

Artificial Intelligence for Healthcare Delivery

AI for Socio-Economic Development Summit 2019
Lagos, Nigeria

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Medical Practice





Clinical Data

- History (e.g. Symptoms)
- Physical Exam (Signs)
- Laboratory Tests
- Medical Imaging

- Clinical Data**
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Feature extraction



Disease Features
(Well-Annotated Machine-Learnable Data)

**Defining & Understanding
the Clinical Problem**



Machine Learning



**Trained Model
(Disease Detector)**



Diabetes

Diabetes in Nigeria & Globally

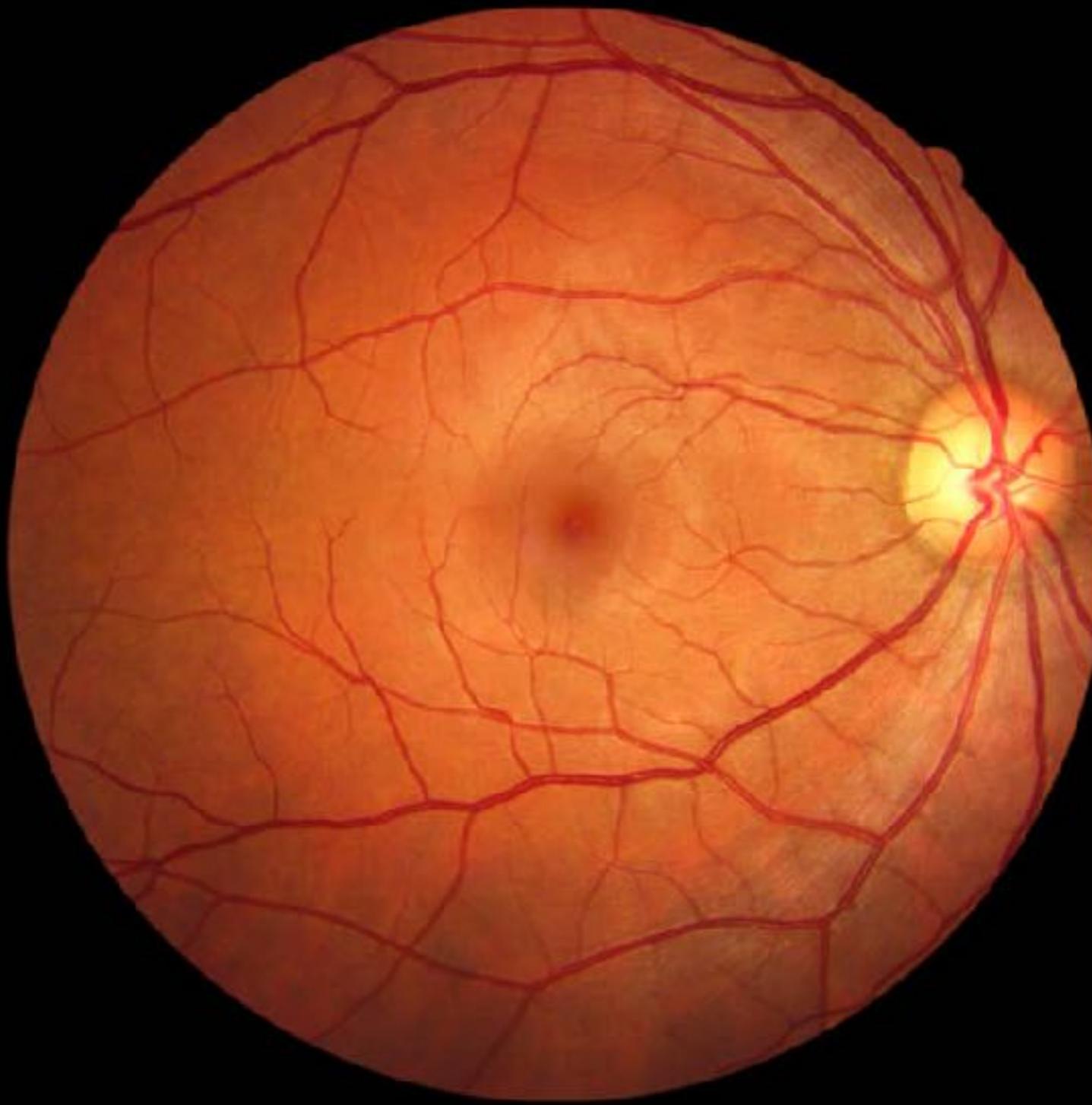
- **Prevalence 4-11% in Nigeria**
- **Undiagnosed in 80% (in Africa) vs 35% (Europe & America)**
- **400 million affected globally**
- **Causes 1.6 million death per year globally**
- **Multiple potential complications:**
 - **Amputation, blindness, kidney disease, strokes, heart attacks, etc**
 - **(Oguejiofor et al. 2014)**

