Activity tracking in broilers

Animal Welfare Group Nigeria Webinar

March 16th 2022, Malou van der Sluis

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Acknowledgements

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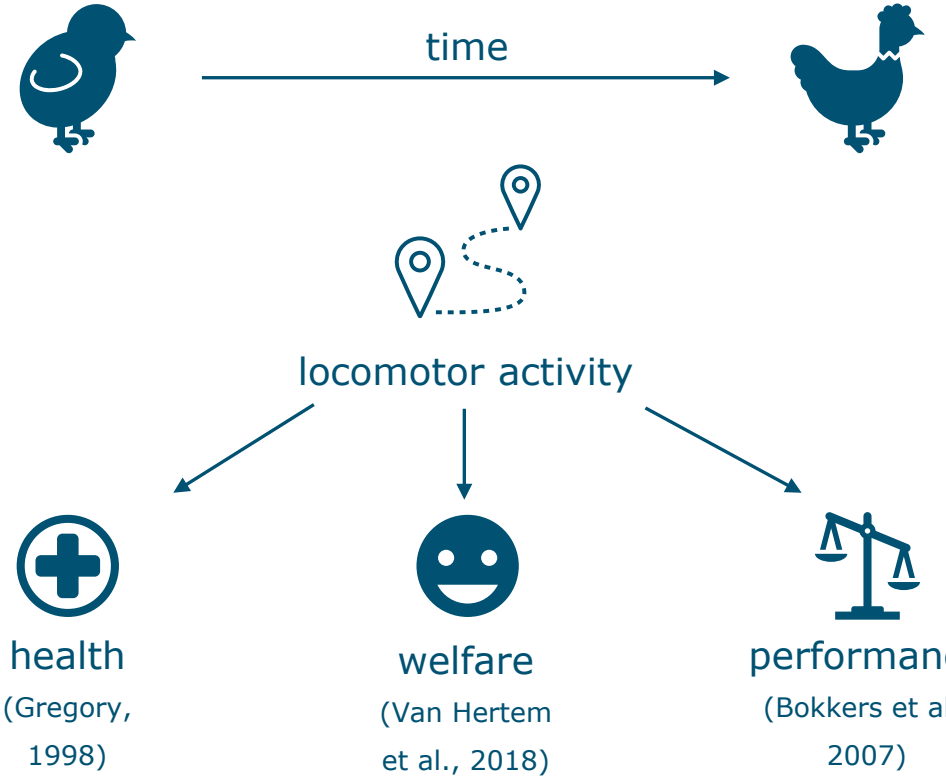
Background


time
locomotor activity
health
(Gregory, 1998)
welfare
(Van Hertem et al., 2018)
performance
(Bokkers et al., 2007)

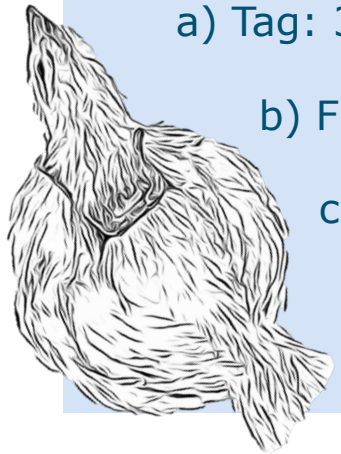
Sensor technologies

Ultra-wideband (UWB) tracking

a) Tag: 3.8 x 3.9 cm, ~ 25 g

b) From 2 weeks old

c) Coordinates

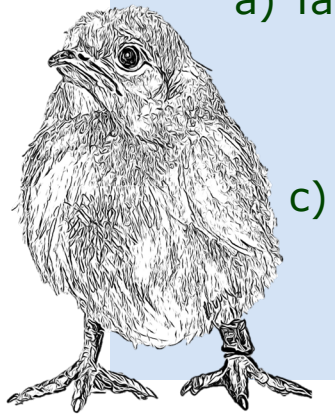


Radio frequency identification (RFID)

