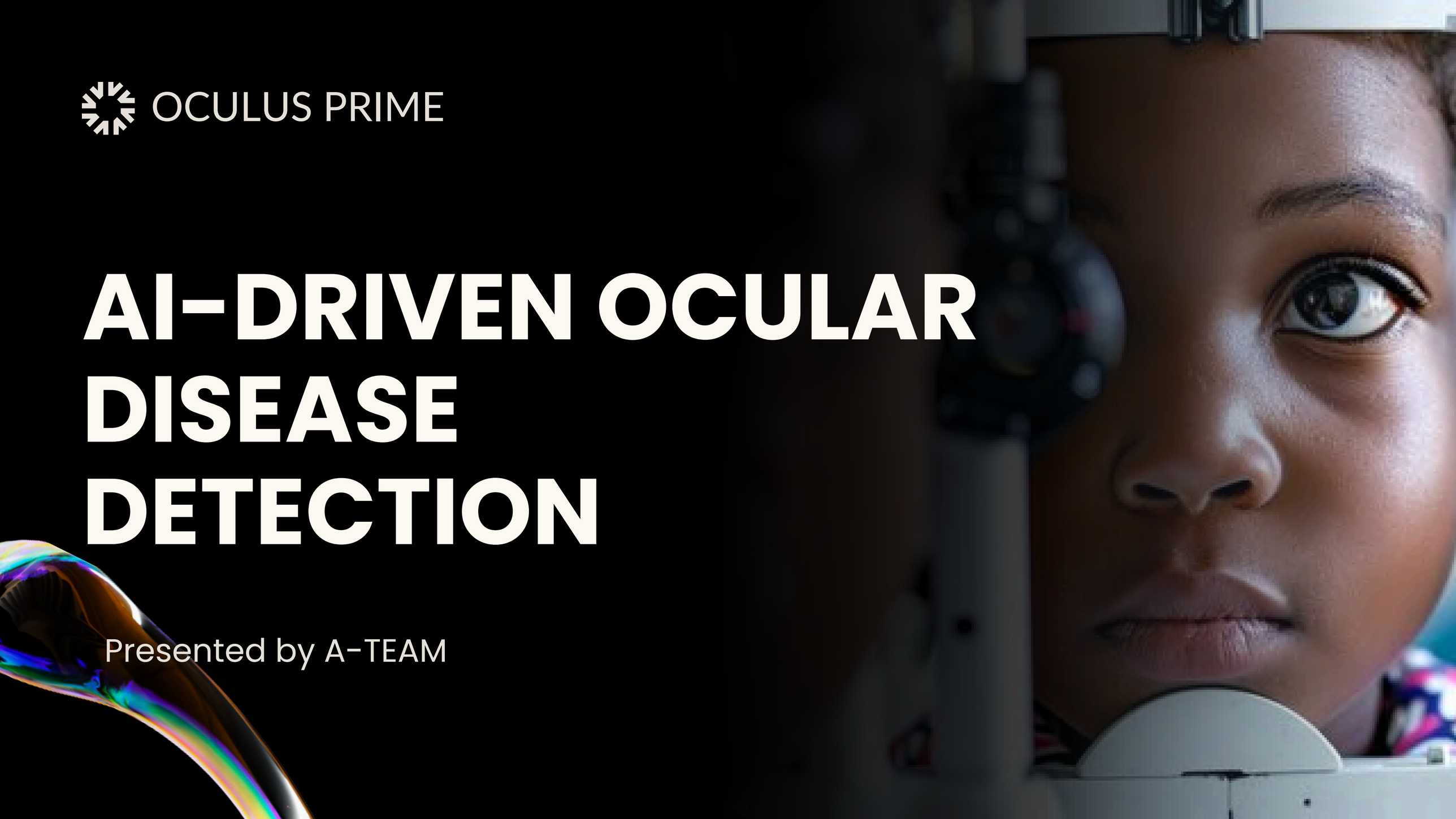
OCULUS PRIME

AI-DRIVEN OCULAR DISEASE DETECTION



Presented by A-TEAM

MEET THE TEAM

JEFF MOGAKA

Team Lead

KELVIN KINOTI

Deployment

FRIDAH NJUNG'E

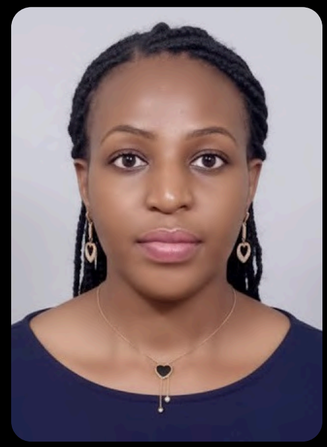
Research

JUDITH OTIENO

Modeling

KITTS KIKUMU

Modeling



TERESIA NDUNG'U

Data Analysis

AGENDA

INTRODUCTION

This project represents a robust and highly relevant application of deep learning for critical public health needs. The project entails an 8-class, multi-label ocular disease classifier developed using a pretrained Convolutional Neural Network (CNN), trained on the Ocular Disease Intelligent Recognition (ODIR-5K) dataset. The project has been advanced to a conceptual deployment stage, aiming to provide predictive diagnostics for fundus images

PROBLEM STATEMENT

A Pandemic of Preventable Blindness

Cabinet Secretary of Health Aden Duale noted that the statistics show that with early detection and timely care, cases of vision loss could be addressed. He noted that globally, 1.1 billion people live with vision impairment, with nearly 90 per cent of the cases being preventable or treatable.

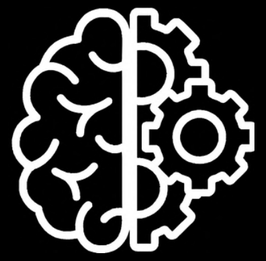
The Crisis in Africa and Kenya

Approximately 26.3 million people in Africa have a form of visual impairment. Of these, 5.9 million are completely blind. Estimates state that 15.5% of Kenyans have eye problems that require ophthalmic care.

The Problem isn't Medicine, It's Access

The WHO identifies the primary barriers in the African region as a "dire shortage of financial resources" and, crucially, a "concentration of scarce human resources in urban areas". Millions remain at risk "due to the lack of eye-care services"

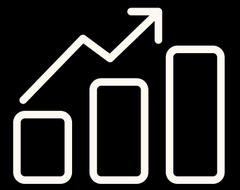
OUR INNOVATIVE SOLUTION



Our AI tool is not designed to replace the small, overburdened cohort of ophthalmologists. It is designed to solve the access problem by acting as a diagnostic "force multiplier." It empowers a general practitioner, nurse, or technician in a remote or primary care clinic to perform an instant, low-cost, and highly accurate screening.

The tool can reduce the burden on specialists by filtering out the large percentage of healthy patients from the referral queue, allowing specialists to focus on high-risk cases.

The Oculus Prime platform is, therefore, an economic engine that saves sight, restores livelihoods, and unlocks human potential.



