Diagnosis of Diabetic Retinopathy Using Deep Neural Networks

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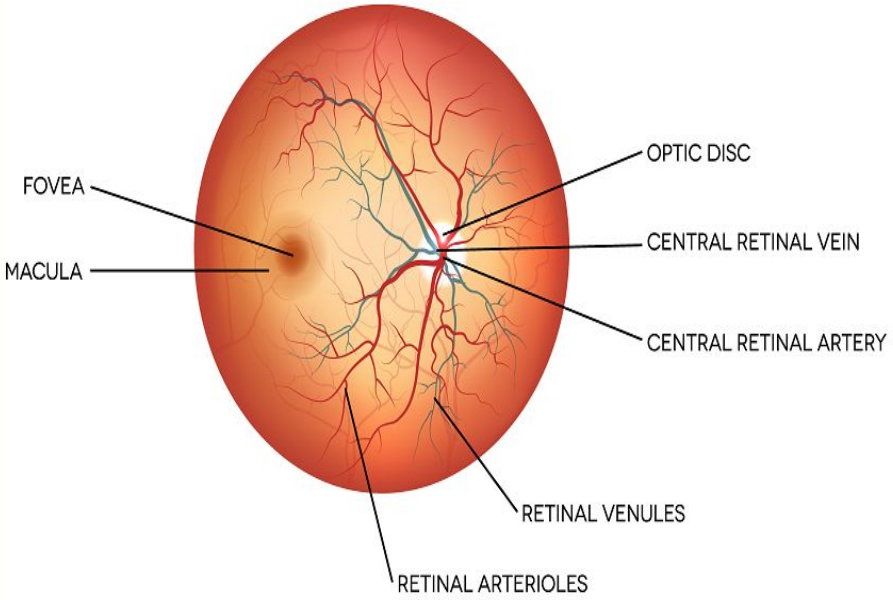
What is diabetic retinopathy?

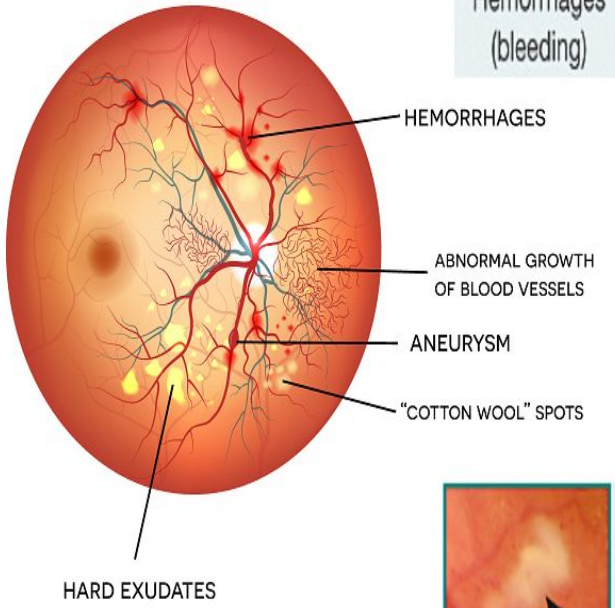
- Diabetic retinopathy (DR) is a common eye disease and a significant cause of blindness in diabetic patients.
- Diabetic retinopathy affects blood vessels in the light-sensitive tissue called the retina that lines the back of the eye.
- It is the most common cause of vision loss among people with diabetes and the leading cause of vision impairment and blindness among working-age adults.
- In India, it is a major problem due to lack of resources, education and poverty.

NORMAL RETINA



DIABETIC RETINOPATHY

Hemorrhages
(bleeding)



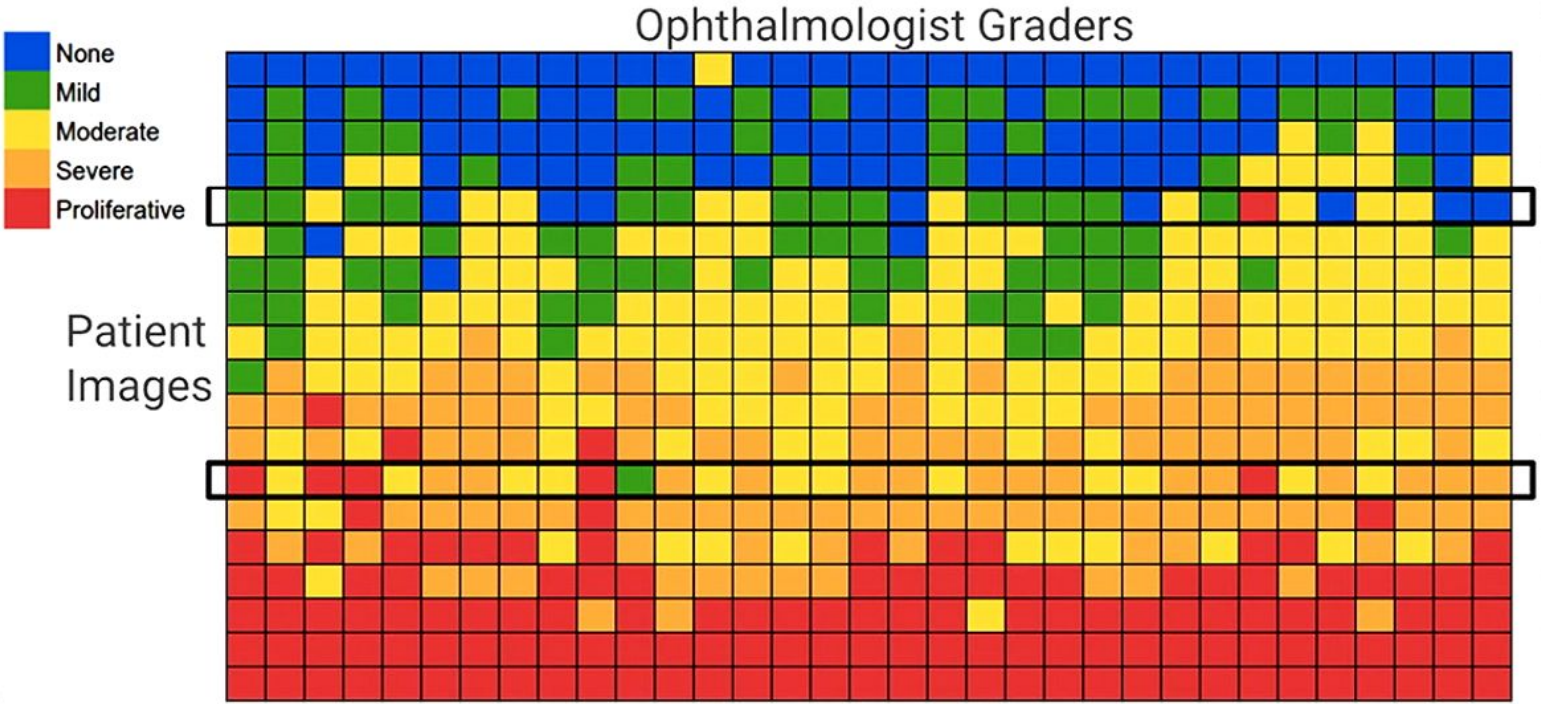
Exudates
(fatty deposits)

