

SHEEP IDENTIFICATION

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Pipeline:

Objective: Build a robust sheep-ID system that:

- Correctly recognizes “known” sheep and Flags “unknown” sheep at test time

End-to-End Pipeline (two branches for face & muzzle):

a. **Dataset Preparation:**

- 14 classes → split into 12 “known” vs. 2 “unknown”
- 85 % of known for training; 15 % for closed-set test; unknown into open-set test

b. **Region Detection (YOLOv8):**

- Face detector → crops facial region → face_data/
- Muzzle detector → crops muzzle region → muzzle_data/

c. **Embedding Generation (ResNet-50 + Triplet Loss)**

- face_model: learns 128-D embeddings on facial crops
- muzzle_model: learns 128-D embeddings on muzzle crops

d. **Classification (SVMs on Embeddings):**

- Face-SVM: classifies based on face embeddings
- Muzzle-SVM: classifies based on muzzle embeddings

e. **Decision & Thresholding:**

- For each test image: pick higher-confidence ID from the two SVMs
- If that confidence $\geq \tau$ → assign ID; else → “unknown”

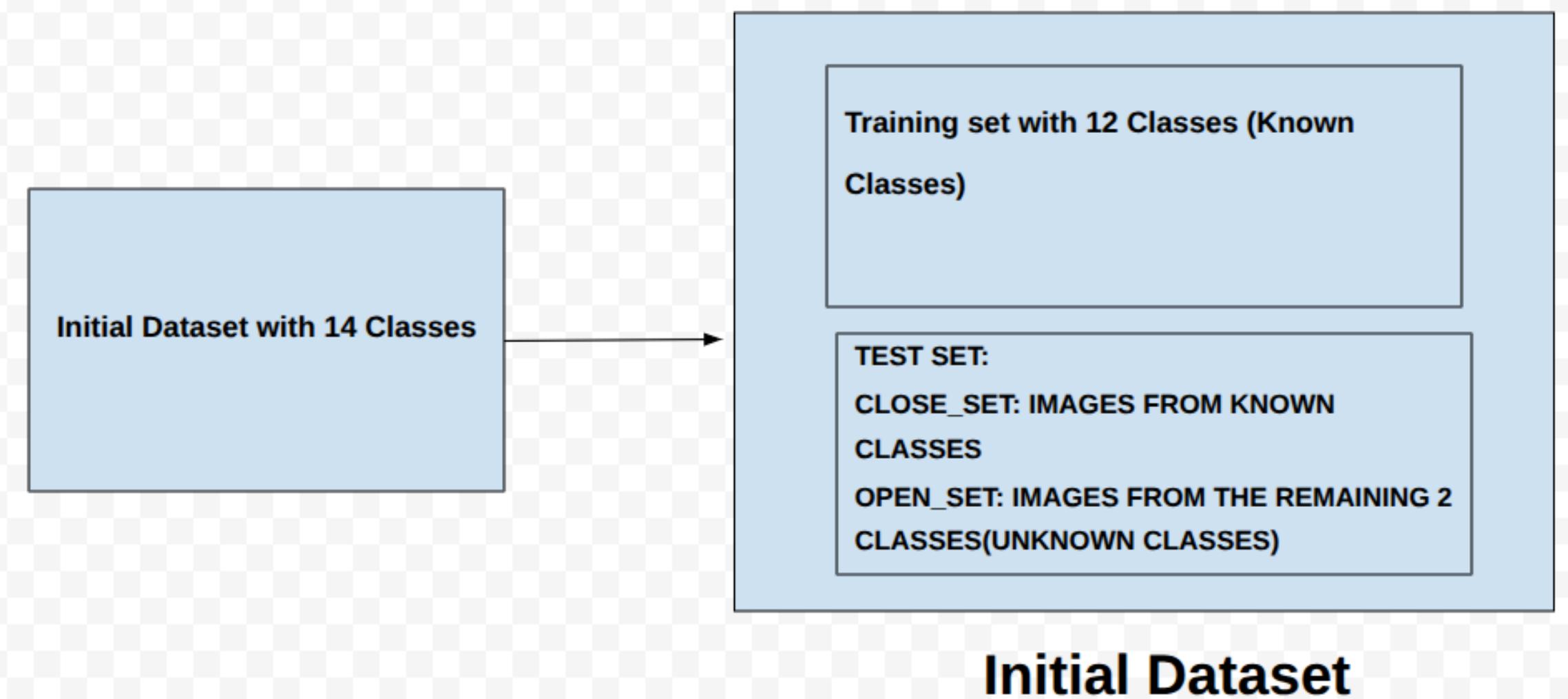
Dataset: Classes & Splits:

14 total sheep classes

- Known (12): 85 % → train; 15 % → closed-set test
- Unknown (2): 100 % → open-set test

