

Methodological aspects in exploring gait patterns of persistently lame and non-lame dairy cows



KLAUENfitnet

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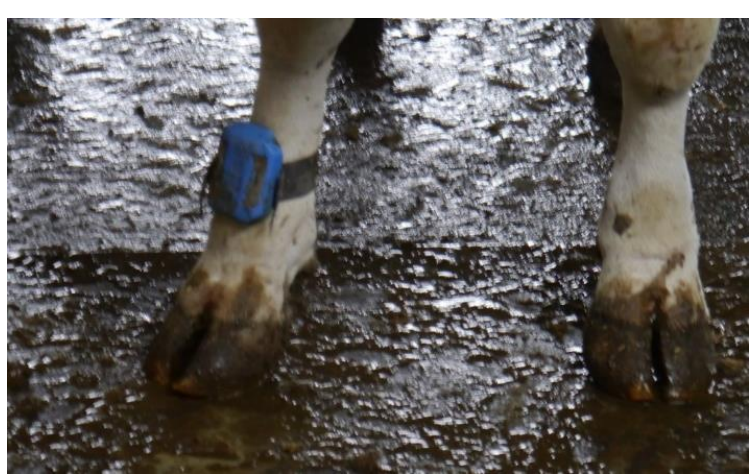
Summary

Previous studies on sensor systems for locomotion impairments showed an association between sensor data on activity behaviour and lameness in dairy cows (e.g. [1], [2]). The objective of our research is to recognize patterns and abnormalities in time series of persistently lame and non-lame dairy cows. Therefore, we investigate similarity between locomotion data employing techniques of time series analysis. We expect our results to facilitate understanding of risk factors for lameness and development of automated diagnostic tools.

Material

Collecting data within the framework of the project KLAUENfitnet (www.klaufenfitnet.de)

Animal movement records (by FULLEXPRT® Software)



Pedometer by Lemmer Fullwood GmbH, Lohmar, Germany

Sensor derived data from 3752 dairy cows in 2015/16:

- Daily average activity impulses/h
- Daily frequency of lying bouts
- Daily average lying bout duration

Visual lameness scoring (by Sprecher et al., 1997 [3])



- October 2015 - August 2016
- 1589 persistently lame or non-lame* cows on 7 farms

*all scorings were lame (>=3) or non-lame (<3)

