SDP END-TERM EVALUATION

DIABETIC RETINOPATHY USING DEEP LEARNING

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Group L2

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Presentation Outline

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What is Deep Learning?

Deep learning is the **subset** of **machine learning** methods based on **neural networks** with representation learning. The adjective "**deep**" refers to the **use** of **multiple layers** in the **network**. Methods used can be either **supervised**, **semi-supervised** or **unsupervised**.

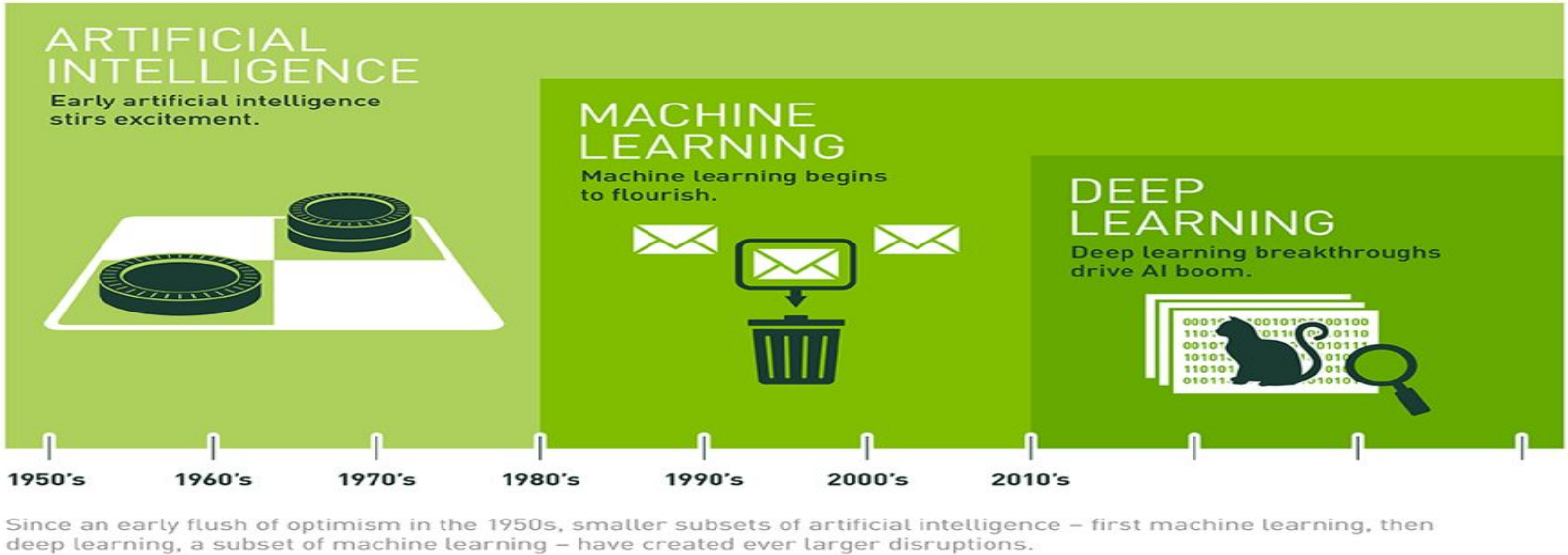

Fig 1 : Timeline of Deep Learning

Source: https://images.app.goo.gl/adJWJTm1M9rrRnHW9

Diabetic Retinopathy (DR)

- Diabetic retinopathy is an **eye disease** caused by **diabetes**.
- Progressive dysfunction of the retinal blood vessels caused by chronic **hyperglycemia**.
- DR can be a complication of diabetes type 1 or diabetes type 2.
- Initially, DR is **asymptomatic**, if not treated though it can cause **low vision** and **blindness**.