a) Tag: 15 x 3.7 mm, < 1 g

b) From 1 day old

c) Absence / presence



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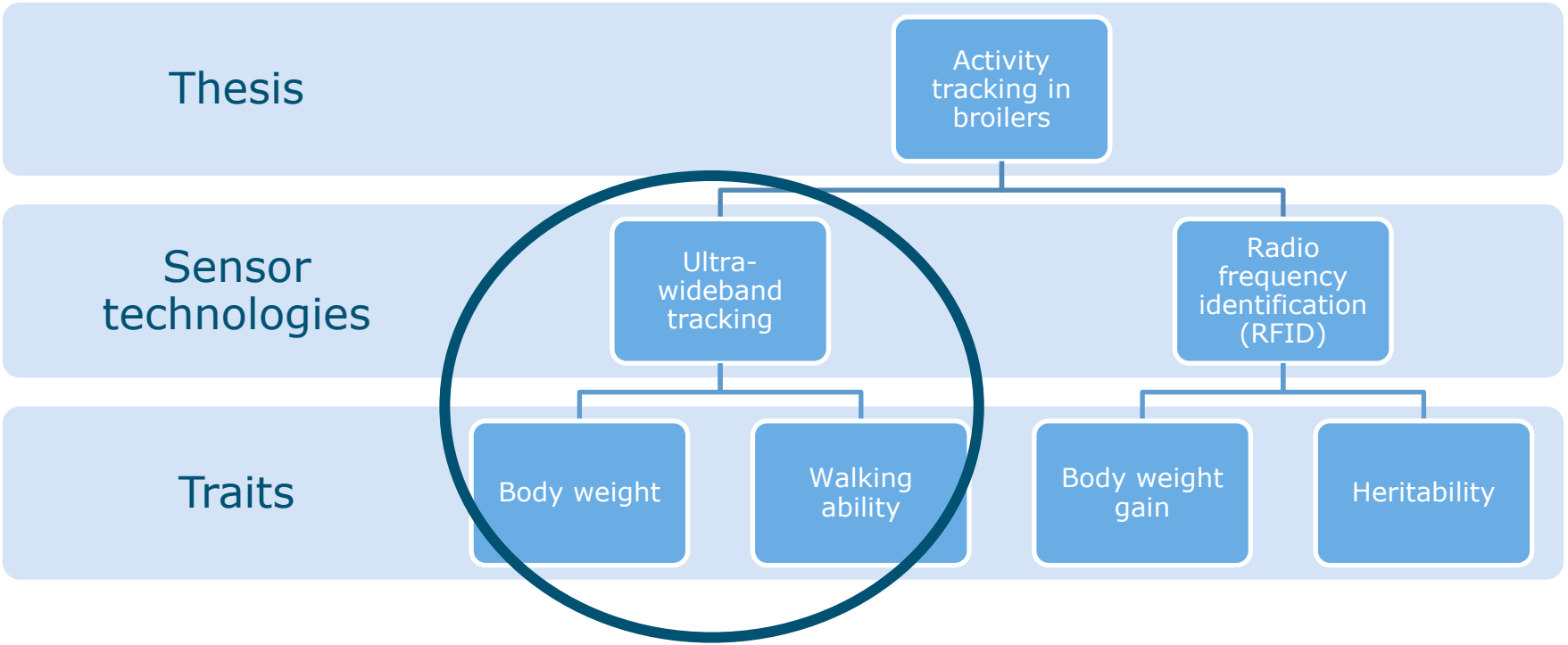
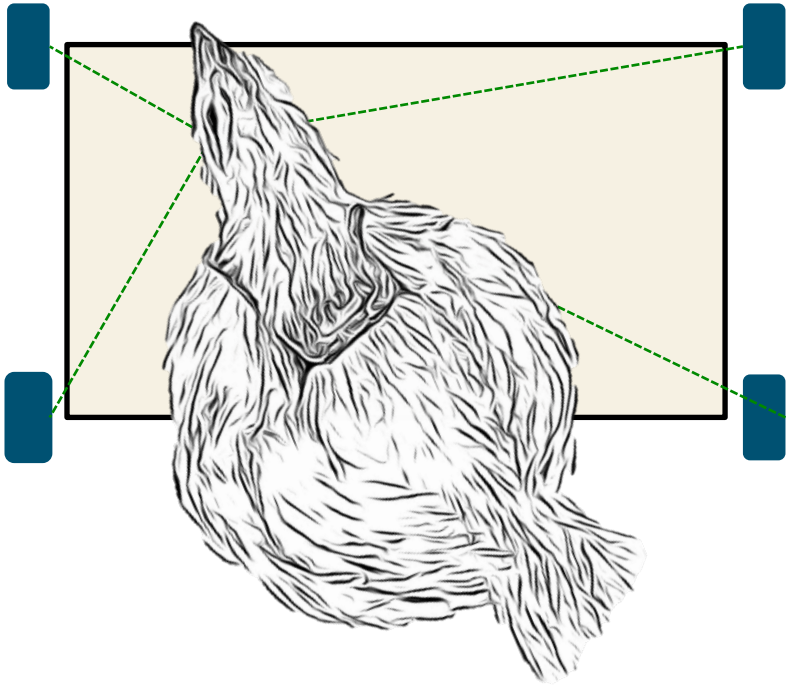
Overview of the project



