

WEBINAR

# BIG DATA E INTELLIGENZA ARTIFICIALE

per migliorare  
**benessere animale,**  
**sostenibilità**  
**e produttività**  
negli allevamenti  
di bovine da latte

Organizzato da:



Mediapartner:



**5 DIC.**  
**2022**  
dalle ore  
11.00  
alle ore  
13.00



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA  
DIPARTIMENTO DI SCIENZE E TECNOLOGIE  
AGRO-ALIMENTARI  
Ingegneria Agraria - Costruzioni Rurali

**KU LEUVEN**

Department of Biosystems  
Division of Animal and Human Health  
EngineeringLivestock Technology lab

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FLANDERS'  
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**Innovatiesteunpunt**  
voor landbouw en platteland



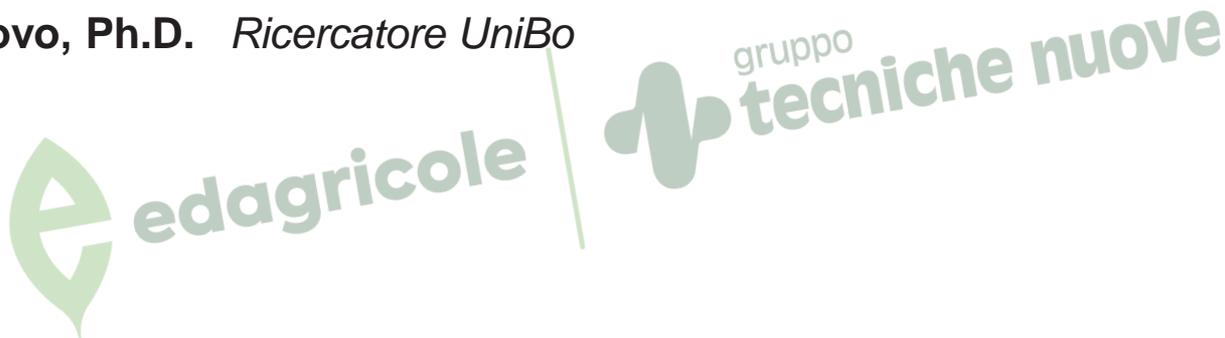
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# 3.

## Modelli numerici per lo stress da caldo

Ing. Marco Bovo, Ph.D. *Ricercatore UniBo*



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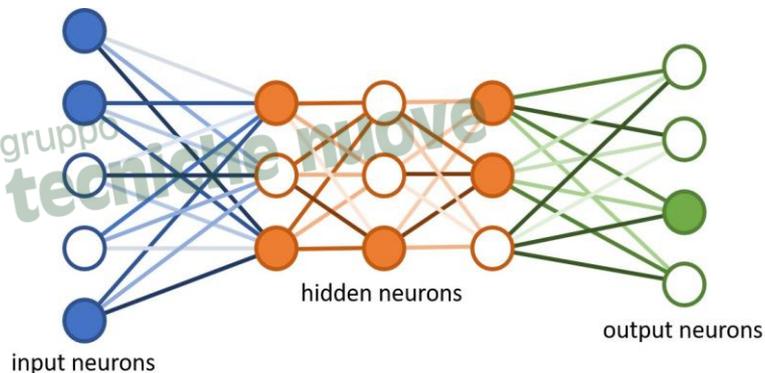
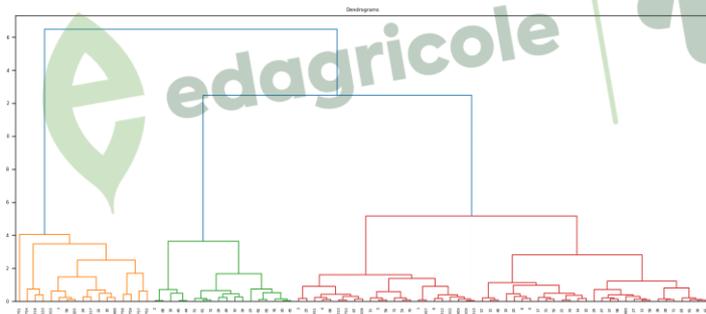


