Leegality Assignment

-Siddharth Joshi

Problem Statement

The objective of this assignment is to develop a machine learning model that can automatically verify the authenticity of handwritten signatures(dataset). Given a dataset of signature images, the model should be trained to distinguish between genuine and forged signatures and return the match percentage between two input signatures.

Dataset

The dataset used in this project consists of three folders: BHSig260-Bengali, BHSig260-Hindi, and CEDAR.

BHSig260-Bengali contains 100 folders, BHSig260-Hindi contains 160 folders, each having a different signature. Each folder of these datasets has several TIFF images of genuine and forged signatures. CEDAR contains 55 folders, with pictures in png format.

In total, the dataset comprises 11,280 images of handwritten signatures, including both genuine and forged samples.

Data Preparation and Pre-processing

The following steps were taken for data preparation and pre-processing:

1. **Load Images from Folders**: The ‘load_images_from_folder’ function loads all the images from the provided dataset folders (whether tif or png). It also labels each picture as forgery or genuine..

2. **Image Pre-processing**: The ‘preprocess_images’ function performs several image pre-processing steps:
   - Convert the input image to grayscale
   - Apply Gaussian blurring and dilation to enhance the signature
   - Perform Otsu thresholding for binarization
   - Find contours in the binarized image
   - Extract the signature area using a bounding rectangle
   - Resize the signature area and filtered image to a fixed size (256 x 128)

3. **Data Splitting**: The dataset is split into training and validation sets using `train_test_split` from scikit-learn, with a 20% validation split.

4. **Label Encoding**: Labels ('genuine' or 'forgery') are encoded into a categorical format..

5. **Data Normalization**: Pre-processed images are normalized by dividing the pixel values by 255.0 to bring them into the range of 0 to 1.

Model Architecture

The CNN model architecture is based on Inception V1 architecture. The architecture consists of an **Input layer** (128 x 256 grayscale image), followed by the **inception module** (parallel convolutional layers with different kernel sizes (1x1, 3x3, and 5x5) and a max-pooling layer, with the final output of these layers concatenated along the channel dimension) to capture features at multiple scales. This is followed by a **convolutional layer**, an **average pooling layer,** a **flatten layer**, and **multiple dense layers**. A dense layer with two units and softmax activation, representing the two classes (genuine or forgery) is used as the final **output layer.**

The model is compiled with categorical cross-entropy loss and the Adam optimizer. The accuracy metric is also included for evaluation during training.

Model Training and Evaluation

The model is trained just for 5 epochs with a batch size of 32, using the training and validation data splits, due to time and computation limitations. After training, the model is evaluated on the validation set.

Results

The final model achieved the following results on the validation set:

- **Validation Loss**: 0.6141
- **Validation Accuracy**: 0.7465
- **Precision**: 0.8240
- **Recall**: 0.6754
- **F1-Score**: 0.7423

The confusion matrix shows that the model correctly classified **860 genuine signatures** and **824 forged signatures**, while misclassifying **396 genuine signatures as forged** and **176 forged signatures as genuine**.

The model can be improved by several ways, that may include: training for more epochs, using more data (Bengali signatures), using data augmentation techniques such as adding noise, rotation, etc., hyperparameter tuning, or trying other architectures as baseline models such as Siamese Neural Networks,etc. which are good in similarity detection.

Reference used for the model architecture:

R. K. Mohapatra, K. Shaswat and S. Kedia, "Offline Handwritten Signature Verification using CNN inspired by Inception V1 Architecture," 2019 Fifth International Conference on Image Information Processing (ICIIP), Shimla, India, 2019, pp. 263-267, doi: 10.1109/ICIIP47207.2019.8985925. keywords: {Handwritten Signature;Biometrics;Convolutional Neural Network;Inception V1},