FACULTY OF BIOSCIENCE ENGINEERING

Fiducial marker-assisted animal tracking to quantify individual feeding time in group-housed piglets

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Bovi-Analytics
data-driven herd health

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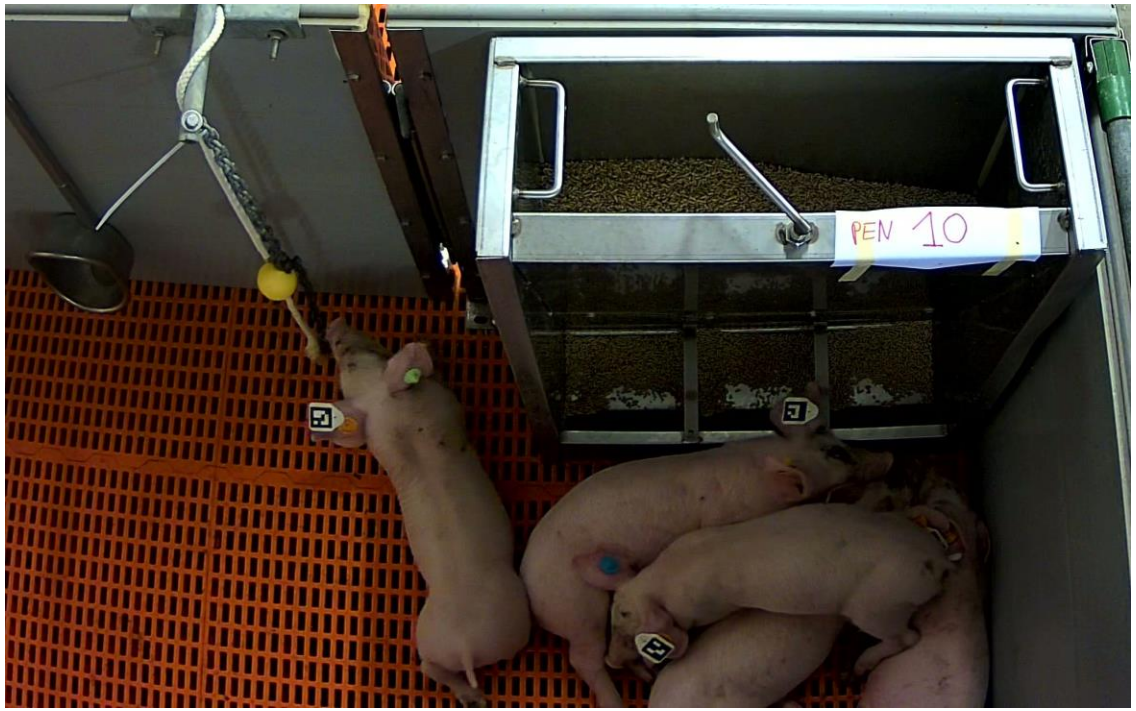
MATERIAL AND METHODS - *INTRODUCTION*

Individual feeding behavior after weaning

new environment – new diet – new social situation



Aim

- First interaction with the feeder
- Time spent at the feeder
- Behavioral development over time

Why conventional dry feeders?

- Avoid constrained feeder access from electronic feeding stations
- Preserve natural group feeding behavior
- Comparable to practical farming conditions

Technical challenge

How to preserve individual identity when piglets disappear, overlap, and return later?

