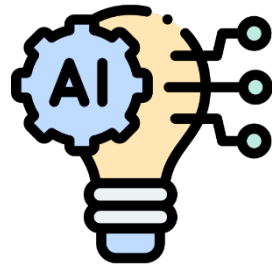




SCIENCE AND
EDUCATION **FOR**
SUSTAINABLE
LIFE



Sustainable and Responsible Digitalisation and AI in livestock production

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Jordbruksverket FoU days, October 25th & 26th, Linköping, 2023

We must build an agenda for **speedy yet sustainable economic growth that is **inclusive** of all, is **respectful** of individuals, **responsive** to innovation and **responsible** towards future generations.**

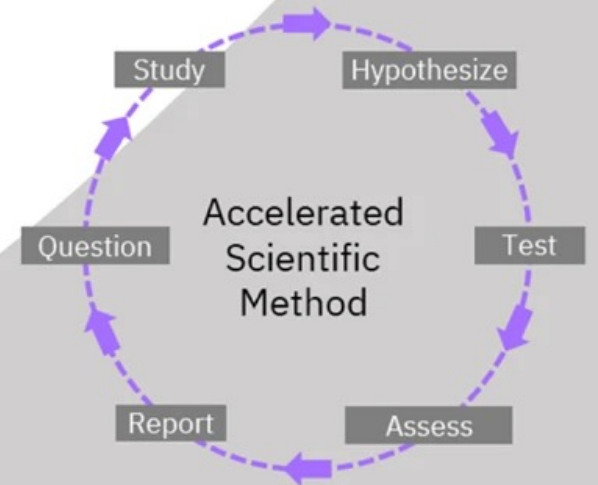
- Narendra Modi

Generative AI

Increasing speed, automation, and scale



Accelerated Discovery



Empirical Science
1st Paradigm

Observations
Experimentation

1600s

Theoretical Science
2nd Paradigm

Scientific laws
Physics, biology,
chemistry, etc

1950s

Computational Science
3rd Paradigm

- Simulations
- Molecular dynamics