PROJECT WORKFLOW AND METHODOLOGY

THE DATASET

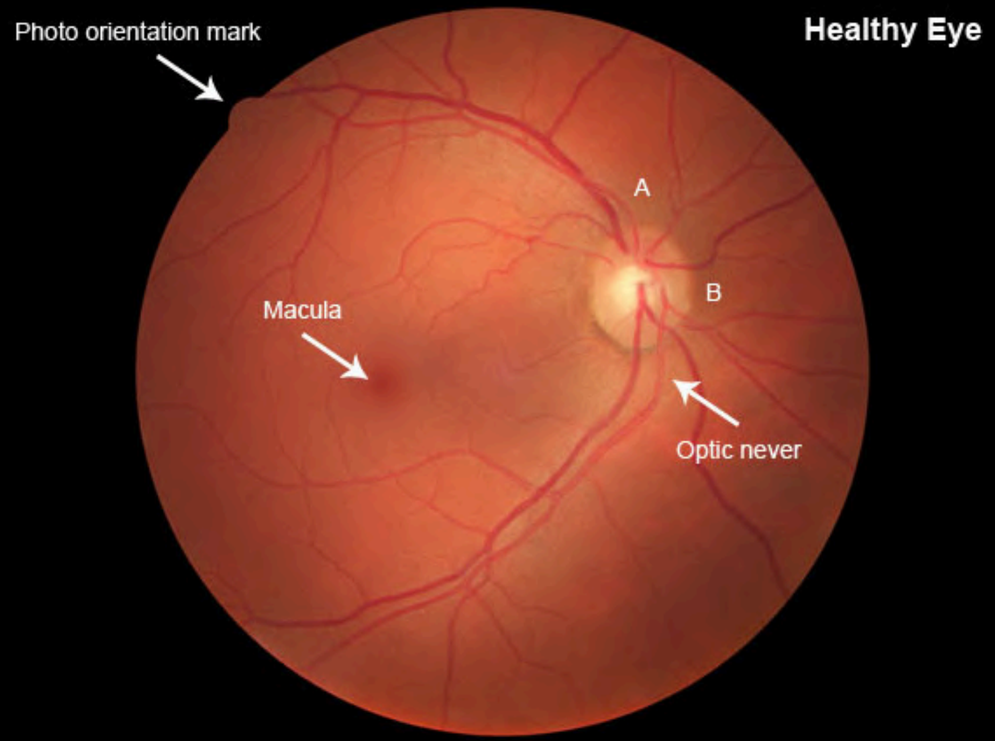
The model was trained on the ODIR-5K (Ocular Disease Intelligent Recognition) dataset , a well-regarded, publicly available ophthalmic database. It consists of patient records, including paired left and right eye color fundus photographs and diagnostic keywords

