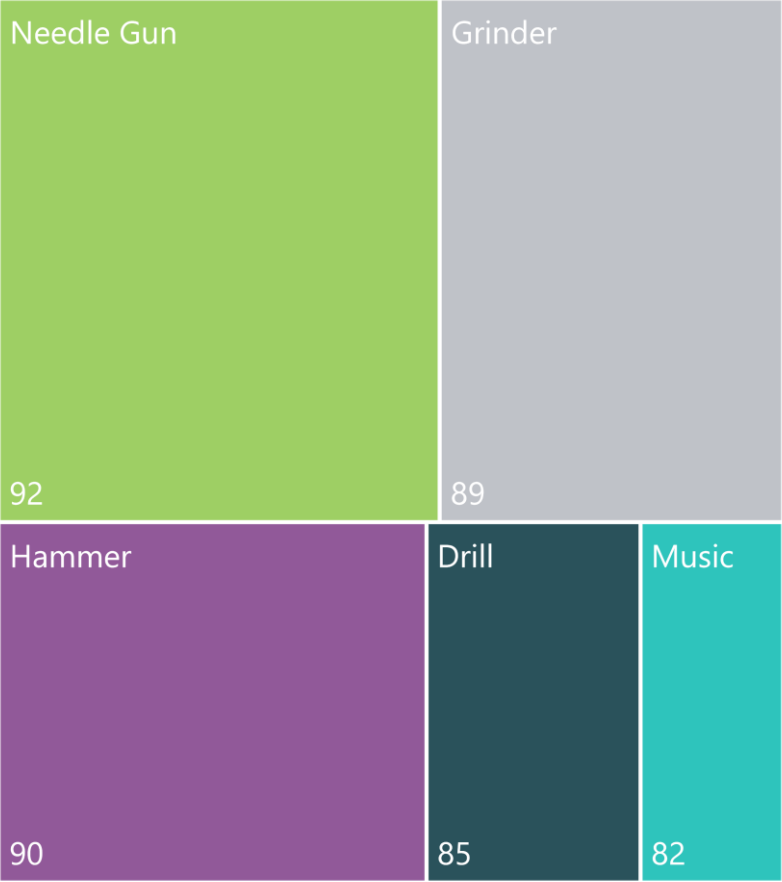
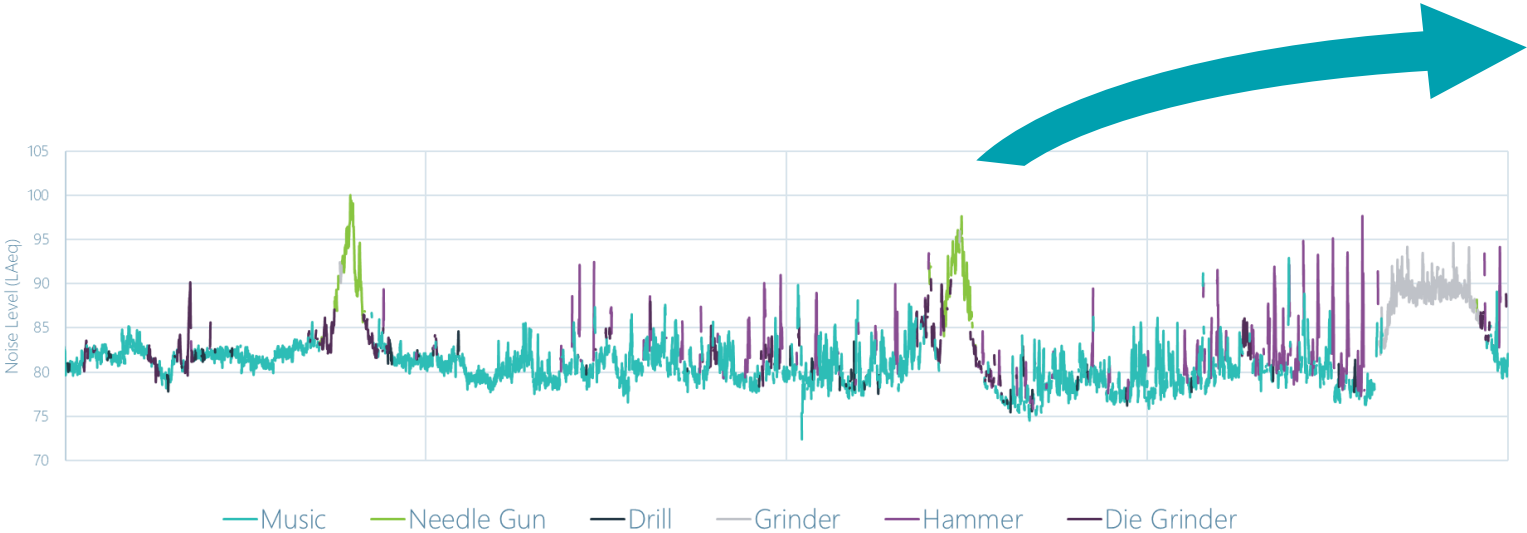
noiseAI classifies the dosimetry time history



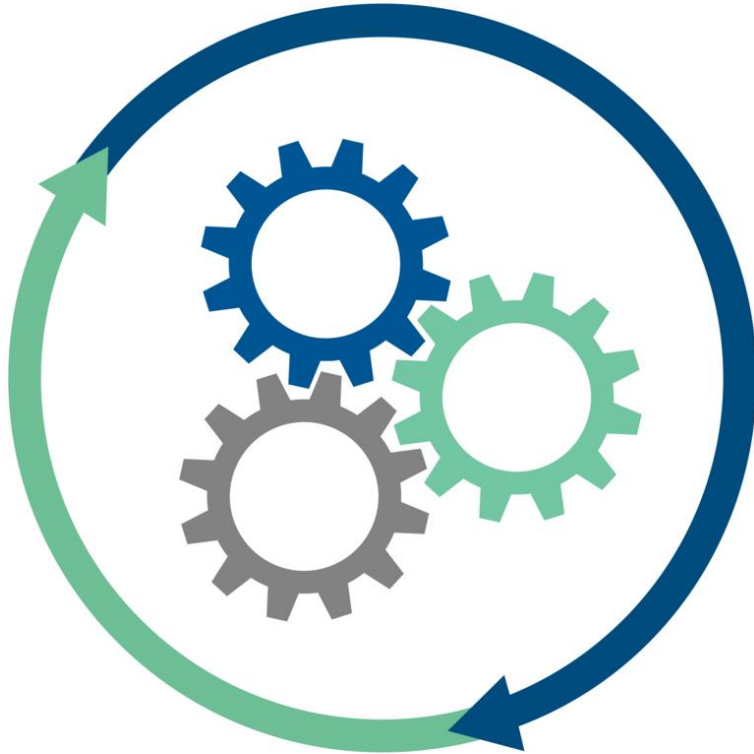
noiseAI determines exposure contributions

Exposure Contribution Summary

- Box size: Exposure contribution
- Box value: Average source level (dB(A))



The Process



Normal dosimetry program



Label noise sources from select samples



Upload dosimetry files to web-app

wood.