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# Heat stress module and algorithms

Developed using artificial intelligence and machine learning



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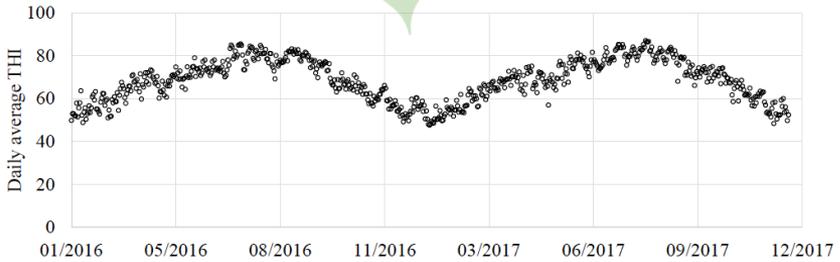
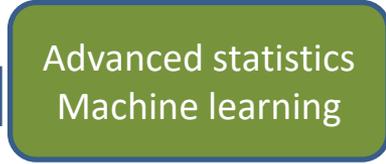
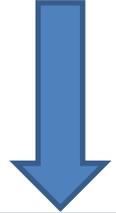


# Methodology

Raw daily data from sensors and Automatic Milking System

- Production
- Activity and behaviour
- Temperature and Relative humidity

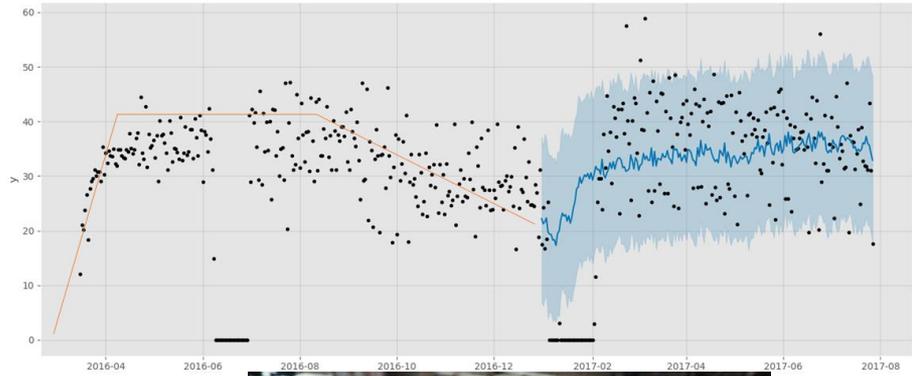
data cleaning and pre-processing



THI (Temperature-Humidity Index) calculation

# Results and impact

- Detecting heat stress and assessing effects on production and animal welfare for better farm management
- Evaluation of the consequences of climate change scenarios



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Modelli numerici per lo stress da caldo

# STIMA DELLA PRODUZIONE DI LATTE SULLA BASE DEI PARAMETRI AMBIENTALI E CON ANIMALI IN STRESS DA CALDO



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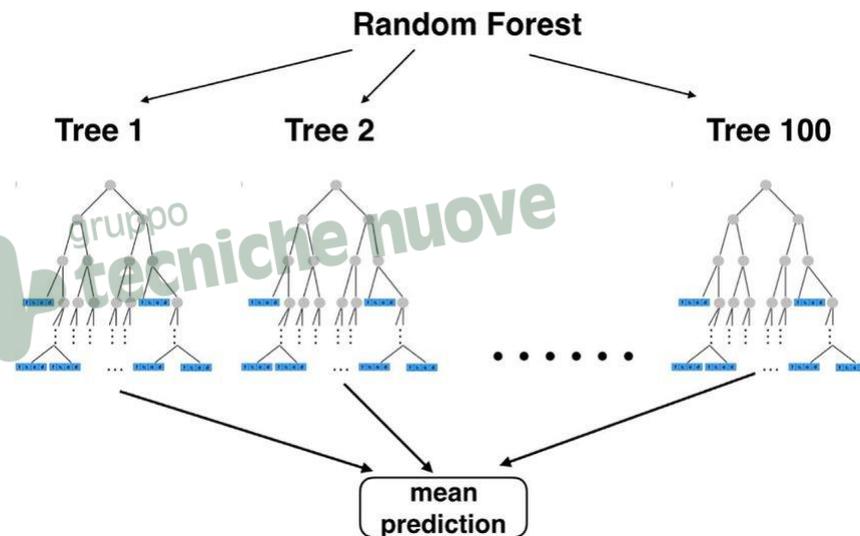
# Milk yield modelling in relation to environmental parameters and heat stress - Prediction of production drops