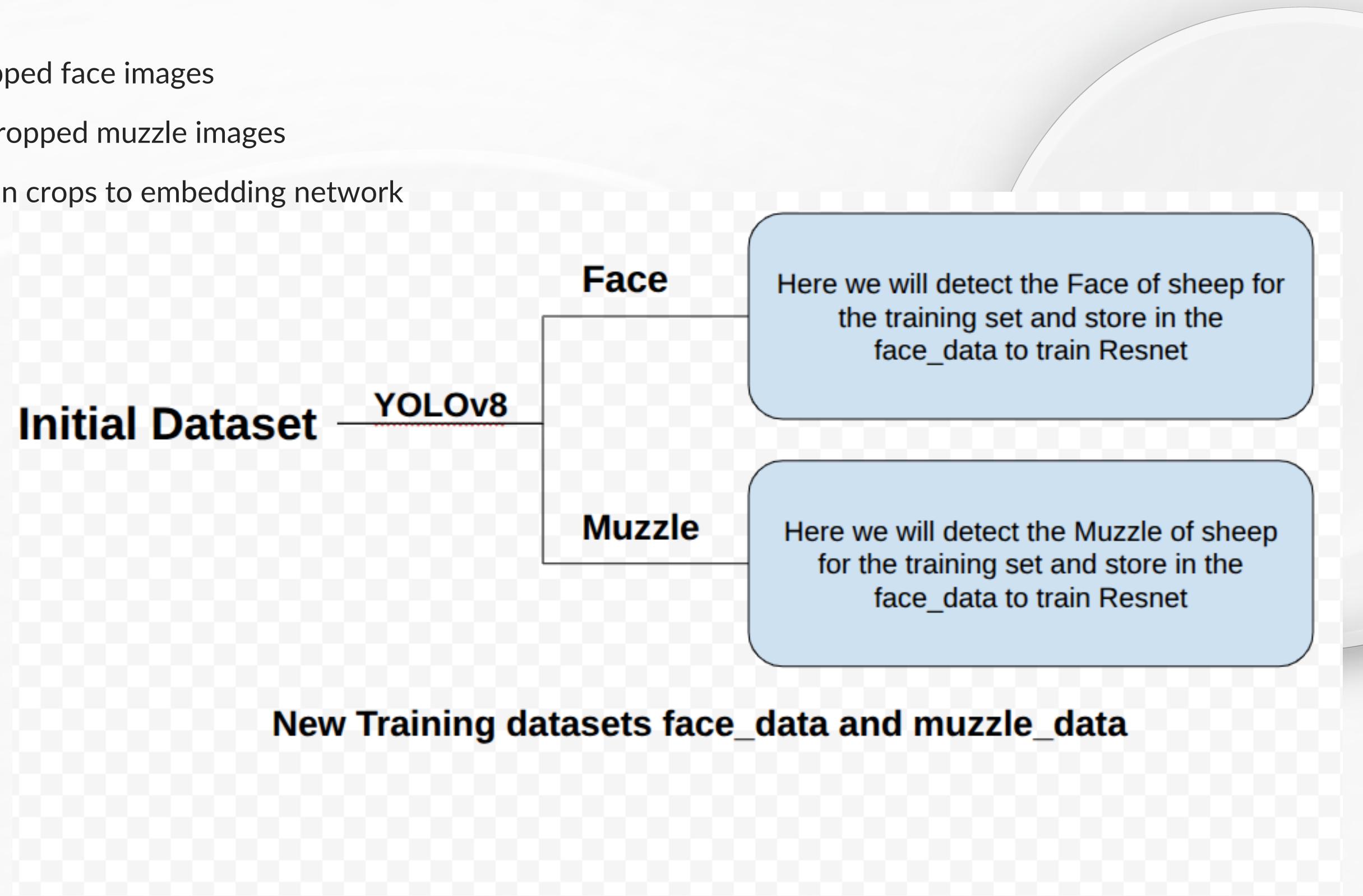
Why split this way?

- Simulate real-world: new (unknown) sheep appear at test time.