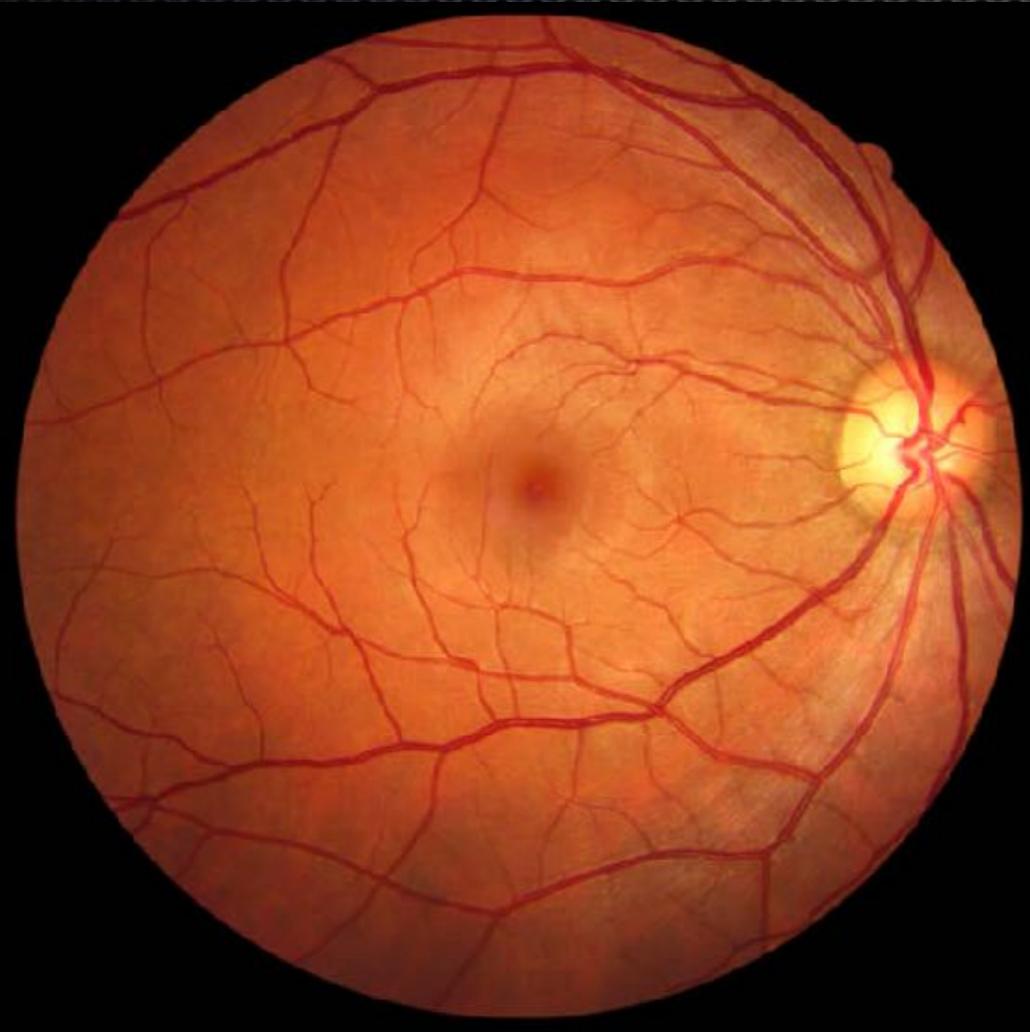
Many Complications



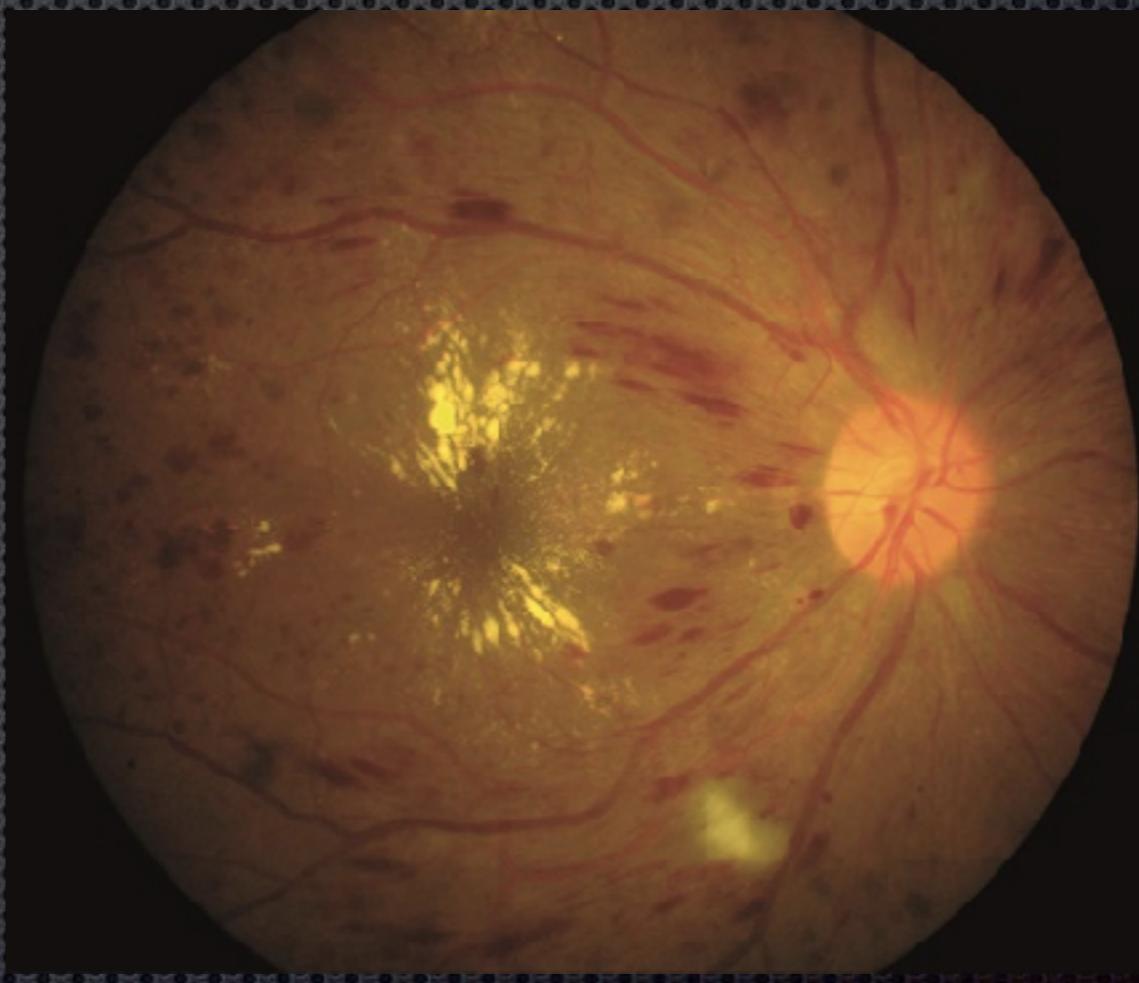


All about vision



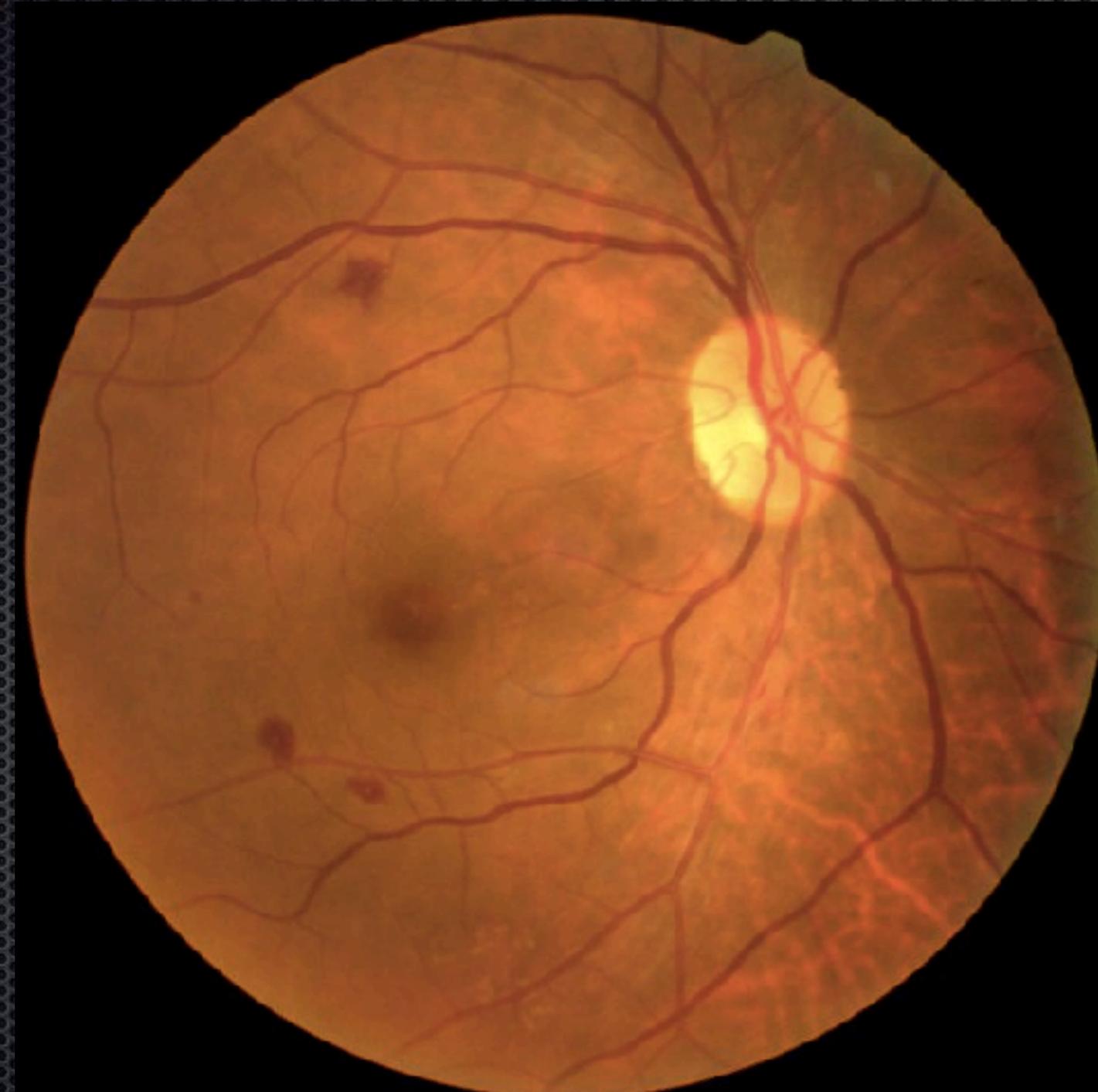


Normal Retina



Diabetic Retinopathy

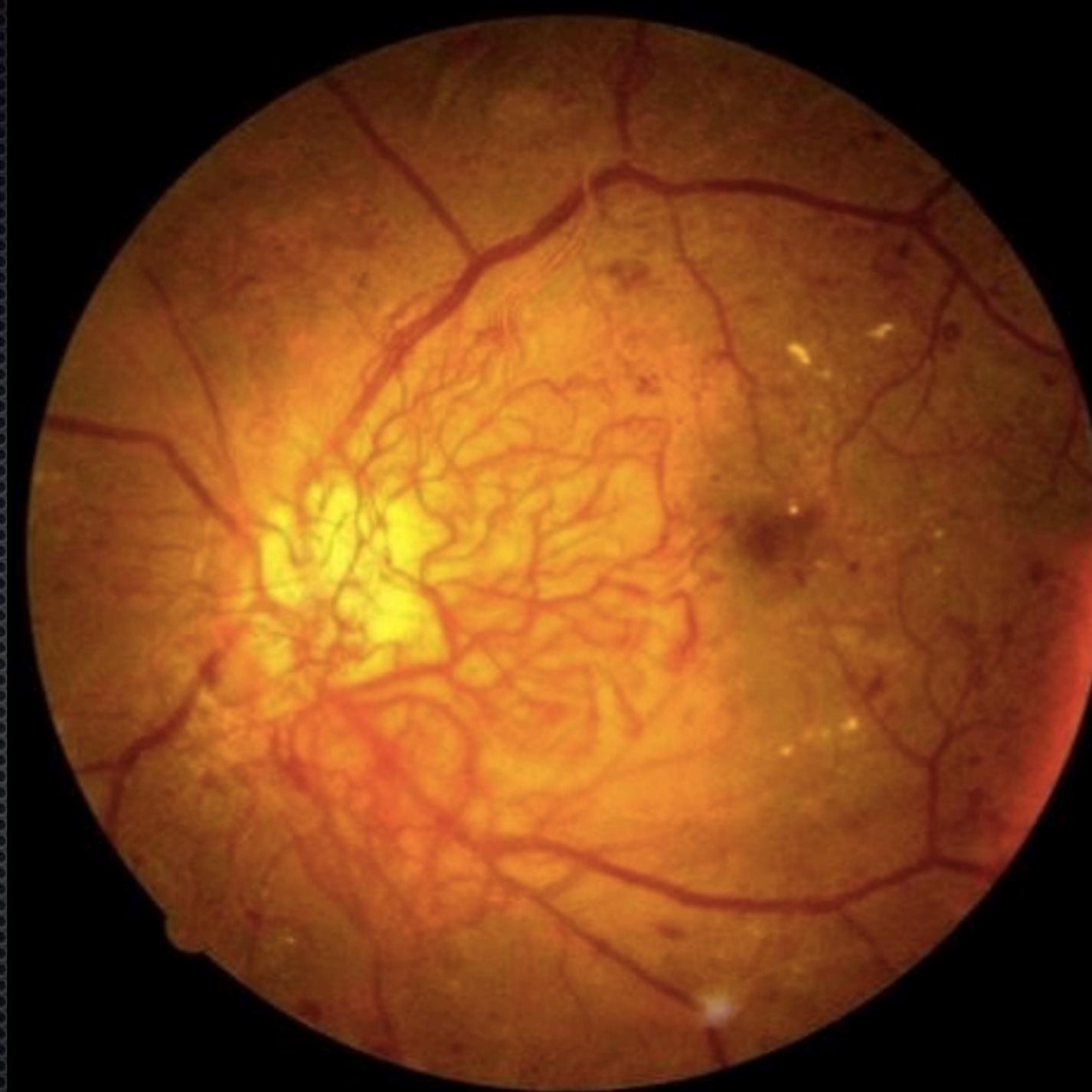
Mild Non-Proliferative Diabetic Retinopathy



