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Accelerometery and Machine Learning for Early Health Detection in Livestock and Companion Animals

Montout et al., The Veterinary Journal, bioRxiv 2024
https://doi.org/10.1016/j.tvjl.2025.106352
https://www.biorxiv.org/content/10.1101/2020.08.03.234203v4

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Environmental sustainability and net-zero

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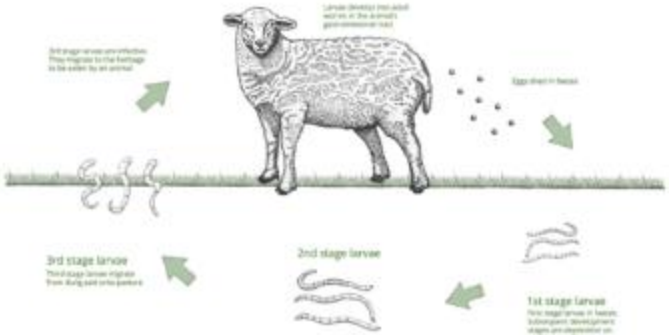
Picture from: https://www.atlas-h2020.eu/european-conference-on-precision-livestock-farming-postponed/

Haemonchus contortus infection and FAMACHA



*Picture from /www.farmhealthfirst.com

*Picture from zootecniaativa.com

FAMACHA Transition

FAMACHA Evaluation A
Score 1

FAMACHA Evaluation B
Score 2

Day1 Day2 Day3 Day4 Day5 Day6 **Day7** Day8 Day9 Day10 Day11 Day12 Day13

First Transition label: 1To2

FAMACHA Evaluation C
Score 2

FAMACHA Evaluation D
Score 1

Day14 Day15 Day16 Day17 Day18 Day19 **Day20** Day21 Day22 Day23 Day24 Day25

Second Transition label: 2To2

Third Transition label: 2To1

Data Acquisition and Hardware

Base station:

- Range >1 Km (clear sight)

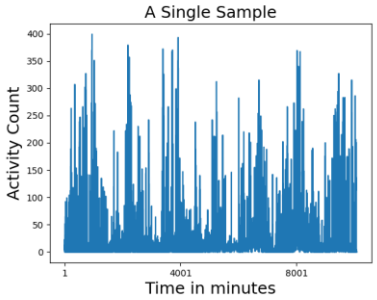
Sensor main components:

- Accelerometer.
- RFID communication chip.
- Battery.

Actical Accelerometer (Philips)

*Photo from Bristol Cats Study Newsletter - Autumn 2019

Machine learning Pipeline



Raw data

Repair to 1 min bin (backfill, unify time axis, export csv)