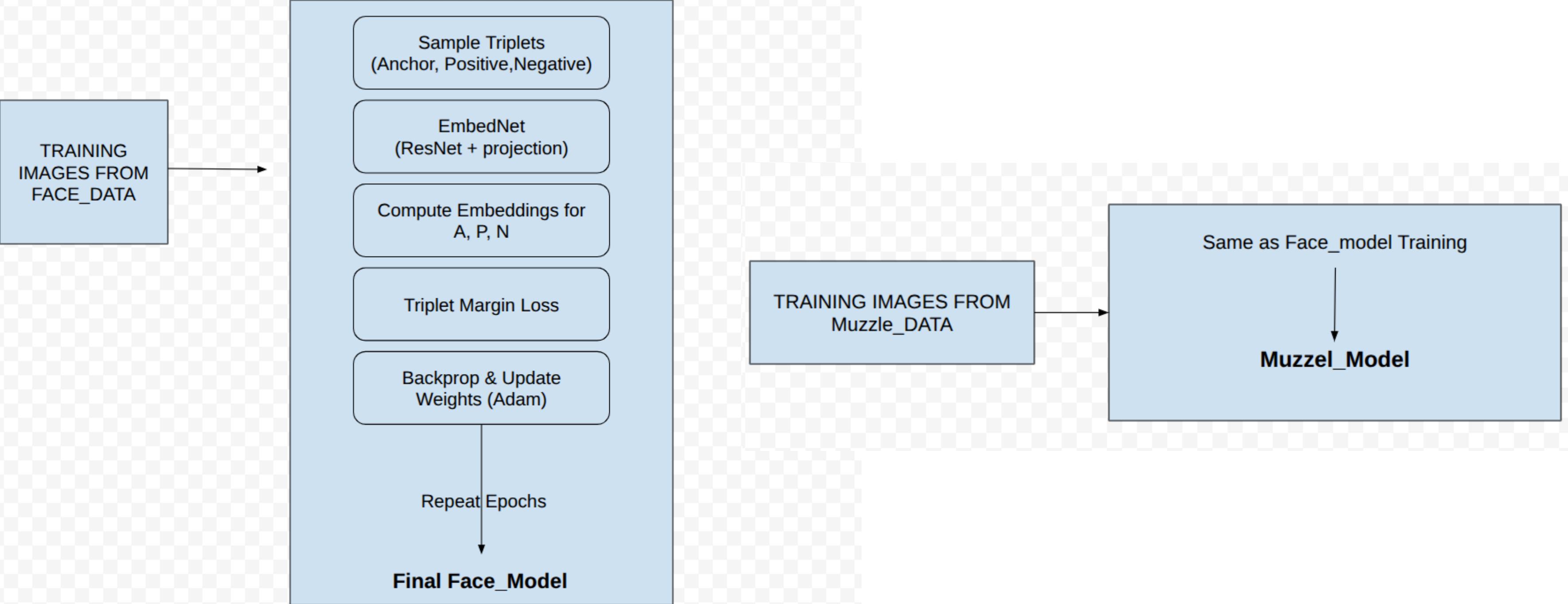
YOLOv8 Region Detection & Data Prep:

- Detection models: YOLOv8 for face & muzzle
- Outputs:
 - face_data/: cropped face images
 - muzzle_data/: cropped muzzle images
- Purpose: Feed region crops to embedding network



Embedding Generation: ResNet-50 + Triplet Loss:

- **Overall Goal:** Learn compact 128-D feature vectors that cluster same-sheep crops and separate different-sheep crops, enabling simple downstream classification.
- **Dual-Model Strategy**
 - Face Model (face_model): Captures eye-region textures, wool patterns around eyes.
 - Muzzle Model (muzzle_model): Focuses on shape and texture of the nose/muzzle area.
 - Why two? Faces and muzzles exhibit distinct discriminative cues; separate embedding spaces maximize per-region accuracy.
- **Triplet-Loss Objective**
 - a. Anchor (A): sample crop
 - b. Positive (P): another crop of the same sheep
 - c. Negative (N): crop of a different sheep
 - d. Loss:
$$L = \max(d(f(A), f(P)) - d(f(A), f(N)) + \alpha, 0)$$
pushes A → P closer by at least margin α below A → N.
- **Data Flow:**
 - a. Input: 256×256 RGB crop (face or muzzle)
 - b. Network: ResNet-50 backbone + final FC → 128-D
 - c. Output: ℓ_2 -normalized 128-D embedding



Resnet Training Loop

SVM Classification on Embeddings:

Purpose: Here we will train 2 SVM Classifiers , one is face_SVM, and other is muzzle_SVM, the purpose of these 2 SVMs is to predict the sheep IDs using the face_crop and muzzle crop

Dual-SVM Strategy:

- Face-SVM
 - Operates on 128-D face embeddings
 - Learns decision boundary between 12 known sheep IDs
- Muzzle-SVM
 - Operates on 128-D muzzle embeddings
 - Independently classifies same 12 IDs
- Why two SVMs?
 - Complementary signals: face vs. muzzle features differ under pose/occlusion
 - Robustness: if one branch fails, the other may still succeed

