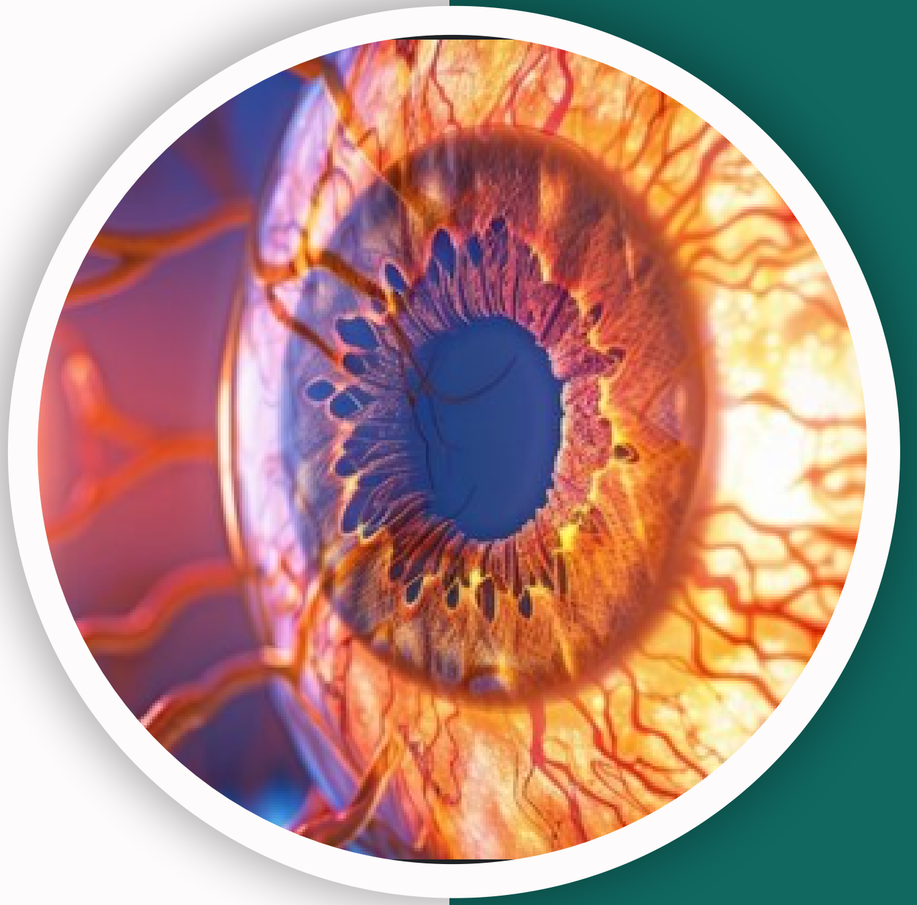
IML-CSL2010 Team 29
Course project

Retinal Image Analysis for Classification of Diabetic Retinopathy