Severe Non-Proliferative Diabetic Retinopathy

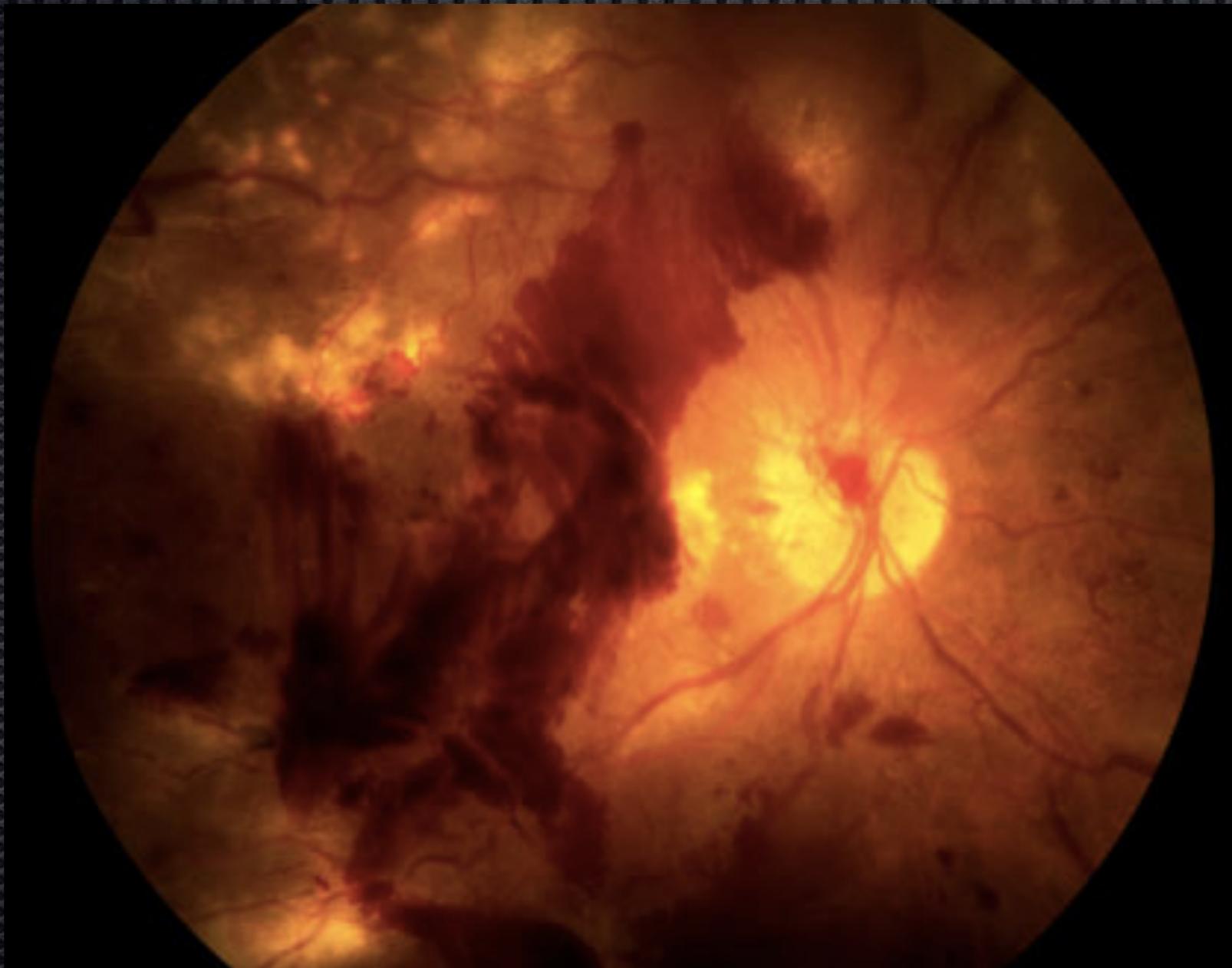


Proliferative Diabetic Retinopathy

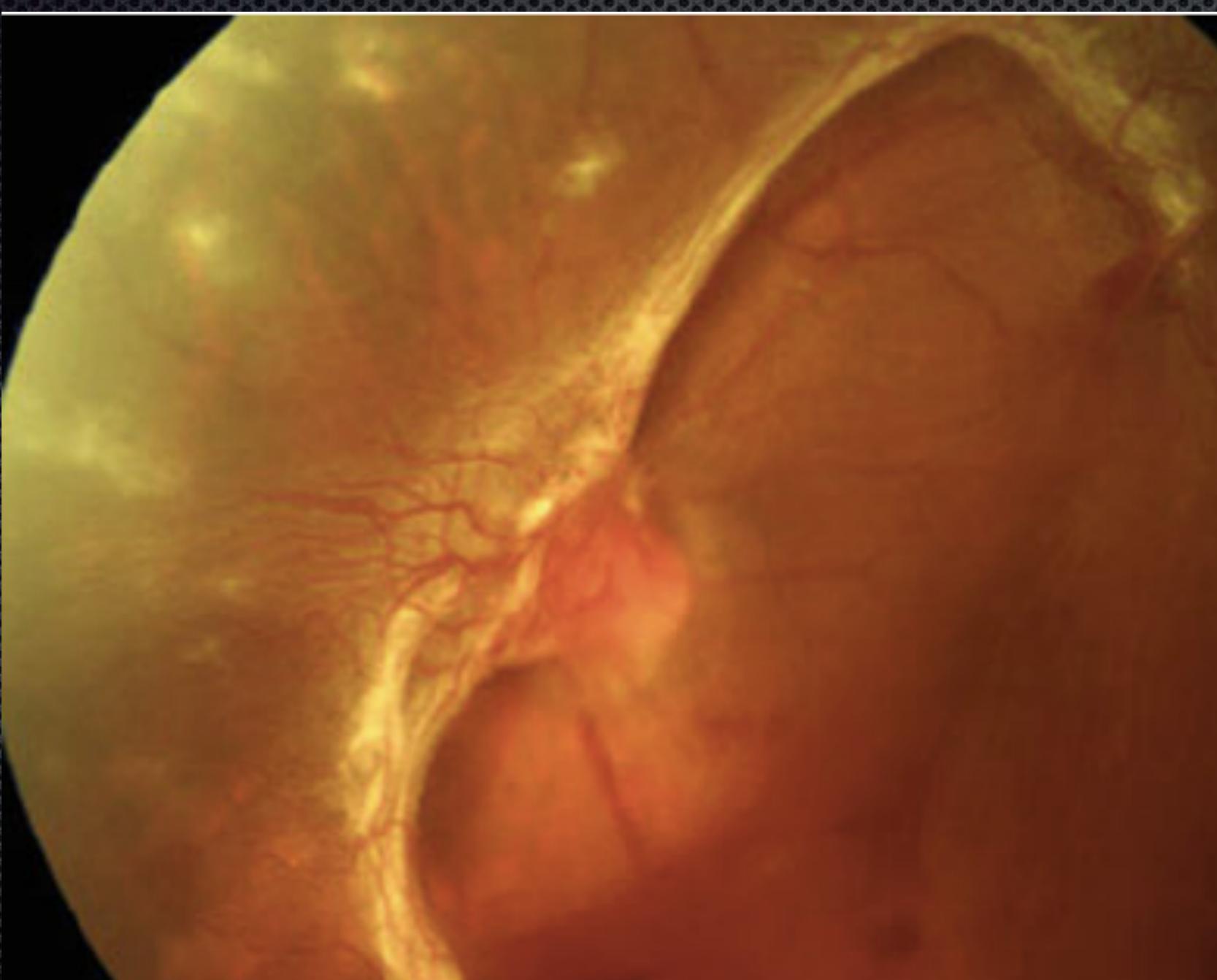


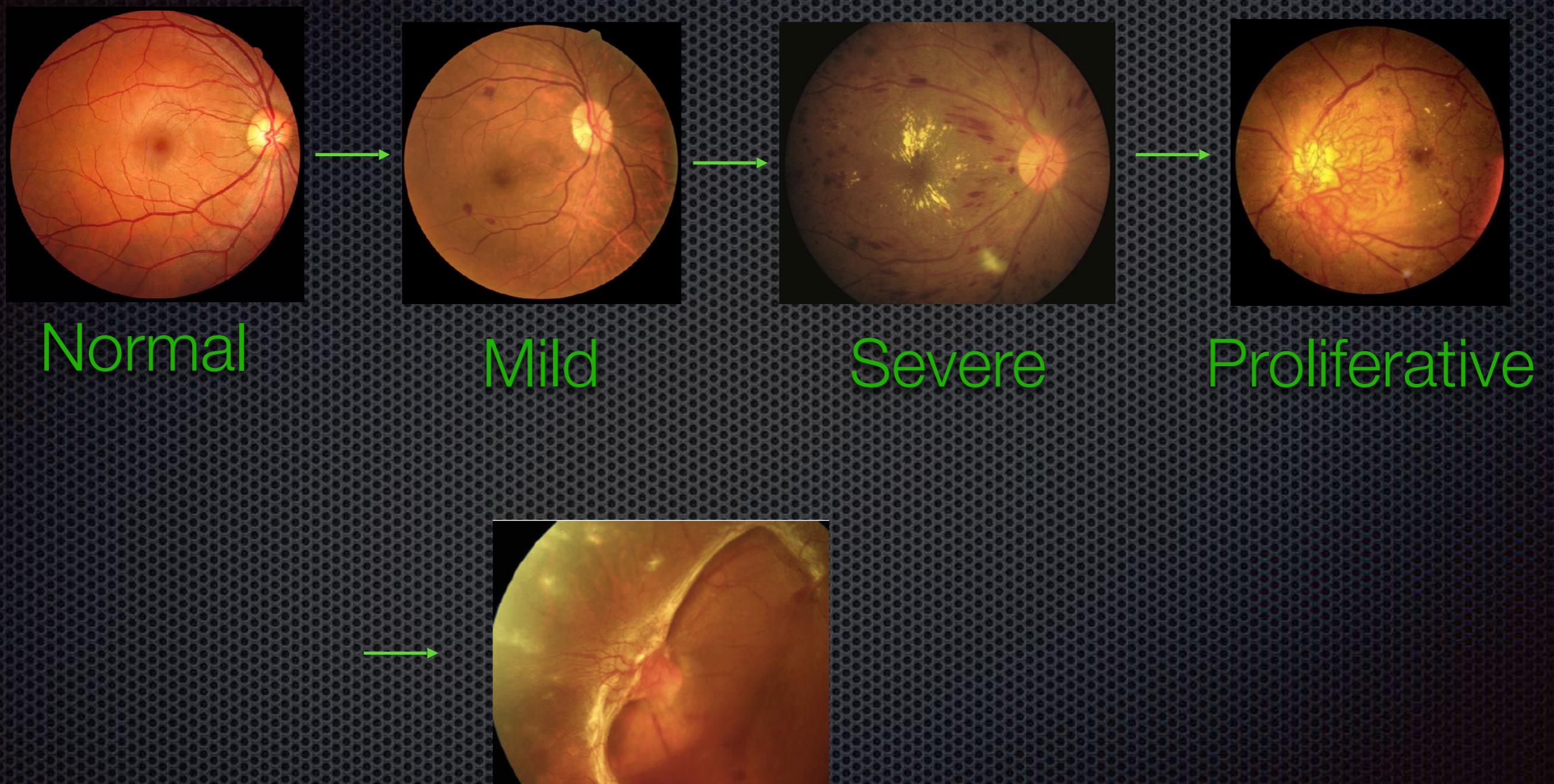
RETINA-AI

Diabetic Vitreous Hemorrhage

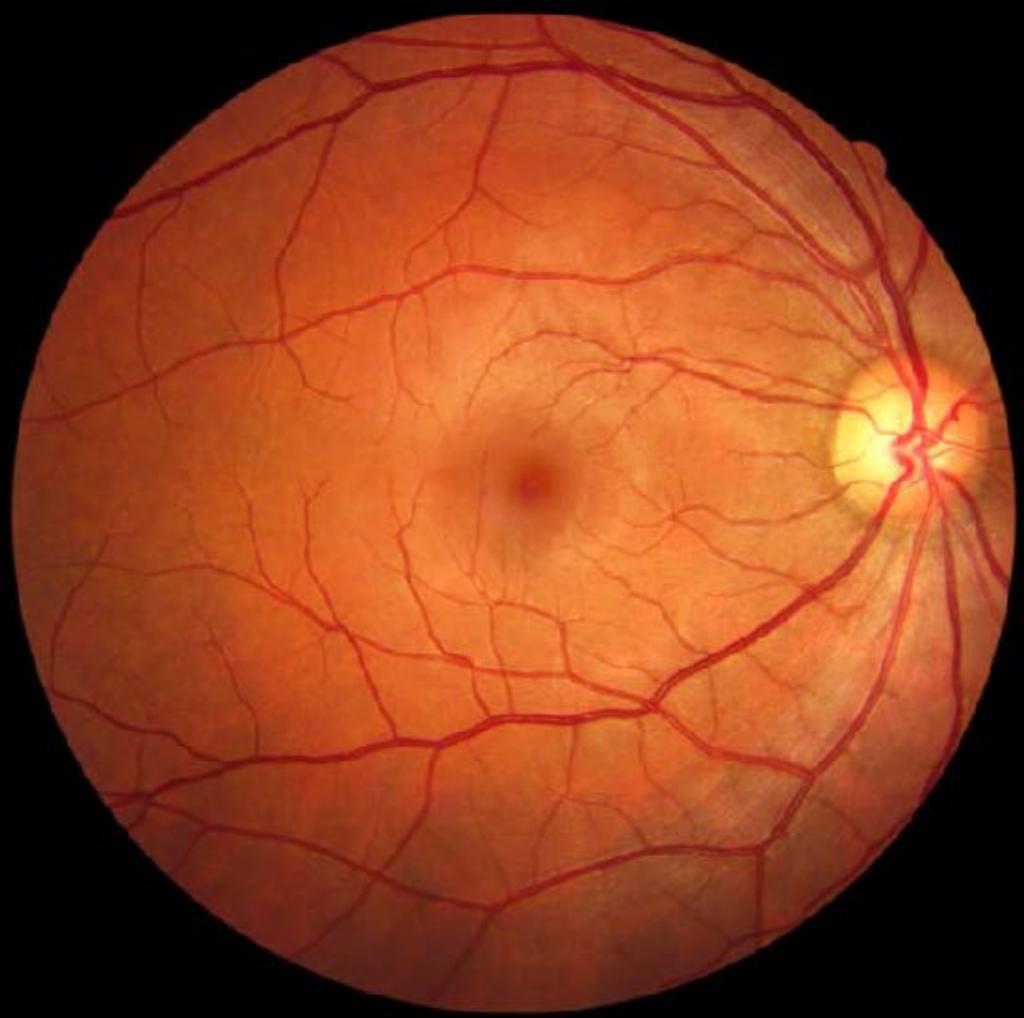


Diabetic Retinal Detachment

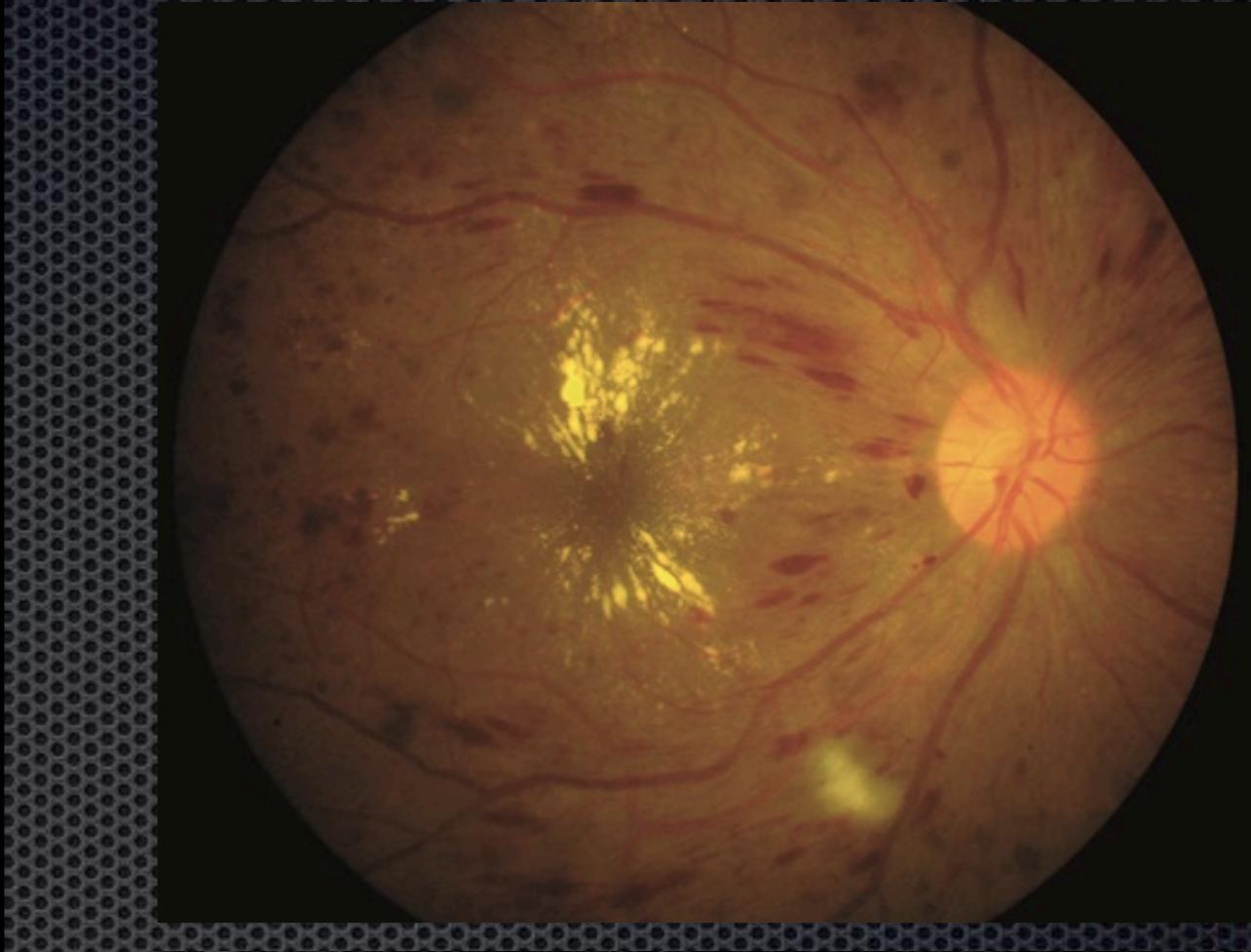