- Mechanistic models

2000s

Big Data-driven Science
4th Paradigm

- Big data, machine learning
- Patterns, anomalies
- Visualization

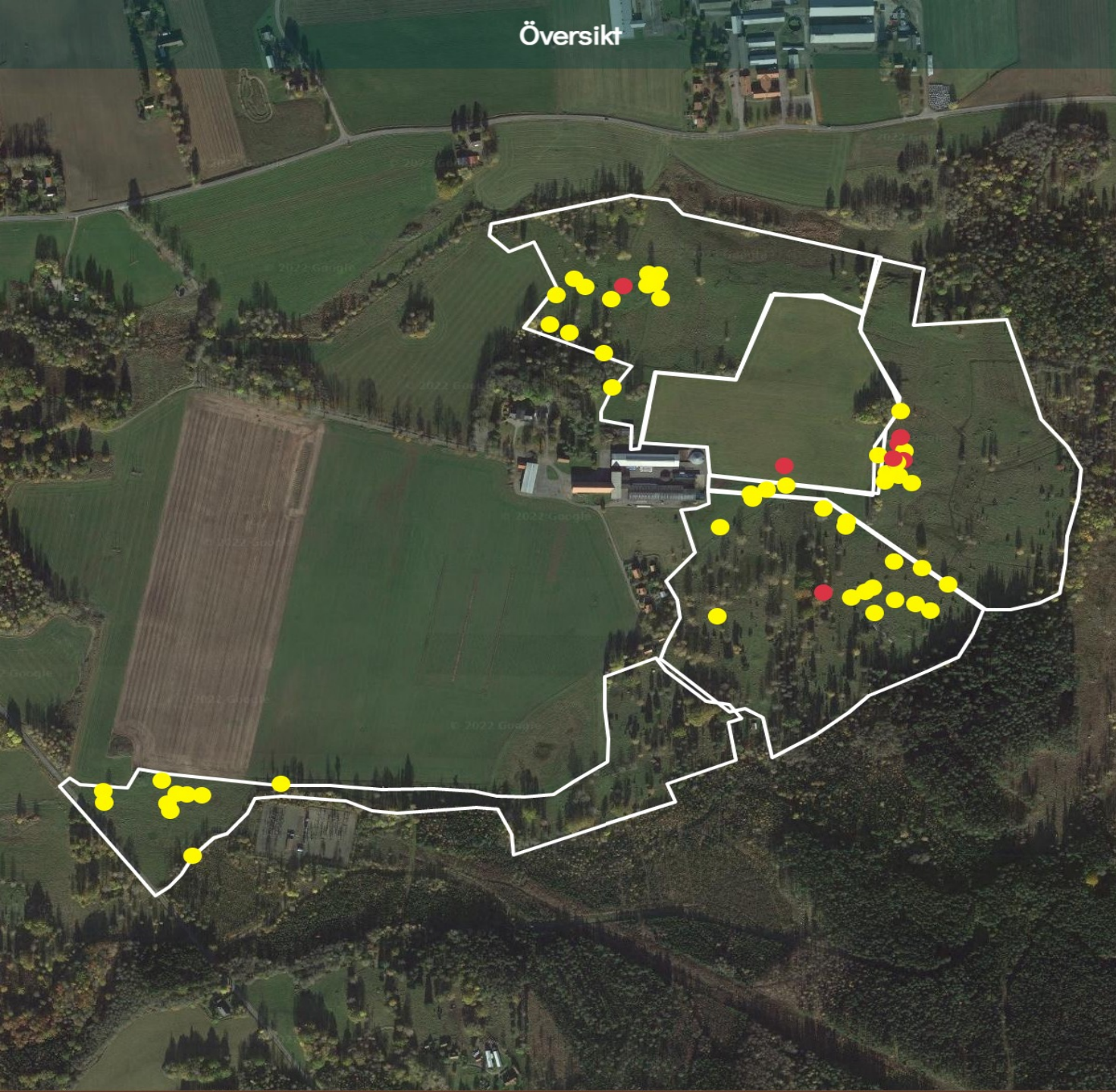
2020s

- Scientific knowledge at scale
- AI generated hypotheses
- Autonomous testing





Översikt



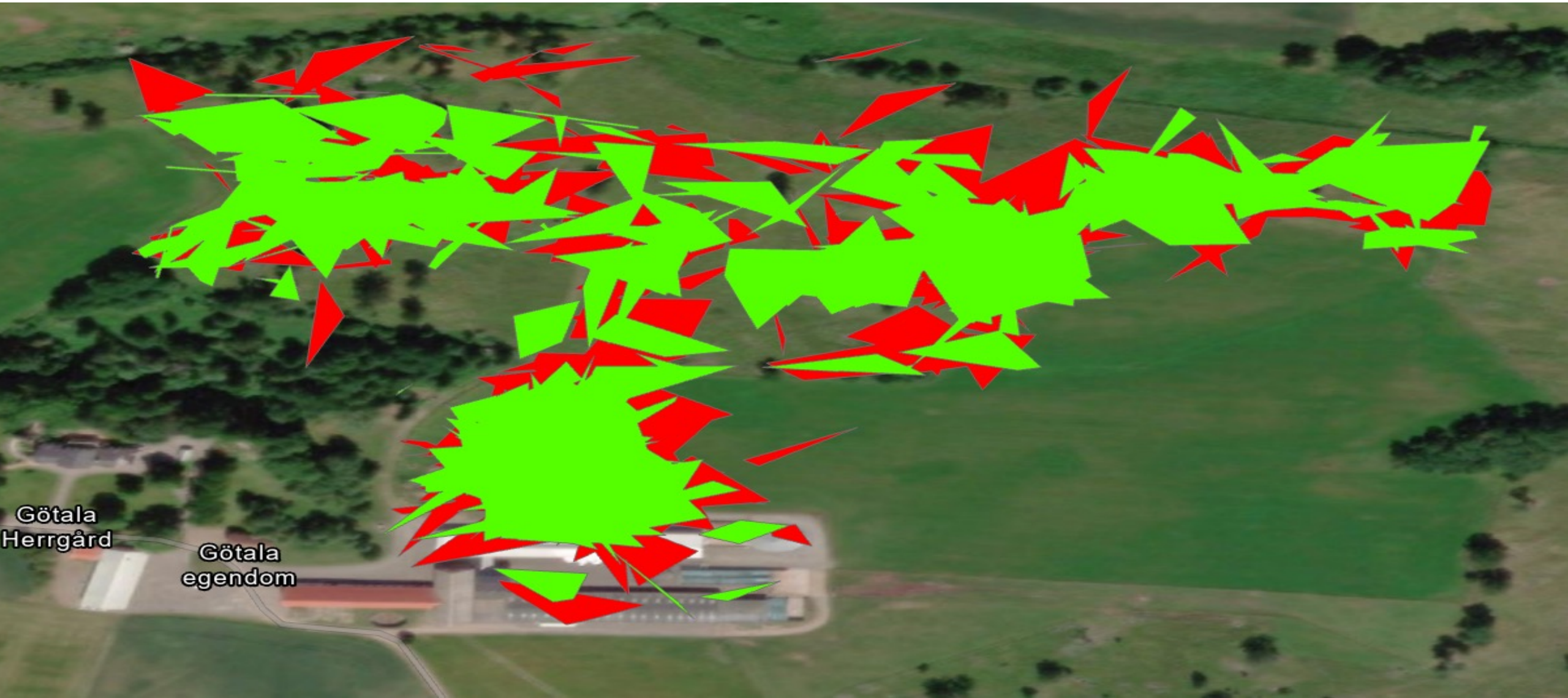
Experimental Design and Assumptions

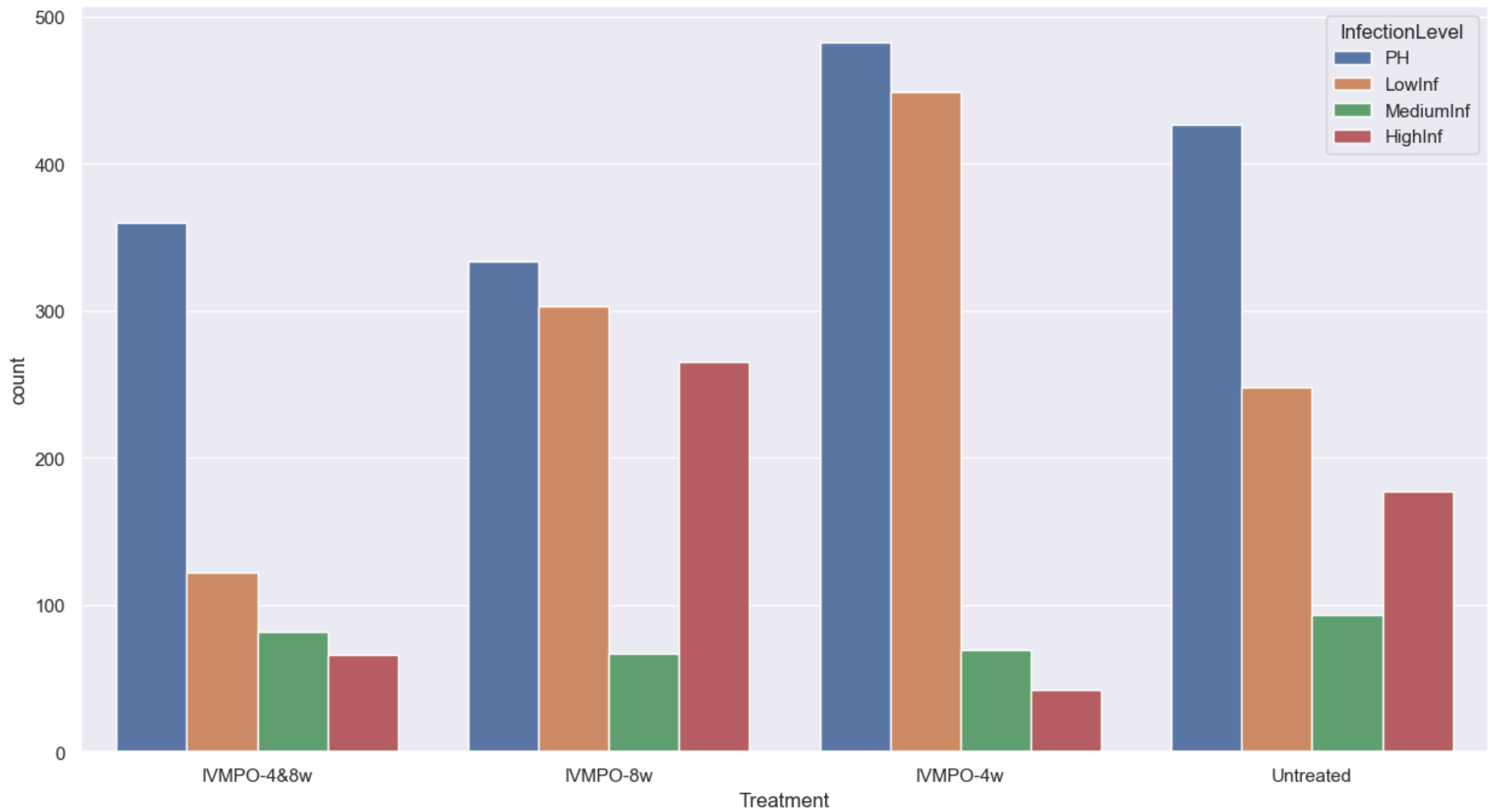
- 58 steers (of SH and SR breeds) with GPS-collars and IceQube devices to register position and activity;
- 10 weeks on pasture (infected upon release to pasture);
- 4 treatments: Untreated, IVM PO-4w, IVM PO-8w and IVM PO-4&8w;
- Blood and faecal samples + weights at regular intervals;
- Initial assumption was to get four groups with relatively high "contrast" in-between groups, exponential increase in EPG levels and fairly clear separation between treatments...

