Detection of Rumination in Cattle using Bolus Accelerometer Sensors and Machine Learning

Andrew Hamilton, Chris Davison, Christos Tachtatzis, Craig Michie

Ivan Andonovic

University of Strathclyde
IoF2020 Dairy Trial Use Case 2.3 - Herdsman+

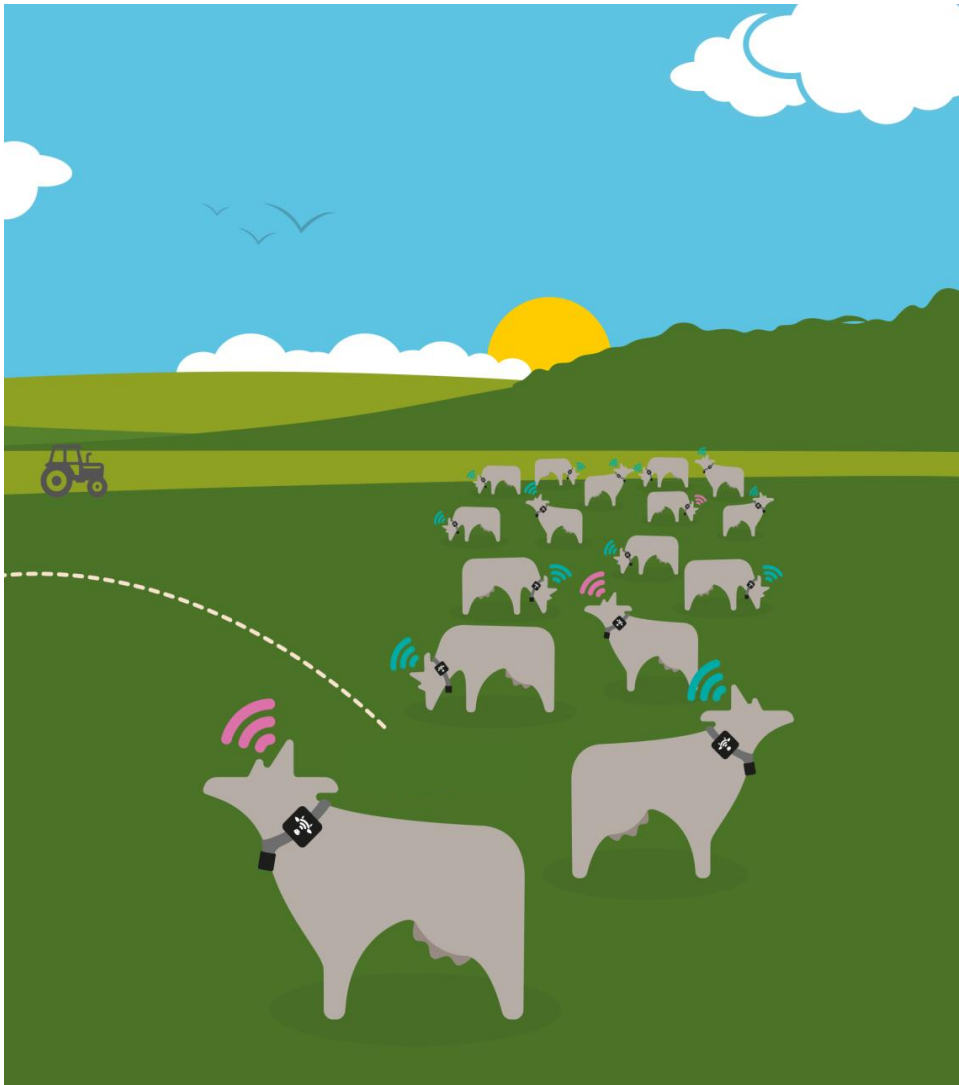
Nicholas Jonsson

University of Glasgow

Institute of Biodiversity Animal Health & Comparative Medicine