Use of **machine learning techniques** to assess the **trend in daily milk yield** of each cow in relation to **environmental conditions**.

A **Random Forest Algorithm** has been used as a regressor in order to **estimate the *daily milking yield*** considering the **DIM** and the average **THI** of the previous days.

**Random decision trees**, with each decision tree depending on a collection of random variables.

**For each animal a different model** has been trained (**individual-based model**)



Representative scheme of Random Forest Algorithm

# Milk yield modelling in relation to environmental parameters and heat stress - Prediction of production drops

Input predictive features of the *Random Forest algorithm* used to predict the heat stress effect

$$Y_{i,j} = DIM_{i,j} + THI_{i,j} + THI_{i,j-1} + THI_{i,j-2} + THI_{i,j-3} + THI_{i,j-4} + THI_{i,j-5} + e_{i,j}$$

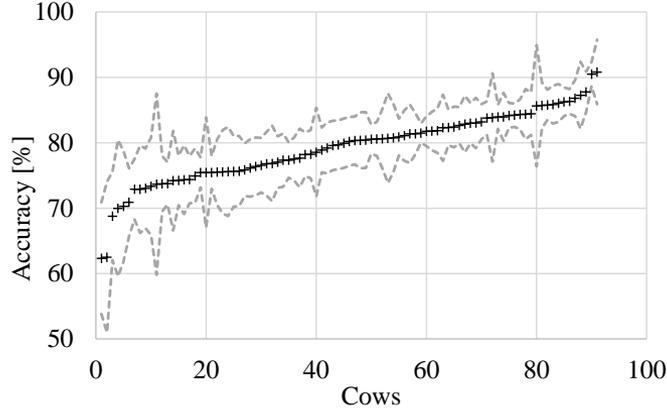
↑  
**Target Feature**  
Daily Milk yield of each cow (i) on each day (j)

↑  
effect on milk yield of the DIM of cow i at day j

— effect on milk yield for cow i of the daily average THI at day j, j-1, ..... j-5

random residual effect

The model considers the heat load duration and delay and cumulative effects of heat stress



The model is a reliable tool for the evaluation of productive scenarios under heat stress

Modelli numerici per lo stress da caldo

# RICONOSCIMENTO DEGLI ANIMALI IN STRESS DA CALDO



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# Early detection of heat stress for each cow

## Detecting deviations (days with anomalies) related to heat stress

A deviation is determined, for a single cow on a specific day, when the following three conditions are detected:

- 1. Production decrease anomaly:** based on difference in milk yield variation speed between the single cow and average herd data (reference lactation curve, assumed as a baseline)
- 2. Daily Rest time reduction anomaly:** based on difference in rest time between the single cow and average herd data
- 3. Thermal-Humidity Discomfort:** based on measurement of cumulated heat stress, obtained as the sum of the positive contributions, in a moving window of N days, of  $THI - 72$ .