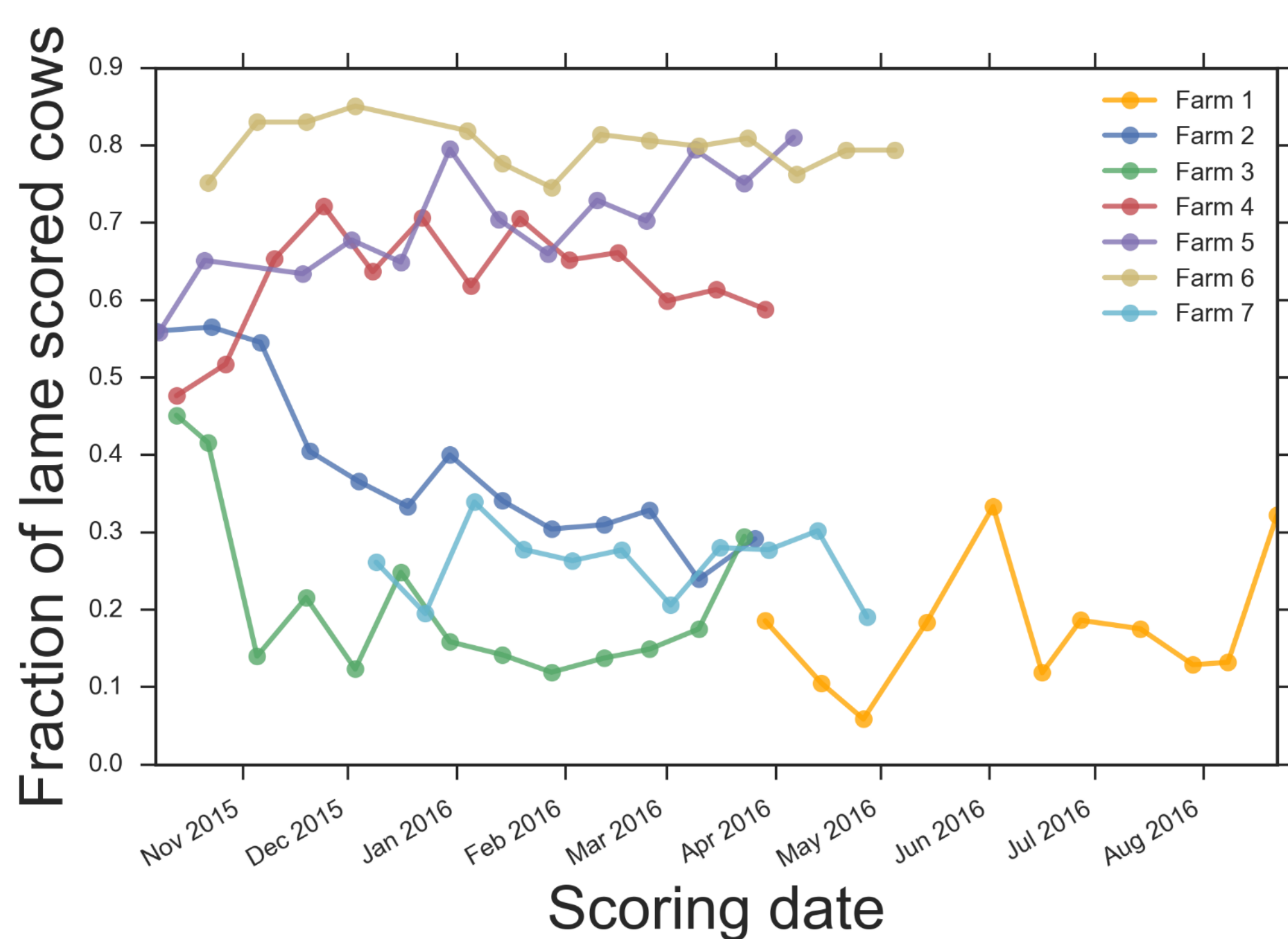


Fig. 1: Fraction of lame scored cows at farm visits per scoring date in 2015/16

Data extraction / transfer / cleaning

Data analysis

- Using R, python
- Cross-correlations
- Time series analysis: ARIMA modelling, spectral filtering

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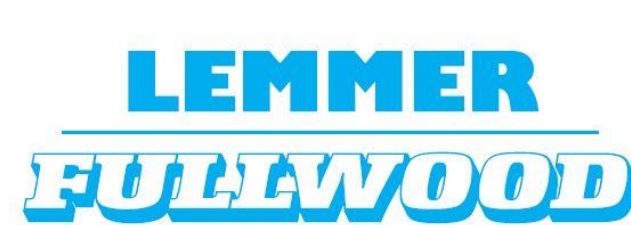
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Methods & Results

To analyse the similarity of the activity behaviour patterns we use Spearman cross-correlation for the raw data. Time series could be represented as the sum of trend (T_t), seasonal (S_t), and residual (ε_t) components: $Y_t = T_t + S_t + \varepsilon_t$ (additive model). To obtain residuals from raw data we plan to use filtering methods for trend and seasonal components i) moving average (Fig. 2), ii) ARIMA modelling, and iii) spectral filtering (Fig. 4). For example, regular high peaks (cow's in heat) could be filtered (Fig. 2 and Fig. 4). The residuals at different times might not be independent, and thus could require autoregressive (ARIMA) modelling.

