Automatic Classification Of The Preliminary Diabetic Retinopathy Stages

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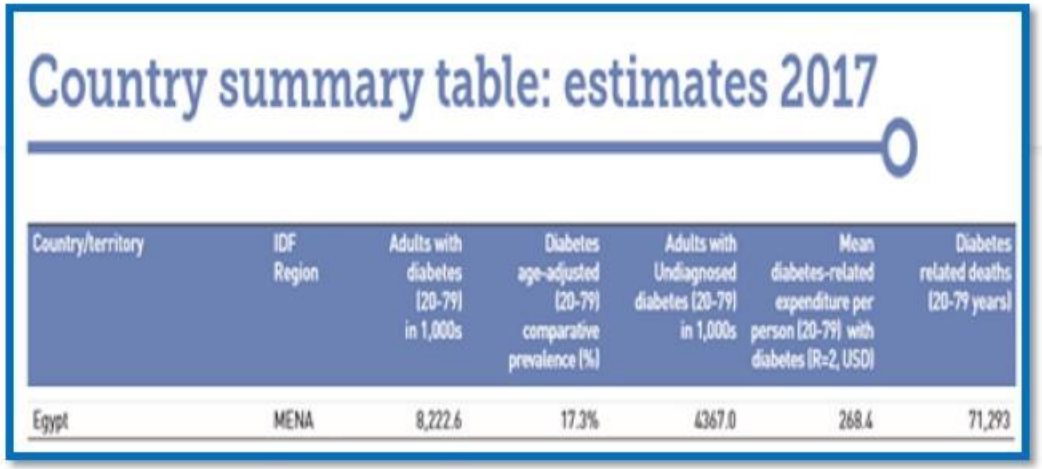
OUTLINE

INTRODUCTION

- As of 2017, around 2.73 million Diabetic Retinopathy (DR) patients have been identified in Egypt [1].



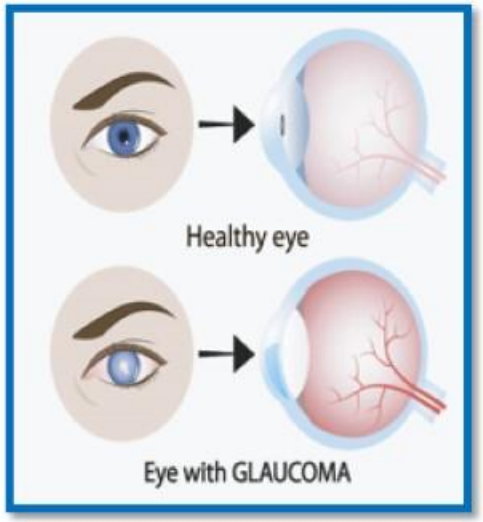
Country summary table: estimates 2017

Country/territory	IDF Region	Adults with diabetes (20-79) in 1,000s	Diabetes age-adjusted (20-79) comparative prevalence (%)	Adults with Undiagnosed diabetes (20-79) in 1,000s	Mean diabetes-related expenditure per person (20-79) with diabetes (IR=2, USD)	Diabetes related deaths (20-79 years)
Egypt	MENA	8,222.6	17.3%	4367.0	268.4	71,293

- Diabetic Retinopathy (DR) Challenges & Tasks:

1- (DR) can lead to more severe consequences such as total blindness and/or Glaucoma.

2- Manual Classification of (DR) is not always accurate.



- Eye Affected By Glaucoma

[1] International Diabetes Federation. "IDF Diabetes Atlas 8th Edition (2017)." (2017).