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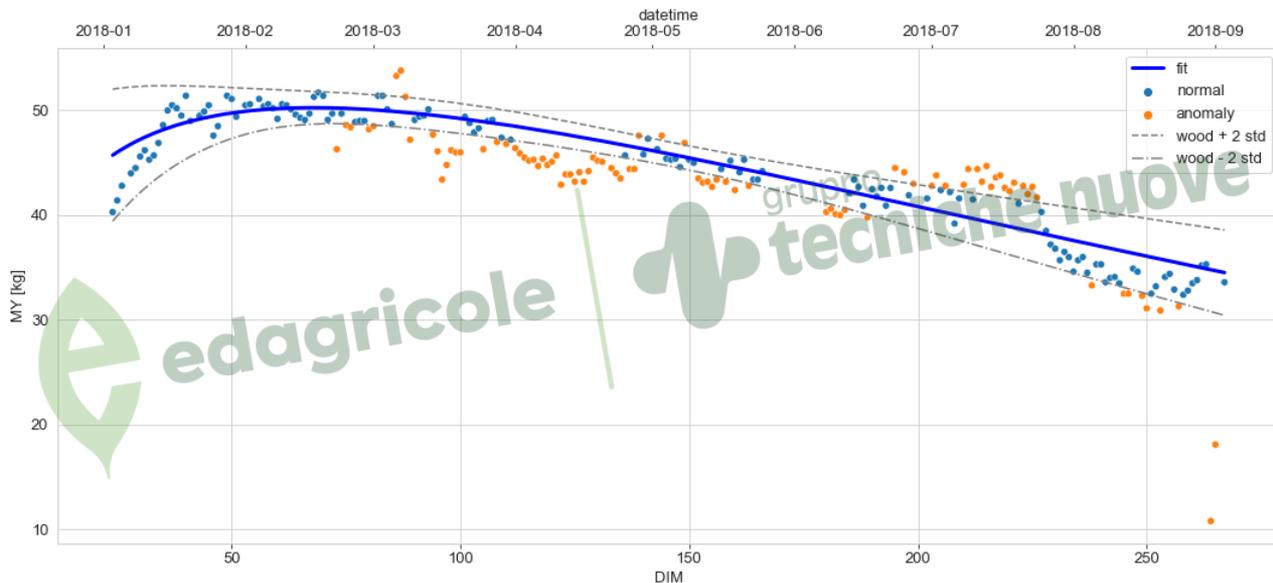
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# Early detection of heat stress for each cow

## Detecting deviations (days with anomalies) related to heat stress

### PRODUCTION DECREASE ANOMALY



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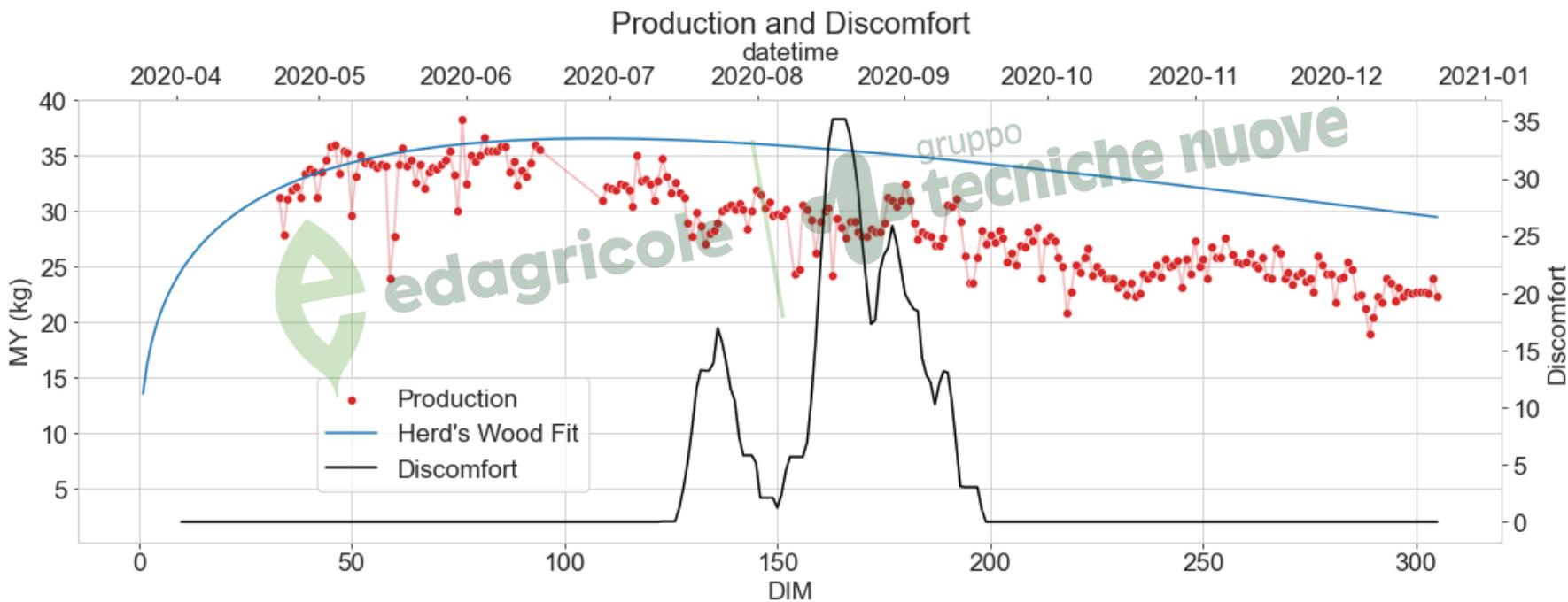
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# Early detection of heat stress for each cow