Herdsman+

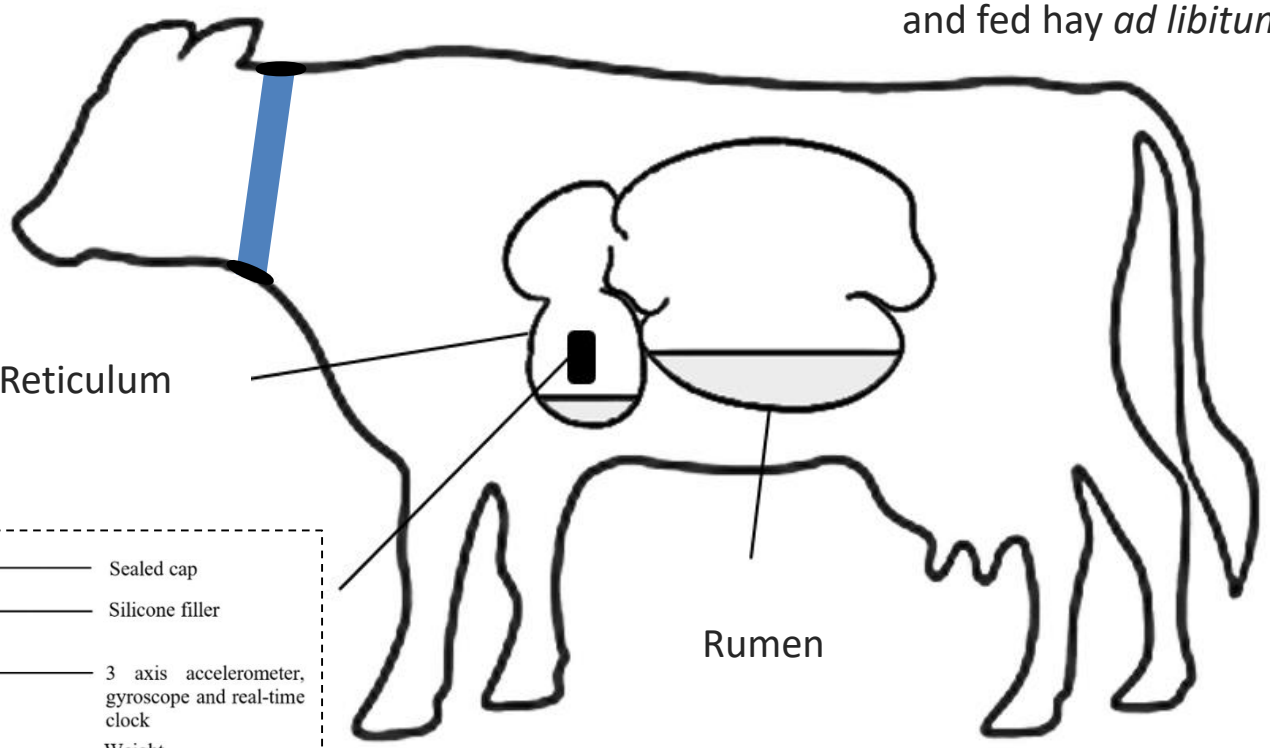
- Herdsman+ aims to integrate discrete sensor systems to provide greater insights into dairy cow fertility and health
- sensor outputs are combined to provide added value through improved behavioral classifications and health alerts
- novel analysis methods can be integrated to platform such as machine learning
- Case study is bolus sensors

