CA18105

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Applications of Computer Vision Systems for meat safety assurance in abattoirs:

A systematic review

On behalf of WG 3 & WG 4: Marianne Sandberg | 30-March-2023 | Denmark

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From the 19th into 20th century (EC 854/2004)

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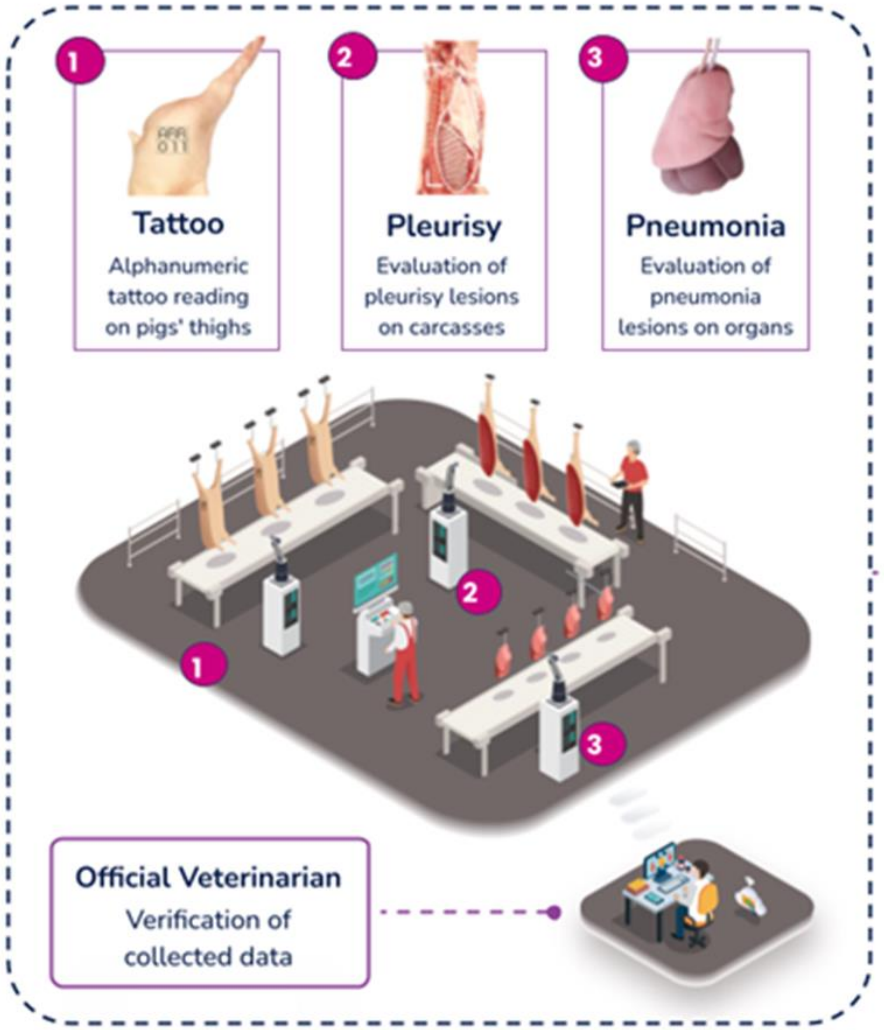
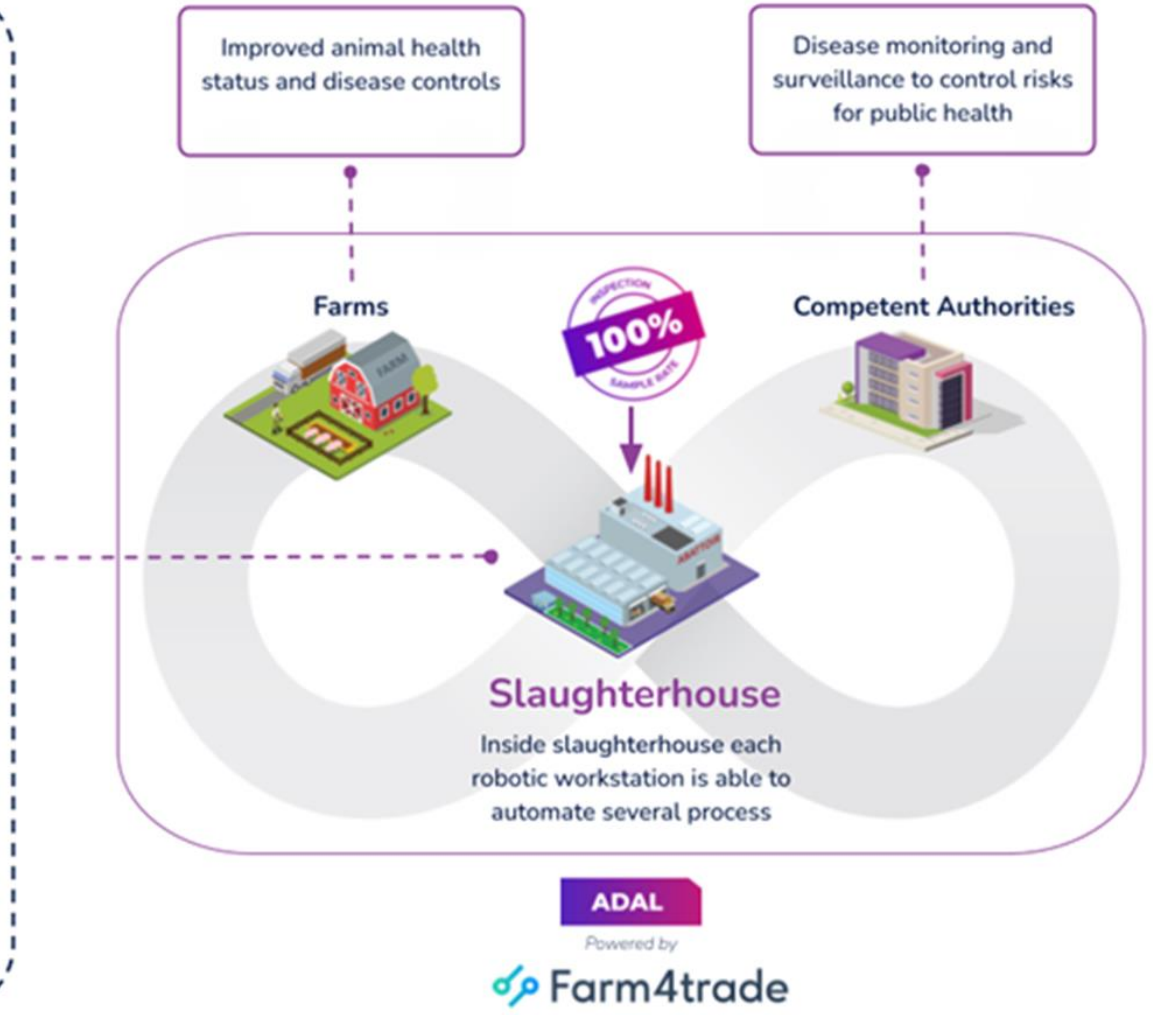
Into the future





