Diabetic retinopathy

Using Kaggle Dataset

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October 2018

What is diabetic retinopathy and how to recognize it?

Diabetic retinopathy is damage to retina of eye due to abnormal blood flow while patient is suffering from diabetes.

The following are the symptoms of diabetic retinopathy-

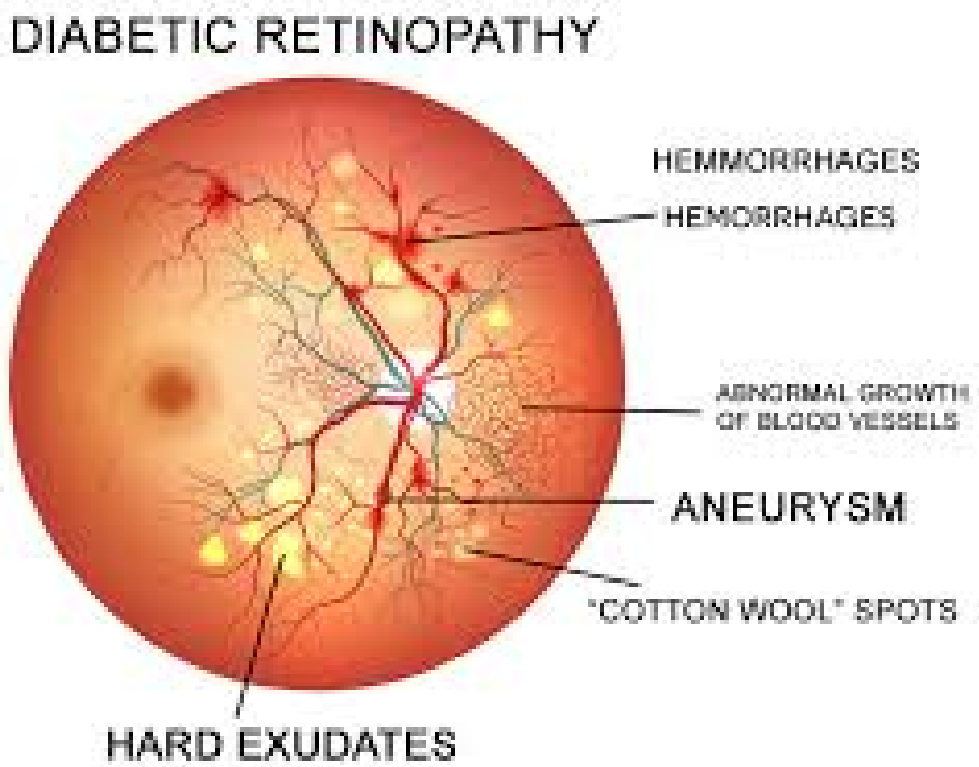


Figure: Symptoms of diabetic retinopathy

Let us see an example from kaggle dataset!

Figure: Normal vs abnormal retina

Dataset

- Total training data provided by kaggle consists of 31192 images.
- Total test images given by kaggle are 51232.We were able to find labels for these test images.
- This means total number of images available are 82424.
- Total number of categories in data
  - 0 - Normal
  - 1 - Mild
  - 2 - Moderate
  - 3 - Severe
  - 4 - Proliferative

Flaws in dataset

- Images mislabeled by opthamologist
- Poor lightning conditions
- Images not covering entire fundus of eye
- Blurred or out of focus images

Why inception network ?

- Google has been successfully using inception network for detecting DR.They have got a F1-score of 0.95 and auc of 0.99 on dataset of 130,000 images.
- Inception network outperforms most of the algorithms on image tasks with very little preprocessing.
- Weights learnt on imagenet dataset seem help learning.
- Other convolutional network architectures like Resnet-50 do not perform equally well on the task.

Results for full training set

We trained inception network on 31192 images out of which 1600 images were used in testing stage.
Category 0 will be treated as normal retina while categories 1,2,3,4 will be clubbed together to form abnormal(diseased) retina.
This gives us around 22000 images as normal and about 8000 images as abnormal.Abnormal images are simply oversampled so that there is no imbalance in data.

Color mode	Accuracy	Recall	Precision	F1-score	Roc Auc score
RGB	0.79	0.71	0.84	0.77	0.86
Gray	0.69	0.45	0.86	0.59	0.75

Table: Results for full training set

How to improve these results?

- The main reason behind low accuracy is noise in data.
- It is seen that there are lot of images in mild and moderate which are mislabeled.
- Difficult for network to distinguish mild and moderate categories from normal retina images.Eliminate category 1 and 2 from training data.
- Try various preprocessing techniques.

