

Adoption of computer vision algorithms to monitor respiratory rates in dairy cattle



Prof. Dr. Ricardo Ventura

Department of Animal Production and Nutrition
University of São Paulo – Pirassununga, Brazil



University of São Paulo (USP)



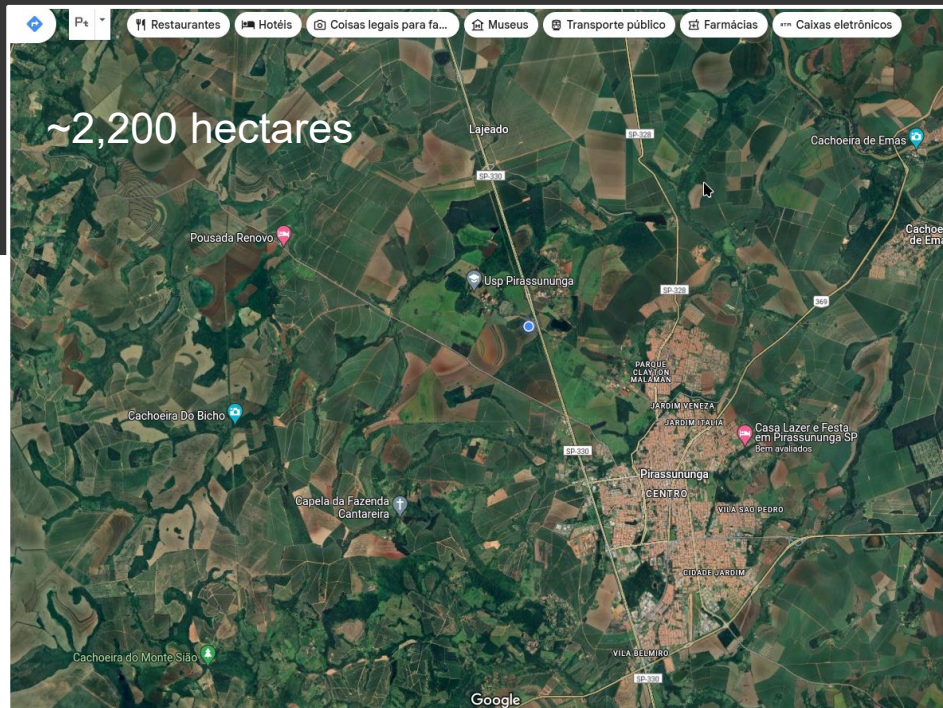
University of São Paulo (USP)



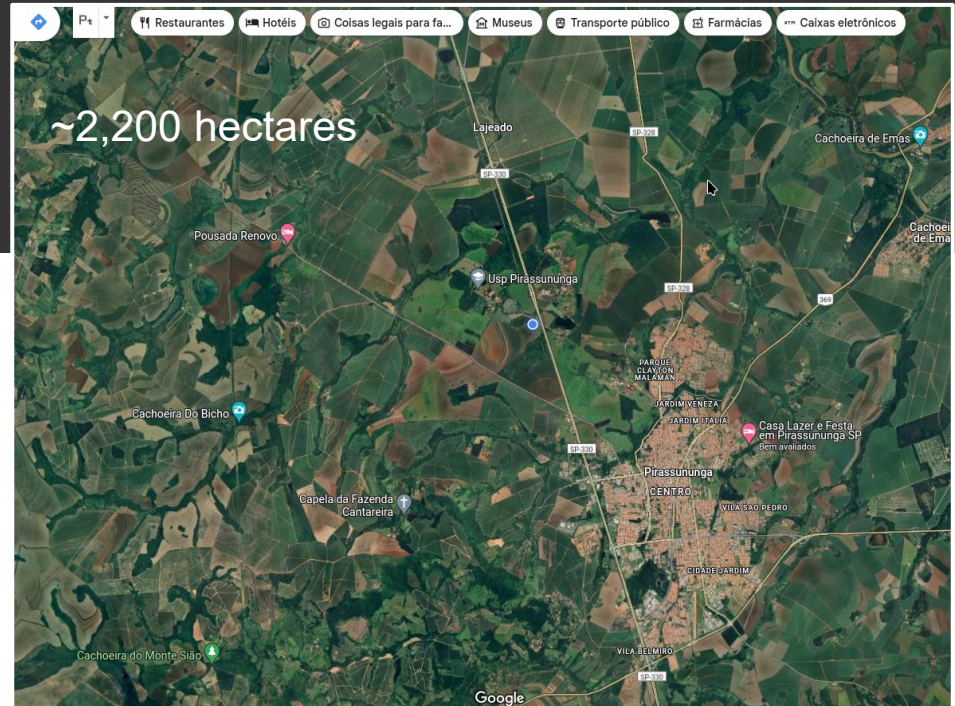
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
QS University Rankings por Região - América Latina	1ª	1ª	1ª	2ª	1ª	1ª	1ª	3ª	2ª	2ª	2ª	2ª	1ª

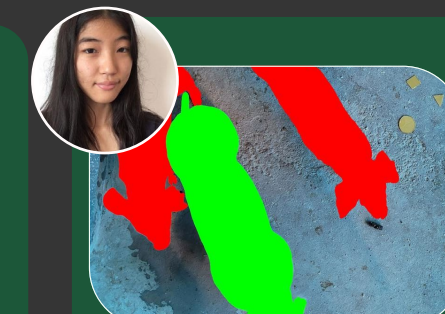
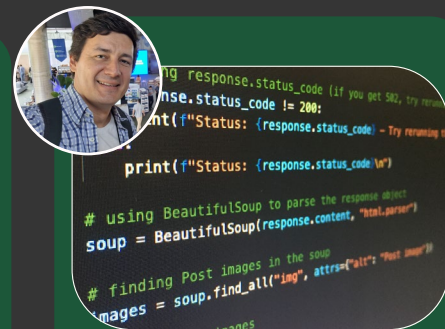
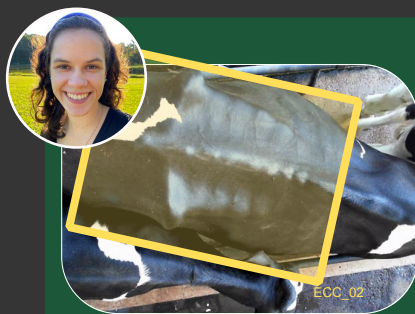
University of São Paulo (USP)

