Estimating sow posture from computer vision: influence of the sampling rate

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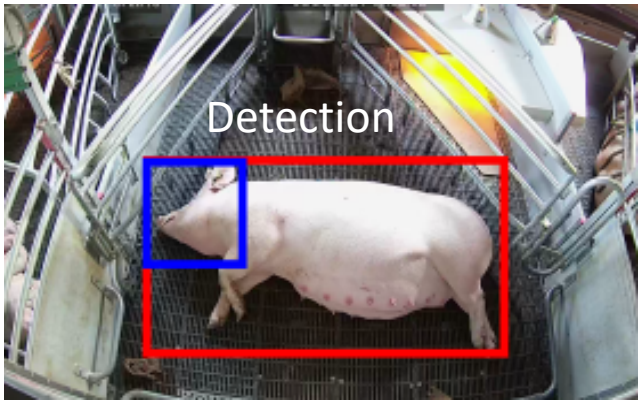
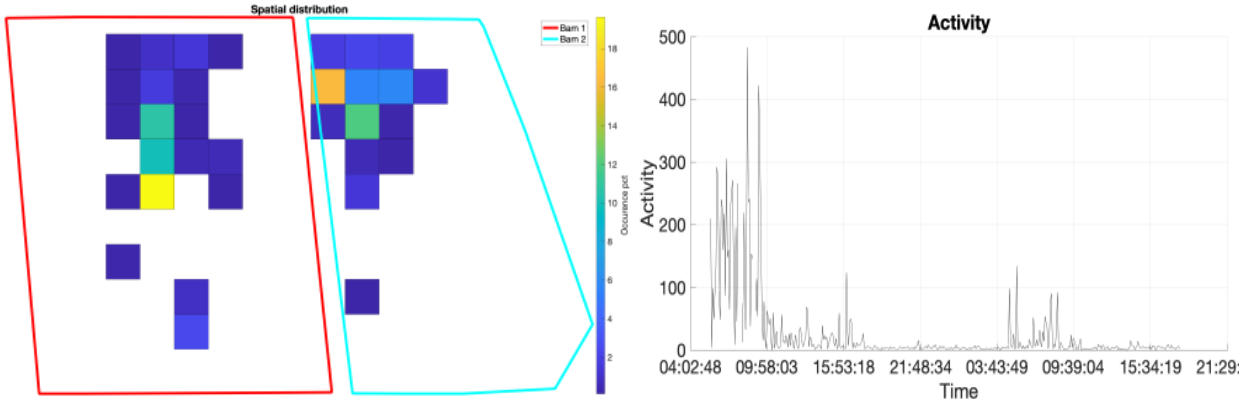
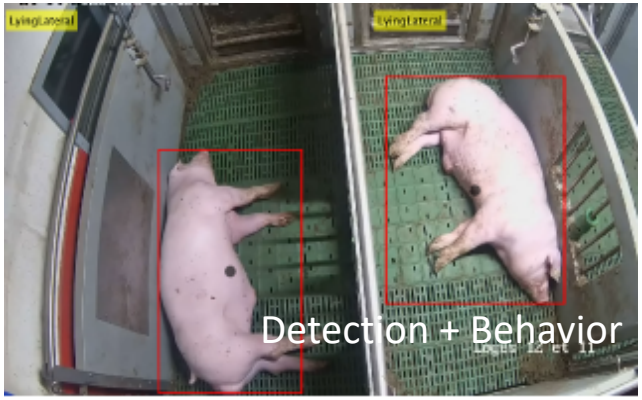
Introduction