36 piglets
at weaning

6 pens
balanced for body weight and sex

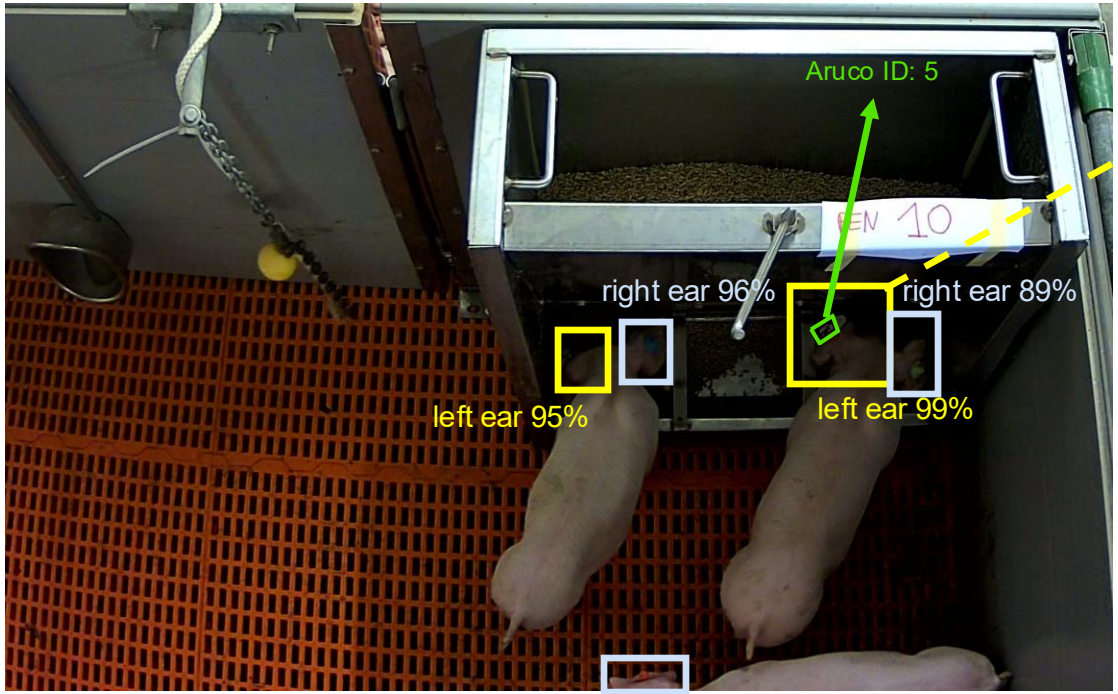
Topigs TN70 × Piétrain
genetics

7.2 ± 0.9 kg
mean body weight at weaning

MATERIAL AND METHODS – *FIDUCIAL MARKERS, TRACKING AND RE-IDENTIFICATION*

Fiducial marker-assisted ear tracking

Ear detections = continuity | ArUco detections = identity



- Ear tracking
- ArUco marker

Tracking strategy

- YOLOv5 ear detection at 4 fps
- Left and right ears detected separately
- 3 × 3 cm ArUco marker on the ear mark
- Lightweight custom tracking algorithm

Key idea

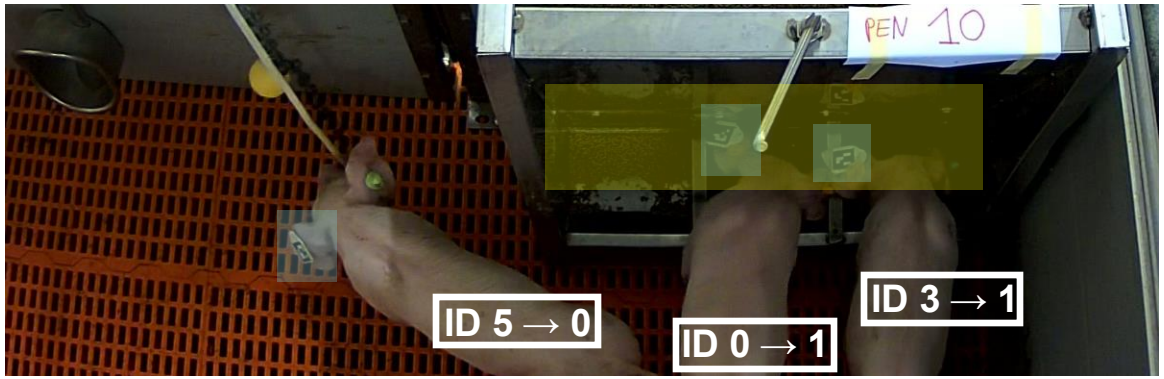
- Ear detections provide frequent position updates
- ArUco detections provide reliable identity updates
- Combining both improves robustness