Imputation

Build samples

FAMACHA farmer's report

Quotient Normalisation

Anscombe

Log

CWT

Pre-processing

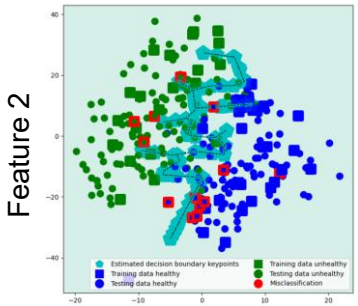
Machine learning

SVM

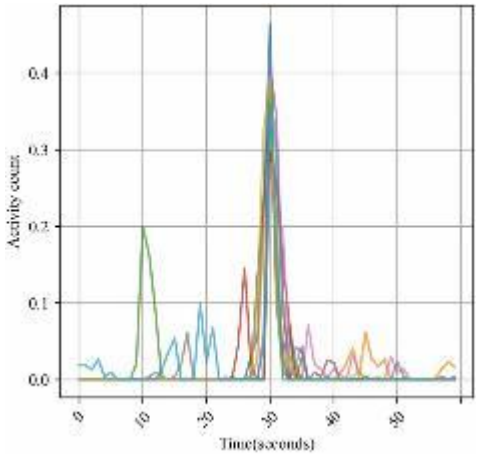
LREG

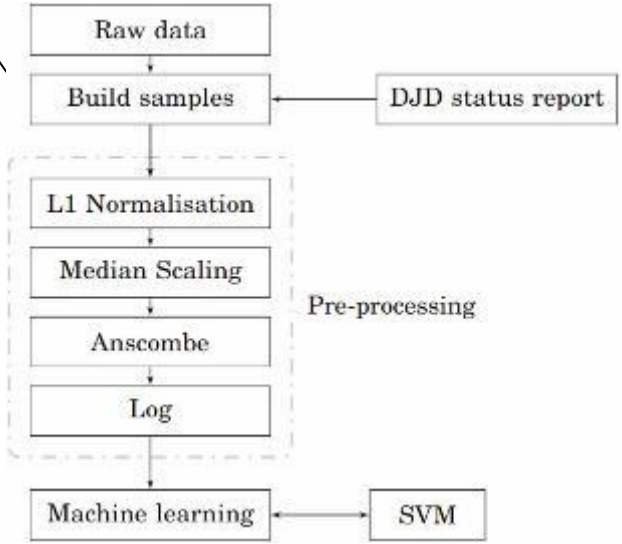
KNN

DTREE



Machine learning Pipeline





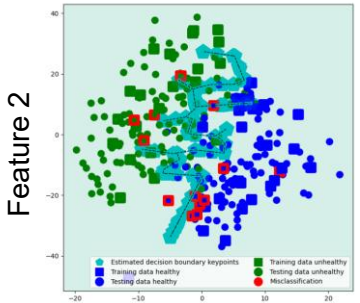
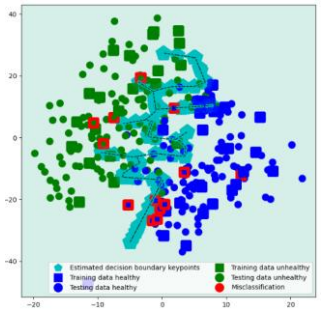


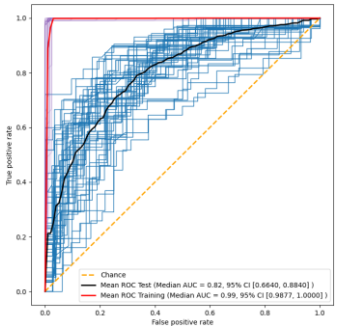
Table 1. Characteristics of the study group

	Cedara	**Delmas**
Data collection period	April 2012 to July 2013	March 2015 to April 2016
Species	Goat	Sheep
Animals tagged	227	64
Tag type	Accitrack v1	Accitrack v2
Age range	2-6 years	2-6 years
Average weight	44.19 kg	72.79 kg
FAMACHA evaluation	fortnightly	weekly
Animals evaluated	64	31
FAMACHA 1 $\rightarrow$ 1	31.9%	34.9%
FAMACHA 1 $\rightarrow$ 2	12.8%	18.3%
FAMACHA 2 $\rightarrow$ 1	13.5%	18.4%
FAMACHA 2 $\rightarrow$ 2	13.9%	28.2%
FAMACHA 3+	28.8%	0.2%

Classification of health status with SVM

Healthy class: FAMACHA 1To1
Unhealthy class: FAMACHA 2To2
Cross validation: Repeated K-Fold

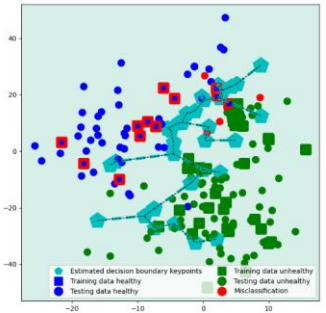


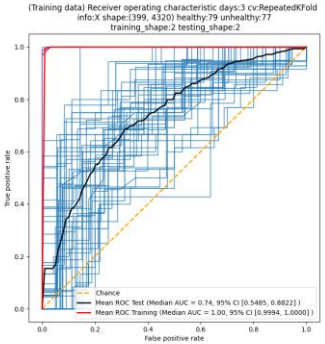


Class 1To1: 156
Class 2To2: 146

Precision class healthy: 0.75%
Precision class unhealthy: 0.73%

Chance
Mean ROC Test (Median AUC = 0.82, 95% CI [0.6640, 0.8840])
Mean ROC Training (Median AUC = 0.99, 95% CI [0.9877, 1.0000])