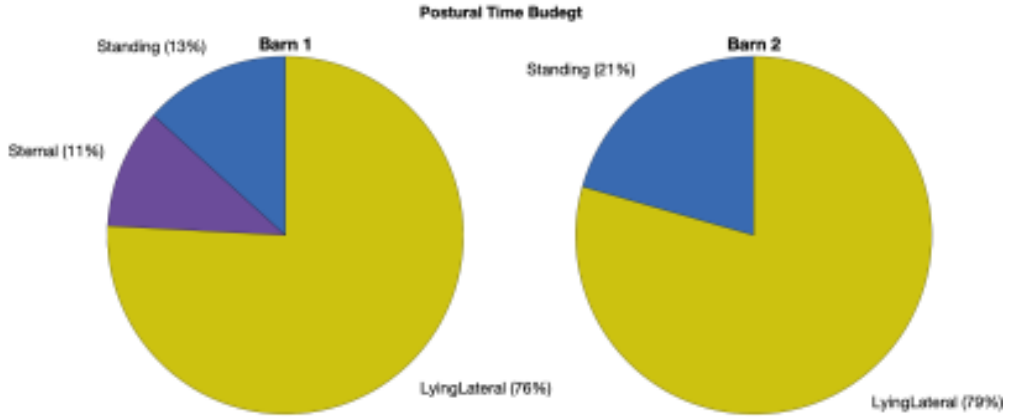
- **Monitoring behavior** becomes an important question for managing and studying **health** and **welfare**.

- **Computer vision** offers valuable solutions:
  - No need to handle animal
  - No battery problem







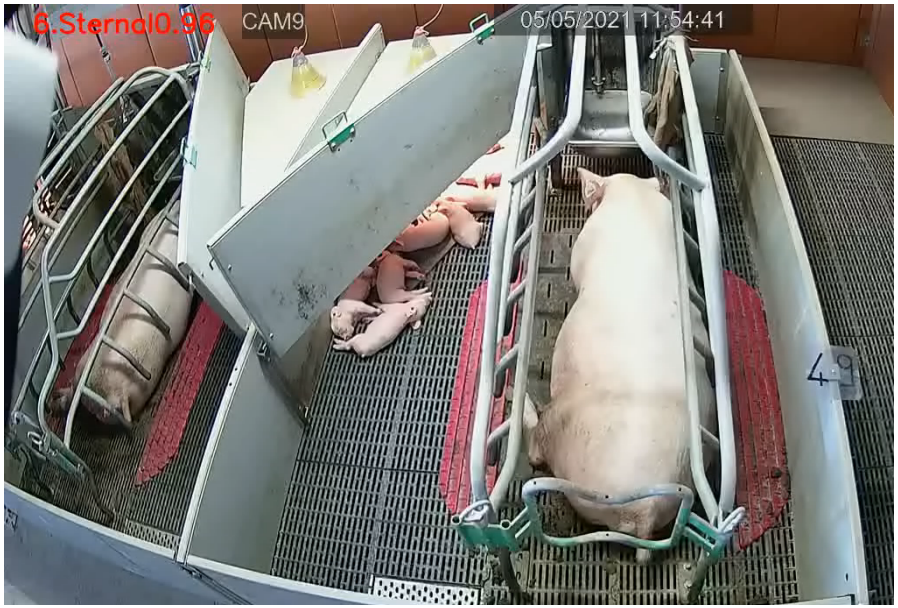


Monitoring Postural Time Budget

- Postural Time Budget (PTB):
  - Percentage of Time Budget spend in given postures.
- Interesting for comparing behavior between individuals
  - Comparison during stress (e.g. nutritional or temperature).
- Monitoring over the long term implies several constraints:
  - Large amount of data to store.
  - Computation time.
- Need to control the amount of data recorded:
  - Which monitoring frequency for a good estimation of the PTB?

Experimental set-up

- Sows kept in crate.
- Recorded using CCTV cameras.
- Initial frame rate is 10 image/s (10 fps).
- Convolutional Neural Network for posture estimation (trained of thousands of images).