A Machine Learning Approach



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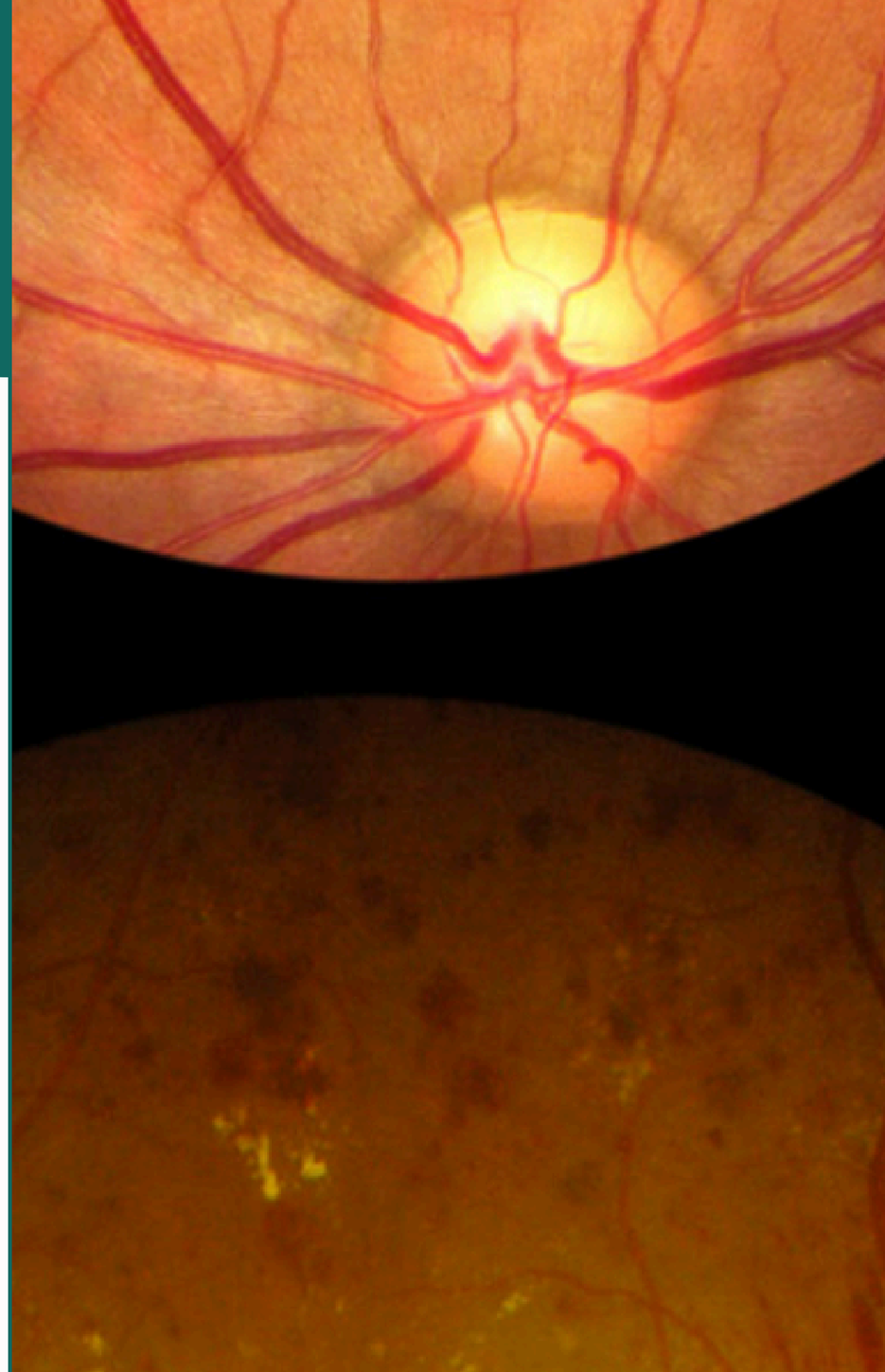
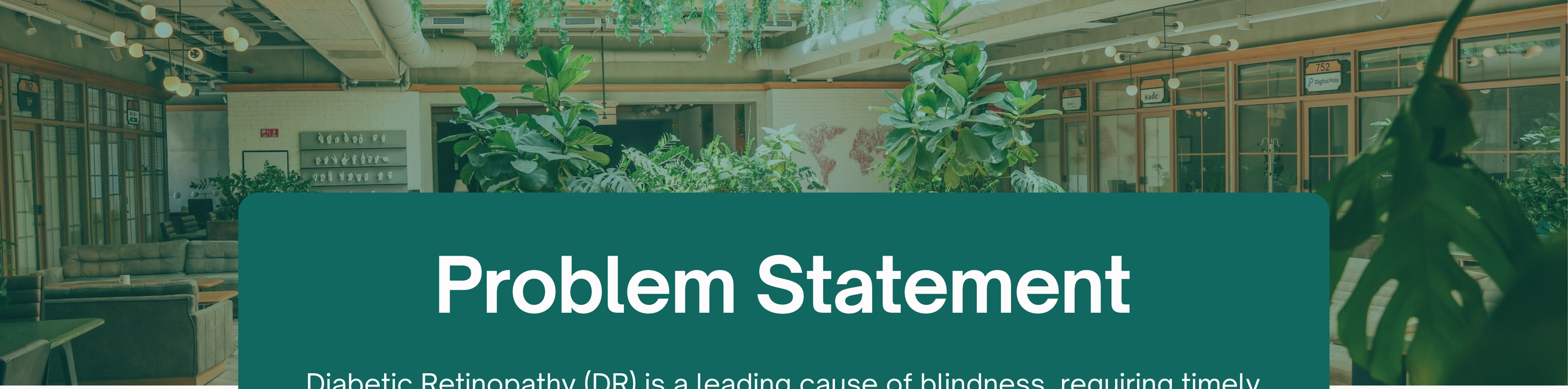




