Practical solutions to computerized vision systems

Andrea Capobianco Dondona, DVM, MSc

Farm4trade

An integrated vision

AI applied to **precision livestock farming** to improve animal health and welfare, business productivity and supply chain traceability

Farm4trade SUITE

F4t SUITE
farm4tradesuite.com

Integrated in-cloud system, for breeders and livestock companies

ADAL

Automatic Detection of Abattoir Lesions
f4tlab.com/adal

Automatic lesions assessment and carcass classification system at the slaughterhouse.

ReaDOP

Read DOP
f4tlab.com/readop

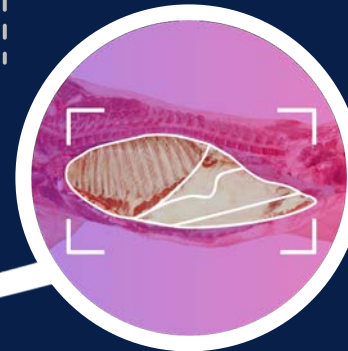Automated vision system for the acquisition, verification and annotation of tattoos on stocks.

PHAiD

PHoto Animal IDentification
f4tlab.com/phaid

Contactless biometric recognition system for livestock identification.

#bigdata

#Animalwelfare

#Animalidentification

#Animalidentification

Farm4trade

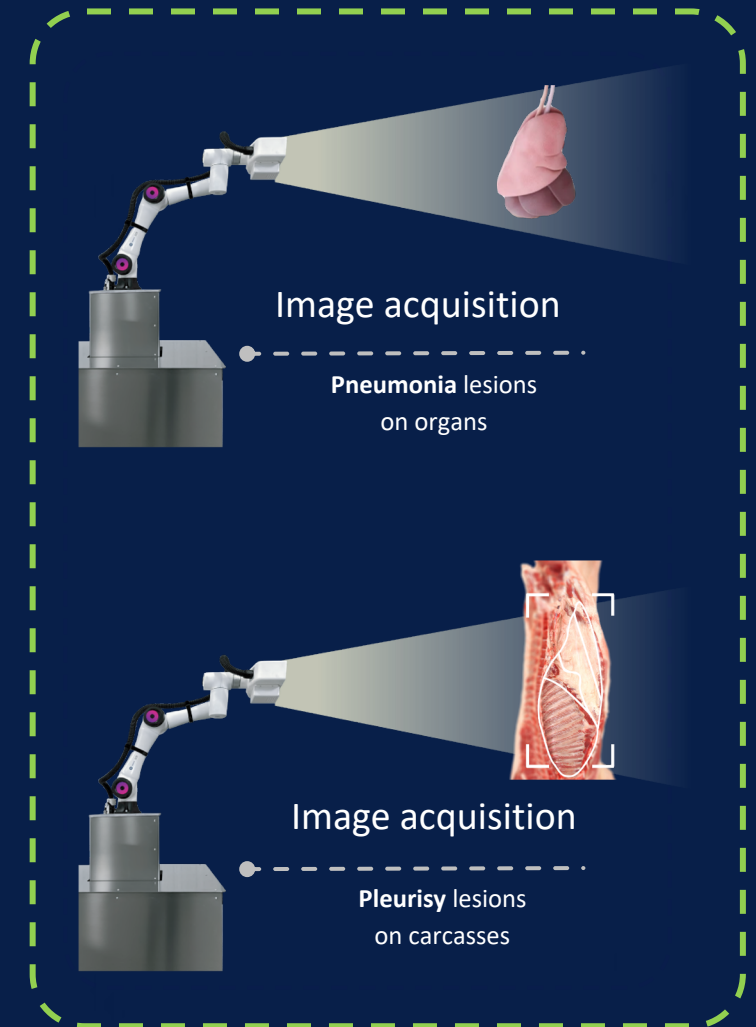Advancing Artificial Intelligence Technology for Food Traceability

European Meat Inspection Regulations and Framework

- **EU Regulation 2017/625**, Regulation (EC) No **853/2004**, and Regulation **2019/627** govern meat inspection, information transmission, and implementation of new technologies
- EU legislation follows a **farm-to-fork approach**, covering the entire production chain
- **Meat safety assurance systems (MSAS)** include <u>risk assessment and control measures</u>
- Official controls components include **Ante-mortem (AM)** and **post-mortem (PM)** inspection <u>to detect hazards and carcass contamination</u>
- <u>Food business operators (FBOs) are responsible for carcass inspection</u>, that are then verified by **competent authorities (CAs)** such as **official veterinarians (OVs)**
- **Risk-based meat safety assurance systems (RB-MSAS) use visual and detailed inspection** methods
- Flexibility in legislation allows official auxiliaries (OAs) to conduct inspections in low-capacity abattoirs
- **Condemnation criteria rely on clinical signs, lesions, and abnormalities using predefined lesion codes**

Potential and Advantages of Computer Vision Systems (CVSs)

- **Digital transformation of MI** enhances quality, efficacy, and feedback to farmers

- CVSs support risk-based meat inspection by accurately detecting lesions, abnormalities, and contamination

- **Greater consistency and speed compared to human inspectors**, reducing intra- and inter-rater variation

- **Facilitates trace-back systems, outbreak investigations, and recall of food batches**

- Remote AM and PM inspections are possible, improving efficiency and access

- Enables efficient reporting of findings from inspections and facilitates food chain information (FCI) exchange