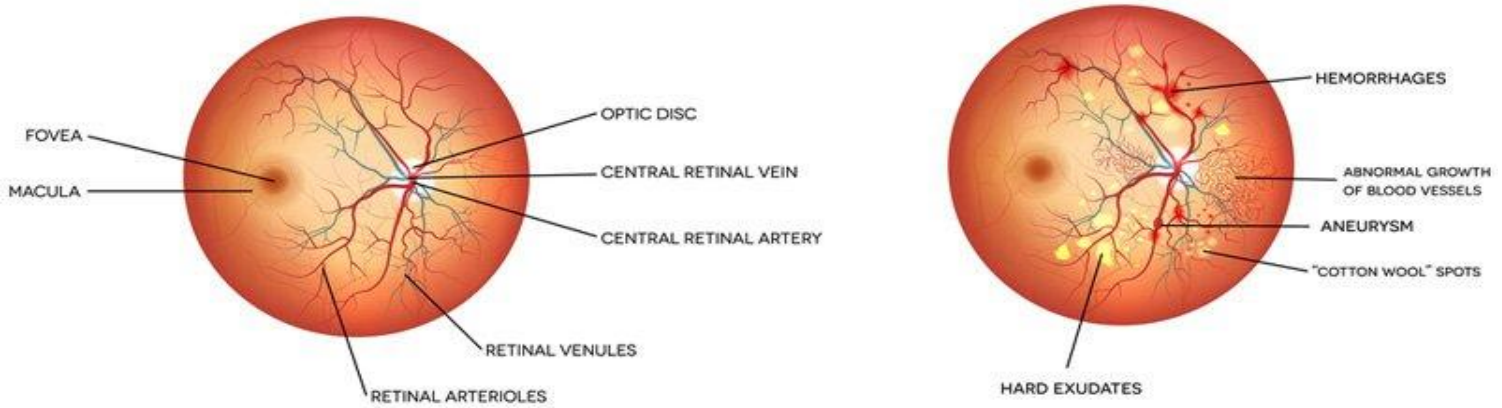

Fig 2: Normal Retina Vs Diabetic Retinopathy infected eye
Source: https://images.app.goo.gl/GJDfze48UA8tUQCD7

Literature Survey

Different stages for Diabetic retinopathy

- Mild non-proliferative retinopathy
- Moderate non-proliferative retinopathy
- Severe non-proliferative retinopathy
- Proliferative diabetic retinopathy (PDR)

Symptoms and Detection

- Problems with night vision
- Halo’s around lights
- Blurred vision
- Dark or empty spots in the centre of your vision

Literature Survey Cont'd..

Detection and diagnosis of diabetic retinopathy : Diabetic retinopathy can be detected by undergoing a **comprehensive eye examination** that emphasises on the **evaluation** of specifically the **retina** and **macula**. Such a test may include:

- ***Visual acuity measurements*** – measuring a patient's ability to see at different distances.
- ***Patient history*** – to determine the presence of diabetes, vision impairments and other general health issues that may affect vision.
- ***Tonometry*** – Measuring pressure within the eye.
- ***Refraction*** – to establish whether a prescription for new glasses is required.
- ***Pupil dilation*** – evaluation of eye structures, including assessment of the retina and optic nerve through a dilated pupil.

Experimentation

Dataset Description

- The images consist of **gaussian filtered** retina scan **images** to detect diabetic retinopathy. The original dataset is available at APTOS 2019 Blindness Detection. These images are resized into 224x224 pixels so that they can be readily used with many pre-trained deep learning models.
- All of the images are already saved into their respective folders according to the severity/stage of diabetic retinopathy. You will find five directories with the respective images:

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

Exploratory Data Analysis

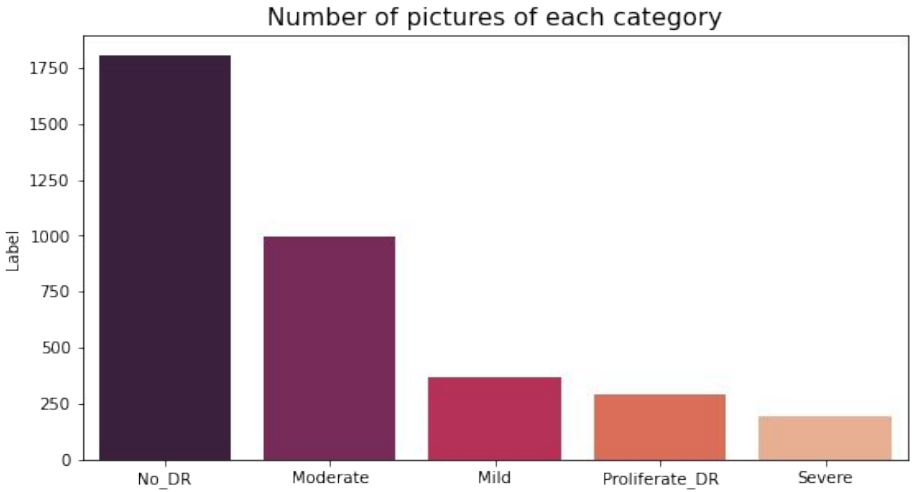

Fig 3: Bar Graph representation of NO_DR, MODERATE, MILD, PROLIFERATE, SEVERE

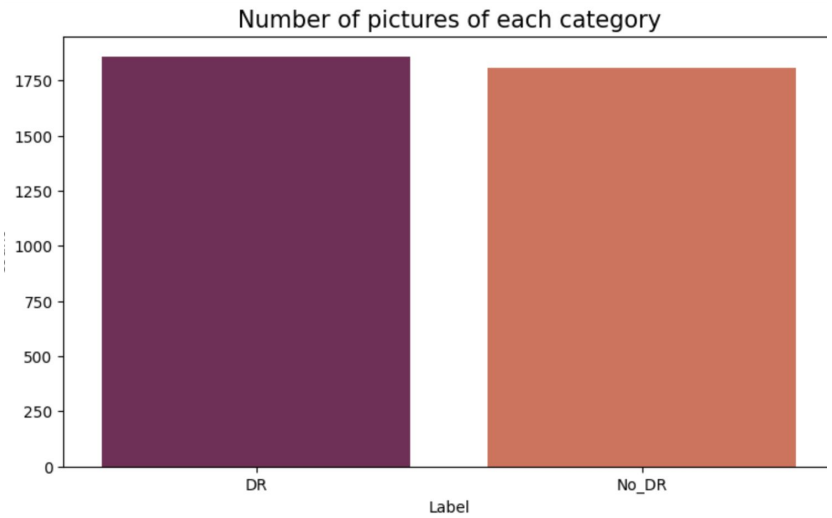

Fig 4: Bar Graph representation of DR vs NO_DR