Ear detections → Tracks ← ArUco marker-based re-identification

MATERIAL AND METHODS – *FEEDING CLASSIFICATION AND POST-PROCESSING*

From tracked ears to feeding behavior

Overlap with the deeper feeder zone = feeding behavior

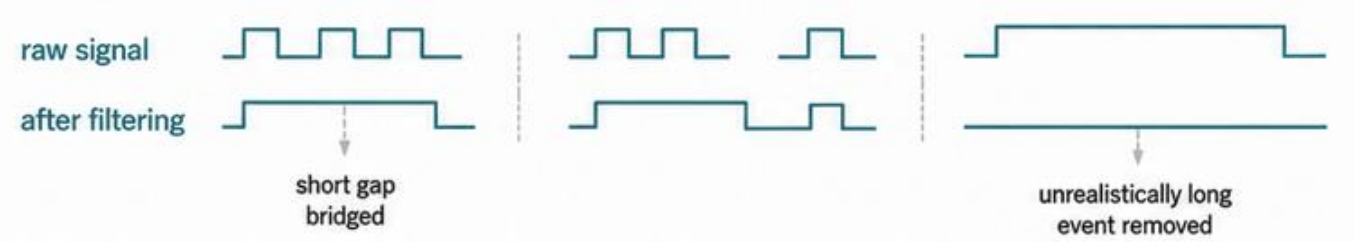


Feeding classification

- Deep feeder area manually predefined
- Ear bounding box overlaps with feeder zone
- 0 = no feeder-related activity
- 1 = feeding behavior: eating or feed exploration

Post-processing

- Short interruptions bridged
- Unrealistically long events excluded
- Binary output converted to plausible feeding bouts



MATERIAL AND METHODS – *VALIDATION*

Validation against human observation

30-min video per pen
day 2–5 after weaning

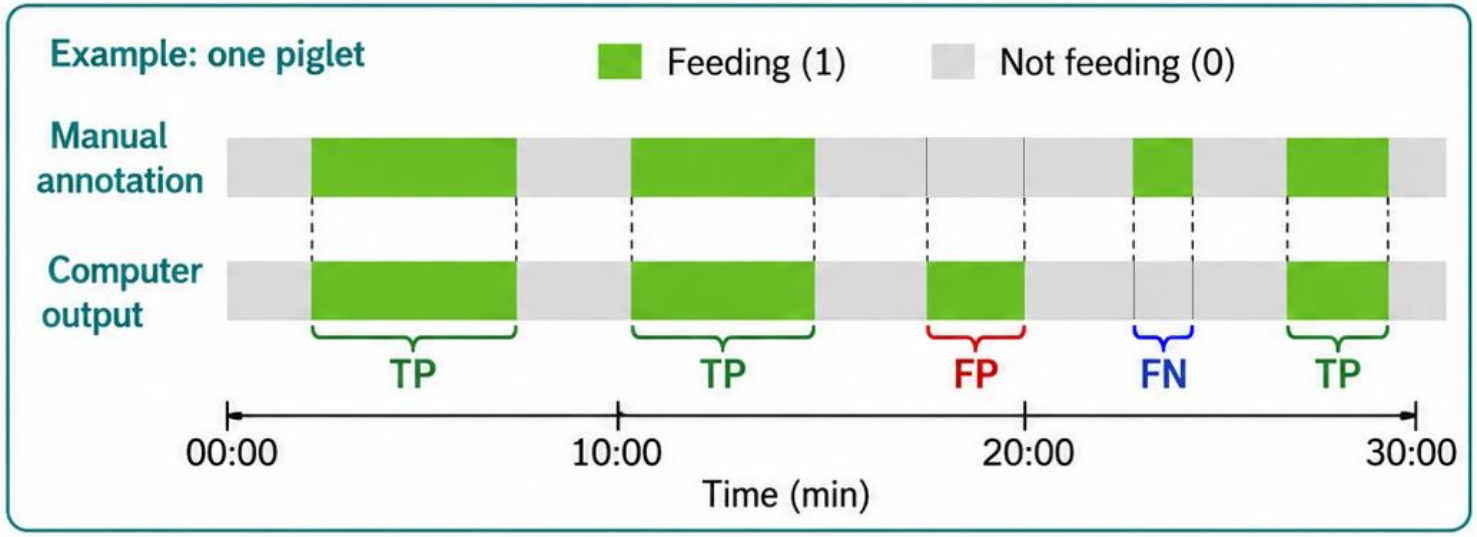
Human observer annotation
colour-coded ear tags start / end of every feeding visit

Comparison
one-second resolution classified as TP, FP or FN

TP = correctly detected feeding second

FP = false feeding second

FN = missed feeding second



Performance metrics

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1\text{-}score = \frac{2 \times Precision \times Recall}{Precision + Recall}$$

RESULTS – *VALIDATION*

Good precision, lower recall: the system was conservative

Precision	Recall	F1-score
93%	84%	88%

Interpretation

- When feeding behavior was detected, it was usually correct
- 7% was non-feeding or incorrectly assigned feeding
- 16% of true feeding was missed

Main causes

- Short identity swaps during ear tracking
- Track deletion when no ArUco marker could be assigned

