Silkworm feeding prediction and habitat analysis

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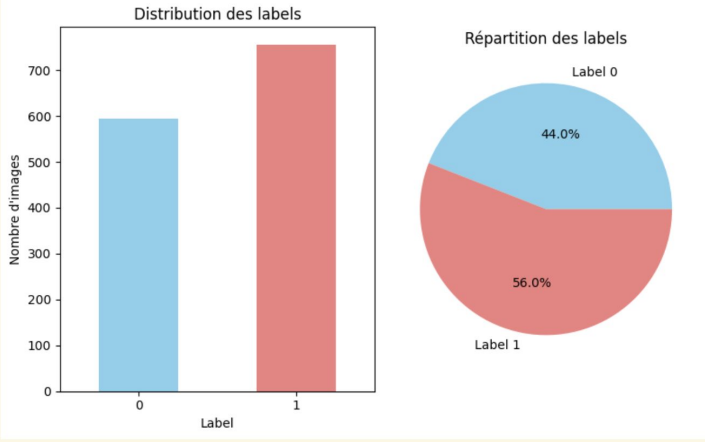
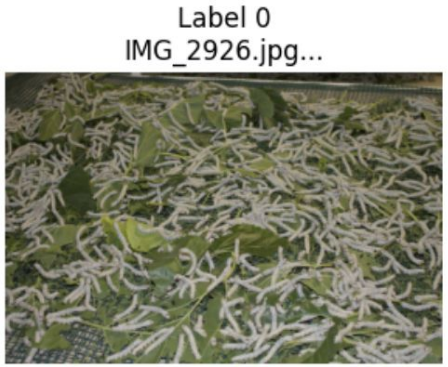
Project aim : Efficient silkworm rearing is essential for sustainable silk production.

- Implement a model for binary classification to determine whether the silkworm need feeding ;
- Implement a method to segment silkworms, mulberry leaves and background (3 classes) without relying on human segmented examples. For instance, this method would be really helpful to count the silkworms …

The dataset : 1 folder with 1351 images + a CSV file with the labels ⇢ *need to organize the dataset before processing*





Classification model :

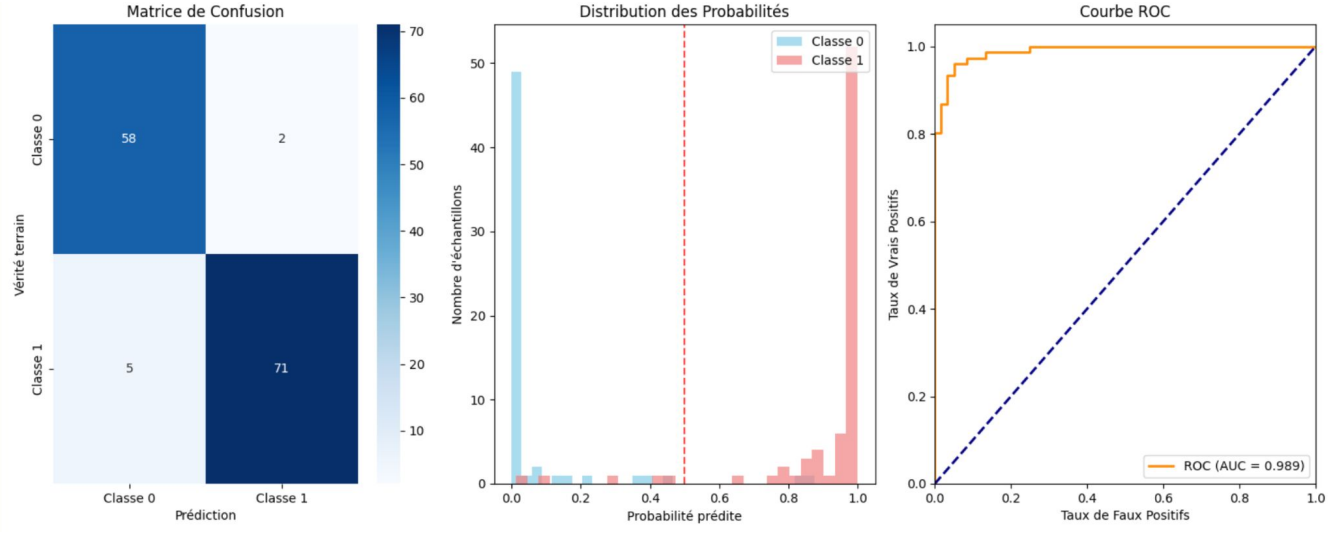
- Backbone: DINOv2-base (ViT-S, 22M parameters) - FROZEN
- Classifier Head: 3-layer MLP (768 → 256 → 128 → 1)
- Training: Only classifier head parameters updated (less adaptable but faster training

