



**GHENT
UNIVERSITY**

IMAGE CLASSIFICATION TO ESTIMATE FEED INTAKE BEHAVIOR IN WEANED PIGLETS

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INTRODUCTION

Stress factors caused by weaning

- Sudden change in **environment**
- Loss of maternal **protection**
- Sudden change in **diet**
 - Form: liquid – solid
 - Composition and digestibility
 - Switch from milk protein – plant products

Resulting in

- Reduced feed intake
- Severe dysregulation of small intestine functionality
- Post-weaning diarrhea
- Increased vulnerability for **infections**
- **Production losses**
- Increased mortality



A STUDY ABOUT GROUP BEHAVIOUR AND THE ADAPTION TO NEW FEEDS

- **2x2 factorial design**
 - **Factor 1** = Management strategy before weaning (HOUSING):
 - Litters kept under **conventional (CON)** conditions
 - **Group housing (GH)** (3 litters co-mingled, 10 days before weaning)
 - **Factor 2** = Feeding strategy at weaning (FEEDFAMILIARITY):
 - Creep feed + weaner diet (**CREEP**)
 - Weaner diet (**WEAN**)
- Data contains valuable variation in weaning stressors
- **Video** recorded 2 rounds x 12 pens x 12 piglets continuously for **3 days**
- Is **computer vision** suitable to estimate feed intake and learn about animal behavior?
- **Manually weighed** daily feed intake

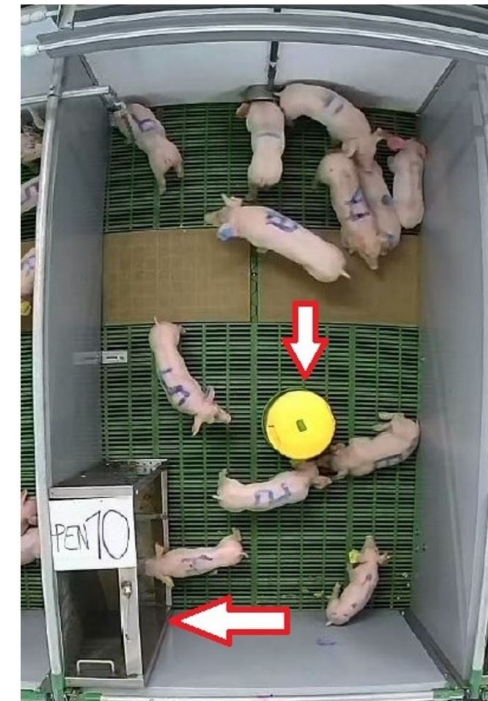


CON1

CON2



group housing (GH)

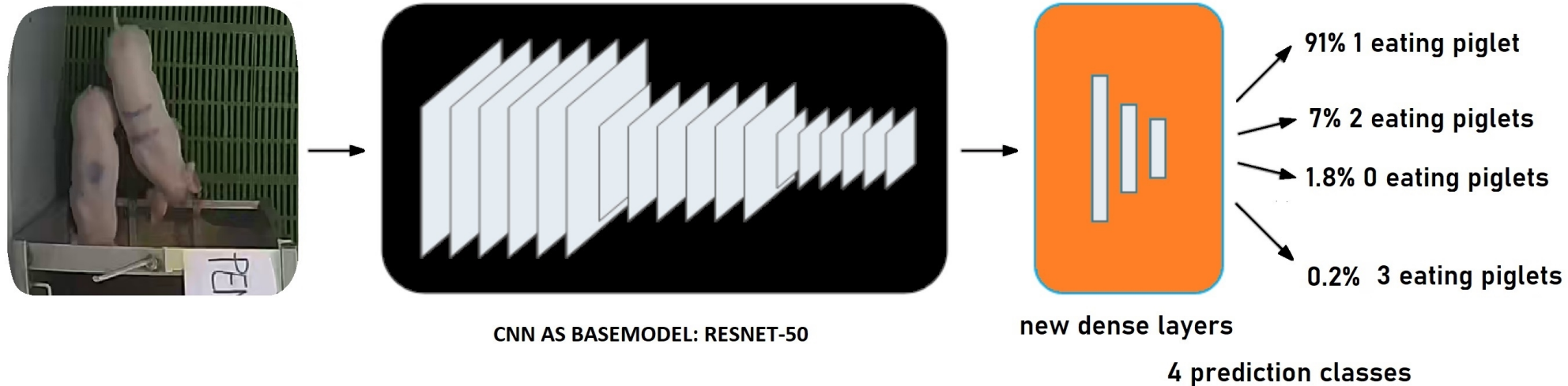


creep feed (CREEP)



no creep feed (WEAN)

TRAINING A CONVOLUTIONAL NEURAL NETWORK ON SMALL SUBSET OF VIDEO DATA



- The highest probability for each class was chosen
- 3-space dry feeder with weaner feed: '0', '1', '2', '3' eating animals
- 2 extra classes for creep feeder: '0', '1', '2', '3', '4', '5'