Improvement potential

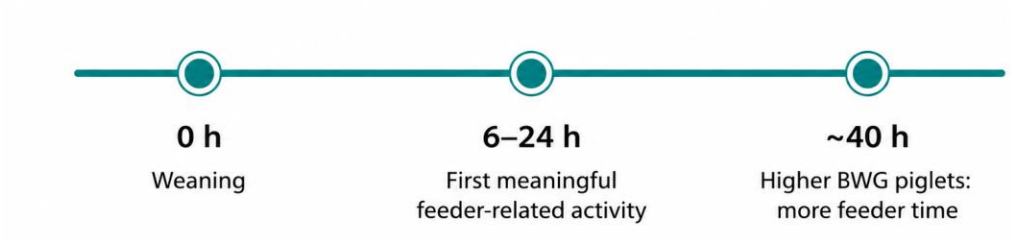
- More robust ear tracking to reduce identity switches
- Further marker development: better readability under angle, blur, dirt and wear

RESULTS – *FROM FEEDER TIME TO BEHAVIORAL FEATURES*

- Time at the feeder ≠ feed intake in g or kg
- Individual intake rate during feeder visits was unknown
- Therefore, real individual feed intake could not be estimated

Early post-weaning feeding behavior

- Feeding onset latency: first meaningful feeding behavior: 6–24 h after weaning
- This timing was not clearly associated with body weight at weaning (BW) or body weight gain in the first 14 days (BWG)
- Around 40 h after weaning, feeder time was moderately correlated with BWG
- This timing should not be generalized too strongly, because it was not fully consistent with previous findings