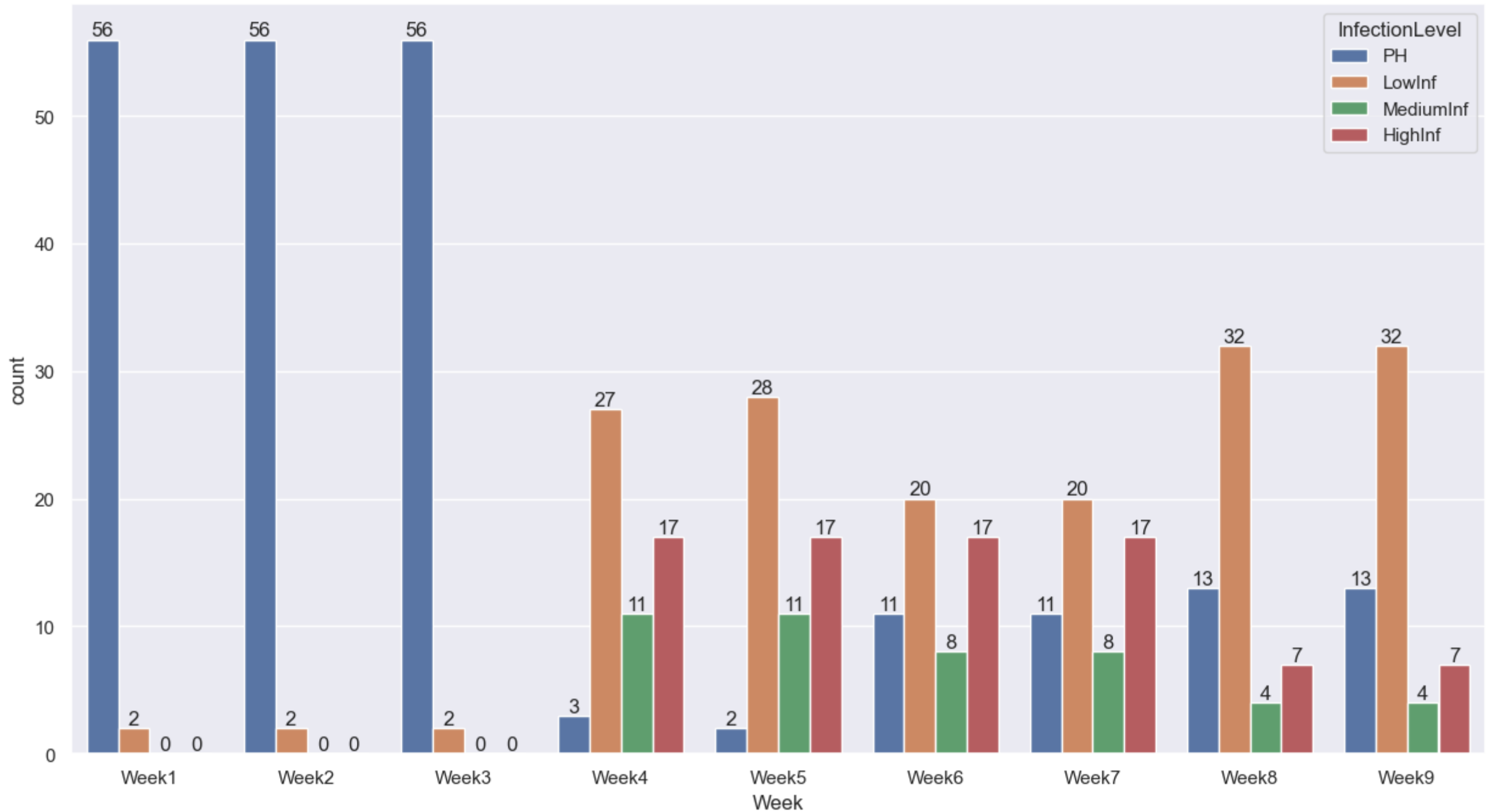
...vs High Infection Levels



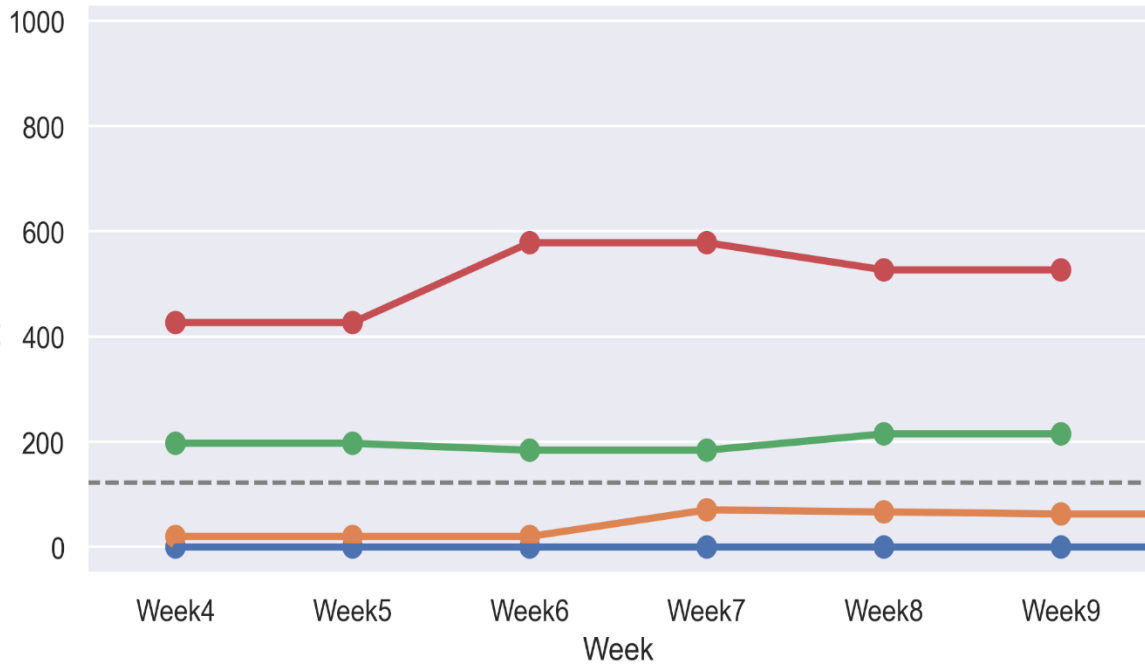
Do animals use the pasture in the same way???