Preprocessing :

- `transforms.Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225])` DINOv2 was pre-trained on ImageNet with these specific statistics. Without proper normalization, the model would receive out-of-distribution inputs, leading to poor performance
- `transforms.ToTensor()`Enables GPU processing and batch operations
- `transforms.Resize((224, 224))` Neural networks require fixed input dimensions
- `transforms.RandomHorizontalFlip(p=0.5);` `transforms.RandomRotation(degrees=15)` ; `transforms.ColorJitter(brightness=0.2, contrast=0.2, saturation=0.2, hue=0.1)` Artificially increases dataset diversity, thus teaches invariance to common transformations and reduces overfitting

Evaluation :

	precision	recall	f1-score	support
Classe 0	0.9206	0.9667	0.9431	60
Classe 1	0.9726	0.9342	0.9530	76
accuracy			0.9485	136
macro avg	0.9466	0.9504	0.9481	136
weighted avg	0.9497	0.9485	0.9486	136



Main difficulties : the leaf veins can be interpreted as object boundaries, making it difficult to "remove the background" by identifying it as a large uniform area ; difficult to "remove the background" by identifying it as a large uniform area, since it contains a fine mesh ; many silkworms in the images, which requires a fine-grained model...

Preprocessing : different filters are used upstream of the model to try to address the previously mentioned problems: bilateral, Gaussian, morphological, and NLM filters.

