

Project Title: Hybrid Deep Learning Pipelines for Gender Classification & Face Verification

Problem Statement

Develop two systems:

- **Task A:** Classify Genders by training through the given images
 - **Task B:** Verify whether two face images belong to the same person, even under distortion.
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Task A – Gender Classification

Approach: Binary classification using deep feature fusion + traditional ML.

Pipeline:

- **Preprocessing:** Resize (224×224), normalize, label from folders.
 - **Feature Extraction:**
 - **ResNet-50** (2048D), **EfficientNet-B3** (1536D), **DeepFace (VGG-Face)** (2622D).
 - **Feature Fusion:** Concatenated features → normalized via StandardScaler.
 - **Classification Models:**
 - Logistic Regression (scikit-learn) ○ Support Vector Machine (SVM with linear kernel)
 - **Evaluation:** Accuracy, Precision, Recall, F1-score (weighted).
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Task B – Face Verification

Approach: Face verification using a Siamese neural network + hard negative mining.

Pipeline:

- **Face Detection:** DeepFace.extract_faces() (OpenCV backend), normalized & cached.
- **Embeddings:** DeepFace.represent() using **ArcFace** (512D).
- **Pair Generation:**
 - Positive: same identity;
 - Hard Negative: cosine similarity with other identities.
- **Model:**
 - Siamese Net: [Embedding A + B] → FC(1024→256→1) → Sigmoid.
- **Training:** Binary Cross Entropy loss, Adam optimizer.
- **Prediction:** Match if score > threshold; else predict “unknown”.

- **Evaluation:** Accuracy, Precision, Recall, F1-score.

Key Innovations

- **Hybrid Feature Fusion:** Combines CNNs + DeepFace for rich representations.
- **Hard Negative Mining:** Ensures challenging training pairs.
- **Open-Set Support:** Threshold-based unknown face detection.
- **Efficient Caching:** For embeddings, faces, and labels.
- **Concatenating Model Outputs:** For gender classification, led to reduction in overfitting and better performance.

Tools & Technologies

- Python, PyTorch, DeepFace, scikit-learn, OpenCV
- Pretrained models: ResNet50, EfficientNet-B3, ArcFace, VGG-Face