- Contributes to reducing food waste through **improved partial condemnation capabilities**

- **Harmonized detection and condemnation criteria** can lead to fairer economic outcomes for livestock producers

- Supports future integration of new technologies in risk-based meat safety assurance systems (RB-MSAS)

Image acquisition

Pneumonia lesions on organs

Image acquisition

Pleurisy lesions on carcasses

Current state of art of meat inspection

- The **veterinarians** serving the slaughter chain **manually perform lesions scoring** and other assessments.
- This is a time-consuming and **repetitive activity**
- **No standardised procedure** and **inconsistencies** among different abattoirs.
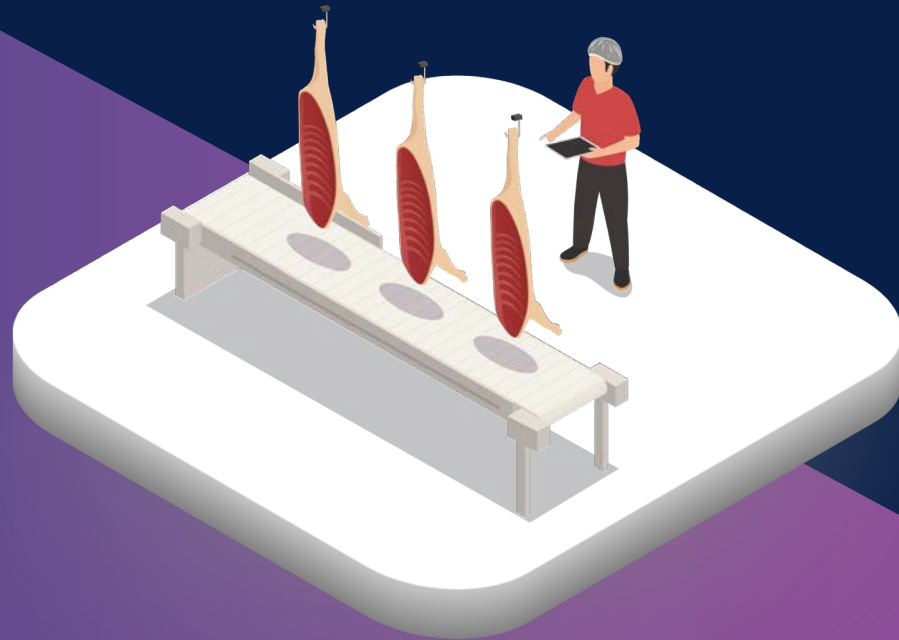
LUNG SCORING SYSTEM IN USE

- **Madec's grid**: each lobe is inspected and palpated, divided into quarters and scored from 0 to 4 points regardless of its size.

- **Madec's grid** is usually combined with a method to account for each lobe volume.

Limitations of traditional and current systems
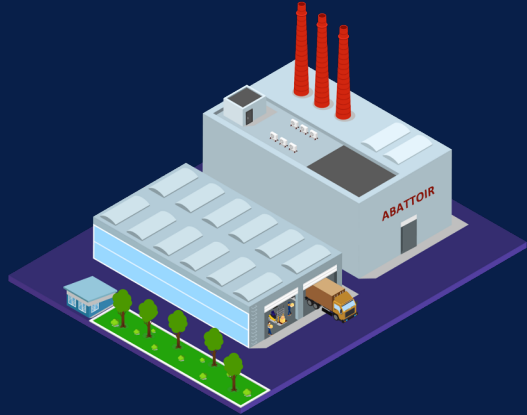
Postmortem evaluations at slaughterhouses are outdated and inherently flawed

PARTIAL INSPECTION RATE

NON FULLY RELIABLE DATASETS FOR EPIDEMIOLOGICAL ANALYSIS

SUBJECTIVE SCORING BETWEEN OPERATORS

EXPENSIVE AND ERROR PRONE MANUAL DATA RECORDING

ADAL

COSTS ASSOCIATED WITH PARTIAL OR COMPLETE CONDEMNATION OF PIG CARCASSES

Overall, pig carcass condemnation due to disease (pleurisy, pneumonia, and liver lesions) incurs direct financial losses to producers and processors. Suboptimal pig welfare, such as disease conditions, result in financial losses to the pig industry.

PLEURISY

PROCESSORS

For a batch of 100 pigs where 10% (10 pigs) have severe pleurisy, an estimate of the cost in terms of extra trimming and disposal of condemned material based on records from a batch of 1,191 pigs is as follows:

	Impact	Cost/100 pigs
Overtime for entire slaughter	8.5% reduction in line speed (+25 min) = €230/batch	€ 19,00
Additional staff required	1 additional slaughter man = €40/batch	€ 3,45
Overtime for MHS	€122/batch	€ 10,30
Increased costs of disposal for Category 2 animal by product	€16/batch	€ 1,50
TOTAL		**€ 34,25**

SOURCE: www.thepigsite.com/articles/pleurisy

PRODUCERS

In a batch of 100 pigs in which 10 pigs had signs of pleurisy, the cost in terms of increased post-weaning mortality reduced carcass weight and increased age at slaughter, is as follows:

	Impact	Cost/100 pigs
Increased post weaning mortality	3,3% increase € 46/Pig	€ 153,00
Reduced carcass weight	700g/pig @ 150p/kg = 70kg	€ 121,00
Increased days to slaughter	2.6 days/pig with feed @ £215/ tonne = 260 days	€ 155,00
TOTAL		**€ 429,00**

Production losses from PLEURISY **€4,64** *per pig*

PNEUMONIA

PRODUCERS

Pneumonia, specifically enzootic pneumonia (EP), is a major cause of losses in the pig industry. One study found that moving from a group with the lowest incidence of lung lesions (<55%) to the highest (>88%) due to EP resulted in a decrease of 42g in the ADG, an increase of 50g in the FCR, an increase of 0.9% in mortality, and an increase of 0.84 € in costs.