Cotton-wool spot
(microstroke)

Problem with classical medical methods

- The population of diabetic patients is enormous, and the prevalence of diabetes has been rising rapidly, the global prevalence of diabetes among adults has increased.
- Only, 29 ophthalmologists per 1 million persons
- For middle- and low-income countries, the gap between the population of diabetic patients and ophthalmologists can be extremely wide.
- Time is lost between patients getting their eyes scanned , having their images analyzed by doctors, and scheduling a follow-up appointment.
- So, an urgent need for systems that diagnose DR automatically and accurately.

Even when available, ophthalmologists are inconsistent



Consistency: intragrader ~65%, intergrader ~60%

Solution

- Computer-vision-based approach for the detection of diabetic retinopathy stages using color fundus images.

- Develop a network with CNN architecture and data augmentation, to identify the intricate features involved in the classification task such as micro-aneurysms, exudate, and hemorrhages in the retina and consequently provide a diagnosis automatically.

- By processing images in real-time, CNN would allow people to seek & schedule treatment the same day.

Dataset

Dataset has been taken from Kaggle

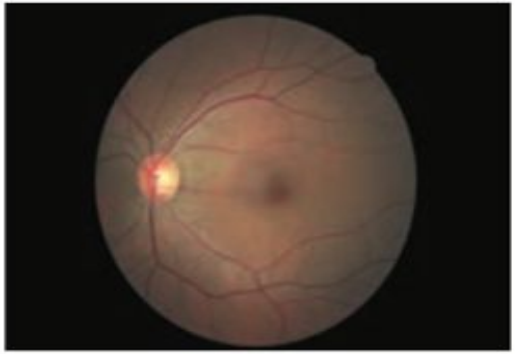
- The dataset consists of around 35,000 images of various classes and it is highly imbalanced.
- The data found related to this topic is noisy, and requires multiple pre-processing steps to get all images to a usable format for training a model.
- Left and right field are provided for every subject. Images are labelled with a subject id as well as either left or right (e.g. 1_left.jpeg is the left eye of patient id 1).

The dataset classes has been labelled as :

- No diabetic retinopathy (label 0)
- Mild diabetic retinopathy (label 1)
- Moderate diabetic retinopathy (label 2)
- Severe diabetic retinopathy (label 3)
- Proliferative diabetic retinopathy (label 4)