Exploratory Data Analysis

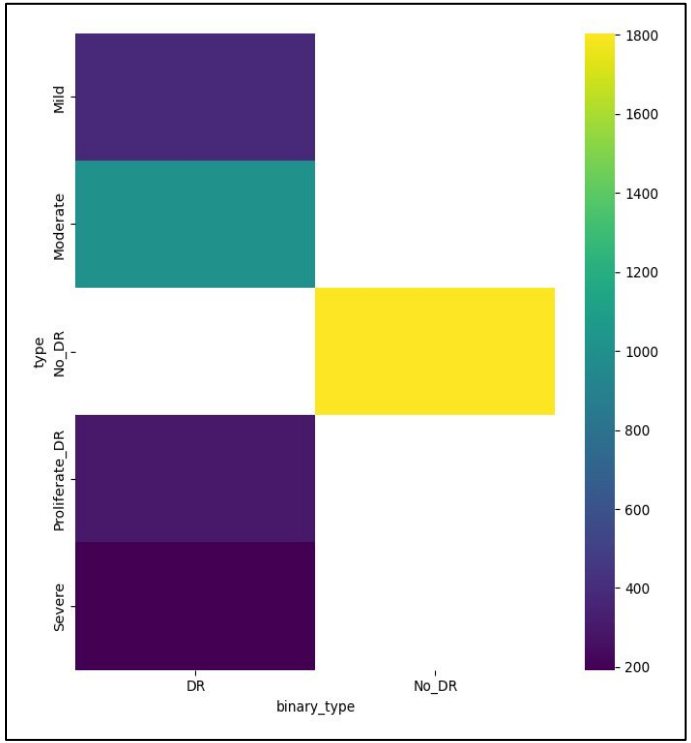

Fig 5: Heatmap Showing DR types Vs NO_DR

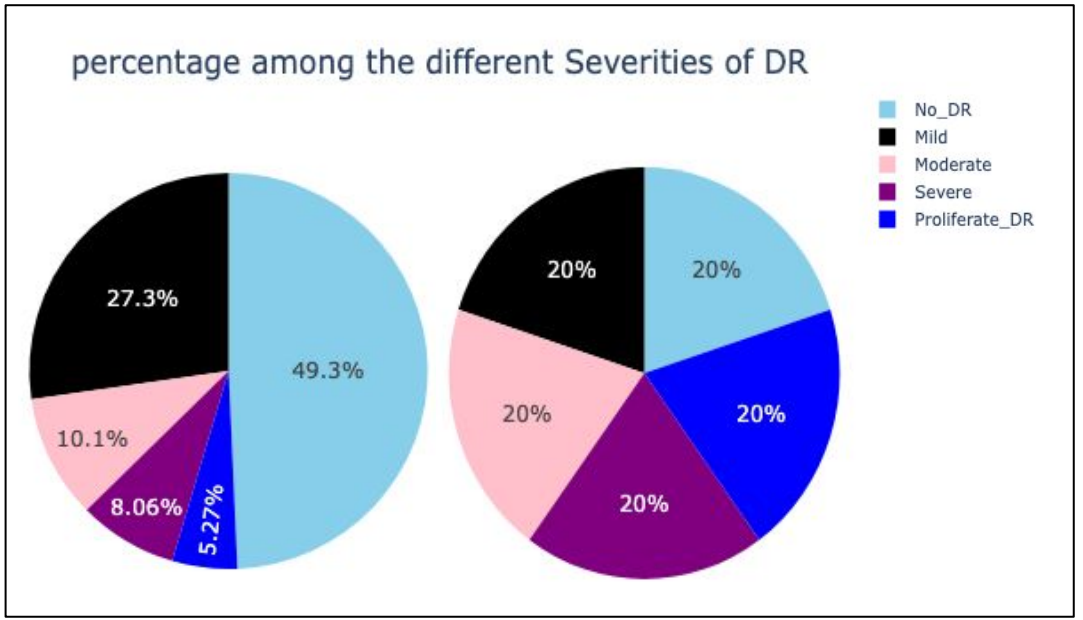

Fig 6: Pie chart showing original dataset distribution Vs Pre Trained dataset distribution

Exploratory Data Analysis Cont'd..