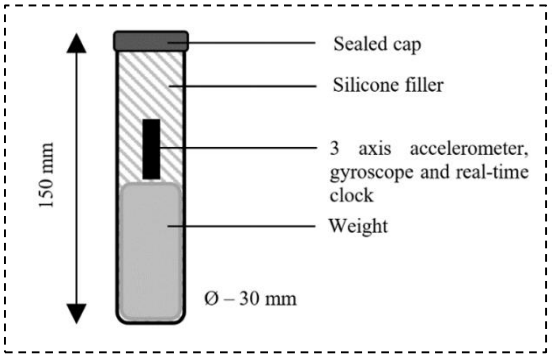


Bolus

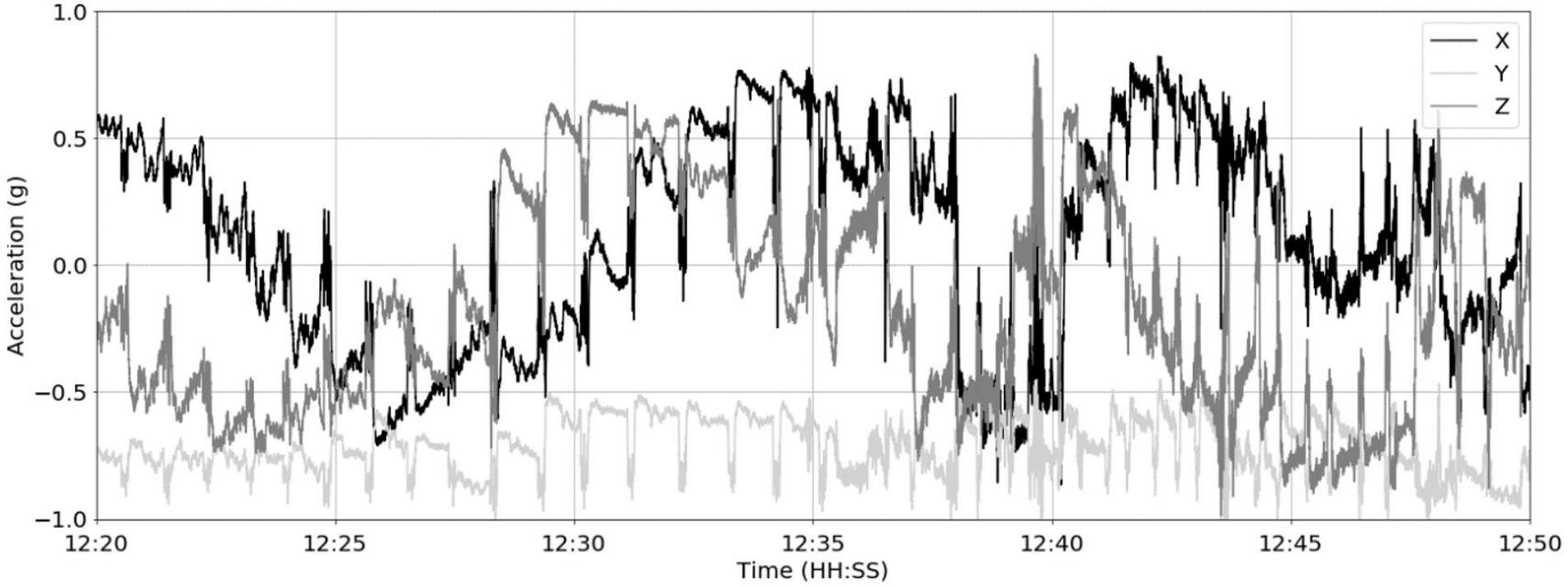
Activity collars to correlate motion of bolus sensor cow rumination, a key indicator for health and fertility