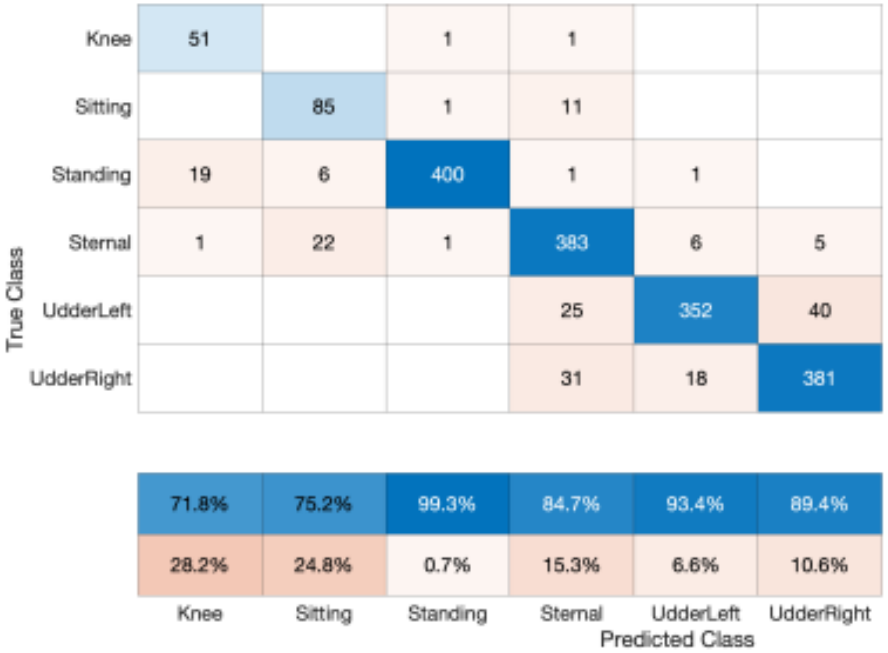


Animal id	Record day (duration)
1	1 (14h)
2	1 (14h)
3	1 (14h)
4	1 (14h), 10 (24h), 20 (24h)
5	1 (14h)
6	1 (8h), 21 (14h)
7	1 (14h)
8	10 (24h), 20 (24h)
9	1 (14h), 10 (24h), 20 (24h)
10	1 (14h)
11	1 (14h)
12	1 (14h)
13	1 (14h), 10 (24h), 20 (24h)
14	1 (14h), 10 (24h), 20 (24h)
15	1 (9h)

- 15 individuals recorded on different day after farrowing.

Posture Estimation

- 8 postures considered:
  - Knee, Sitting, Standing, Sternal, UdderLeft and UdderRight.
- 16,245 pictures for training and 3,573 for validation.
- 1,842 pictures for testing.
- Use EfficientNet.



Average Precision: 90.36%

Average Sensitivity: 85.64%

Analysis

1. Posture estimation ran using the original 10 fps (10/s).
2. Down sampling at: 1/s, 1/5s, 1/10s, 1/30s, 1/min, 1/5min, 1/h.
3. Estimation of the PTB for each sampling rate.
4. Comparison of the PTB for each sampling rate:

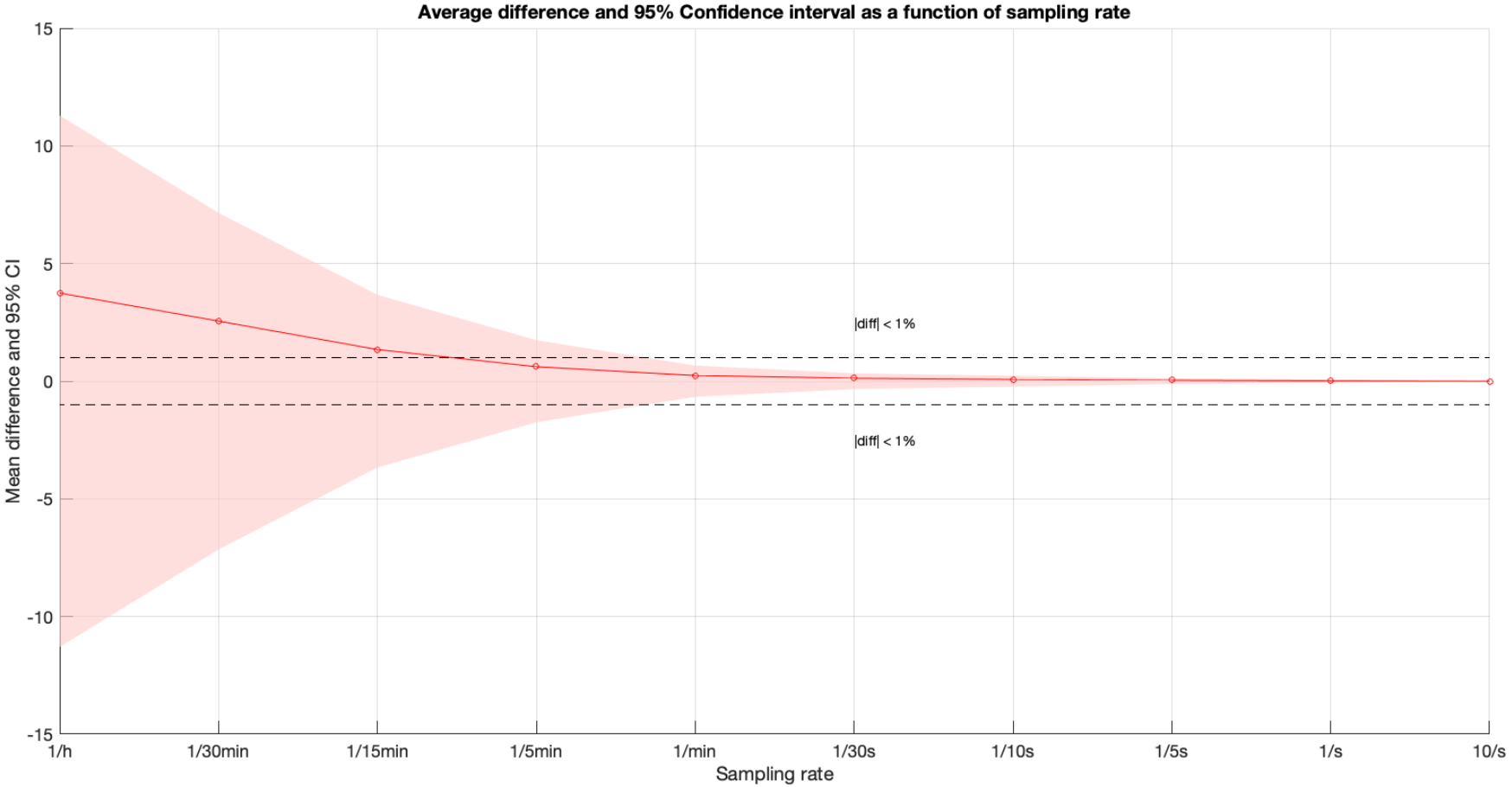
   $$\text{Error} = \frac{1}{6} \sum_{p \in P} \left(x^p - \tilde{x}^p \right), \qquad P = \{\text{Knee, Sitting, Standing, Sternal, UdderLeft and UdderRight}\}$$

   x^p is the estimated percentage of time spend in posture p.

   $\tilde{x}^p$ is the « true » estimated percentage of time spend in posture p (using 10 fps data).