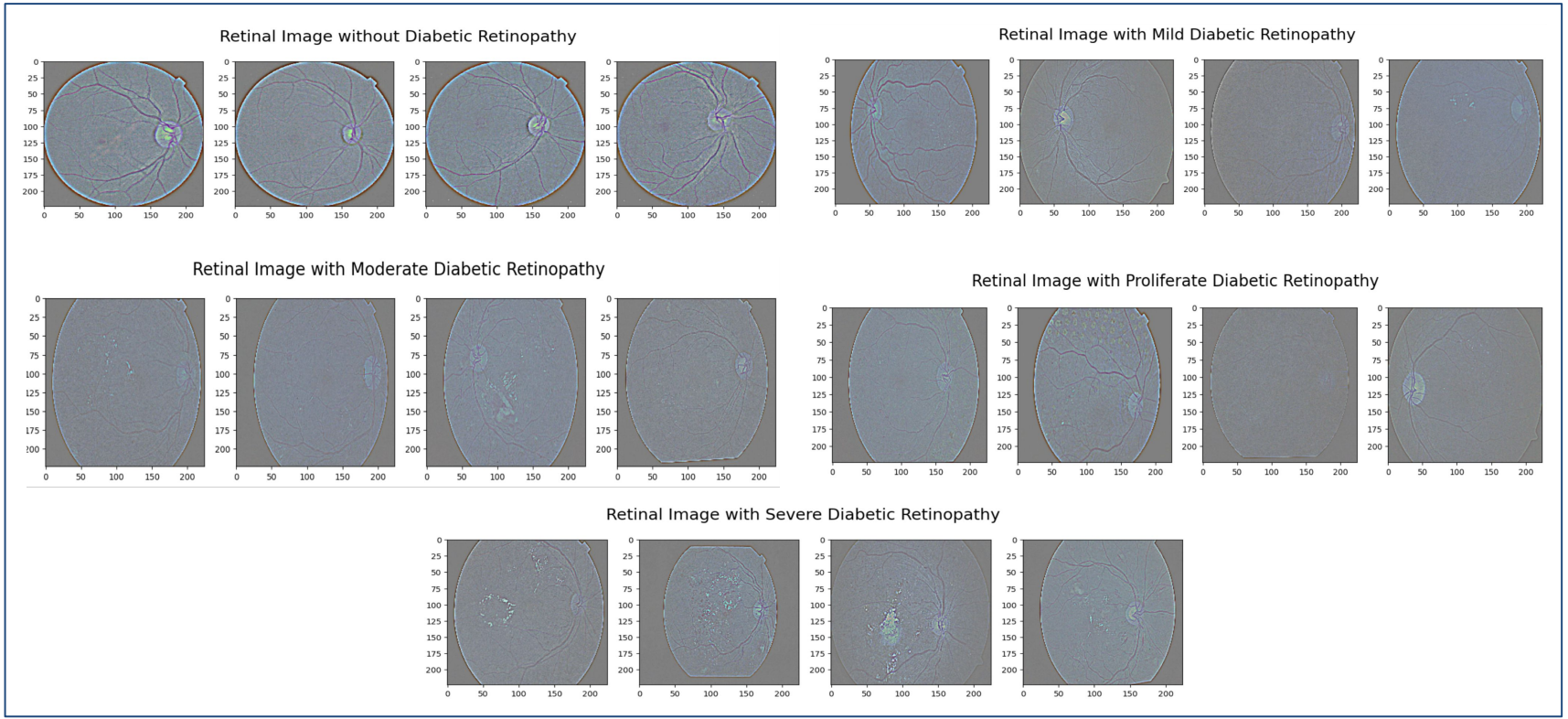

Fig 7: Pictographic representation of NO_DR and different stages of DR with captions

Approach towards the Problem Statement

- **CNN (Convolutional Neural Networks)**
  A convolutional neural network (CNN) is a category of machine learning model, namely a type of deep learning algorithm well suited to analyzing visual data.
- **Pretrained Models**
  A pretrained model is a deep learning model that has been trained on large datasets to solve a specific task.
- **Ensemble Models**
  machine learning techniques that combine multiple models to improve the accuracy of predictions
- **Binary Classification**
  a machine learning algorithm that uses training data to predict a binary outcome, such as positive or negative

- **CNN (Convolutional Neural Networks)**

  CNNs use a series of **convolution** and **pooling layers** to **extract features** from images and videos, and then use these features to **classify** or **detect objects** or scenes. It's useful for **finding patterns** in images to *recognize objects*, *classes*, and *categories*. They can also be quite effective for classifying audio, time-series, and signal data.

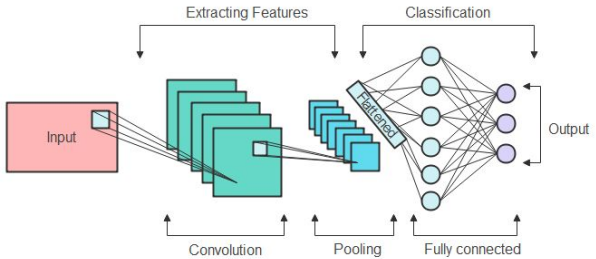

Fig 8: CNN Model Diagram
Source: https://images.app.goo.gl/bgkLRctefviukF6H8

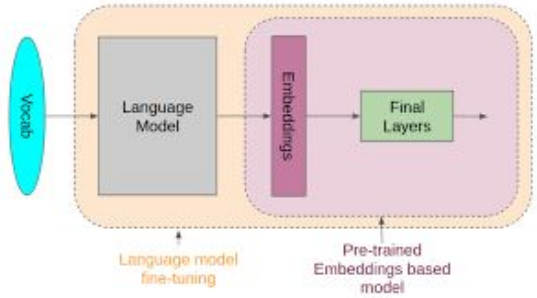

Fig 9: Pretrained Model Diagram
Source: https://images.app.goo.gl/z6tMguvMxcnXsEBy8