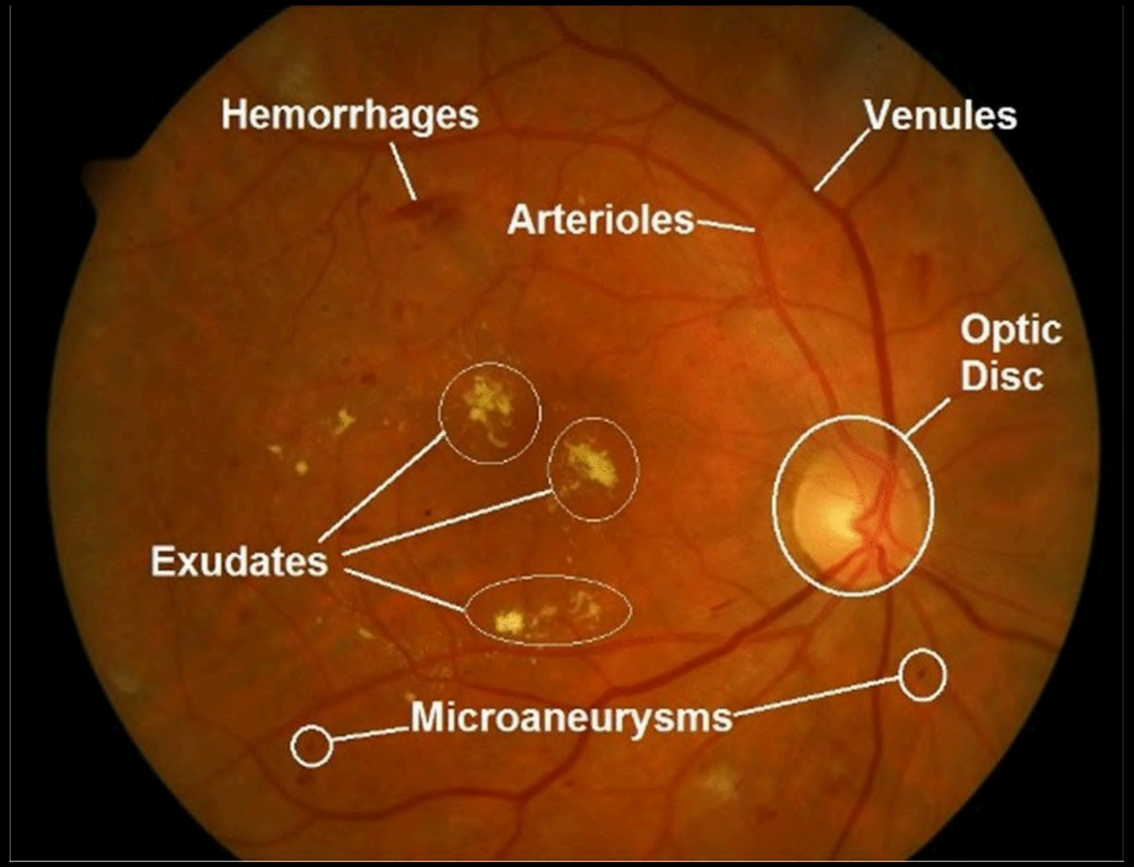
MULTI-LABEL CLASSIFICATION

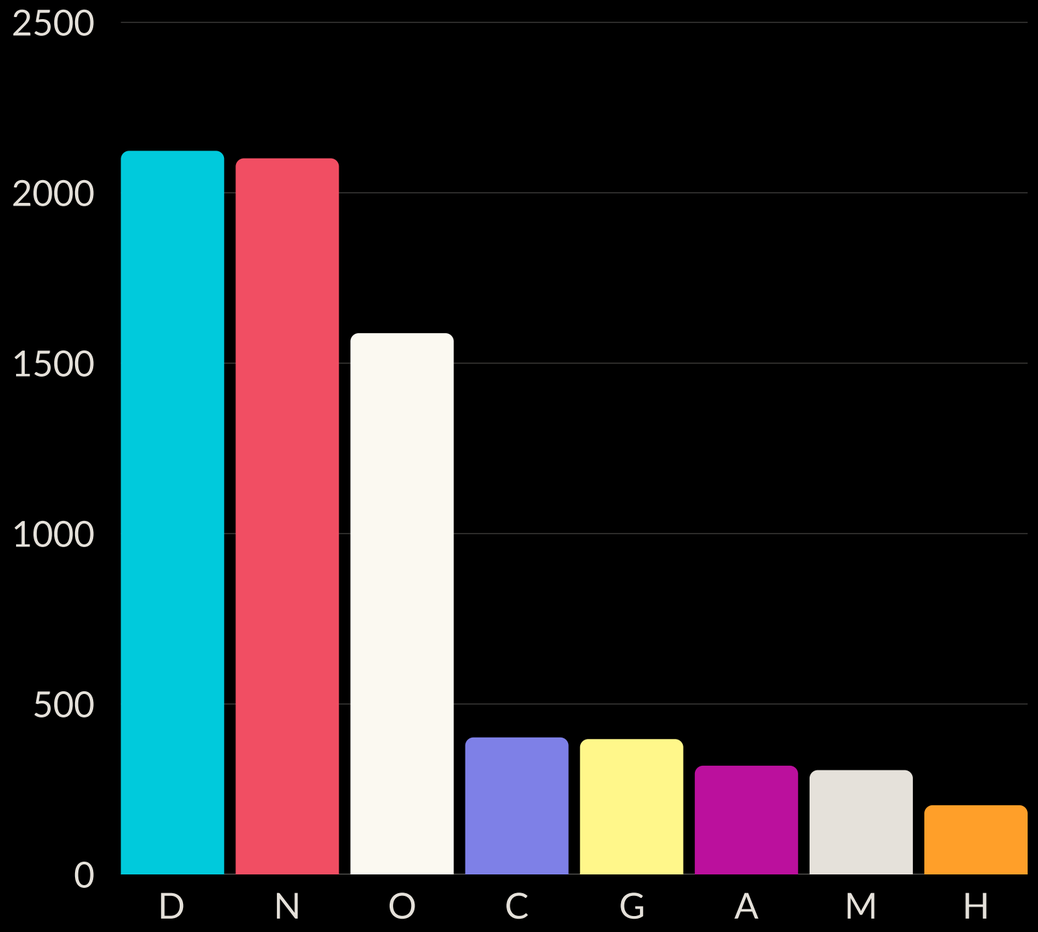
This dataset presents a multi-label classification problem, meaning a single patient image can be associated with multiple pathologies, reflecting real-world clinical complexity. The model is trained to detect 8 distinct classes