LABELING

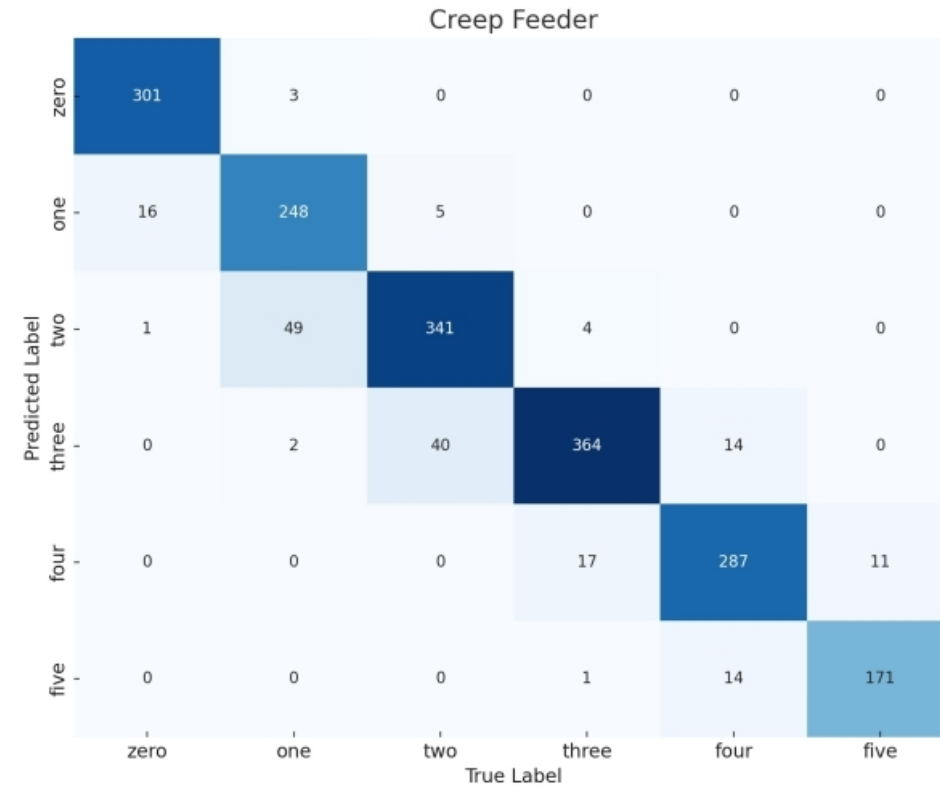
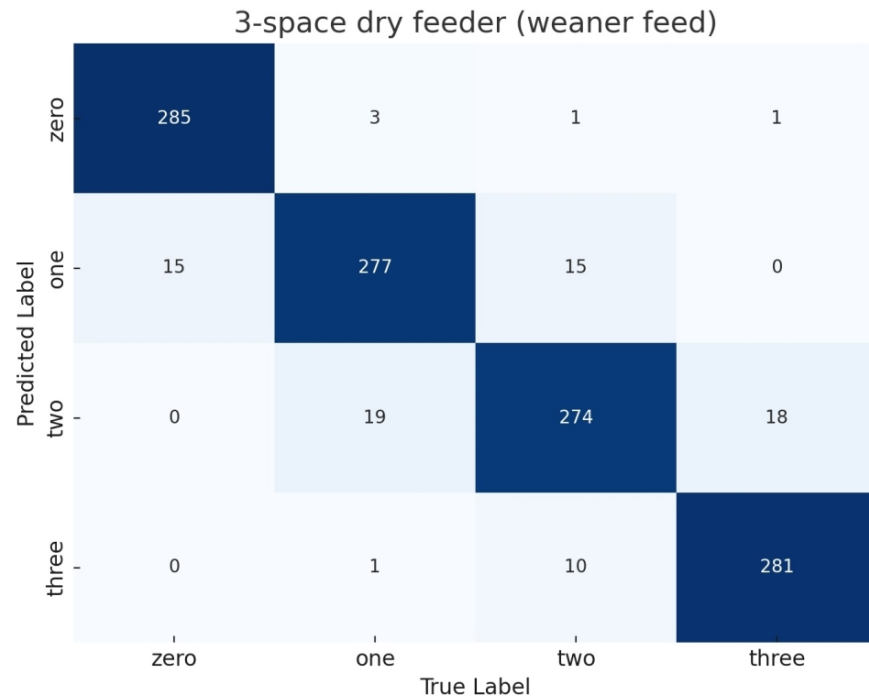
only one animal eating