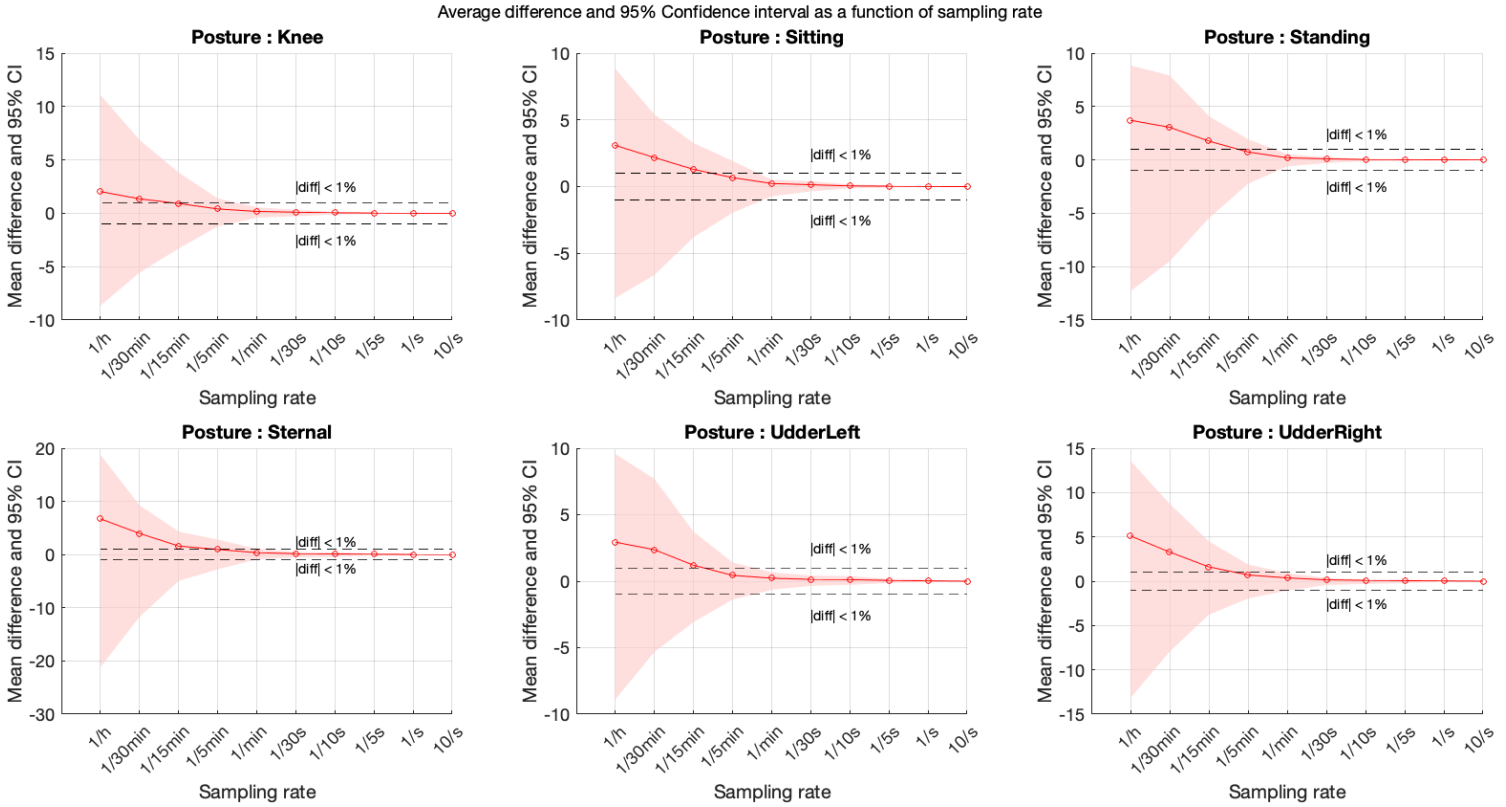
5. Analysis of variance to test the influence of the animal id, recording day and sampling rate on the PTB.

Results



- A sampling rate of **1/min** is, in average, sufficient to have a difference <1% with the original PTB, with 95% confidence.

Results



- For **Sternal** and **UdderRight**, a sampling rate of **1/30s** is, in average, sufficient to have a difference <1% with the original PTB, with 95% confidence.