Introduction

- Introduction of the new EU legislation on official controls in food production in 2017-2019 opened up for use of Computer Vision Systems (CVS) as a complementary tool in meat inspection of bovines, pigs and poultry
- CVS´s for meat quality assurance date back to the mid-nineties and the extensive work conducted by the USDA Agricultural Research Service
- Post Mortem (PM) inspection presents a challenge for the high-speed slaughter of poultry – hence was recognised long ago that applying CVS's was the key to solve this problem

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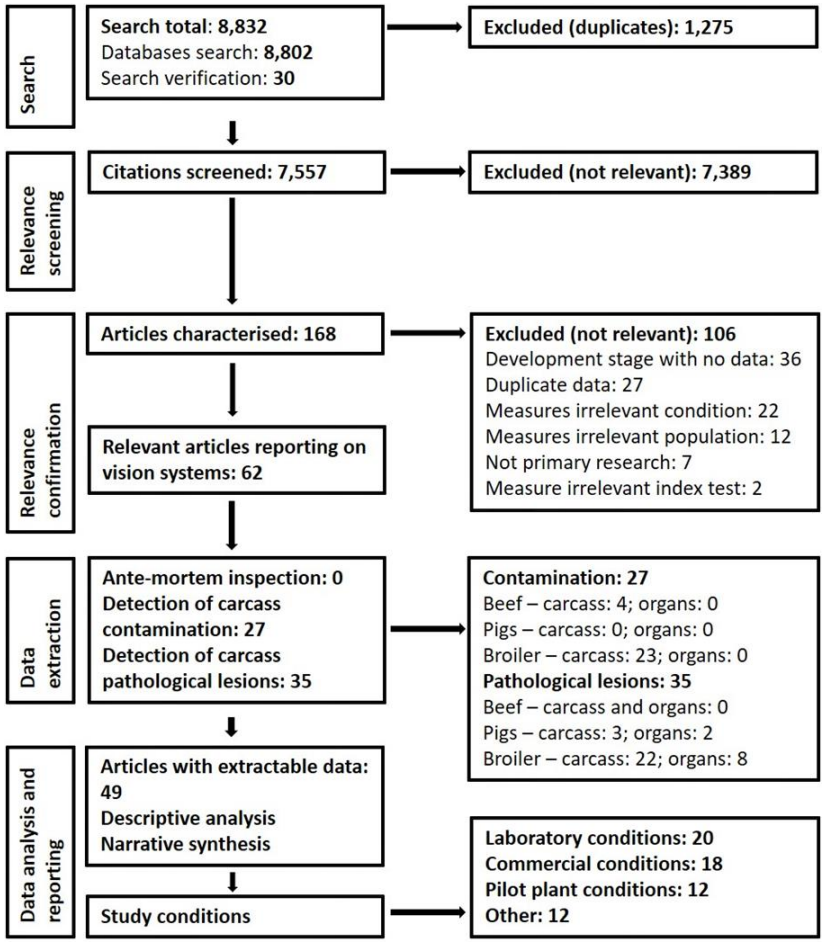
Scope and approach

- Review question: What is the effectiveness and detection performance of all available CVS's used in abattoirs to detect carcass contamination and pathological lesions?
- A review protocol was developed using the Cochrane methodology for systematic reviews (www.cochrane.org)
- The review team: 10 team members with expertise in: CVS´s develop., official control, epidemiology and meat safety



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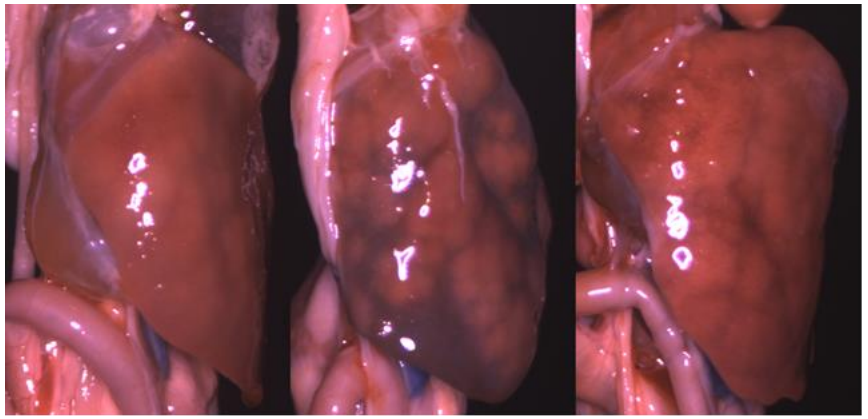
Key findings – descriptive information

- CVS articles identified in this review:
  - 62 in total
  - None describing CVS's for ante mortem inspection
  - 35 reporting CVS's for the detection of carcass/organ lesions
  - 27 reporting CVS's for the detection of carcass contamination