- **Pretrained Models**

  Pretrained Models are a deep learning model that's **trained** on **large datasets** to accomplish a **specific task**, and it can be used as it is or **customized** to **suit application** requirements. PM allows for knowledge transfer and can **improve** the **accuracy** of models in the target domain, even with **limited** training **data**

- **Ensemble Models**
  Ensemble models are a machine learning **approach** to **combine** multiple other **models** in the **prediction process**. These models are referred to as base estimators. Ensemble models offer a solution to overcome the **technical challenges** of building a **single estimator**.

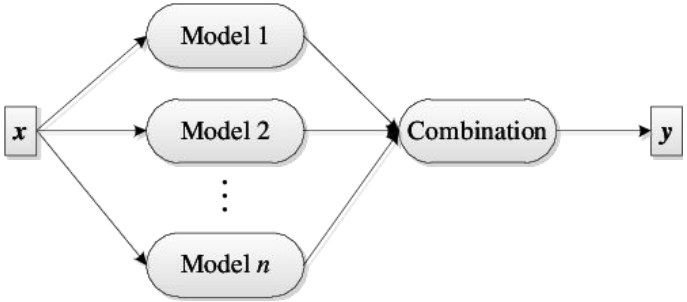

Fig 10: Ensemble Model Diagram
Source: https://images.app.goo.gl/wHBwcraN3yUgCAHH7

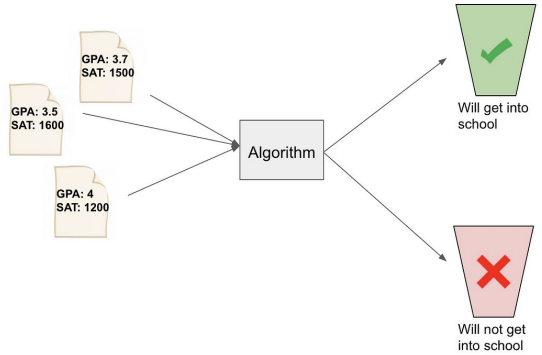

Fig 11: Binary Classification Model Diagram
Source: https://images.app.goo.gl/CRf2ygP3MHthnH5U9

- **Binary Classification**
  Binary classification is a machine learning algorithm that **classifies data** into **two categories**, or classes, based on a classification rule. The result of binary classification is either **positive** or **negative**, and the goal is to accurately predict the answer to a **yes** or **no** question.

Methods, Tools & Algorithms Used

- **DenseNet121**: Dense connectivity between layers, reducing the vanishing-gradient problem.
- **MobileNet**: Designed for mobile and embedded vision applications, using depth-wise separable convolutions for efficiency.
- **InceptionV3**: Efficient use of computational resources with multiple kernel sizes within inception modules.
- **Xception**: An extension of Inception modules using depthwise separable convolutions for complex pattern recognition.
- **ResNet101V2**: Addresses vanishing-gradient problem with residual connections, enabling training of deeper neural networks.
- **CNN**: Convolutional Neural Network architecture widely used in computer vision tasks for feature extraction and pattern recognition.

Experimentation and Results

CNN

Unbalanced (10 epochs)

F1 score	Accuracy	Precision	Recall
35.2%	37.4%	33.6%	37.4%

Table 1 (a): Performance metrics of CNN model on unbalanced dataset

Balanced (10 epochs)

F1 score	Accuracy	Precision	Recall
71.8%	73.2%	70.8%	73.1%

Table 1 (b): Performance metrics of CNN model on balanced dataset

Experimentation and Results Cont'd..

