Automated detection of asymmetrical udders in dairy goats using deep learning-based imaging

Kacper Libera*, Maxime Pals, Yvette de Geus, Gerrit Koop, Lidwien A.M. Smit, Alex Bossers

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Artificial Intelligence 4 Animal Science, Zurich, 6.06.2025
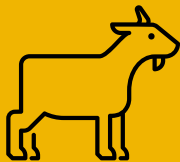
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Background
Goat milk production

- There are almost 0.5 million of dairy goats in the Netherlands [1]

- Average herd size is around 1000 goats per farm [2]

- Excellent properties of goat milk [3]

Background
Milking procedure

- Goats are milked twice
  (two types of milking parlours)

- Done by farmer/farm worker
  (usually no pre-milking or teat hygiene)

- Possibility to perform health check-ups

- Need to be careful
 (mastitis/drug withdrawal period)

Background
Udder inflammation in goats

- Udder inflammation (mastitis) in dairy goats is a complex health problem
- Clinical/subclinical form (20-50% of the herd is affected (5, 6)), bacterial etiology
- Quality/quantity of the milk is impaired
- Animal welfare/health issue + risk for other animals (+ people)
- Udder asymmetry is a phenomenon described in goats – can facilitate early diagnosis (6)
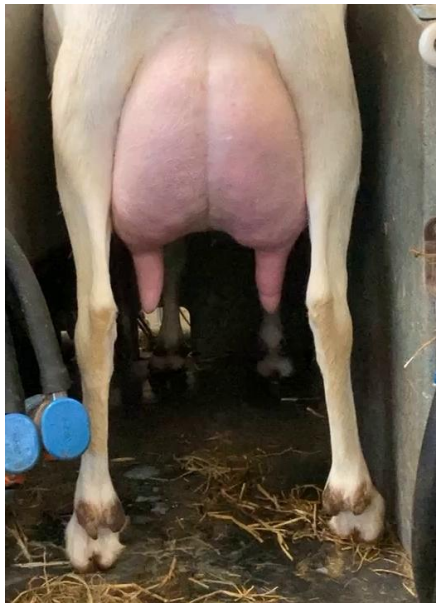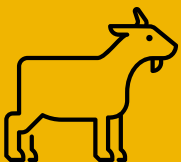

HEAL

LEFT_ASYMMETRY
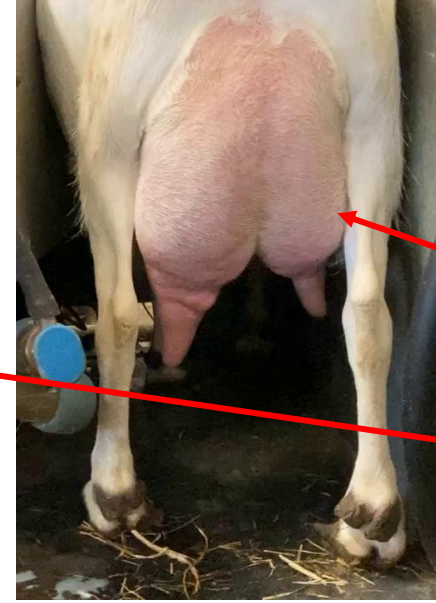
RIGHT_ASYMMETRY

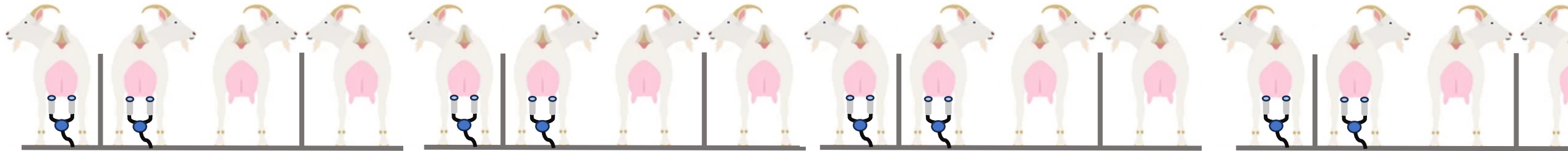**Asymmetry considered if the disparity between udder halves at least 40:60**

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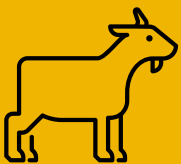
Background
Udder inflammation in goats

Aim of the study

To develop and evaluate deep learning model to detect udder asymmetry in dairy goats during milking.