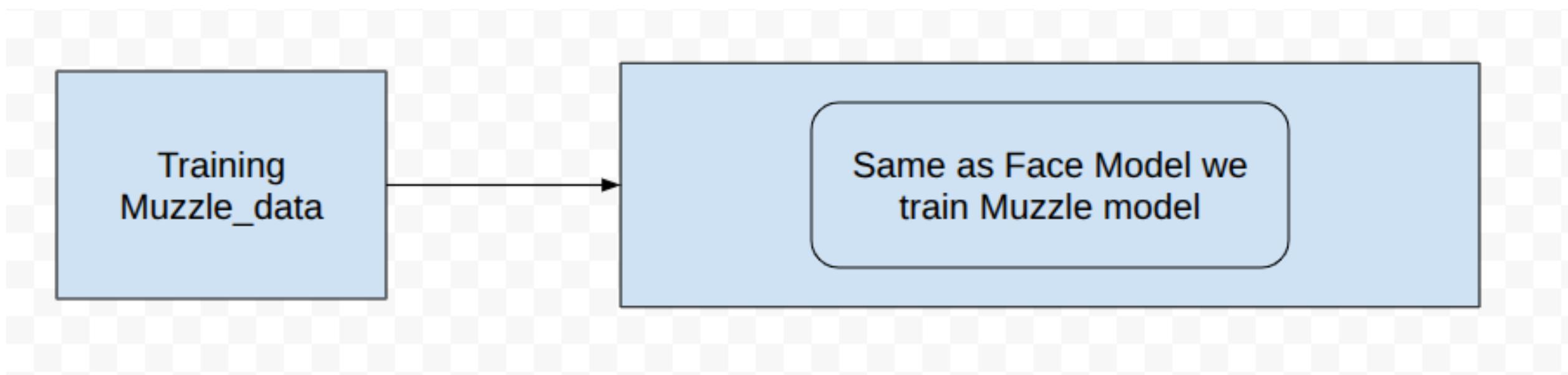
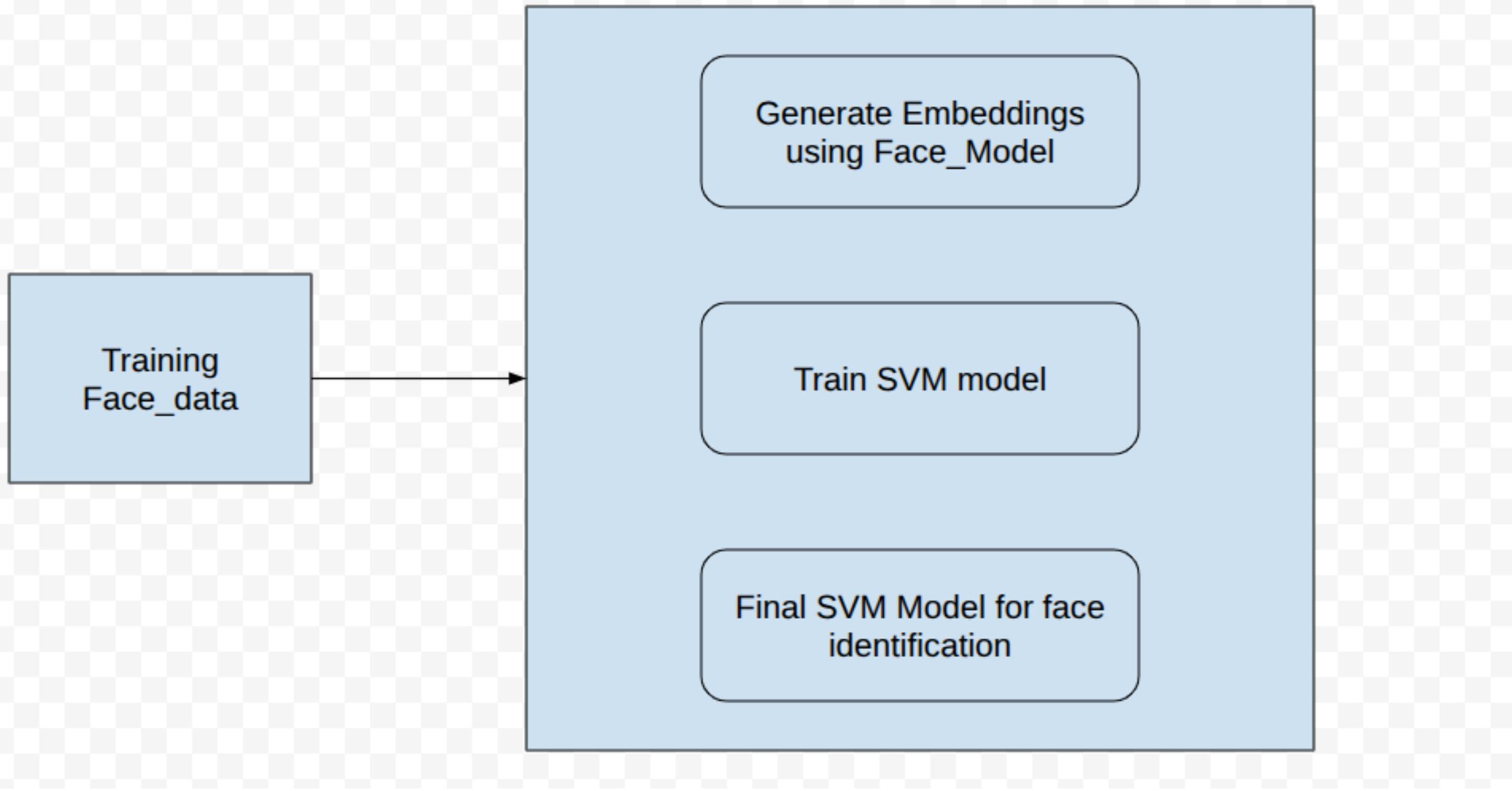
Training of SVMs:

- Kernel: linear for both face_SVM and muzzle_SVM
- Training Data: Face_EMBEDDINGS for Face_SVM, Muzzle EMBEDDINGS for Muzzle_SVM.

Outputs:

- a. Compute face embedding → Face-SVM → (ID_1 , score₁)
- b. Compute muzzle embedding → Muzzle-SVM → (ID_2 , score₂)

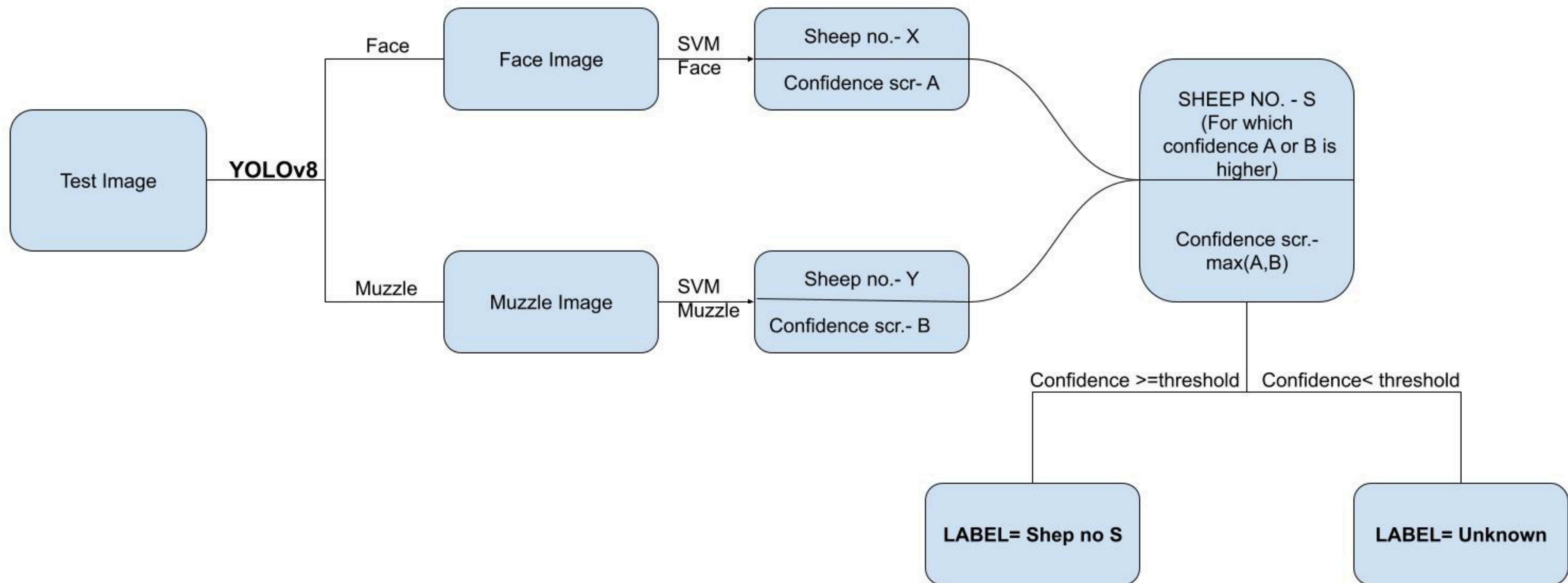
Training SVM classifiers for Face and muzzle