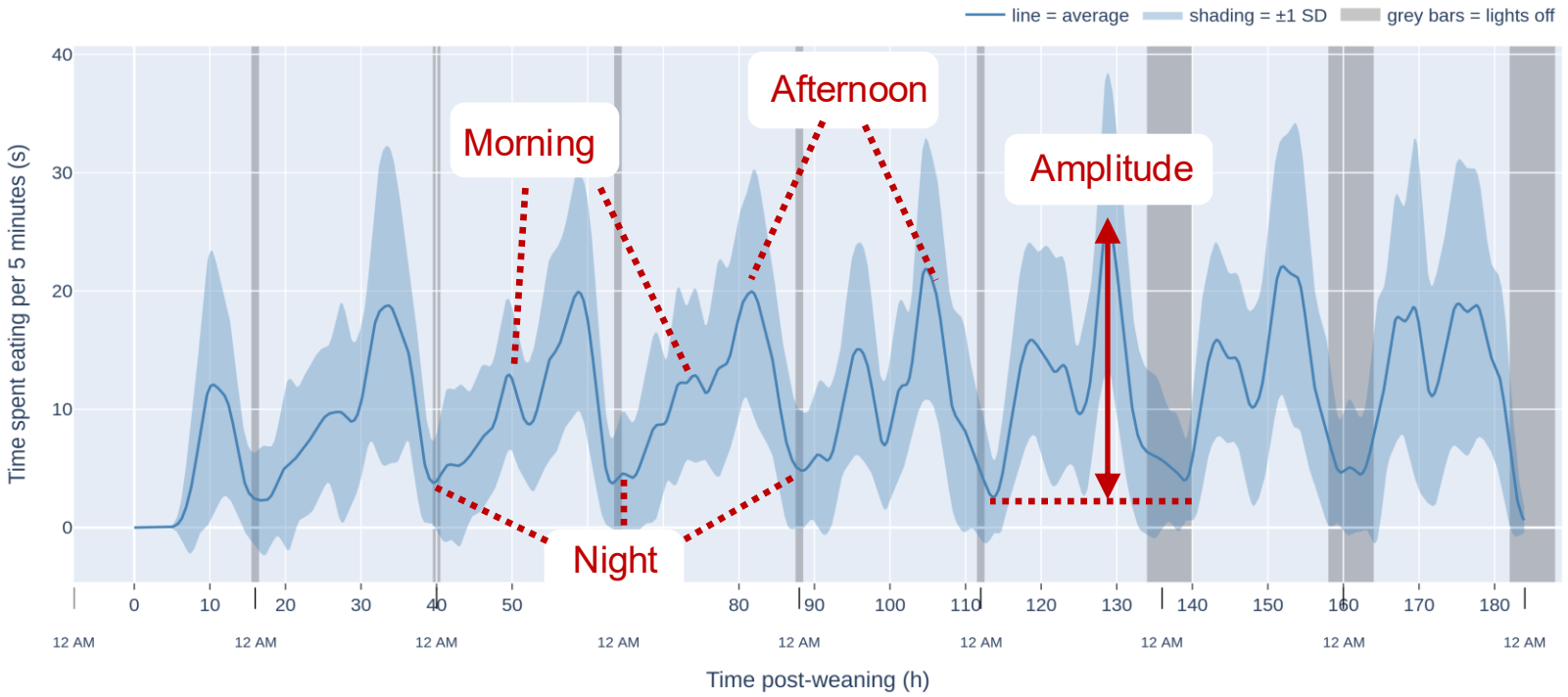


RESULTS – *FROM FEEDER TIME TO BEHAVIORAL FEATURES*

Daily distribution of feeding behavior

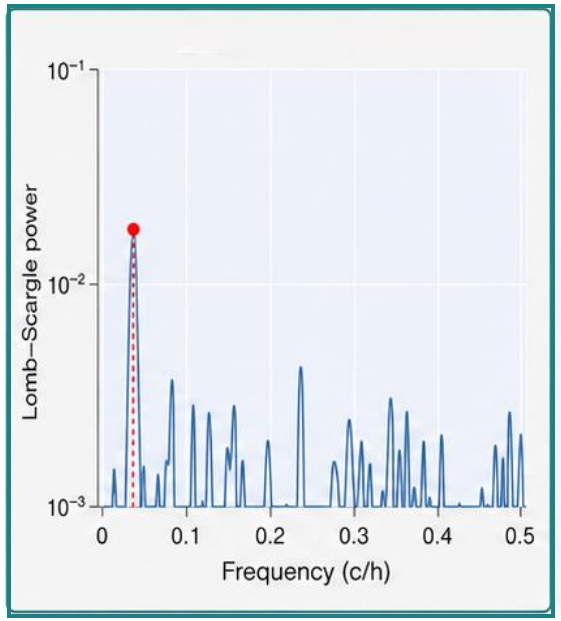
Average activity

- Morning: 4.0% of the time at feeder
- Afternoon: 6.5%
- Night: 1.5%
- Feeding activity amplitude = peak-to-night difference
- Area under curve
- These features were not clearly associated with BW or early growth

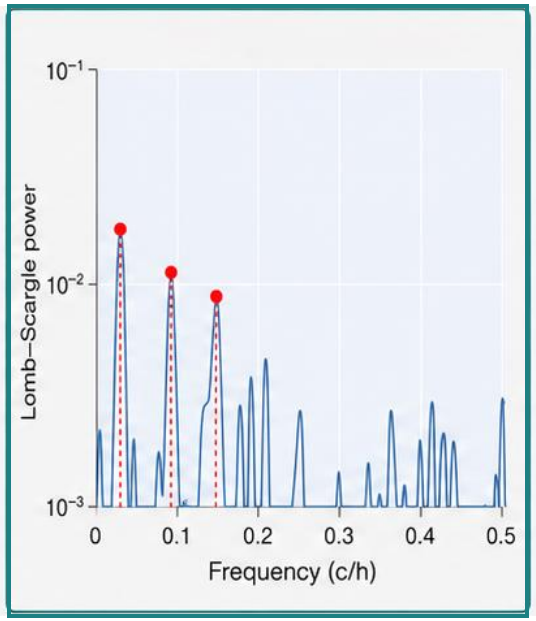


RESULTS – *FROM FEEDER TIME TO BEHAVIORAL FEATURES*

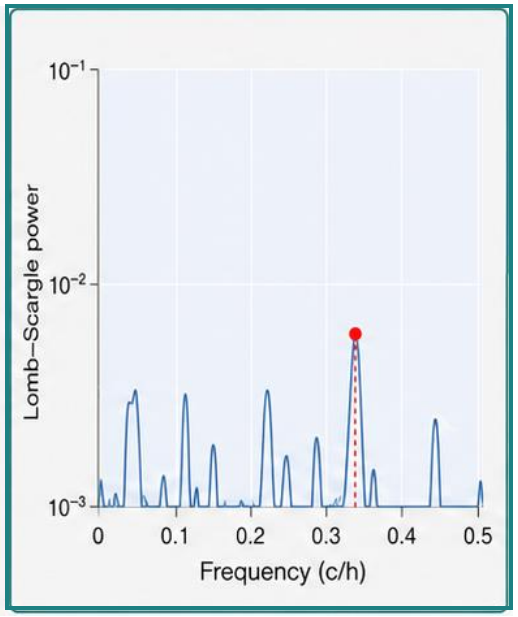
Rhythmicity in feeding behavior



ID 44
24h rhythm



ID 42
24h + 12h + 8h rhythms



ID 37
~3h ultradian rhythm

Rhythm speed score

- Lomb-Scargle periodogram computed for each piglet
- Three strongest spectral peaks selected
- Central frequencies of these peaks were summed
- Higher value = faster recurring feeding rhythm