Production losses from PNEUMONIA **€2,7** *per pig*

SOURCE: https://veterinaryresearch.biomedcentral.com/articles/10.1186/s13567-023-01136-2#Tab5

Extrapolated all pigs raised and marketed in the U.S., the losses associated with *M. hyopneumoniae* was in the range of 375 to 400 million US$ annually

SOURCE: https://www.pig333.com/articles/economic-impact-of-mycoplasma-hyopneumoniae-on-pig-farms_8936/

Farm4trade

ADAL

GREATER CONFIDENCE IN MEAT FOOD QUALITY FOR ALL

The **ADAL** system is the **first automated image acquisition and analysis system** based on Artificial Intelligence (**AI**) capable of objectively identifying and quantifying the lesions of slaughtered animals in real time.

ADAL Technology innovates the animal inspection process at the slaughterhouse by introducing automated quantified risk assessment tools.
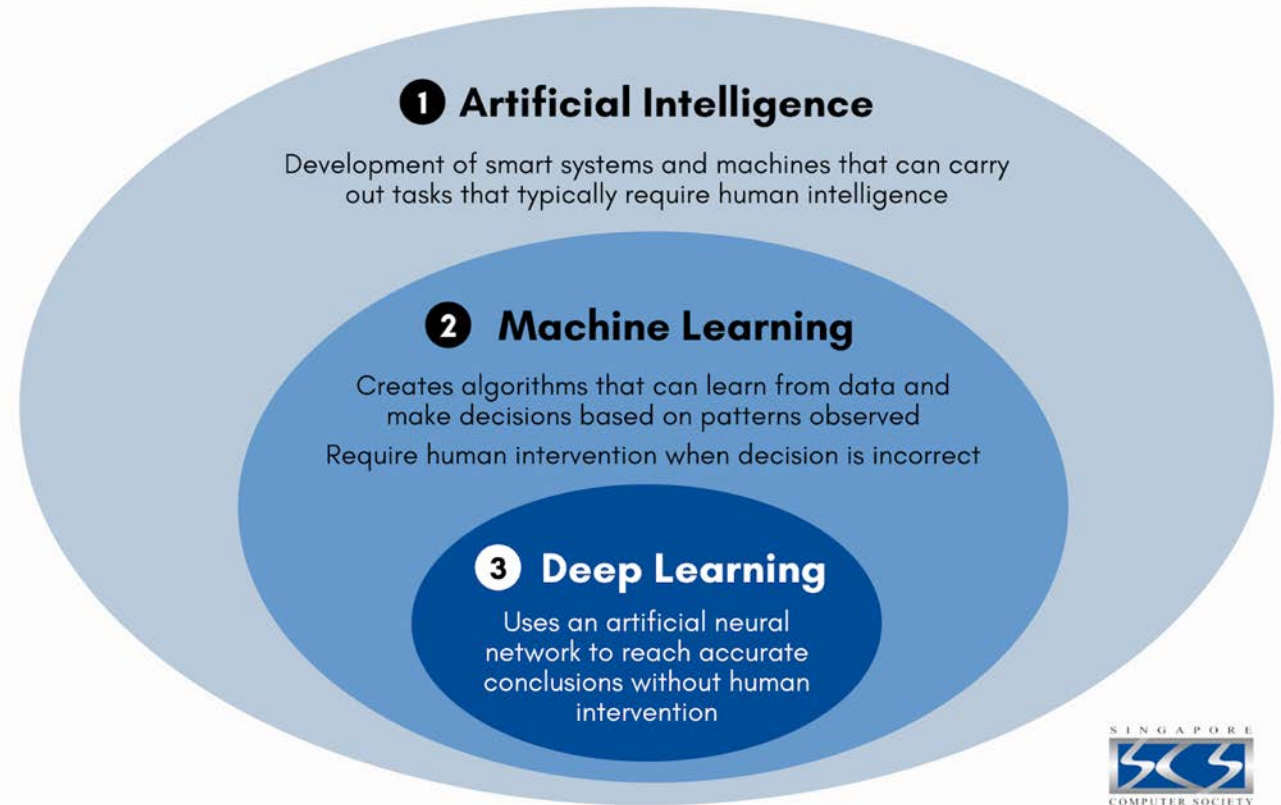
Partners