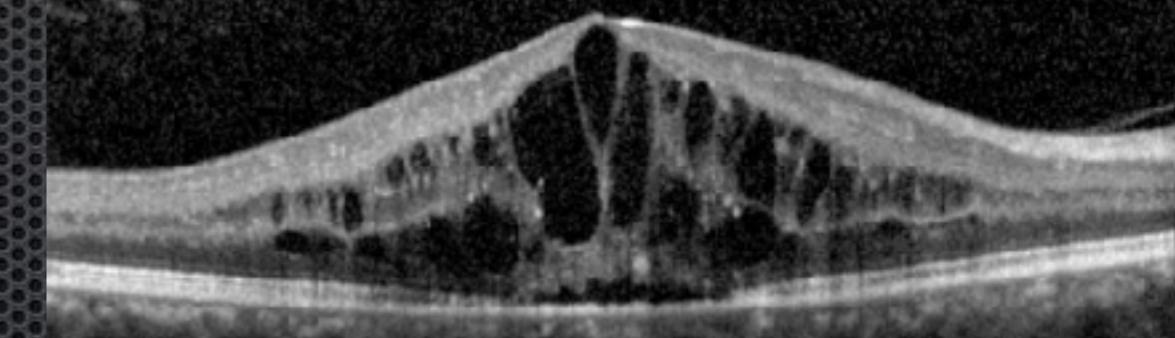
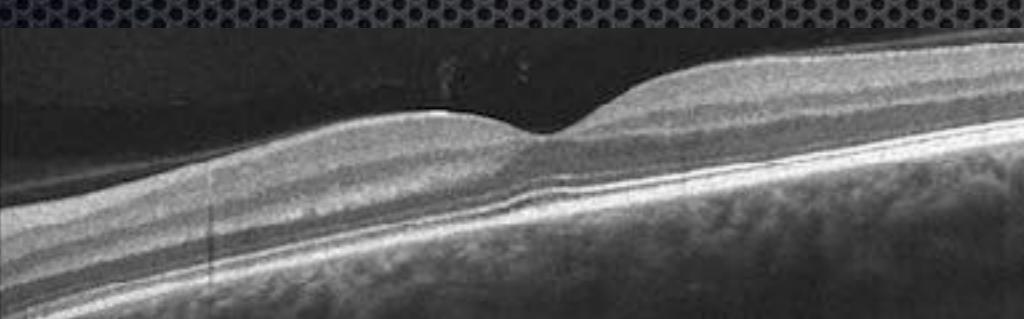
End-Stage (Tractional Retinal Detachments)



Normal Retina



Diabetic Macula Edema



RETINA-AI



<https://youtu.be/i1529o9c0i4>

Early Detection is Key!

- But ...

Massive physician shortage



Approximately 500* Ophthalmologists practice in Nigeria

Population: 190 million