picture + label from the experts
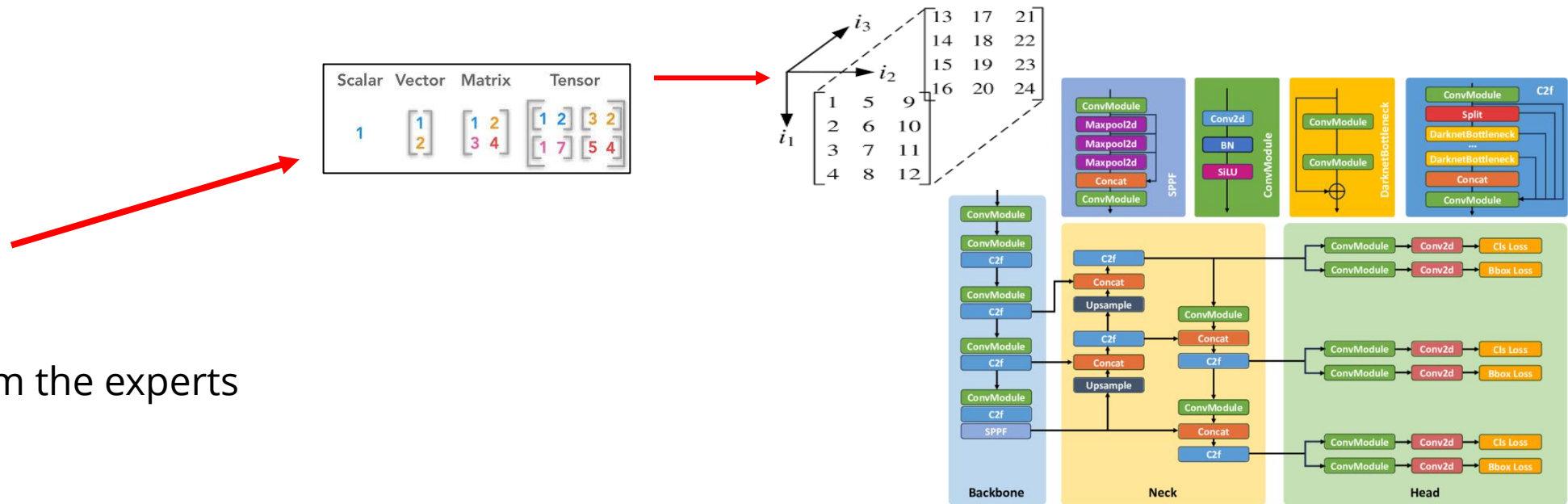
Materials and methods
on-farm setup

- Video recordings from one dairy goat farm
  (3 days, around 4 hours, around 1630 goats scored, divided in 2-3-minutes)

- 52 milking spots (one full round)

- Two experts in the field scoring **on-site**

- Simple setup with smartphone camera on a tripod
  (goats move, camera stays)

Data annotation

- Giving a label to every picture (translating to AI language) -> around 4200 pictures to be annotated (goal: 4500)
- **Ground truth (HEAL, LEFT_ASYMMETRY, RIGHT_ASYMMETRY)**
- LabelImg – manually labelled (platforms or annotation centers available)
- Asymmetrical label (if at least one expert recognized it) -> agreement around 70%
- Quality extremely important (garbage in, garbage out)

The outcome of data annotation: **4232 annotated images + 373 background images (8% of the dataset) = TOTAL 4605 images**

- Divided randomly in train, val and test datasets (60:20:20) (stratified by the day of recordings)

Deep learning model training
Stats for nerds

- Object detection model -> YOLOv12m (medium version) as architecture implemented in PyTorch [7]
- Jupyter Notebook with CUDA (GPU 1x NVIDIA A10 cloud or NVIDIA ADA RTX 4500 locally)
- Around 300 training rounds (epoch) with early stopping on
- Batch size n=32, resolution 640 pixels
- Training time around 5 hours
- Hyperparameters – default (optimalization pending)

Deep Neural Network

input layer   hidden layer 1   hidden layer 2   hidden layer 3   output layer

Figure 12.2 Deep network architecture with multiple layers.

Three categories: 1. heal (symmetric udder) 2. right_asymmetry (right asymmetry) 3. left_asymmetry (left asymmetry)
Every AI model is a probabilistic model (never 100% confident)

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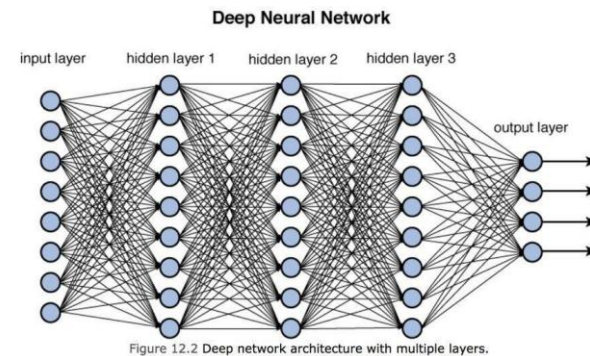by Kacper Libera, Maxime Pals, Yvette de Geus, Gerrit Koop, Lidwien A.M. Smit and Alex Bossers