- CVS articles for:
  - Poultry: 53
  - Pig: 5
  - Bovine: 4



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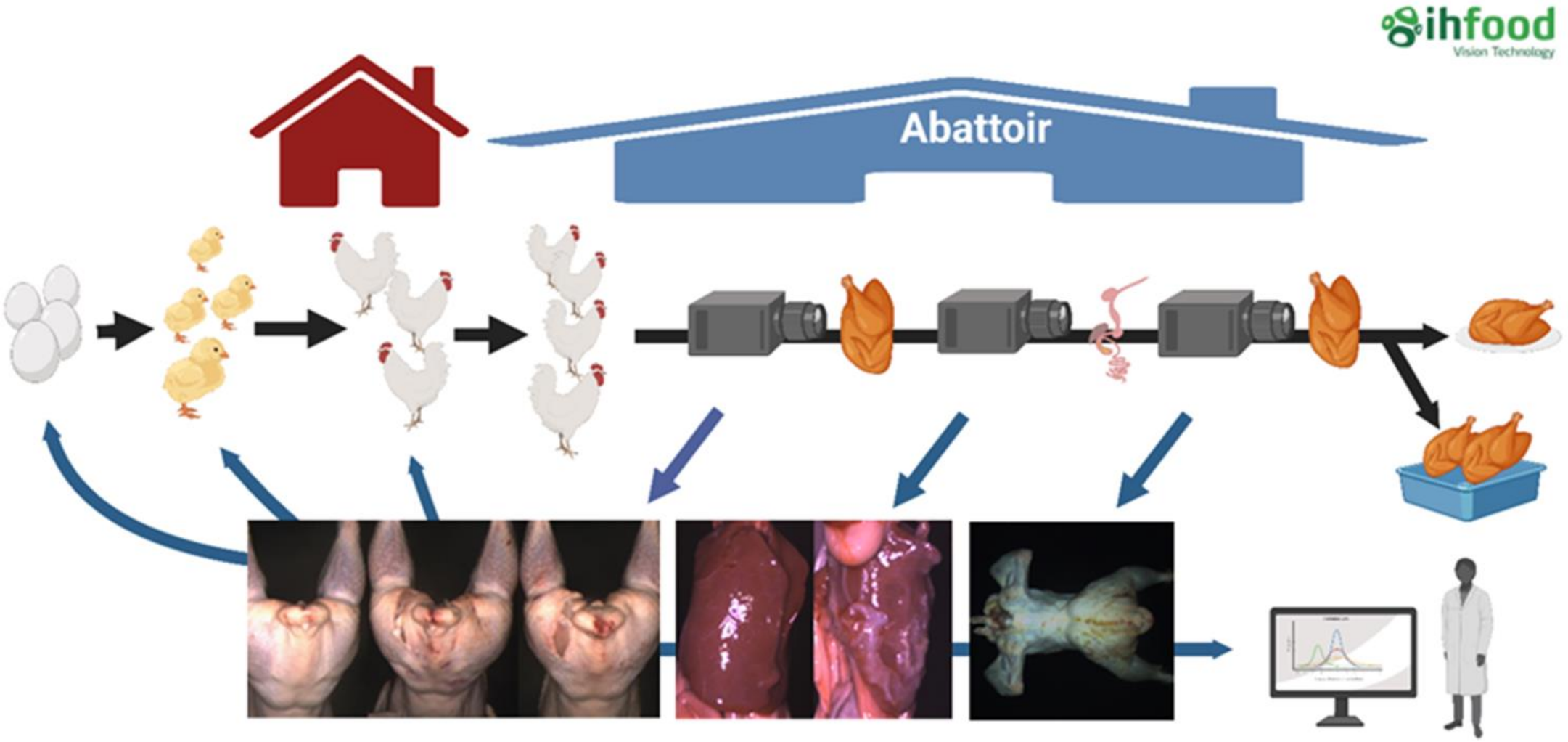
VetInspector - Computer based post mortem veterinary inspection of chickens



