Retinal Fundus Image Classification Using PyTorch

1 Introduction

A simple image classification task using retinal fundus image dataset [1] containing 7673 images belonging to 4 classes, namely normal (N), cataract (C), proliferative diabetic retinopathy (PDR) and glaucoma (G).

2 Dataset

The dataset used in this work was made available through the Kaggle community, specifically Retinal Fundus Images [1]. It consists of 11 different classes of pathologies, out of which I use 4 classes (normal, cataract, proliferative diabetic retinopathy and glaucoma) for training the convolutional neural network (CNN) model in this work. The dataset is split into the training, validation and test subsets as shown in the Table 1.

The image size varies from 512 x 512 to 1024 x 1024. To train the classification CNN model, they were resized to 224 x 224. We can see some of the examples of these fundus images in Fig. 1 and Fig. 2.

Table 1: Number of images of each class in the training, validation and test set, respectively.

Pathology	Train	Validation	Test
Normal	2641	54	179
Cataract	1369	24	112
Proliferative DR	1295	30	91
Glaucoma	1678	44	156

3 Methodology

The model used to train this image classification task was VGG11 made publicly available at [2]. The networks are trained by randomly augmenting the fundus images on-the-fly using a series of translation, rotation, flipping and gamma correction operations. The networks are trained using the SGD optimizer with a learning rate of 0.01, a momentum of 0.9 for 100 epochs and batch size of 32 on a machine equipped with NVIDIA RTX 2080 Ti GPU with 11GB of memory. The VGG11 model was trained using cross entropy loss as objective function.

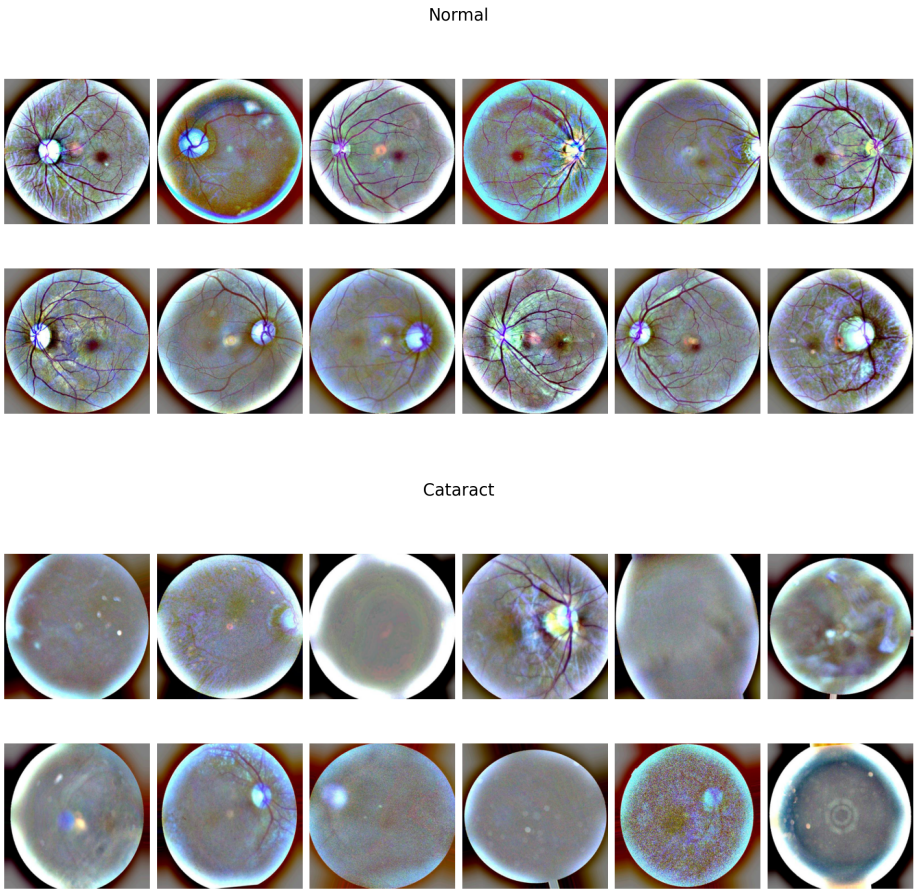

Fig. 1: Examples of Normal (top) and Cataract (bottom) retinal fundus images, respectively.