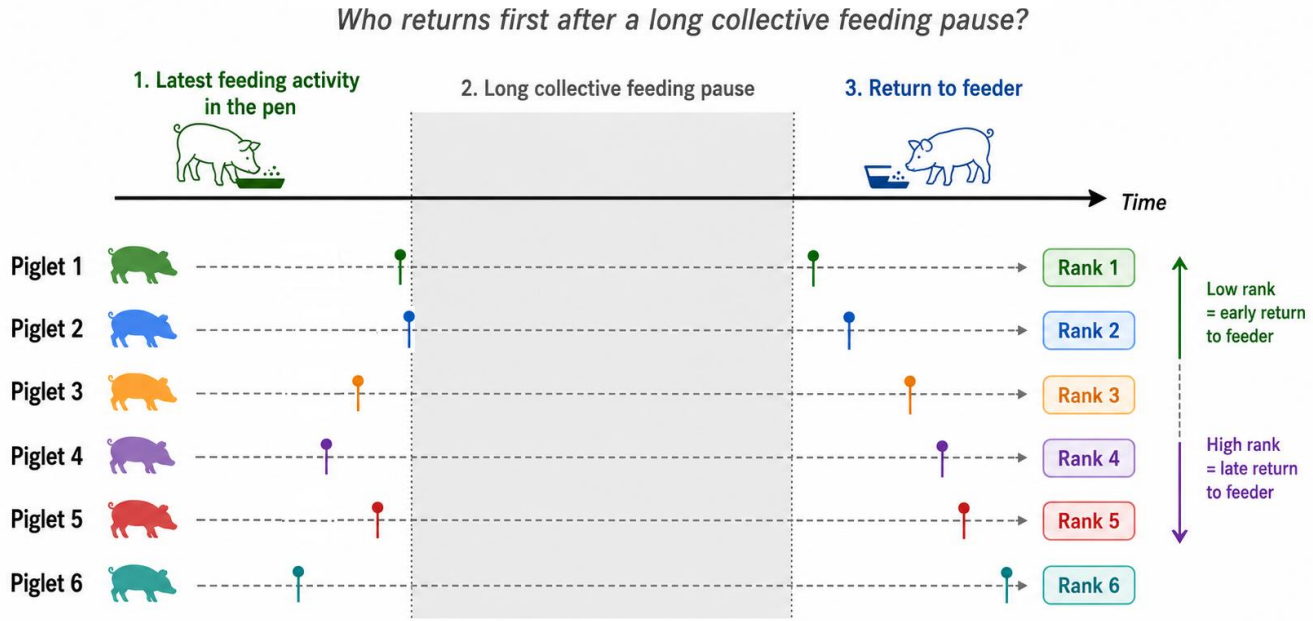
Association with growth

- Moderately positively related to BWG over the first 14 days
- R = 0.45
- Better-growing piglet may show more frequently recurring feeding patterns

RESULTS – *FROM FEEDER TIME TO BEHAVIORAL FEATURES*

- The 5% longest collective pen feeding pauses within a pen were identified
- The piglets were ranked according to the order in which they resumed feeding
- The first piglet to return to the feeder received the lowest rank whereas the last piglet received the highest rank
- This feature may reflect feeding motivation or social position

Post-pause return order



- Lower post-pause return order = earlier return to the feeder = higher BWG over the first 14 days
- R = -0.60

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CONCLUSION

01 Computer vision with fiducial markers enables **reliable re-identification** when piglets leave the camera view for a prolonged period

02 **Further marker development is needed** to improve readability under difficult viewing angles, motion blur, dirt, and wear

03 The proposed method is scalable and can reveal **individual behavioral patterns** in weaned piglets **without constraining group dynamics**

04 The method **allowed us to extract features** such as feeding onset latency, day–night distribution, feeding activity amplitude, rhythmicity, and post-pause return order

05 These features, or future refinements of them, **may serve as early indicators of adaptation after weaning** and potentially also of later performance

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