zero animals eating



4TH GENERATION MODELS TEST-SET-PERFORMANCE

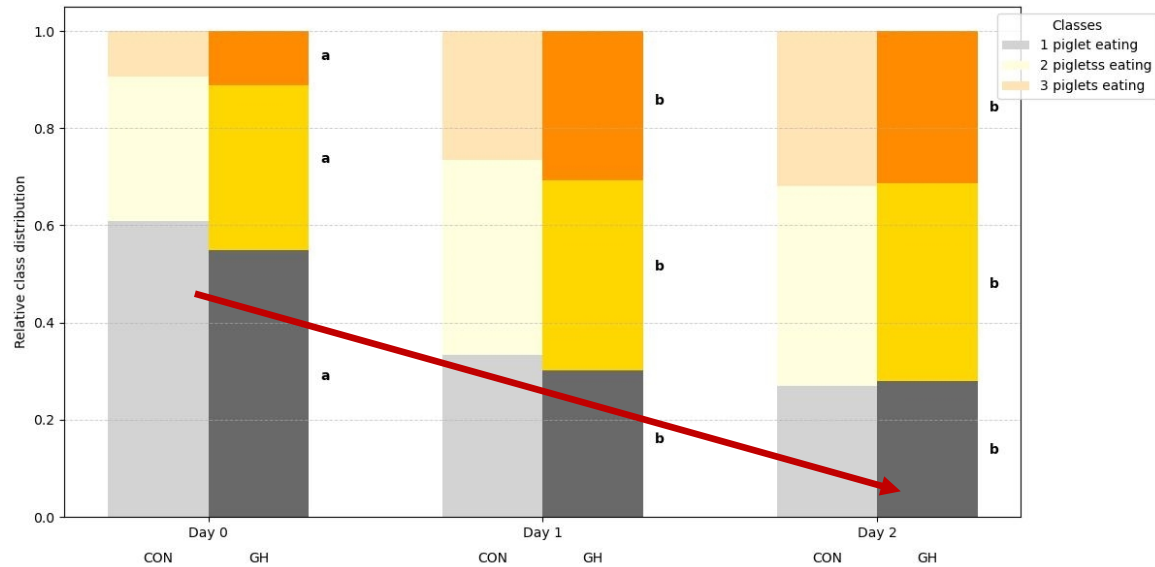


	3-space dry feeder (weaner feed)	creep feeder
average recall	93%	91%
average precision	93%	91%

EATING BEHAVIOR ANALYSIS IN THE COMPLETE VIDEO DATASET

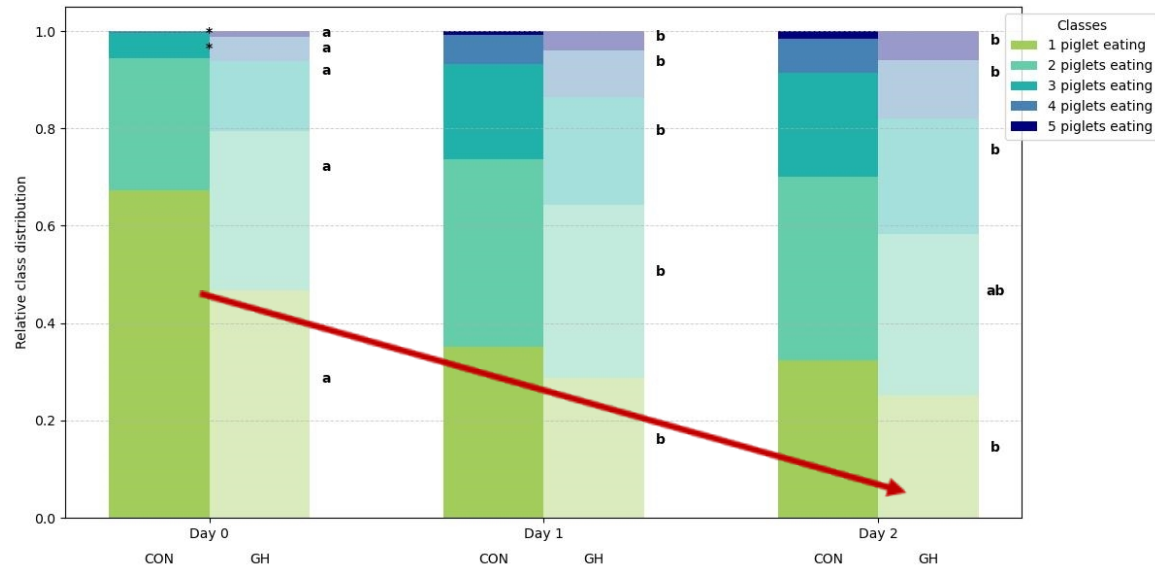
- **72h video data**
- Analyzing 1 frame per second in each **PEN**
- An **example** for an imaginary period of 1 minute:
 - Class 1: 1 animal eating for 32 seconds = $1 \times 32 = 32$ animal*seconds
 - Class 2: 2 animals eating for 17 seconds = $2 \times 17 = 34$ animal*seconds
 - Class 3: 3 animals eating for 11 seconds = $3 \times 11 = 33$ animal*seconds
 - Total: $32 + 34 + 33 = 99$ animal*seconds

PIGLETS DEVELOP GROUP FEEDING BEHAVIOR



For piglets exclusively fed the weaner diet:

- Class 1 decreases while class 2 and 3 increase
- HOUSING did not affect the class distribution