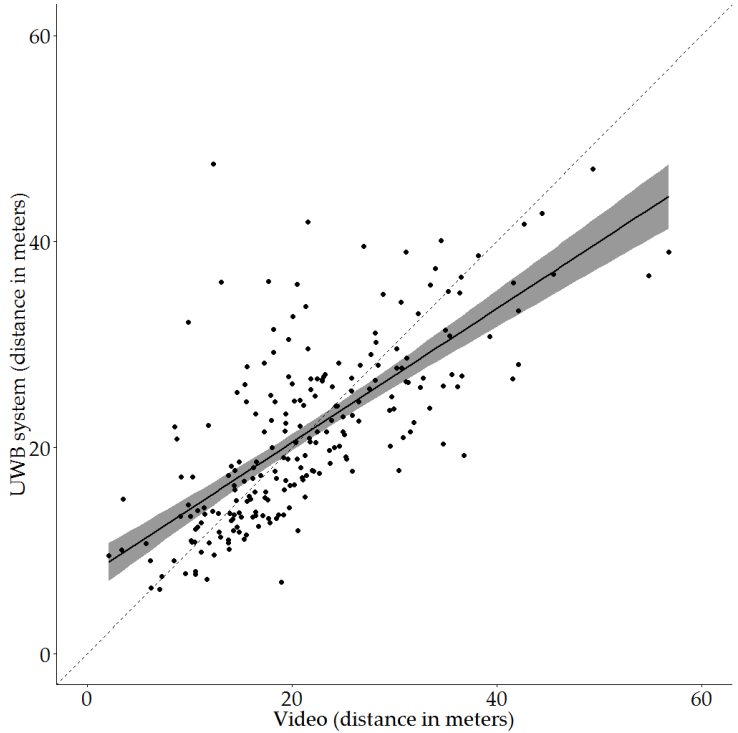
Ultra-wideband tracking

- Tag sends out signal every ~7 seconds
- Triangulation of signal
- Distance moved over time from TrackLab software



Validation of the UWB system

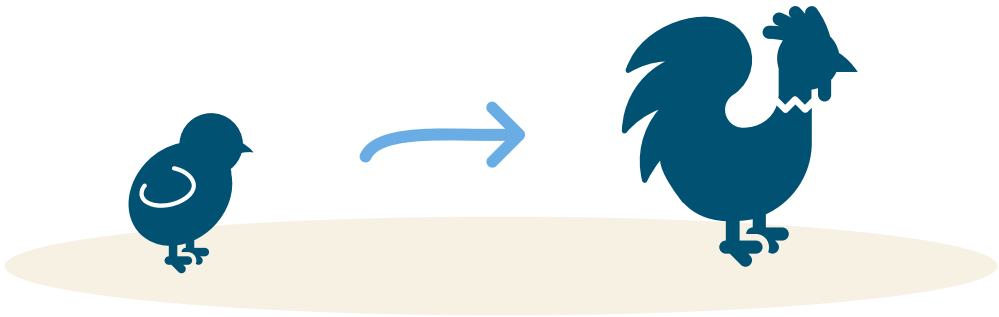
- Correlation with video ~0.71
  - Overestimation at low distances
    - Noise
  - Underestimation at high distances
    - Part of track missed



van der Sluis et al. (2019)