## Detecting deviations (days with anomalies) related to heat stress

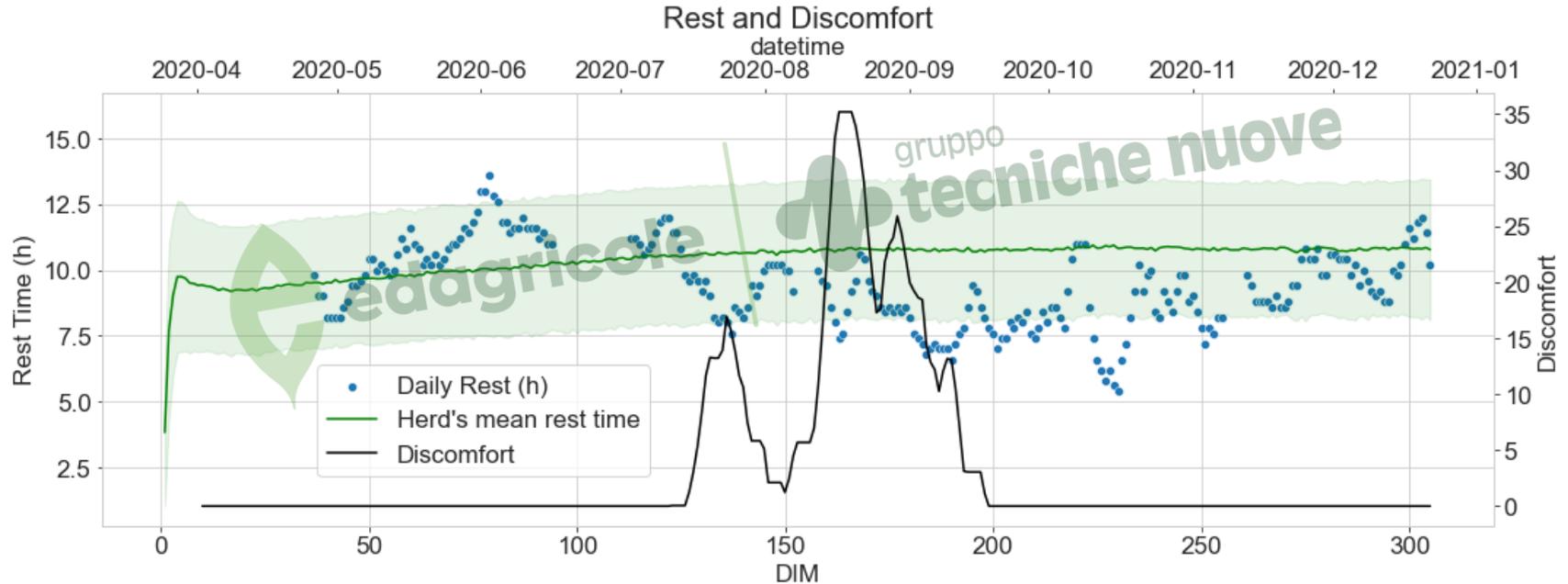
### PRODUCTION DECREASE ANOMALY vs THERMAL-HUMIDITY DISCOMFORT