CLAHE(Contrast Limited Adaptive Histogram Equaliation)

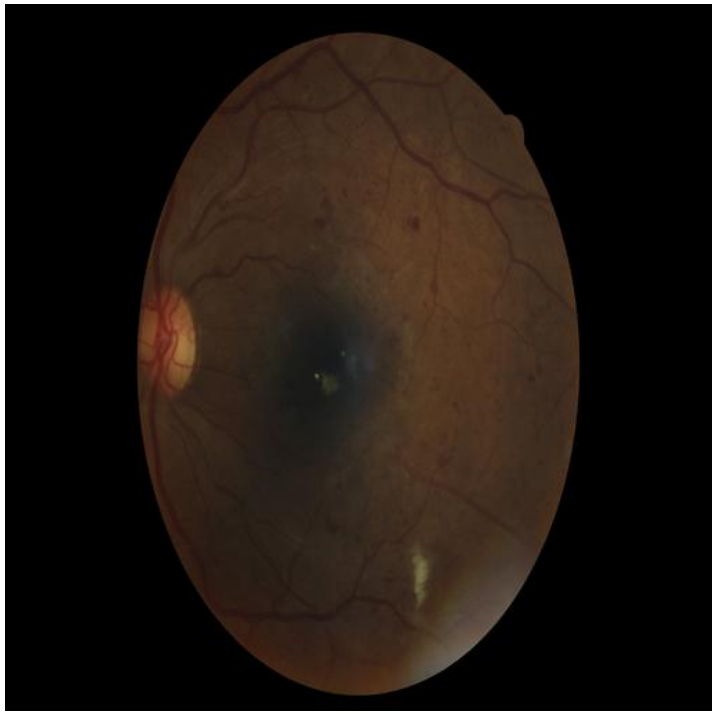


Figure: Before

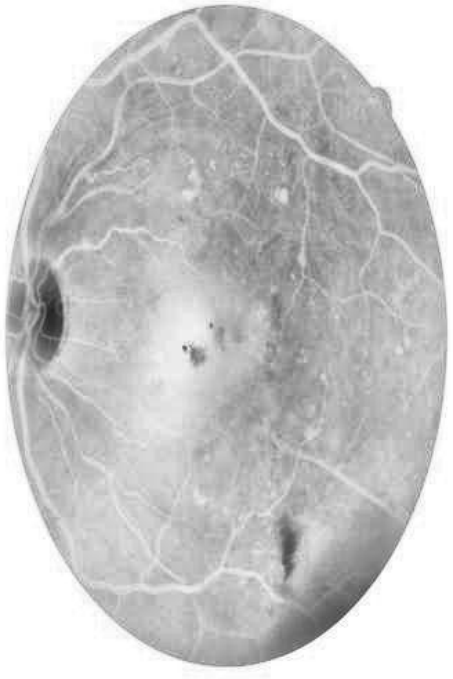


Figure: After

Gaussian Blur

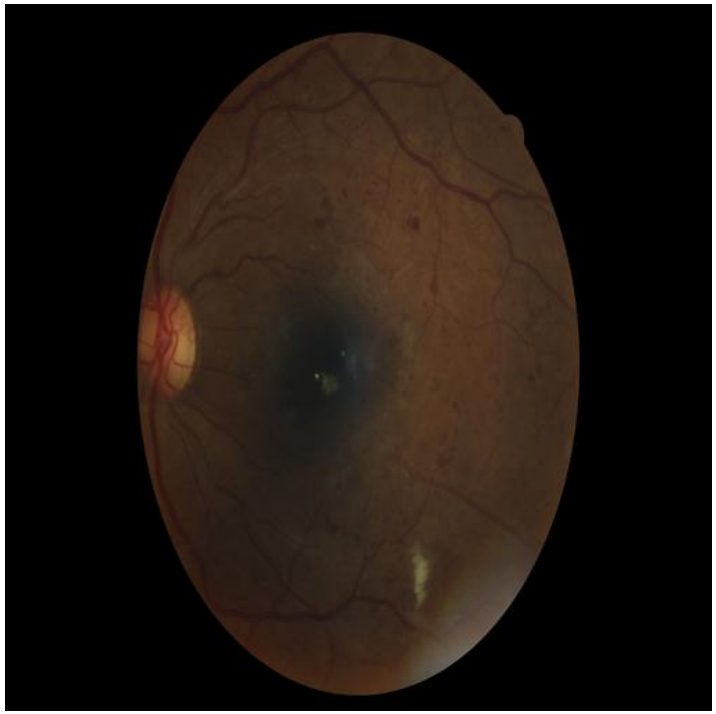


Figure: Before

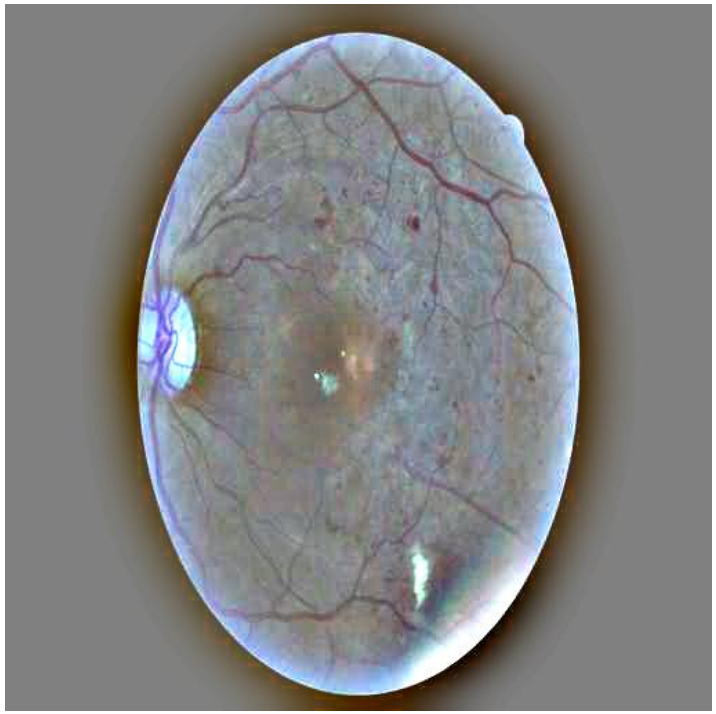


Figure: After

Results for smaller data set

We trained inception network on 6032 images out of which 400 images were used in testing stage.
Category 0 is normal retina while categories 3,4 will be clubbed together to form abnormal(diseased) retina.

