Ocular Disease Intelligent Recognition Methodology

## Project Review - I

Batch - 4

Project Guide - Aruna Kumari G L

Abstract

The complexity problem of diagnosing ocular-based diseases has become prevalent in Ophthalmology. Initially, doctors were are obligated to use techniques to conduct a procedure that includes manual photography and post-analysis without any computer-aided methodologies. In the contemporary epoch, computers are now integrated into the ecosystem of Healthcare with most of the processes evolved into Automation Pipelines. Yet, there are still no compelling Intelligent Systems that can guide Medical Image analytics. With the recent advances in Machine Learning and Deep Learning theory, novel approaches like Convolutional Neural Networks (CNNs) enabled scientists to build Intelligent systems that can classify the data through automated learning. Through this research we aim to apply this concept to the Ophthalmological Diagnosis procedure and develop an Ocular Disease Intelligent Recognition System (ODIRS). This research focuses on the most prevailing cases of ocular diseases like Diabetic Retinopathy, Cataract, Glaucoma, and Pathological Myopia and presents a novel methodology that can efficiently address all conditions at once.

Medical Significance & Disease Prevalence

A Normal Fundus Image Samples
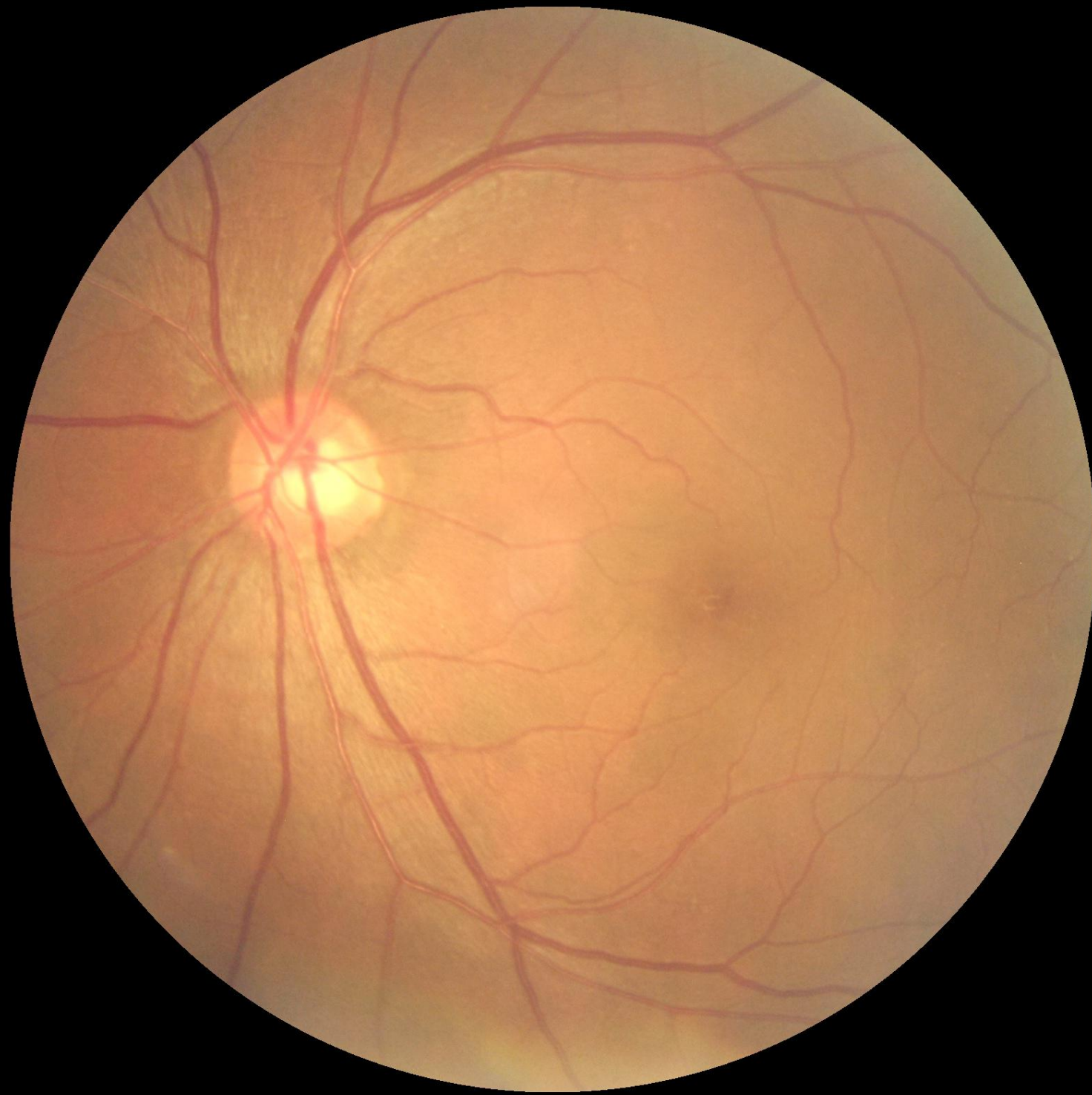
Left Fundus