Campus: Pirassununga, SP



Campus: Pirassununga, SP





Computer Vision



Source: Ventura
(Family's Farm)



Source: Ventura (USP)

Digital Phenotypes

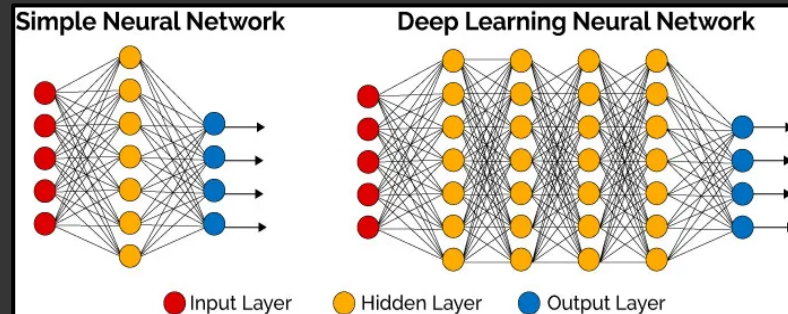
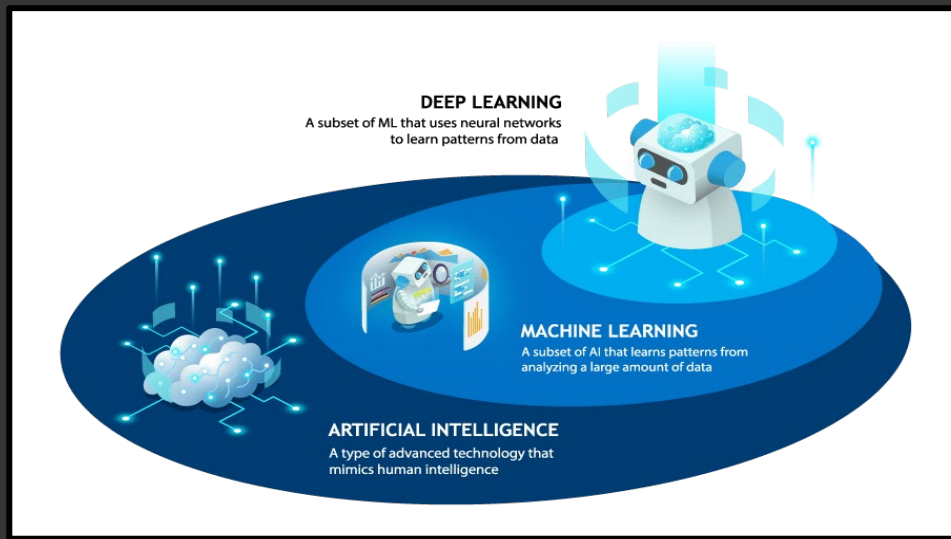
Cost reduction

Massive
data collection

Reduce the subjectivity

New biological insights

AI, ML and DL



<https://analyticsindiamag.com/comprehensive-guide-to-different-pooling-layers-in-deep-learning/>

Different ways to capture DP

Thematic Section: 36th Annual Meeting of the Brazilian Embryo Technology Society (SBTE)

Applications of livestock monitoring devices and machine learning algorithms in animal production and reproduction: an overview

Paula de Freitas Curti^{1*}, Alana Selli¹, Diógenes Lodi Pinto¹, Alexandre Merlos-Ruiz¹,
Julio Cesar de Carvalho Balieiro¹, Ricardo Vieira Ventura¹

¹Departamento de Nutrição e Produção Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Pirassununga, SP, Brasil

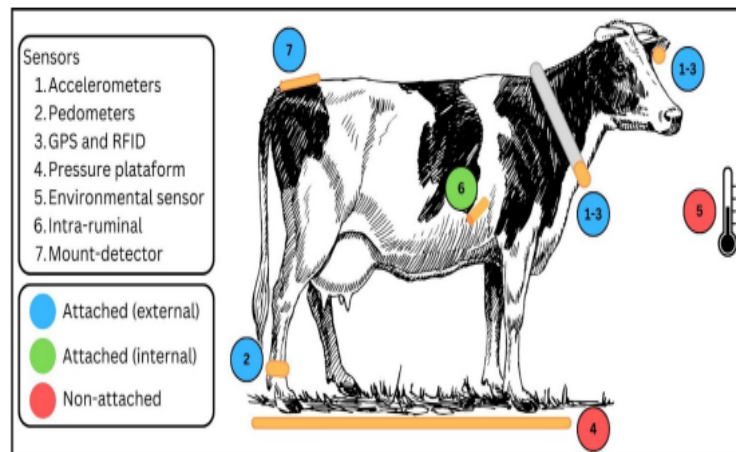
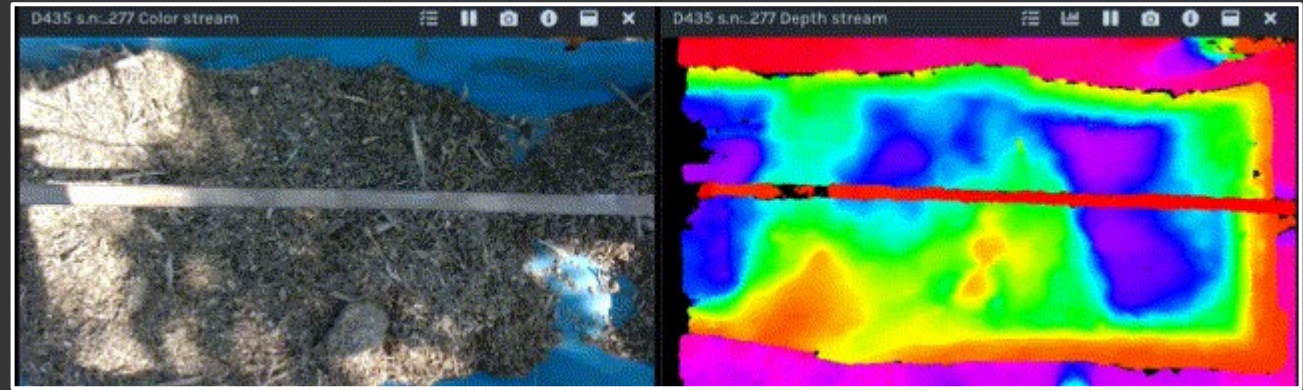