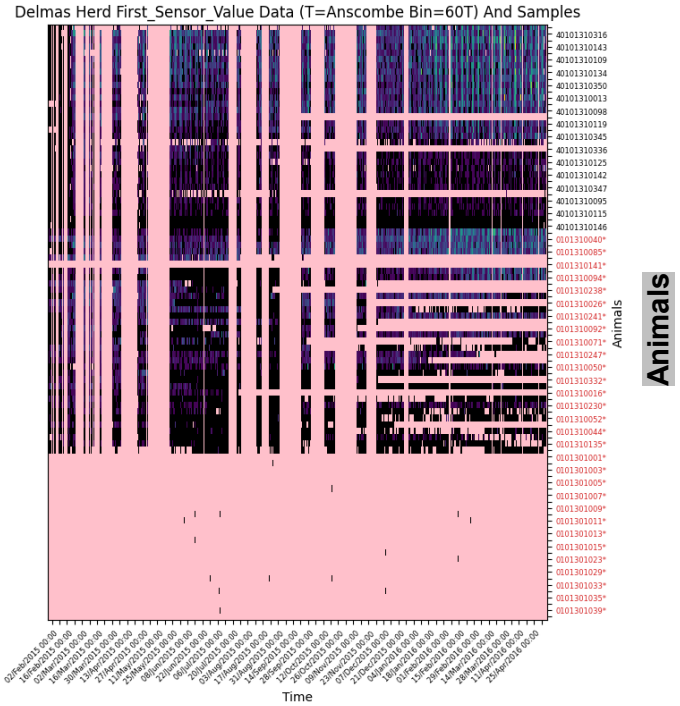
Class 1To1: 79
Class 2To2: 77

Precision class healthy: 0.66%
Precision class unhealthy: 0.66%

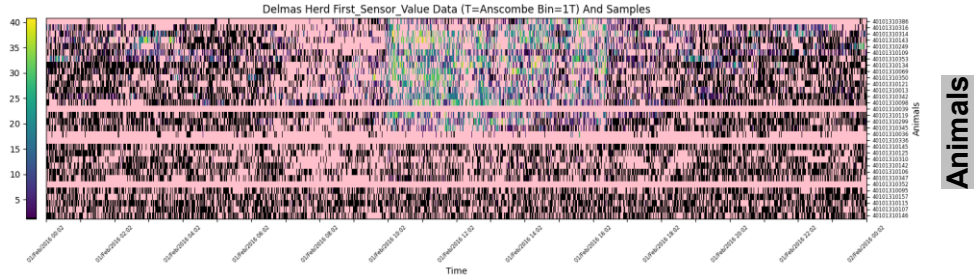
Chance
Mean ROC Test (Median AUC = 0.74, 95% CI [0.5485, 0.8822])
Mean ROC Training (Median AUC = 1.00, 95% CI [0.9994, 1.0000])

* Precision = tp / (tp + fp)