Problem Statement

Diabetic Retinopathy (DR) is a leading cause of blindness, requiring timely detection to prevent vision loss. Current diagnostic methods are manual and time-consuming, leading to treatment delays. An automated solution could enable faster, more accurate DR detection from retinal images, improving patient outcomes.

Need of Diabetic Retinopathy Detection

Diabetic retinopathy is a leading cause of vision impairment and blindness among adults, resulting from damage to the blood vessels of the retina due to prolonged high blood sugar levels. Early detection is critical because, in the initial stages, the condition often has no symptoms but can progress rapidly, leading to severe vision loss or blindness.

Benefits of Early Diagnosis:

- Prevent Vision Loss: Early diagnosis allows timely intervention through treatments such as laser therapy, medication, or surgery, significantly reducing the risk of blindness.
- Better Management: Early intervention can help control disease progression and improve the patient's quality of life.
- Cost-Effective: Preventing severe complications through early screening reduces healthcare costs associated with advanced treatments.

Automated screening tools powered by machine learning can help improve detection rates, making early diagnosis more accessible and efficient.

Objective: To develop an accurate and efficient model that assists medical professionals in diagnosing retinal conditions promptly.

Multiclass Model

01 Objectives:

- Detect and classify Diabetic Retinopathy stages from retinal images.
- Aim: Provide a reliable, automated system to aid early diagnosis and prevent blindness.

02 Selected Dataset:

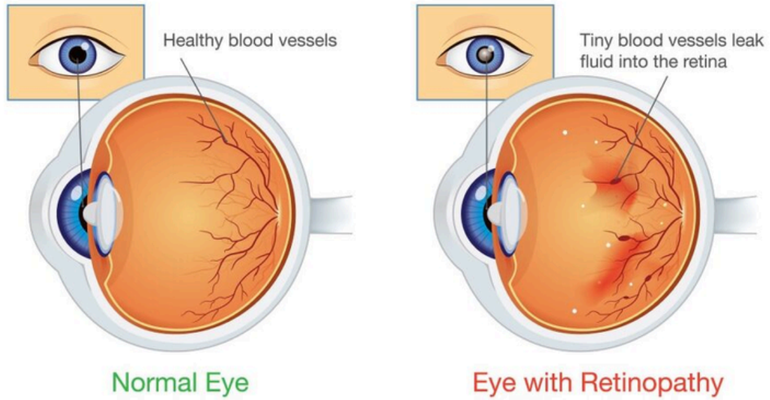
Diabetic Retinopathy 224x224 Gaussian Filtered