Figure 1. Overview of the positioning and types of sensors widely studied on precision livestock projects.
Figure created on Canva.

Hardware specs (\$ price)



Adoption of computer vision algorithms to monitor respiratory rates in dairy cattle



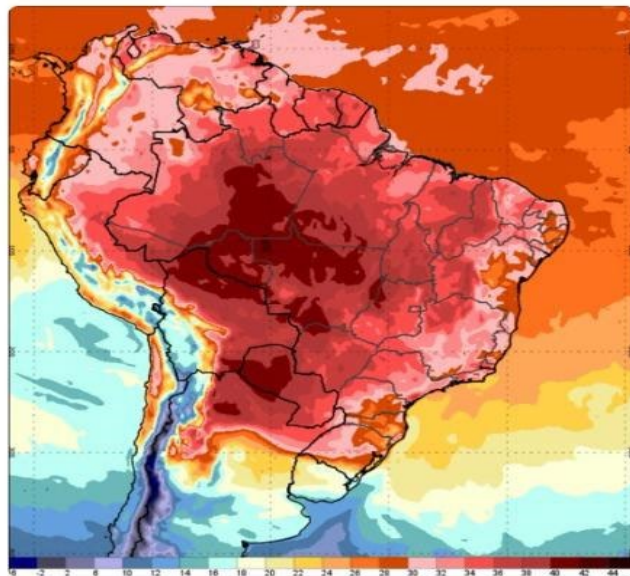
Paula Curti
Master Student

Brasil enfrenta onda de calor e pode ter recordes de temperatura em pleno inverno; previsão vai até 40°C

Praticamente todo o país será afetado pelo calor: as máximas devem chegar a 34°C em São Paulo e no Rio Grande do Sul. Já no Rio de Janeiro e no Triângulo Mineiro, os termômetros podem bater 40°C.

Por g1

22/08/2023 00h00 · Atualizado há 3 meses



— Previsão de temperatura máxima para o dia 22 de agosto de 2023, às 15h. — Foto: Reprodução/INMET

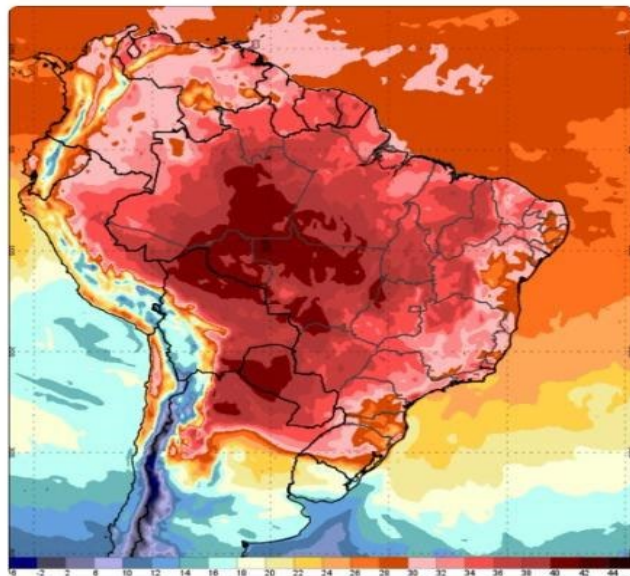


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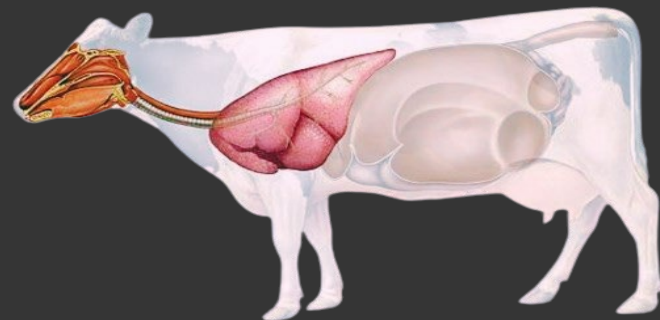
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22/08/2023 00h00 - Atualizado há 3 meses

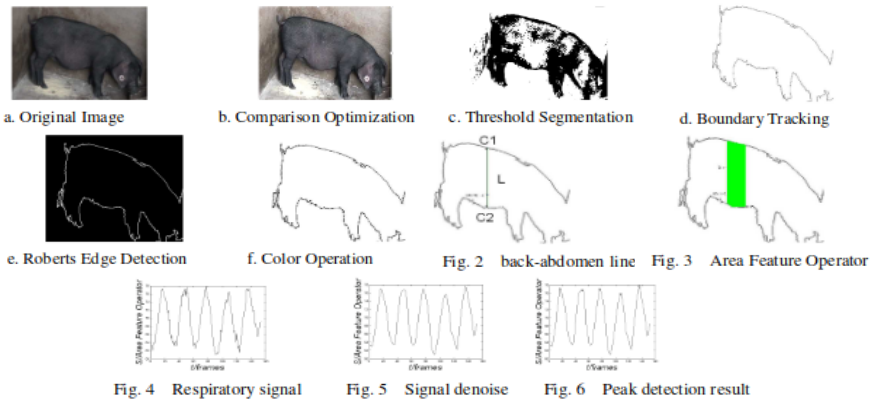


— Previsão de temperatura máxima para o dia 22 de agosto de 2023, às 15h. — Foto: Reprodução/INMET