Linking activity to gait

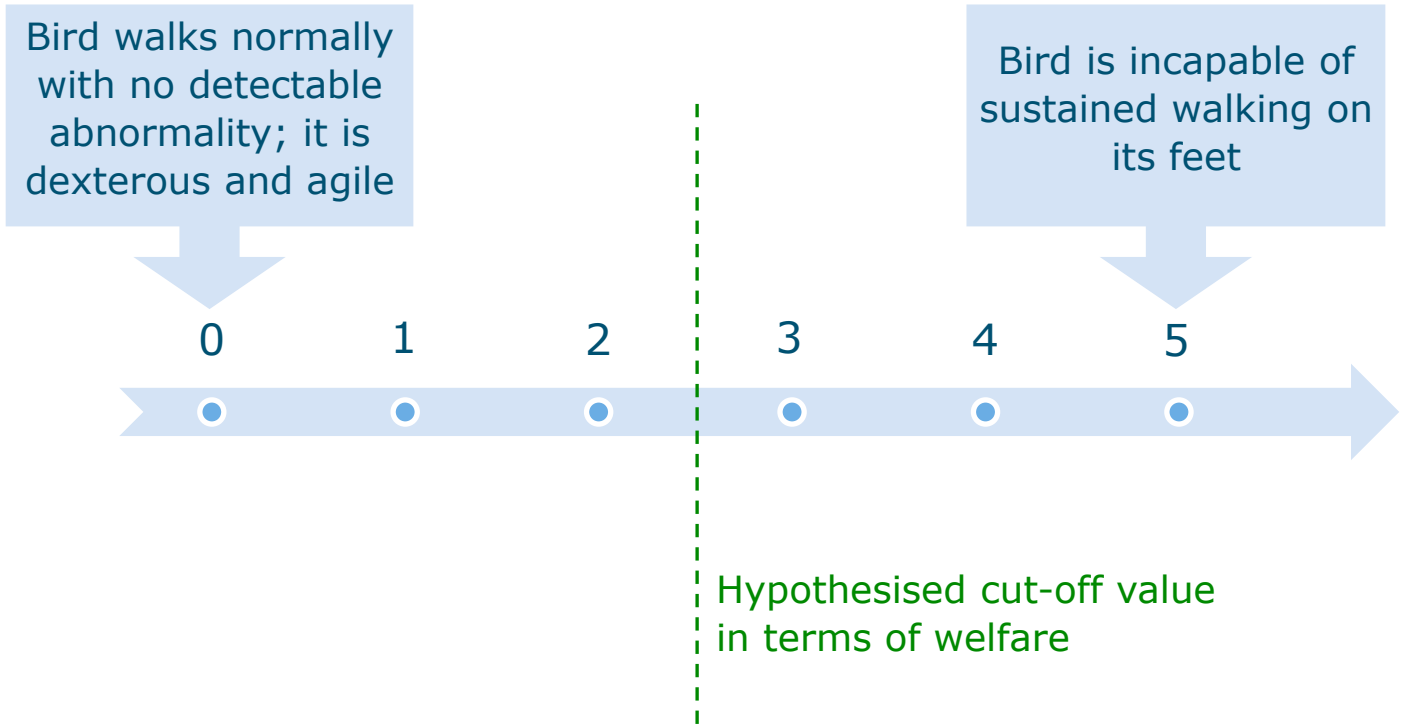
Broiler gait



- High body weight and fast growth → leg health problems[1]
- Negatively affects welfare: painful, reduction in several behaviours including activity[2]

[1] Kestin et al. (2001)
[2] Danbury et al. (2000); Weeks et al. (2000); Van Hertem et al. (2018)

Manual gait scoring



Kestin et al. (1992)

Activity as a proxy for gait

- Manual scoring: time-consuming and subjective
- Automated methods available but often at group-level[1]
- Correlation between activity and leg health[2]
    - Worse gait → lower activity

Automated recordings of individual activity as a proxy for individual gait?

[1] E.g., Aydin et al. (2010); Dawkins et al. (2012)
[2] Weeks et al. (2000); van Hertem et al. (2018)

Relationship with gait: methods

- 137 broilers

- 4 consecutive production rounds with 17 days of UWB location data (16-32 days old)

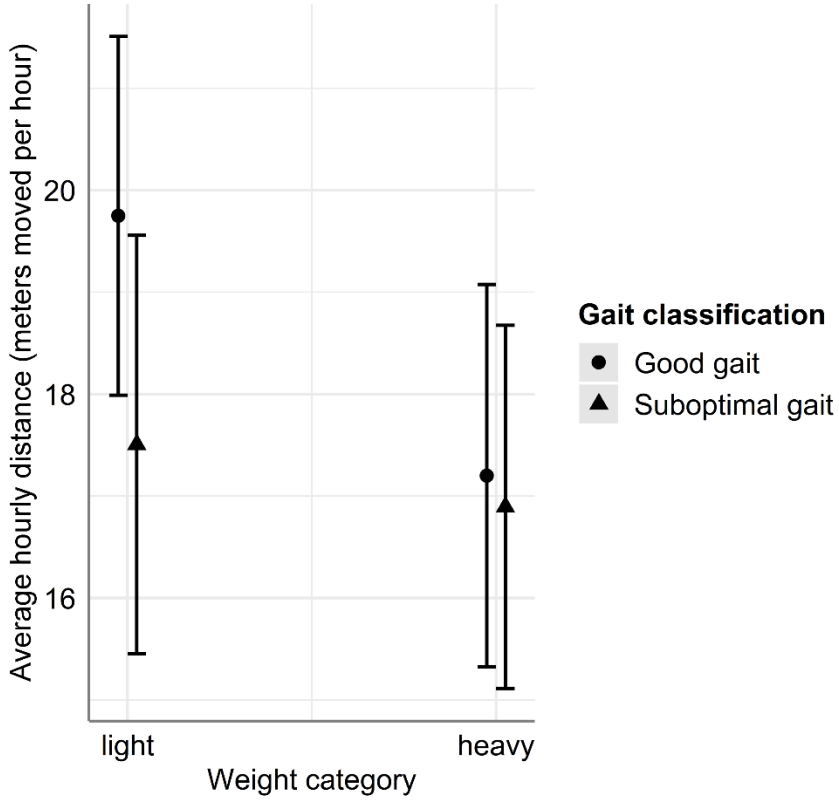
- Categorised as lightweight (**L**) or heavyweight (**H**) at ~2 weeks old