Pretrained models

Unbalanced (10-epochs)

Model name	Accuracy	Precision	Recall	F1-score
DenseNet121	87.6	77.2	77.2	77.2
MobileNet	94.8	78.4	78.4	78.4
Xception	85.1	77.5	77.5	77.5
InceptionV3	91.8	76.8	76.8	76.8
ResNet101V2	94.5	76.9	76.9	76.9

Table 2 (a): Performance metrics of pre-trained models on unbalanced dataset

Balanced (10-epochs)

Model name	Accuracy	Precision	Recall	F1-score
DenseNet121	99.28	93.52	93.52	93.52
MobileNet	98.02	91.80	91.80	91.80
Xception	92.44	86.76	86.76	86.76
InceptionV3	97.29	88.86	88.86	88.86
ResNet101V2	98.53	91.69	91.69	91.69

Table 2 (b): Performance metrics of pre-trained models on balanced dataset

Experimentation & Results Cont'd..

Ensemble

Unbalanced (5-epochs)

Model name	Accuracy	Precision	Recall	F1-score
Average	69.78	69.85	69.85	69.85
Weighted Average	70.33	70.26	70.26	70.26

Fig 3 (a): Performance metrics of ensemble models on unbalanced dataset

Balanced (5-epochs)

Model name	Accuracy	Precision	Recall	F1-score
Average	99.28	94.96	94.96	94.96
Weighted Average	99.39	95.40	95.40	95.40

Fig 3 (b): Performance metrics of ensemble models on balanced dataset

Experimentation & Results Cont'd..

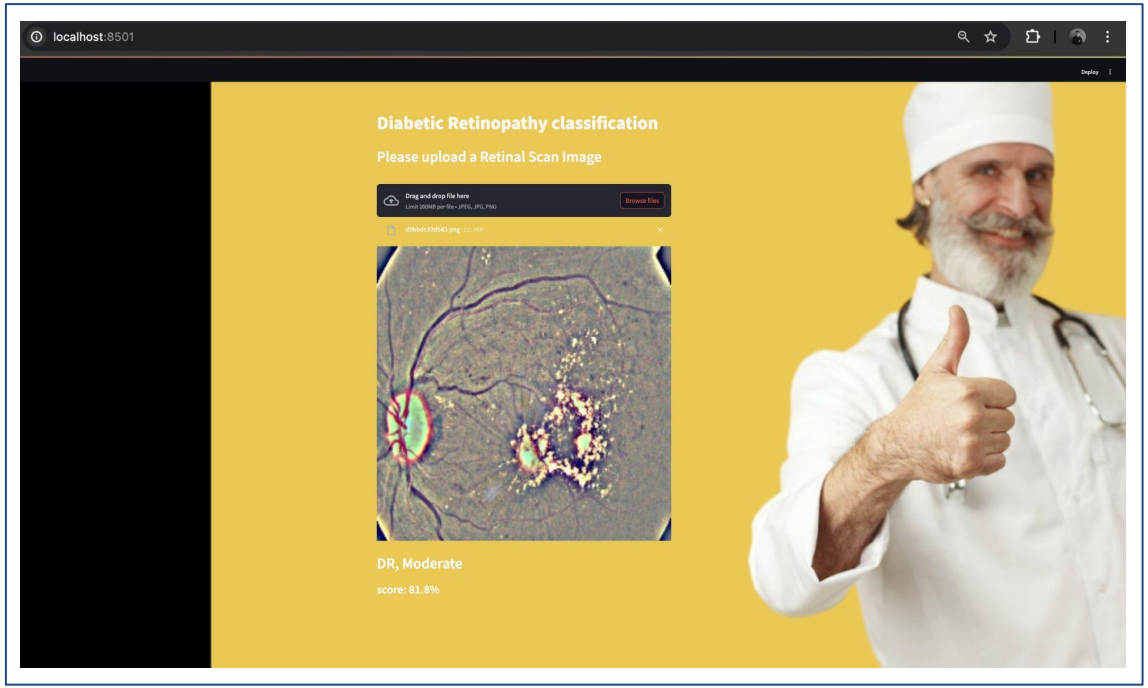

Fig 11: Retinal scan classified into DR with a moderate sub-category by the web app