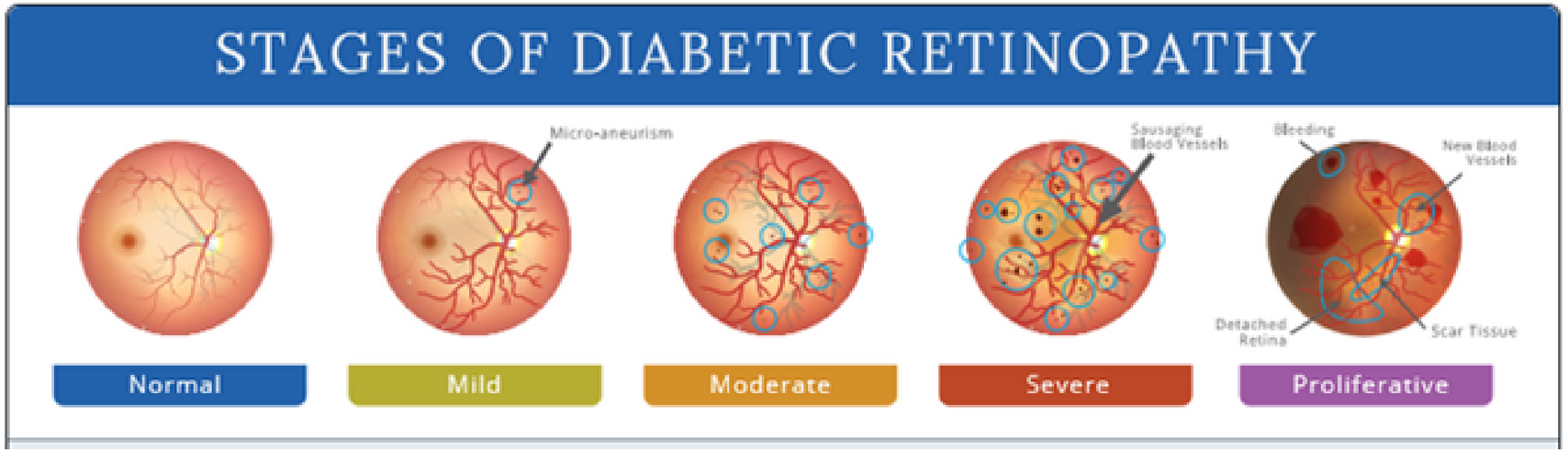
- The images consist of gaussian filtered retina scan images to detect diabetic retinopathy.
- All of the images are already saved into their respective folders according to the severity/stage of diabetic retinopathy using the train.csv file provided. You will find five directories with the respective images:

0 - No_DR
1 - Mild
2 - Moderate
3 - Severe
4 - Proliferate_DR

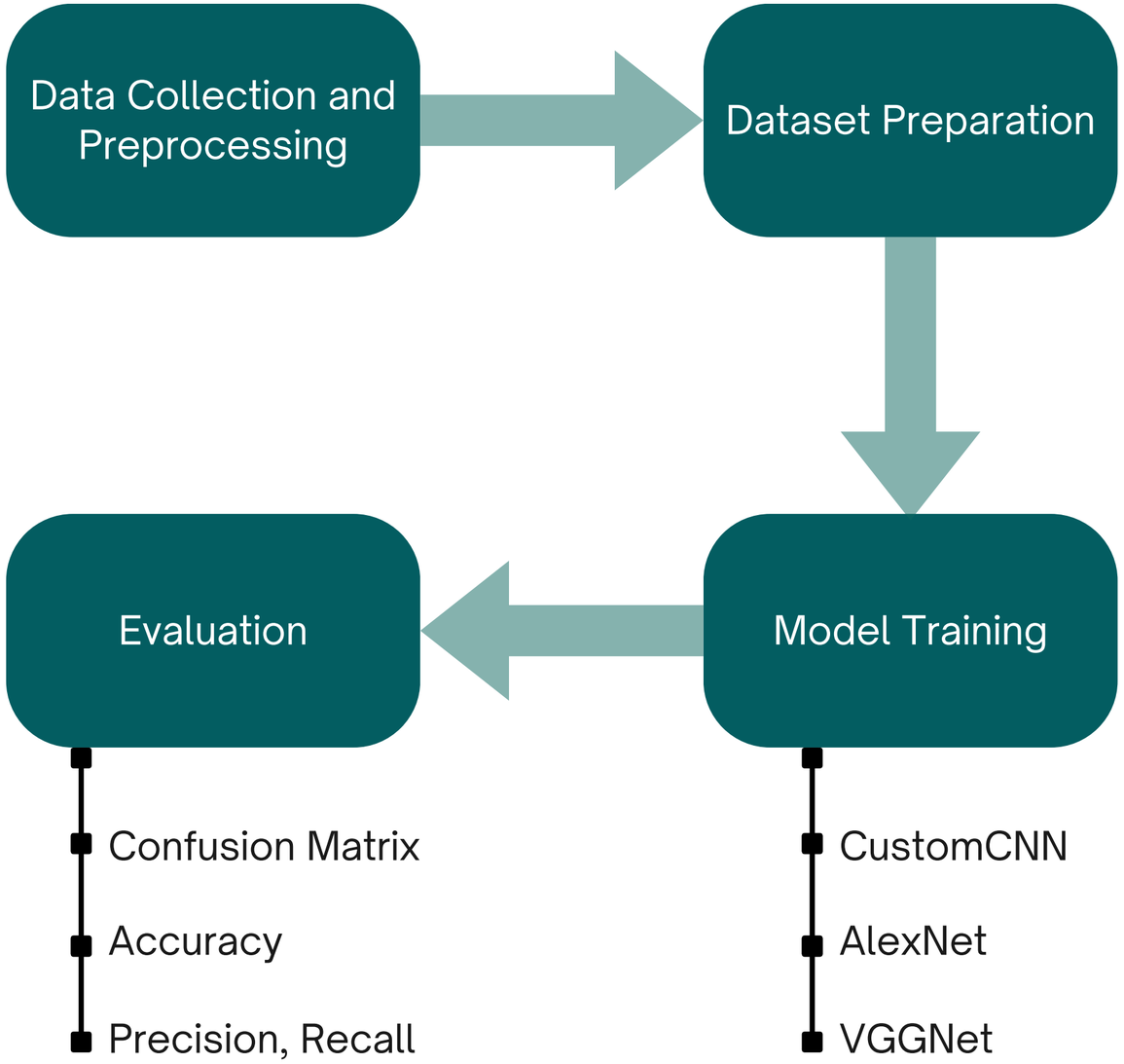
Understanding the Stages of Diabetic Retinopathy

Elevated blood sugar, blood pressure and cholesterol levels and increased body weight are associated with uncontrolled diabetes and can damage the delicate blood vessels of the retina, causing a disease called diabetic retinopathy. In the early stages of diabetic retinopathy, vision loss may be prevented or limited; but as the condition advances, it becomes more difficult to prevent vision loss.





Workflow and Libraries Used



PyTorch

scikit learn

Models Selection

01

CustomCNN

The CustomCNN is a CNN model with three convolutional layers for feature extraction, followed by a fully connected layer and dropout for classification across five classes.

02

AlexNet

The CustomAlexNet is a modified AlexNet model with five convolutional layers for feature extraction, followed by fully connected layers with dropout for classification across five classes.

03

VGG

The CustomVGG model is a VGG-style architecture with multiple convolutional and pooling layers for feature extraction, followed by fully connected layers with dropout for classifying five categories.

Models Evaluation

01

CustomCNN

Accuracy: 0.7364,
Precision: 0.6755,
Recall: 0.7364,
F1: 0.6908

02

AlexNet

Accuracy: 0.7127,
Precision: 0.6413,
Recall: 0.7127,
F1: 0.6705

03

VGG

Accuracy: 0.7055,
Precision: 0.5826,
Recall: 0.7055,
F1: 0.6275

Observations

Recall

This shows we have less number of Type I error i.e. False Negatives which is essential for this project as a Medical Classifier.