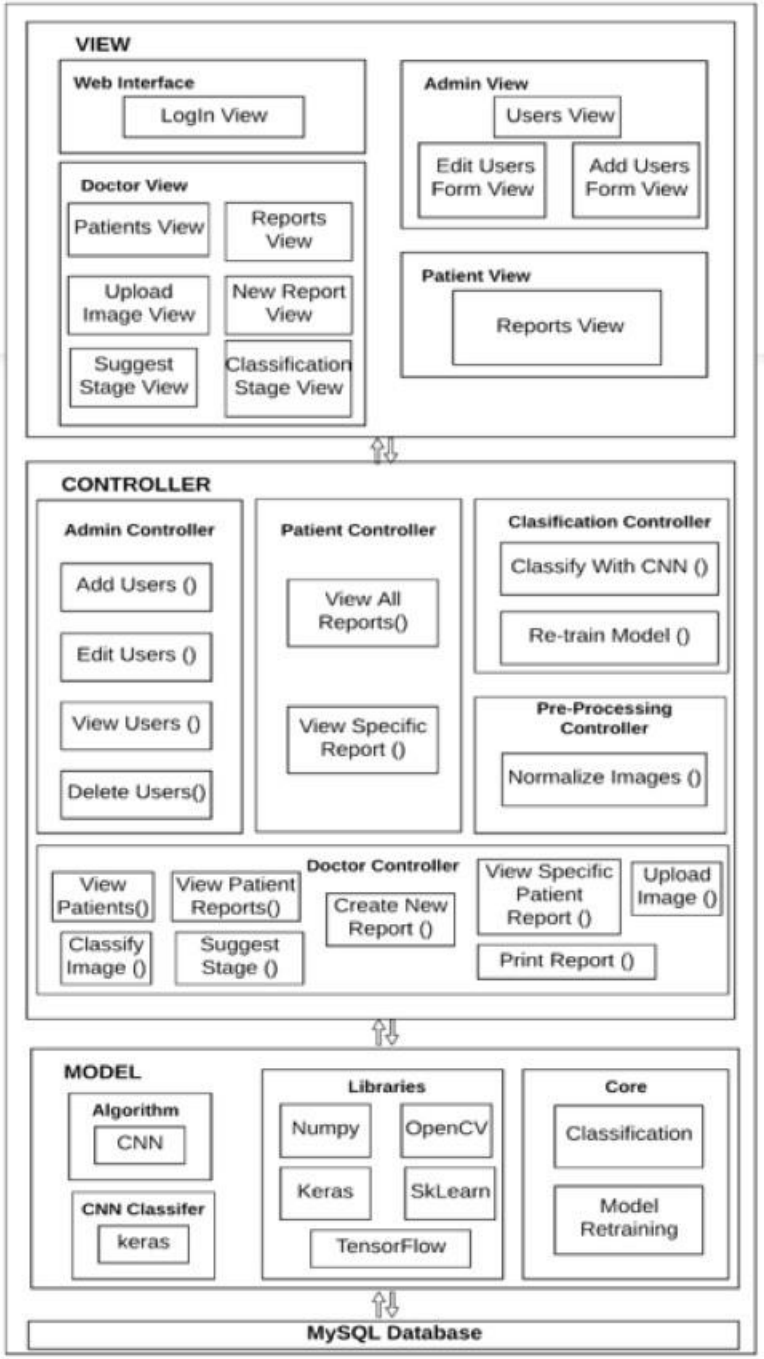
PROBLEM STATEMENT

- Automatically Detecting the presence of Diabetic Retinopathy and Classifying the different Stages of the disease in the patient's body.

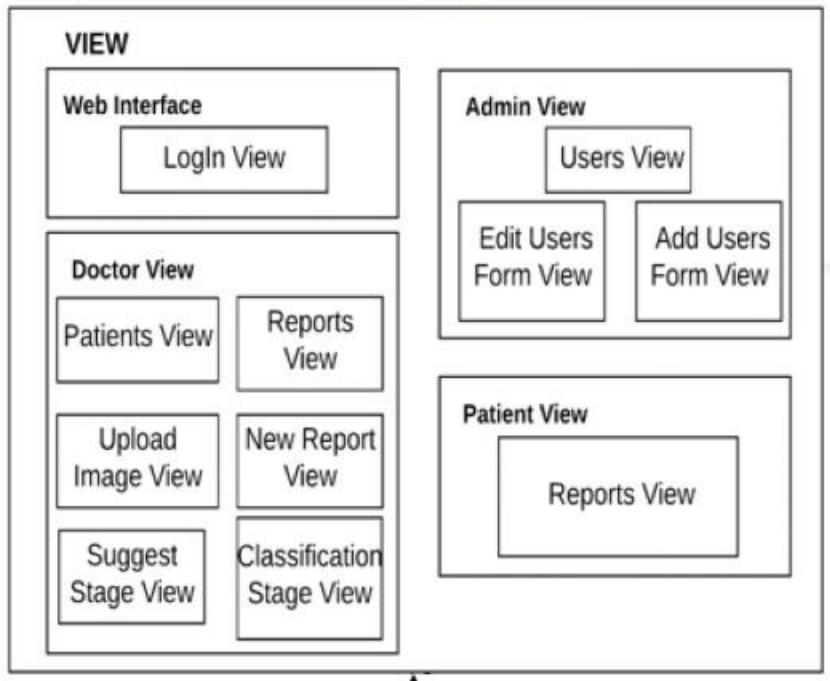
- We aim to minimize and reduce the inaccurate and erroneous diagnosis of (DR), and increase the classification accuracy rate among the four different stages of the disease.