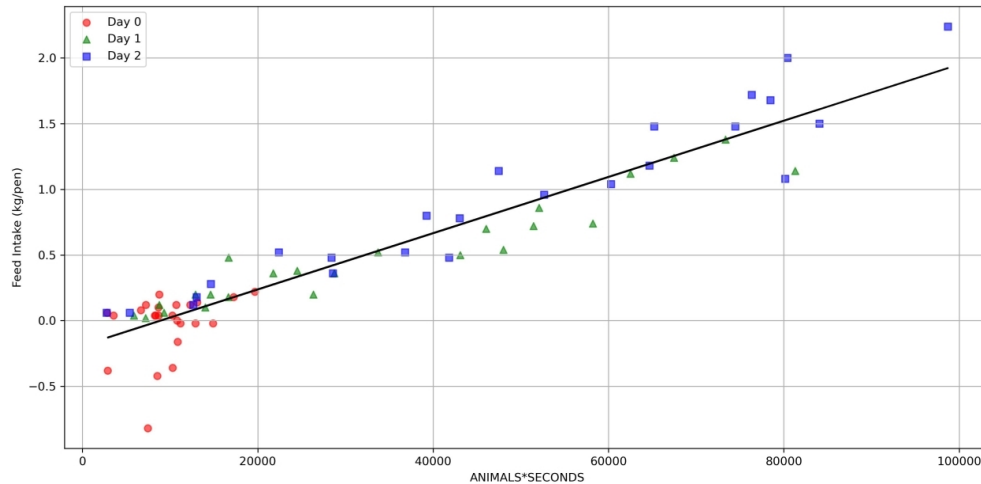
For piglets fed creep feed:

- Class 1 decreases while others increase
- GH increased class 4 and 5 eating events on d0

a,b: indicate the effect of day by class disregarding HOUSING (group housing (GH) – conventional (CON))

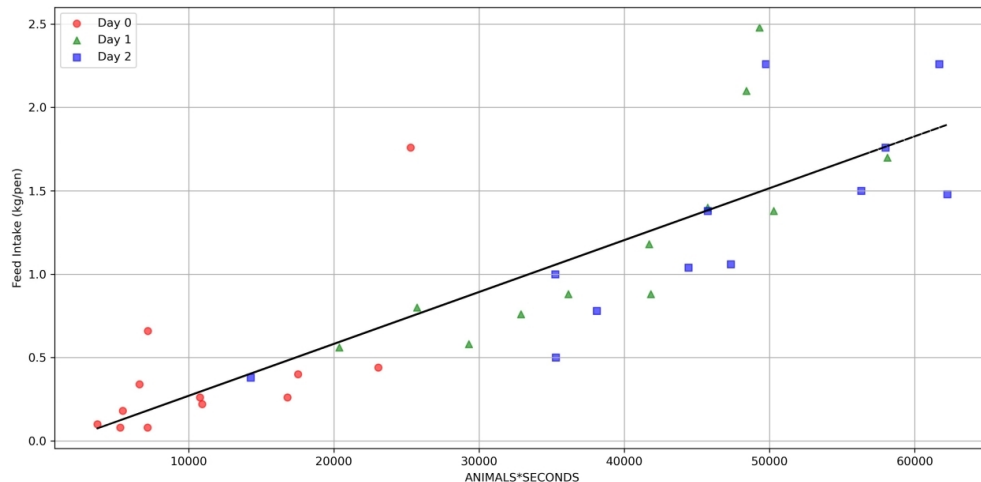
*: indicates the effect of HOUSING within each class and each day.

EARLY FEED INTAKE BEHAVIOR RELATES TO FEED INTAKE



Intake of the **weaner diet** vs. time spent eating

- Feed intake (kg) = $-0.19 + 0.00002141 * \text{ANIMAL*SECONDS}$
- Adj. R-squared: 0.881



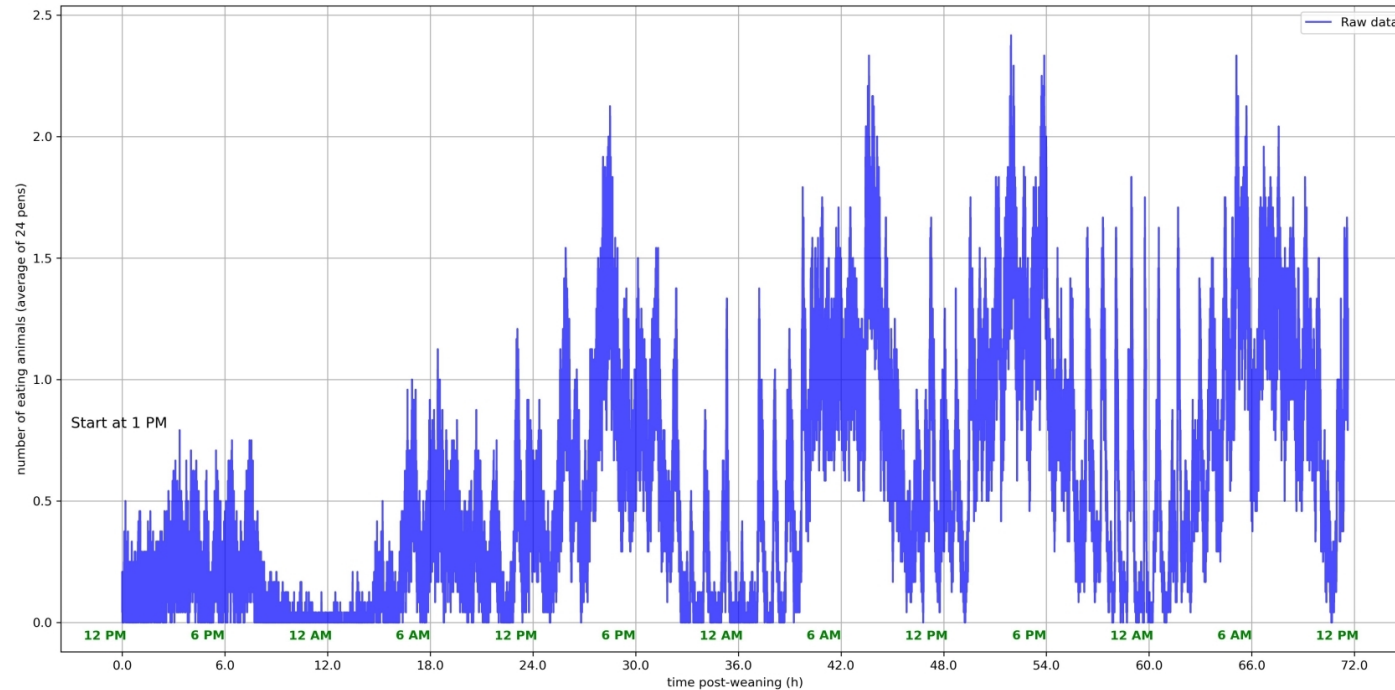
Intake of **creep feed** vs. time spent eating