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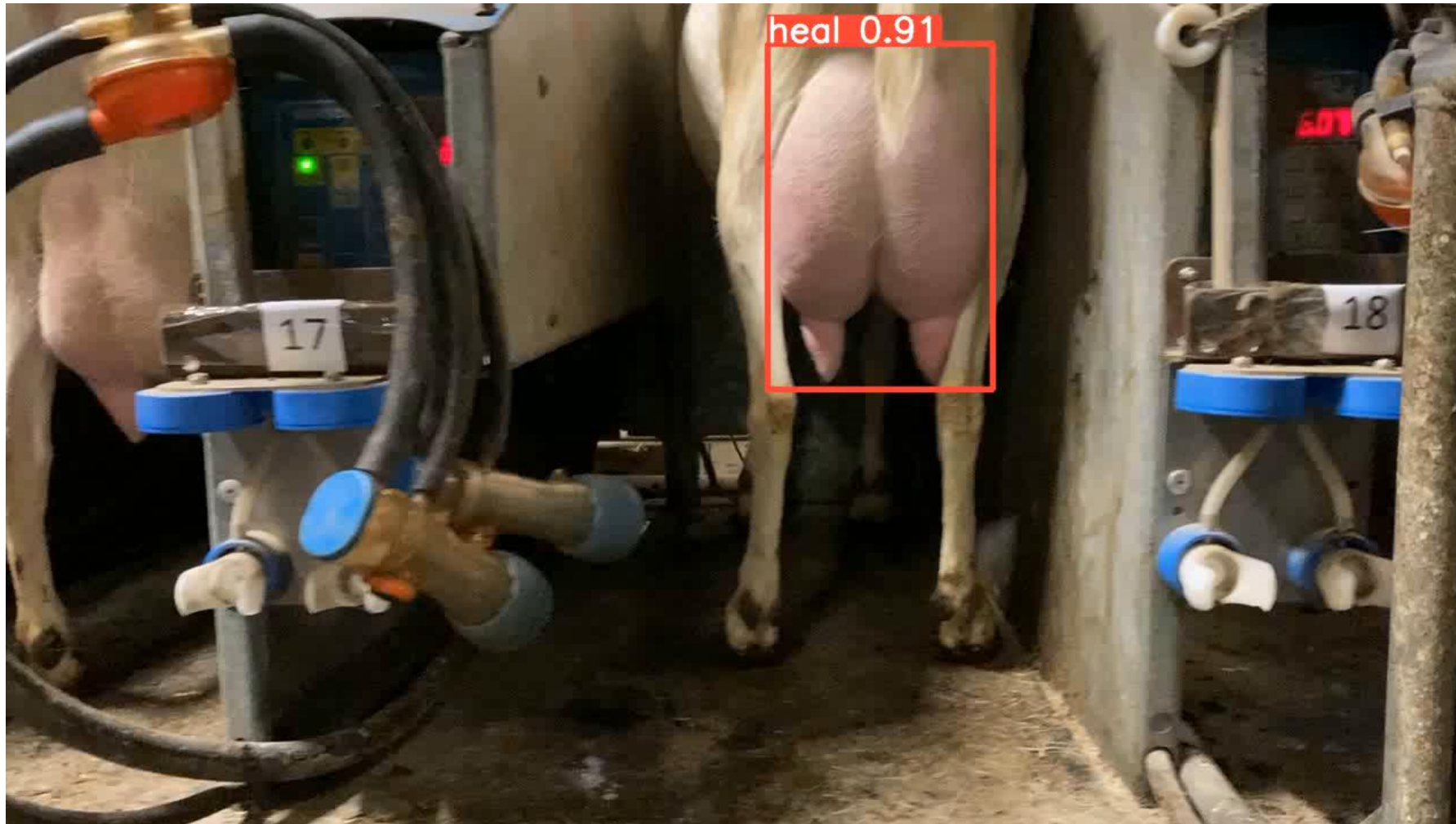by Kacper Libera, Maxime Pals, Yvette de Geus, Gerrit Koop, Lidwien A.M. Smit and Alex Bossers

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Results
performance evaluation

Model`s performance on the test dataset (n=900 images):
mAP50 = **0.89**, mAP50-95=**0.78**, precision=**0.82**, recall=**0.87**