Robot workstation

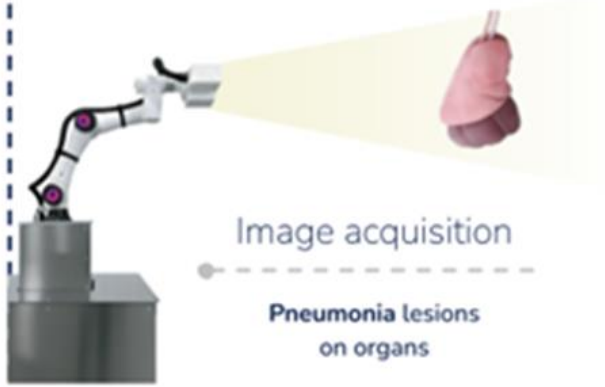


Image acquisition

Pneumonia lesions
on organs

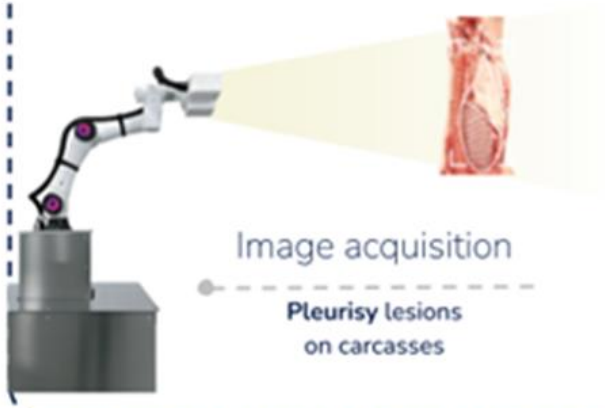


Image acquisition

Pleurisy lesions
on carcasses

Access data in real time for:

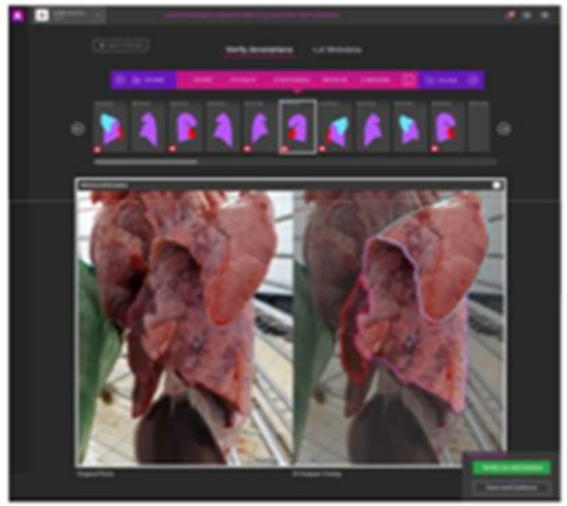
Manage batches
Double verification
Access to annotations details
Manage Metadata

ADAL

Powered by

Farm4trade

Remote Web App



Key findings – methodology CVS

- CVS´s rapid development was associated with development of information technologies, particularly image processing techniques
  - USDA group active from early nineties – also for veterinary inspection of poultry carcasses – IHFood from 2011 continued, also with poultry viscera
- Conventional fluorescence imaging has limitations in meat safety assessment –not all materials can be excited to fluoresce – hence integration with other imaging tools:
  - Hyperspectral imaging integrates computer vision and conventional spectroscopic techniques, so that both spectral and spatial information can be provided simultaneously
- The initial CVS models were based on principle components analysis whereas the more recent models are based on fuzzy logic, random forest or neural networks/machine learning

Feasibility steps: collect information from literature, suggest scoring system, collect test data and conduct test(s) of the scoring system

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Development, training, validation and test steps: collect a suitable number of images from veterinary inspection

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Data clean-up

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Manually label the data to define what the CVS model must identify (ground truth)

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Select algorithm, and select metric for the outcome