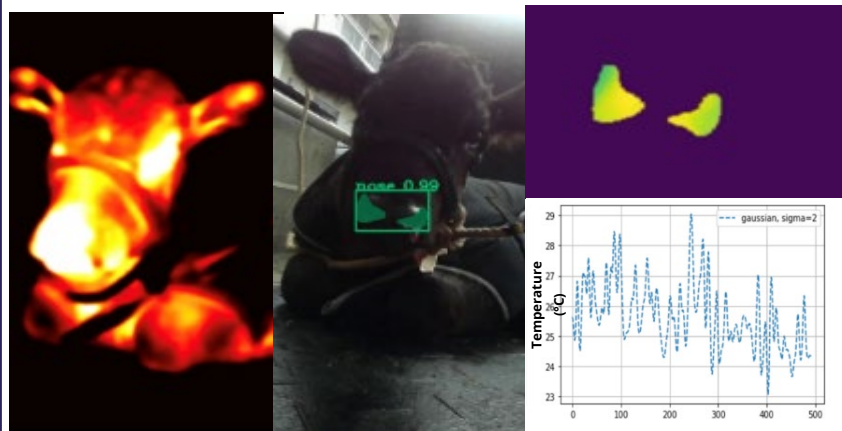
Zhu et al., 2015

Respiratory Frequency Detection of Pigs Based on Area Feature Operator



Kim & Hidaka, 2021

Breathing Pattern Analysis in Cattle Using Infrared Thermography and Computer Vision



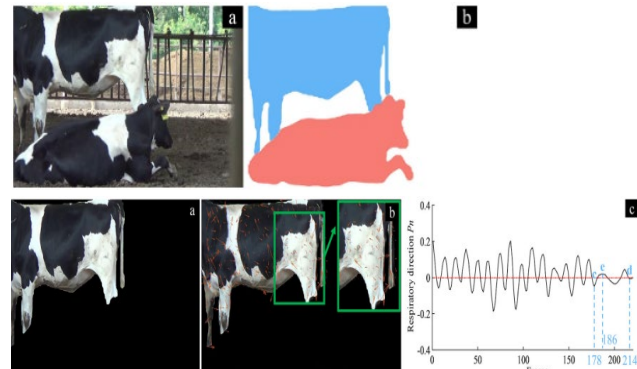
Wu et al., 2020

Detection of the respiratory rate of standing cows by combining the Deeplab V3p semantic segmentation model with the phase-based video magnification algorithm



Wu et al., 2023

Monitoring the respiratory behavior of multiple cows based on computer vision and deep learning



Measuring Respiratory Rate (RR)



15/30/60 seconds

Subjectivity among technicians

Very hard to measure in large herds
(Considering all animals and 24/7)