6 Jersey cows, 60 day trial, housed indoors in a straw yard and fed hay *ad libitum*



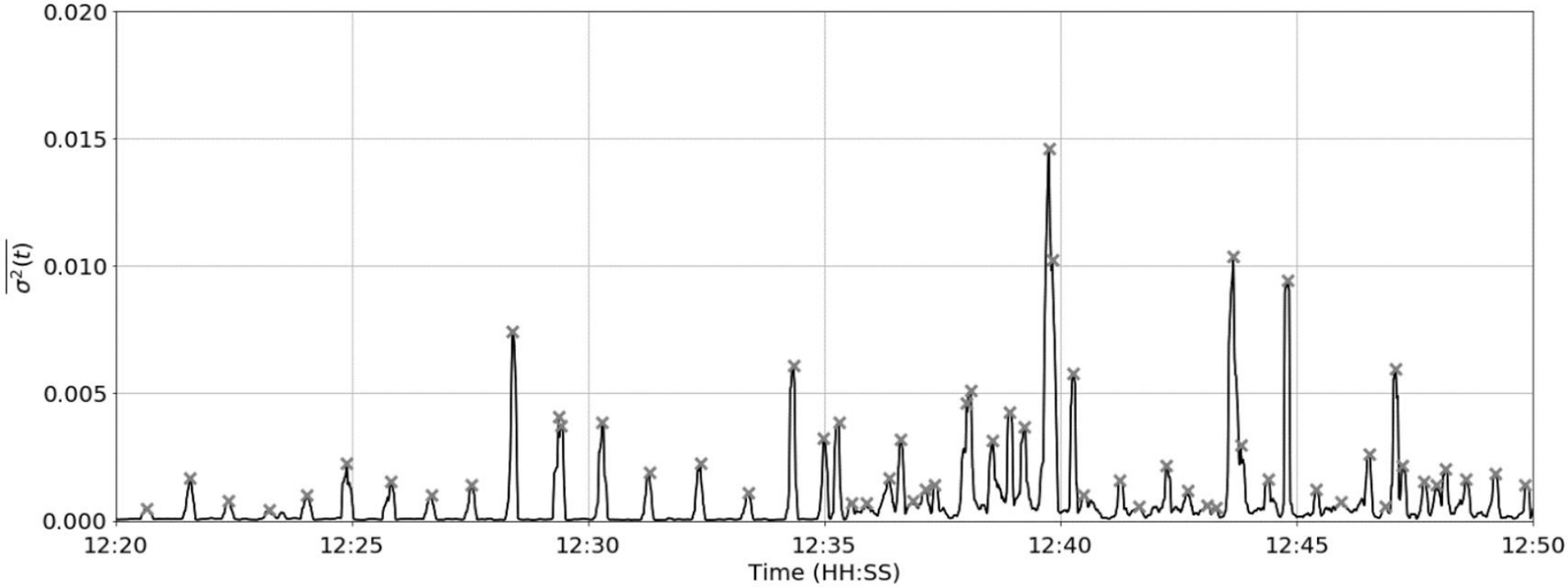


Raw Bolus Acceleration



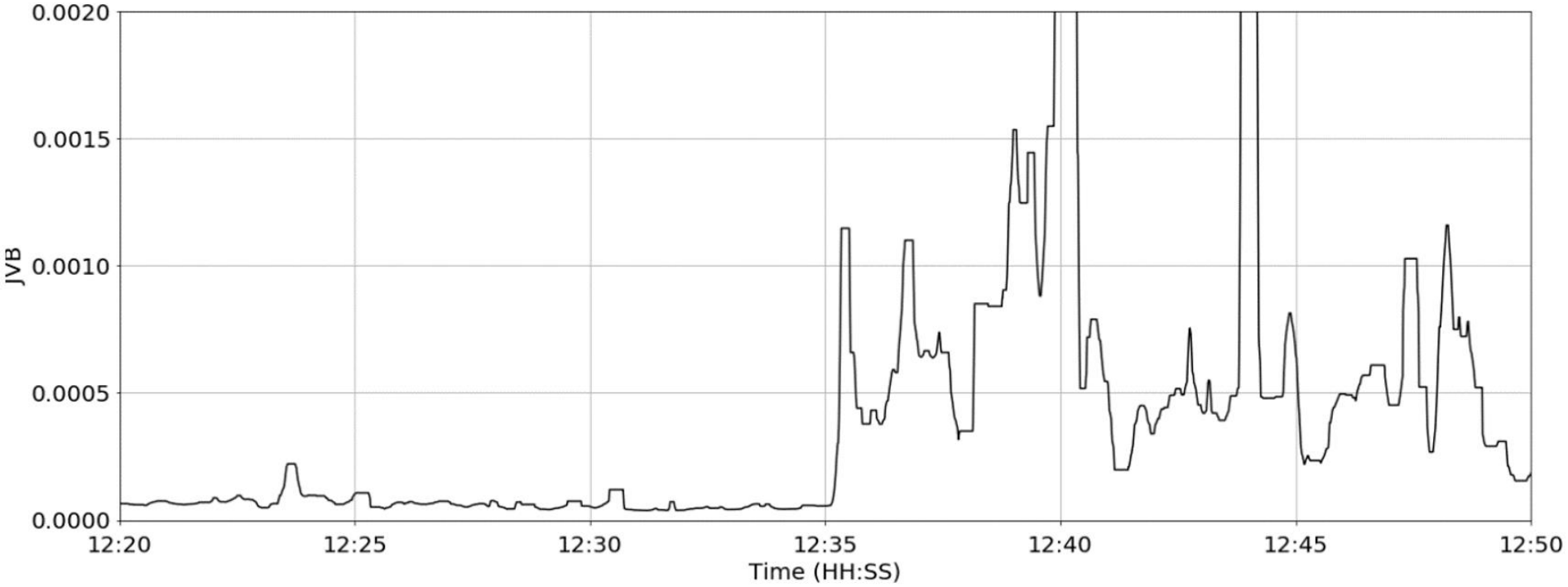
- 3 axes acceleration with range of +/- 1 g
- Behaviour states from collars were used as truthing