Testing & Thresholding Strategy

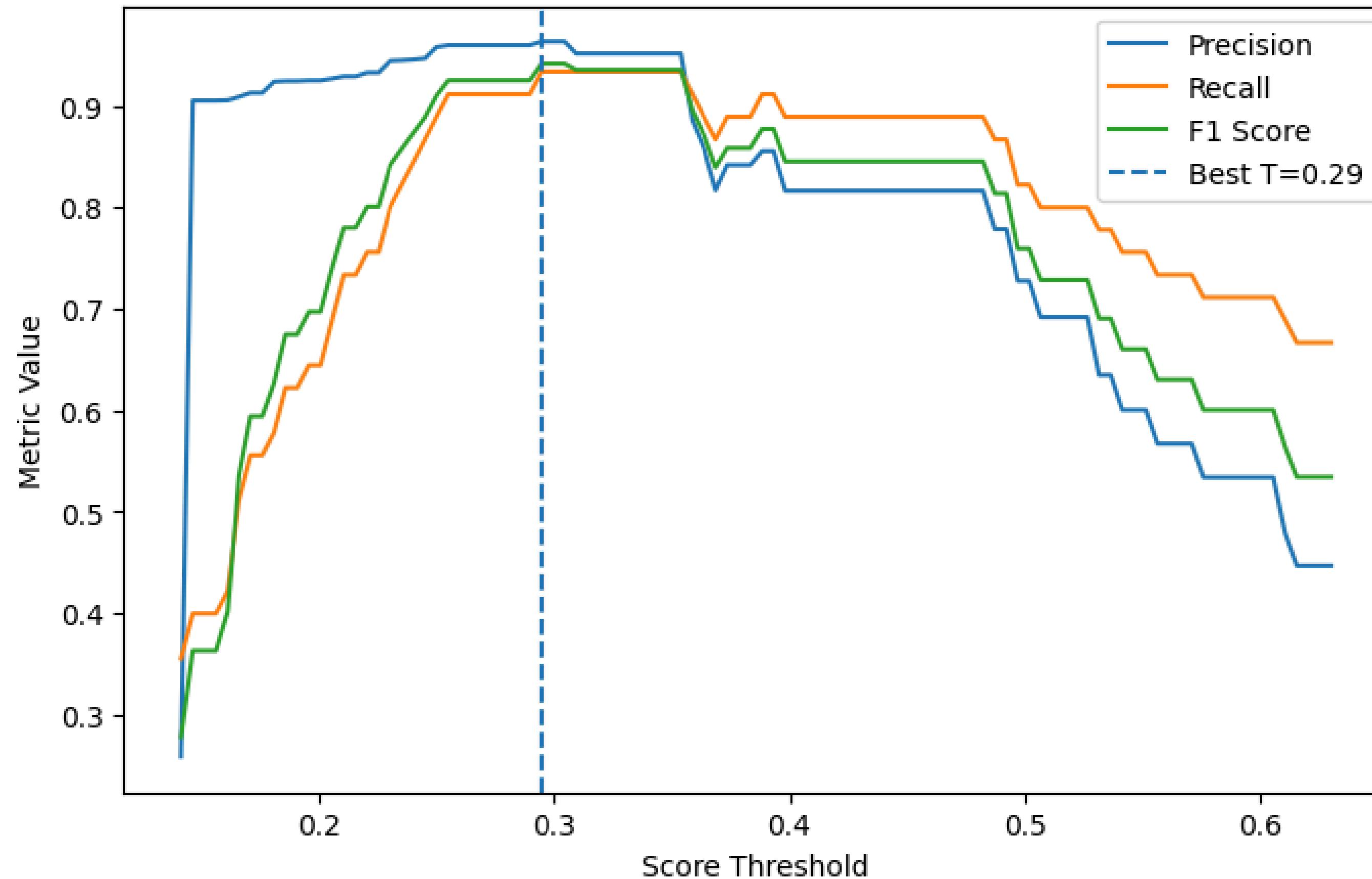
- Per test image:
 - a. Detect & crop face, muzzle
 - b. Generate 2 embeddings - Face Embeddings , Muzzle Embeddings
 - c. $\text{face_SVM} \rightarrow (\text{ID}_1, \text{conf}_1)$, $\text{Muzzle_SVM} \rightarrow (\text{ID}_2, \text{conf}_2)$
 - d. Pick ID_a with $\max(\text{conf}_1, \text{conf}_2)$
 - e. If $\text{conf}_a \geq \tau \rightarrow \text{assign that ID}; \text{ else} \rightarrow \text{"unknown"}$
- Threshold τ tuning:
 - Sweep $\tau \in [0.1, 1.0]$ on val set
 - Optimize F_1 score for mixed open/closed task

Evaluation



Threshold Tuning:

Precision, Recall, F1 vs. Threshold



Results & Metrics:

--- Overall ---

Accuracy: 0.9333

Precision: 0.9630

Recall: 0.9333

F1: 0.9411

ROC AUC: 0.9656

--- Close-set ---

Accuracy: 1.0000

Precision: 1.0000

Recall: 1.0000

F1: 1.0000

--- Open-set ---

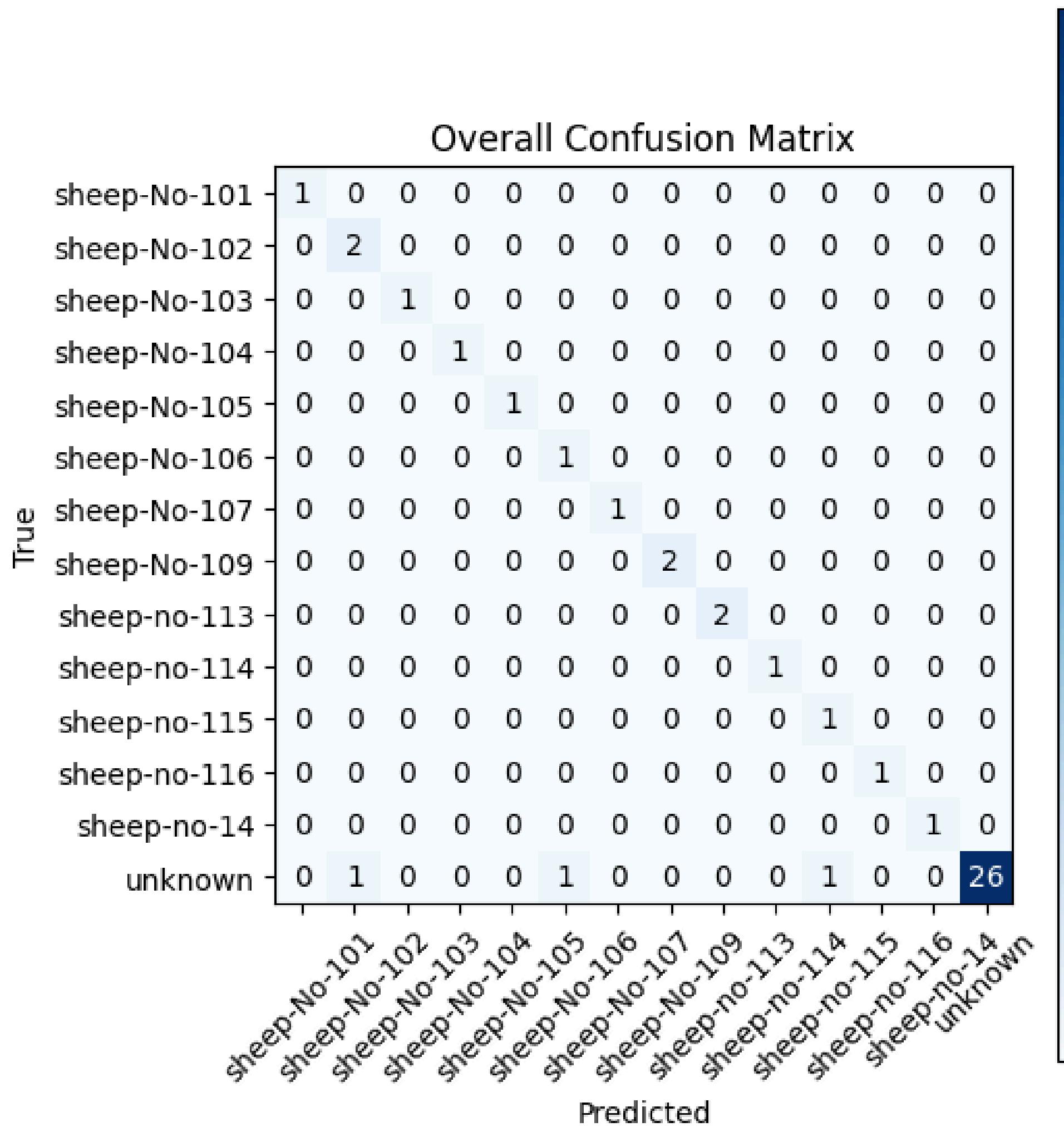
Accuracy: 0.8966

Precision: 1.0000

Recall: 0.8966

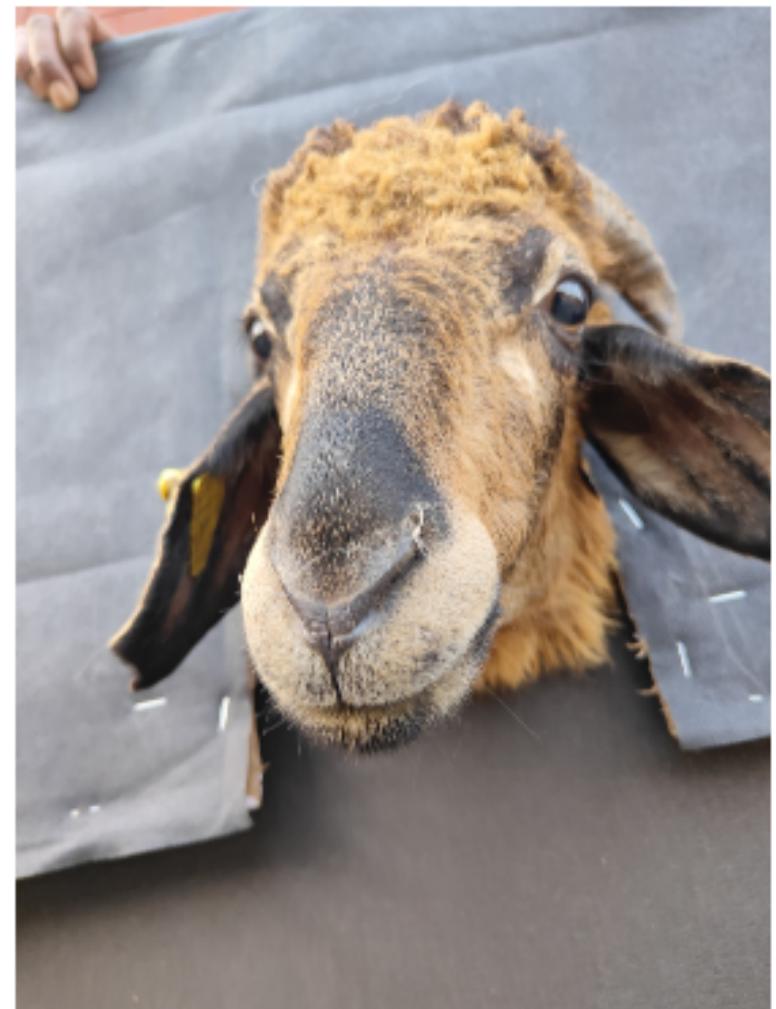
F1: 0.9455