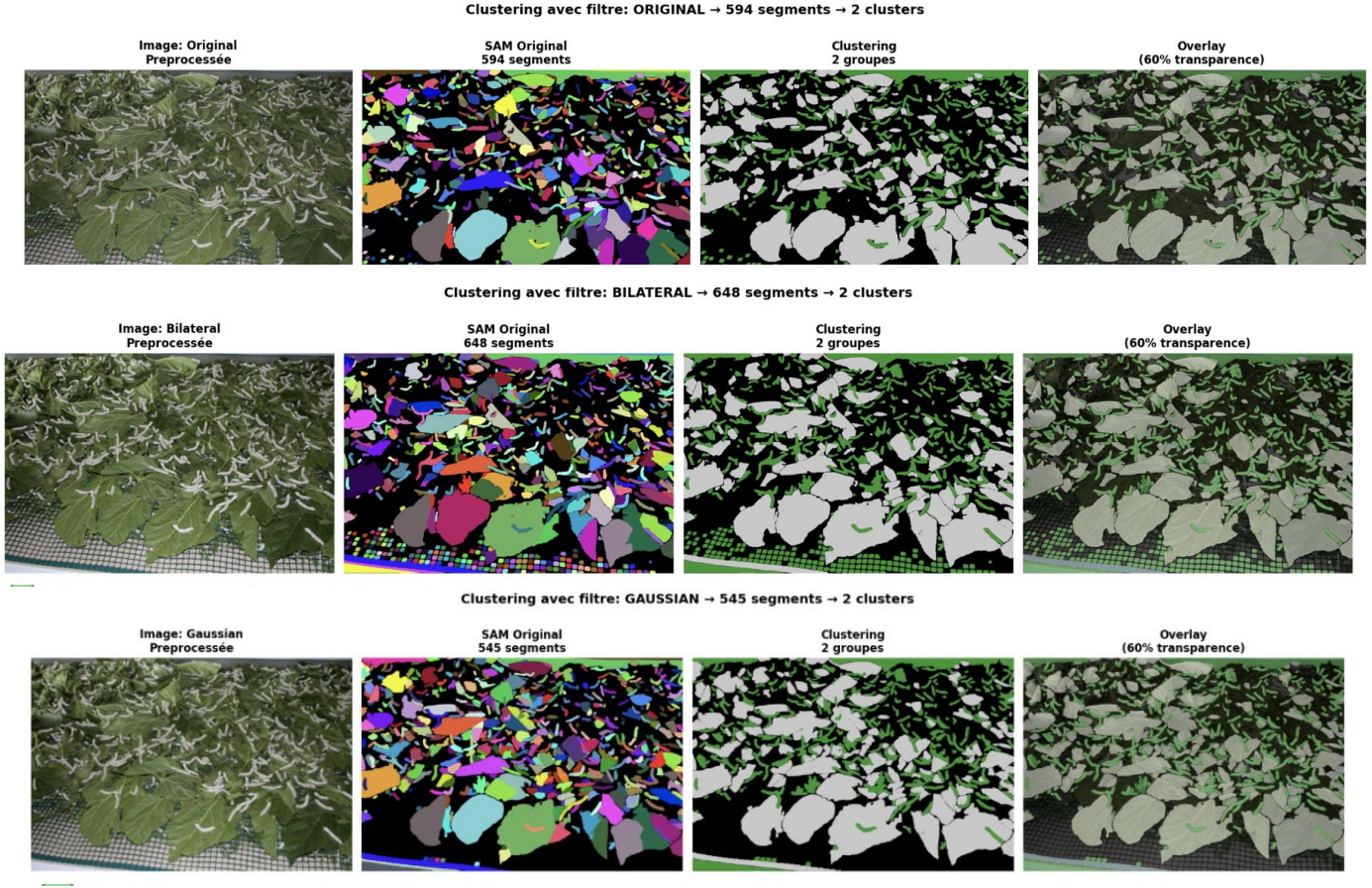
Model : SAM is a model designed to segment images.