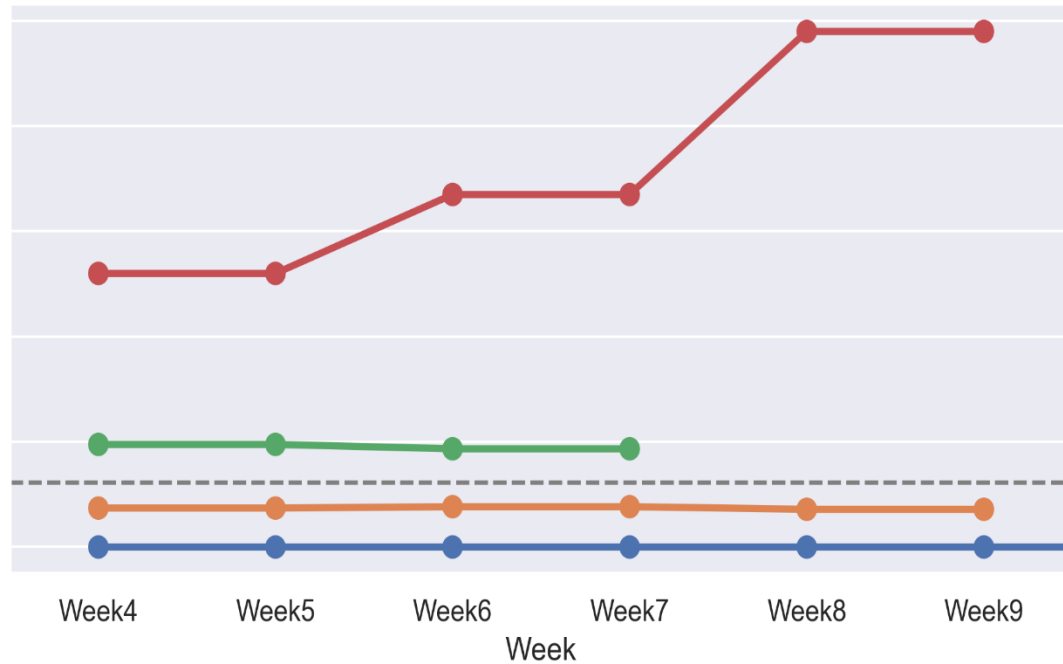




Breed = SLB



Breed = SRB

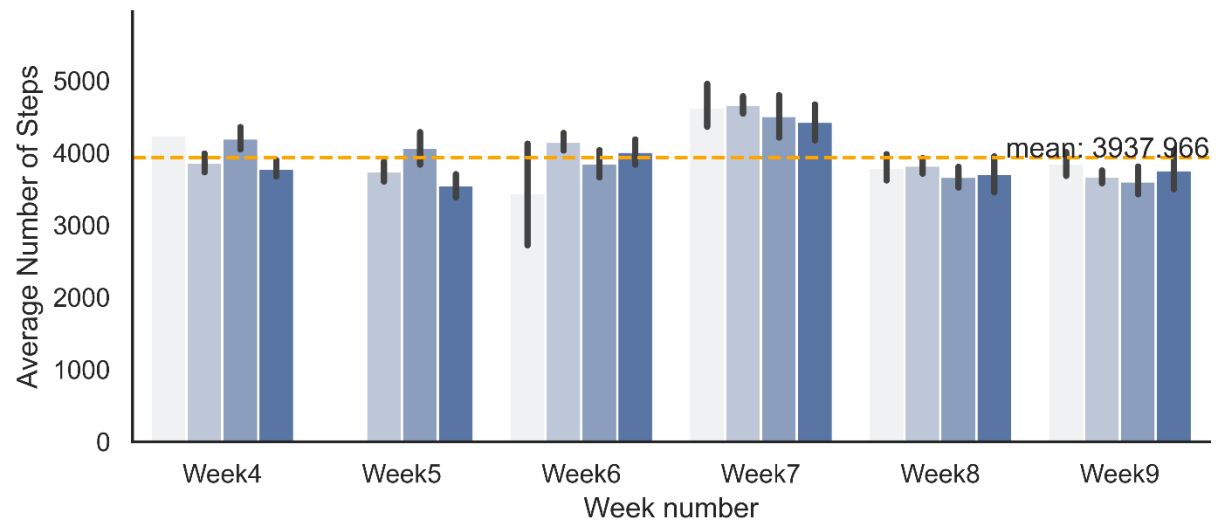


InfectionLevel

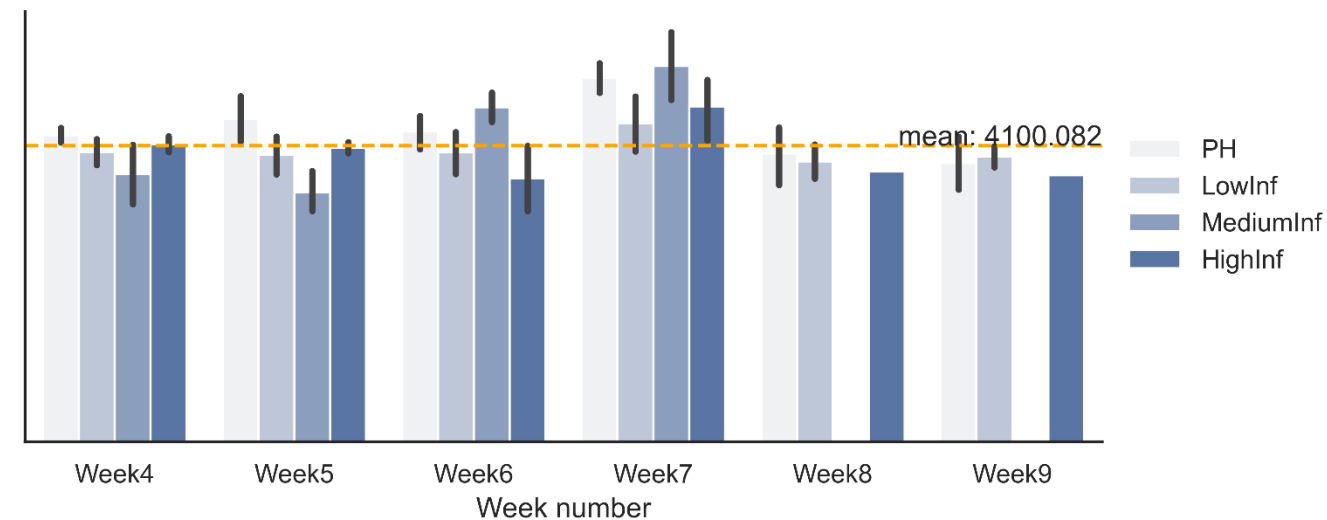