Objectives



RR pattern in cattle 24 x 7 x 12 months



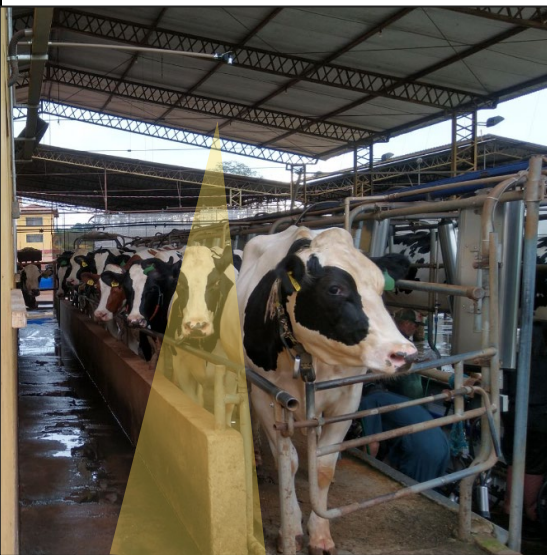
Low cost cameras



GPU x computational cost



Tool to classify frames prior to
computer RR



LPBL - FMVZ USP



CEUA: #3621310323



Microsoft Livecam Studio USB e
Intelbras VIP 1430 B G2



March/2023, December/2023, January/2024



304,4 GB
Transformed to segments of 30s

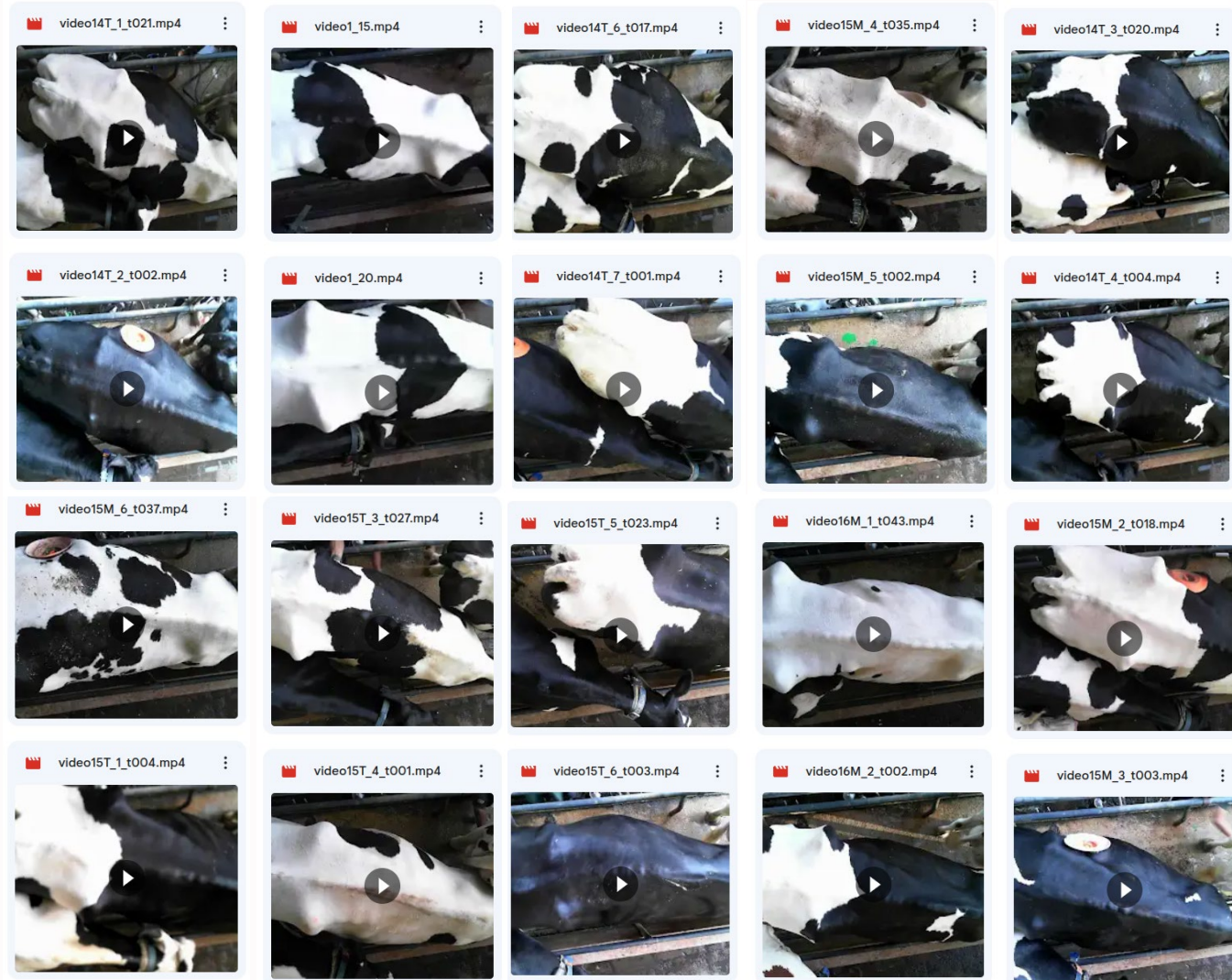
MANUAL LABELING



688 annotated files



400+ hours



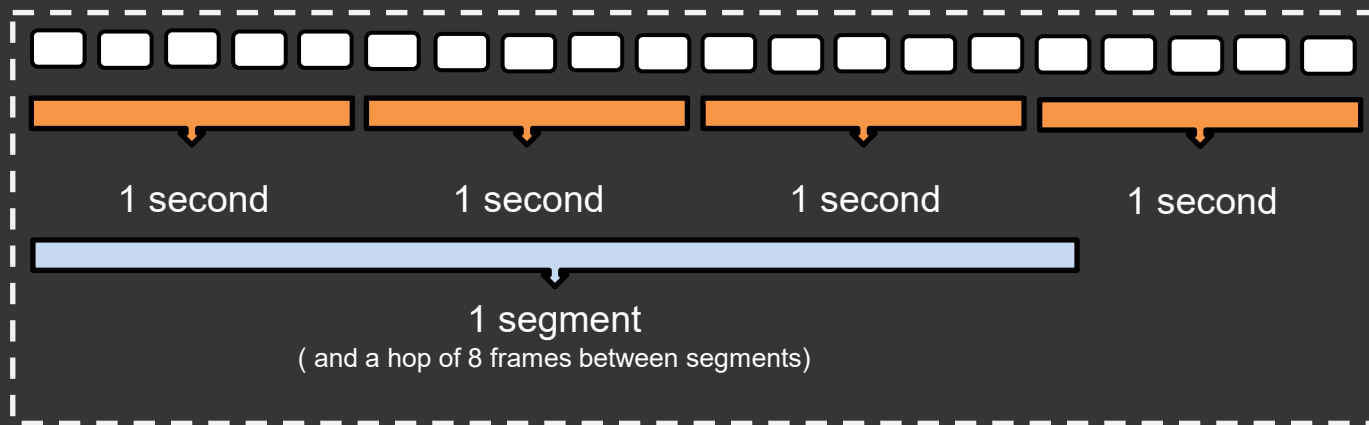
Classifying frames : Predicting RR



20 frames per sec



5 frames per sec
(Classification and Prediction)



1,000 segments for training/evaluating

128 x 171



112 x 112



NVIDIA A100 40GB GPU

Spatiotemporal Conv:
Deep Residual Neural Network

Classifying frames

1

RR (30s) – True annotated value

46



31



20



Source: Ventura
(Family's Farm)

Classifying frames

1

RR (30s) – True annotated value

46



31



20



2

Labelling for classification purposes
(at the frame level)

Keep



Discard



Source: Ve
(Family's R

Classifying frames

1

RR (30s) – True annotated value

46



31



20



2

Labelling for classification purposes
(at the frame level)