Mahmoud et al (2012)

ICO survey (2012)

Numbers

- **350-500 Ophthalmologists (<600)**
- **200 million people**
- **5-10% diabetes prevalence:**
- **20,000-40,000 diabetics/ophthalmologist**



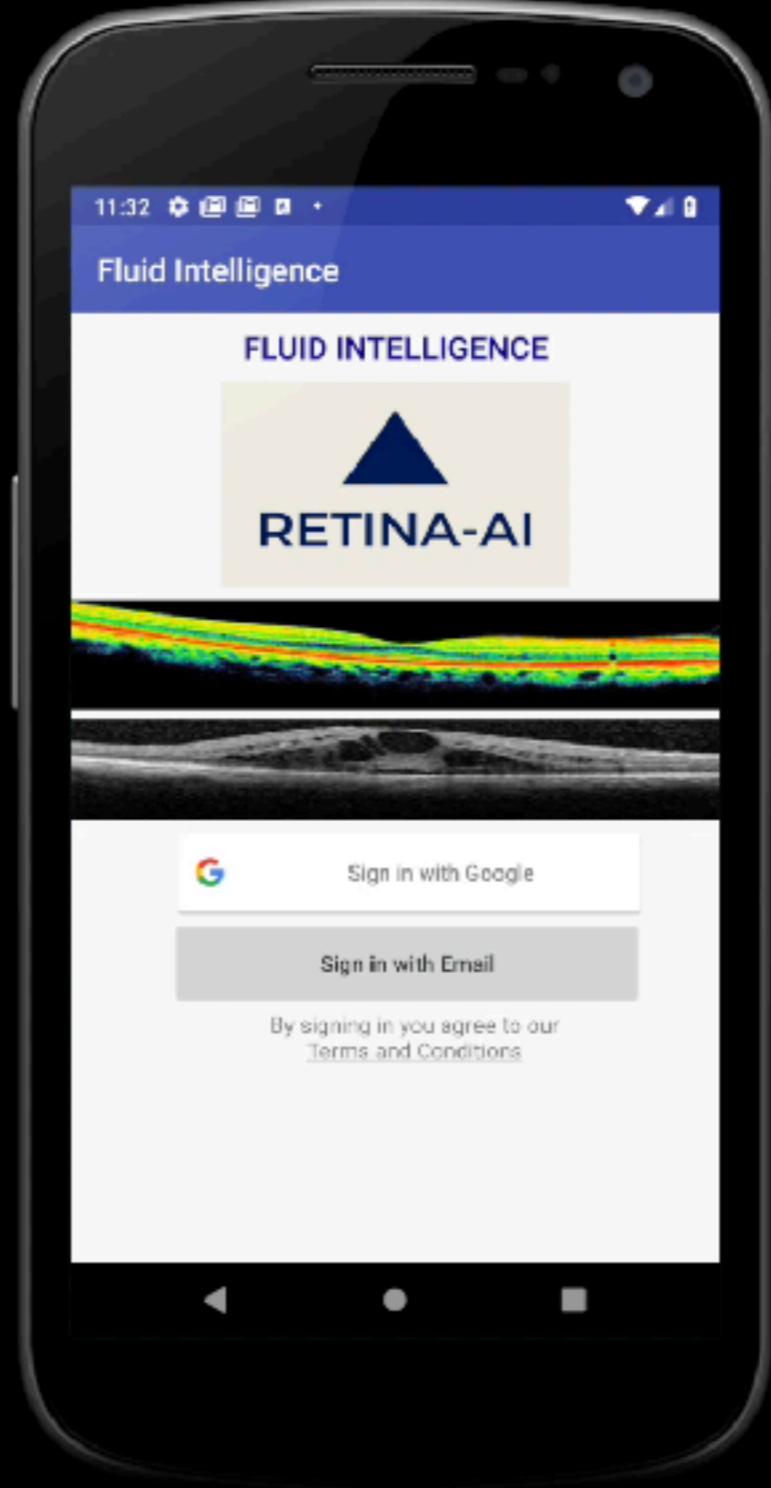
RETINA-AI Health

- **FLUID INTELLIGENCE**

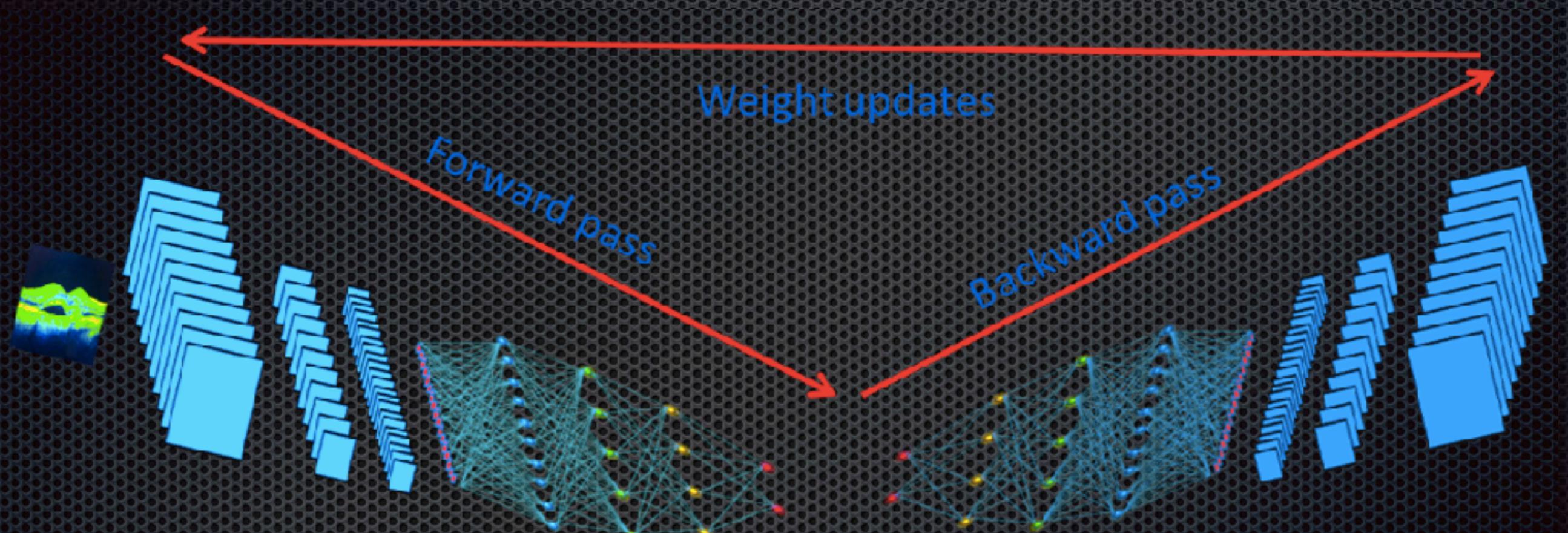
-  World's first AI app for eye care providers

