AUTOMATED PIG GUT SEGMENTATION IN CT IMAGES USING DEEP LEARNING

Theatre Session D 05/06/2025

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Partner for your innovations !

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I. INTRODUCTION

- From dissection to image processing

Cannot be repeatable for the same animal

Multiple scans possible over time

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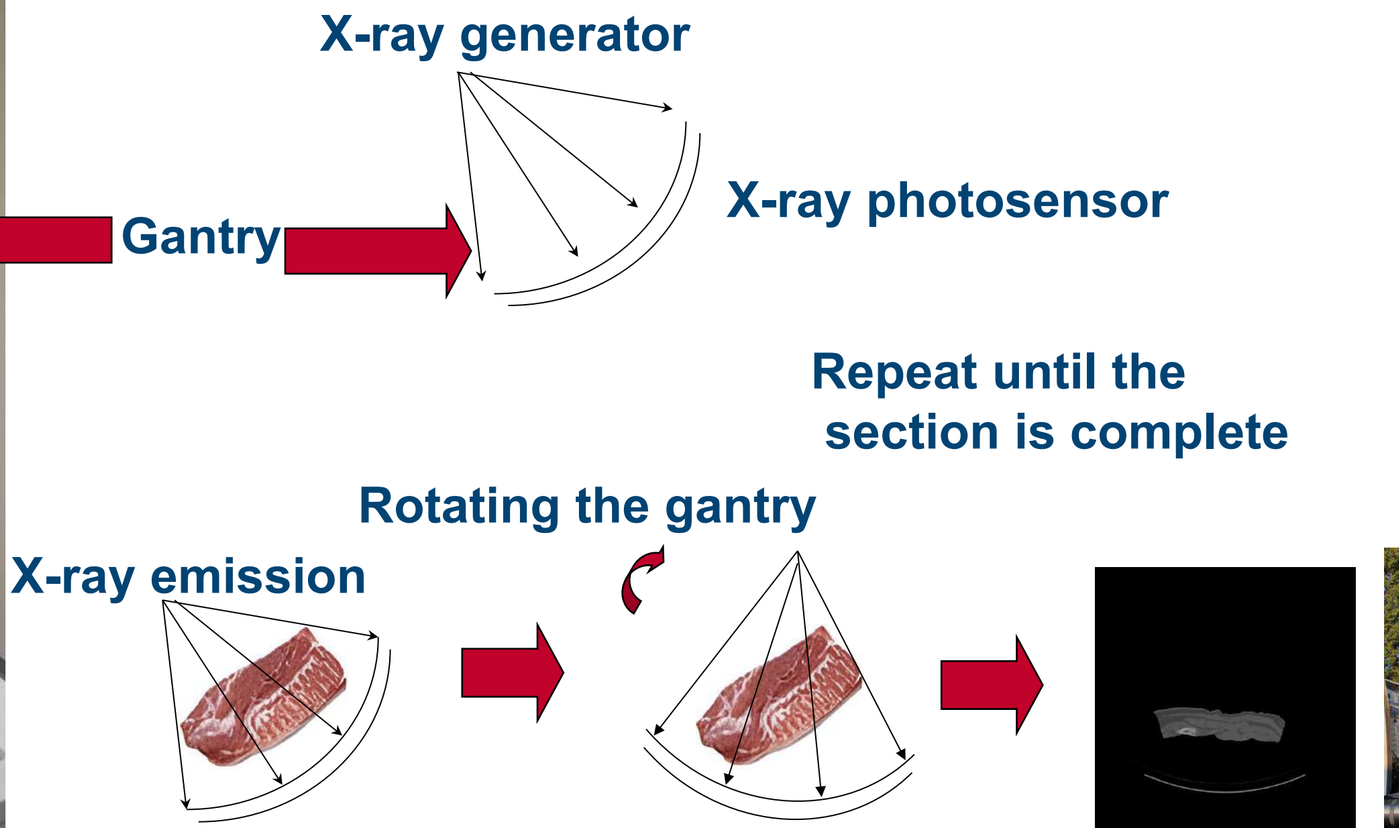
II. MATERIALS
- X-RAY SCANNER ACQUISITION