Right Fundus

Diabetic Retinopathy

- When sugar levels are high, the blood vessels in your retina can swell and leak, sometimes abnormal new blood vessels can also grow on the retina, all this can steal your vision.

- Symptoms include seeing floaters or dark spots, colours appear faded etc.

- National diabetes and diabetic. retinopathy survey was conducted in India during 2015-2019, with a sample size of 56,771 for age group of 50 and above.

  - Prevalence of Diabetes Retinopathy in India

    - Andhra Pradesh is 27.3%.
    - Telangana is 9%.

A Fundus Image diagnosed with *Diabetic Retinopathy*

Glaucoma

- Glaucoma is a disease which damages your eye's optic nerve, which connects the eye to the brain by building up of fluid in your front part of the eye, which increases the intra-ocular pressure in your eye .

- Symptoms include blind spots in vision, eye pain, nausea etc.

- Prevalence of Glaucoma in India
  - Tamil Nadu during 2003 is 2.6% for sample size of 5150 and age group 40 and above.
  - Eastern Maharashtra during 2013 is 2.67% for a sample size of 4570 and age group of 30 and above.
  - Chhattisgarh during 2001 is 3.68% for a sample size of 7438 and age group of 35 and above.

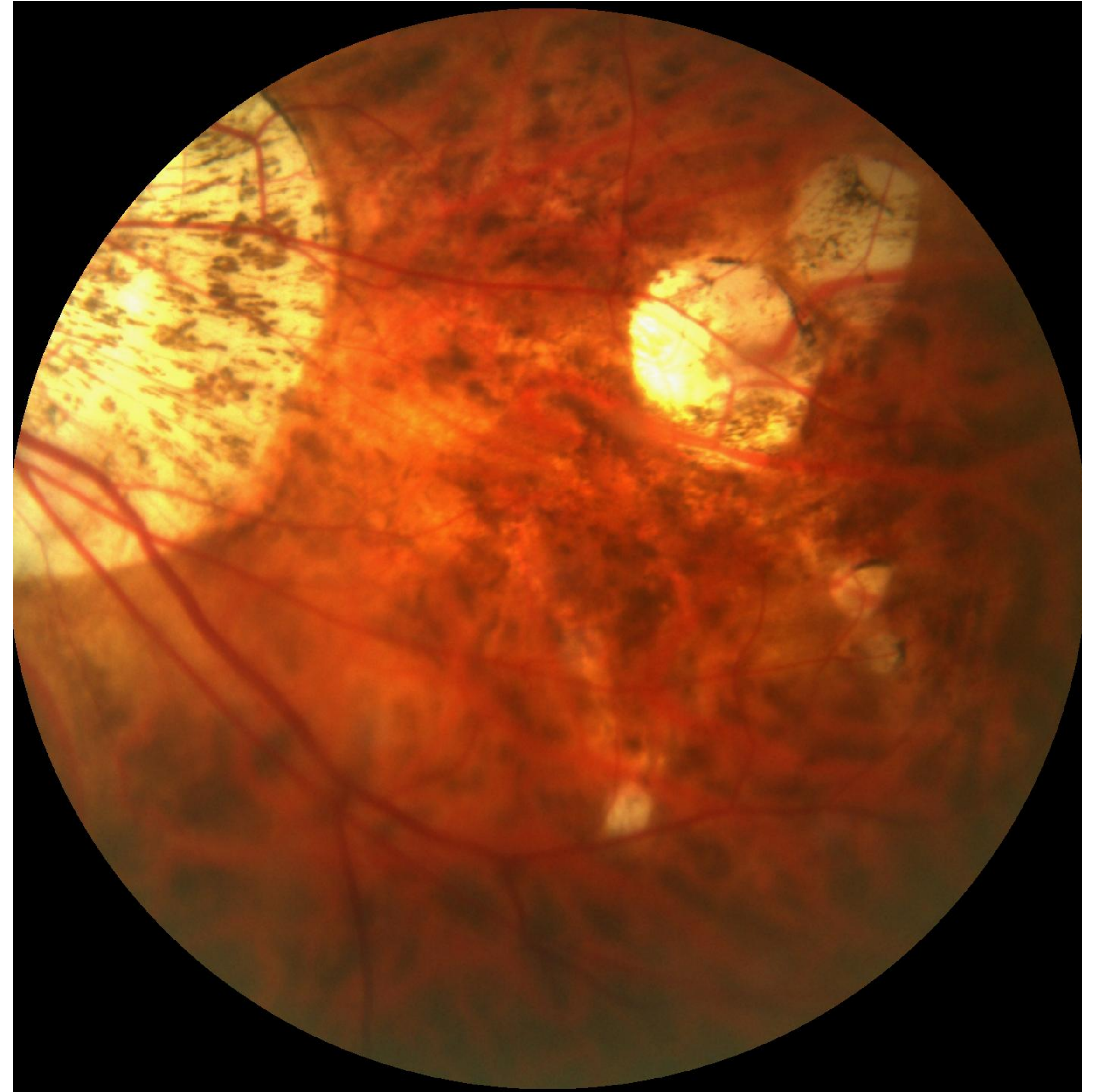A Fundus Image diagnosed with *Glaucoma*

Cataract

- A cataract begins when proteins in the eye form clumps that prevent the lens from sending clear images to the retina.