-  Autonomously detects diabetic macula edema

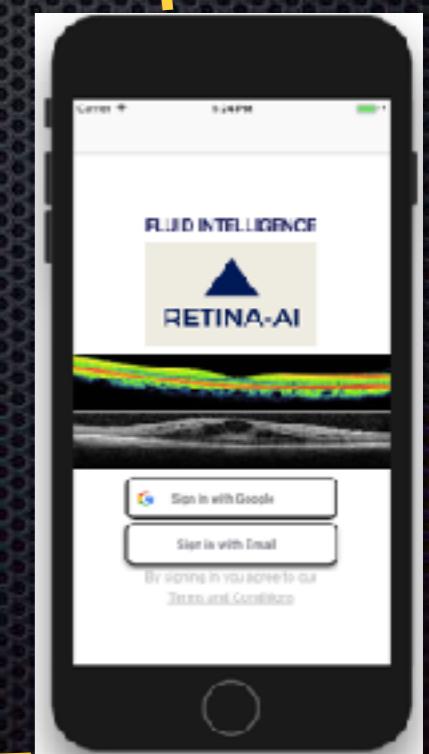
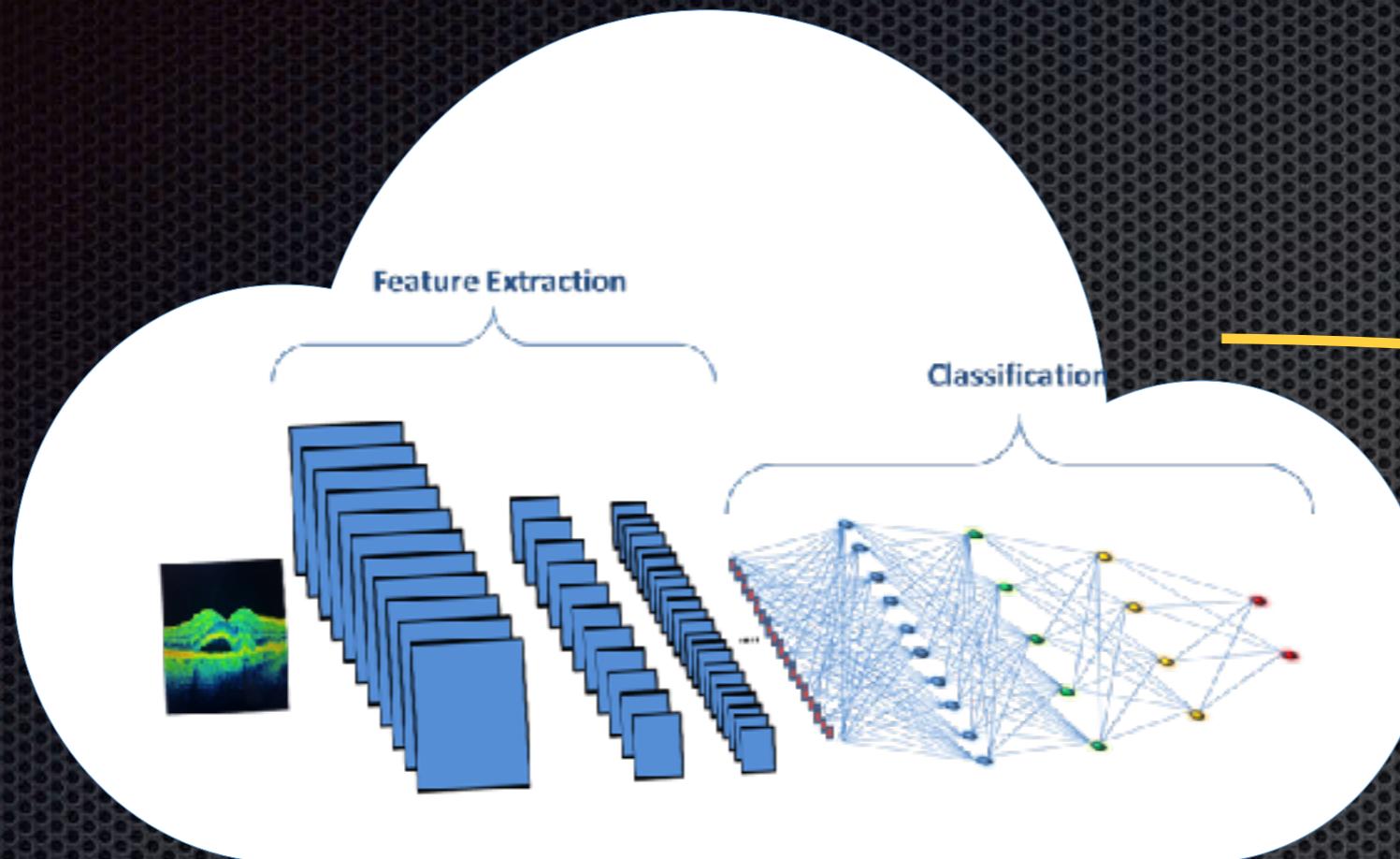
- **LIVE DEMO**



Convolutional Neural Networks



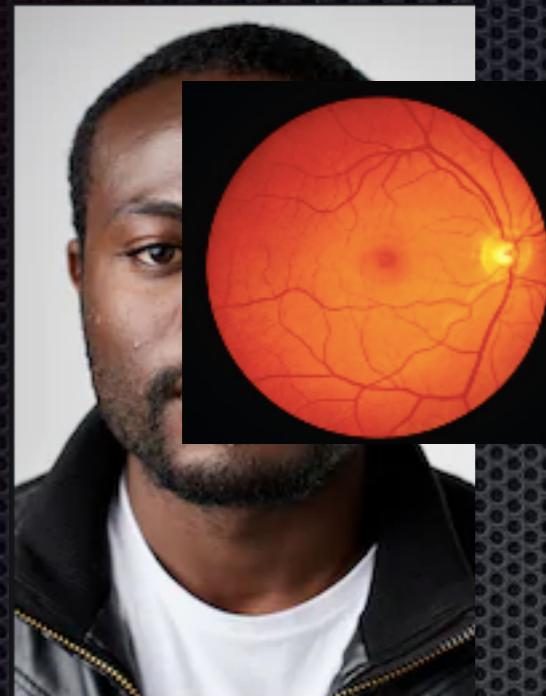
“Inference”



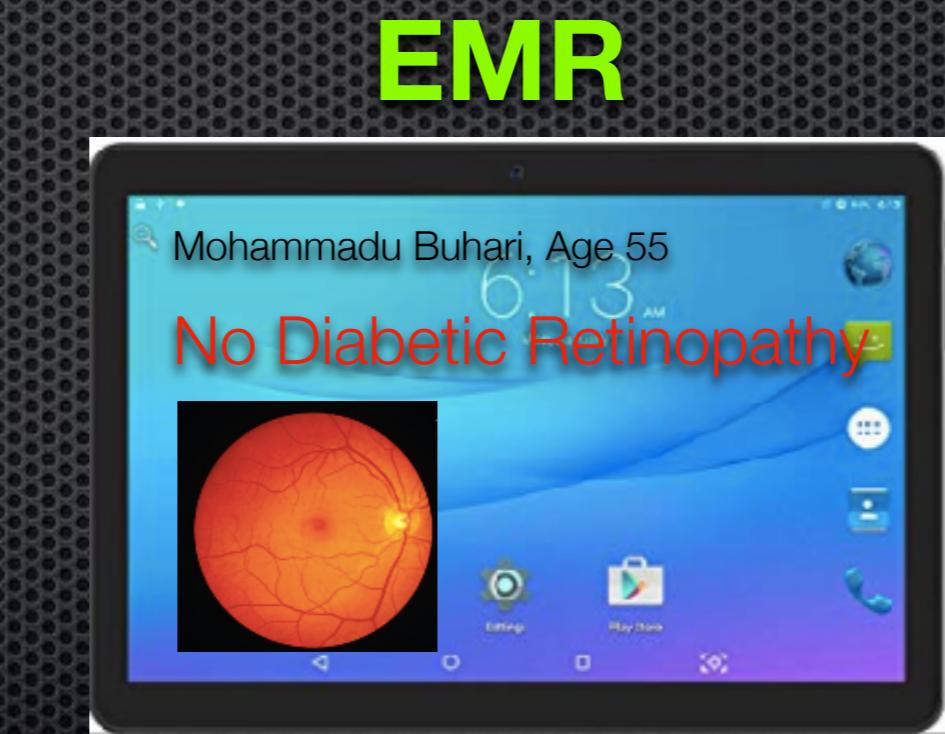
Screening Options

- **Human-based Telemedicine**
- vs:
- **AI-based Autonomous Screening**

Conventional Tele-Ophthalmology Workflow



Fundus Camera



EMR

2-7 days later

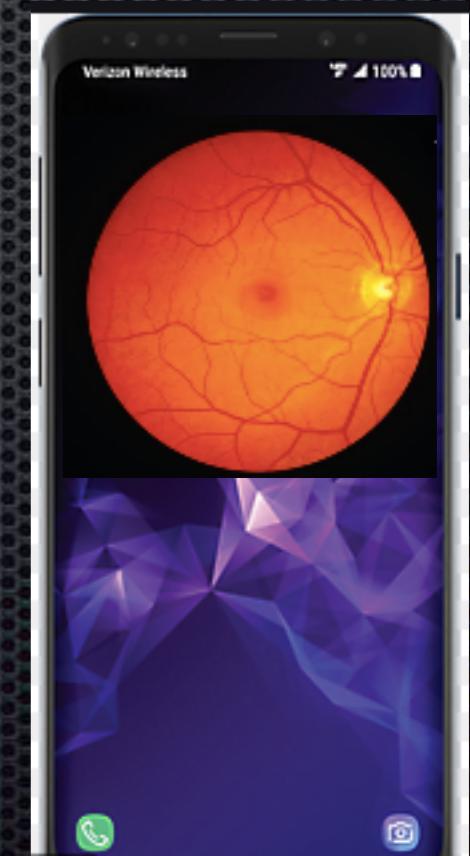
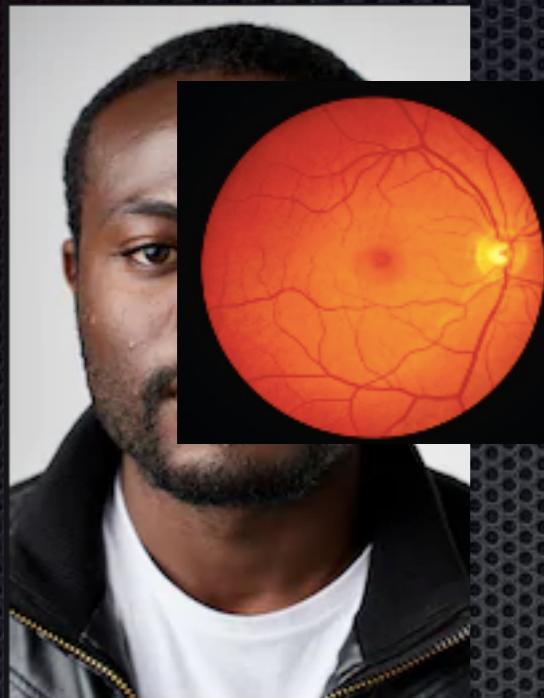