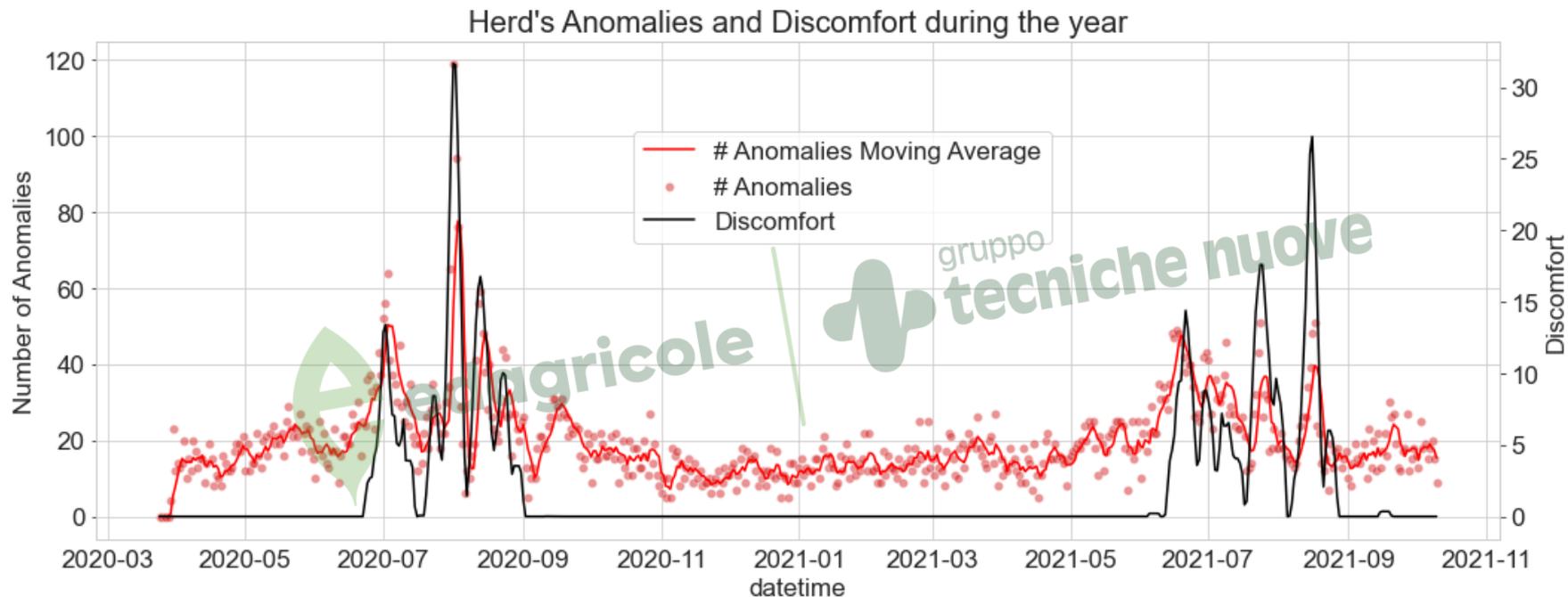
# Early detection of heat stress for each cow

## Detecting deviations (days with anomalies) related to heat stress

### DAILY REST TIME REDUCTION ANOMALY vs THERMAL-HUMIDITY DISCOMFORT



# HEAT STRESS ANOMALIES DETECTION FOR EACH COW



Anomalies detection and time distribution can assist farmers in **identifying more sensitive cows, quantifying susceptibility, and to take proper actions**



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