Master 2 internship

Development of deep learning models for estimating the sensory quality of meat using image analysis

IMS laboratory, CNRS – Bordeaux Sciences Agro

Key words: deep learning, classification, semantic segmentation, regression, marbling of meat

Challenges

Artificial intelligence and computer vision are currently transforming sectors as diverse as healthcare, automotive, robotics... and even agri-food. Every product we consume goes through a complex quality control chain. However, in many cases, evaluation still relies on the human eye: a costly, time-consuming and subjective process. This is particularly true for beef. One essential sensory criterion is marbling. These fine infiltrations of fat in the muscle determine the juiciness, tenderness and flavor of the meat. Today, its assessment is based on accredited graders who assign a marbling score based on a visual color chart. Two international reference scales are used: AUS-MEAT (score from 0 to 9) and Meat Standards Australia (score from 100 to 1,190).

Although these scales are recognized worldwide, their application in slaughterhouses has several limitations: the need for continuous training and refresher courses, significant grading time, and variability between assessors. The challenge is therefore to develop fast, reliable and non-destructive industrial tools capable of automatically predicting marbling scores and other criteria (fat cover, meat yield) to direct carcasses to their target markets with greater accuracy and transparency.

Context

The proposed approach involves the use of image analysis. In other words, using photos of the meat to automatically assess marbling using deep learning models. This approach is part of a wider effort to modernize carcass classification. In Europe, the EUROP classification grid (conformation/fat cover) does not take marbling into account, even though this sensory criterion is crucial to meat quality. However, several studies have shown the importance of this criterion for the sensory quality of meat, which has led the French and European industries to consider its integration into classification grids (Monteils et al., 2017).

Emerging technologies now offer promising alternatives for objective, automated marbling assessment:
- the Q-FOM™ Beef camera (Frontmatec), recently validated by AUS-MEAT/MSA for predicting marbling as well as meat and fat color (Mendes et al., 2025)
- portable or innovative tools such as near-infrared spectroscopy (NIRS) (INDIGO sensors, smartphone-based sensors), hyperspectral imaging (HSI, BBQ), REIMS mass spectrometry and ultrasound (Mendes et al., 2024).

The aim of this project is to evaluate the potential of another type of modality: color imaging for estimating meat marbling using deep learning models. Deep learning methods applied to image analysis offer new perspectives for processing textured images. In the case of meat cuts, they will make it possible to recognize subtle visual patterns such as marbling (fine white streaks in the meat) and to better characterize quality, where conventional approaches may reach their limits.

Internship schedule

To carry out this work, the internship will be divided into five phases.

1. First, we will create a labeled database containing images of beef ribs and weighing tickets.

2. Secondly, we will develop a **semantic segmentation** model such as YOLOv11 (Khanam et al. 2024) to recognize the rib eye (circled in yellow in the figure above) from beef rib images.
3. Focusing on this piece of meat, a second deep learning model will be developed to assess the marbling of the meat. A comparison between **classification** and **regression** approaches will be carried out (Krizhevsky et al. 1012, He et al. 2016).
4. To improve the predictive performance of these models, we will look at the **inclusion of metadata** such as the age and breed of the beef, the type of cattle, etc. These metadata can be accessed from the barcode on the weighing tickets. To this end, we will look at the **automatic reading of barcodes** in a highly disturbed context (presence of stains on the ticket, faded ink, etc.) and integrate these metadata into prediction models by comparing different early or late fusion approaches (Lu et al. 2021).
5. Finally, the models developed during this internship will be validated through **comparisons with other approaches in the literature** (Q-FOM™, NIRS, HSI).

References

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Candidate profile

- You are in your final year of a **master's degree or engineering school** with a specialization in image processing and/or artificial intelligence.
- You have a good knowledge of image analysis. You are familiar with **deep learning** and **supervised learning** techniques.
- You have solid skills in development languages such as **Python** and are familiar with the main **artificial intelligence** tools (Pytorch).
- You are **rigorous** and **organized**, with an appetite for working in an interdisciplinary field (computer vision and animal production).

Internship organization and application procedures

- IMS Laboratory - Signal and Image Group, Talence campus (33) and Bordeaux Sciences Agro (1, cours du Général de Gaulle, CS 40201 - 33175 Gradignan Cedex, France).
- Duration of internship: 5/6 months from February/March 2026.
- Internship allowance in accordance with current regulations.
- Send a letter of application + CV by e-mail.

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This internship will be carried out in collaboration with Barna Keresztes (IMS/Bordeaux Sciences Agro) for computer vision aspects, and Marie-Pierre Ellies and Sandrine Papillon (Bordeaux Sciences Agro) for application issues.

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