Preprocessing	Accuracy	Recall	Precision	F1-score	Roc Auc score
None	0.93	0.89	0.97	0.93	0.98
Clahe	0.945	0.935	0.95	0.94	0.98
Gaussian Blur	0.90	0.95	0.87	0.91	0.98

Table: Results for smaller training set

ROC Curve

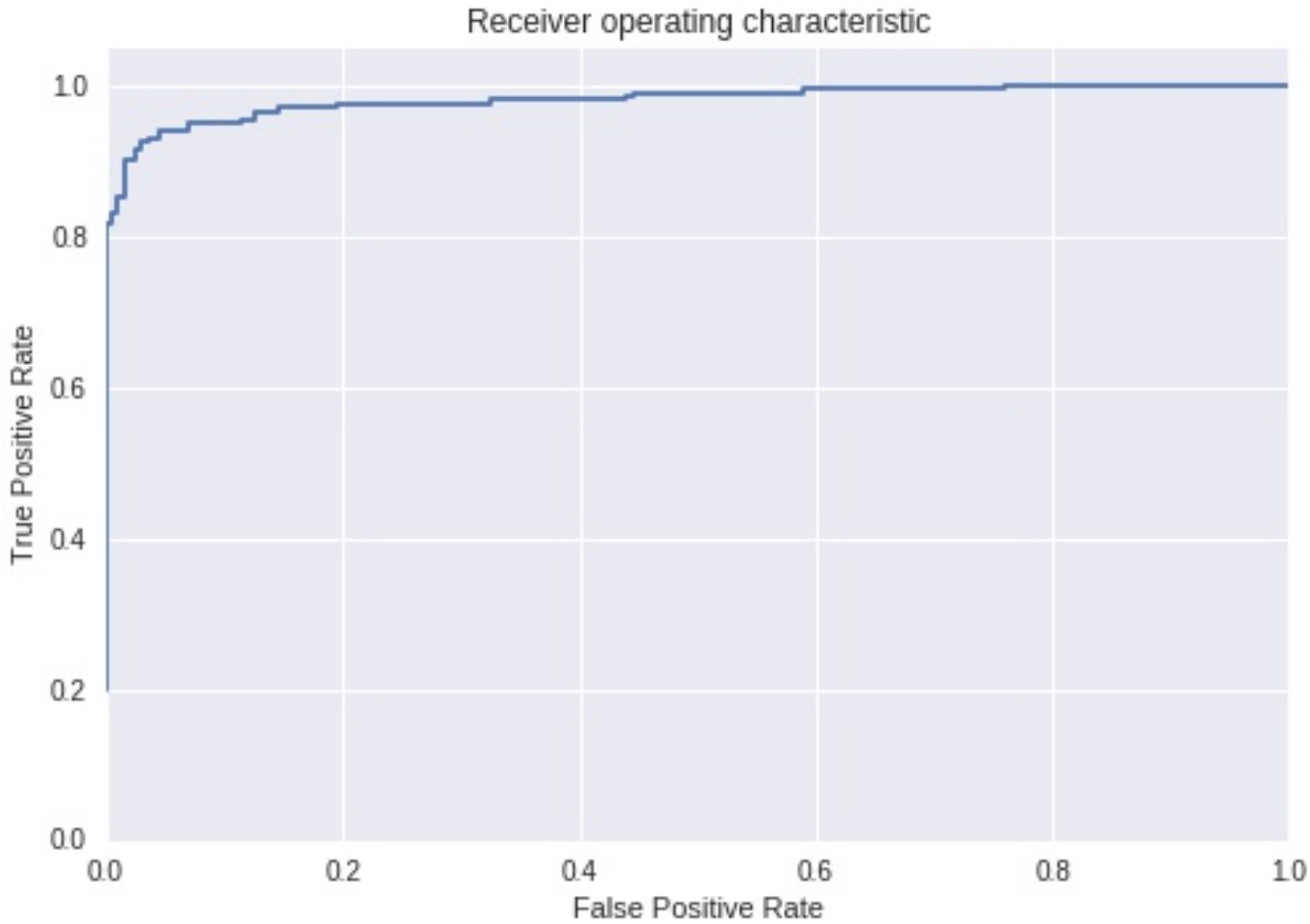
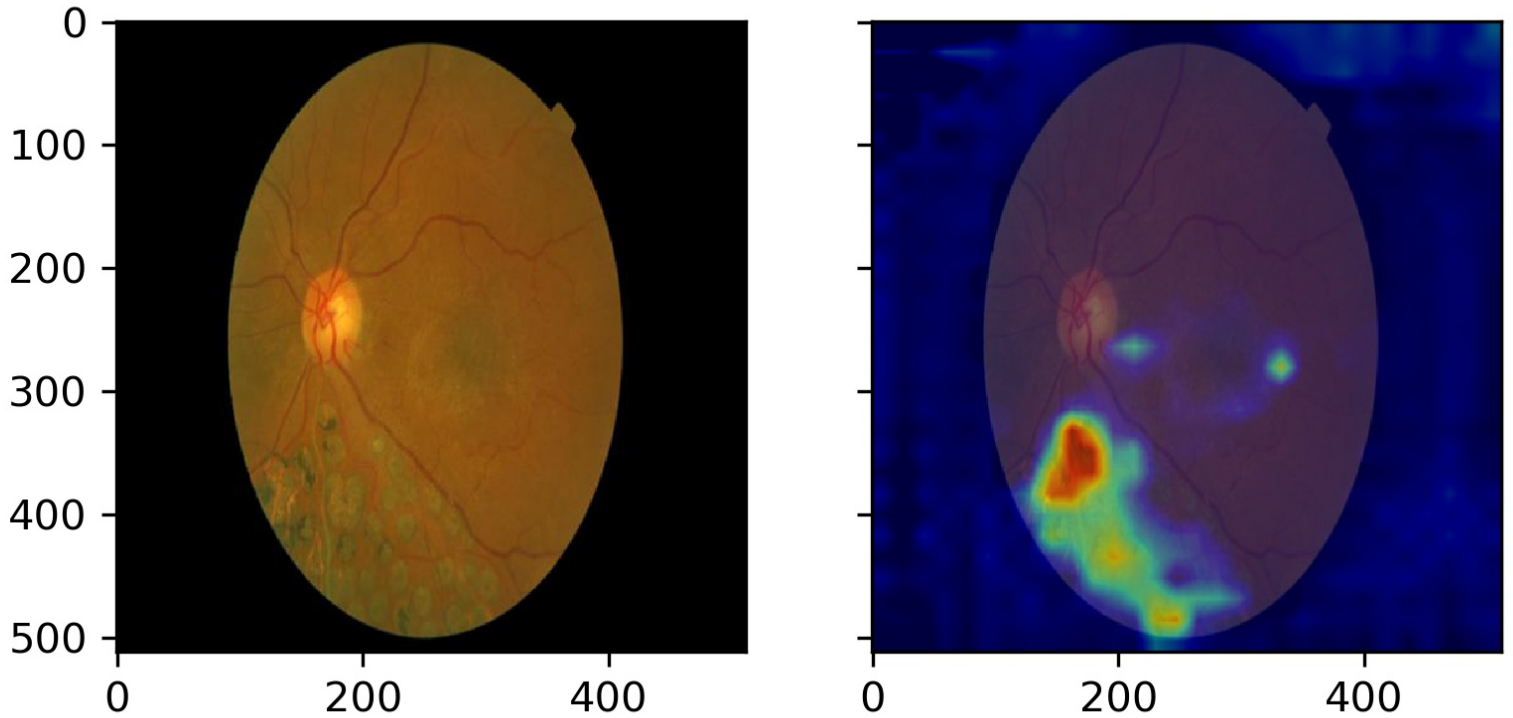