Need for Imputation



~1 Year



1 Day

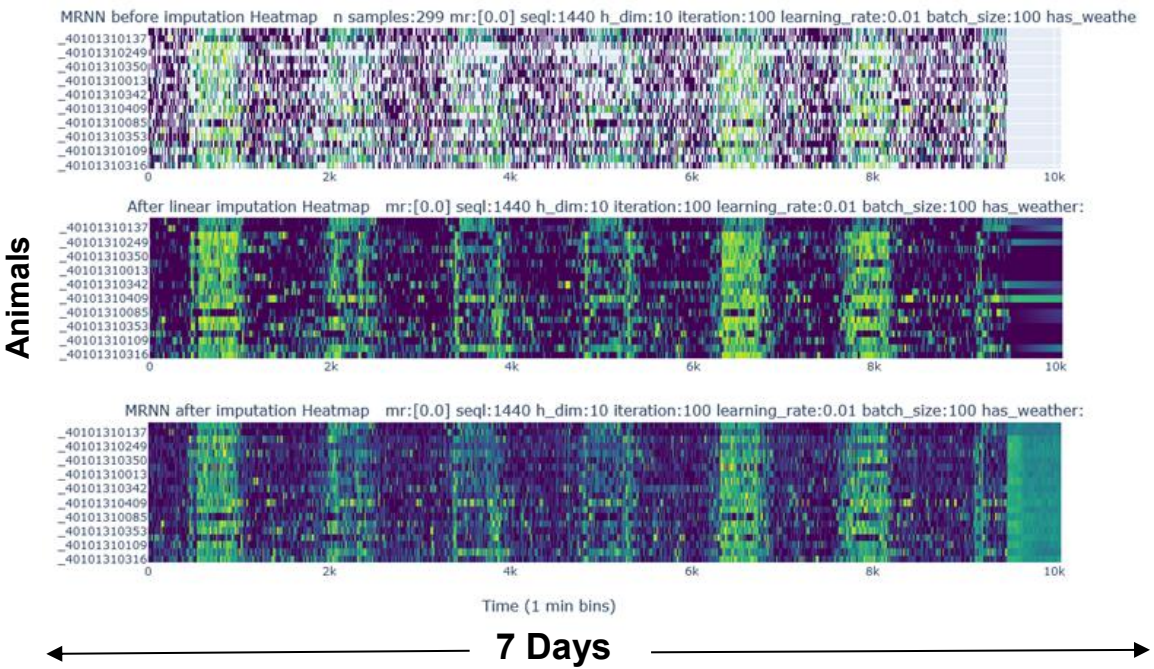
Causes of Missing Data:

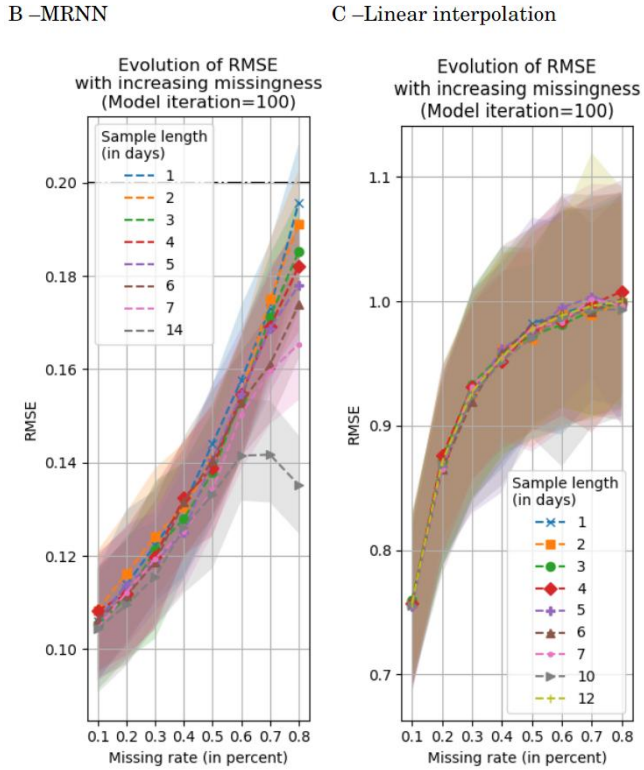
- Long periods with no data due to data administrator oversight.
- Drop of information packets during transponder-base station communication.

Importance of Data Imputation:

- Data imputation is essential for optimal functioning of the ML pipeline in predicting animal health.