Architectural Design

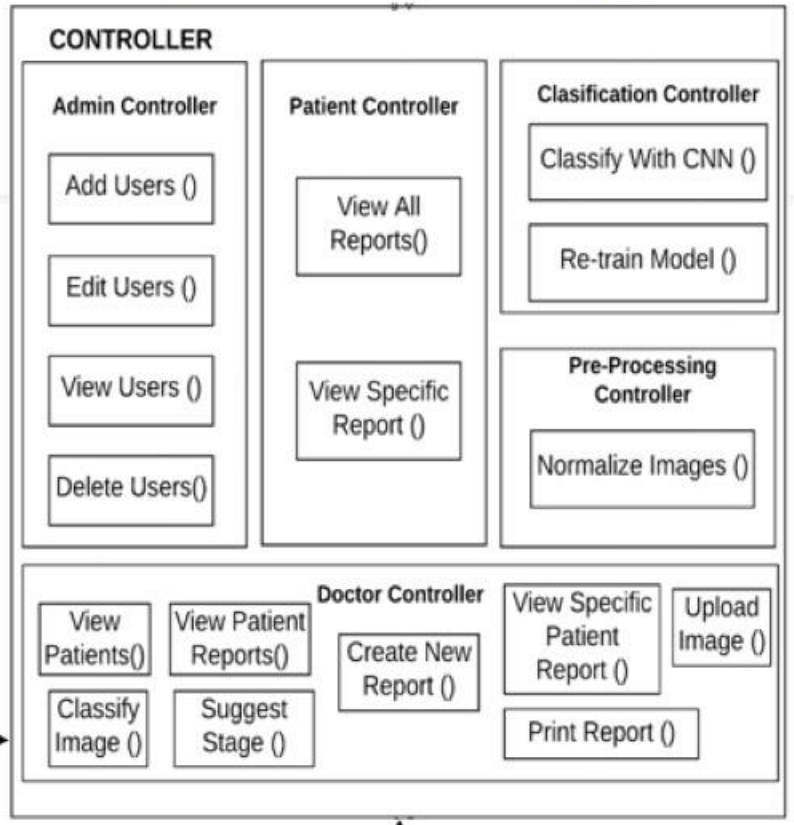
System Architecture FULL VIEW



#1 VIEW Layer

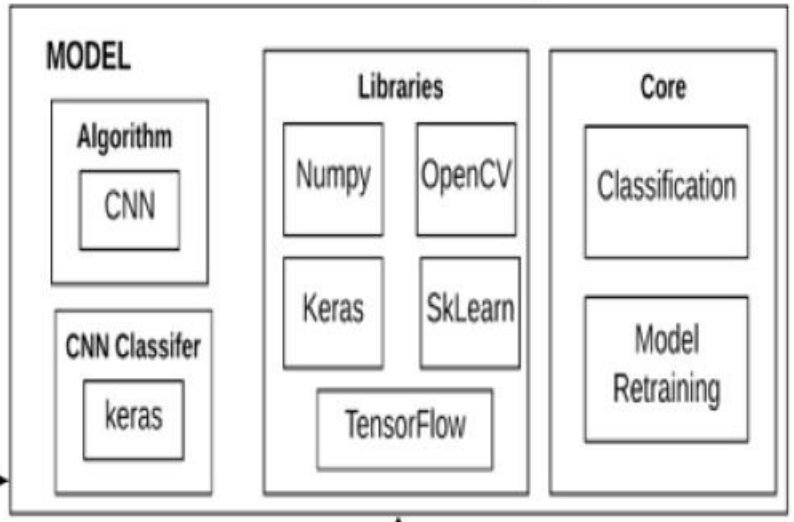


#2 CONTROLLER Layer



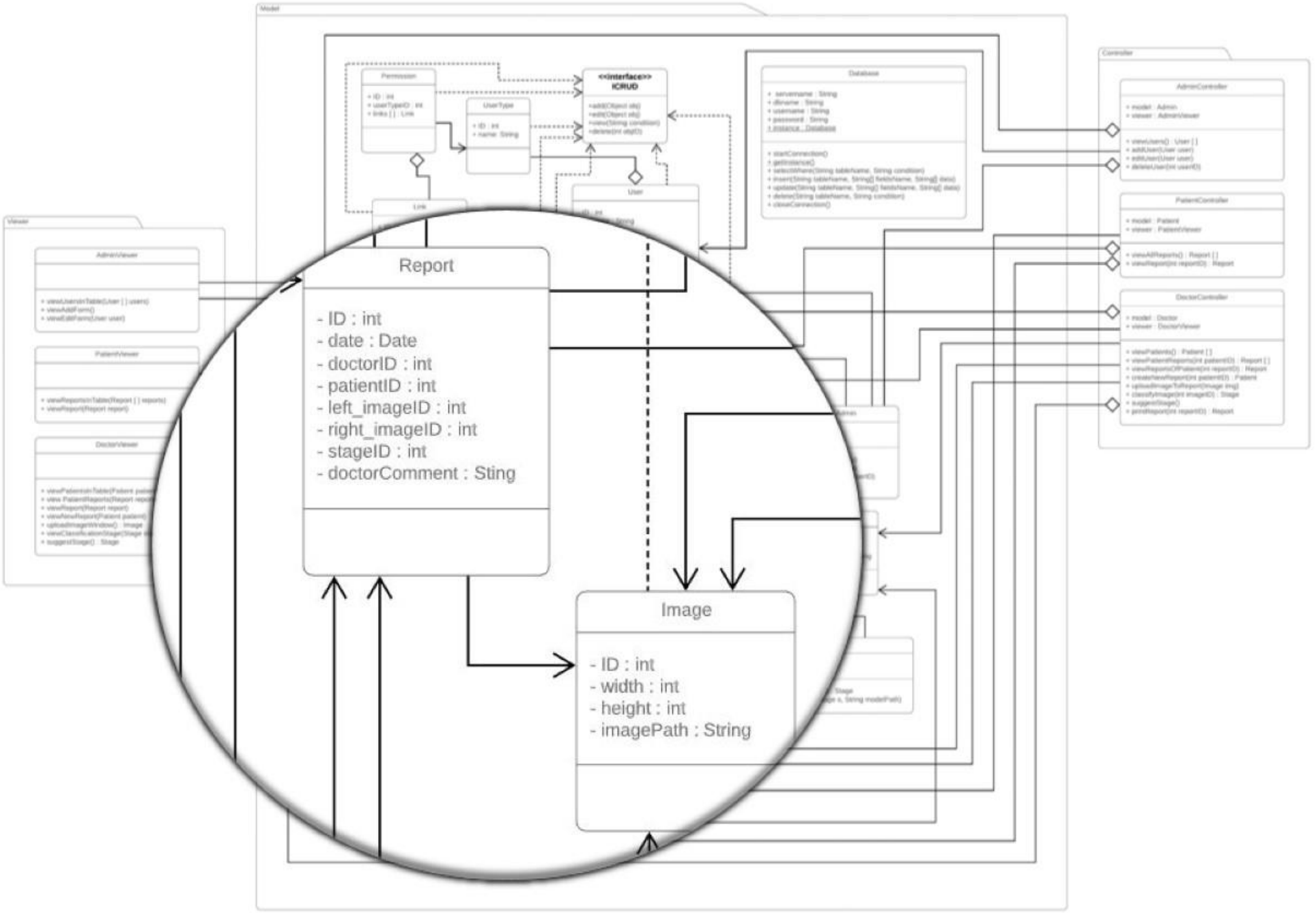
(M-V-C)