Result Analysis and Validation

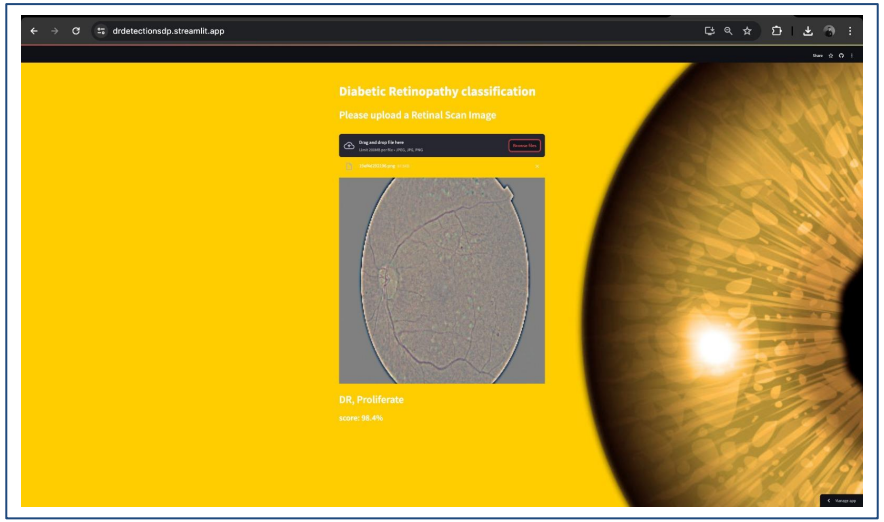

Fig 12: Retinal scan classified into DR with a proliferate sub-category by the web app

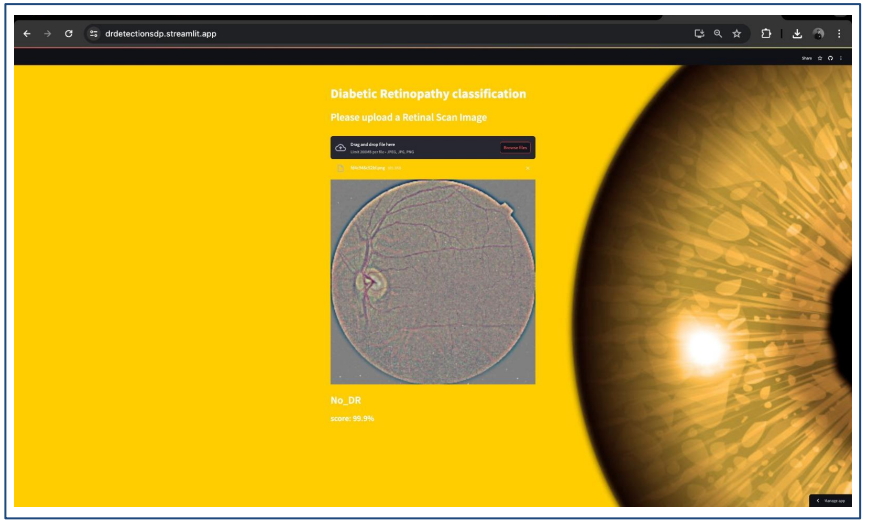

Fig 13: Retinal scan classified into No DR by the web app

Binary Classification

The model is highly accurate in classifying the retinal scans into DR or No DR. The model needs to be trained further to classify DR into subcategories.

Conclusion and Future Scope

1 Existing system

All classes of DR were not taken into consideration, necessitated the need of concepts as ensemble learning to achieve better accuracy

2 Model Selection

Researched and tested various deep learning models and selected Ensemble model

3 Balanced Dataset

Prevents the model from becoming biased

4 Accuracy

Achieved an accuracy of 99.39% with balanced weighted average ensemble model

5 Web based App

Designed a static webpage to allow users to enter their scans and get the prediction

Future Scope

With advancements in machine learning algorithms, a better accuracy can be achieved. → Activation functions can be improved for training the model efficiently

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Thank You