- Symptoms include blurry vision, seeing faded colours, trouble seeing at night etc.
- Prevalence of Cataract in India
  - Gurgaon during 2011 is 58% for a sample size of 3586 and age group of 60 and above.
  - Pondicherry during 2011 is 53% for a sample size of 3932 and age group of 60 and above.
  - Kondur during 2015 is 62.8% for a sample size of 369 and age group of 50 and above.
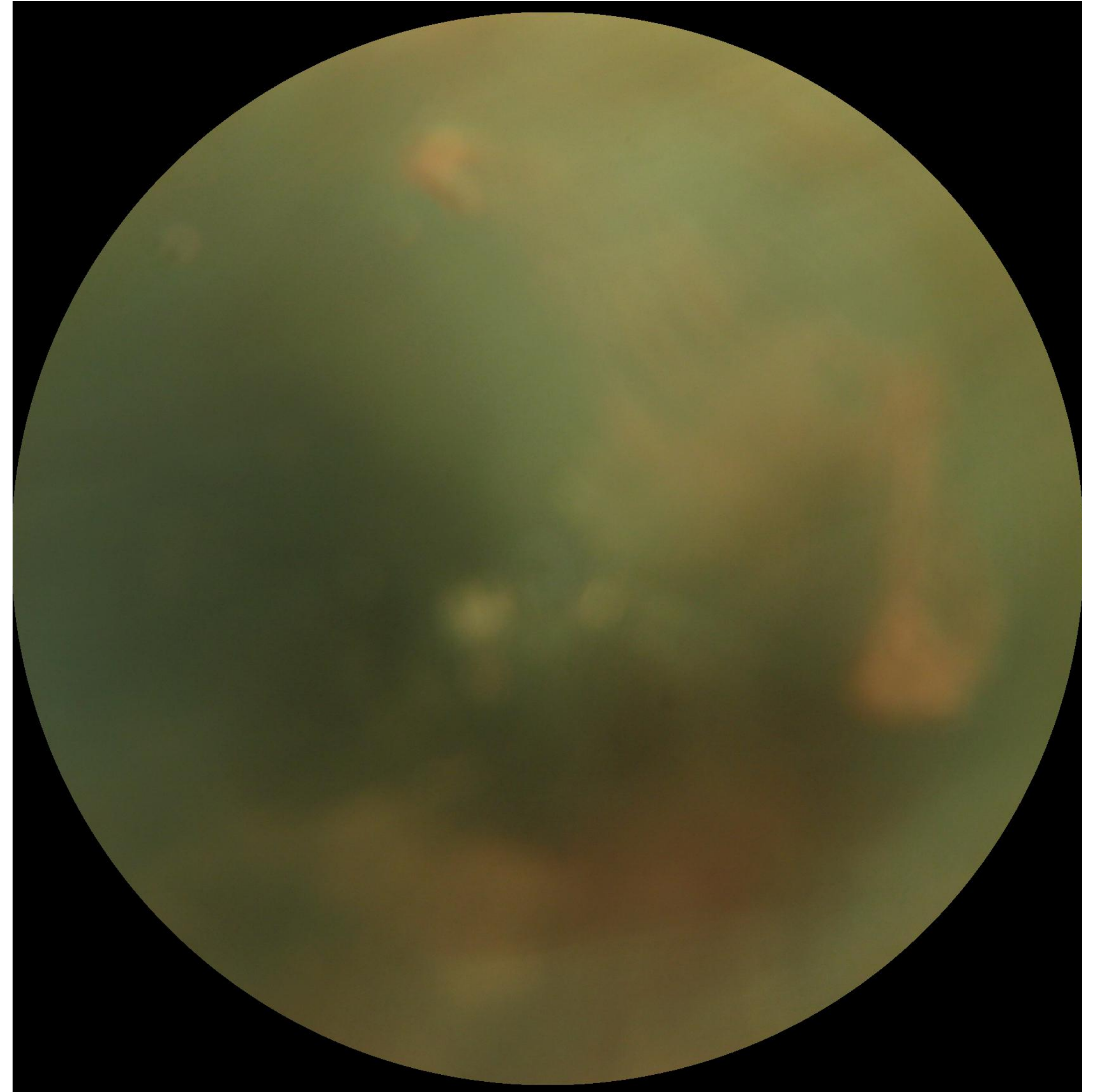
A Fundus Image diagnosed with *Cataract*

Pathological Myopia

- Pathological myopia means that you are very short sighted and that this has caused degenerative changes to the back of your eye. Major contributor to the Global vision loss problem

- Symptoms include floaters, sudden appearance of flashes of lights etc.