Minimal 50 % overlap

from 50% to 95% overlap

Ground-truth bounding box

Predicted bounding box

Inference time: around 80 ms per image

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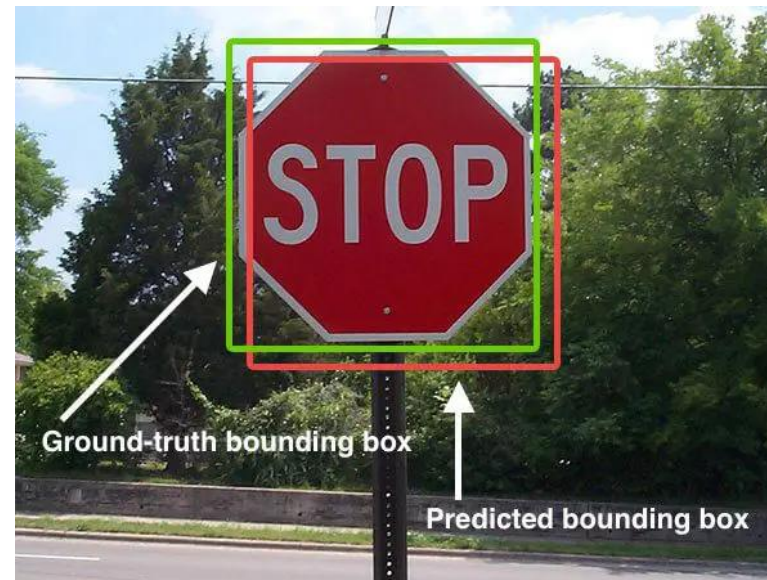Artificial Intelligence 4 Animal Science, Zurich, 6.06.2025

Practical implications

- Farmers can get a report after every milking about the asymmetry status (herd level/individual goat) -> trying to reduce prevalence, objectively compare different farms, dairy processors might also set some targets (and pay extra) + help for the vet

- Individual goats can be tracked, and early signs of asymmetry might be detected -> better udder health management
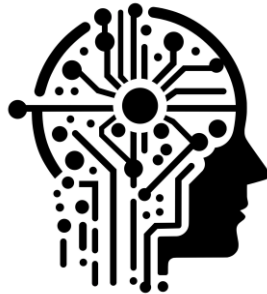
Objective, relatively cheap, easy to use

Strengths and limitations of the study

- **STRENGTHS** 💪
  - Own data collection, manually annotated and reviewed
  - Experts in the field as the source of ground truth (+ scoring on-site)
  - Well recognized architecture
  - Open code/transparent approach

- **LIMITATIONS** 👎

  - Relatively small dataset
  - Only one farm included (not "unique" goats)
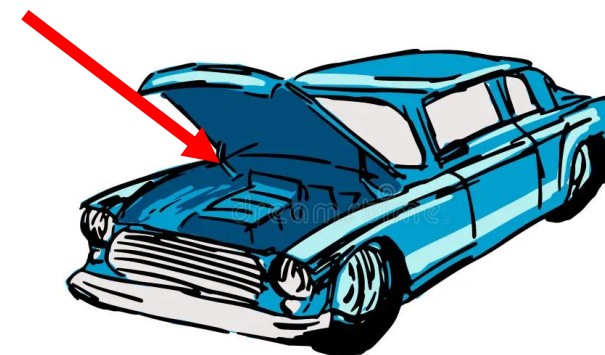 - Milking parlour must be a carrousel type

The next steps

- Hyperparameters fine-tuning (pending)

- Publishing these results (manuscript in preparation)

AI model

- Model deployment (MLOps) -> requires collaboration with technical company and further model improvement

- Test in real-life (and further improvements)

software

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Demo-app (Gradio)

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Thank you for your attention !

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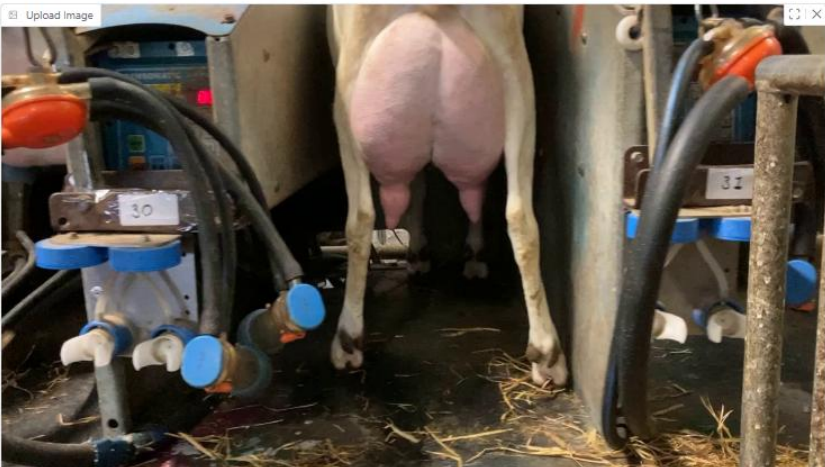Artificial Intelligence 4 Animal Science, Zurich, 6.06.2025

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Improving the udder health of dairy goats
WP4: to develop automated system of
udder health monitoring

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- Yvette de Geus
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Thank you very much !

netherlands centre for one health

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shaping tomorrow

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