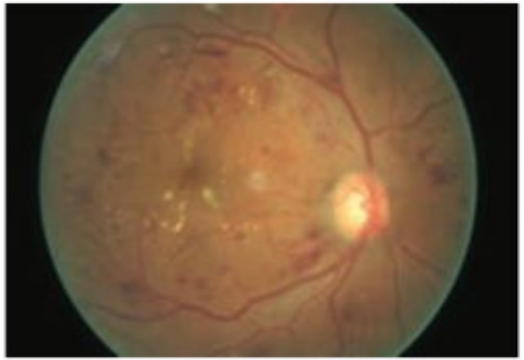
Output Classes

(a) No DR

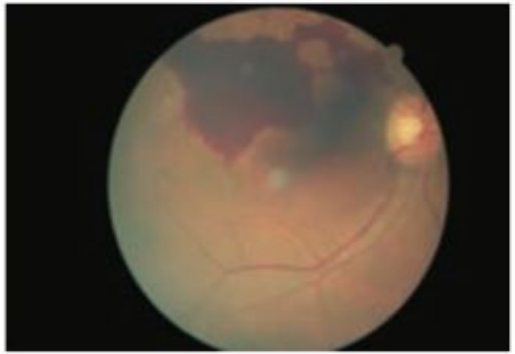


(b) Mild DR

(c) Moderate DR



(d) Severe DR

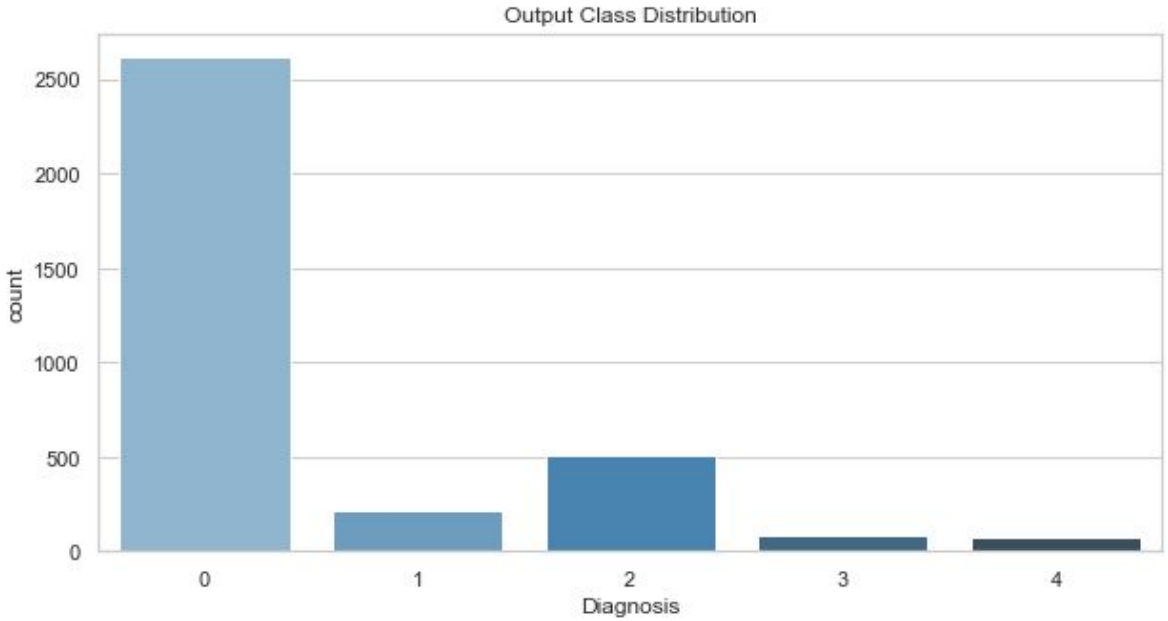


(e) Proliferative DR

Pre processing steps

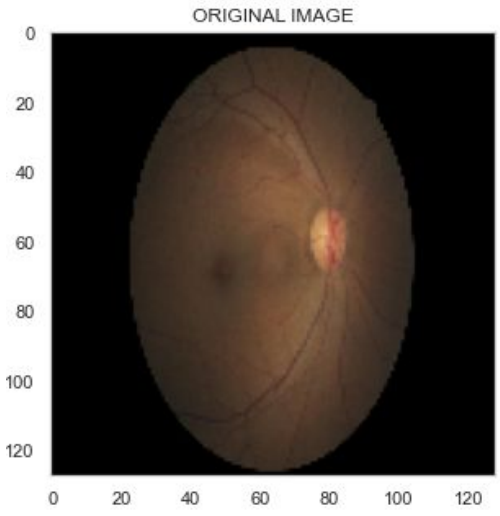
1. **Grayscale conversion**
2. **Resizing** of images.
3. **Gaussian blurring and Blending** to normalize intensity levels and extract features.
4. **Circular cropping**
5. Proper **data cleaning** by removing black images.
6. **Rotation and mirroring (data augmentation)** of images to balance the dataset.

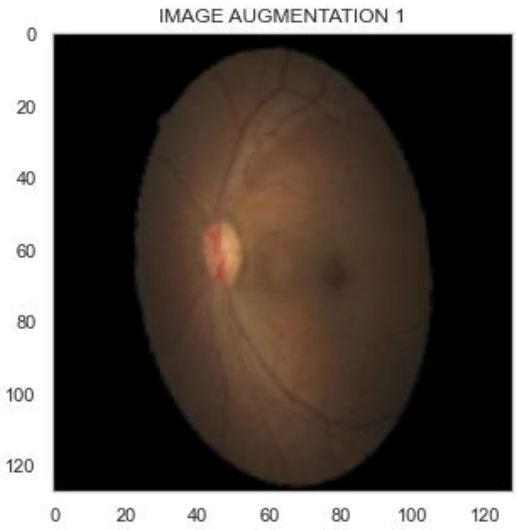
Visualising the dataset

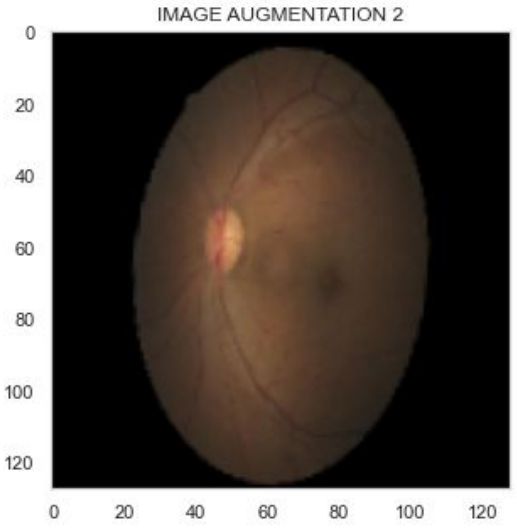


This barchart shows that our dataset is highly imbalanced.

