DLOps

Project Report

Glaucoma Detection

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Abstract

Glaucoma is a chronic neuro-degenerative condition that is one of the leading causes of irreversible but preventable blindness in the world. It is caused by a high intra-ocular pressure (IOP) that increases as a consequence of abnormal accumulation of aqueous humor in the eye, induced by pathological defects in the eye's drainage system. In this project we have implemented the glaucoma detection / classification using the techniques learned in the DLOps class.

Keywords

Glaucoma; DLOps; NVIDIA

Contents

1 Resources

Link of the Demo: https://youtu.be/h95ZpUtWKFQ

Link of the Source Code: https://github.com/ranjankumar-gh/dlops-project

Link of Wandb: https://wandb.ai/somexgupta/dlops-project

2 Introduction

We have trained a segmentation model using UNet architecture that can segment optic disc and optic cup given fundus image. The *vertical cup to disc ratio* determines if the given image is having glaucoma or not.

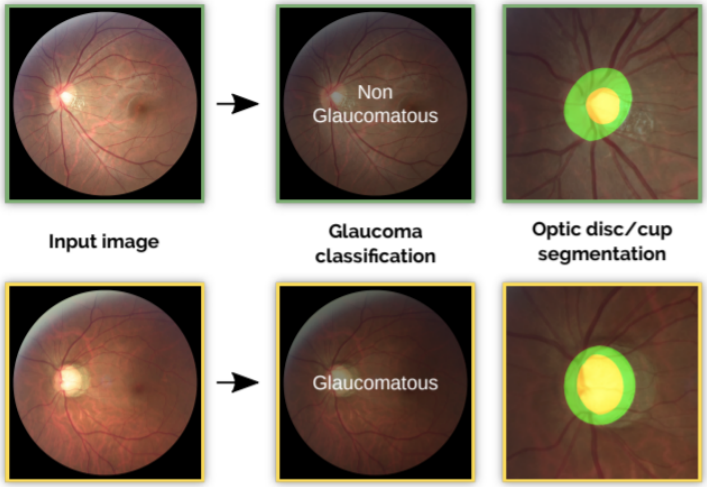

Figure 1: Segmentation of fundus image for glaucoma detection

3 Implementation

3.1 Dataset

The origin of the dataset is **REFUGE** competition [1][2]. We have downloaded it from the second version of the same competition hosted at *kaggle* [3]. There are 1200 retinal fundus images (400 for training, 400 for validation, 400 for testing), issued from different cameras, and annotated by human experts.

3.2 Frameworks / Libraries

Deep Learning: Pytorch

Machine Learning: Scikit-learn

3.3 Methods

Metrics: Metrics used for measuring the segmentation accuracy is *'Dice Coefficient'*. Fovea, is a small depression within the neurosensory retina where visual acuity is the highest. For calculating how much accurately we are able to localize the fovea is determined by *'Fovea localization error metric'*.

Deep Learning Architecture for segmentation: UNet

Data Augmentation: Dataset is unbalanced. The ratio of glaucoma images vs non-glaucoma image is 0.1. To overcome this, we have used data augmentation technique where we sample more images from the less represented class. This technique gives better accuracy and this is done only on the training set. Test set represent the true distribution of the dataset.

4 Training and Inference

4.1 Hyperparameters

Loss Function: Binary Cross Entropy Loss

Optimizer: Adam

4.2 Training

We trained the UNet model for 50 epochs using Pytorch. In each epoch, model was compared to check if it is giving best accuracy on validation data. Best model was saved in *.pth* format of Pytorch. Following chart explains how training and validation loss converge.