- Prevalence of pathological myopia in India
  - Tamil Nadu during 2022 is 17.5% for a sample size of 14,342 and age group of 5 to 16.
  - Delhi during 2015 is 13.1% for a sample size of 9,884 and age group of 5 to 15.
  - Andhra Pradesh during 2019 is 7.3% for a sample size of 1,738 and age group of 9 to 15.
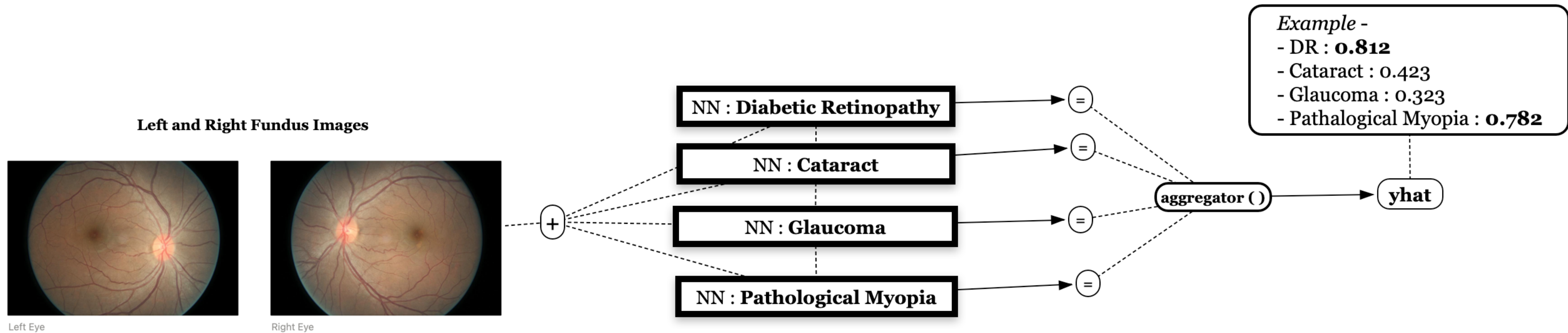

A Fundus Image diagnosed with *Pathological Myopia*

Approach
Conceptualisation

ODIR Ophthalmic Database

- The Ocular Image database consists of 5000 patient records manually collected by *Shanggong Medical Technology.*

- This dataset is meant to represent the "real-life" set of patient information from different medical centers in China.

- They classify patients into eight labels including
  - Normal (N),
  - Diabetes (D),
  - Glaucoma (G),
  - Cataract (C),
  - AMD (A),
  - Hypertension (H),
  - Myopia (M), and
  - other diseases/abnormalities (O).

Approach Illustration

Left and Right Fundus Images

Left Eye

Right Eye

+

NN : **Diabetic Retinopathy**

NN : **Cataract**

NN : **Glaucoma**

NN : **Pathological Myopia**

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aggregator ( )

yhat

Example -
- DR : **0.812**
- Cataract : 0.423
- Glaucoma : 0.323
- Pathalogical Myopia : **0.782**

Legend

NN - *Neural Network Approach (CNN)*

= - *Logistic Classification Activation*

+ - *Sample Input of two Fundus images, Left and Right*

aggregator() - *A function used to combine and deduce the final classification of the pair*

- Each CNN network will be trained to classify between a ***Degraded Fundus*** and a ***Normal Fundus*** Image.

- This approaches of training individual CNN's subjective to the Data will be robust against the prominent class-imbalance problem.

- In a normal input scenario, each orientation fundus images are fed to the the architecture as a pair. The resultant prediction will output ***Likelihoods*** for each Disease highest being the most possible out of all.

- In an Ideal scenario, only two of the 4 networks will output a probability higher than the others, obviously stating that the patient has the diseases associated with that Network.

References

- Meller, Grzegorz. "Ocular Disease Recognition Using Convolutional Neural Networks." Medium, 21 Dec. 2020, <u>towardsdatascience.com/ocular-disease-recognition-using-convolutional-neural-networks-c04d63a7a2da</u>

- **Diabetes retinopathy**
  - https://npcbvi.gov.in/writeReadData/mainlinkFile/File342.pdf

- *Glaucoma*
  - https://pubmed.ncbi.nlm.nih.gov/12917161/
  - https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0076434

- *Cataract*
  - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3146699/#:~:text=The%20prevalence%20of%20unoperated%20cataract,India%20(P%20%3D%200.01).

- *Pathological myopia*
  - https://onlinelibrary.wiley.com/doi/10.1111/opo.12943?af=R
  - https://www.researchgate.net/publication/339881846_A_Comprehensive_Study_on_Prevalence_of_Myopia_in_School_Going_Children