Precision

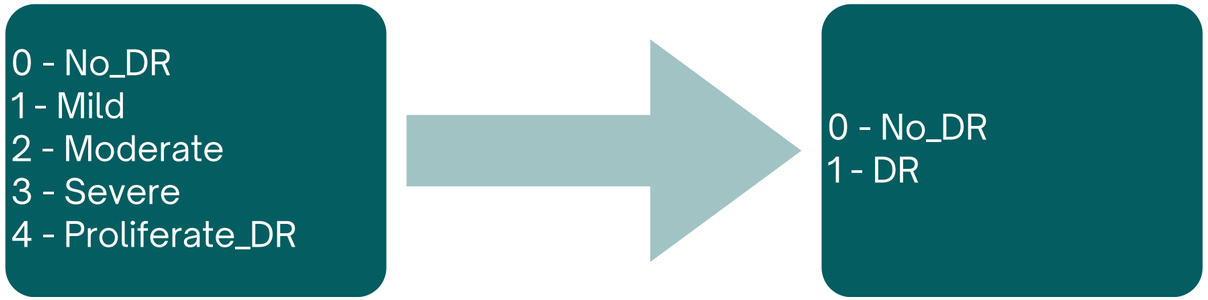
These values are low, Reason Could be the Distribution of the project.

Binary Model

01 Objectives:

- Simplification of the model to Binary Classification
- Aim: Classify retinal images as either diseased or healthy.
- Reason: We need to perform better in terms of Recall and Precision

02 Classes Conversion:



Models Selection

CustomCNN

The CustomCNN class is a PyTorch convolutional neural network for binary image classification of RGB images. It features three convolutional layers with max pooling and batch normalization for effective feature extraction, followed by a fully connected layer with dropout to prevent overfitting. The output layer has two neurons representing class probabilities, making this model suitable for various computer vision tasks.

Observations

Since Because of Simpler models we got a good results in terms of precision and recall

Recall

This shows we have less number of Type I error i.e. False Negatives which is essential for this project as a Medical Classifier.

Precision

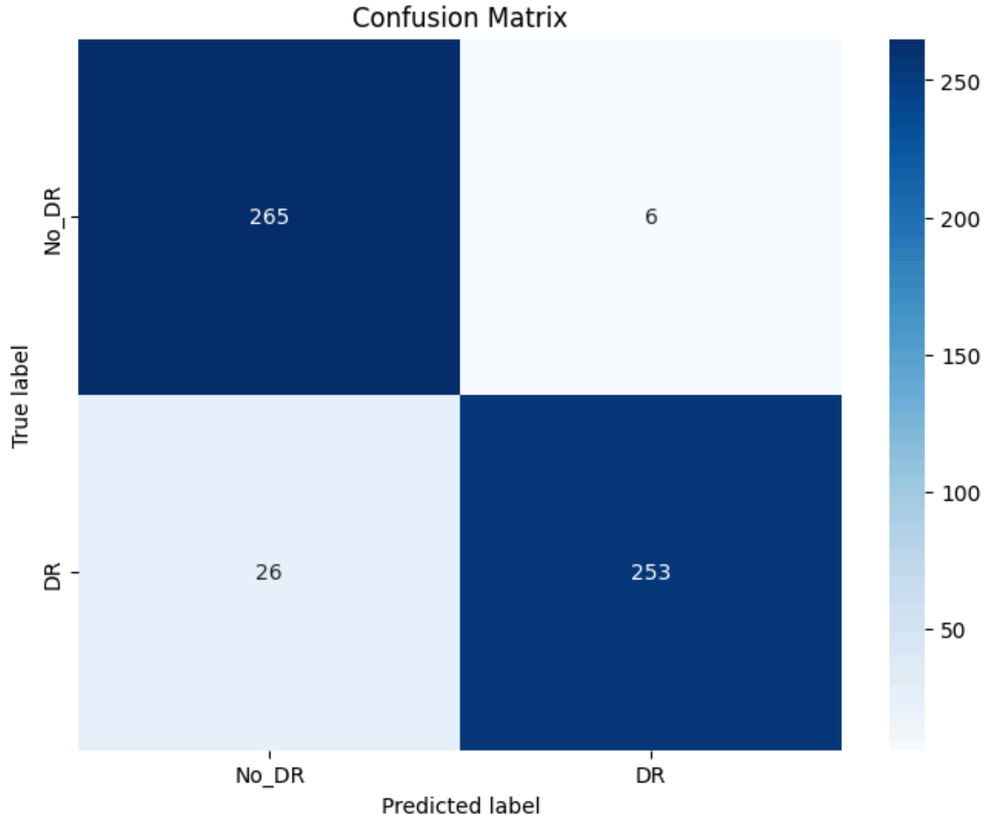
These values are low, Reason Could be the Distribution of the project.