MRNN* Imputation VS Linear Interpolation





- MRNN learns what a typical day in the herd looks like

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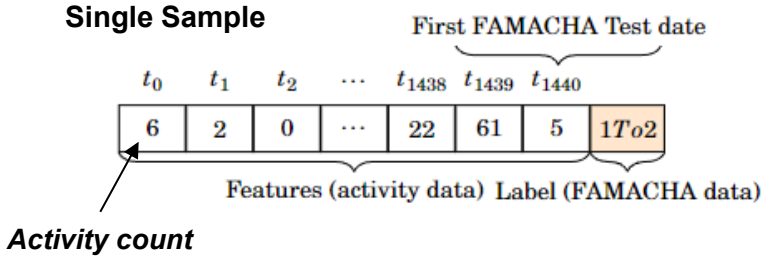
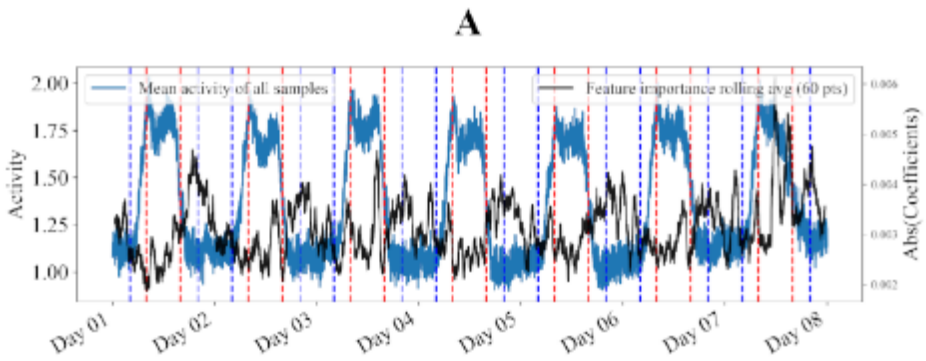
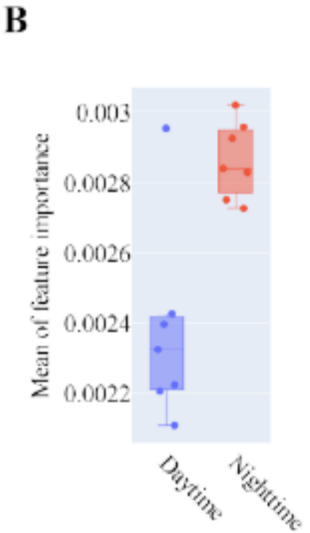
* https://ieeexplore.ieee.org/document/8485748

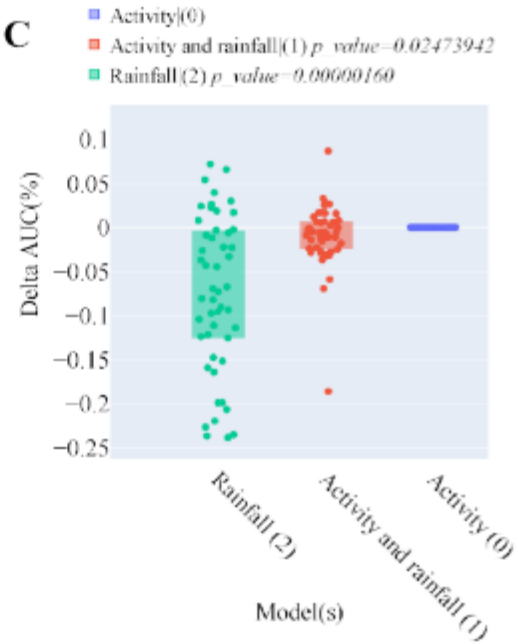
Machine Learning Sample



Feature Importance and Interpretation (Linear SVM)