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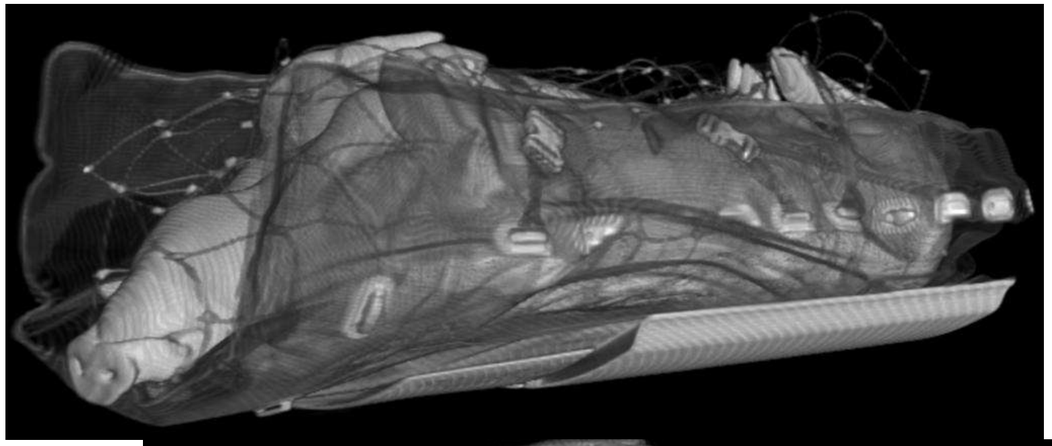
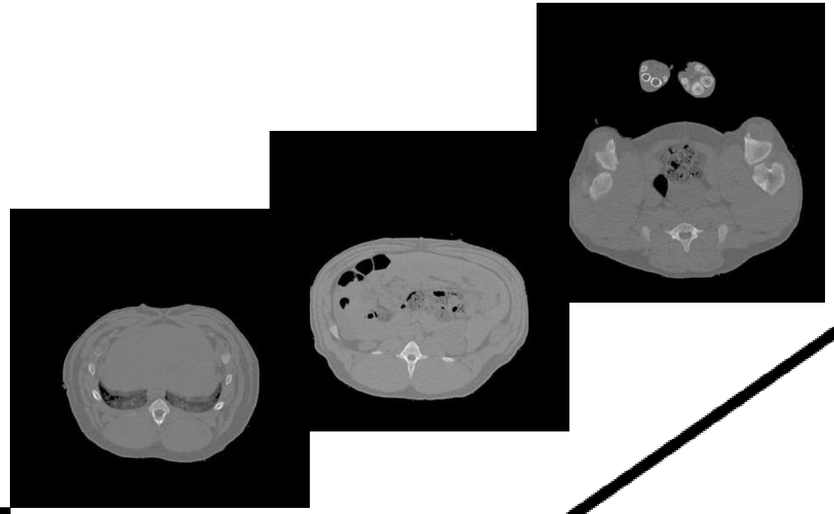
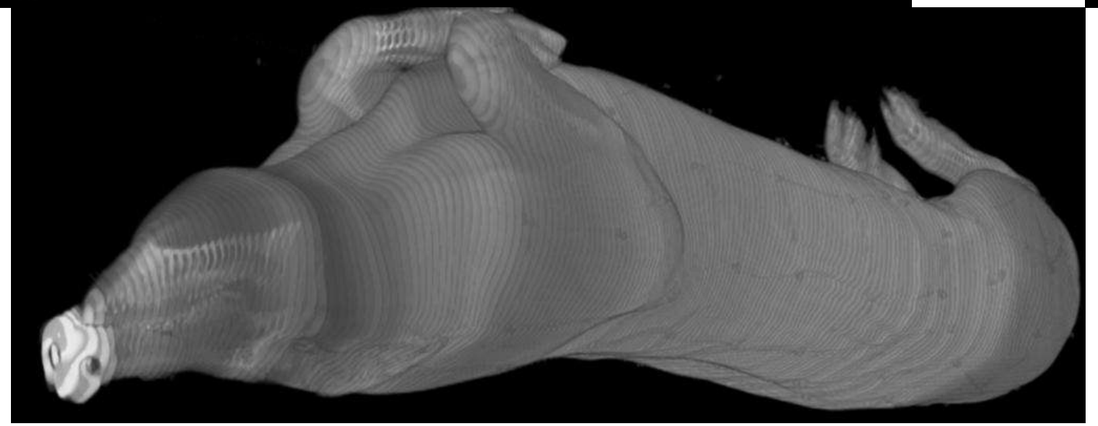
II. MATERIALS
- Dicom pictures