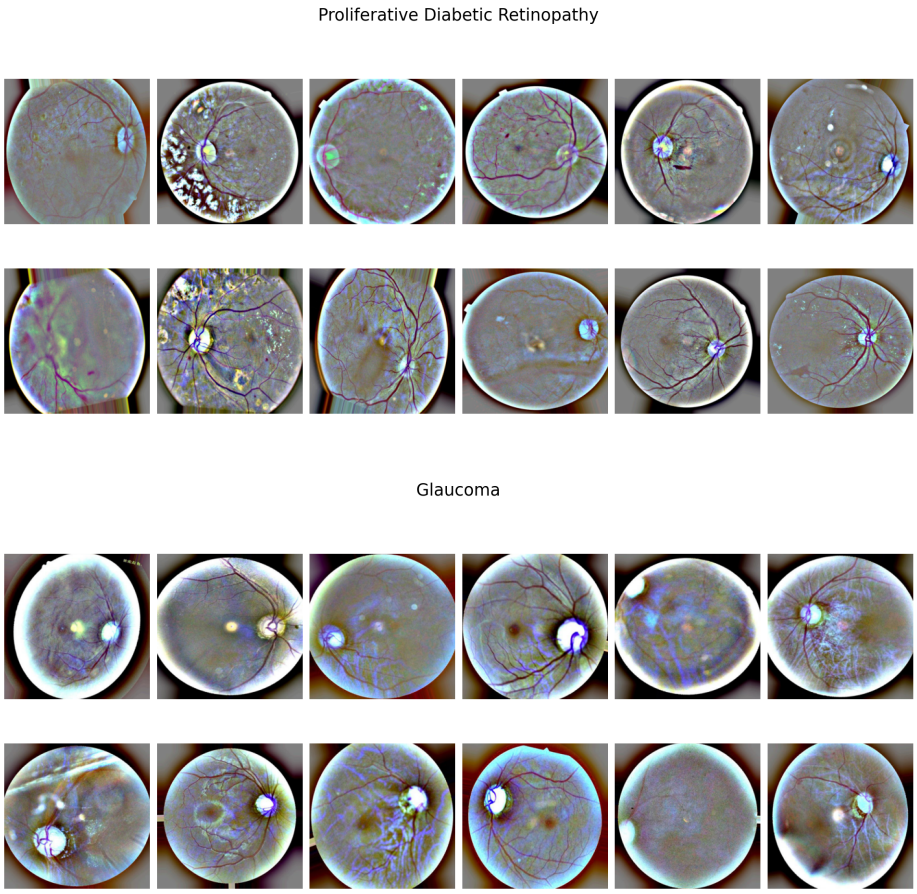

Fig. 2: Examples of Proliferative Diabetic Retinopathy (top) and Glaucoma (bottom) retinal fundus images, respectively.

3.1 Dependencies

- Python3
- Numpy, Pandas, Scikit-learn, ImageIO, OpenCV
- Pytorch, PIL

3.2 How to run

- Download and install the dataset from [1].
- Use .csv files in the csvs folder and edit the image file location in them.
- To train, edit lines 17 to 26 as required in trainModel.py and run: python trainModel.py
- To evaluate, edit lines 17 to 23 as required in testModel.py and run: python testModel.py

4 Results

- Training Time: 206 seconds per epoch
- Inference Time: 13 seconds on the test dataset
- Average Accuracy on the test dataset: 0.981
- Average F1 Score on the test dataset: 0.961

The training results are given in the 'train001.csv' file in the trainedModels folder above. The per class accuracy, sensitivity, specificity and F1 score are shown in Table 2.

Table 2: Per-class evaluation metrics on the test set.

Pathology	Accuracy	Sensitivity	Specificity	F1 Score
Normal	0.998	1.00	0.997	0.997
Cataract	0.968	0.955	0.971	0.926
Proliferative DR	0.996	1.00	0.995	0.989
Glaucoma	0.962	0.903	0.986	0.933

References

1. K S Sanjay Nithish: Retinal Fundus Images, https://www.kaggle.com/datasets/kssanjaynithish03/retinal-fundus-images
2. Sathyan, A.: Pytorch-image-classification. https://github.com/anilsathyan7/pytorch-image-classification (2019)