Diabetic Retinopathy Detection using Convolutional Neural Networks

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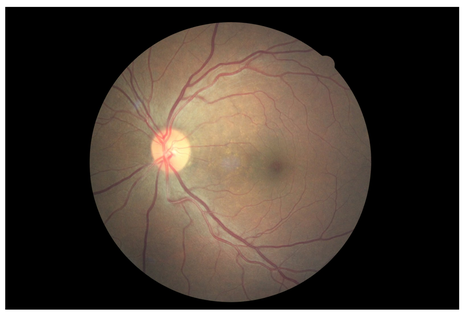
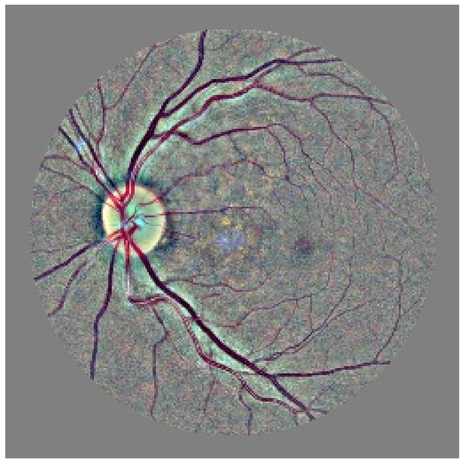
Objective

Build a Convolutional Neural Network to detect signs of Diabetic Retinopathy in eye images

Before Pre-Processing



After Pre-Processing



INTRODUCTION

Diabetic retinopathy is the leading cause of blindness in the working-age population of the developed world. It is estimated to affect over 93 million people. Progression to vision impairment can be slowed or averted if DR is detected in time, however this can be difficult as the disease often shows few symptoms until it is too late to provide effective treatment. Diabetic Retinopathy (DR) is one of the major causes of blindness in the world. It occurs when diabetes affects the circulatory blood system of eye retina and damages the blood vessels in the retina which leads to partial or complete blindness. The effect of blood leakage from these vessels creates certain lesions in eye retina. Our aim is to provide an effective and accurate replacement for the current method of DR Detection.

Pre-Processing

1. Perform a Gaussian blur on the image, subtract blurred image from the original image to obtain a normalized image of the eye.
2. Due to presence of a bright ring of the eye a circle is drawn with approximately 90 percent of actual radius to remove the ring.
3. Finally images are re-sized to 256 X 256 before being fed into the model.

Training

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 254, 254, 32)	896
conv2d_2 (Conv2D)	(None, 252, 252, 32)	9248
max_pooling2d_1 (MaxPooling2	(None, 126, 126, 32)	0
conv2d_3 (Conv2D)	(None, 124, 124, 96)	27744
conv2d_4 (Conv2D)	(None, 122, 122, 96)	83040
max_pooling2d_2 (MaxPooling2	(None, 61, 61, 96)	0
conv2d_5 (Conv2D)	(None, 59, 59, 128)	110720
conv2d_6 (Conv2D)	(None, 57, 57, 128)	147584
max_pooling2d_3 (MaxPooling2	(None, 28, 28, 128)	0
conv2d_7 (Conv2D)	(None, 26, 26, 192)	221376
conv2d_8 (Conv2D)	(None, 24, 24, 192)	331968
max_pooling2d_4 (MaxPooling2	(None, 12, 12, 192)	0
conv2d_9 (Conv2D)	(None, 10, 10, 256)	442624
conv2d_10 (Conv2D)	(None, 8, 8, 256)	590080
max_pooling2d_5 (MaxPooling2	(None, 4, 4, 256)	0
conv2d_11 (Conv2D)	(None, 2, 2, 256)	590080
max_pooling2d_6 (MaxPooling2	(None, 1, 1, 256)	0
flatten_1 (Flatten)	(None, 256)	0
dense_1 (Dense)	(None, 256)	65792
dense_2 (Dense)	(None, 5)	1285

Total params: 2,622,437
Trainable params: 2,622,437
Non-trainable params: 0

Accuracy

The Dataset is heavily skewed in the sense that there are 25810 cases for Non-DR whereas only 708 for proliferative.

Improvements on the Model

1. **Class weights:** We assign a weight to each class to ensure that the model pays equal attention to each class
2. **Unequal Data Augmentation:** We randomly rotate and flip images in order to get more examples of the classes with less examples to begin with.
3. **Binary classification:** We first address the problem as classifying weather the test image has DR or Non-DR. Then we use the images with DR to classify them in order of their type.

Accuracy: 76%

Advantages

Currently, detecting DR is a time-consuming and manual process that requires a trained clinician to examine and evaluate digital color fundus photographs of the retina. By the time human readers submit their reviews, often a day or two later, the delayed results lead to lost follow up, miscommunication, and delayed treatment.
CNN will provide results:

1. **without** delay.
2. **more accurate** and will possibly help in early detection.

Future Scope

1. Could be used in Health care sector as a cheap and effective solution in detecting Diabetic Retinopathy(DR).
2. The current model can be expanded to detect different degrees of Diabetic Retinopathy (DR).

References

1. https://www.kaggle.com/c/diabetic-retinopathy-detection
2. https://ieeexplore.ieee.org/document/8050011
3. cs.uccs.edu/ jkalita/work/reu/REU2017/16Small.pdf