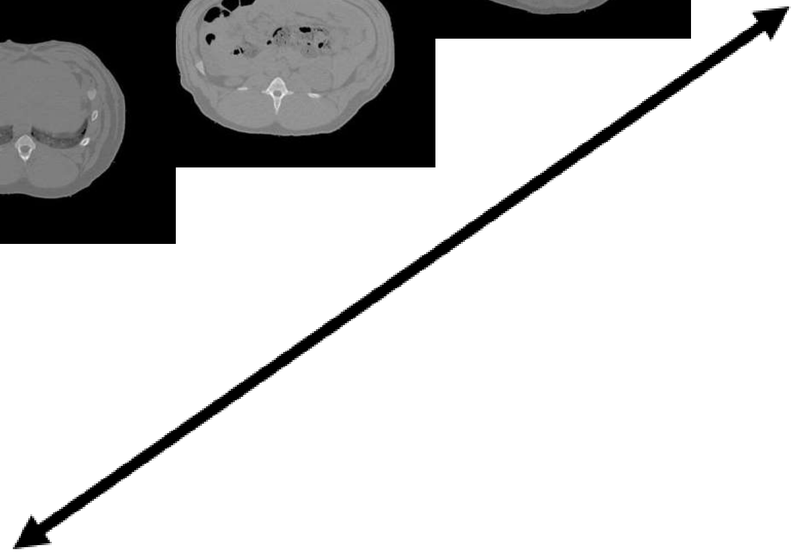
3D visualization of pork (raw)





3D visualization of pork (filtered)





350 slices

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III. Semi-automatic method

- TurtleSeg

TurtleSeg[1] is an interactive segmentation tool designed for 3D medical images.

Main features :

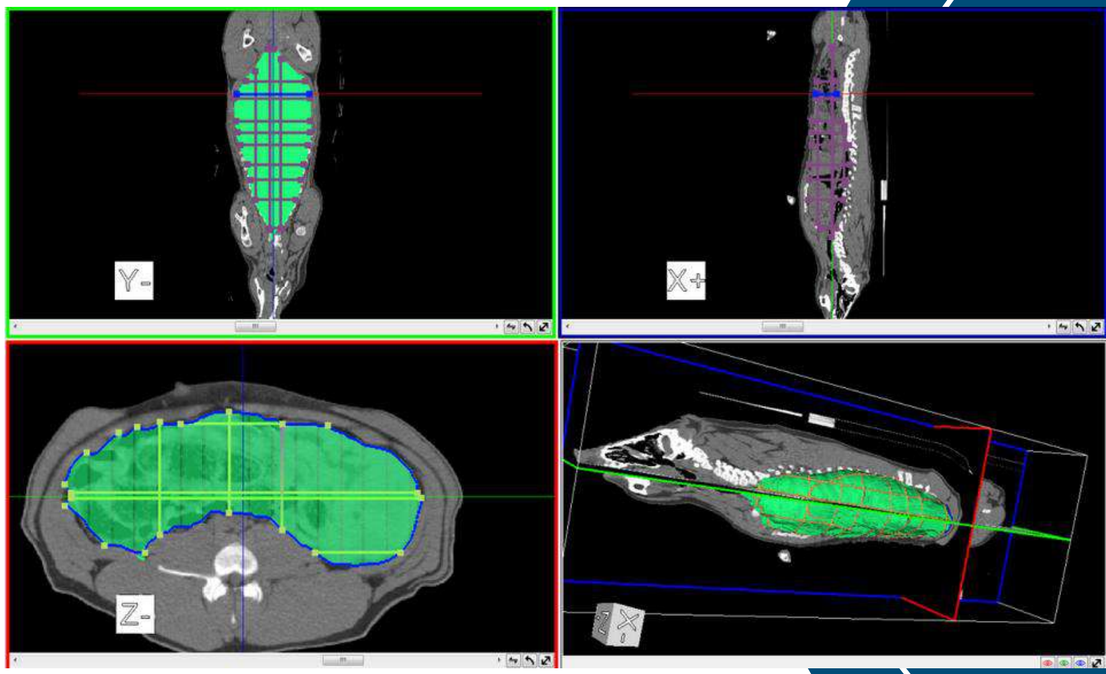
► Natural 3D navigation with support for oblique slice planes.