Data Augmentation



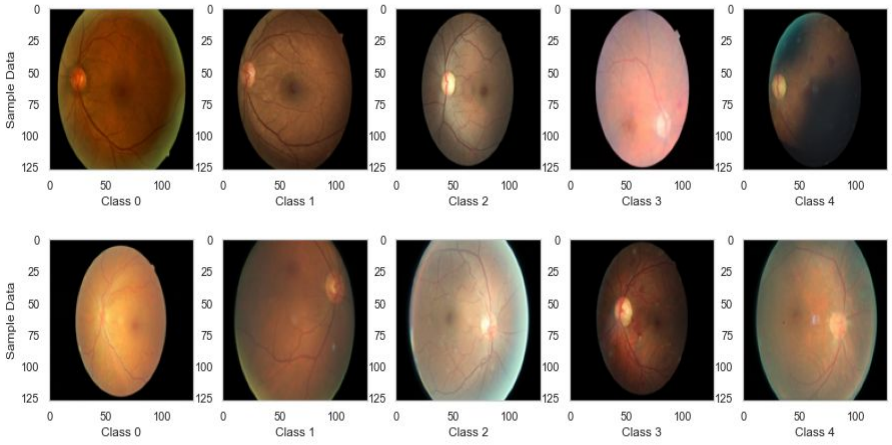




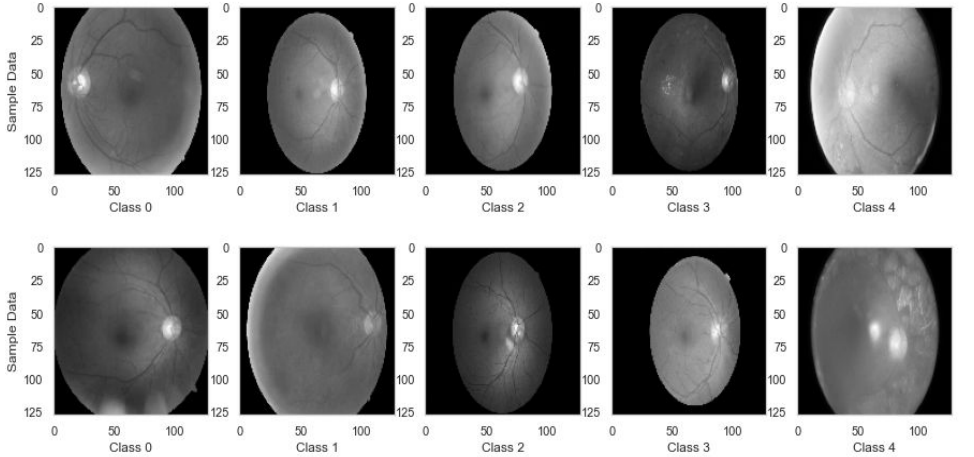
Images are rotated,flipped to generate new images to make balanced dataset

Applying grayscale to the images

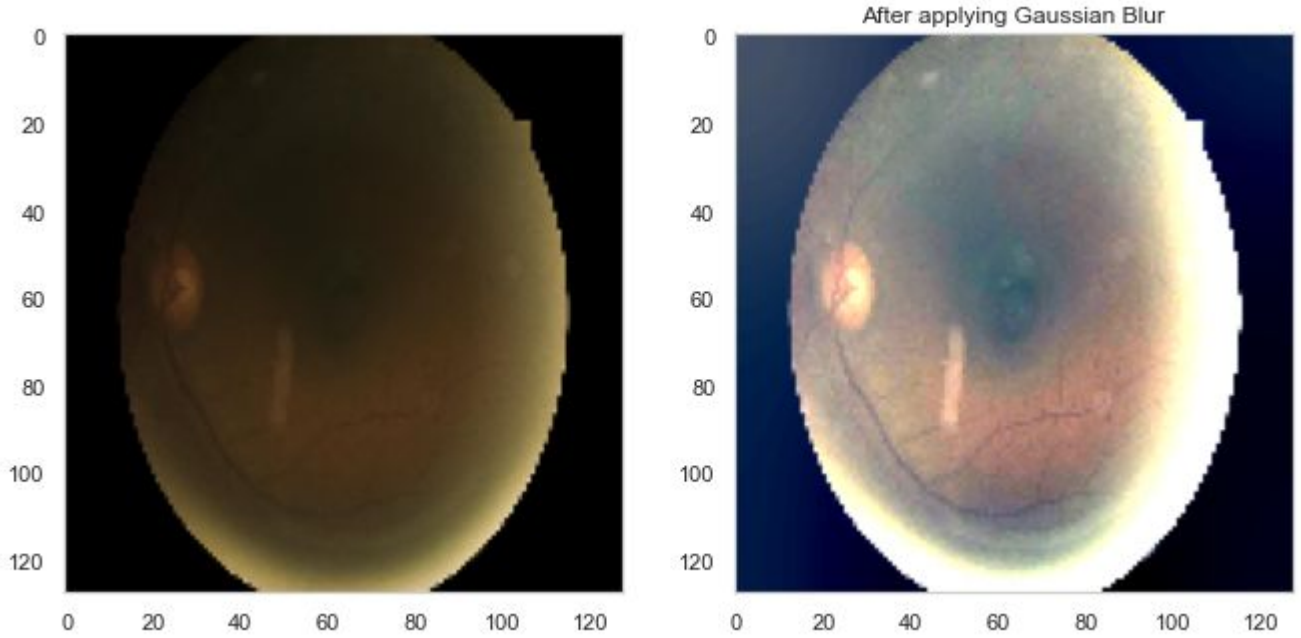
```
visualize_imgs(df_train,2,color_scale = None)
```




```
visualize_imgs(df_train,2,color_scale = 'gray')
```