- NORMAL (N)
- DIABETES (D)
- CATARACT (C)
- HYPERTENSION (H)
- GLAUCOMA (G)
- PATHOLOGICAL MYOPIA (M)
- AGE-RELATED MACULAR DEGENERATION (A)
- OTHER DISEASES/ABNORMALITIES (O)

NORMAL FUNDUS VS DIABETIC RETINOPATHY







OCULAR DISEASE DISTRIBUTION

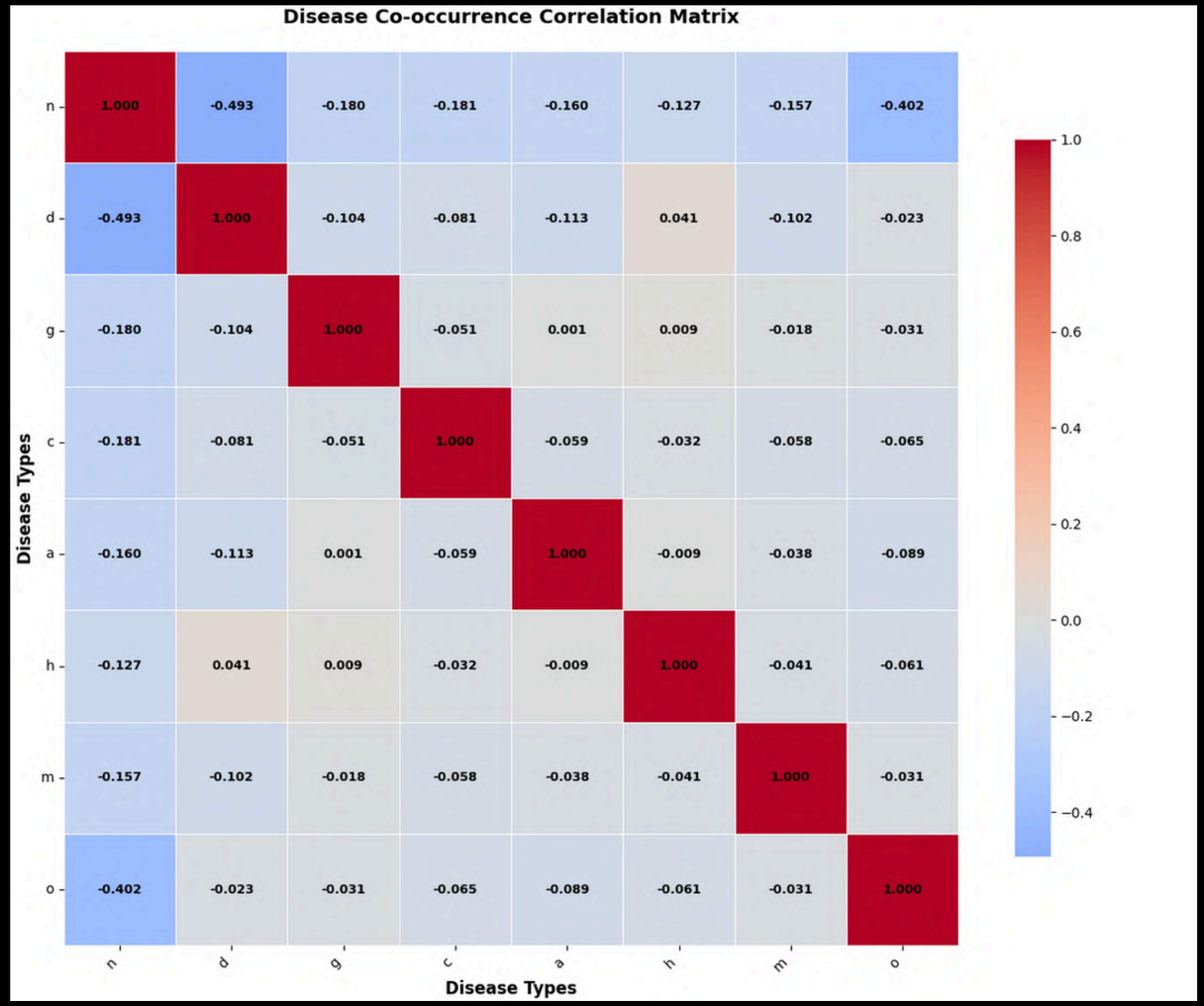
8 ocular disease categories, Normal (n), Myopia (m), Diabetes (d), Glaucoma (g), Cataract (c), Hypertension (h), Age-related Macular Degeneration (a), and Other abnormalities (o)