- Gait scored at 33-35 days old; categorised as **good gait** (**GG**; 0-2) or **suboptimal gait** (**SG**; 3-5)

	L	H	Total
GG	46	33	79
SG	20	38	58

Results

- Linear regression with only gait
  - GG birds higher average activity (estimate = 1.12 ± 0.41, p = 0.007)
  - No difference in slope
- Linear mixed effects model →



Discussion

- Lower activity for SG matches with literature[1]
  - Higher activity → lower prevalence of gait problems[2]
  - Worse gait → lower activity e.g. due to pain[3]
- Relationship with body weight
  - Possibly heavier birds already limit their activity
- Remains difficult to distinguish GS groups –measure earlier in life?

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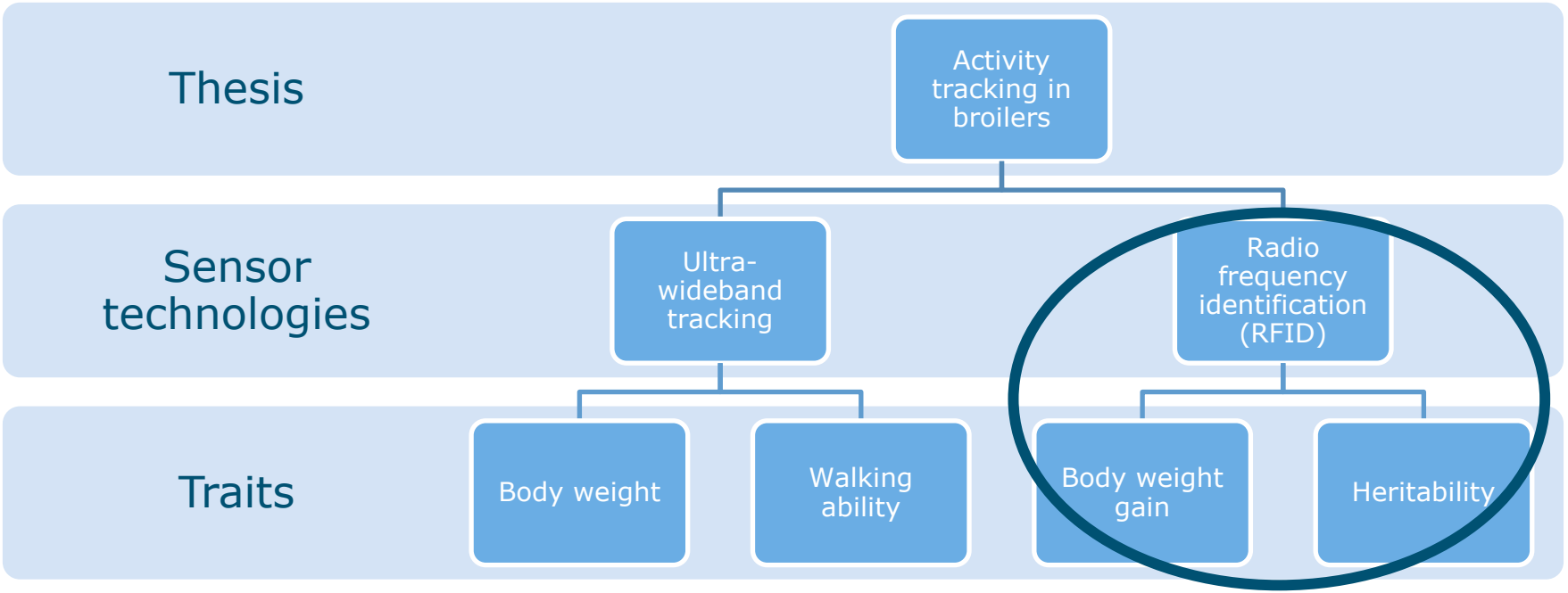
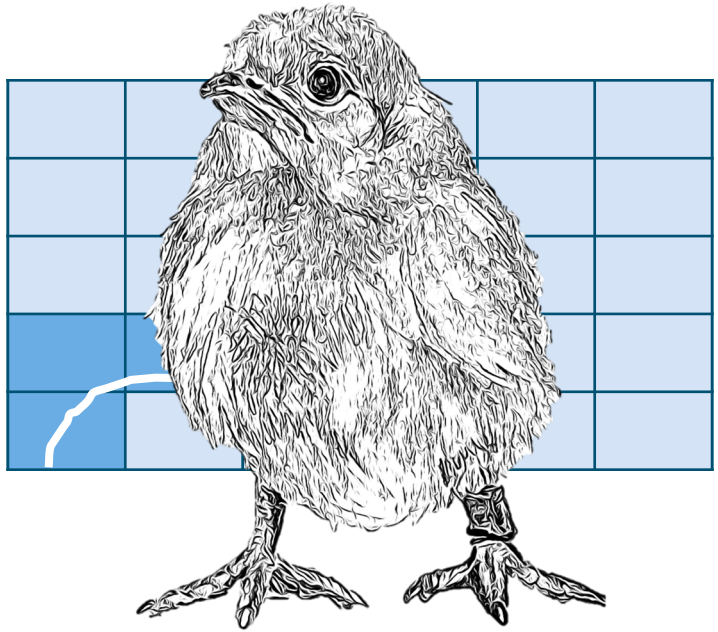
[1] Weeks et al. (2000); Van Hertem et al. (2018)
[2] Reiter & Bessei (2009)
[3] Danbury et al. (2000)