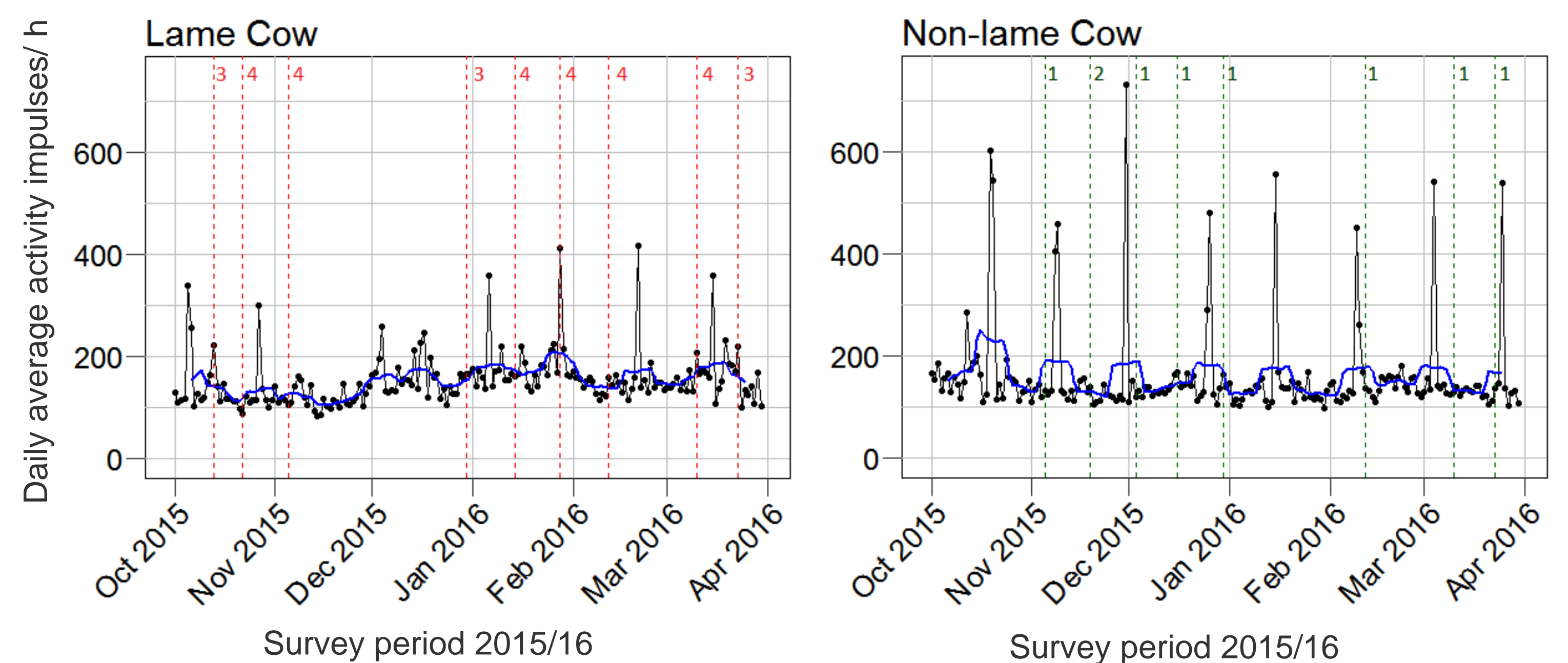


Fig. 2: Time Series plot: raw data of lame and non-lame cow show horizontal time series patterns with regular seasonal patterns of variability S_t . The blue line refers to moving average (window: 10d) and the dashed lines characterise farm visits with numbers accounting for locomotion score.