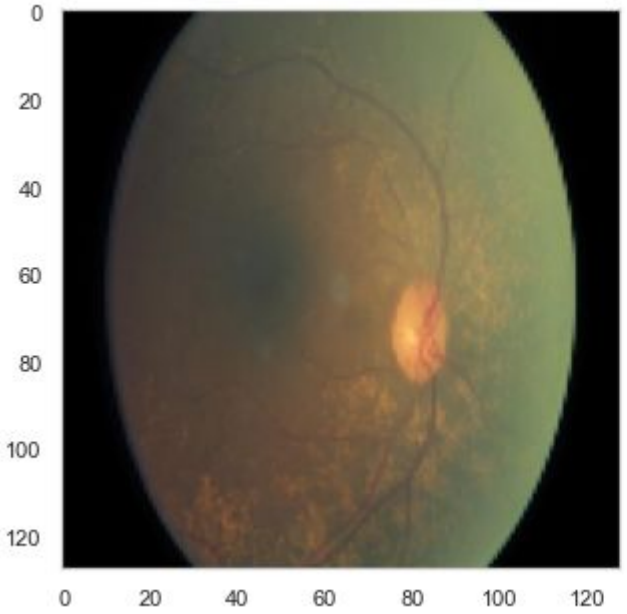


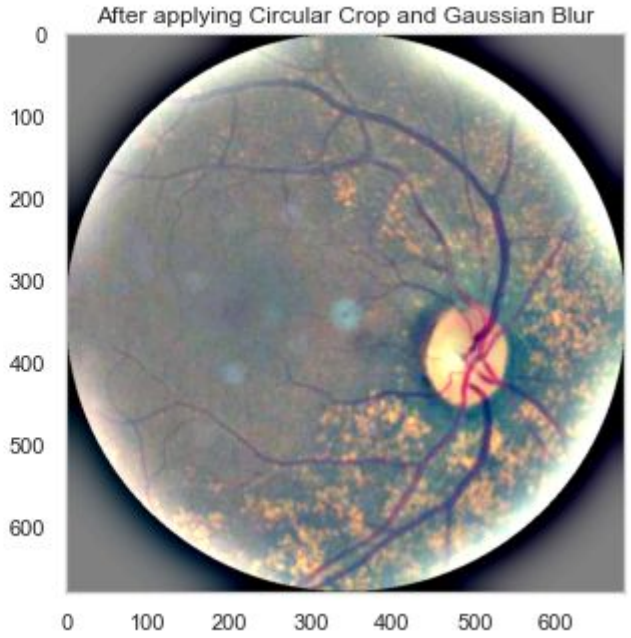
Applying Gaussian blurring



After applying Gaussian Blur, We are able to bring out the features/image details much more clearer.