- PH
- LowInf
- MediumInf
- HighInf

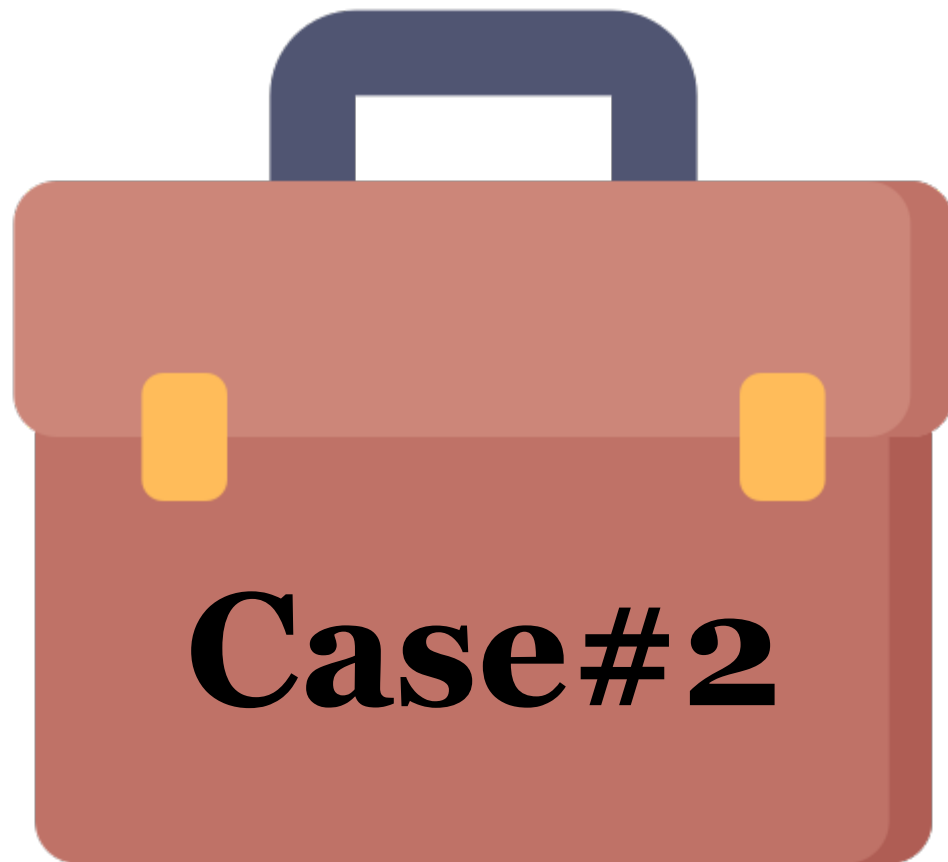
Weekly Average Steps at different Individual Infection Levels