Image Interpretation

Conventional Tele-Ophthalmology Workflow



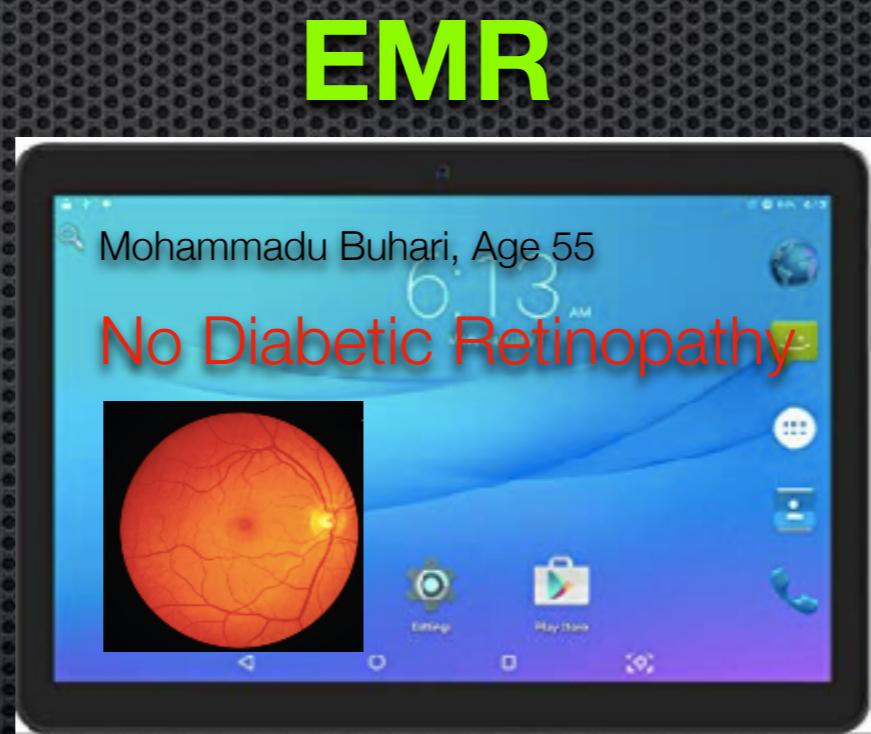
Fundus Camera



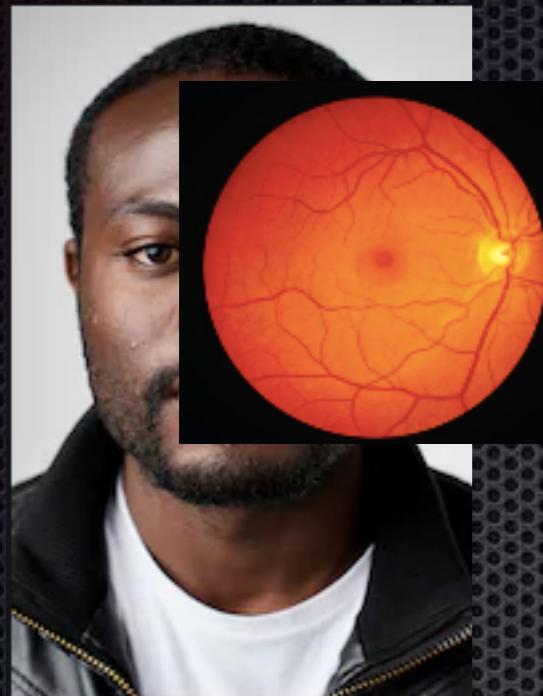
Cloud storage

- Fast
- No Internet required
- Access to continuous Learning

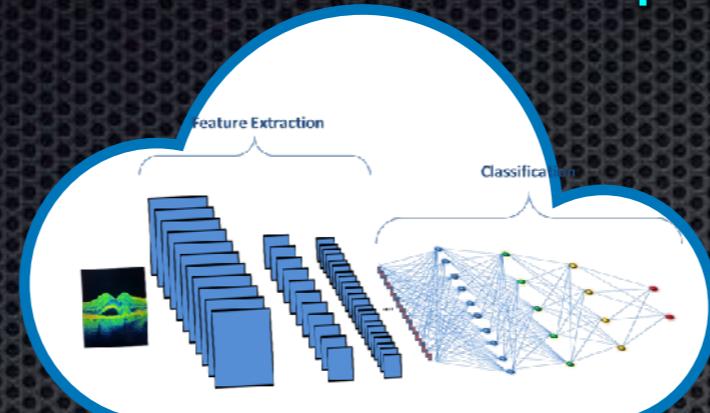
Image Interpretation



Cloud-Hosted AI Interpretation



Fundus Camera



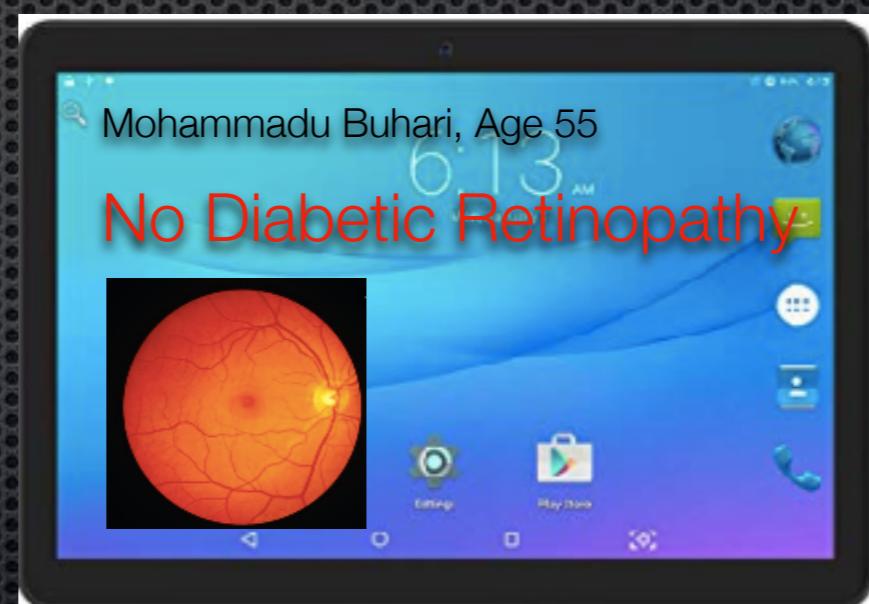
RETINA-AI interpretation & Cloud storage

- Fast
- No Internet required
- Access to continuous Learning

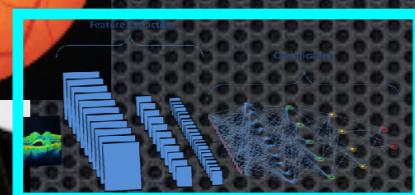
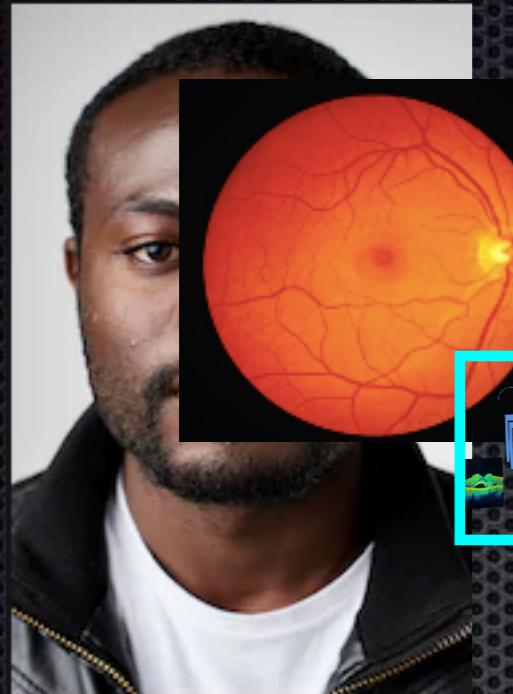
Immediate



