SmartCow

an integrated infrastructure for increased research capability and innovation in the European cattle sector

Using sensor data to phenotype behavioural traits, health and feed efficiency

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924

Behaviour...

manifestation of the animal's internal state

Can we process data from sensors

to detect states such as sickness behaviour, stress, oestrus, calving ?

PLF tools

link between the animal and its environment: exploring, eating, interacting with others

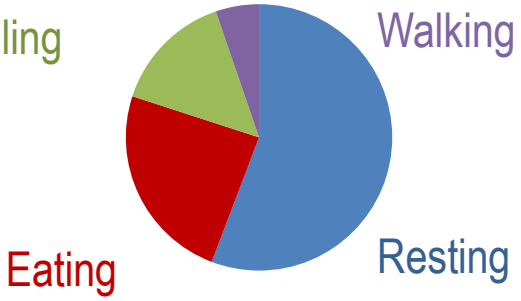
to predict complex traits such as feed efficiency and sensitivity to health disorders?

Extraction of activity descriptors from sensor data = 24 h time series

Domain

Time

Budget



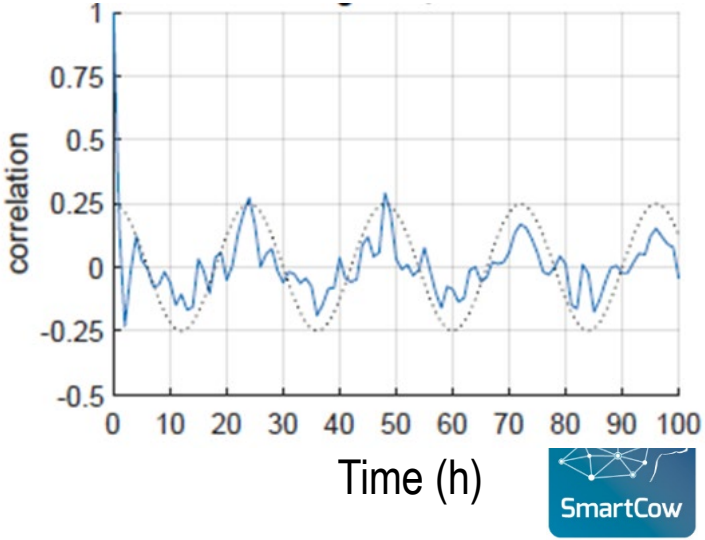
And also

- Activity level (How much active is a cow?)
- Min-Max
- Distribution (STD, quantiles), …

Frequency

Are there cyclic patterns?

- Autocorrelations
- Ad hoc operator for non-periodicity
- Fourier Transform



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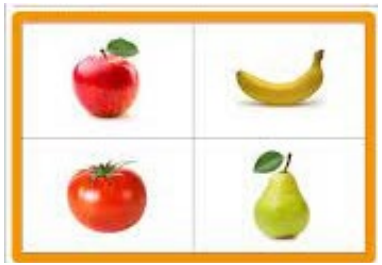
Relation between sensor-based activity data and other animal characteristics



Phenotyping of behaviour (traits)
to characterise animal efficiency
to detect animals that can be at risk

Monitoring of behaviour (events)
to detect occurrence
of stress, disease, oestrus, calving

A- Prediction of feed efficiency

Feed efficiency defined as
energy-corrected milk (ECM) / Feed intake (DMI)
with ECM = (*0.3246 kg milk) + (12.86 kg fat) + (7.04 kg protein)*

Data from feed bin

27% of variability in Feed efficiency explained by

- Eating rate β = -0.0014
- Var(Number of feed bin visits) 0.0011

Prediction is not increased by taking into account the activity of the animal (apart from eating)

The slower the cow eats and the more variable its feeding frequency, the more efficient the cow is

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B- Prediction of cow sensitivity to health disorders

Activity meters before calving

?

Health after calving:
Clinical observations + assays
= Total Deficit Score

38% variability in Total Deficit Score explained by

- Non-periodicity of standing up events $\beta = 4.535$
- Cyclic component of time spent standing -0.384
- Time spent inactive 0.0234

The more a cow show cyclic patterns of activity before calving,
the better its health after calving

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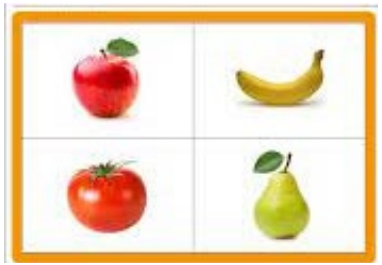
Relation between sensor-based activity data and other animal characteristics



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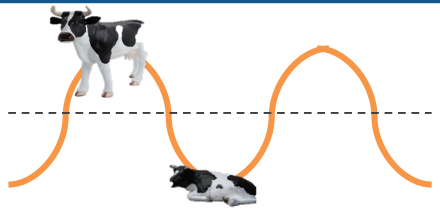
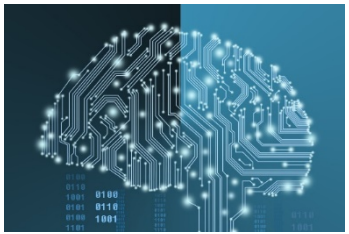
Analysis of cow state in real time