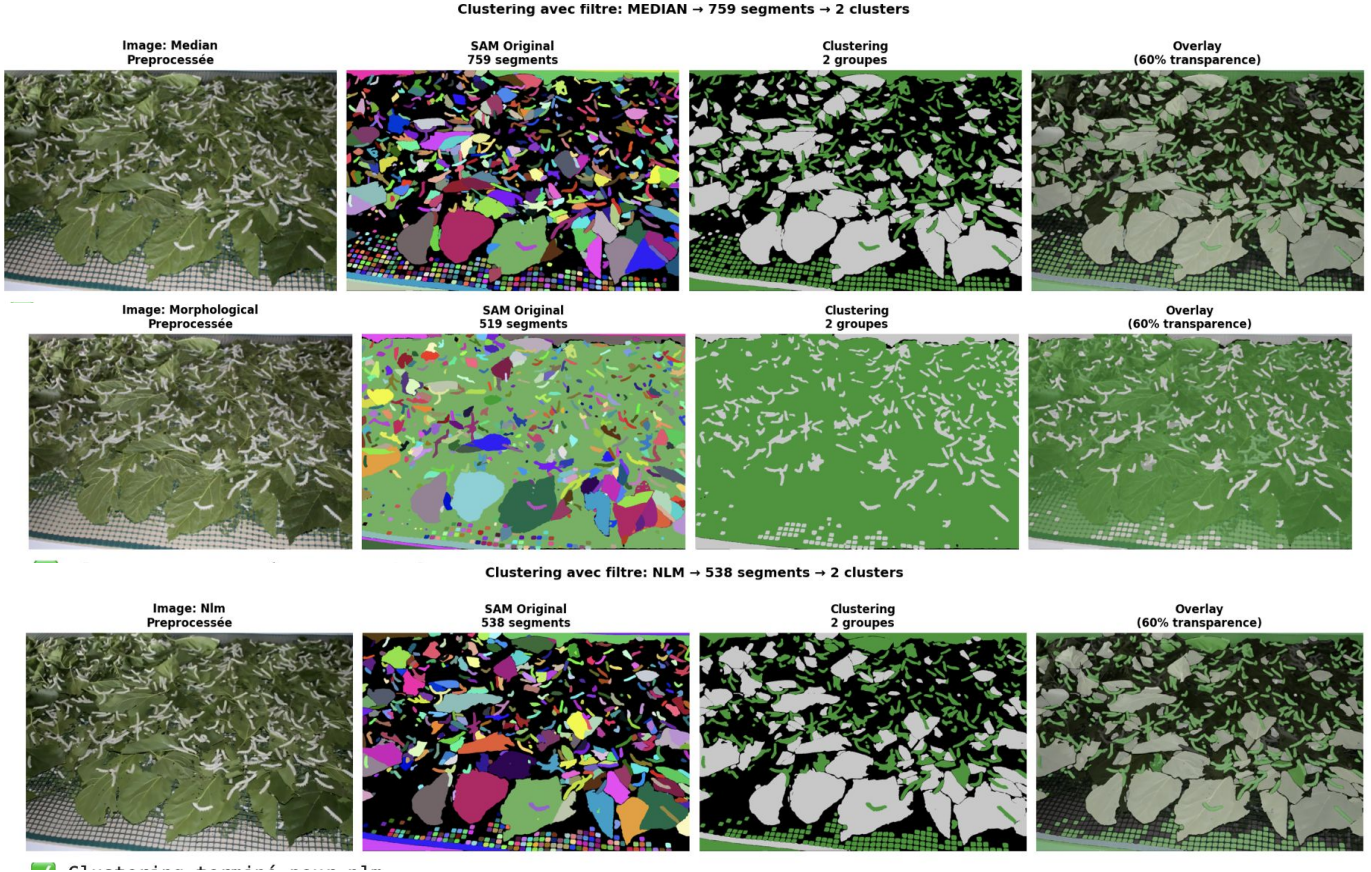
- Unlike traditional segmentation models, **SAM is *not* trained to segment an entire image all at once**. Instead, SAM is trained to **take an image and a *prompt*** (e.g., a point on an object) and to **predict the precise mask corresponding to the object indicated by that prompt** ;
- SAM was trained on a **massive dataset SA-1B (Segment Anything 1-Billion)**, which contains : over 11 million images ; Over 1.1 billion segmentation masks ;
- In this training setup, **the prompts were automatically generated** by a dedicated pipeline (grid sampling of points).

Clustering :

- Color-based (colors of the original image)
- Data standardization is performed before clustering.

Results


Clustering avec filtre: ORIGINAL → 594 segments → 2 clusters
Image: Original Preprocessée
SAM Original 594 segments
Clustering 2 groupes
Overlay (60% transparence)
Clustering avec filtre: BILATERAL → 648 segments → 2 clusters
Image: Bilateral Preprocessée
SAM Original 648 segments
Clustering 2 groupes
Overlay (60% transparence)
Clustering avec filtre: GAUSSIAN → 545 segments → 2 clusters
Image: Gaussian Preprocessée
SAM Original 545 segments
Clustering 2 groupes
Overlay (60% transparence)


Clustering avec filtre: MEDIAN → 759 segments → 2 clusters
Image: Median
Preprocessée
SAM Original
759 segments
Clustering
2 groupes
Overlay
(60% transparence)
Image: Morphological
Preprocessée
SAM Original
519 segments
Clustering
2 groupes
Overlay
(60% transparence)
Clustering avec filtre: NLM → 538 segments → 2 clusters
Image: Nlm
Preprocessée
SAM Original
538 segments
Clustering
2 groupes
Overlay
(60% transparence)

Work perspectives :

- Gradually unfreeze layers of the backbone
- Try other architectures ; ensemble model
- Try other hyperparameters : SAM parameters ; filter parameters
- Feed the classification model with the segmented dataset