► Multi-level undo/redo support.

► Support for many popular 3D image formats.

► Export the segmentation as an image mask or surface mesh.

► Full contour editing support makes fixing mistakes easy.



[1] A. Top, G. Hamarneh, and R. Abugharbieh, "Active Learning for Interactive 3D Image Segmentation," in *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*, vol. 6893, LNCS, pp. 603–610, 2011, Springer Berlin / Heidelberg.

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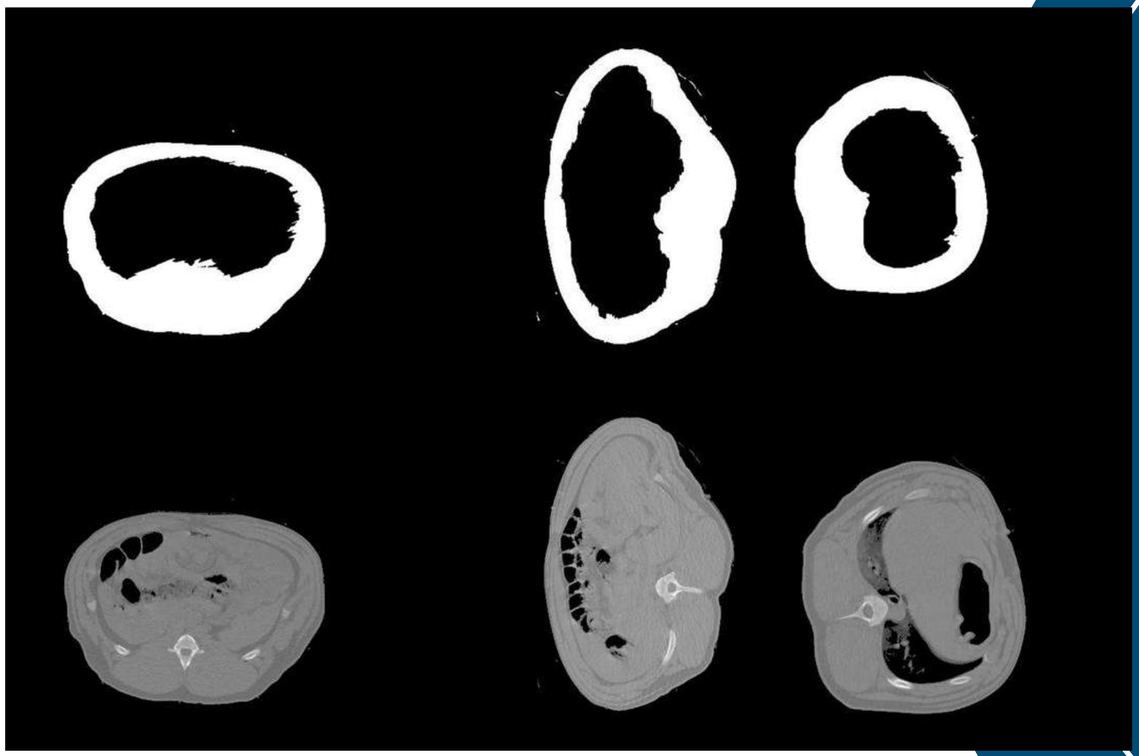
IV. DEEP LEARNING METHOD
- DATASET

Categories	Descriptions
Encoding	JPEG
Format	8 bits
Canal	1
Range of values	0 to 255
Visualization	Grayscale
Number of paires	276 087
Angle	$0\ ;\ \frac{\pi}{2}\ ;\ -\frac{\pi}{2}$ (rad)



Dataset 262 pigs + dataset augmentation (276 087 paires)
252 real pigs for training
10 real pigs for testing