Figure: AUC 0.98

Does this network really work that well?

Lets see which parts network think are important for retina to be abnormal?

Probability: 0.81533045



Probability: 0.8469489

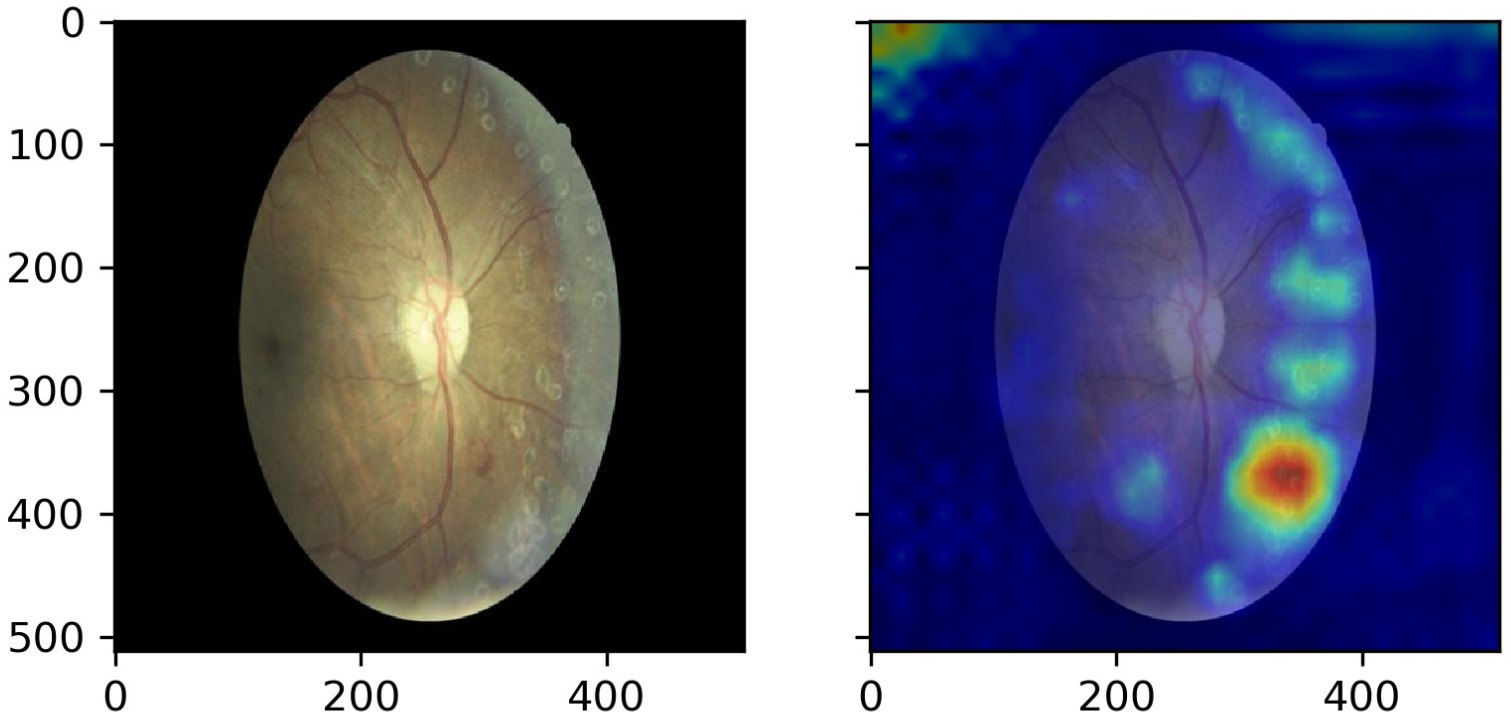


Figure: 17669-right

Probability: 1.0

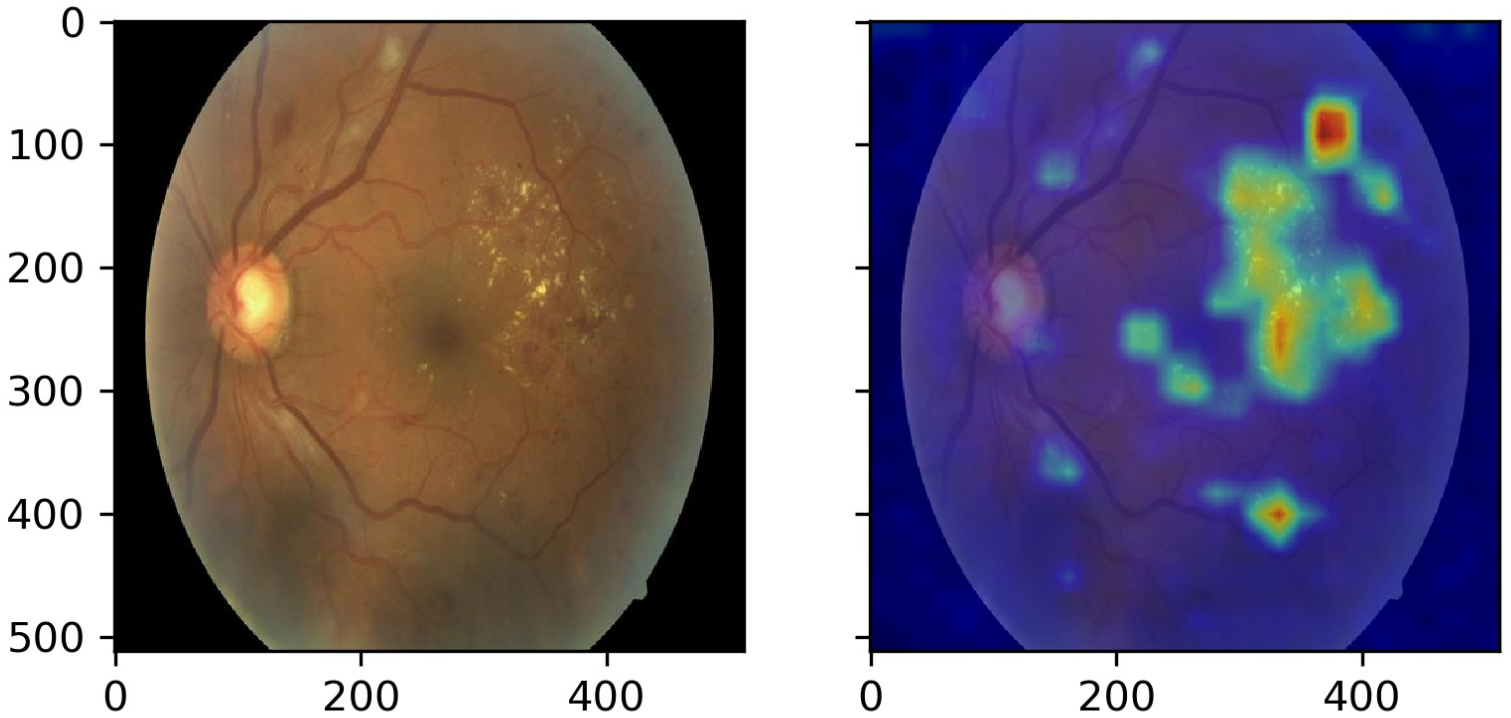


