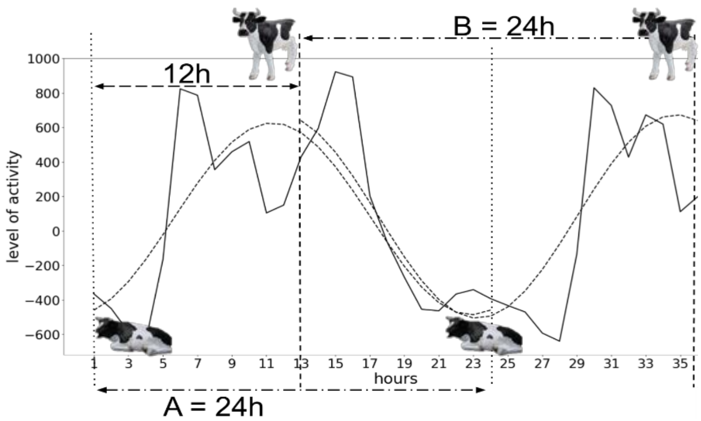
HIGHLIGHT

Detection of activity rhythm anomalies in relation to pre-pathological conditions or stress

Like humans, diurnal animals are active during the day and rest at night. This rhythm is altered during stress or illness. With the development of precision breeding, many sensors are available to monitor the activity of the animals 24 hours a day. It remains difficult to determine when activity becomes abnormal. We applied Machine Learning tools to positioning sensor data obtained from dairy cows. We use the Fourier transform to model activity variations (resting, standing, eating, ...) during the day into a sinusoid. We compare the sinusoids of two consecutive days: A too big difference generates an anomaly. This method produces less than 20% false alarms. It can detect 90 to 100% of anomalies due to a health problem, often one to two days before clinical signs are detected by caretakers. The method also makes it possible to detect 60 to 70% of anomalies due to stress. Such a detection is likely to help farmers make quick decisions: seek additional information to diagnose the problem, isolate the animal, or even treat it, without waiting for the appearance of clinical disorders.

Like humans, diurnal animals are active during the day and rest at night. This rhythm is altered during stress or illness (often before the onset of clinical signs). Identifying such disturbances could help farmers look for additional signs to identify the cause of the disorder, which are essential to good herd management, and take prompt corrective action (e.g., isolate the animal, treat it).
Detecting disturbances in the activity rhythm requires continuous observations.

Thanks to the development of Precision Livestock Farming, sensors are now available to monitor animal activity 24 hours a day. it is still difficult to detect exactly when the rhythm begins to be disturbed. Nicolas Wagner's thesis, co-funded by the Phase Department and the Université Clermont Auvergne, aimed to propose a method to detect anomalies in activity rhythm in relation to a state of illness, stress, or a reproduction event (heat, calving).



Légend: Example of a 36-h series of cow activity modeled by a Fourier transform. Continuous line: activity level calculated from the basic activities (weighted sum of time spent "resting", "standing" or "eating", without unit). Dotted lines: Fourier transform of the first (in black) and last (in red) 24-h segments of this 36-h series. If the distance between these 2 transforms is too important then we consider that there is an anomaly.

We used data from cow positioning sensors to estimate their activity (resting, standing, eating). We weighted the different activities to estimate the level of activity of the cow during the different hours of the day. We had 4 datasets from commercial or experimental farms, with a total of 120,000 cow xdays for which we had access to records of all health and other events. We were looking for a method that could classify the rhythm observed on a given day on a given cow as normal or not, the normal rhythm corresponding to a day without a particular event and the abnormal rhythm on a day when the cow was sick, disturbed (e.g. by a change of pen), in heat or calving.
Recent Machine Learning algorithms were tested before we developed the FBAT (Fourier-Based Approximation with Thresholding) method, which is adapted to rhythmically changing time series. We used the Fourier transform to model the activity variations during the day into a sinusoid. We compared the sinusoids of two 24-hour series shifted by 12 hours: a too large difference generates an anomaly. This method produced less than 20% false alarms. It made it possible to detect 90 to 100% of anomalies due to a health problem or heat - one to two days before the detection of clinical signs. The method also made it possible to detect 60 to 70% of anomalies due to stress.

The development of the method continues by integrating fuzzy logic, which seems to clearly reduce the number of false alarms. It remains to identify the specificities linked to the different disorders with a view to distinguish disease, stress, calving, heat. We are in contact with two precision livestock farming companies that could use our method to refine the alerts theyir systems transmit to farmers.

Learn more:

Wagner N., Mialon MM, Sloth KH, Lardy R., Ledoux D., Silberberg M., De Boyer Des Roches A., Veissier I., 2020. Detection of changes in the circadian rhythm of cattle in relation to disease, stress, and reproductive events. Methods, in press. Cet article contribue au numéro spécial « Methods to face the big challenges of ruminants or ruminant products phenotyping » (coord. M. Bonnet).

Wagner, N., V., A., Koko, J., Mialon, M., Lardy, R., Veissier, I., 2020. Comparison of Machine Learning methods to detect anomalies in the activity of dairy cows, In: Helic, D., Leitner, G., Stettinger, M., Felfernig, A., Raś, Z.W. (Eds.), IFoundations of Intelligent Systems. ISMIS 2020, Springer, Cham., pp. 342-351.

Wagner, N., Antoine, V., Richard, M. M., Lardy, R., Silberberg, M., Koho, J., Veissier, I. (2020). Machine learning to detect behavioural anomalies in dairy cows under subacute ruminal acidosis. *Computers and Electronics in Agriculture, 170*.

Wagner, N., Antoine, V., Koko J., Lardy, R., 2020. Fuzzy k-NN Based Classifiers for Time Series with Soft Labels. In: Lesot MJ. et al. (Eds) Information Processing and Management of Uncertainty in Knowledge-Based Systems. IPMU 2020. *Communications in Computer and Information Science*, 1239:578-89. Springer, Cham.

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