Diabetes and Normal are the most common disease categories. The remaining diseases including Cataract, Glaucoma, AMD, Myopia, and Hypertension, have fewer samples

There is a class imbalance which has to be addressed

DISEASE CO-OCCURENCE MATRIX

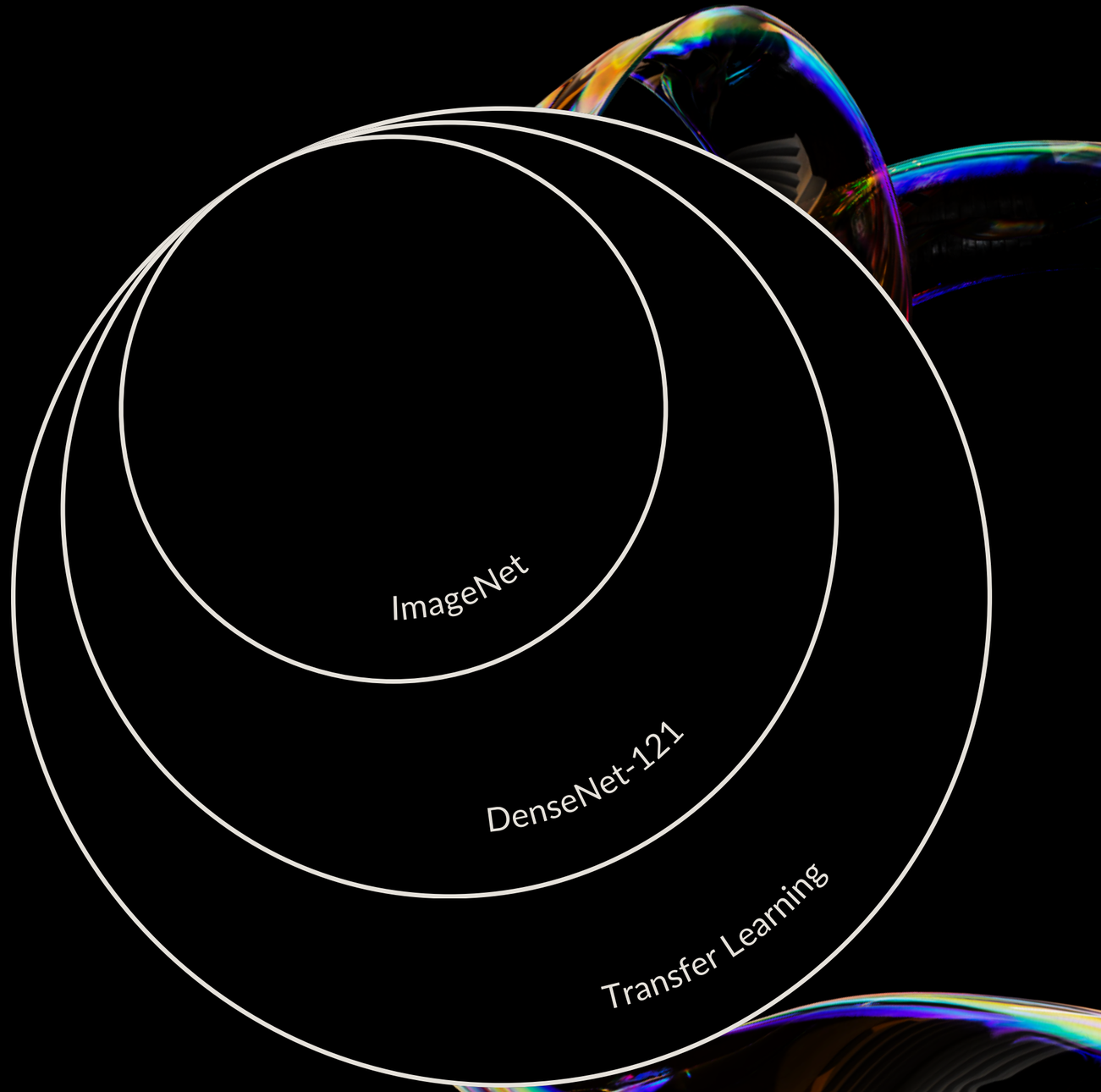
- The heatmap above visualizes the correlation between different ocular diseases, showing how often they co-occur in patients.



