ORIOLE: a web application for cleaning data from the walk-over-weighing device in livestock systems

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Session 39

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The use of the walk-over-weighing (**WoW**), which automatically records animal live weight (**LW**) in an automated, non-invasive manner, involves filtering the primary datasets produced by this technology. Removing outliers allowsthe correct data to be retained for a more consistent interpretation of individual daily physical activity progression. However, the standard methods used so far to perform this cleaning were impractical, time-consuming and required minimal mastery of the methods used. This limits the adoption of WoW by farmers and other end users. Our team previously developed a Kalman filter with impulse noised outliers algorithm for the automatic detection of outliers generated by the WoW (kfino; https://arxiv.org/abs/2208.00961). Once the kfino algorithm was tuned, the **ORIOLE** web-application was developed and deployed by our team (for OutlieRs detectIOn waLk wEighing; https://oriole.sk8.inrae.fr/). The Shiny library of the *R* software which enables to easily create user-friendly interactive web apps straight from R was used (https://shiny.rstudio.com/). Our web application allows users to import raw data measured from the WoW and through simple settings to perform outlier detection and weight prediction during the experiment. Descriptive statistics are then available such as number of daily weighing, evolution of weight per animal, evolution of the flock weight, 24 h kinetics of individuals. The web app is a dashboard composed of a menu of several subsets offering a user-friendly experience: (1) a 'Welcome' section; (2) the 'Genesis' of the technology and the web-app project; (3) the heart of the app with a section for the import and analysis of 'WoW data' and producing useful reports; (4) a 'How to' section documenting how to use the app. Users can analyse their data using full advantage of descriptive and statistics plots and download reports for communication and decision making.

ORIOLE
A web application for cleaning data from the walk-over-weighing device in livestock systems

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WoW: Walk-over-weighing

TechCare Project

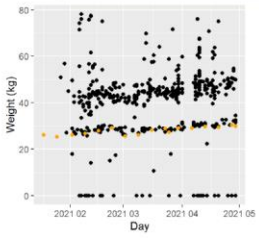
Global Objective: Integrating innovative **TECH**nologies along the value Chain to improve small ruminant welf**ARE** management

Original device: The Walk-over-weighing device is a prototype measuring automatically weights at **high frequency** in indoor or outdoor settings. The WoW 'allow to improve the animals welfare monitoring by limiting manipulation and providing tools for the farmer's management.

Issue: High-throughput data with a high ratio of outliers (usually more than half) due to the gregarious behavior of small ruminants.

Objective of this work: To conceive a friendly user tool for the automatic filtering of outliers produced by the WoW whatever the system.

Motivating Example



- Data from [1].
- Each black point is the measurement from the WoW at a certain moment of the same individual.
- Black points are Y_k in our model
- Each gold point is a liveweight measured with a static scale. They are our gold standard.
- For each measure k, we aim to recover:
  - the real weight X_k
  - the status (OK/KO namely good/bad)

Model for impulse noised outliers

We assume that the latent weight (X_k) are modelled through an Ornstein Uhlenbeck process (first order autocorrelation) :

$$X_k \mid X_{k-1} \sim \mathcal{N}\left(X_{k-1}e^{-a(t_k-t_{k-1})} + m(1-e^{-a(t_k-t_{k-1})}), \frac{\sigma_m^2}{2a}(1-e^{-2a(t_k-t_{k-1})})\right)$$

with some physiological parameters m, a, σ_m and times of measurement (t_k). Measurement k is well monitored ($Z_k = \text{OK}$,) with probability p or badly monitored ($Z_k = \text{KO}$). We assume that the measure of the WoW Y_k verifies

$$Y_k \mid (X_k, Z_k = \text{KO}) \sim \mathcal{P},$$

with some fixed law $\mathcal{P}$ for the outliers, and

$$Y_k \mid (X_k, Z_k = \text{OK}) \sim \mathcal{N}(X_k, \sigma_p).$$

Initial weight and most of these parameters are unknown and individual.

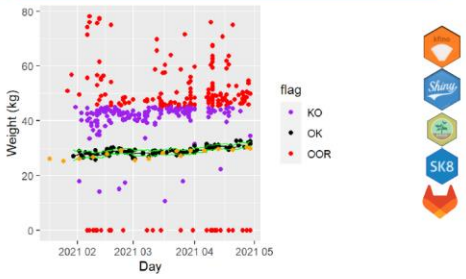
KFINO - an innovative algorithm

Kalman Filter for Impulse Noised Outliers (KFINO) aims to both filters the data and detects outliers [2]. It is based on the iteration of the following two steps:

- **Expectation step** : KALMAN type Filter
  - From $\mathbb{E}[X_1], p, m$, for all data time k
    - Prediction of X_{k+1} from the model and X_k
    - Correction of X_{k+1} from Y_{k+1} depending if $Z_{k+1} = \text{OK}$ and $Z_{k+1} = \text{KO}$
    - Prunning step: keep the more probable path
- **Maximisation step**: estimation of $\mathbb{E}[X_1], p, m$ from explicit computation (no optimization)

⇒ **KFINO** is fully integrated in the **ORIOLE web application** to help users in the outlier detection and prediction.
A pre-traitement is done by removing obvious outliers that are points Out Of a Range (OOR) fixed by the user of ORIOLE.

Data outlier filtering using KFINO



ORIOLE - a web application

- **OutlieRs detectIOn waLk wEighing** : Outlier detection and weight prediction
- **Descriptive statistics** available (number of daily weighing, progress of liveweight at individual and flock level, 24h kinetics of individual behavior (visits to the WoW), 24h kinetics of individuals...)
- **User-friendly** experience with easy steps and an 'How to' section documenting the app.
- Versioned web application, easily scalable and reproducible
- Up to 200 analyzed dynamics in ~ 4 mins

Users can analyse their data using full advantage of descriptive and statistics plots and download reports for communication and decision making.

Access & Dissemination

100% open source technologies

The article | The R package | The Shiny web application

Acknowlegments

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[1] Leroux, E., Llach, I., Besche, G., Guyonneau, J. D., Montier, D., Bouquet, P. M., Sanchez, I., González-García, E. 2023. Evaluating a Walk-over-Weighing system for the automatic monitoring of growth in post-weaned Mérinos d'Arles ewelambs under Mediterranean grazing conditions. animal -open space (https://doi.org/10.1016/j.anopes.2022.100032).
[2] Cloez, B., Fontez, B., González-García, E., Sanchez, I. 2022. Kalman filter with impulse noised outliers: a robust sequential algorithm to filter data with a large number of outliers. https://arxiv.org/abs/2208.00961. hal-03740301.