Keep

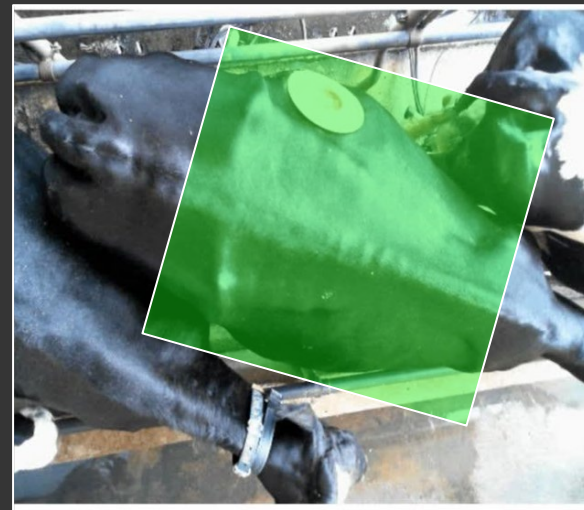


Discard



3

Bounding box



Center Crop (CC)



Full Bounding Box (FBB)



Corner Bounding Box (CBB)





BiomaTech

Center Crop (CC)

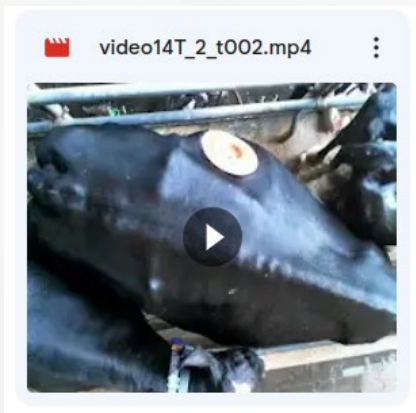


Full Bounding Box (FBB)



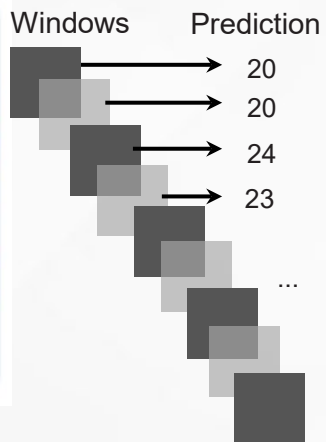
Corner Bounding Box (CBB)





Respiratory Rate
(real + annotated)

23



Per segment

Predicted	Real	Abs Error
20	23	3
20	23	3
24	23	1
23	23	0

Per animal

Predicted	Median	Real	Abs Error
20	21,5	23	1,5
20			
25			
23			

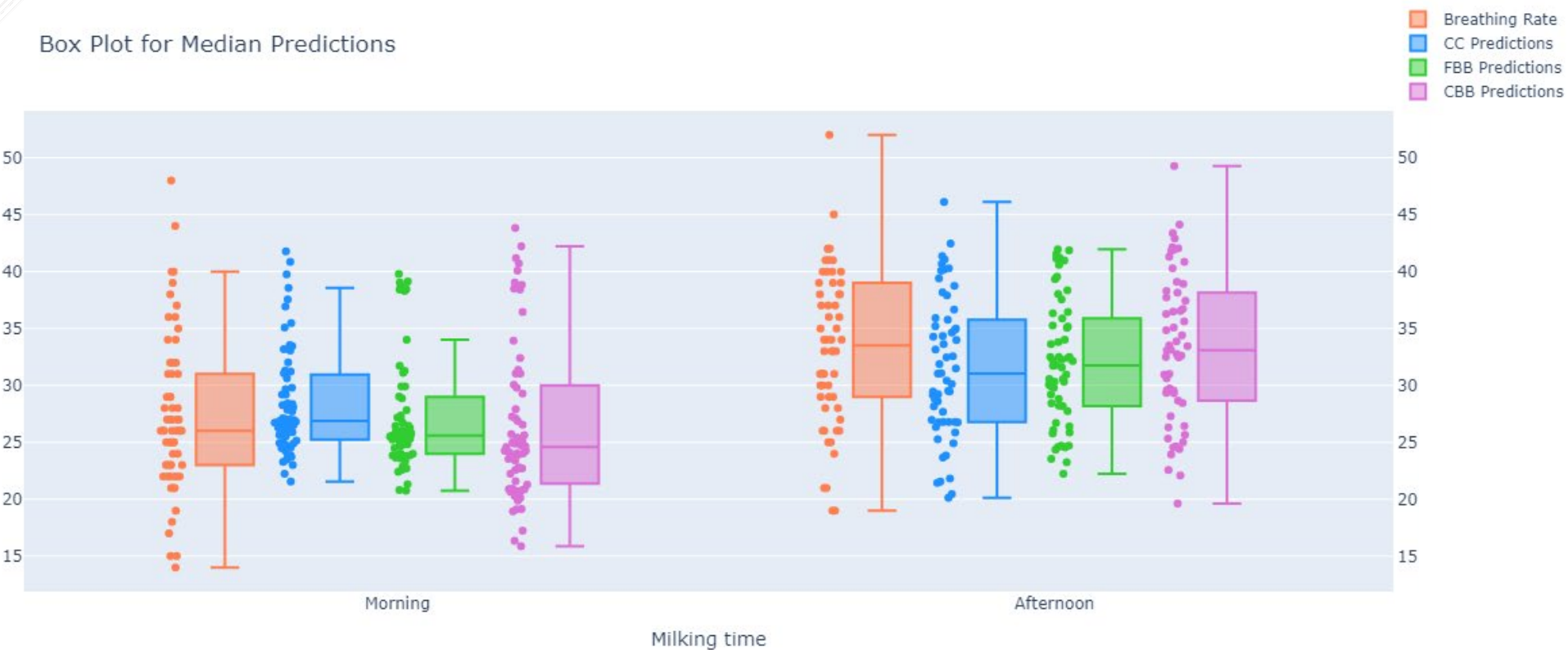


$$RMSE = \sqrt{\frac{\sum_{i=1}^N (Predicted_i - Actual_i)^2}{N}}$$

$$MAPE = \frac{1}{n} \times \sum \left| \frac{actual\ value - forecast\ value}{actual\ value} \right|$$