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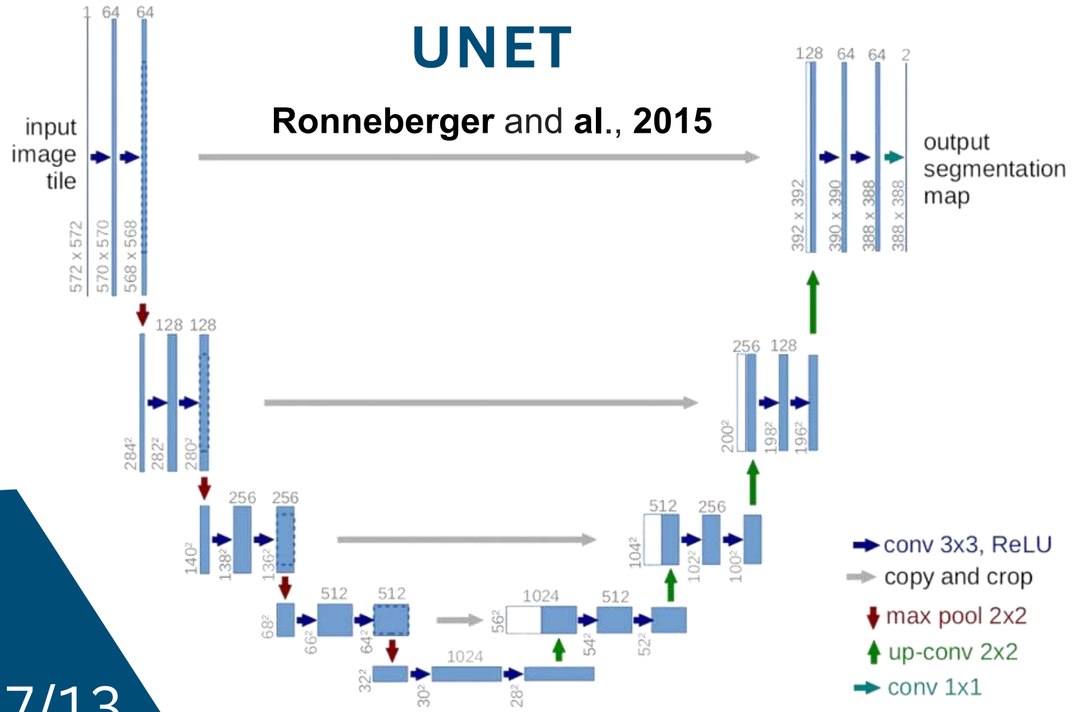
IV. DEEP LEARNING METHOD

- TRAINING CONFIGURATION



Librairies/Frame works	Version
Python	3.12
Pytorch	2.6.0
Streamlit	1.42.0
Cuda	12.4

Training specs	Descriptions
Loss function	Binary Cross Entropy*
Time	28 hours
Graphics Processing Unit (GPU)	Nvidia RTX 4080 SUPER 16GB
Epochs	40

$$*BCE = -\frac{1}{N}\sum_{i=0}^{N} Y_i \cdot log(\hat{Y}_i) + (1 - Y_i) \cdot log(1 - \hat{Y}_i)$$