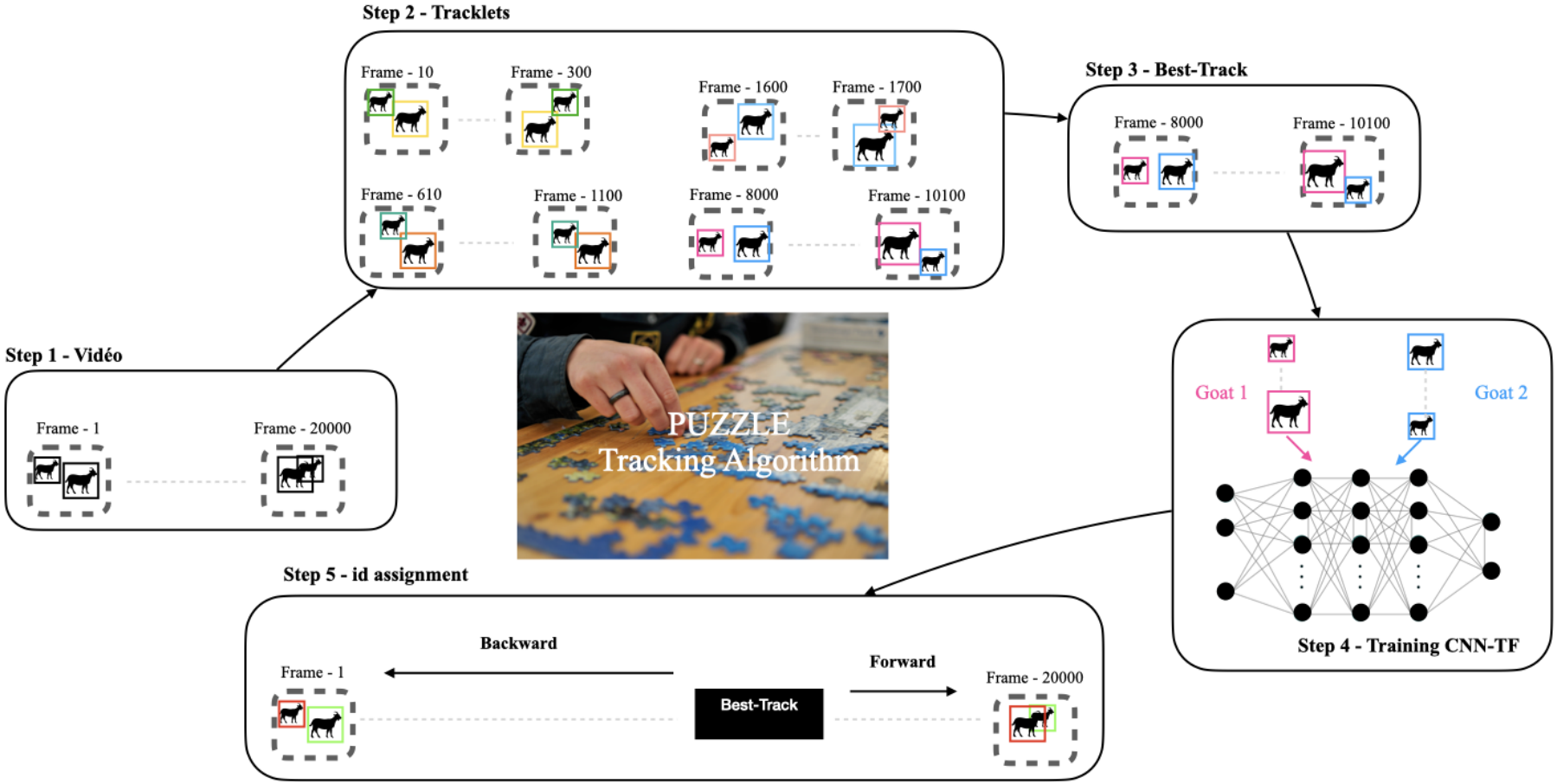
Conclusions

- Use monitoring of 15 sows during 430 hours on different days after farrowing.
- Compare the estimation of the postural time budget for a sampling rate of 1/s, 1/5s, 1/10s, 1/30s, 1/min, 1/5min, 1/h with the original 10/s sampling rate.
- The error depends on the posture.
- A sampling rate of 1/30s is sufficient to have < 1% error, with <5% risk.
- Difficult to know if the results could be generalize to other species/conditions.
- Important question when monitoring over the long term
    - Cost of storage.
    - Time for analysis and video transfert