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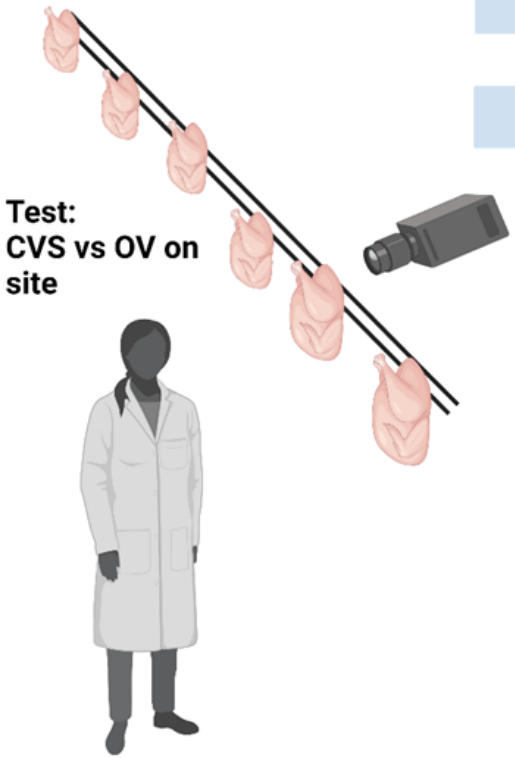
Prepare data sets to:



- Test
- Train
- Validate

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Pre-process data

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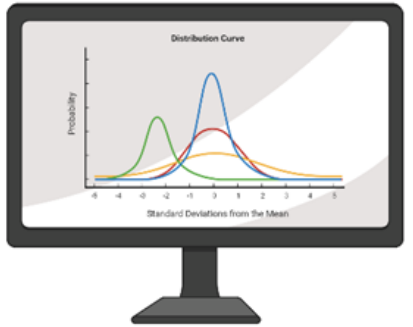
Train

↓

Final CVS model

↓

Predict for classification of new images



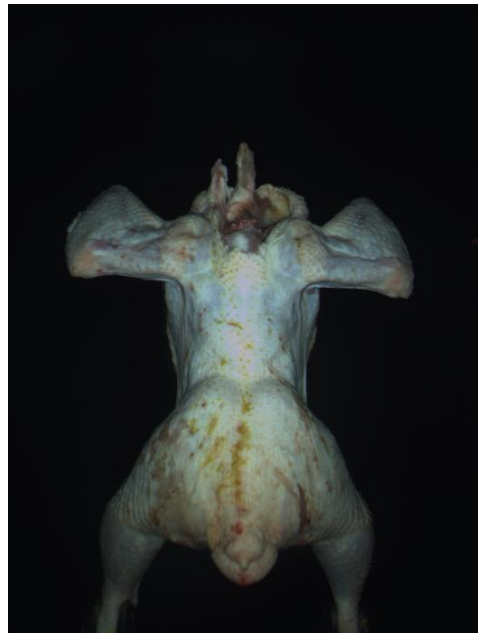
Key findings – performance

- Not all CVS's were validated – only 3 articles reported results from real-time evaluation of CVS performance in abattoir vs performance of the OV
- Most of the reported CVS´s performance measures (i.e., sensitivity and specificity) were >80%
  - A high specificity in detecting lesions and carcass contamination (a low number of false positives) is of uttermost importance for the food business operator in order to minimise food waste, whereas
  - A high sensitivity (a low number of false negatives) is required for production of wholesome and safe meat

Conclusion

- Existing CVS's developed for overall meat safety assurance of poultry carcasses and organs has come far in regard to optimisition as well as legal wise
  - demonstrated high sensitivities but suboptimal specificities
- CVS's for pig and cattle PM inspection is not yet complete technically or legally

Hence there is a need for further CVS development and optimisation



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transition in meat hygienic concepts...

traditional

- macroscopically visible diseases and zoonoses
- inspection including
  - visual inspection
  - palpation
  - incision

current

- more focus on knowledge about invisible biological and chemical hazards
- holistic view of the food chain
- risk-based meat inspection assurance system [MSAS]
- food business operator should take responsibility
- following the One Health concept

future

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Thank you! – and thanks to all co-authors:

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