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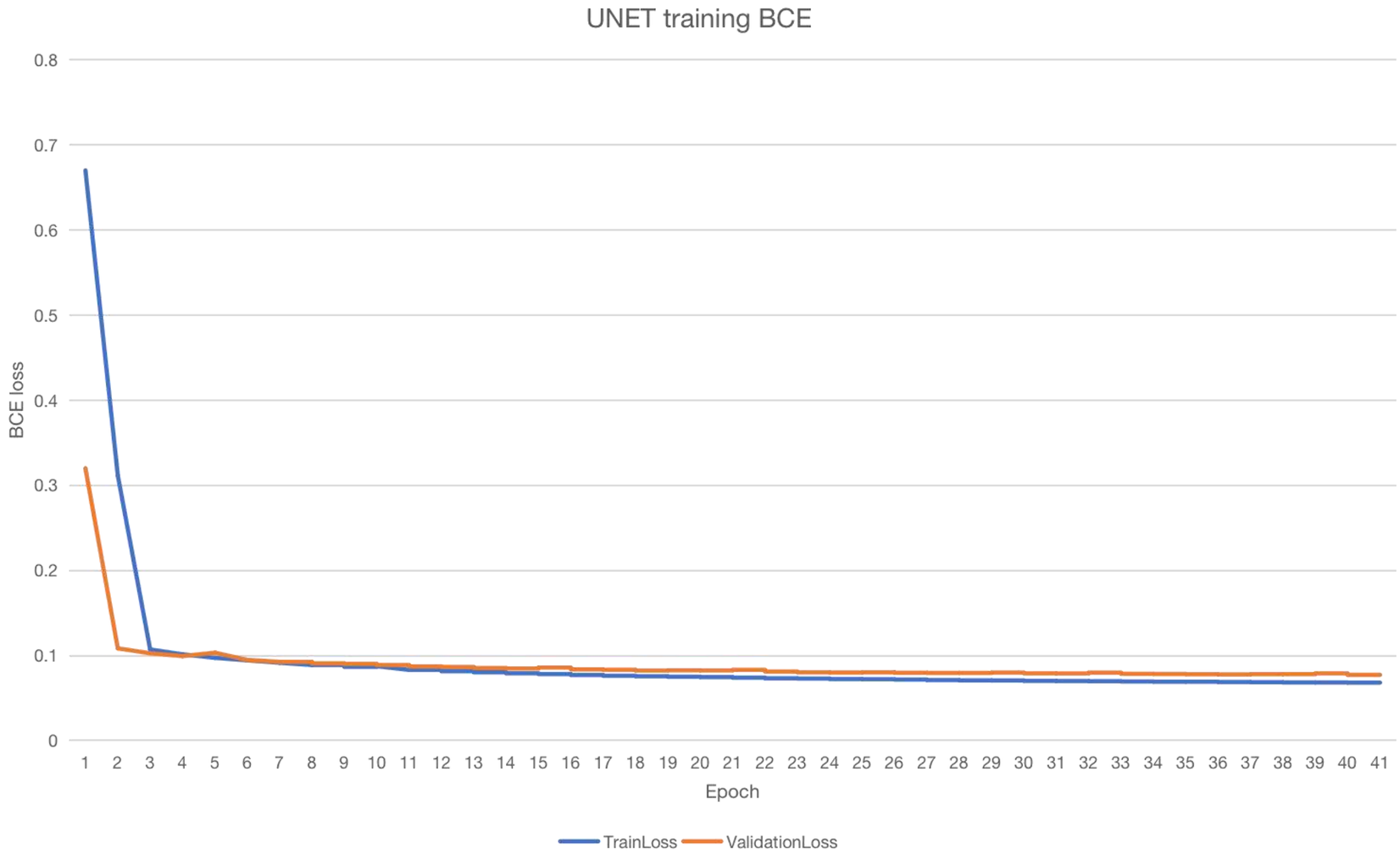
IV. DEEP LEARNING METHOD

- DEEP LEARNING RESULTS



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IV. DEEP LEARNING METHOD

- DEEP LEARNING RESULTS

Model	Metrics	Values
UNET	DICE	0.927
UNET	IoU	0.876
UNET	Accuracy	0.997
UNET	Recall (F1-Score)	0.915

Model_Unet.pth

$$\mathrm{Dice}(A,B) = \frac{2 \cdot |A \cap B|}{|A| + |B|}$$

$$\mathrm{IoU}(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

$$\mathrm{Accuracy} = \frac{\mathrm{TP} + \mathrm{TN}}{\mathrm{TP} + \mathrm{TN} + \mathrm{FP} + \mathrm{FN}}$$

$$\mathrm{Recall} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}} = \frac{|A \cap B|}{|A|}$$

- TP = True positive
- TN = True negative
- FP = False positive
- FN = False negative