- Feed intake (kg) = $-0.04 + 0.00003113 * \text{ANIMAL*SECONDS}$
- Adj. R-squared: 0.702

Multiple linear regression using class info

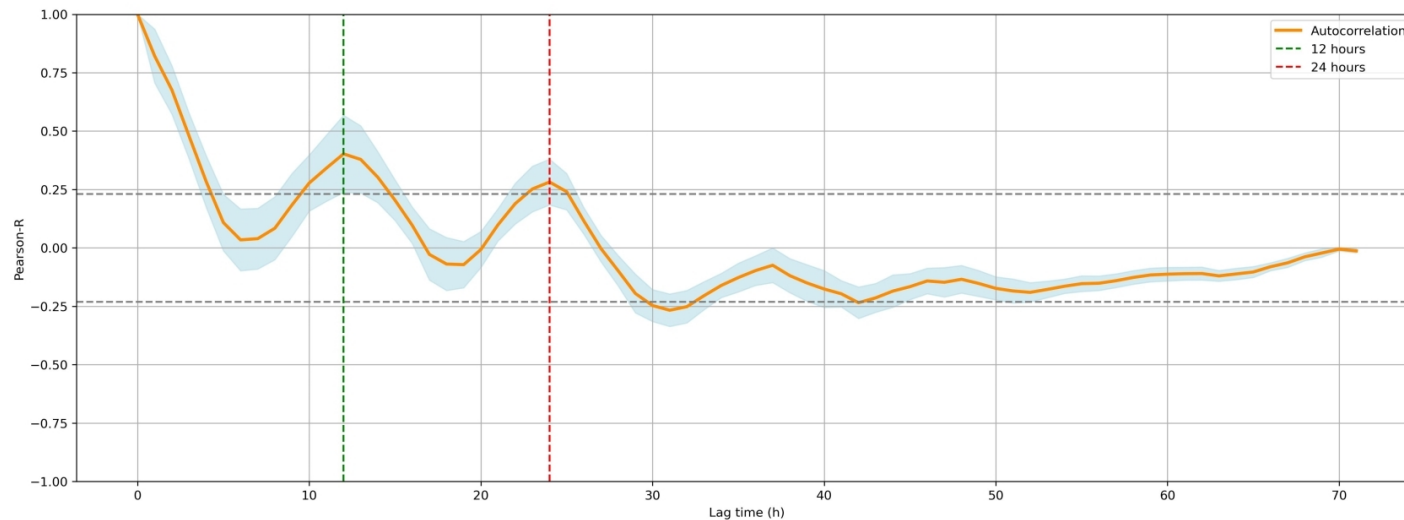
- R^2 not improved as compared to simple linear regression
- Challenging to isolate the effect of each class due to multicollinearity

DAILY PATTERNS IN THE RAW DATA



Raw data:

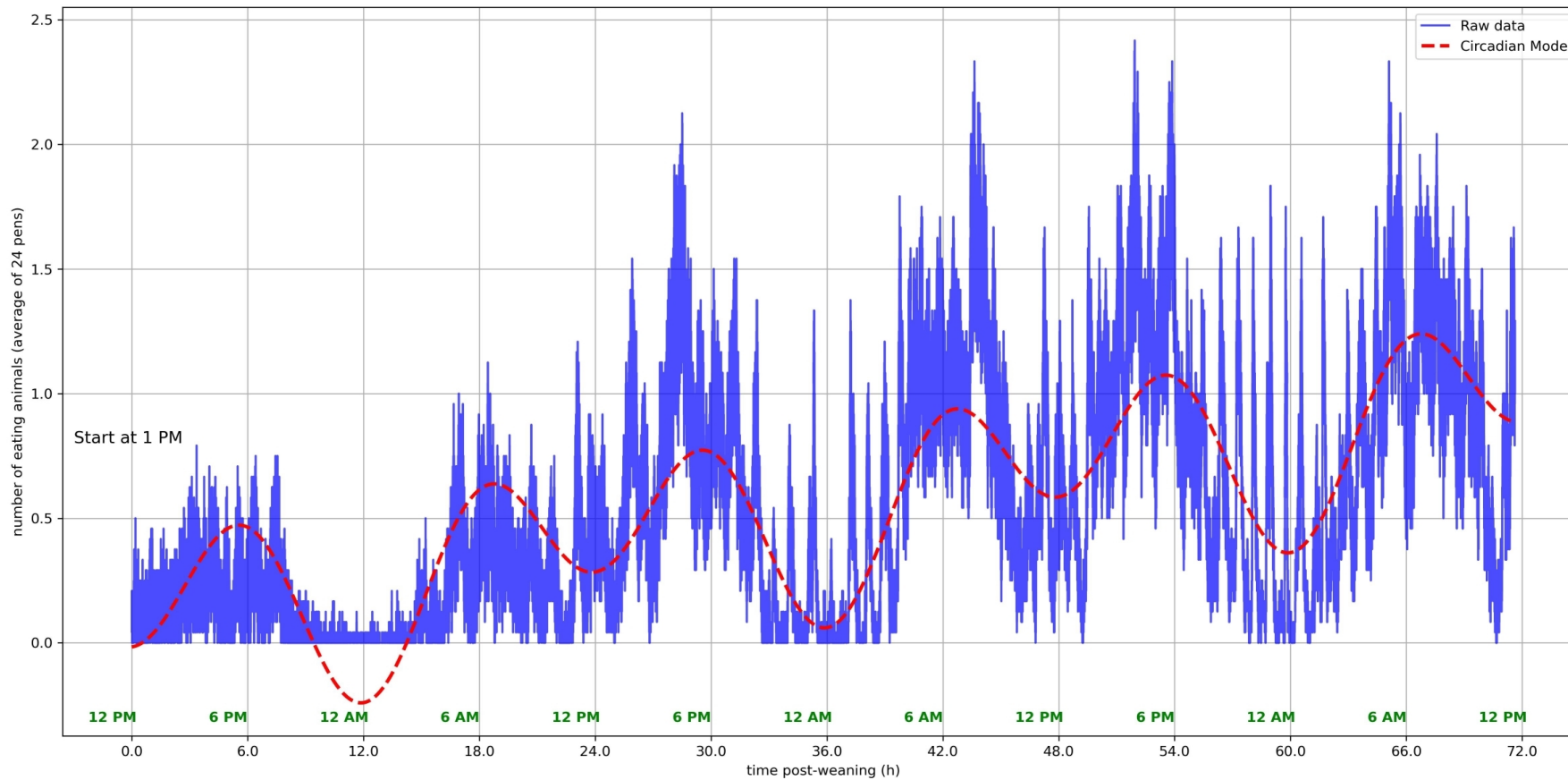
- Average of 24 pens
- Shows a wavelike pattern
- Low feed intake behavior at 12h AM and 12h PM



Autocorrelation analysis:

- After smoothing the raw data
- 2 peaks visible at 24h and 12h

ONE-HARMONIC TRENDED CIRCADIAN MODEL



Model fit:

- $R^2 = 0.59$

Influence of light:

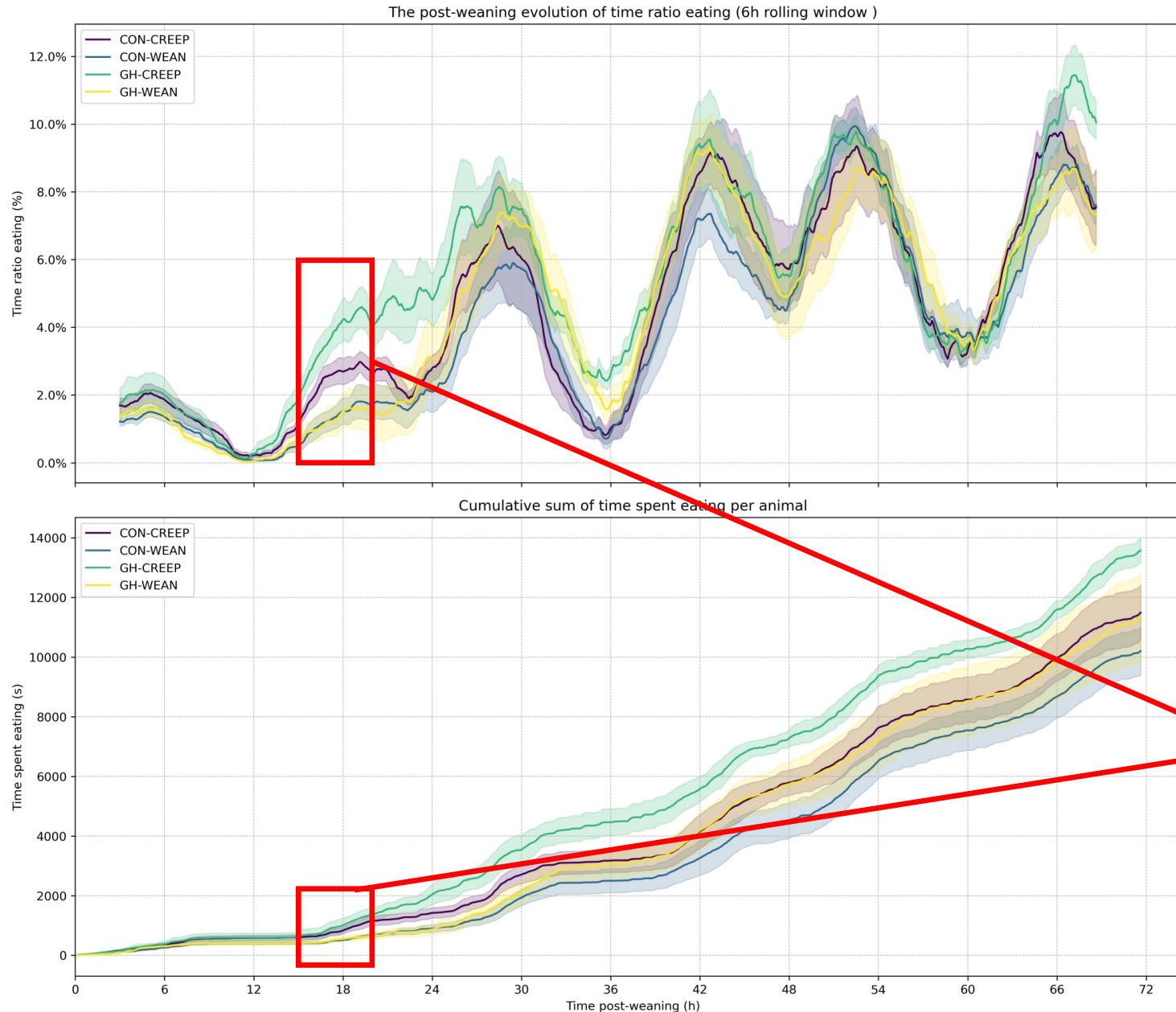
- Only limited daylight in the stable
- Artificial light 24/7

	value
Alpha	0.92511
Beta0 (linear trend coefficient)	0.01254
Beta1 (cosine coefficient for primary frequency)	0.18702
Beta2 (cosine coefficient for first harmonic)	-0.29605

$$Y(t) = \alpha + \beta_0 * t + \beta_1 * \cos(2\pi * f_{\text{circadian}} * t) + \beta_2 * \cos(4\pi * f_{\text{circadian}} * t)$$

where $f_{\text{circadian}} = 1/24$ is the frequency corresponding to the circadian rhythm