UNIVERSITÀ DEGLI STUDI DI TERAMO
UNITE

AImage Lab

MM SYSTEMS srl

#Research   #Artificial Intelligence   #Automation

What is Artificial Intelligence

- **AI** aims to create systems capable of human-like tasks: learning, reasoning, problem-solving, and perception.
- **Machine learning (ML)** is a subset of AI, using algorithms to learn from data and make predictions or decisions.
- **Deep learning**, a subfield of ML, employs artificial neural networks to model complex patterns in data.
- Types of machine learning: supervised, unsupervised, and reinforcement learning.
- AI has applications in various industries: healthcare, finance, transportation, agriculture, and entertainment.
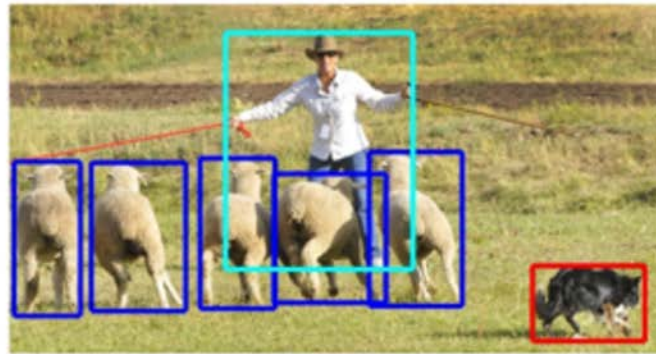

ARTIFICIAL INTELLIGENCE VS **MACHINE LEARNING** VS **DEEP LEARNING**

❶ Artificial Intelligence
Development of smart systems and machines that can carry out tasks that typically require human intelligence

❷ Machine Learning
Creates algorithms that can learn from data and make decisions based on patterns observed
Require human intervention when decision is incorrect

❸ Deep Learning
Uses an artificial neural network to reach accurate conclusions without human intervention

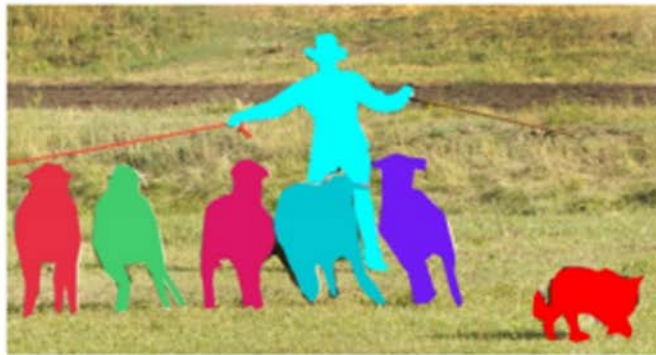# Image analysis and AI

(a) Image classification

(b) Object localization

(c) Semantic segmentation

(d) Instance segmentation

- **Image analysis** involves extracting meaningful information from images or videos.
- Computer vision, a subfield of AI, enables computers to understand and process visual information.
- AI, using techniques like CNNs, enhances image analysis by automatically detecting, classifying, and analyzing visual data.
- **AI-powered image analysis** is. more accurate, faster, and scalable compared to traditional methods
- AI is suitable for **various tasks**, such as object recognition, facial recognition, and semantic segmentation.

Problem identification and model development

In 2019, two work units were created in collaboration with the University of Teramo:

- Image collection unit: gathered images directly from abattoirs to build a diverse and extensive dataset.
- Neural network development unit: focused on creating AI solutions to address the lesion scoring problem more effectively.
- The main objective: ensure high variance between images of the same problem and a large number of different animals for effective training and recognition.
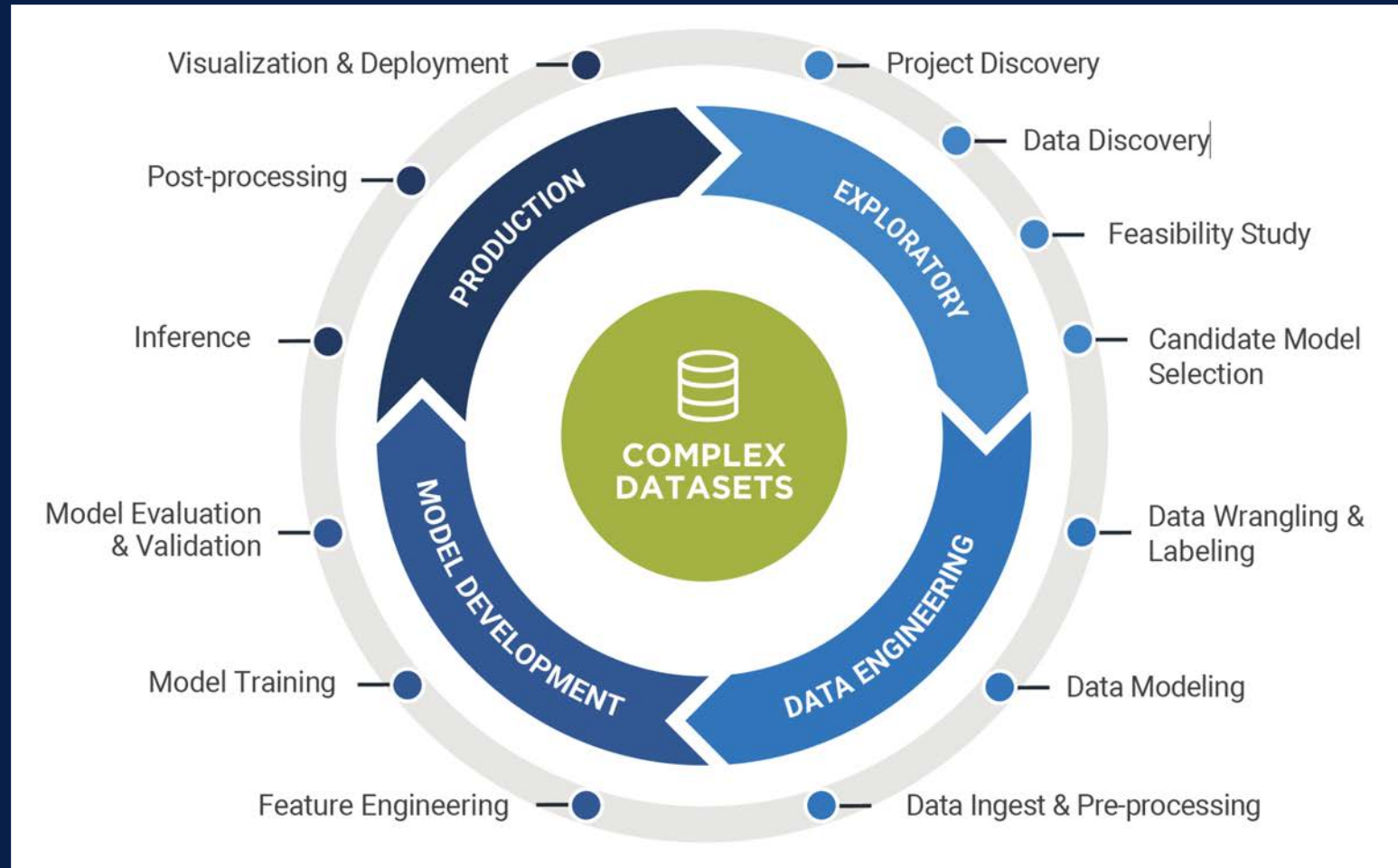
How it works