Feature Extraction – Inter-contraction Interval (ICI)



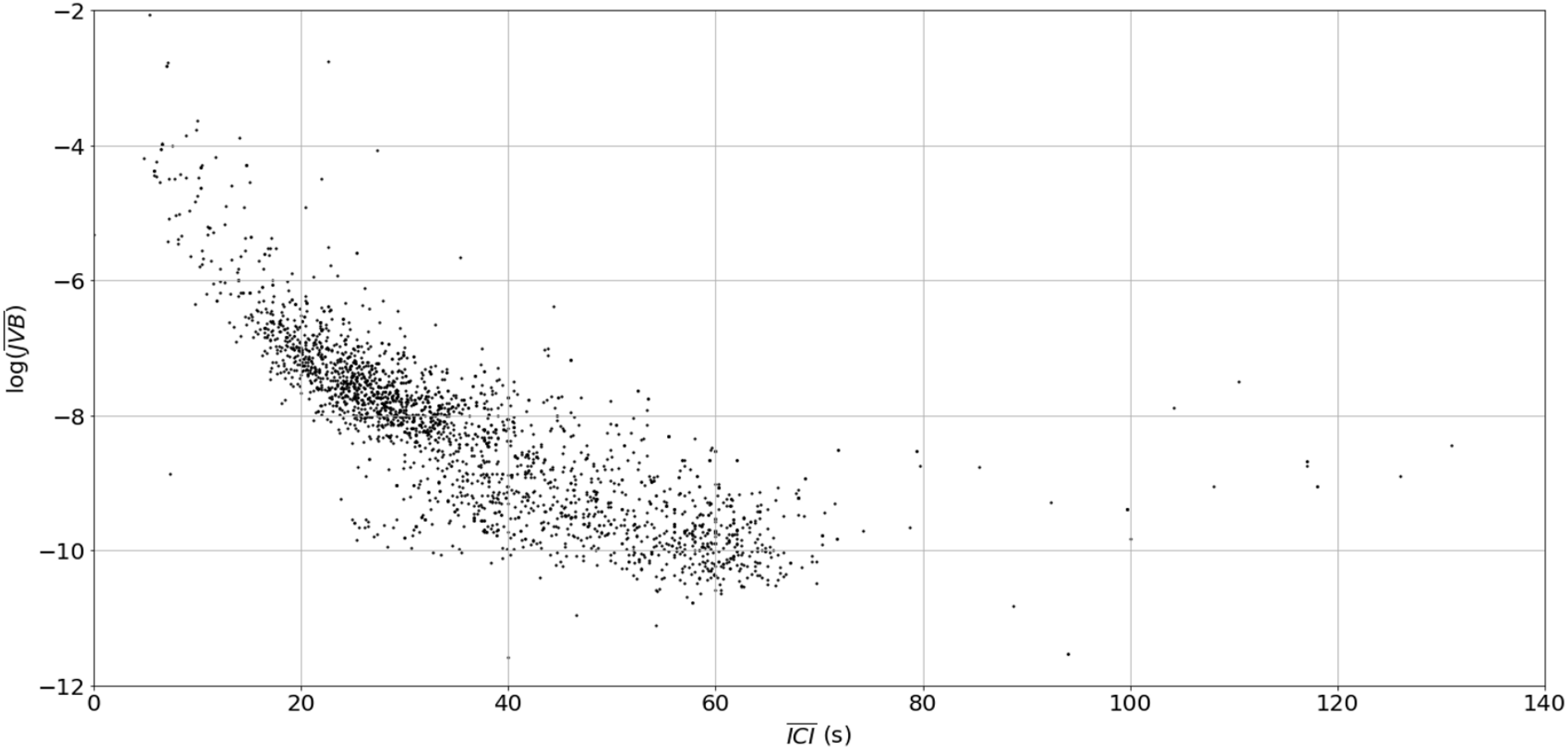
- 1st feature extracted – inter-contraction interval (ICI)
- Time between high energy movement of fluid in reticulum, associated with rumination and eating behaviours