Overview of the project



RFID to track broilers

- Passive high frequency RFID
- RFID tags fitted to leg
    - 15 x 3.7 mm, < 1 gram
- Grid of 30 antennas
- Used 1 sample/second



van der Sluis et al. (2020)

Raw RFID recordings

Live view in software

Log file stored

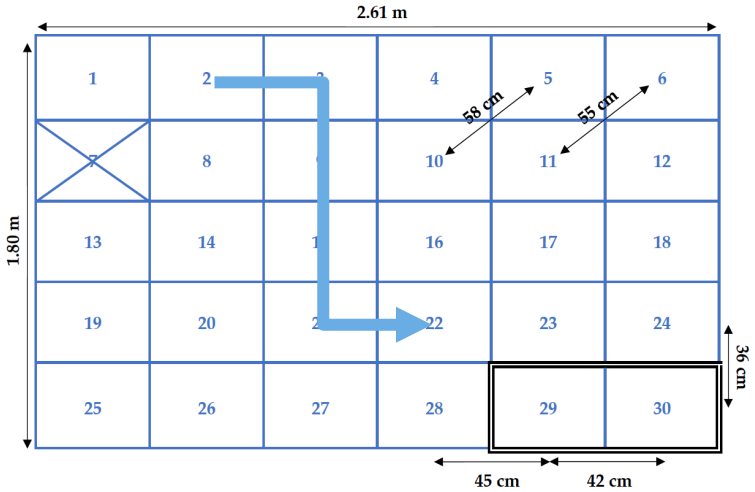
	A	B	C	D
1	2	003000000000000000148627F7129F671	19-3-2019)	12:20:47
2	3	003000000000000000148637F708D5D87	19-3-2019)	12:20:47
3	9	003000000000000000148637F71B5401B	19-3-2019)	12:20:47
4	4	003000000000000000148637F70A51208	19-3-2019)	12:20:47
5	4	003000000000000000148627F72A1A4D3	19-3-2019)	12:20:47
6	2	003000000000000000148627F7101B9FE	19-3-2019)	12:20:47
7	3	003000000000000000148617F72A1F48A	19-3-2019)	12:20:47
8	9	003000000000000000148637F70D92645	19-3-2019)	12:20:47