THE LIST OF MISSCLASSIFIED IMAGES
ARE IN MISSCLAAIFIED IMAGES ARE IN
MISSCLASSIFIED.CSV AND ONLY 3
SHEEPS WERE MISSCLASSIFIED



MISSCLASSIFIED IMAGES:

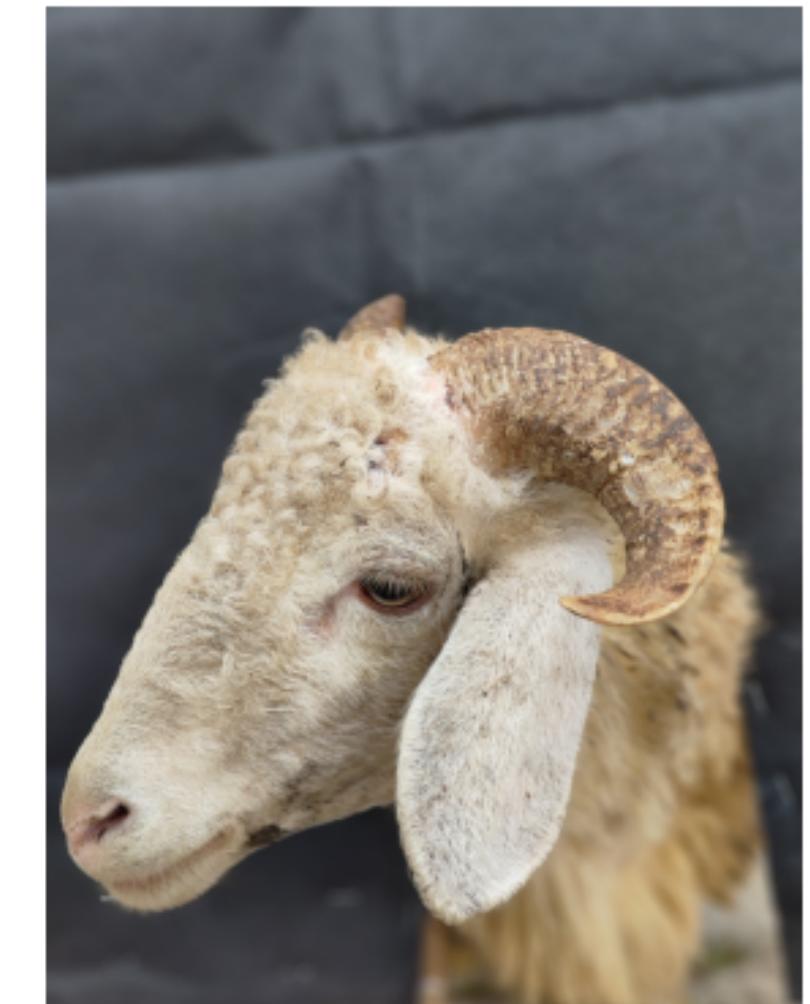
True: unknown | Pred: sheep-No-106
Score: 0.39



True: unknown | Pred: sheep-No-102
Score: 0.37



True: unknown | Pred: sheep-no-115
Score: 0.31





Thank You