Project Proposal - Diabetic Retinopathy Detection

1. Domain background(Life Sciences) :

Diabetic retinopathy(DR) is an eye disease caused by diabetes that can lead to loss of vision or even complete blindness. Diabetic retinopathy accounts for 12% of all new cases of blindness in the United States, and is the leading cause of blindness for people aged 20 to 64 years.7 If caught early enough, progression to vision impairment can be slowed if not altogether stopped, however, this is often difficult because symptoms may appear too late to provide effective treatment.

Currently, diagnosing DR is a slow process that requires trained doctors to analyze color photographs of retinas. They then classify the level of deterioration the patient's eye has experienced into one of four categories. While this process is effective, it is very slow. It takes about 2 days to get the results. Furthermore, in areas where access to trained clinicians or suitable equipment is limited, individuals are left without any support. As the number of people with diabetes increases this manual detection system will become even more insufficient.

2. Problem Statement :

To create an automated analysis system capable of classifying a retinal image for the presence of diabetic retinopathy. It is a binary classification problem. The input to the model is a pre-processed 256px x 256px retina image and the output is a class label indicating whether or not the retina has DR.

3. Datasets and Inputs :

A subset of dataset of retina images from the Kaggle competition is used for the project(https://www.kaggle.com/c/diabetic-retinopathy-detection).These are a set of high resolution retina images taken in a variety of conditions, including different cameras, colors, lighting and orientations. For each person there is an image of their left and right eye, along with a DR classification diagnosed by a clinician.

4. Solution Statement:

I chose to use Convolutional Neural Networks(CNN) model to solve the image classification problem. CNN is a class of deep, feed-forward artificial neural networks that has successfully been applied to analyzing visual imagery.

The images are of large size (approximately 3000*2000 pixels) and most of the images contain black border as black color is used as the background of the retina. To remove most of these black borders, the images should be downscaled by a factor like 3 or 5.

Since images are taken using different cameras and under different environmental conditions, data augmentation techniques like random crops, random shear, random rotation by x degree, flipping images randomly are needed to be done. Resizing of the data is to be done after cropping the images so the latter data transformations requires less computations.

The common preprocessing techniques for images like mean subtraction which involves subtracting the mean across every individual feature in the data and Normalization can be applied to make the pixel values in the range of 0 to 1.

5. Benchmark Model:

The data set has a total of 9504 images comprising 7315 healthy retina images and 1581 DR affected images. If the model naively predicts every image every image as healthy image then the accuracy is 76.96%. This can be considered as benchmark model accuracy because this is the accuracy where the model does not learn anything.

6. Evaluation Metrics:

The performance of the built model is evaluated using accuracy score and f1_score. Accuracy score can be interpreted as the degree to which the predicted class label conforms to the correct value . The F1 score can be interpreted as a weighted average of the precision and recall, where an F1 score reaches its best value at 1 and worst score at 0.

7. Project Design:

The preprocessed and augmented data which is ready to be given as input to the CNN is fed as batches to a series of convolutional layers along with maxpooling. The convolutional layers are followed by flattening function to convert the multidimensional data to

flatten and can be fed as input to the fully connected layers. The fully connected layers are subjected to alternate dropout functions to reduce overfitting. Thus a decent regularization can be done. Then optimization is done using techniques like Adam optimizer. The model is trained in batches and the built model is used to predict the class label of the test data. Then the model is evaluated using our evaluation metrics.