Extracting activity information

Antenna positions over time

Distances between center points of antennas

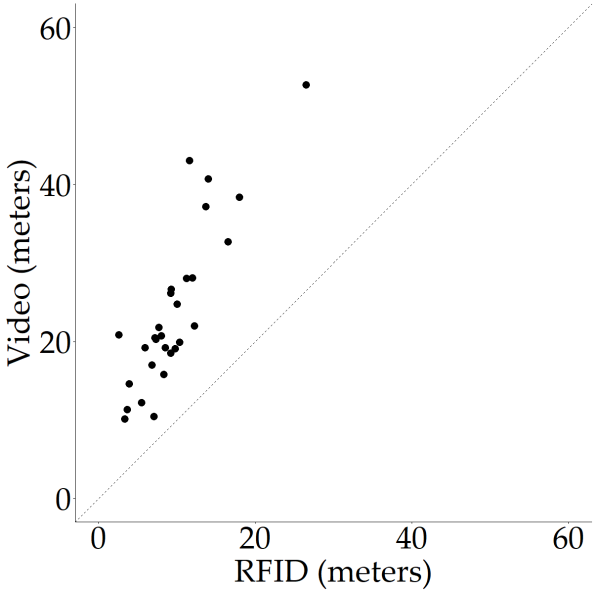
Estimated distances moved



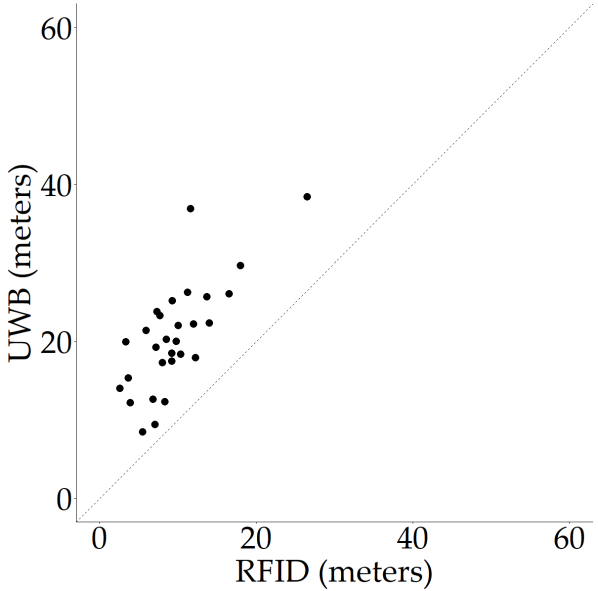
E.g. antenna order 2 – 3 – 9 – 15 – 21 – 22
= 0.45 + 0.36 + 0.36 + 0.36 + 0.42 = 1.95 m

van der Sluis et al. (2020)

Validation of the RFID system



$r_s = 0.82, p < 0.001$



$r_s = 0.70, p < 0.001$

van der Sluis et al. (2020)

Is activity heritable?

Heritability of activity

- Activity as a proxy for other traits and in breeding programs → needs to be heritable
    - E.g., laying hens at 5 weeks old: 0.33-0.38[1]
    - But not at a very young age or throughout life

[1] Kjaer (2017)

Setup

Purebred male broilers

Pen with ~80 broilers; 5 rounds of data

Location every second;
from hatching until near-slaughter

Body weight every week

Results

- Activity is heritable
- Lower heritability observed when the birds are older
- Strong genetic correlations between adjacent weeks

Dynamic descriptors of activity

Relationship activity and body weight

- Trade-off between increasing growth rates and reducing leg problems
  - Higher BW linked to lower activity (van der Sluis et al., 2019)
  - Hypothesised positive effects of increased activity on leg health (Reiter & Bessei, 2009; Bizeray et al., 2010; Kaukonen et al., 2017)

What is the relationship between activity early in life and body weight gain?

Relationship activity and body weight

- Behaviour is complex and multi-dimensional (Asher et al., 2009)
- Mean behaviour levels alone may provide insufficient insight to detect differences (e.g. Dawkins et al., 2012)
- Dynamic descriptors of activity may be informative

Same setup as earlier

Purebred male broilers

Pen with ~80 broilers; 5 rounds of data

Location every second;
from hatching until near-slaughter

Body weight every week

Dynamic descriptors of activity

- Focussing on first 2 weeks
  - Mean distances moved
  - Skewness asymmetry of distribution
  - Root mean square error (RMSE) differences between model-predicted and observed values
  - Autocorrelation degree of correlation between time series and the same series set off by one time unit
  - **Entropy**

Average daily gain

van der Sluis et al. (*in preparation*)

Entropy

- Two time series
  - A: 0101010101
  - B: 0110100011
- Mean, variance et cetera are the same
- But series A is easy to continue or describe (5x “01”), while B is not

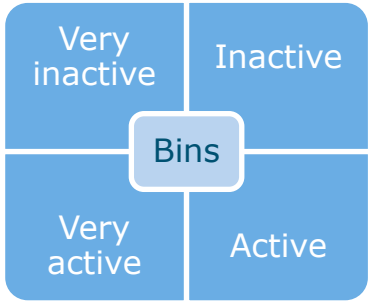
Sample entropy = a measure of the randomness or regularity of time series based on the existence of patterns