#3 MODEL Layer

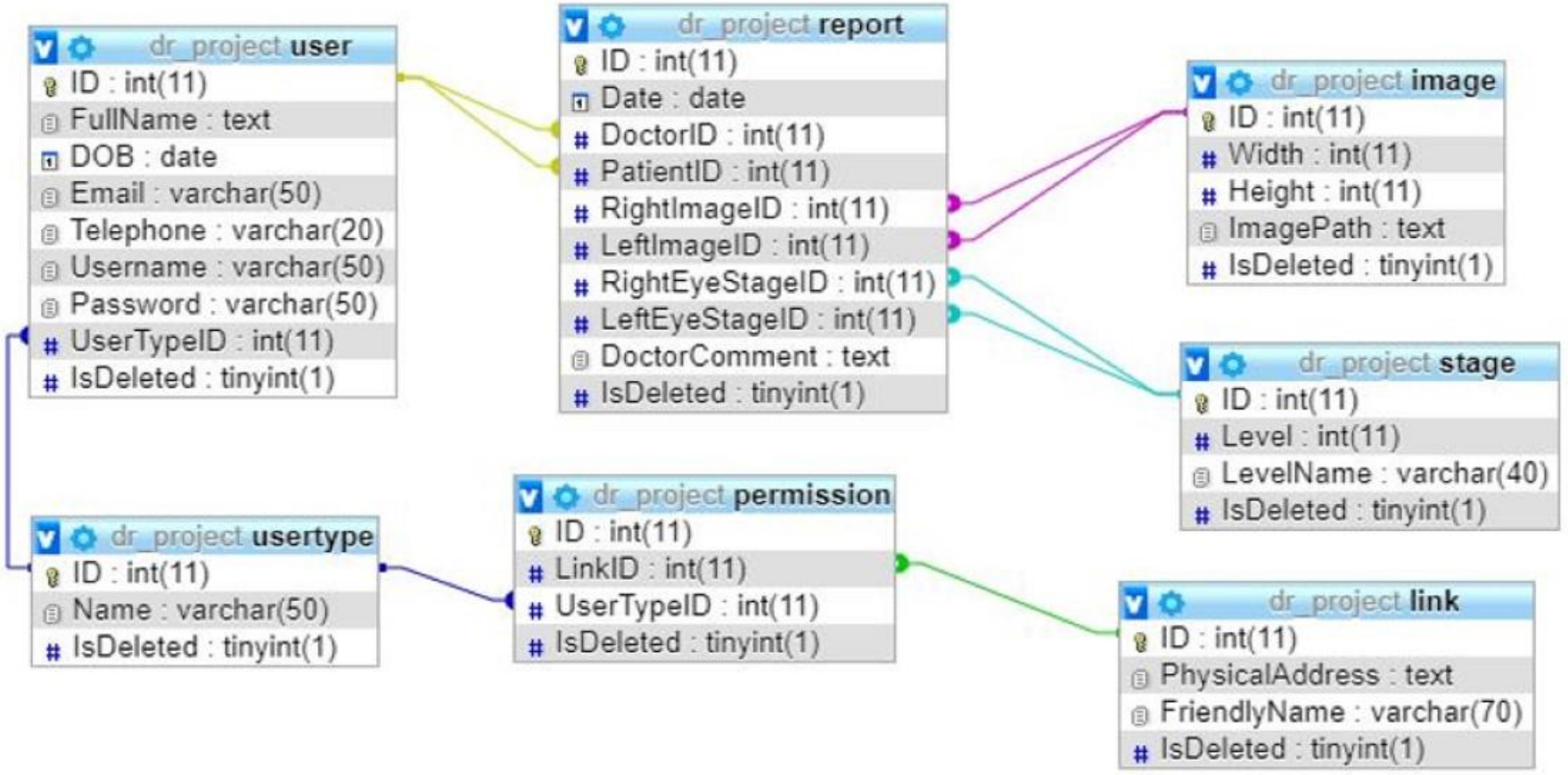


#4 DATABASE Layer

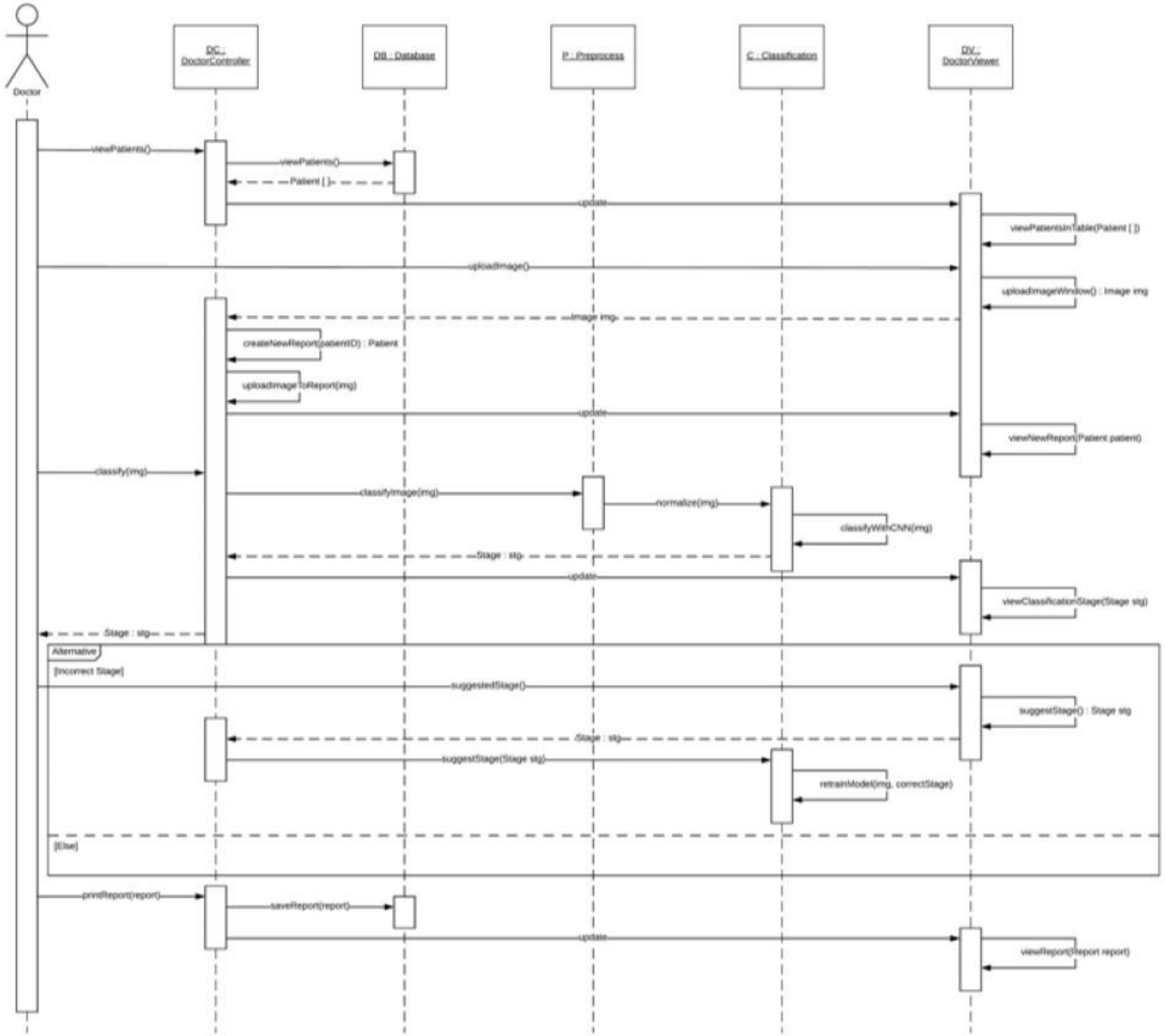
Class Diagram


Report
- ID : int
- date : Date
- doctorID : int
- patientID : int
- left_imageID : int
- right_imageID : int
- stageID : int
- doctorComment : Sting
Image
- ID : int
- width : int
- height : int
- imagePath : String