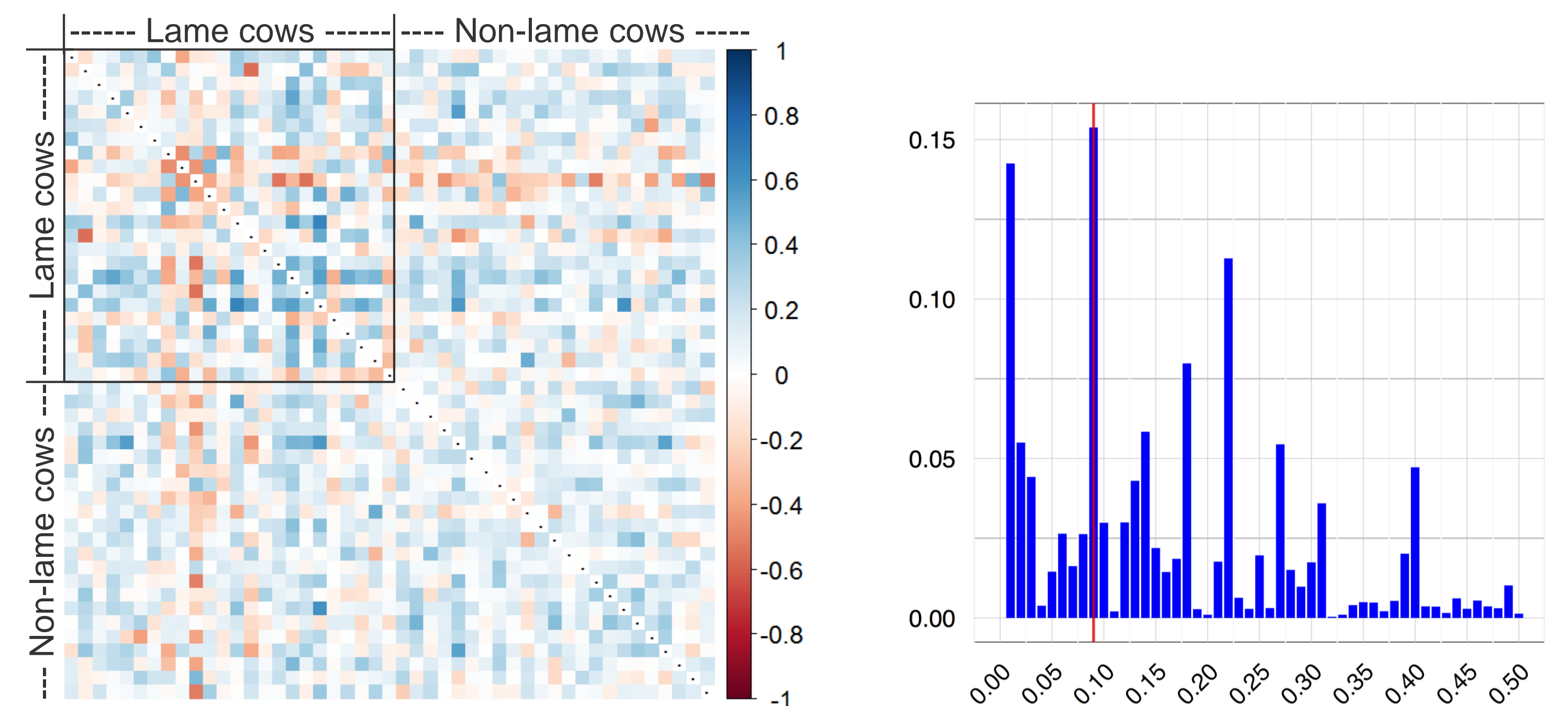


Fig. 3: Spearman cross-correlation matrix of daily average activity impulses/h between persistently lame and non-lame animals. Time series of persistently 'lame' animals are more correlated with each other than time series of non-lame animals (see framed square). An external factor might be influencing lameness persistence.

Fig. 4: Periodogram [4] as an estimate for the spectral density for one animal. The red line corresponds to 18 days periodicity of oestrus.

Conclusions

- Exploratory analysis detects **differences in activity behaviour patterns between persistently lame and non-lame dairy cows.**
- In particular, **cross-correlations are more pronounced between persistently lame than between persistently non-lame animals.**
- Our results **might imply a common external factor, leading to lameness persistence.**

References

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