21 features

Machine Learning



		Predicted class								All datasets	
	Cow state from caretakers	Control	Oestrus	Calving	Lameness	Mastitis	Other	Mixing	Disturbance	At least 1 series Detected	day before
True class	Control	100	0	0	0	0	0	0	0		
	Oestrus	61	37	0	0	0	0	0	1	100	63
	Calving	24	0	23	0	0	0	44	9	100	97
	Lameness	64	0	0	36	0	0	0	0	100	96
	Mastitis	36	0	0	0	39	0	18	7	100	98
	Other disease	48	0	0	0	0	36	16	0	100	95
	Mixing	46	0	11	0	3	4	33	3	92	
	Disturbance	55	1	2	0	1	0	2	31	11	

Detection & distinction of cow states are now possible
+ often 1-2 before recording by caretakers

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IMPACTS

For infrastructures

- Extract of information from sensor data beyond what sensors were designed for
- Access to traits which would be difficult to assess by direct observations (e.g. activity rhythm & regularity)

For academics

- Cyclic patterns of activity seem crucial to ensure animal functioning
- Monitoring with sensors gives access to many data and datasets that can be exploited without further experimentation (3R)

For industry

- Phenotyping: The analysis of behaviour can contribute to select efficient animals or to identify animals that will require close attention → strategic management
- Precision Livestock Farming systems can be enriched to early identify disorders (health, stress), oestrus, calving → operational management

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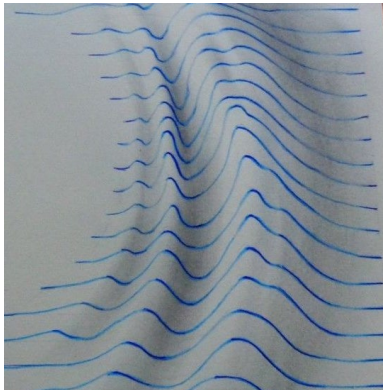
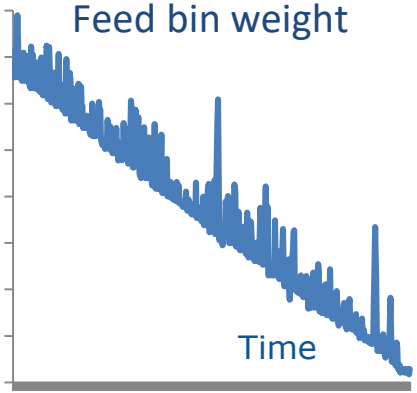
FUTURE PROSPECTS





- Further exploration of description of time series (wavelets, topographical indices,…)
- Fuzzy logic applied to labelling
- Analysis of precise feeding behaviour (taking a bite vs. chewing) in relation to feed efficiency

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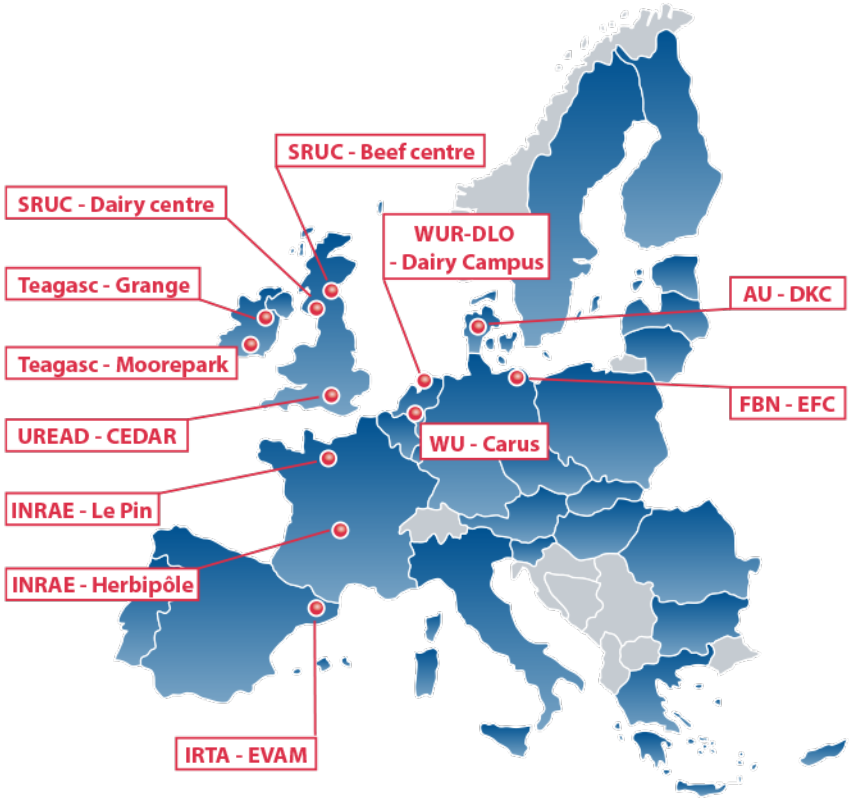
Thank you for your attention



First-class Cattle Research Infrastructures (RIs) across Europe:

- 11 major RIs distributed in 7 EU countries
- 12 locations, which include 18 installations
- 2500 dairy and 1000 beef cows

- **Networking of RIs** to inventorize resources, harmonize procedures, and share data
- **Joint research activities** to improve experimental methods and phenotyping capability
- **Interaction with stakeholders** to stay in line with industry needs and improve dissemination

http://www.smartcow.eu/stakeholders/

TRAINING PROGRAM

For Scientists, Technicians, Stakeholders, PhD students

- Face-to-face training courses
- Free web-conferences
- One-day study tours in 4 different countries

http://www.smartcow.eu/resources/training/

TRANSNATIONAL ACCESS CALLS

Offers external users (academic and industry) free access to SmartCow RIs

- 30 projects during the 4 years of SmartCow
- Access to around 10,000 cow-weeks

http://www.smartcow.eu/calls/

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