DB SCHEMA (ERD)



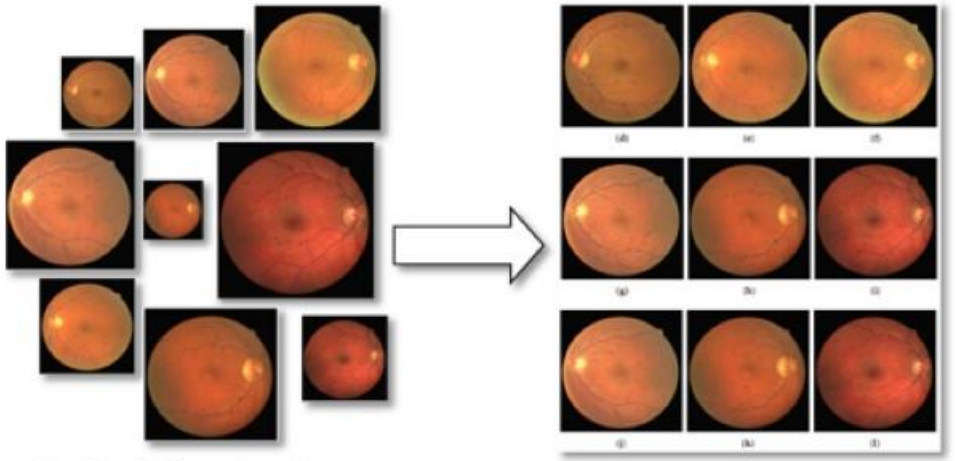
SEQUENCE DIAGRAM


Doctor
DC : DoctorController
DB : Database
P : Preprocess
C : Classification
DV : DoctorViewer
viewPatients()
viewPatients()
Patient [ ]
update
viewPatientsInTable(Patient [ ])
uploadImage()
uploadImageWindow() : Image img
Image img
createNewReport(patientID) : Patient
uploadImageToReport(img)
update
viewNewReport(Patient patient)
classify(img)
classifyImage(img)
normalize(img)
classifyWithCNN(img)
Stage : stg
update
viewClassificationStage(Stage stg)
Stage : stg
Alternative
[Incorrect Stage]
suggestedStage()
suggestStage() : Stage stg
Stage : stg
suggestStage(Stage stg)
retrainModel(img, correctStage)
[Else]
printReport(report)
saveReport(report)
update
viewReport(Report report)

COMPONENT DESIGN 1/4 - (Pre-Processing)

- Normalization: Normalizing all the input images so they are all the same size, before the processing stage.

- Dataset Normalization



COMPONENT DESIGN 2/4 - (Algorithm Used)

Convolutional Neural Network (CNN) algorithm :

- A CNN is a powerful type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data [2].

- A CNN consists of an input layer, an output layer and a hidden layer that includes multiple convolutional layers.

[2] Search Enterprise AI. "https://searchenterpriseai.techtarget.com/definition/convolutional-neural-network" (April, 2018).

COMPONENT DESIGN 3/4 - (Algorithm Used)

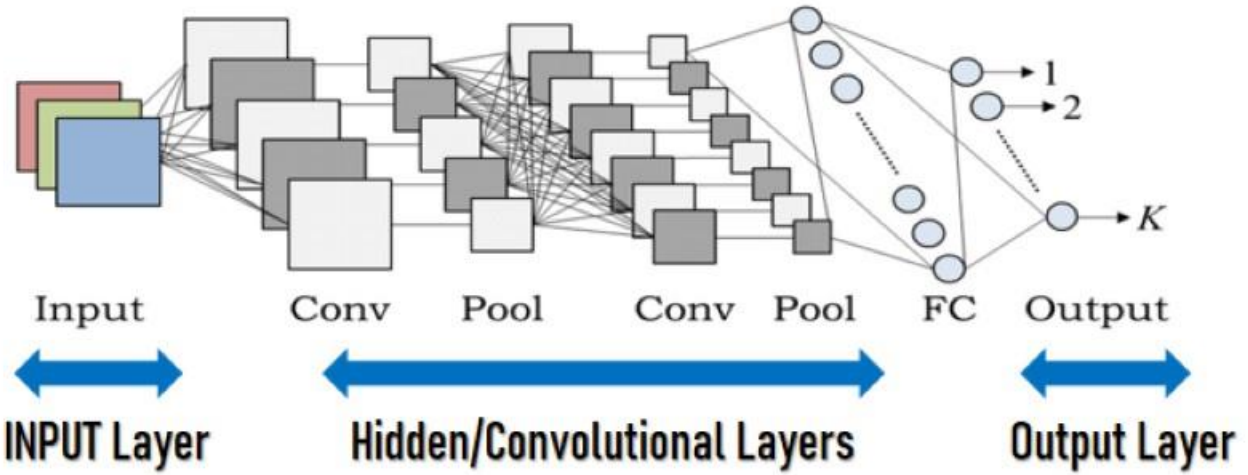
Why CNN algorithm ?