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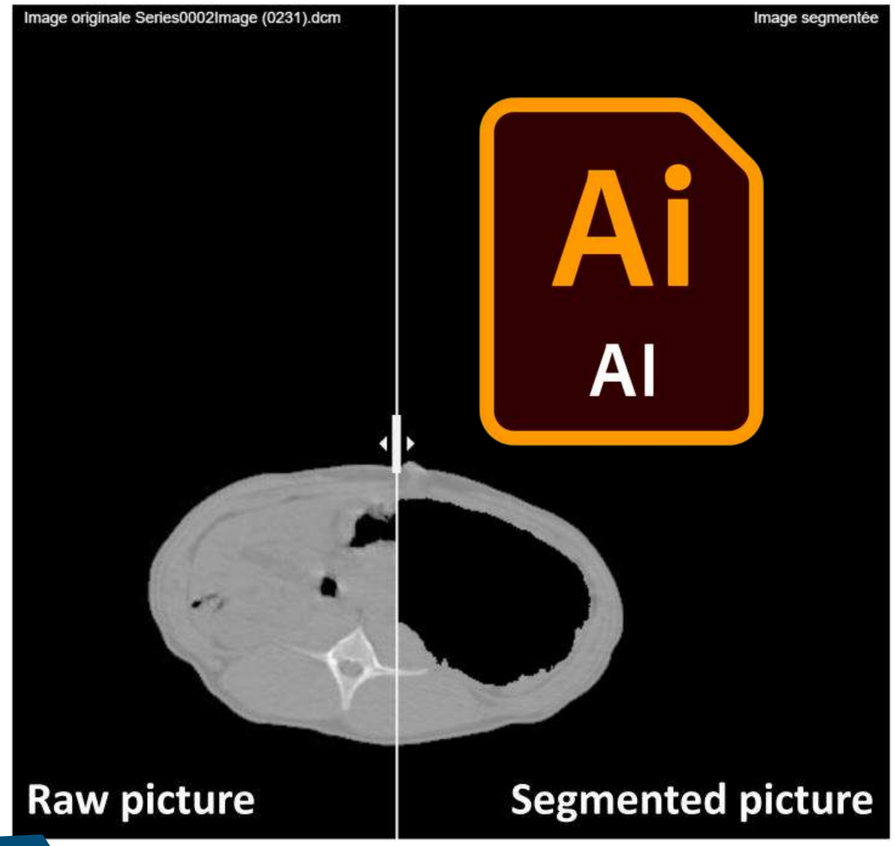
V. INTEGRATION OF THE AI SOLUTION