EMR



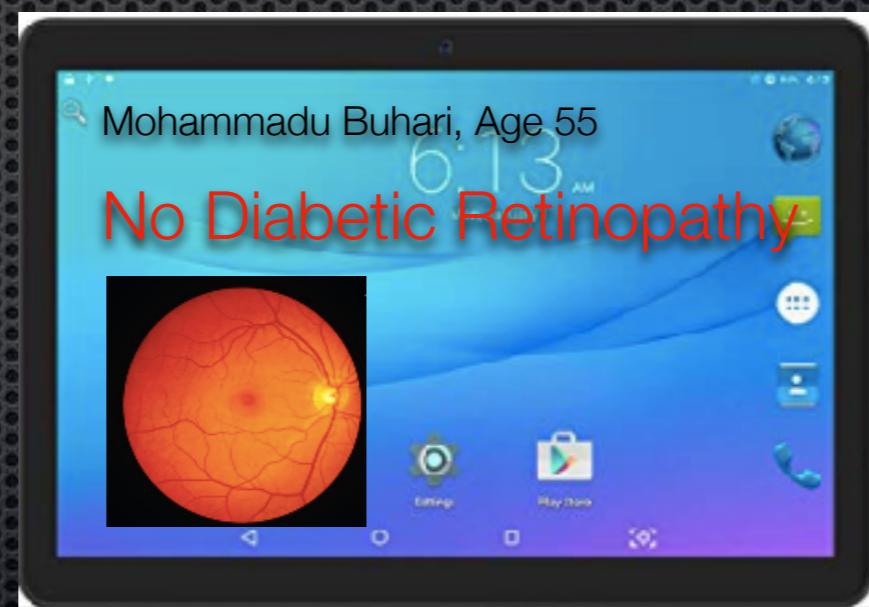
On-Device AI Interpretation



Cloud storage

EMR

- Fast
- ?No Internet required
- Access to continuous Learning



Fundus Camera

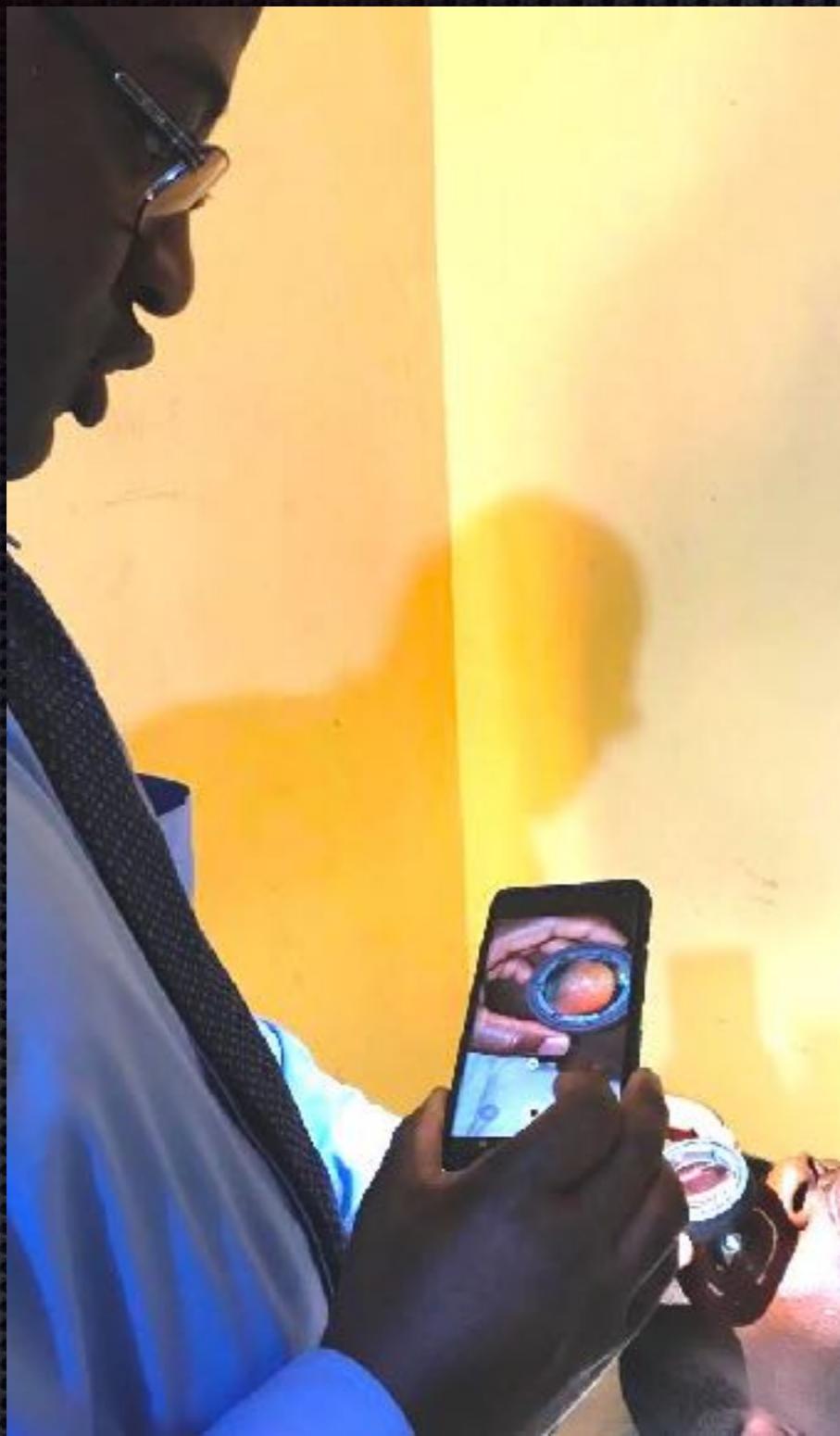
Nigeria



System Goals

- **Affordability**
- **Sustainability**
- **Portability**
- **Ease of use (Secondary School level operator)**
- **Image gradability**
- **Efficacy (High accuracy)**





Efficacy

- ❖ RETINA-AI Health's CADENCE:
 - ❖ **99% sensitivity and 95% specificity** on APTOS dataset
 - ❖ For referable vs non-referable diabetic retinopathy
 - ❖ Currently being independently validated in U.S. Veterans Affairs Healthcare System



Affordability

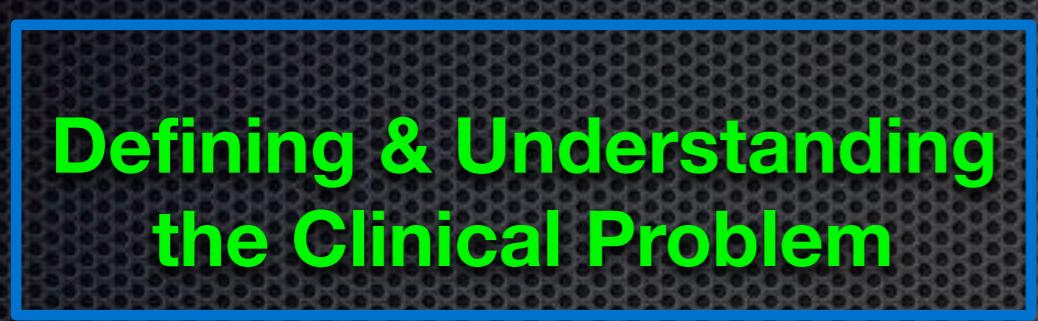
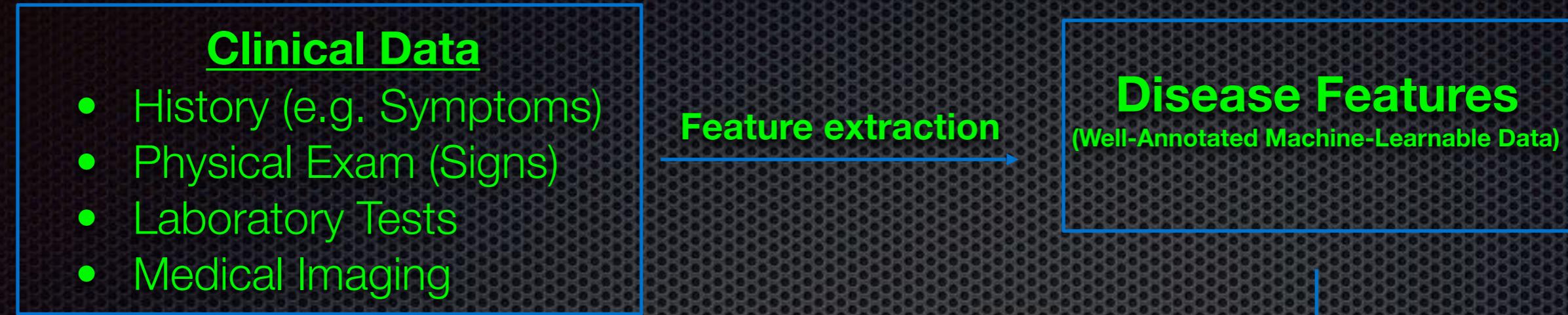


- **Less than 2% of Nigerians have more than \$1500 (N540,000) in Bank Account**
- **Of all monies in Nigerian banks >90% is owned by <2% of bank customers**
- **152 million Nigerians (80%) live on less than \$2/day (N720/day)**

Per new BVN data (August 2019)
African Development Bank (Feb 2019)

What do these numbers really mean?

- ❖ **How should diabetic retinopathy screening be paid for?**
- ❖ **Who should do the paying?**
- ❖ **Will the Nigerian government (or any State govt) allocate a budget for this?**



RETINA-AI Health's Engineering Team



Acknowledgements
Olamide Oyediran
Goodness Duru
Victor Irekpor
Stanley Dukor
Udeme Udofia
Kevin Guo
Dr. Chudi Adi
Dr. Oluwatosin Smith



Artificial Intelligence DevOps Hackathon

Feb 20-22, 2020, Lagos

\$7000 Prize Money