Hyperparameter Tuning and Final model

This code performs hyperparameter tuning for a convolutional neural network (CNN) using the CustomCNN model by testing combinations of learning rates, batch sizes, epochs, and dropout rates. The train_with_hyperparameters function trains the model, evaluates its accuracy on a validation set, and identifies the best-performing configuration. It outputs the highest accuracy and the corresponding optimal hyperparameters after testing all combinations using grid search.

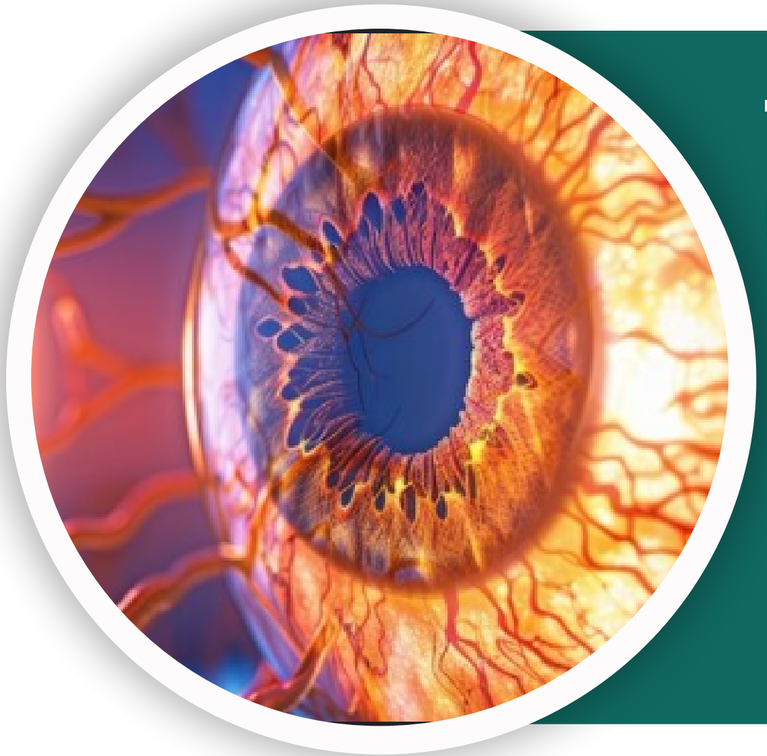
Accuracy

This is the best accuracy we got with the Hyperparameter Tuning
Best Params: 'learning_rate': 0.0001, 'batch_size': 64, 'num_epochs': 15, 'dropout_rate': 0.1



Conclusion

The Best Precision, Recall we got from our Multiclass model were, 73.6% and 67.55%. The confusion matrix shows that the number of true negatives are relatively low in the model so model has a good approach over medical study. While Binary Classification gives use the best results because of simplistic and robust model with an Recall and Pression of 95% each. We can use both the models, the Multiclass is more specific in terms of classes while the Binary Model is more Accurate.



THANK YOU

For watching this presentation

Team 29

- Prasangeet Dongre (B23CH1033)
- Rajas Hitendra Kadu (B23CH1039)
- Pujari Mayuri Rajesh (B23ES1026)
- Prakhar Chauhan (B23BB1032)