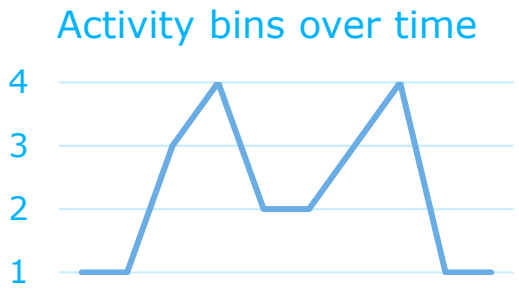
Interpretation of entropy values

- Lower values indicate regularity
- Higher values indicate randomness

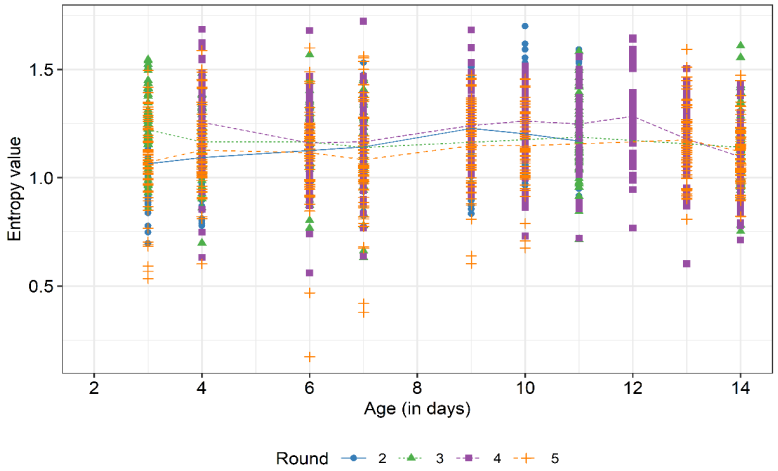
Calculating entropy values

- Per day:
  - 15-minute bins
  - Look at pattern across day
  - Calculate entropy value for each day





Results

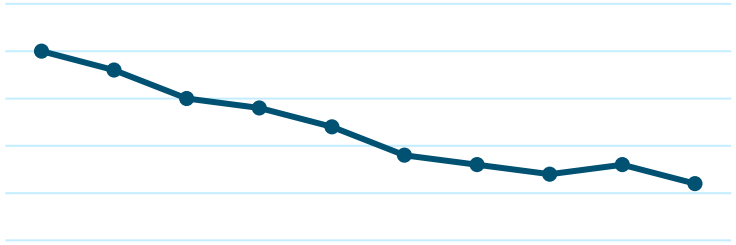


Activity descriptor	tau	95% CI	z value	p value
Mean distance	-0.065	-0.131 – 0.004	-1.724	0.085
Skewness	0.016	-0.069 – 0.097	0.426	0.670
Root mean square error	**-0.105**	**-0.176 – -0.034**	**-2.787**	**0.005**
Autocorrelation	-0.018	-0.092 – 0.055	-0.486	0.627
Entropy	0.024	-0.064 – 0.117	0.564	0.573

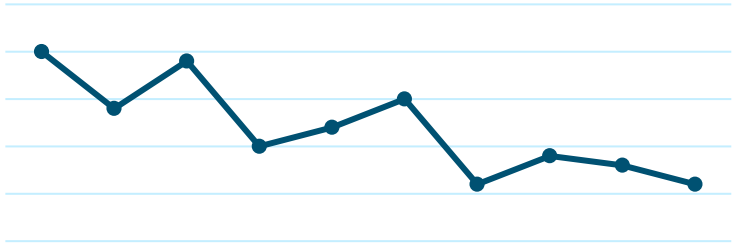
van der Sluis et al. (*in preparation*)

Root mean square error

- More or larger deviations or fluctuations in activity are linked to a reduced weight gain



Few or small deviations



Many or large deviations

van der Sluis et al. (*in preparation*)

Discussion

- Also in model accounting for round and start weight → negative relationship between ADG and RMSE
    - Birds that were more variable in their activity levels → lower ADG
- Limitations
    - Descriptors explained only small part of variation in ADG
    - ADG now looked at as linear
- Suggests that increasing early activity does not necessarily negatively affect body weight gain

Take home messages

- Activity in broilers can be informative for many reasons
- Using sensors, activity can be recorded in a reliable and non-invasive manner
- In the future, activity may be implemented in breeding programs and as early warning systems for farmers

Thank you

B4F Individual tracking

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