

# Technical Summary

## Gender Classification Using MobileNetV2

### Overview

This project presents an efficient deep learning-based solution for **binary gender classification** using facial images. Implemented as part of Task A from the **COMSYS Hackathon-5**, the solution leverages **transfer learning** with **MobileNetV2**, an architecture optimized for resource-constrained environments and real-time inference. The goal is to accurately classify images as *male* or *female*, even in the presence of class imbalance.

### Methodology

#### Model Architecture

- **Base Model:** MobileNetV2 (pre-trained on ImageNet)
- **Added Layers:** Global Average Pooling, Dense layer (128 units, ReLU), Dropout (rate 0.5), and Output layer with Sigmoid activation

#### Transfer Learning

- Initially, the MobileNetV2 base is **frozen** to retain pre-trained features.
- Selective **fine-tuning** is optionally performed on upper layers after convergence.

#### Dataset and Preprocessing

- **Structure:** Separate folders for **train/** and **val/**, subdivided by gender.
- **Imbalance Handling:** Applied class **oversampling** and computed class weights.
- **Augmentations:** Rescaling, flipping, zooming, and shifting via **ImageDataGenerator**.

#### Training and Optimization

- **Loss:** Binary Cross-Entropy    **Optimizer:** Adam
- **Callbacks:** EarlyStopping, ReduceLROnPlateau, ModelCheckpoint
- **Evaluation:** Accuracy, Precision, Recall, F1-score, Confusion Matrix, ROC AUC

## Evaluation and Results

The final model achieved:

- **Accuracy:** 92.89%
- **Macro F1-Score:** 90.17%
- Balanced performance across both classes using data balancing techniques

## Key Innovations

- **Ensemble-Ready:** Easily integrates ResNet50, EfficientNetB0, and others
- **Error Analysis:** Misclassified images saved for post-hoc review
- **Threshold Tuning:** Custom decision thresholds to optimize FAR and FRR

## Future Work

- Incorporate ensemble-based decision strategies
- Experiment with Vision Transformers or attention modules
- Extend to multi-class classification (e.g., age + gender)