		CC	FBB	CBB
By segment	RMSE	5.38	5.77	4.85
	MAPE (%)	15.13	15.9	13.81
By animal	RMSE	5.09	5.38	4.58
	MAPE (%)	13.52	13.97	12.68

Box Plot for Median Predictions



MAPE e RMSE:

the 3 models accurately predicted RR in real milking situations

CBB:

Better performance (smaller size and location)
Best results for the extremes (low and high FR)



CC:

No need for the bounding box operation



GPUs

High resolution and video (.mp4):
waiting for further prices and memory improvements

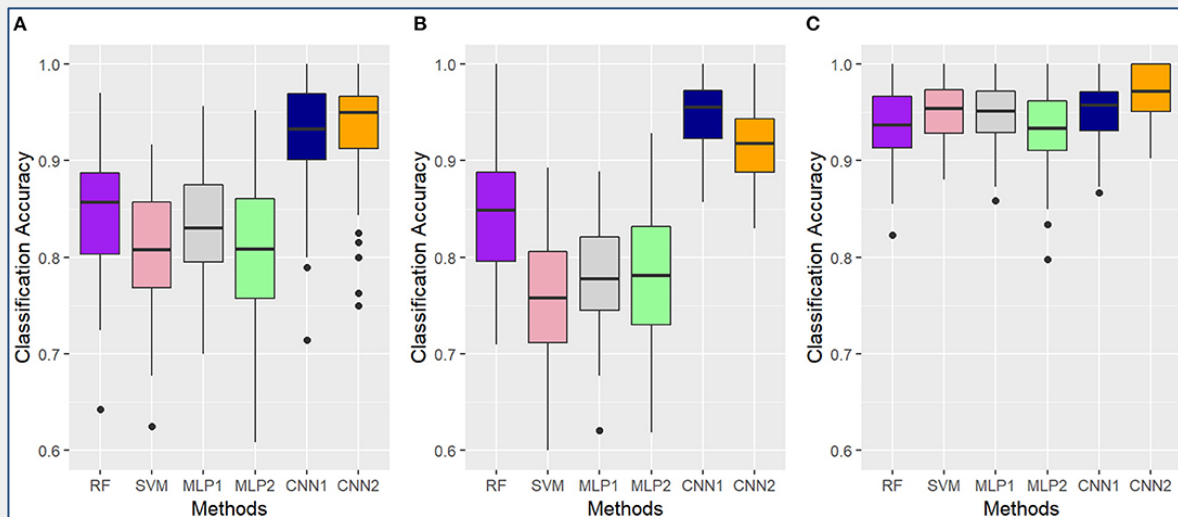
Feature extraction + Models

CNN and traditional ML methods



Feature extraction + Models

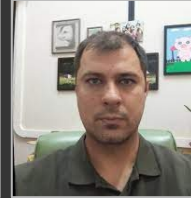
CNN and traditional ML methods



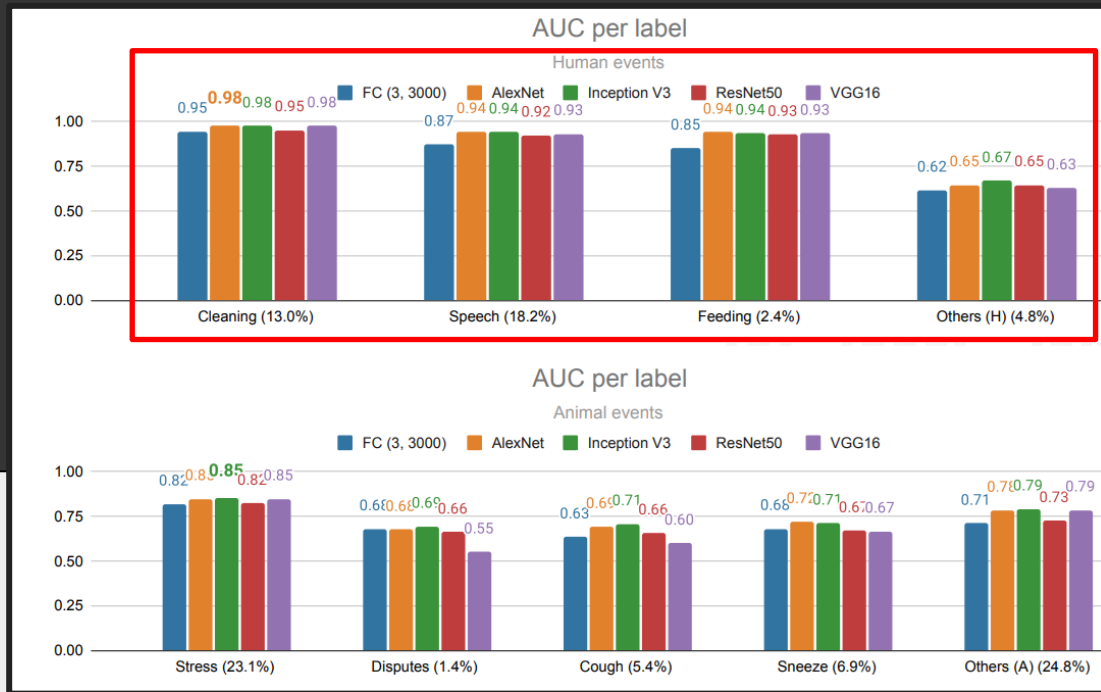
Accuracy values obtained with different algorithms (RF, Random Forest; SVM, Support Vector Machine; MLP, Multilayer Perceptron Neural Networks; CNN, Convolutional Neural Networks)

Audio-feature dataset used as input information (A—Mel-frequency Cepstral Coefficients, B—Onset Strength and C—Tempogram).