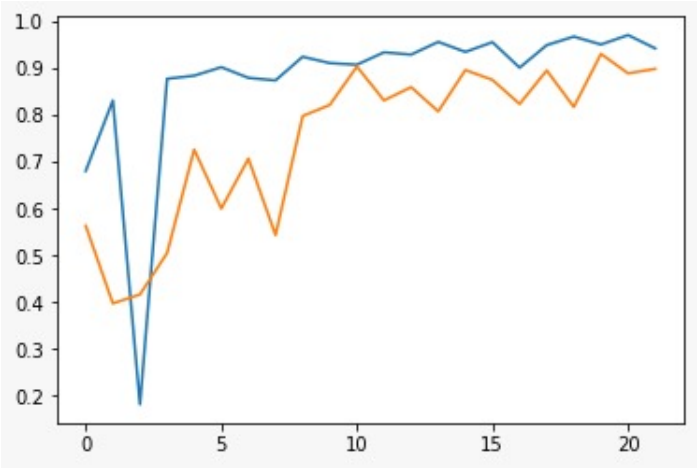

Figure 2: Conversion to ONNX

4.3 ONNX Conversion

We converted the pytorch version of the model to *ONNX* model format.

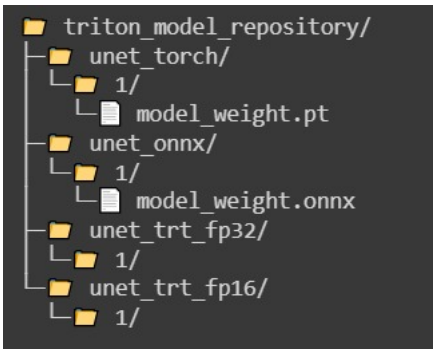

Figure 3: Wandb

4.4 WANDB

Following are the *wandb* details.

URL: https://wandb.ai/somexgupta/dlops-project

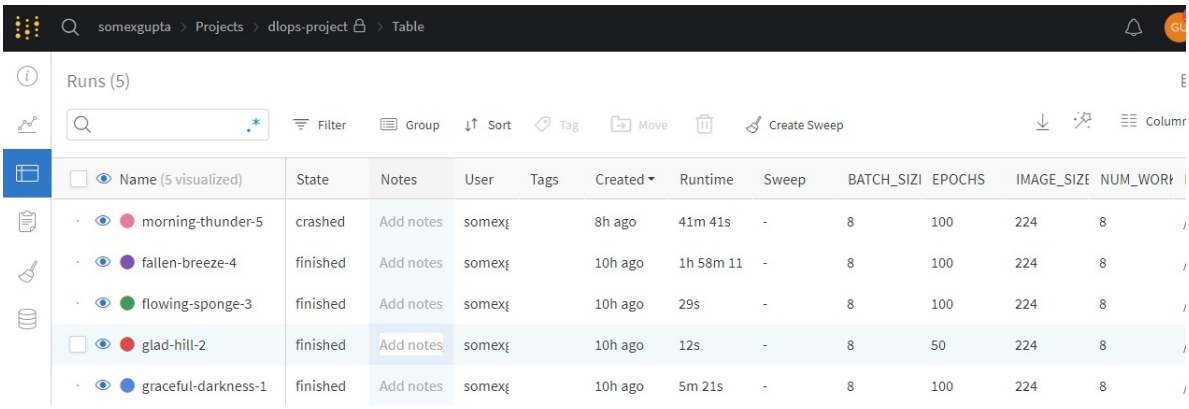

Figure 4: Wandb

4.5 Inference on single image

Following is the result of inference on single input image. First image is the input fundus image. Second image is the segmented image imposed on the input image and third image is the segmented OD and OC.

Figure 5: 1) Input Image 2) With Segmentation imposed on input 3) OD and OC segmentation