We have developed an automatic imaging acquisition system capable of recognizing and evaluating lesions on slaughtered animals. The data acquired by a Robot and processed by the IA Software are made available locally and remotely through the ADAL Web platform.
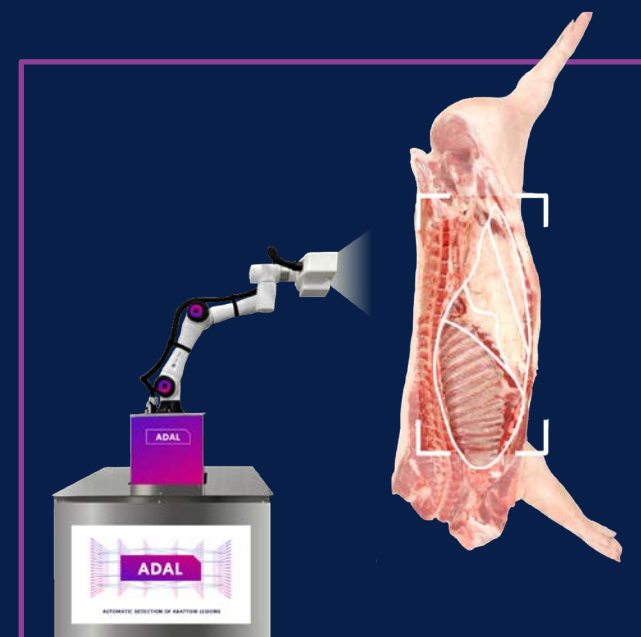
1. Robot
For image acquisition

2. Software AI
For local image processing

3. ADAL web Platform
For remote cloud access and storage

ADAL Prototype

It is a workstation designed for different use, capable of acquiring images at any point in the slaughtering chain.

ADAL

A complete system

To fully express its potential and accomplish the tasks mentioned, the ADAL system needs different robotic stations capable of continuously identifying each animal with the batch of origin and associating the results of all the analysis carried on each animal
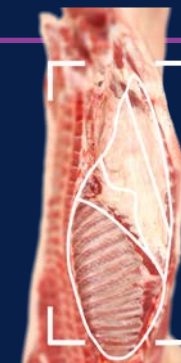
ReaDOP

Tattoo

Alphanumeric tattoo reading on pigs' thighs

1

Pleurisy

Evaluation of pleurisy lesions on carcasses

2

Pneumonia
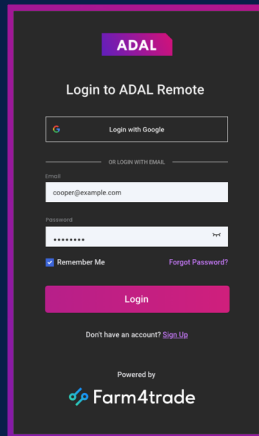
Evaluation of pneumonia lesions on organs

3

ADAL

Web Platform
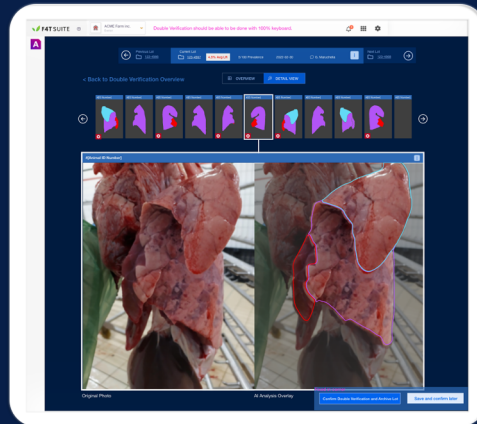
Allows the complete and centralized management of all the analysis carried out by the workstations on each individual and on batch of animals.