Tracking and behavior monitoring

https://gitlab.com/inra-urz/puzzle-livestock-tracking

Tracking and behavior monitoring



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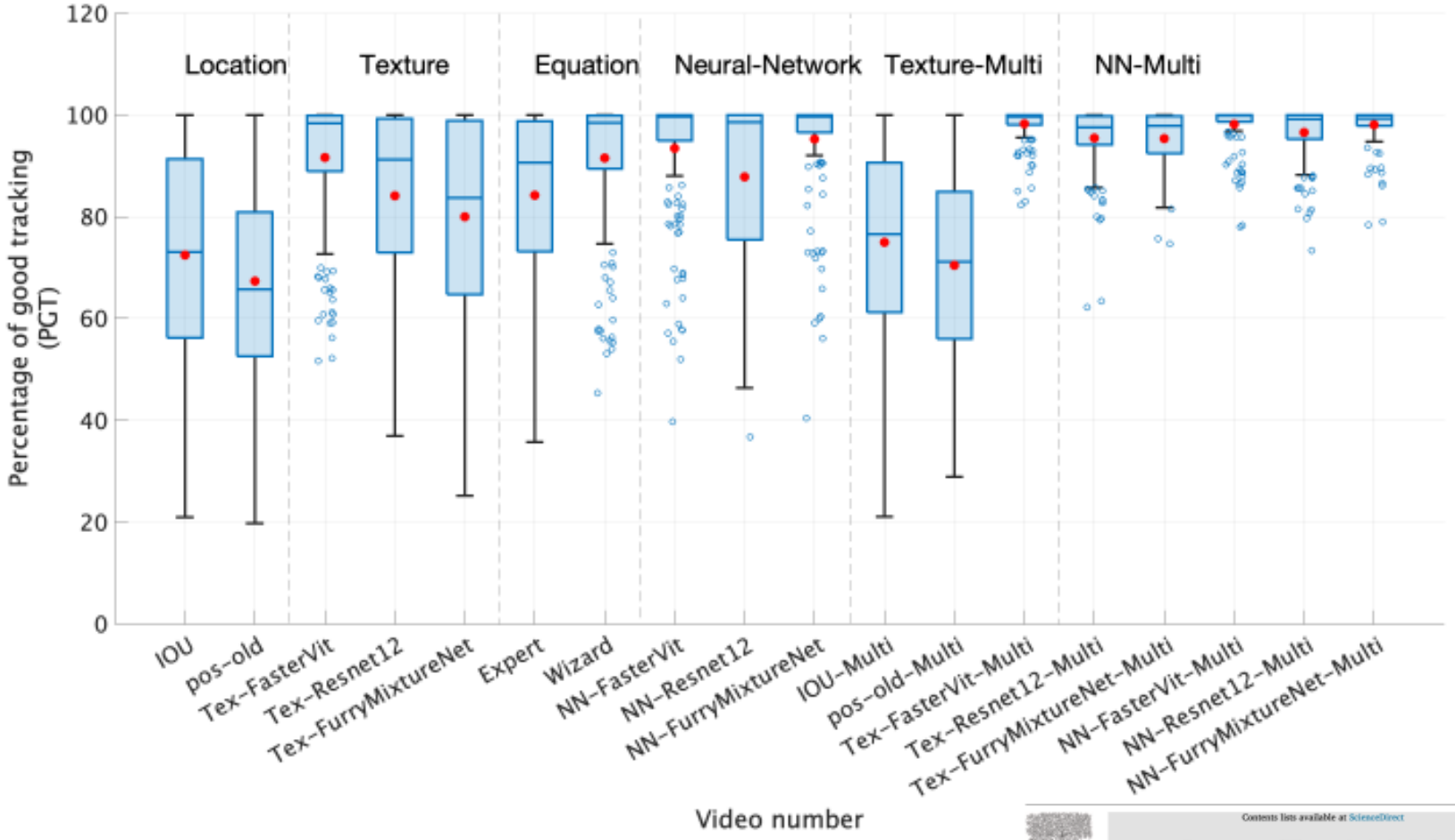
Tracking and behavior monitoring




Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

Wizard: Unsupervised goats tracking algorithm

Jehan-Antoine Vayssade, Xavier Godard, Mathieu Bonneau

This work was founded by the F2E WhatSow Project

THANK YOU