Feature Extraction – Jerk Variance Baseline (JVB)



- 2nd feature extracted – jerk variance baseline (JVB)
- The variance of the combined x, y, z acceleration with filtering to remove high energy peaks

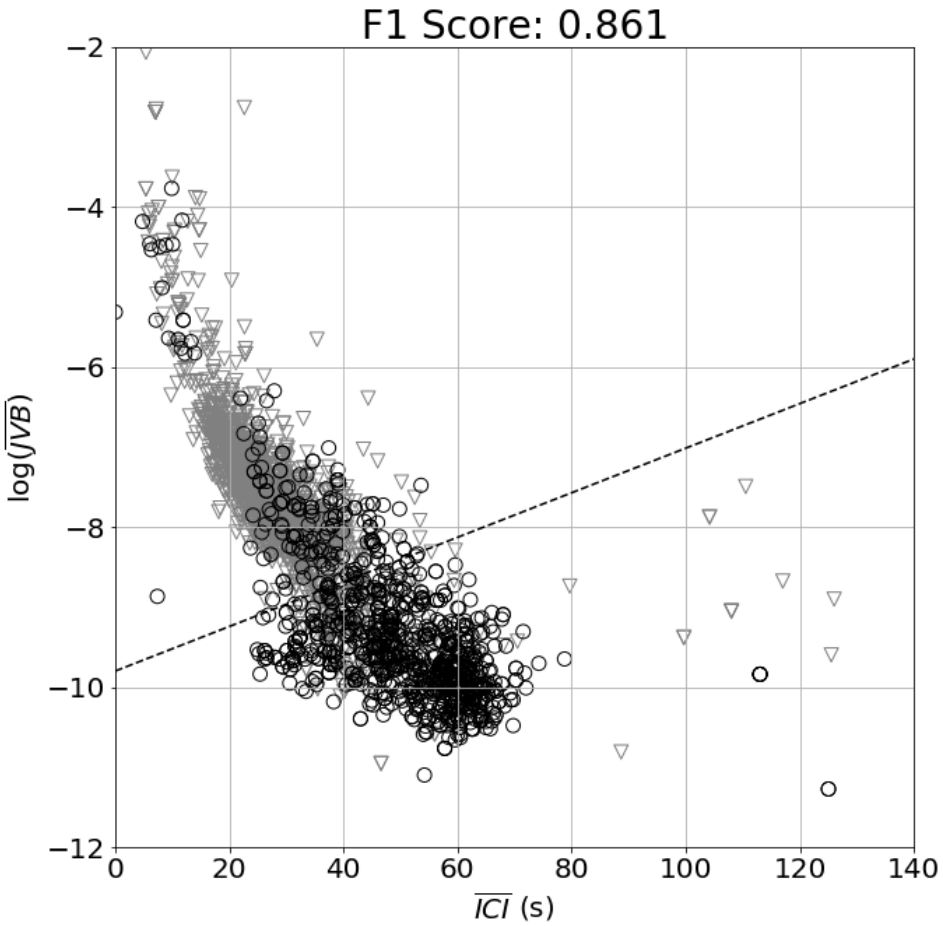
Support Vector Machine (SVM)



- Average ICI and JVB evaluated for window
- Support Vector Machine (SVM) used to evaluate decision boundary between rumination and non-ruminating states