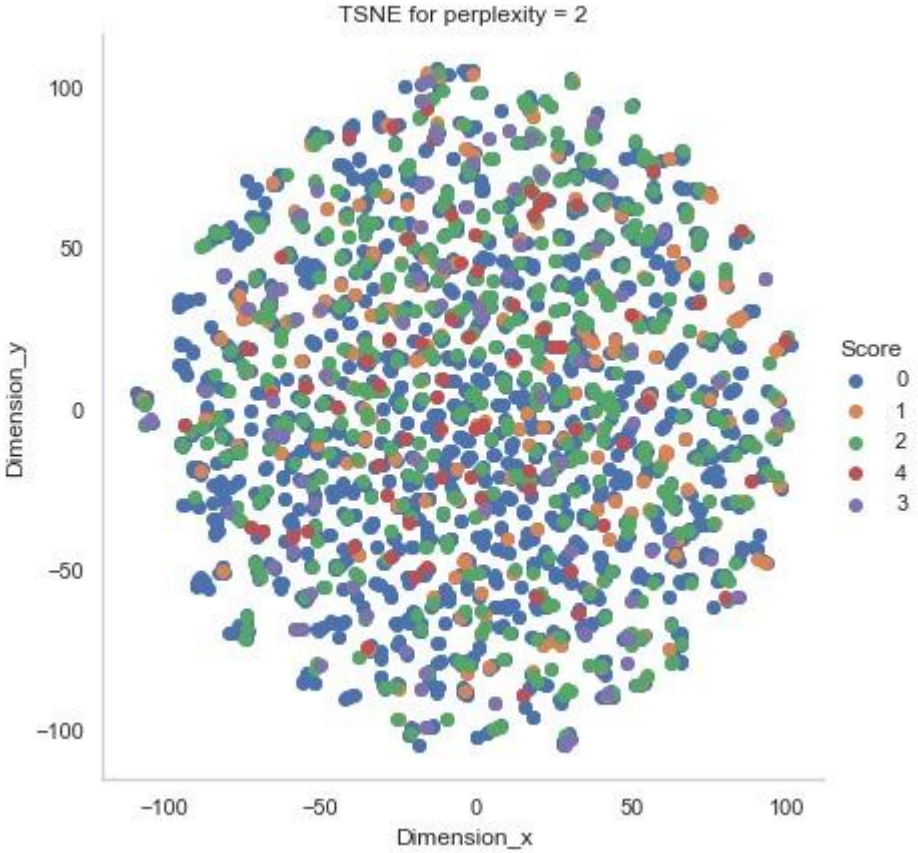
Circular cropping

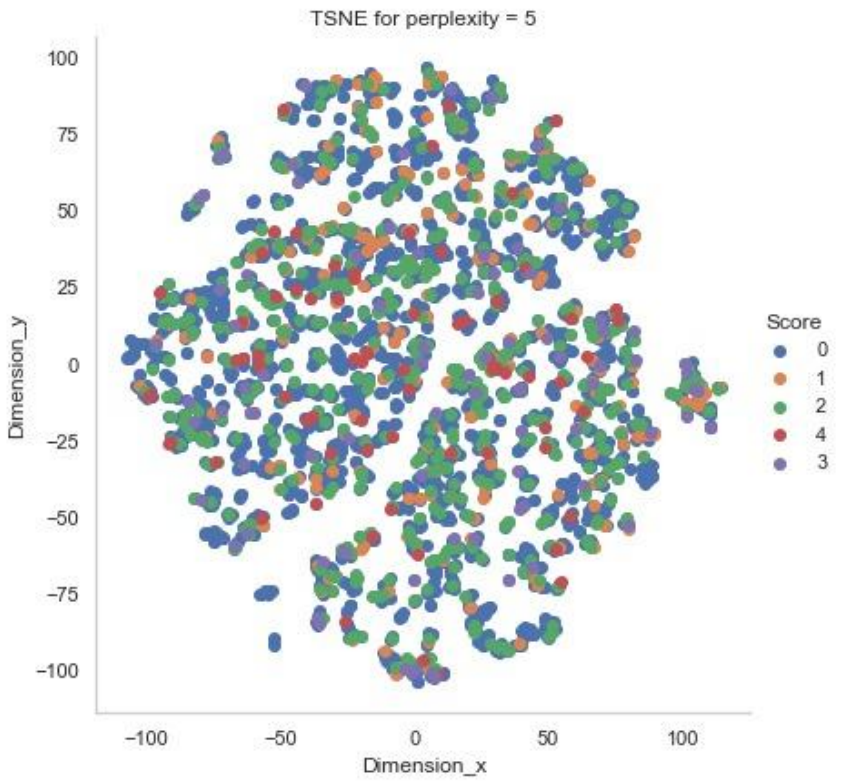


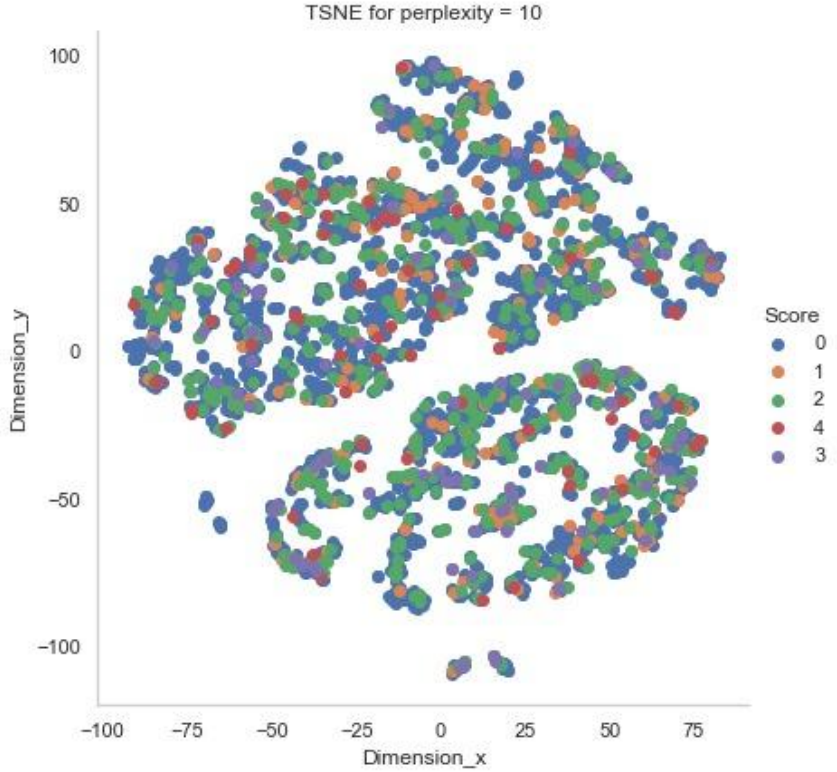


Scaling all the images by circular cropping. Details in the eye are much clearer now.