Figure: 2532*/eft*

Probability: 0.99993205

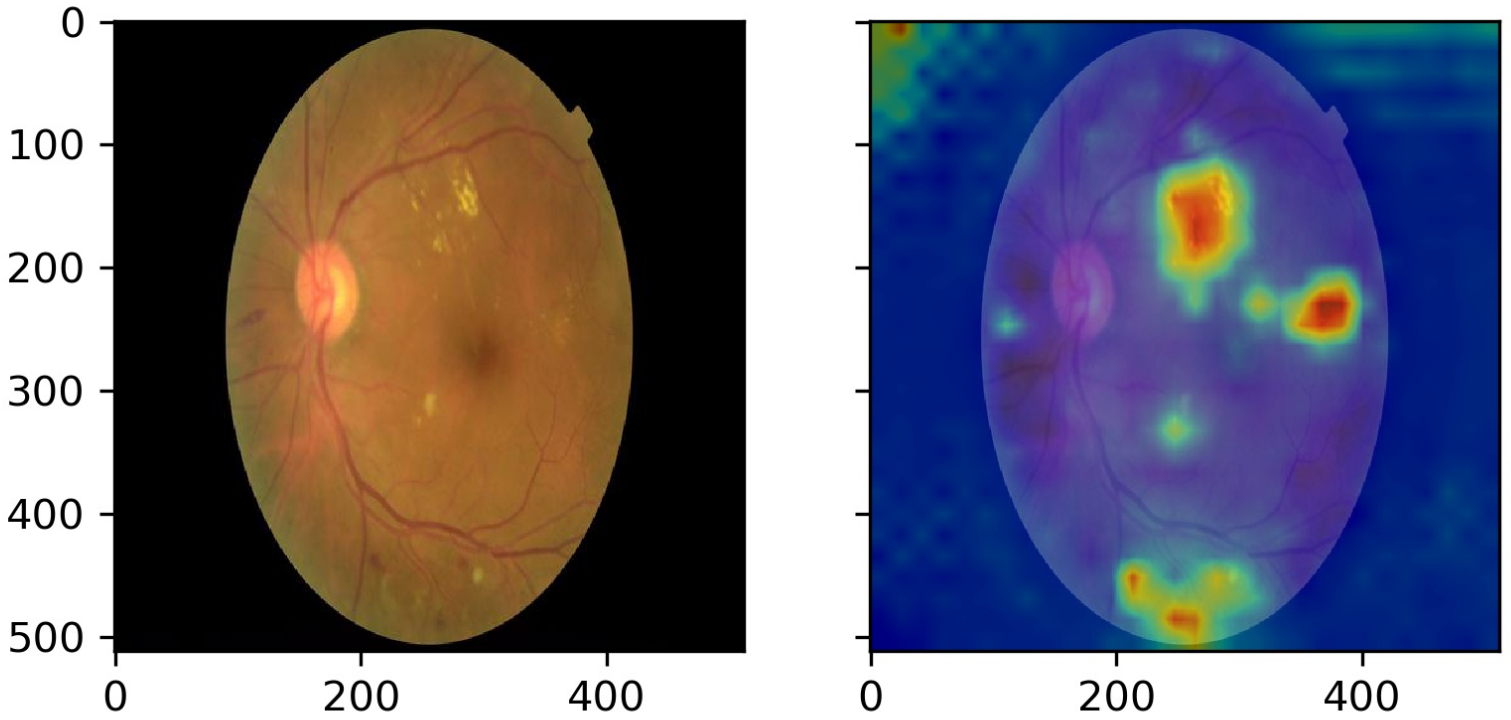


Figure: 2862-left

Probability: 0.9876161

