Convolutional Neural Network Project: **Multi-Task Leaf Classification and Disease Detection**

1. **Introduction**

Timely diagnosis of foliar disease in plantation and horticultural crops is vital for yield and quality. This study explores a multi-task convolutional-neural-network (CNN) that given a single RGB photograph of a leaf simultaneously:

* Identifies the plant species (10 classes)
* Determines the health stats (Healthy vs Diseased)

1. **Dataset**

A Database of Leaf Images from Kaggle, each JPEG is stored in a directory hierarchy Species / Condition; conditions are healthy or diseased.

Species covered (10): Mango (P0), Arjun (P1), Alstonia Scholaris (P2), Guava (P3), Chinar (P11), Jamun (P5), Jatropha (P6), Pongamia Pinnata (P7), Pomegranate (P9), Lemon (P10)

a bar-plot inspection shows moderate imbalance across species and between health labels; some species (e.g., Jamun) contribute noticeably more images than other

The full corpus was shuffled and split 80 % train / 10 % validation / 10 % test using stratified random sampling to preserve both species and health proportions.

1. **Methodology**

3.1 Pre-processing

* Central resize to 128 × 128 px and float-32 rescaling to [0, 1].
* On-the-fly data augmentation: random flips, 90° rotations, brightness / contrast / saturation jitter.
* Labels encoded as one-hot vectors for species (10-way) and scalar {0, 1} for health.

3.2 Network Architecture

* Backbone: MobileNetV2
* Followed by global average pooling
* Species Classification: GAP-> Dropout -> Dense layer (128, ReLU) -> Dense output (10, Softmax)
* Health-Detection: GAP -> Dropout -> Dense layer (64, ReLU) -> Dense output (1, Sigmoid)

1. **Results**

* Convergence:
  + By epoch 30, training accuracies reached 97.3 % (species) and 92.9 % (health), with validation ≈ 96 % and ≈ 95 % respectively
* Performance:
  + Species accuracy: 92.9 %
  + Health accuracy: 92.2 %
  + F1: 0.932 (species), 0.922 (health)
* Class-Level Notes:
  + Lowest species precision: Alstonia Scholaris (0.79)
  + Lowest species recall: Lemon (0.83)
* Error Patterns:
  + Occasional confusion between morphologically similar species (e.g., Alstonia and Jamun)
  + ≈ 3 % healthy-to-diseased false positives