t-SNE visualisation

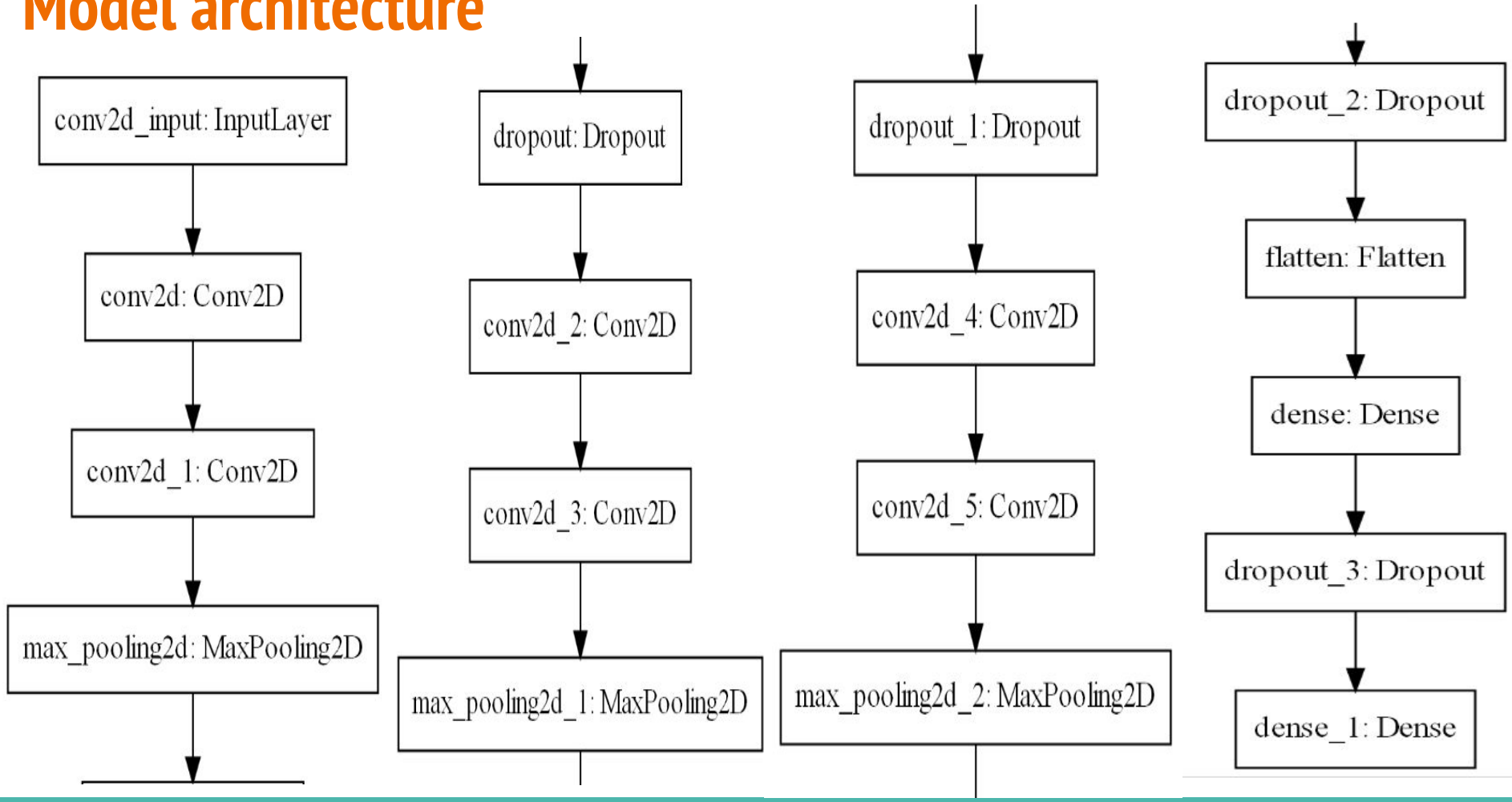




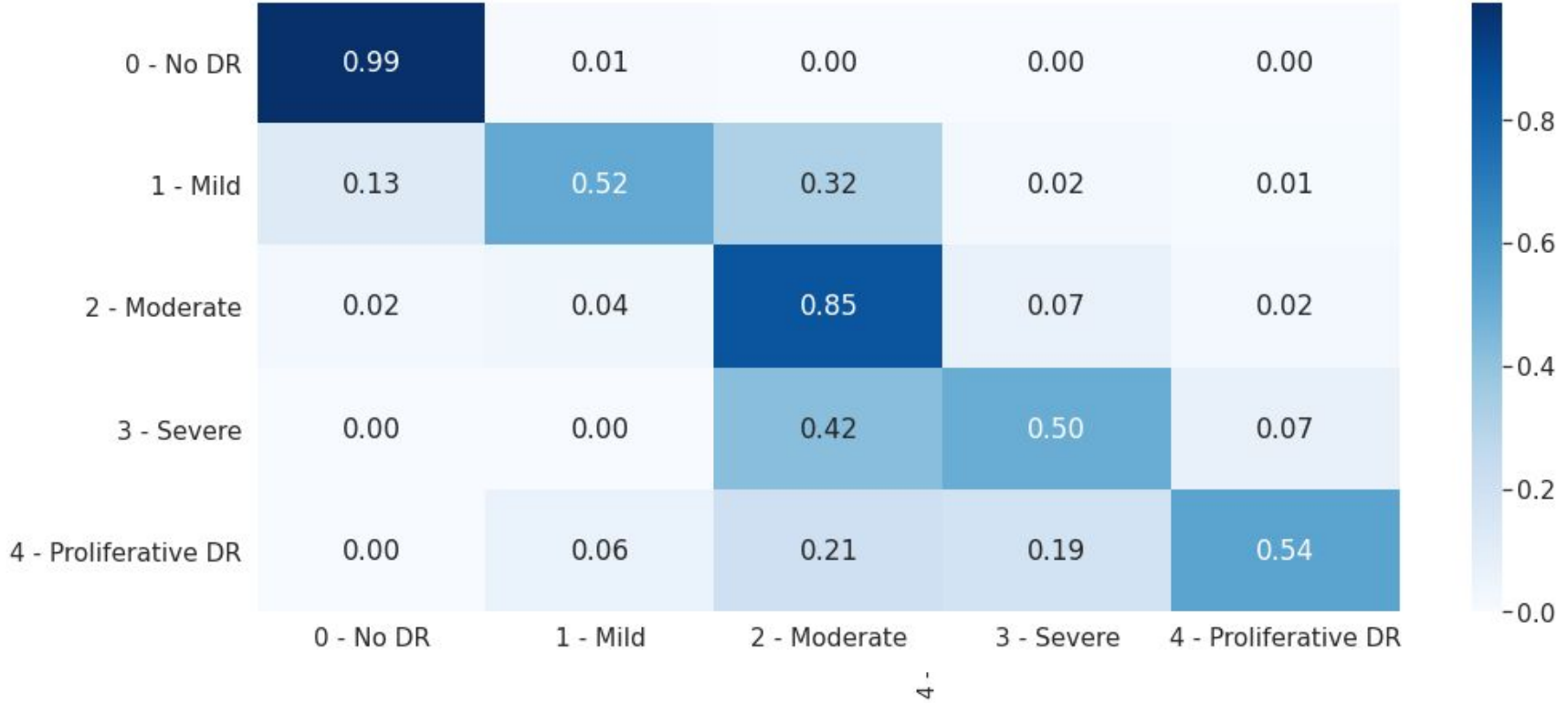


The greater the value of the perplexity, the more global structure is considered in the data