Results

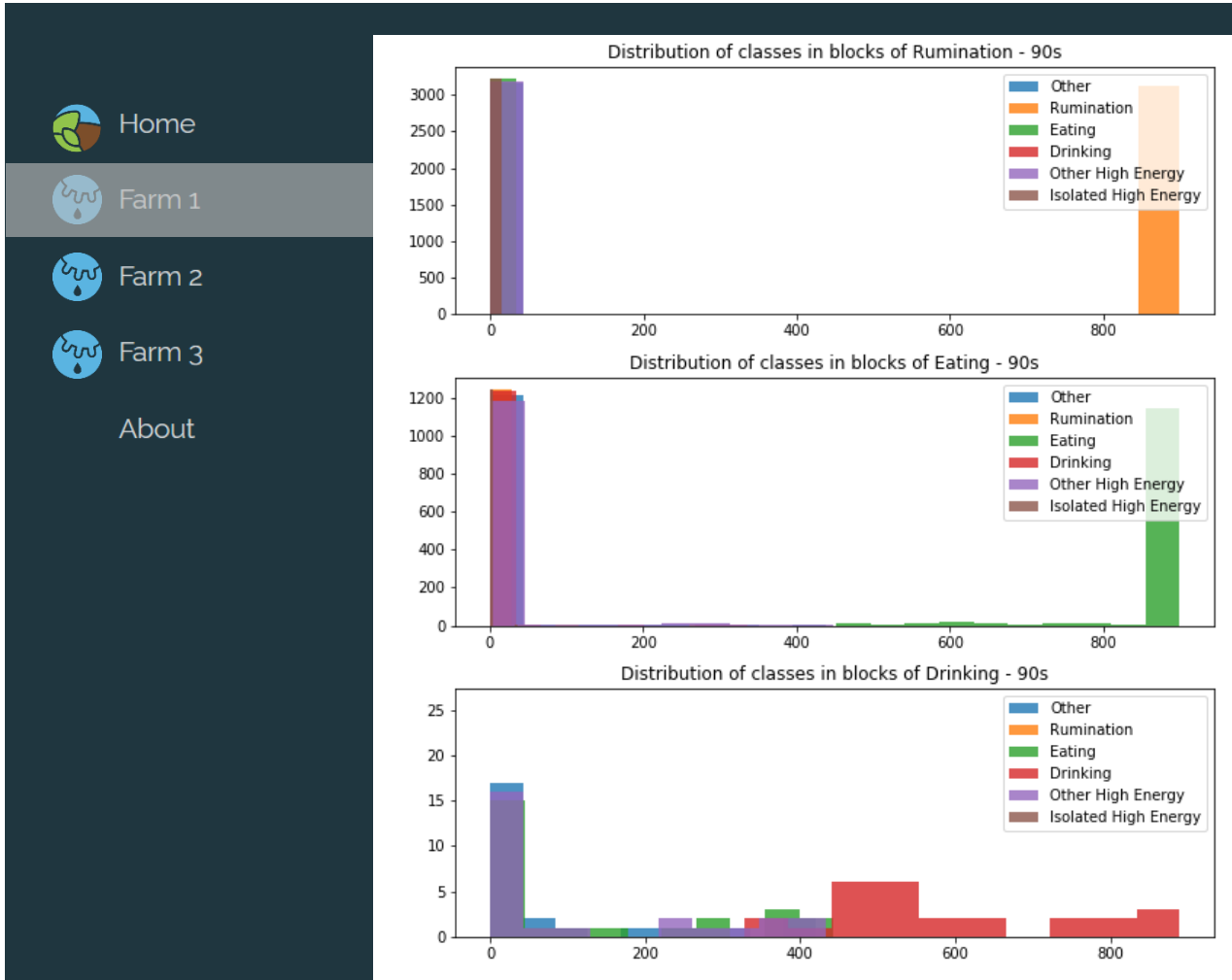
- SVM with selected features able to detect rumination periods with 86.1% accuracy
- Derivation of novel classification model using multi-sensor data analysis and IoT-enabled technology



Hamilton, A., et al [Sensors 2019, 19(5), 1165; https://doi.org/10.3390/s19051165]

Herdsman+

- Integration of discrete sensors such as bolus possible on Herdsman+ app
- Application of novel analysis methods such as CNN's for multi-label classification



Conclusions

- Activity-based boluses indicate the time spent ruminating with acceptable accuracy
- Large cloud-based datasets allows novel analysis methods such as machine learning to improve behavior classifications
- Farmers can benefit from IoT-enabled sensors that enable additional insights into cattle health and fertility

University of
Strathclyde
Glasgow