REMOTE ACCESS

A

MULTI-USER WEB APP

Access data in real time for:
Manage batches
Double verification
Access to annotations details
Manage Metadata

3rd

THIRD-PARTY APPLICATION

Registered data can be integrated with third parties application and/or Farm4trade SUITE

Farm4trade SUITE

Collection of applications dedicated to farmers and other stakeholders

farm4tradesuite.com

Remote Web App
Dashboard

Download images batches from the cloud

Manage batches

Manually upload a new batch of images

Access to all batches

Batches waiting to be double - verified

Screenshot content:

ADAL REMOTE
(Swine Pneumonia)

ACME Farm inc.
Owner

Double Verification Mode

Active Lots — Active

• In Progress

• With Comments — Hover

• High Lesion rate

Archived Lots (Verified)

File Manager

Create Lot — Hover

Settings

Force Sync now
Fetch latest local photo captures

Recently viewed and in progress lots

Force Sync now

123-456
0.0% Avg Lesion Rate
0/100 Prevalence
2022-02-30
G. Maruchella
Verified

123-456
0.0% Avg Lesion Rate
0/100 Prevalence
2022-02-30
G. Maruchella
Verified

Hover
123-456
0.0% Avg Lesion Rate
0/100 Prevalence
2022-02-30
G. Maruchella
Verified

123-456
0.0% Avg Le
0/100 Preva
2022-02-30
G. Maruchell
Verified

Double Verification Mode
Lot Metadata — Hover
Manage Lot

123-456
0.0% Avg Lesion Rate
0/100 Prevalence
2022-02-30
G. Maruchella
Verified

123-456
0.0% Avg Lesion Rate
0/100 Prevalence
2022-02-30
G. Maruchella
Verified

Active Lots

Active
All Active | New | In Progress | Hover Verified | Quick Search | Newest First

Advanced Search

| ⇕ Lot number	⇕ Slaughter Date (Hover)	⇕ AVG LR	⇕ Prevalence	⇕ Verification Date	⇕ Abattoir Verificator	⇕ Farm Verificator	Actions
123-4567	2022-02-30	0.1%	20/200	2022-03-02	G. Maruchella	N/A	
123-4567	2022-02-30	0.1%	20/200	2022-03-02	G. Maruchella	N/A	
123-4567	2022-02-30	0.0%	0/100	2022-03-02	G. Maruchella	N/A	
123-4567	2022-02-30	1.2%	15/100	2022-03-02	G. Maruchella	A.Congnome — Hover	

Remote Web App
Double verification
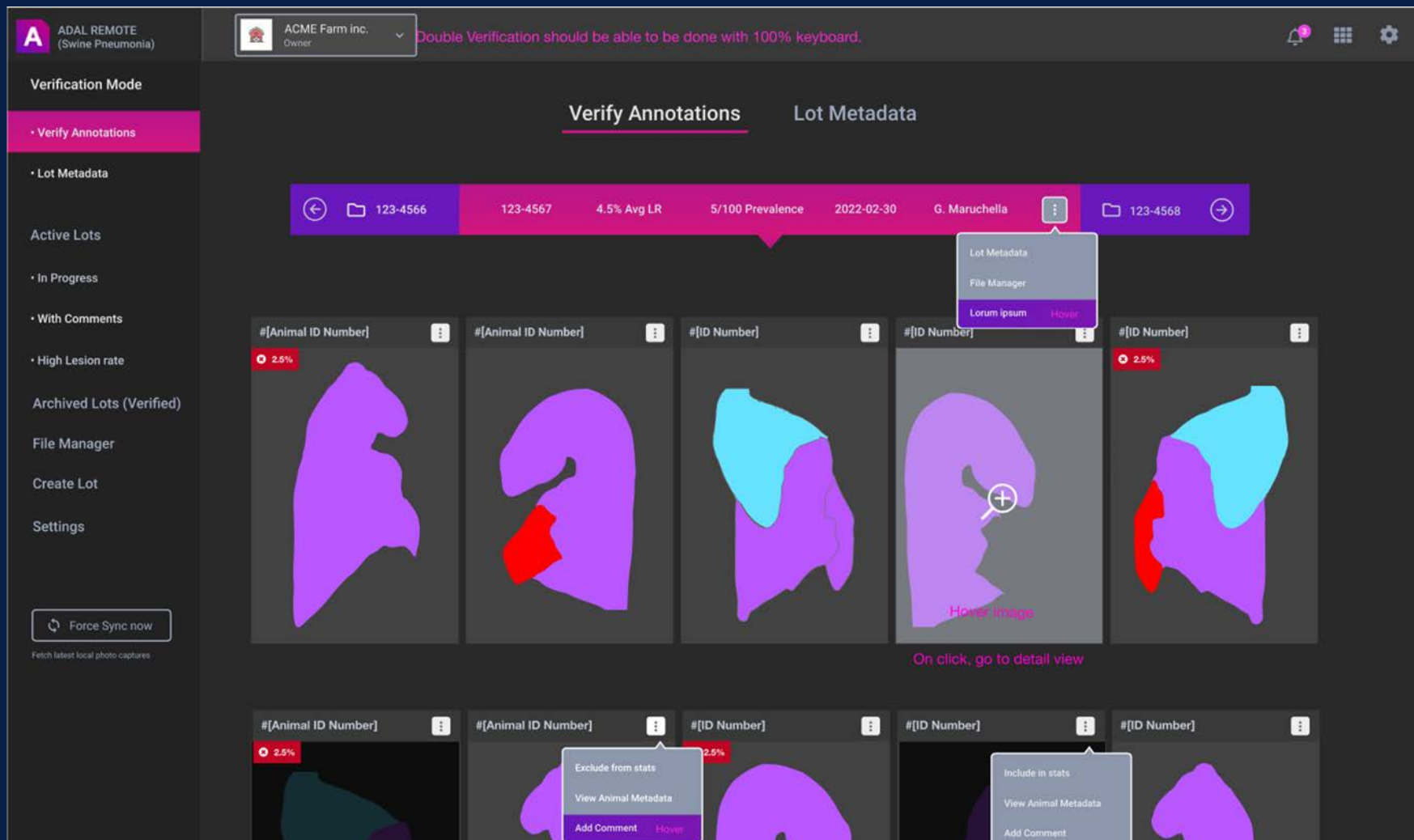
Veterinarians will have access to double verification of annotated images.
If they disagree with the analysis, they can decide to exclude it from the stats.