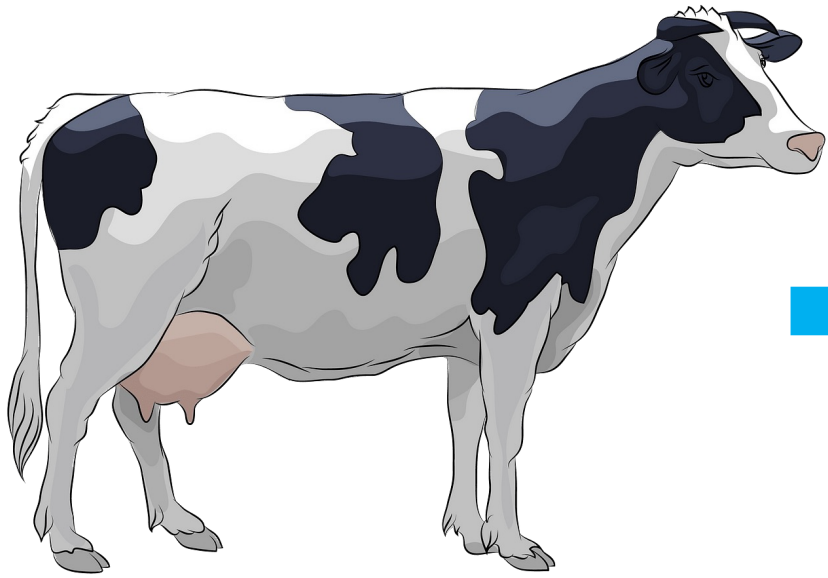
Breed = SLB



Breed = SRB







Experimental Design and Assumptions

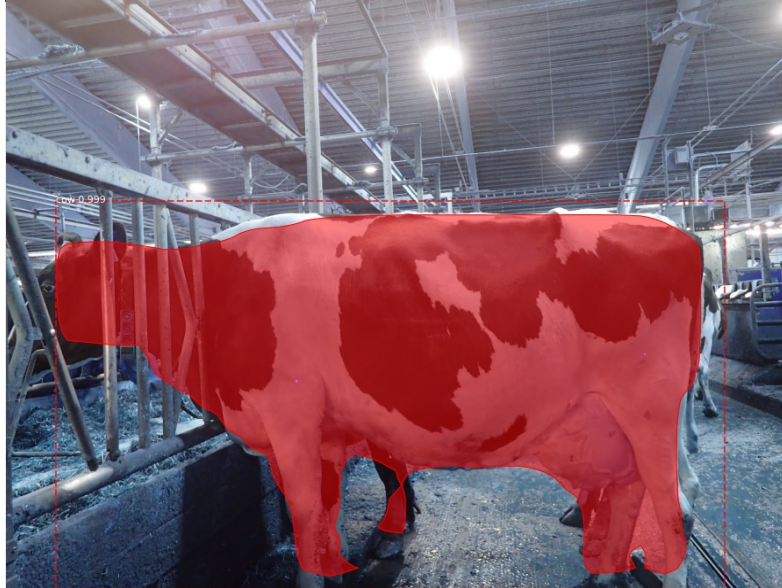
70+ COWS

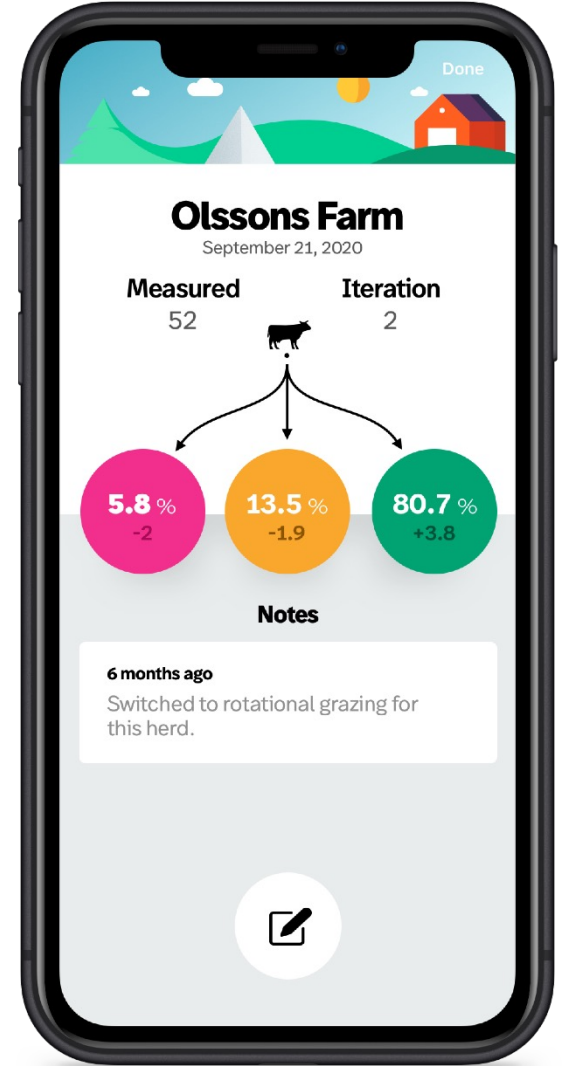
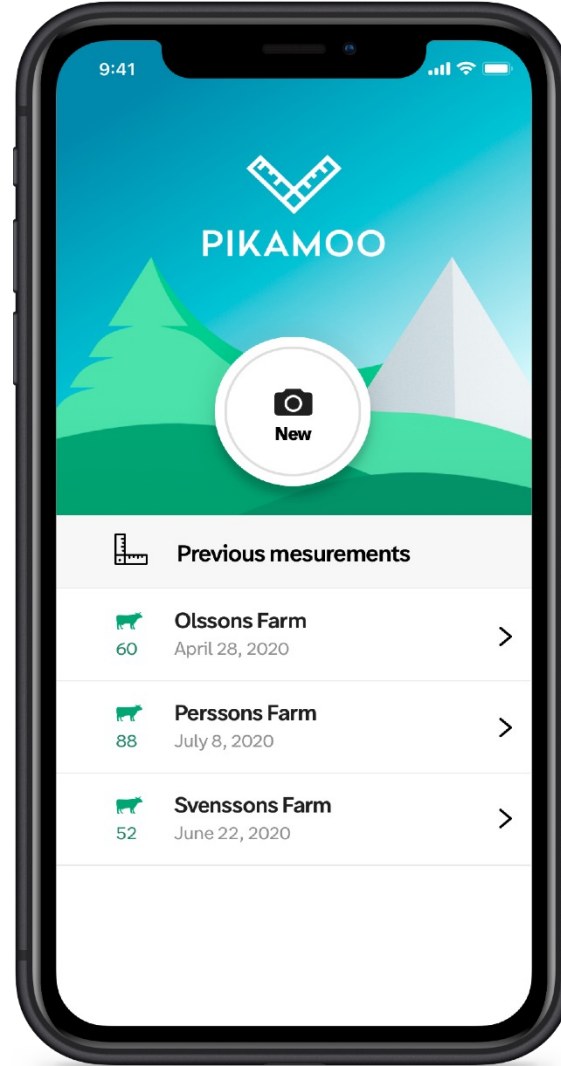
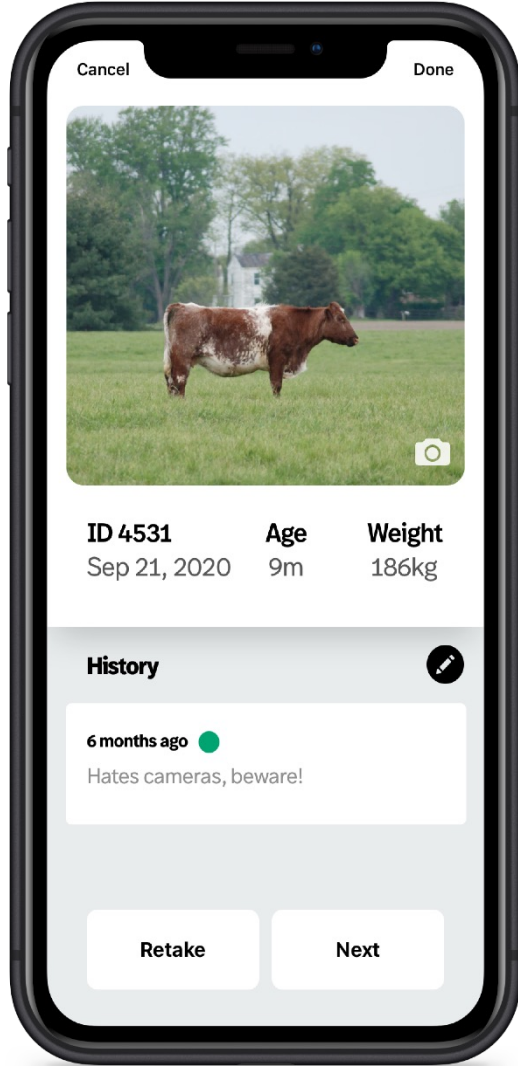
Several thousands of images were collected at SLU's Research Farm at different time points, under different