1. Works great with large datasets. → EyePACS dataset = 88,702 images
2. Automatic feature extraction for the given task.
3. Ability of the system to be updated/modified.
4. Models Used/Tried → VGG_16, VGG_19, ResNet50

COMPONENT DESIGN 4/4 - (Algorithm Used)

How CNN Works :

1. Select Input Images.
2. Apply different filters/convolutions.
3. Output layer produces an activation function to output probability-like predictions for each class [3].

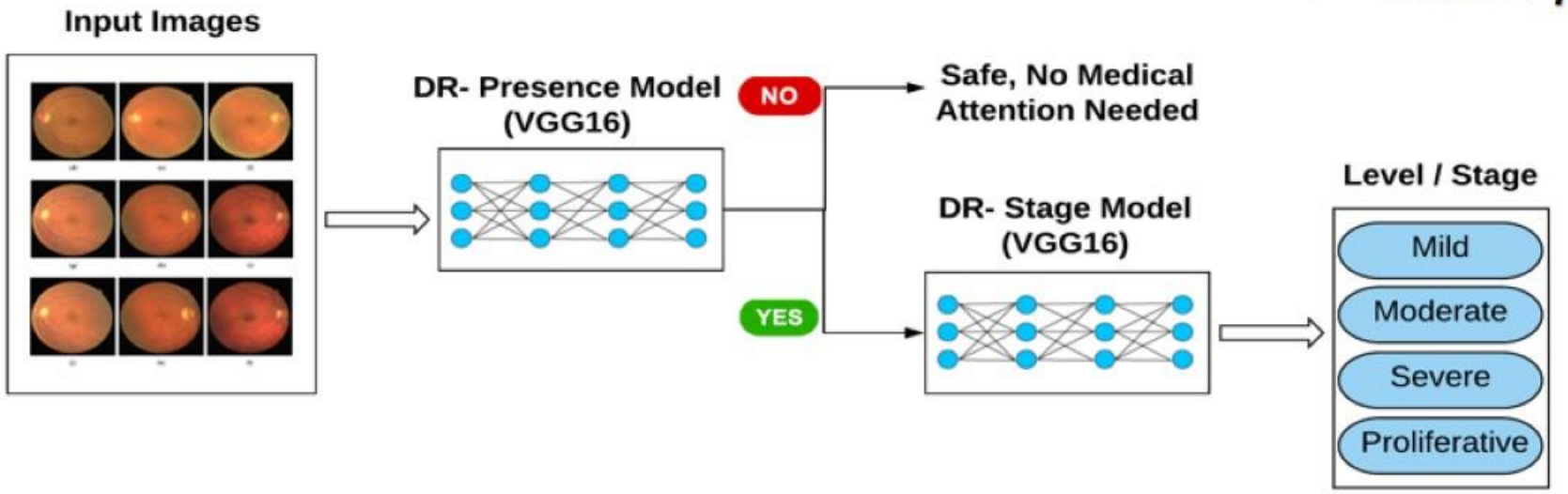


[3] engmrk. "https://engmrk.com/module-22-implementation-of-cnn-using-keras/?utm_campaign=News&utm_medium=Community&utm_source=DataCamp.com" (Sept., 2018).

Cascaded Architecture (DR Presence + DR Stage)