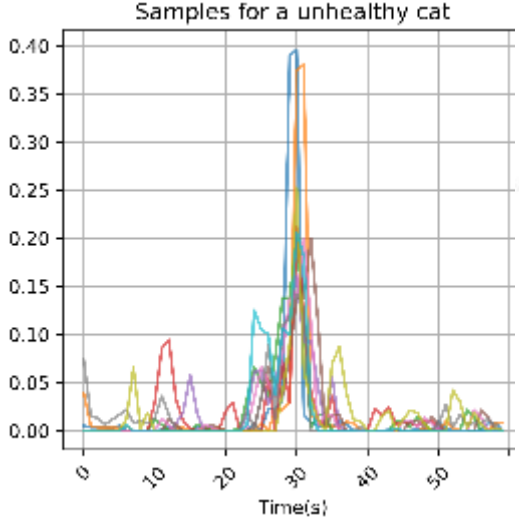


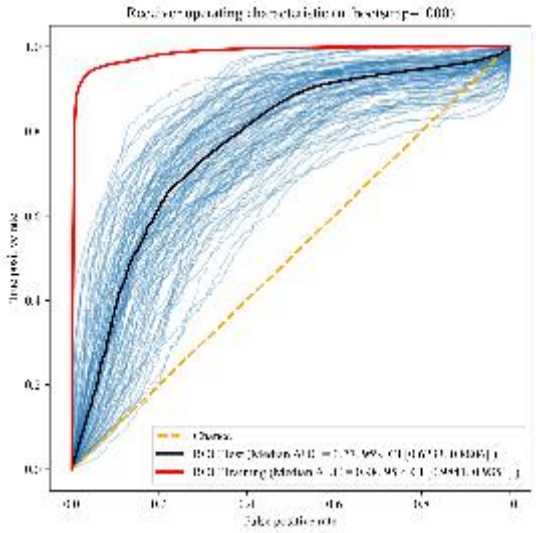


Accelerometer-derived classifiers for early detection of degenerative joint disease in cats

A.X. Montout, E Maniaki, T. Burghardt, M. J. Hezzell, E. Blackwell, A.W. Dowsey

doi: https://doi.org/10.1101/2024.12.13.628330





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Sum up & on the field application

Promising results but not enough samples for generalisation.

Unbalanced dataset.

On-farm Training period.

Online learning.

Data acquisition was difficult.