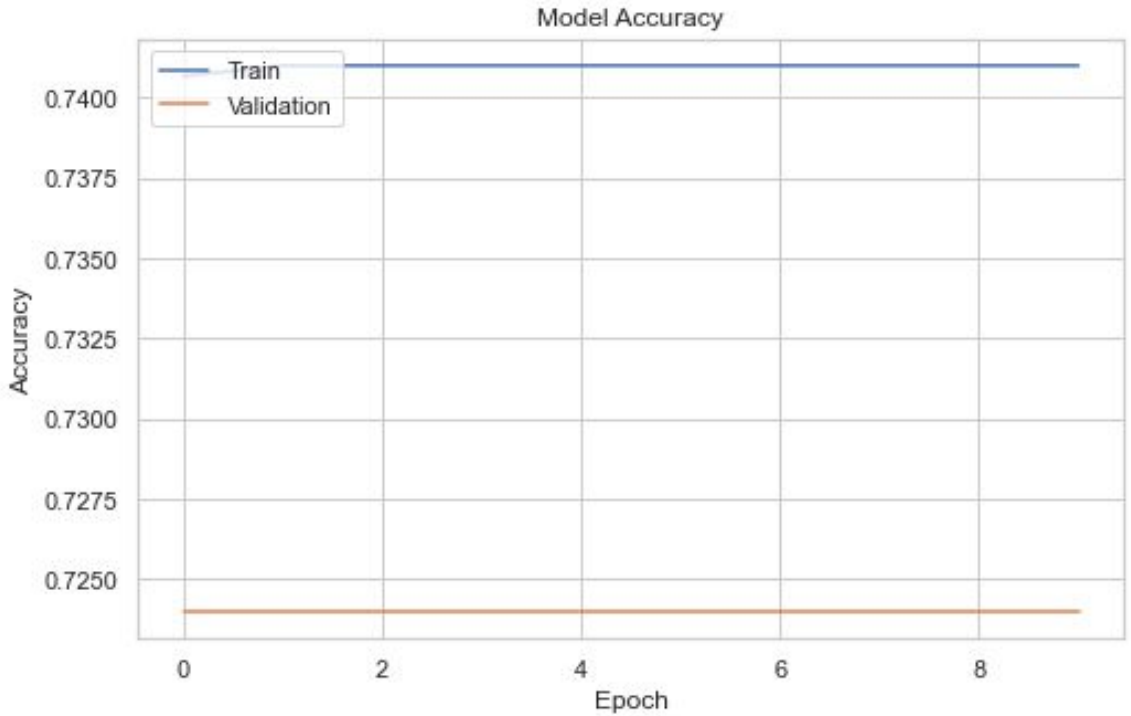
Model architecture



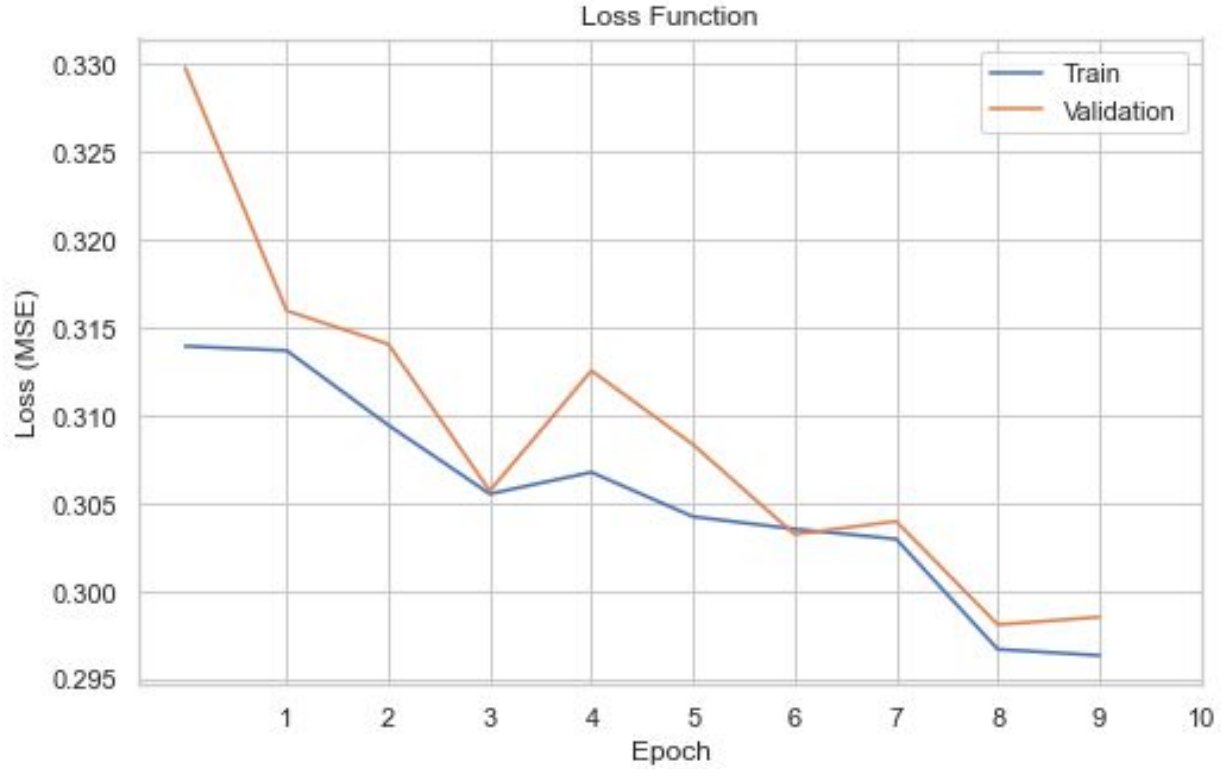
Confusion Matrix



Accuracy


Model Accuracy
Train
Validation
0.7400
0.7375
0.7350
0.7325
0.7300
0.7275
0.7250
Accuracy
0
2
4
6
8
Epoch

Loss Function



Limitations

Convolutional neural networks (CNN) have been successfully applied in many adjacent subjects, and for diagnosis of diabetic retinopathy itself. However, the high cost of big labeled datasets, as well as inconsistency between different doctors, impede the performance of these methods.

Contributions

Sandeep Saurav - Research paper and blogs, data preprocessing, model architecture design , training & testing the model

Jatin Kumar - Research paper and blogs, EDA, model architecture design, PPT

Ashutosh Mitra - Research paper and blogs, data augmentation, model architecture design, PPT

Honor code

We accept the responsibility for our role in ensuring the integrity of the work submitted by the group in which we participated.

THANK YOU