conditions and complemented by manual measures and weight data from automatic weighing stations. Images were taken with handheld camera and smartphone with/without mount equipped with two laser distance measurers

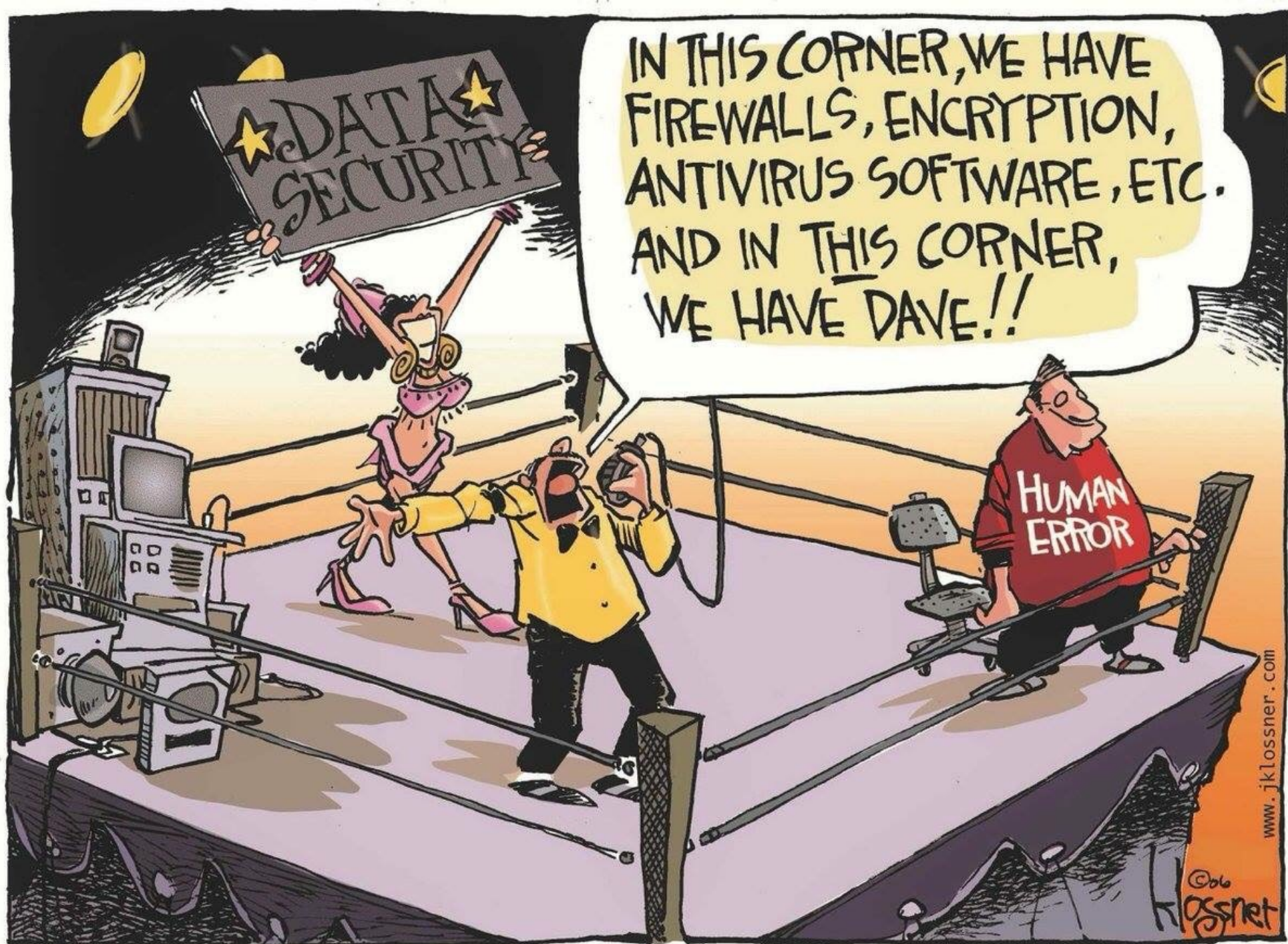
Mask R-CNN trained on 565 images collected at varying distances/angles (1.9 m to 2.15 m), achieving a final segmentation score of 0.99 on new data