Classifying handling operations via sound and Deep Learning



Classifying handling operations via sound and Deep Learning



Classifying handling operations via sound and Deep Learning





Livestock Science
Volume 267, January 2023, 105152



Image feature extraction via local binary patterns for marbling score classification in beef cattle using tree-based algorithms

Diógenes Lodi Pinto^a  , Alana Selli^a, Dan Tulpan^b, Lucas Tassoni Andrietta^a,
Pollyana Leite Matioli Garbossa^a, Gordon Vander Voort^{b c}, Jasper Munro^c, Mike McMorris^d,
Anderson Antonio Carvalho Alves^e, Roberto Carneiro^f, Mirele Daiana Poleti^g,
Júlio Cesar de Carvalho Balieiro^a, Ricardo Vieira Ventura^a  

Show more 

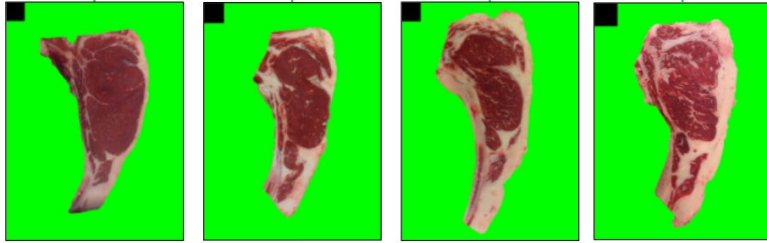
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<https://doi.org/10.1016/j.livsci.2022.105152>

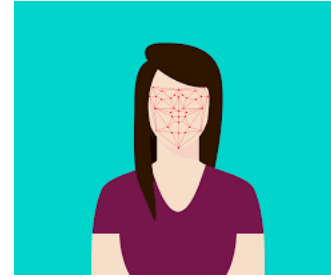
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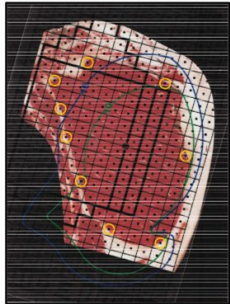
Marbling Score
From Low IMF to High IMF



LBP

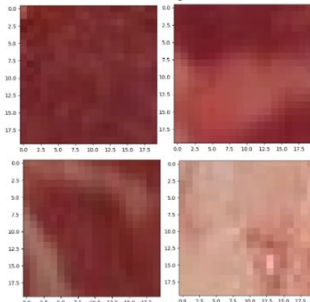


USDA

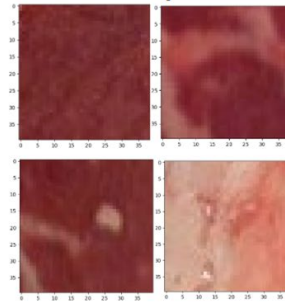


fonte: <https://www.ams.usda.gov/>

20 x 20 pixels



40 x 40 pixels

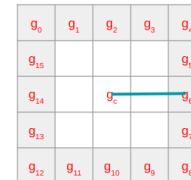


LBP (Local Binary Patterns)

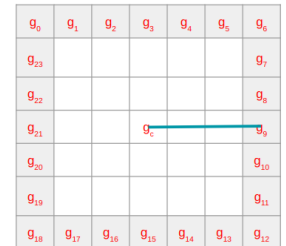
LBP (8,1)



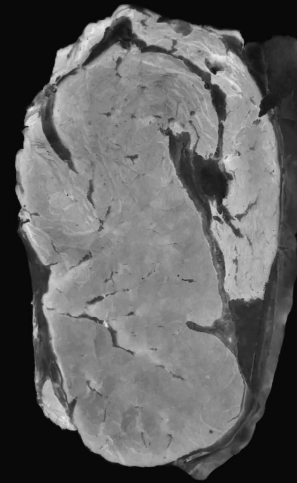
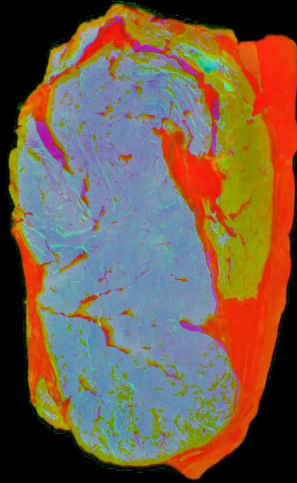
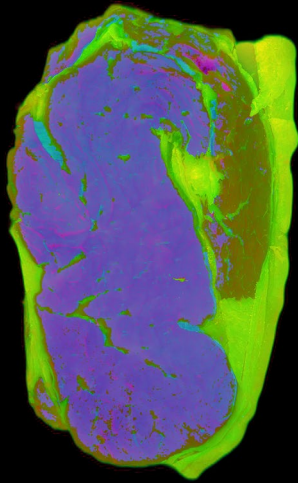
LBP (16,2)



LBP (24,3)

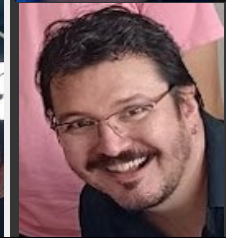


Non traditional methods to explore features related to IMF patterns



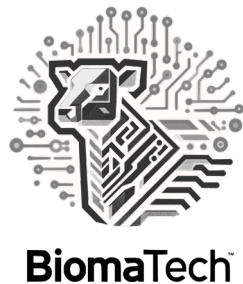
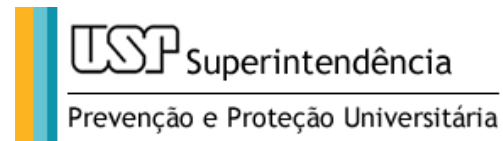
Acknowledgments

God and family



BiomaTech







75th EAAP Annual Meeting
1/5 September 2024 - Florence, Italy



< Programme

Sunday 1 September 2024 – Morning, 8:30

Session 13. Sensing Physiology: Tools towards optimising livestock husbandry

Room: Modicana – Palazzo Affari 3rd Floor

Chair: Montanholi / Garcia-Roche

Session Type: Theme session