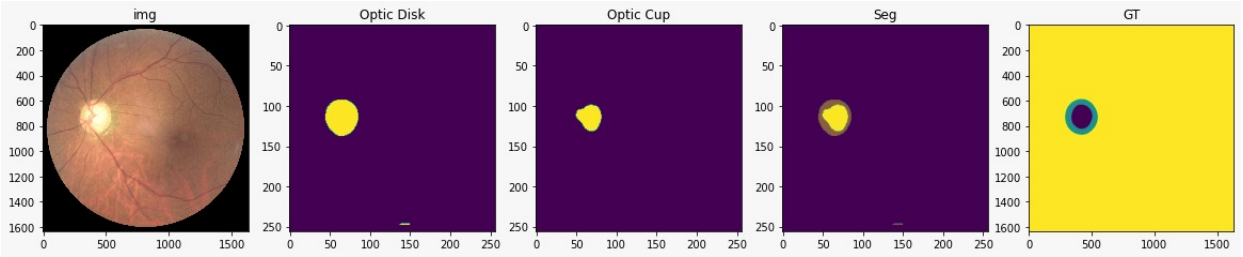

Figure 6: Segmentation

5 Deployment

The Pytorch model that we have trained, we deployed on AWS EC2 instance. We have published API on top of this model using FastAPI. Following is the screenshot of the test page where we can upload the test fundus image and do the inference. In the screenshot you can see the response in JSON format.

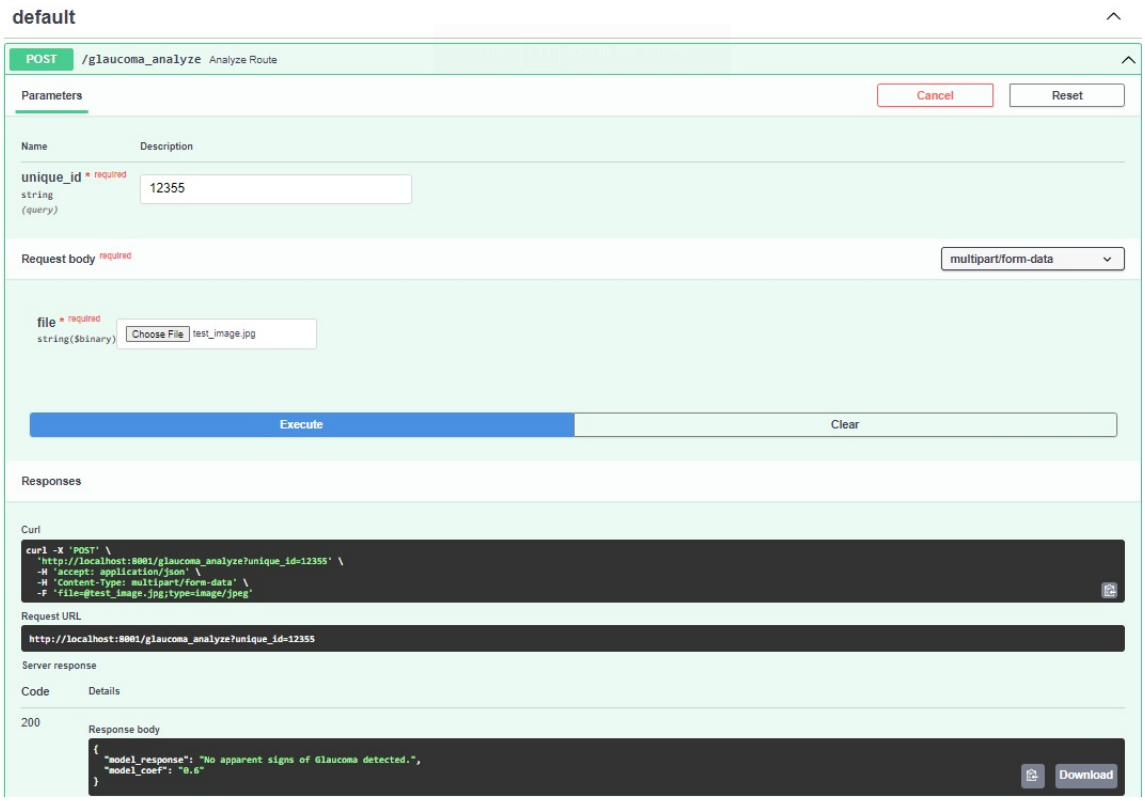

Figure 7: Deployment and Inference

6 Results and Discussion

OD segmentation (Dice Score): 0.9167 (val)

OC segmentation (Dice Score): 0.8082 (val)

vCDR error: 0.0965 (val)

Classification (AUC): 0.9189 (val)

References

[1] https://refuge.grand-challenge.org/

[2] https://refuge.grand-challenge.org/Home2020/

[3] https://www.kaggle.com/c/eurecom-aml-2021-challenge-2