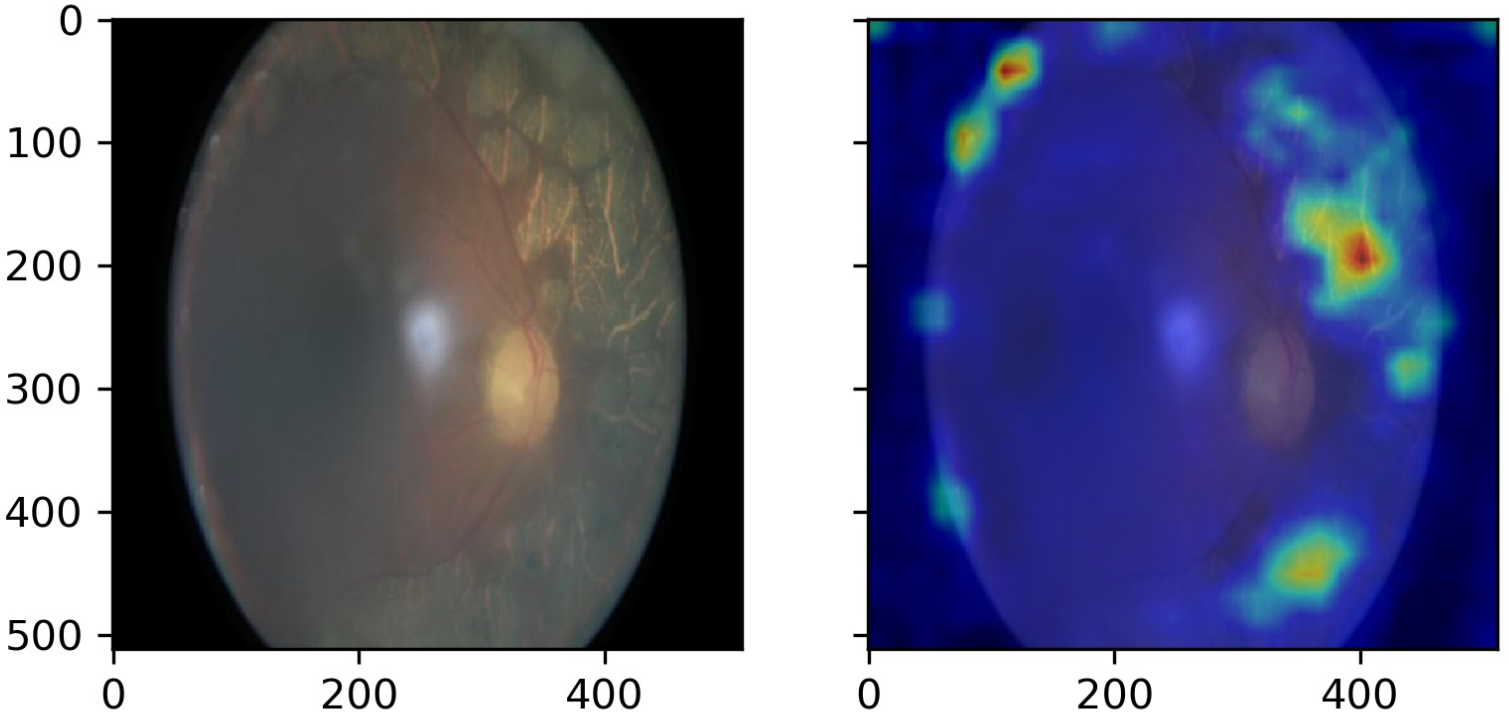


Figure: 3993-left

Probability: 0.9997907

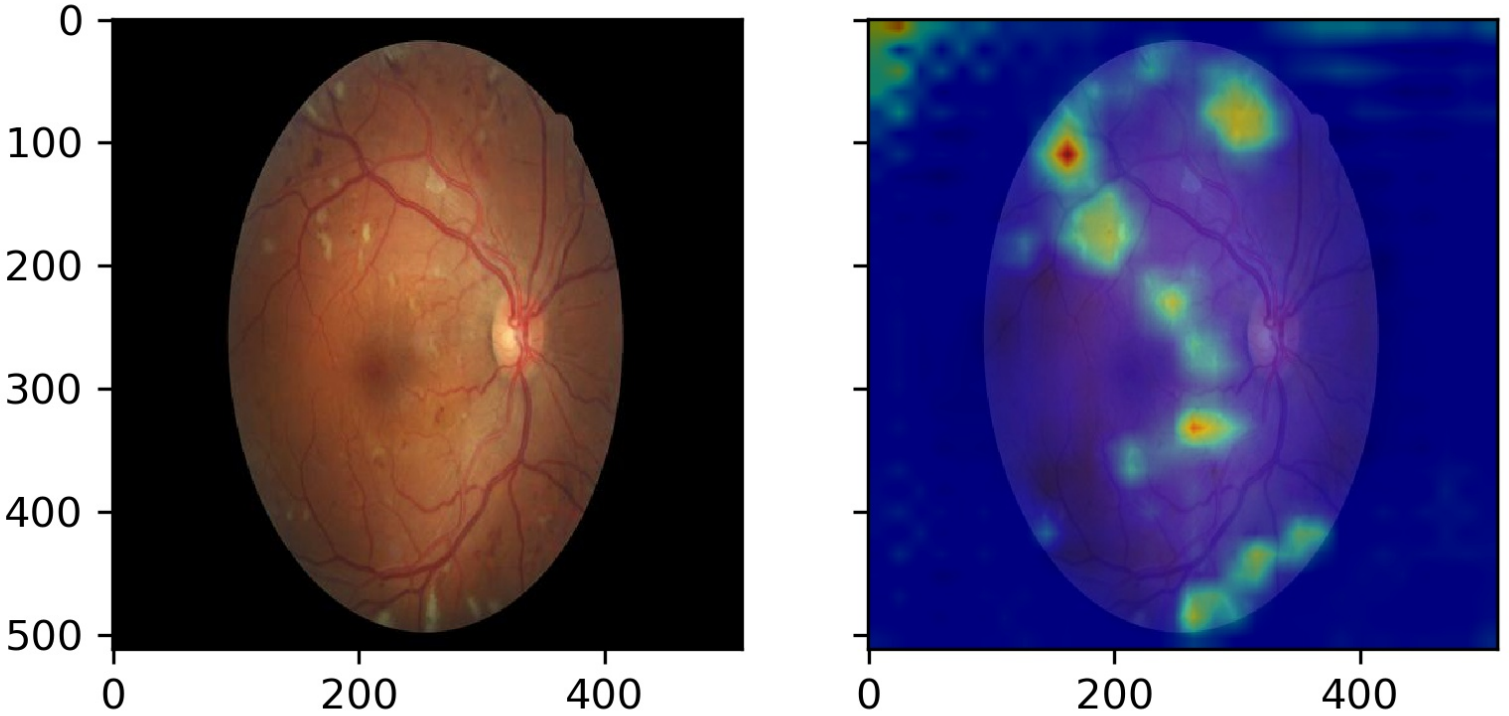
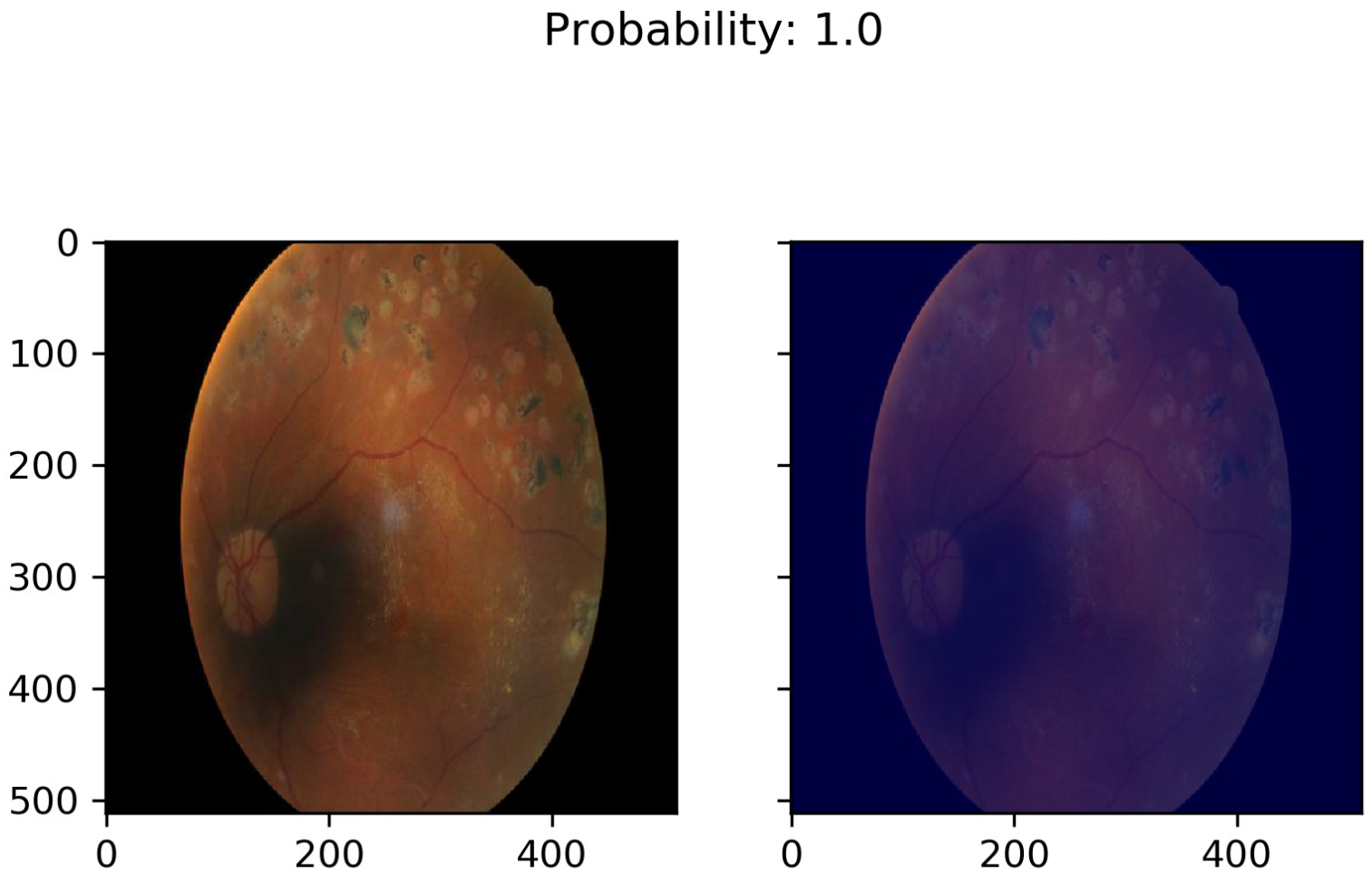