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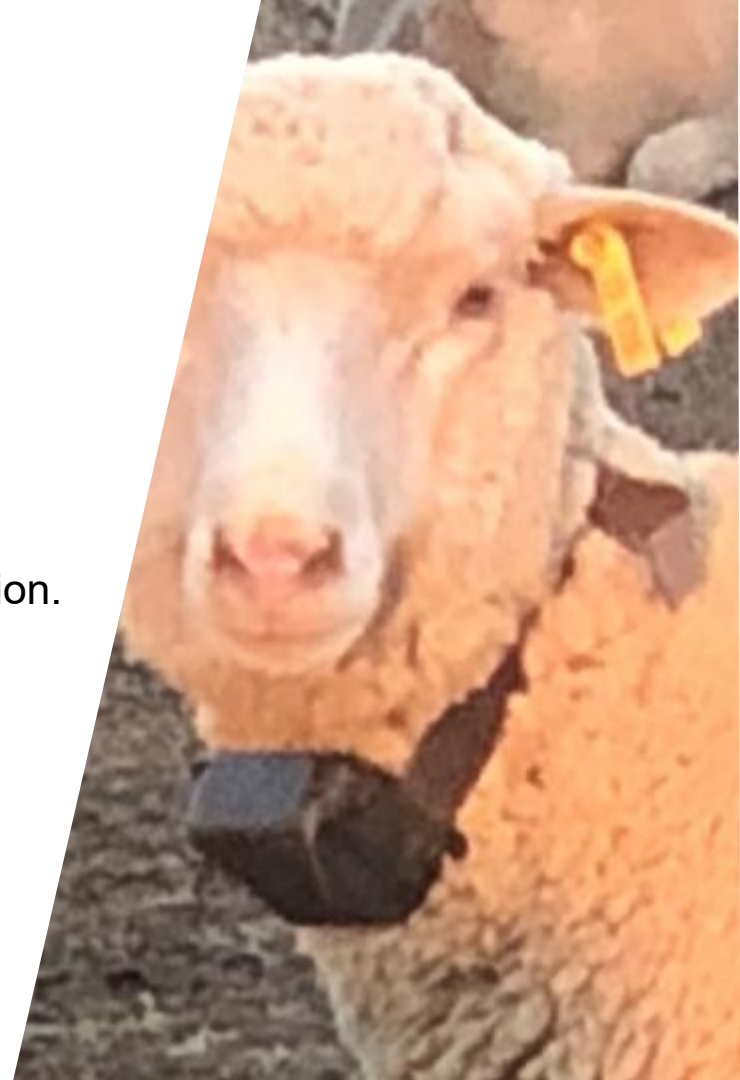
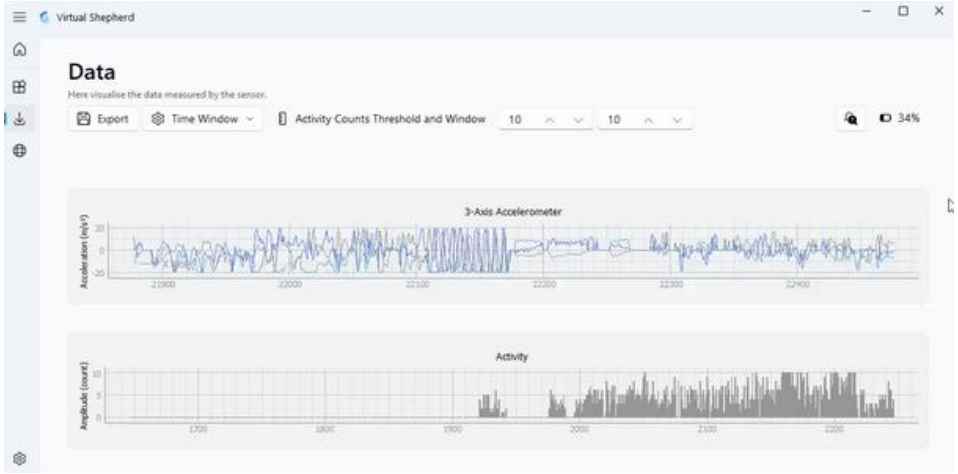
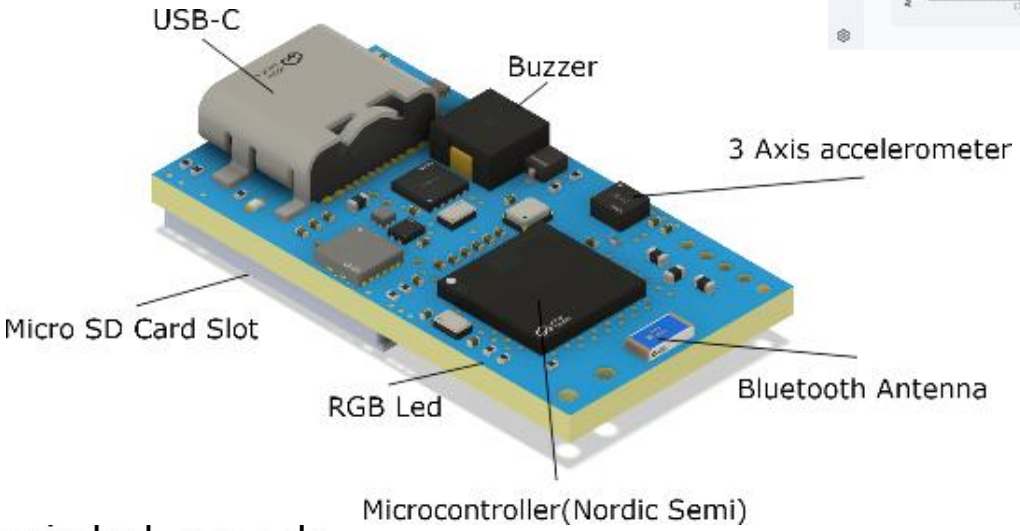


New Open-source sensor

axel.montout@bristol.ac.uk

- Small form factor (3 cm x 1.5 cm)
- On Board Memory (SD)
- Fully programable
- Bluetooth
- Raw data access





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Flexible design

- Soft Silicone sleeve attachment
- Adapts to any collar
- Preserve welfare

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