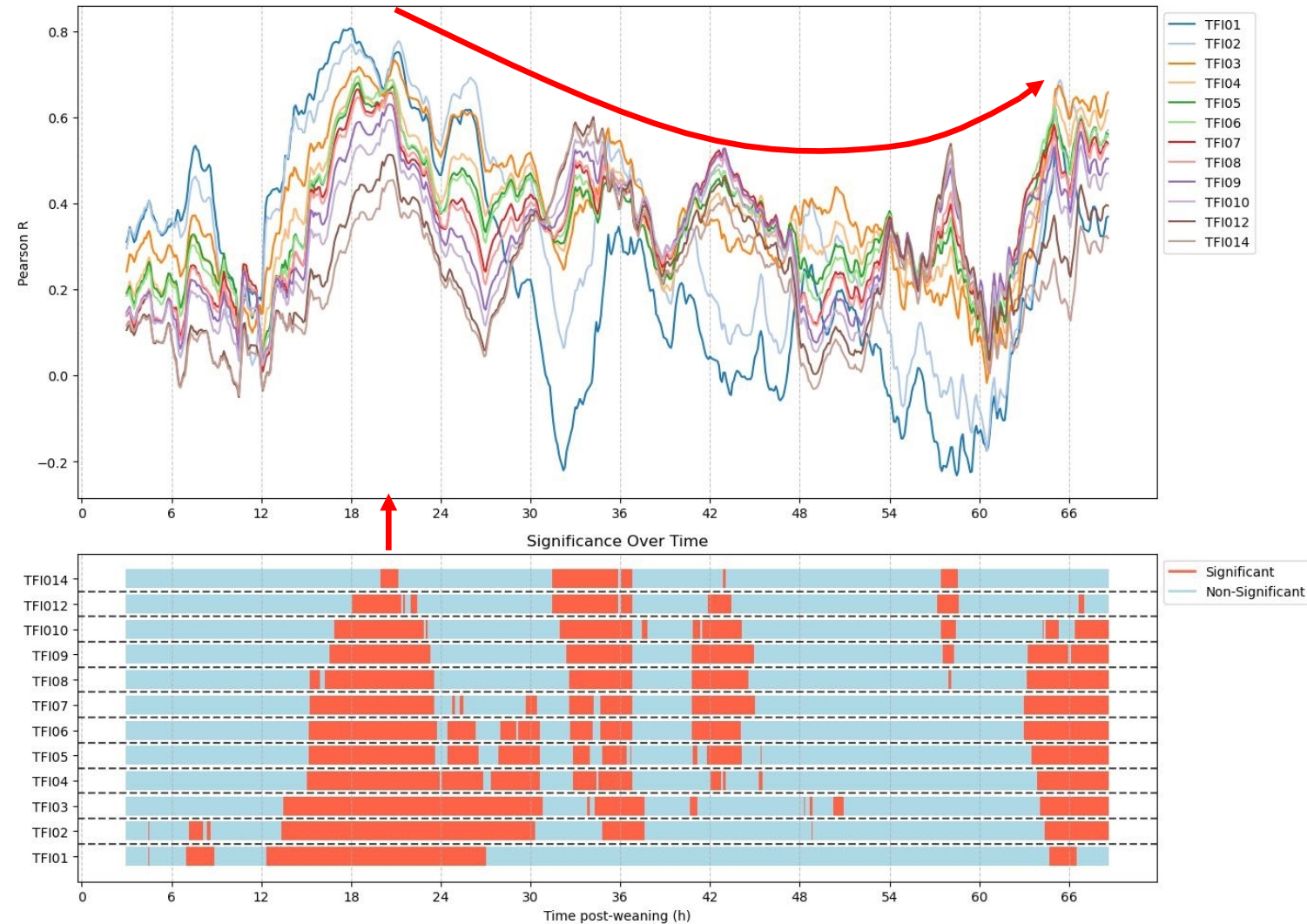
TEMPORAL DIFFERENCES IN INTAKE BEHAVIOR



- Differences in feed intake behavior start to develop during d0 (i.e. starting 12h post-weaning)
- Feeding creep feed increases feed intake behavior in that time window
- Slope might be indicative for the behavior in a certain time window

EARLY FEED INTAKE BEHAVIOR ASSOCIATES WITH FEED INTAKE DURING THE WEANING TRANSITION

- Calculating the slope of the cumulative feed intake behavior in a running window of 6h
- Evaluate the correlation with the total feed intake (TFI) for a certain periods (e.g. TFI014 for d0 to d14 post-weaning)
- The correlations during **16–24h post-weaning** suggest the relative importance of that period in ‘predicting’ the early post-weaning feed intake



EFFECT OF PRE-WEANING SOCIALISATION AND FEED FAMILIARITY

		HOUSING		FEEDFAMILIARITY			HOUSING	FEEDFAMILIARITY	INTERACTION HxF
	Day	CON	GH	CREEP	WEAN	SEM	P-value	P-value	P-value
TOTAL FEED INTAKE (g/animal) (manually weighed)	d0	10	18	37 ^x	0 ^y	8	0.544	0.002	0.182
	d1	78 ^a	108 ^b	121 ^x	66 ^y	9	0.048	0.001	0.725
	d2	121	140	148 ^x	113 ^y	9	0.212	0.033	0.763
TOTAL TIME SPENT (s/animal)	d0	1158	1452	1729 ^x	881 ^y	144	0.202	0.001	0.163
	d1	4001 ^a	5057 ^b	4806	4251	255	0.038	0.256	0.692
	d2	5795	6009	6088	5717	258	0.697	0.501	0.574
TOTAL FEED INTAKE RATE (mg/s)	d0	7	0	21 ^x	0 ^y	8	0.311	0.009	0.201
	d1	19	21	25	15	2	0.515	0.067	0.830
	d2	21	23	25	20	1	0.441	0.142	0.934
TIME SPENT at WEANERFEED (s/animal)	d0	849	790	758	881	69	0.691	0.405	0.844
	d1	2662	3064	1474 ^x	4251 ^y	393	0.456	0.000	0.126
	d2	3982	4014	2279 ^x	5717 ^y	479	0.962	0.000	0.853
WEANERFEED INTAKE RATE (mg/s)	d0	0	0	6	0	8	0.421	0.082	0.156
	d1	14	13	12	15	1	0.640	0.285	0.363
	d2	17	19	17	20	1	0.378	0.275	0.848
TIME SPENT at CREEPFEE (s/animal)	d0	618 ^a	1323 ^b	-	-	176	0.019	-	-
	d1	2678 ^a	3986 ^b	-	-	271	0.007	-	-
	d2	3627	3990	-	-	331	0.597	-	-
CREEPFEE INTAKE RATE (mg/s)	d0	38	29	-	-	7	0.493	-	-
	d1	28	31	-	-	3	0.590	-	-
	d2	26	28	-	-	2	0.694	-	-

CONCLUSIONS

- Image classification using computer vision showed good performance and proved useful in understanding eating behavior.
- Piglets develop group eating behavior upon weaning.
- A circadian feed intake pattern develops, following a one-harmonic trended model.
- Temporal changes in early feed intake behavior relate to intake on a 'longer term'.
- Pre-weaning socialization and feed familiarity affected feed intake and feed intake behavior:
 - Feeding additional creep feed increased total feed intake
 - Pre-weaning co-mingling stimulates creepfeed intake and stimulated creep feed intake behavior at d0 and d1 post-weaning.

Thank you for your attention



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