Figure: 7060-right

Challenges yet to be resolved

Not able to produce good visualization when the probability is exactly 1.0.



Challenges yet to be resolved

Noise in circumference of retinal image.We can use techniques to remove background.

Figure: Before

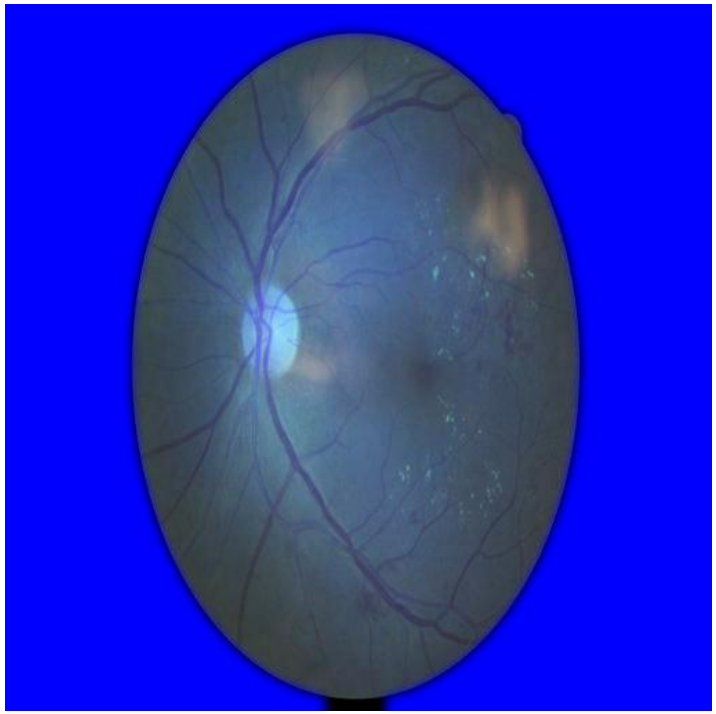


Figure: After removing noise

Future work

- IDRiD dataset is the new dataset found. It provides data for categorization as well as segmentation and localization.
- Morphological preprocessing technique to seperate nerves from retina as well any blots on retina.
- Fine tuning the available models to distinguish between mild, moderate and normal retina.
- Trying attention modules like spatial transformer.