1. **🔧 Imports and Model Loading**
2. **Importing required libraries**

* We use **TensorFlow/Keras** to load .h5 deep learning models.
* pickle is used to load associated **class label mappings** from .pkl files for human-readable output.

1. **loading the pre trained models**

* We load **three trained models**, each likely trained on a different dataset or category.
* python
* Each model has a corresponding .pkl file that maps numeric predictions to class names.

1. **🧼 Image Preprocessing**

Resizing and Normalizing

Standard preprocessing: resizing (64, 64), converting to array, and **normalizing pixel values** to [0, 1].

1. **. 🧠 Prediction Pipeline**

def predict\_sign(image\_file):

* This function accepts an image file (e.g., from a web form), saves it temporarily, and processes it.

**Step-by-step:**

1. **Save and preprocess the image**
   * Temporary file creation allows Keras to work seamlessly.
2. **Model Inference**
   * Each model predicts probabilities over its classes.
3. **Prediction Padding**
   * Different models might have different output dimensions (number of classes).
   * We **pad the outputs** with zeros to match the largest one so we can combine them.
4. **Ensembling**
   * We use **probability averaging** to ensemble predictions — a simple but effective technique to increase robustness.
5. **Final Decision Logic**
   * Even after averaging, we still loop through individual models to find the one with **highest confidence** for the selected class.
   * This ensures we return the **most confident and meaningful label**.
6. **Clean-up**
   * Temporary image is deleted after processing to avoid clutter.

**Advantages of taking this approach:**

* **Modularity**: Separate functions for preprocessing and prediction.
* **Scalability**: Easily expandable to include more models.
* **Robustness**: Handles varying output sizes with padding.
* **Interpretability**: Combines confidence with human-readable labels.
* **Efficiency**: Uses ensemble averaging and deletes temp files to manage resources.