Performance Evaluation for Diabetic Retinopathy

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Introduction:

Diabetic Retinopathy has 2 different stages which are non-proliferative and proliferative. Non - proliferative is an early stage which is hard to detect and Proliferative is an advanced stage which may lead to vision loss. Detecting DR in a non-proliferative stage may help many people to recover their vision loss. Recent studies show that Neural networks are a good approach for DR detection, but it is hard to find a good approach. Here we evaluated the performance of DR detection using different Neural Networks which may help the researcher to focus on specific algorithms.

Diabetic retinopathy is a diabetic condition that affects eye. It is caused by damage to the blood vessels of the light sensitive tissue at the back of the retina. This condition can be developed in both type 1 and type 2 diabetes. Its symptoms include vision loss, blurred vision, frequent changes in clarity of vision, fluctuating vision, dark or empty areas in your vision and dark spots floating in the image.

Data preprocessing:

We have taken training dataset and the dataset includes a list of images. We have used some preprocessing steps to process the data to use it for training purpose. Similarly, we have taken images in testing dataset and used some preprocessing steps to get the images for testing our model.

Problems faced:

1. We did not use fundus images here as mentioned in the project proposal. Organization denied for providing the fundus dataset due to privacy issues. So, we worked only on normal images here. We used below 2 models here:

* Resnet 50
* Inception V3

1. When we scale the images the accuracy is getting low. So we did not scale the images.

Model Architecture:

1. ResNet50:
   1. The ResNet50 model is a pre-trained model with weights initialized from the ImageNet dataset. It takes input images of size 224x224 with 3 channels (RGB) and produces a feature vector of length 2048 for each image.
   2. The Flatten layer is used to convert the 2D feature maps from the previous layer into a 1D vector.
   3. Dense layer is fully connected layer consists of 512 units and applies the rectified linear unit (ReLU) activation function. It helps in learning non-linear relationships between the features.
   4. The final dense layer has a single unit with a sigmoid activation function. It produces a probability value between 0 and 1, representing the likelihood of the input image belonging to the positive class.
   5. The model is compiled with loss function as “Binary cross entropy”, optimizer as “Adam” and Metrics is “accuracy”
2. InceptionV3:
   1. The InceptionV3 model is a pre-trained model with weights initialized from the ImageNet dataset. It takes input images of size 224x224 with 3 channels (RGB) and produces feature maps with a size of 5x5 and 2048 channels.
   2. The Flatten layer is used to convert the 4D feature maps from the previous layer into a 1D vector.
   3. The fully connected dense layer consists of 1024 units and applies the rectified linear unit (ReLU) activation function. It helps in learning non-linear relationships between the features.
   4. The Dropout layer randomly sets 20% of the input units to 0 during training, which helps prevent overfitting.
   5. The final dense layer has a single unit with a sigmoid activation function. It produces a probability value between 0 and 1, representing the likelihood of the input image belonging to the positive class.
   6. The model is compiled with loss function as “Binary cross entropy”, optimizer as “Adam” and Metrics is “accuracy”

Training steps:

We have used a generator model here and for this we have created a generator function “img\_generator” which takes train and test data as input.

1. Data preparation:
   * The dataset is split into training and validation sets using a validation split of 0.2. This ensures that 20% of the data is used for validation during training.
   * The training data is augmented using an **ImageDataGenerator**. This generator applies various transformations such as rotation, zooming, and horizontal flipping to increase the diversity of training samples.
   * The training generator yields batches of images and their corresponding labels (**DR** classes) from the dataframe. The batch size is set to 8, and the images are resized to a target size of 224x224 pixels.
2. Model Training:
   * The model is trained using the training generator for a total of 5 epochs.
   * The initial learning rate is set to 1e-4, and a warmup learning rate of 1e-3 is used for the first 2 epochs. This gradual increase in learning rate during the warmup phase helps the model stabilize at the beginning of training.
   * The model is optimized using the Adam optimizer.
   * The loss function used is binary cross-entropy since the model is performing binary classification (DR or non-DR).
   * The training progress is monitored using accuracy as the evaluation metric.
3. Model Evaluation:
   * During training, the validation generator is used to evaluate the model's performance on the validation set after each epoch.
   * The validation generator follows the same configuration as the training generator but uses a subset of the data specifically for validation.
   * The early stopping mechanism is employed with a patience of 5 epochs. If the validation loss does not improve for 5 consecutive epochs, training is stopped early to prevent overfitting.
4. Test Data:
   * For testing, a separate test generator is created using a different dataframe (**pf**) containing the test data.
   * The test generator yields individual test images without shuffling them.

Results and evaluation:

Accuracy for ResNet50 is 69.7% and for Inception V3 is 62.6%.

So ResNet50 model has better accuracy

References: -

Dataset: - <https://ieee-dataport.org/open-access/indian-diabetic-retinopathy-image-dataset-idrid>

Paper: -https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8331281/

Fundus image dataset: -https://refuge.grand-challenge.org/REFUGE2018/