- BASIC WORKFLOW FOR AI INTEGRATION



Acquiring full-body X-ray images of live pigs

↓

Inputting slices sequentially into our deep learning model

↓

Analyzing body composition

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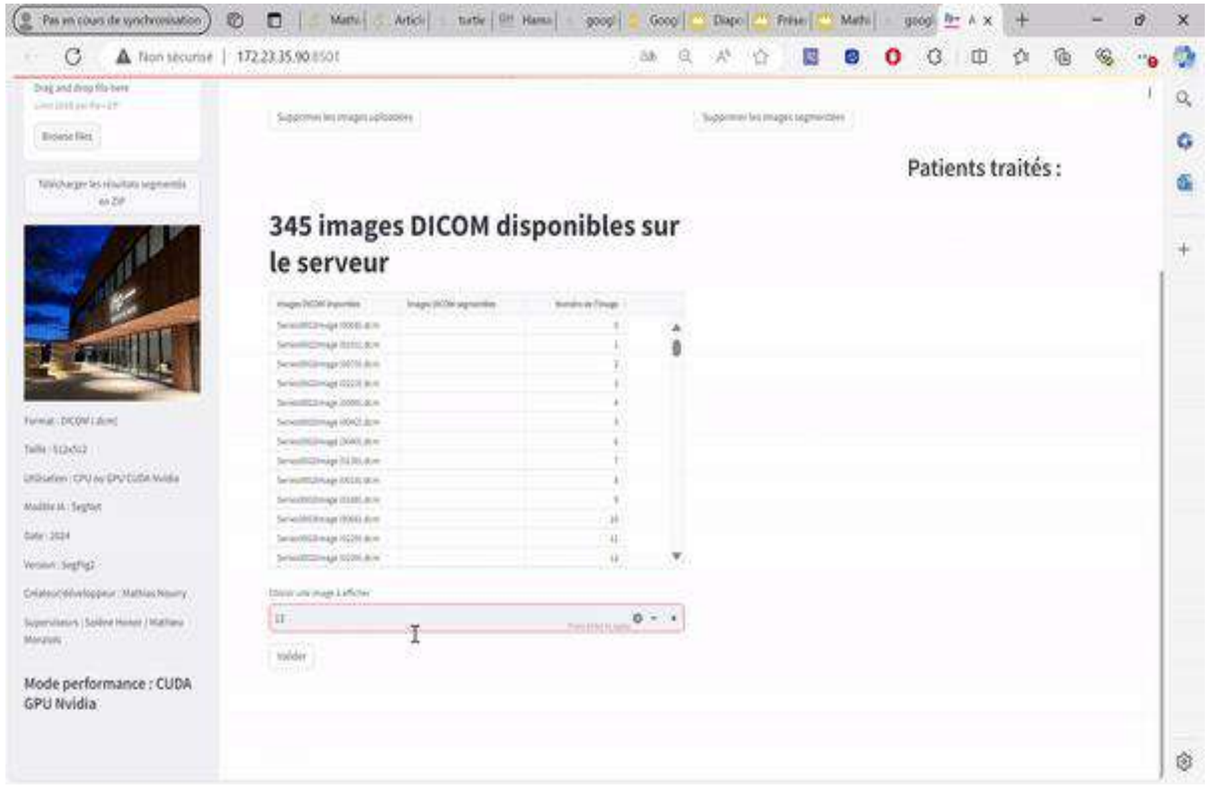
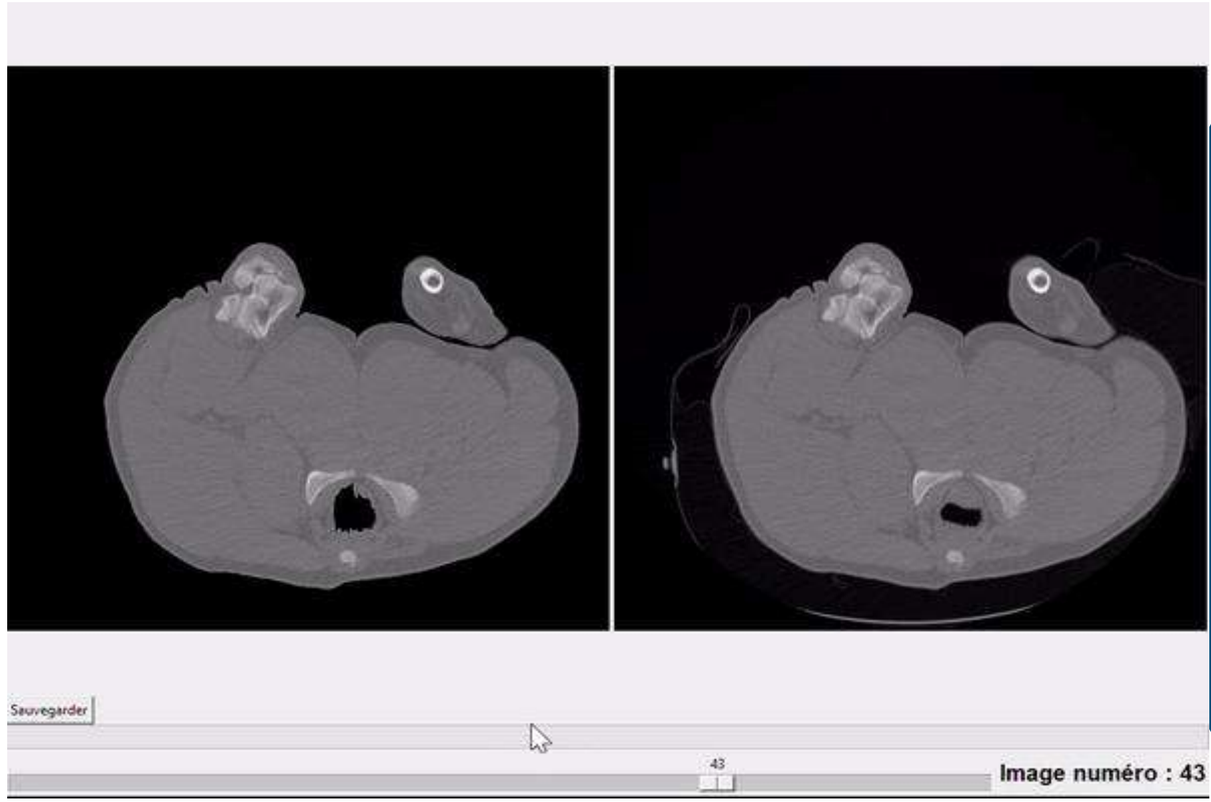
V. INTEGRATION OF THE AI SOLUTION
- SEGPIG DEMO





SEGPIG

SEGPIG CORRECTOR

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VI. CONCLUSION

- TAKE-HOME MESSAGE

Deep learning offers a fast, objective, and fully automatic alternative to semi-manual segmentation tools like TurtleSeg.

By accurately separating viscera from pig's body in X-ray images, our model enables non-invasive, scalable analysis of pig body composition across growth stages paving the way for efficient and ethical livestock research without dissection.

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EAAP partners

THANK YOU FOR YOUR ATTENTION !

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