Each segmented image was used to generate additional features such as Total Mask Area in Pixels, Bounding Box Size and Aspect Ratio, Mask Extent, 1-pixel-weight and distance/weight correction for different scenarios

Random Forest Classifier for weight estimation, based on derived features and tested on 453 images and achieving F1 score of 0.89







Sustainability and (or) Innovation

The complexity of the **cultural** and **legal** frameworks around modern livestock production means that incorporating AI and digitalisation into animal agriculture will also affect multiple aspects of the food sector and society at large, such as:

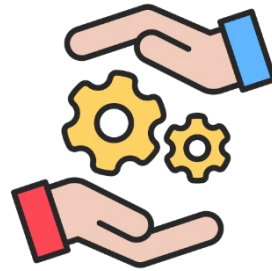
- Impact on the job market resulting from a shift from manual to automated labour;
- The image of automated livestock production and its effects on individual animal welfare and health in the eyes of consumers;
- Changes in the required competencies for working in the livestock sector;
- Acceptance of AI and digitalisation by farmers and other end-users;
- Integration of AI and digitalisation in different ethical, legal, and regulatory frameworks surrounding livestock production.



Circular Bioeconomy



Human Resources



Process Optimization



Resource Re-Use

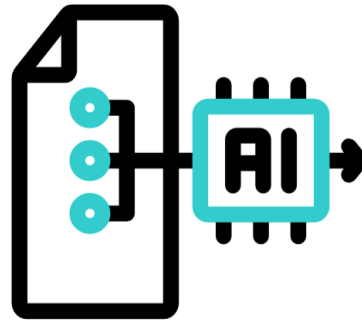


Why is it crucial to think about sustainable AI?

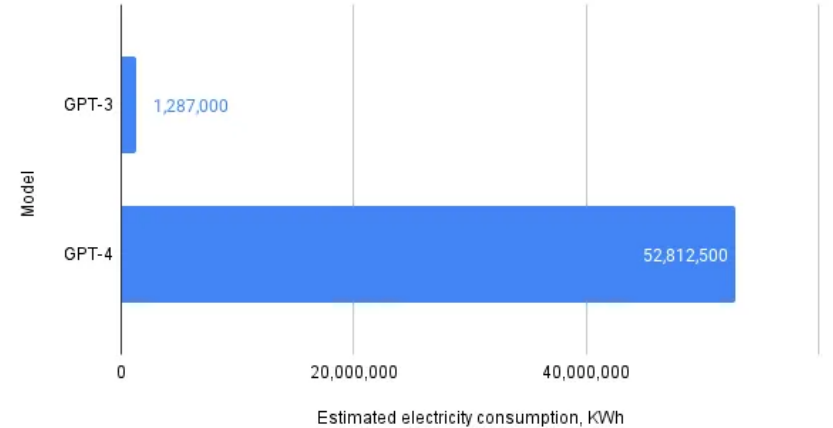


ChatGPT-3 training – 700 000 liters of water evaporated while cooling servers...

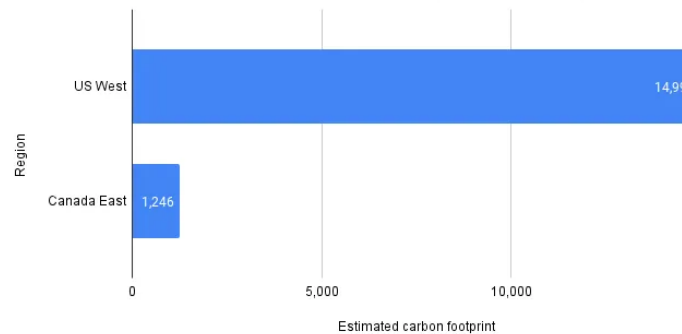
Or in simpler terms, each query on ChatGPT consumes the equivalent amount of energy of running a 5W LED bulb for 1hr 20min!



Estimated training electricity consumption of GPT-3 and GPT-4



Estimated carbon footprint of training GPT-4 vs. Region



Energy is sustainable if it meets the needs of the present without **compromising the ability of future generations to meet their own needs...**

- Kutscher, Milford & Kreith 2019



Questions/Collaboration?

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