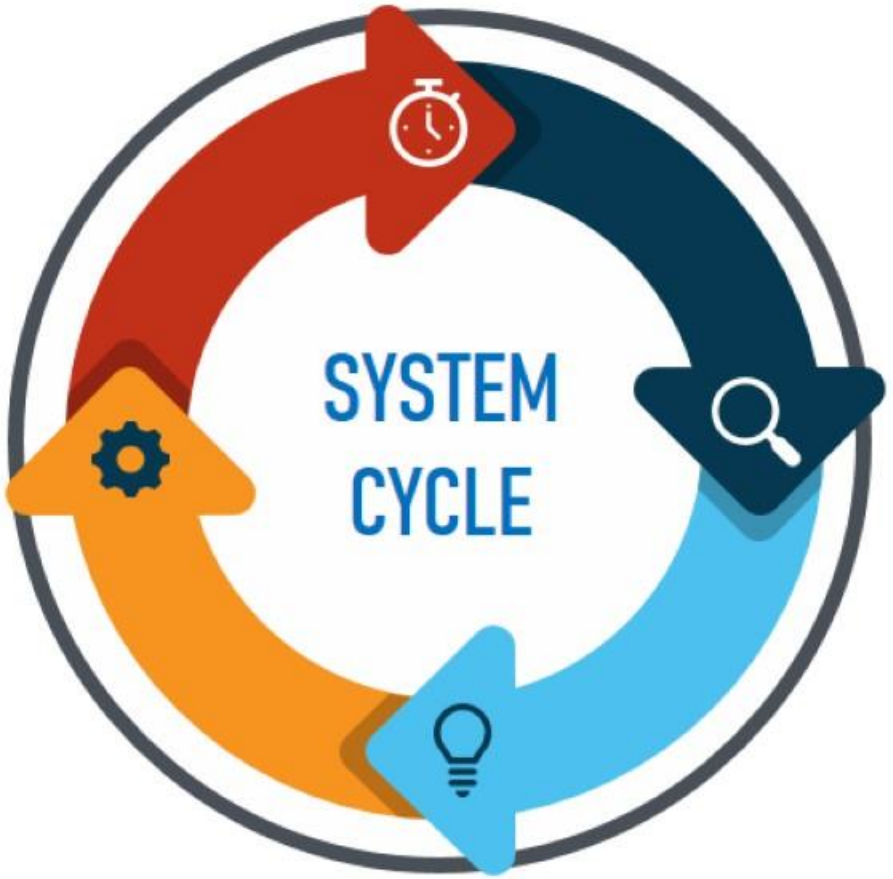
How It Works :

1. Select Input Retinal Fundus Images.
2. The first VGG16 (DR-Presence) model is used to detect the presence of DR. → Yes / No
3. If the output result was (yes), the second VGG16 (DR-Stage) model starts working, to determine the stage of (DR). → Class 1 / 2 / 3 / 4



System Re-Training

The system will use the image and doctor's feedback, to Re-Train itself and improve its classification accuracy by time.



Take an input image (Fundus Images) from the patient

The doctor will provide his/her feedback on the system results.

The system starts classifying the input image and recognizing its stage.

DEMO

Healthcare Template

localhost/DR_Project/portal.php

Doctor Portal

Helping to improve quality

Login To Portal

Username

doctor

Password

Password

Login

Results

By using the **Cascaded Model** mentioned before :

- Used Images from Dataset : 25,518 images → **48,486 images**
- Total Images After Augmentation : 38,280 images → **61,248 images**
- Overall Accuracy Achieved : 52.2% → **63.1%**

REQUIREMENTS MATRIX

Req. ID	Req. Type	Req. Name	Req. Description	Module	Statues	Where in SDD
FR1	Required	Login	Doctors and Admin must be able to login into the system	System	Completed	Sequence diagrams
FR2	Required	AddUser	Admin can add new Users to the system	Admin	Completed	Sequence diagrams
FR3	Required	SearchUser	Admin can search for existing Users' records	Admin	Completed	Class diagram
FR4	Required	ListAllUsers	Admin can get a whole list of all the system Users	Admin	Completed	Sequence diagrams
FR5	Required	EditUserInfo	Admin can edit a specific User's record	Admin	In Progress	Class diagram
FR6	Required	DeleteUser	Admin can remove/delete a specific User's record	Admin	Completed	Class diagram
FR7	Required	UploadImage	Doctor can upload Retinal Fundus Images to the system,	Doctor	Completed	Sequence diagrams
FR8	Required	NormalizeImages	Retinal Fundus Images are normalized before classification	Preprocessing	Completed	Class diagram
FR9	Required	ClassifyDisease	Classify the disease stage on the input fundus image	Classification	Completed	Class diagram
FR10	Required	GenerateReport	Doctor generates a report about the patient	Doctor	In Progress	Sequence diagrams
FR11	Required	ViewReports	Patient can view a list of all his previous reports	Patient	Completed	Sequence diagrams
FR12	Addition	RetrainModel	Enable to system to retrain itself	Classification	In Progress	Class diagram
FR13	New Req.	SuggestStage	Doctor can provide this feedback on the system results	Doctor	In Progress	Class diagram

COMPETITIONS & CONTRIBUTIONS

- DELL (EMC) – Shortlisted for the next phase of the Dell Technologies Envision the Future Competition.

- ICSIE 2020 – Notification of Acceptance, and paper will an be included and published in the upcoming conference.


ANY QUESTIONS ?


THANK YOU

Appendix

- Data Augmentation:

  Augmenting the class with the least number of images (Class 4), through rotating the images by 90, 180 and 270 degrees.

- Dataset Augmentation

	Original Images	DR-Presence Model		DR-Stage Model	
		Augmented Images	Images Used	Augmented Images	Images Used
Class 0	65,343	0	30,624	0	0
Class 1	6,205	1,451	7,656	1,451	7,656
Class 2	13,153	0	7,656	0	7,656
Class 3	2,087	5,569	7,656	5,569	7,656
Class 4	1,914	5,742	7,656	5,742	7,65(
Total	88,702	12,762	61,248	12,762	30,62