All actions can be performed using a keyboard

Remote Web App
Batch Metadata

Farmers, Slaughterhouses and all final users will be allowed to add important information to the batch of images, such as general animal data, health history and others.

Such information can be acquired by automatic integration with animal management systems, national databases, etc...

Advantages

The technology, in addition to produce benefits in terms of improving the working conditions of the operators involved along the slaughtering chain, has the following advantages compared to traditional methods of detecting pathologies at the slaughterhouse:

Automatic data acquisition

Automatic scoring of animal lesions

Inspection of all animals delivered to the slaughterhouse

Big data management in the cloud and BI systems

EyeAM Project

On September 04, 2022, Farm4Trade launched the first pilot project of ADAL technology within the innovative meat inspection project at the slaughterhouse called **EyeAM** and funded by **"The Research Council of Norway".**

Actually the ADAL robot, installed in the FatLand slaughterhouse in Norway, is performing the task of half-carcasses pictures acquisition and evaluation in order to detect pleurisy prevalence in slaughtered pigs.

MAIN PARTNERS

EyeAM Project

ANIMALIA
Norwegian Meat and Poultry Research Centre

Fatland

MEATS

Nortura
bondens selskap

Technology Performance

Fatland Slaughterhouse 🇳🇴

The robot is acquiring and analyzing images from 12th September 2022. Below a summary of the data acquired until 02 December 2022.

Dataset					
N. of working days	N° Images acquired *	Average image per day	Good quality images *	Healthy carcasses	Pathologic carcasses
50	37.798	756	19.029	~17.080	1.948
			~50%	89,76%	10,24%

* Fatland decided not to implement a carcass presentation system to assure 100% quality images

Pleurisy Score	No. of Pigs	Percentage
0	17,081	89.76%
1	323	1.7%
2	894	4.7%
3	731	3.84%

Publications of results

SafePork Conference 2023 Louisiana

SAFEPORK
NEW ORLEANS, LOUISIANA
15-17 MAY 2023

Nortura bondens selskap Slaughterhouse 🇳🇴

In June 2023 we will test the technology on lungs to detect and assess pneumonia for which an automated scoring system has been already developed (see DEMO).

GO to the DEMO

ADAL — NEXT STEPS
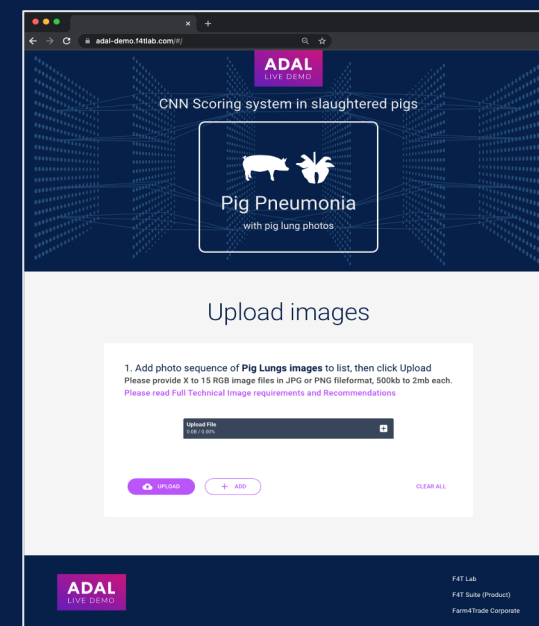
We aim to expand the fields of application of the technology developed to other pathologies both of health interest and related to animal welfare. The first ones we have started to work on are the following:

SKIN LESIONS

Evaluating skin lesions, which can be of infectious or traumatic origin, helps to provide information on the welfare of animals on farm, during transport and during slaughtering operations. These injuries can significantly affect product quality and processing, with repercussions on the productivity and profitability of the entire supply chain.
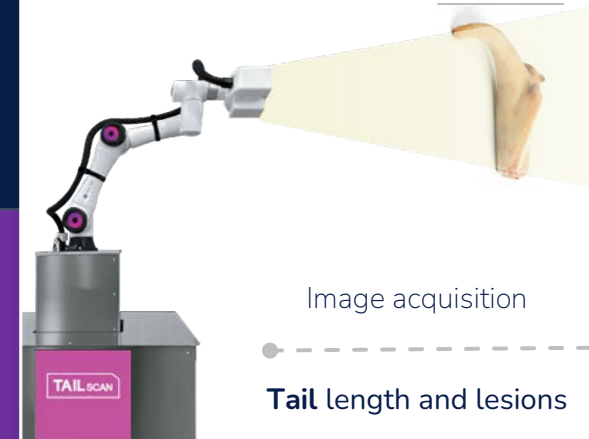
LIVER LESIONS

Evaluating and assigning a score to parasitic hepatitis which is the main parasitic pathology found in intensive pig breeding is one of the best indicators of the health status within livestock farms.

TAIL LESIONS

TAIL SCAN

Image acquisition

Tail length and lesions

Current Applications and Future Perspectives of CVSs in MI

- **CVSs** primarily support inspection in poultry, with potential for expansion to bovines and pigs

- **EU Regulation 2017/625** encourages the adoption of new technologies in meat inspection, subject to member state approval

- **High-speed processing** challenges addressed by CVSs, enabling **more accurate and consistent inspections**

- **Minimizes human inspector fatigue and ensures reliable inspection** for extended periods

- Increased **uniformity** in inspection findings and condemnation criteria benefits livestock producers

- **Technological advancements to enable individual carcass tracing and routine handling** of different meat categories

- Investigating the efficacy of CVSs in detecting lesions and carcass contamination for bovines, pigs, and broiler chickens

- Exploration of remote inspection capabilities through augmented reality and live-stream video software

- **Continuous development of CVS technologies to improve meat inspection and align with evolving legislation**

More info

Two journal articles

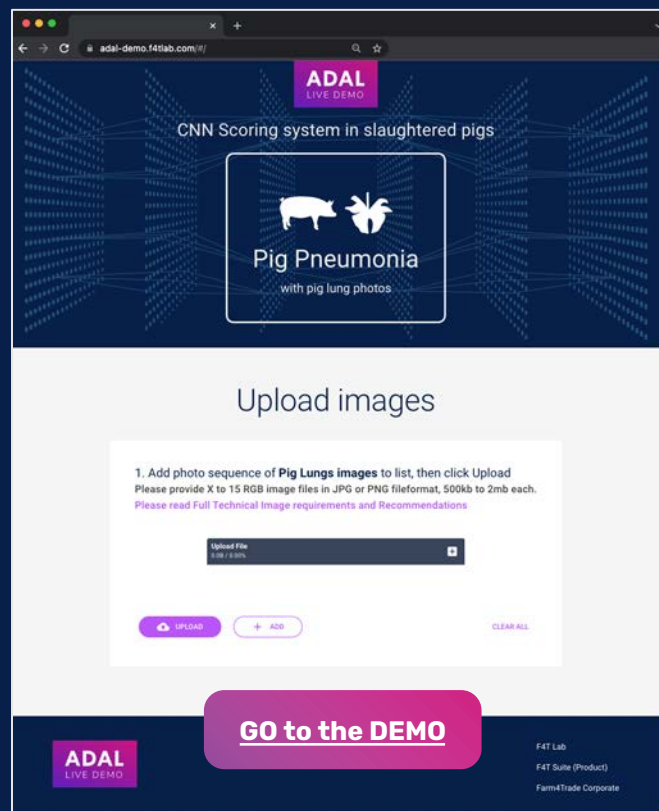Training Convolutional Neural Networks to Score Pneumonia in Slaughtered Pigs
Animals
vol. 11, article 3290 (2021)

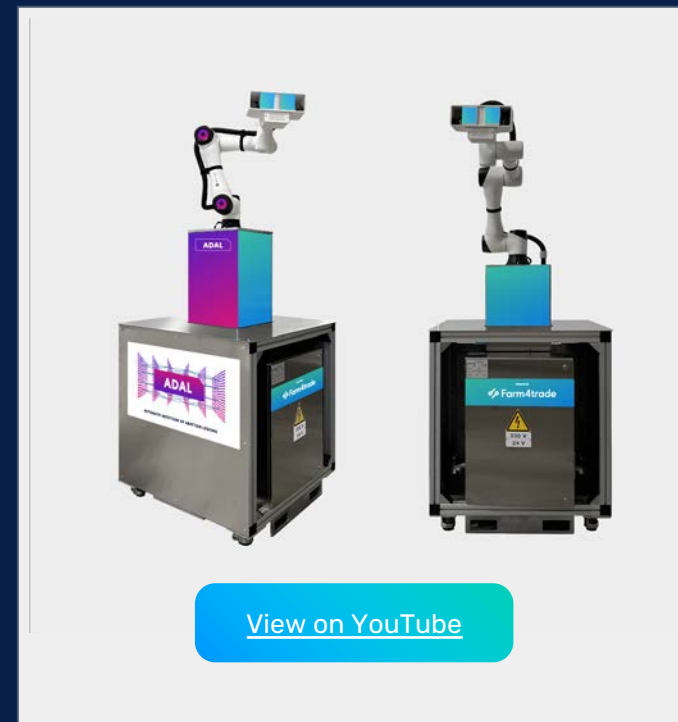Scoring pleurisy in slaughtered pigs using convolutional neural networks
Veterinary Research
vol. 51, article 51 (2020)

Online Live demo

Photo capture robot

View on YouTube

ADAL Video

View on YouTube

Contact

Andrea Capobianco Dondona
CEO – Founder
andrea@farm4trade.com

Farm4trade

WE INVITE YOU TO LEARN MORE

ADAL

Greater confidence
in meat quality for all

f4tlab.com/adal

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Animal Health Traceability and Data Solutions

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