THE ARCHITECTURE

The project utilizes the DenseNet-121 model , a powerful and well-justified architectural choice for this task. DenseNet-121 is a state-of-the-art CNN whose key innovation is "dense connectivity." In this architecture, each layer is connected to every other subsequent layer in a feed-forward manner.

Where diagnoses hinge on subtle features—such as micro-aneurysms for DR or changes in the optic disc cup-to-disc ratio for Glaucoma—DenseNet's ability to preserve and pass on these "weak" features is a significant advantage



CLINICAL TRUST WITH EXPLAINABLE AI

The Primary Limitation: The "Black Box" Problem

Most deep neural networks are a "black box". The model can render a highly accurate prediction but cannot articulate the reason for that prediction. It cannot answer: "What features in the fundus image led to this diagnosis?

The Solution: Explainable AI with Grad-CAM

This limitation is not a dead end; it is an opportunity to integrate a critical feature. The most appropriate and widely used technique for this model is Gradient-weighted Class Activation Mapping (Grad-CAM). This provides a visual explanation for a CNN's prediction

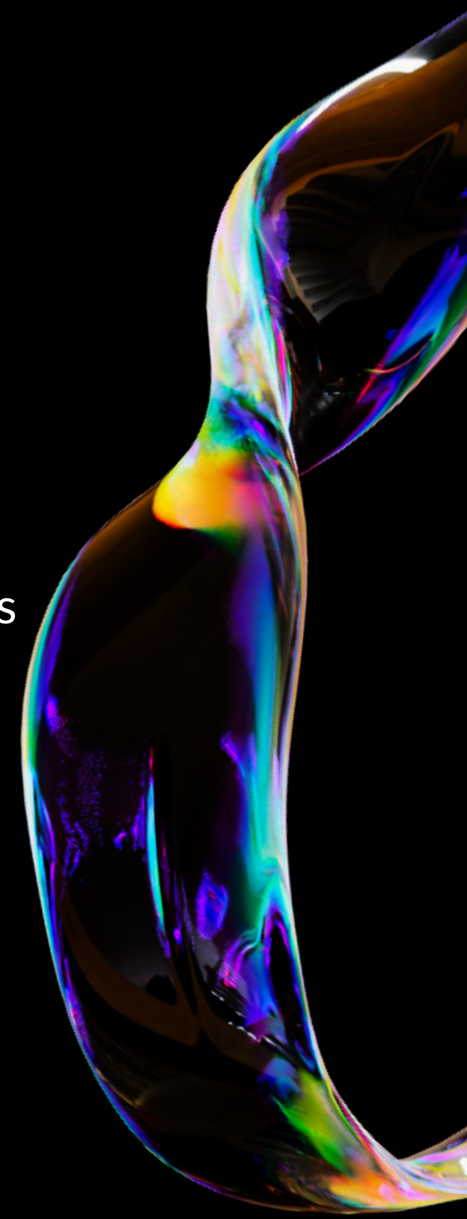
MODEL PERFORMANCE

PERFORMANCE METRIC

- For a medical screening tool, and especially for one trained on an imbalanced dataset , Accuracy is a highly misleading metric

- **Recall (Sensitivity):** Of all the patients who actually had Glaucoma, how many did the model find? This is arguably the most critical clinical metric, as low recall means dangerous false negatives.

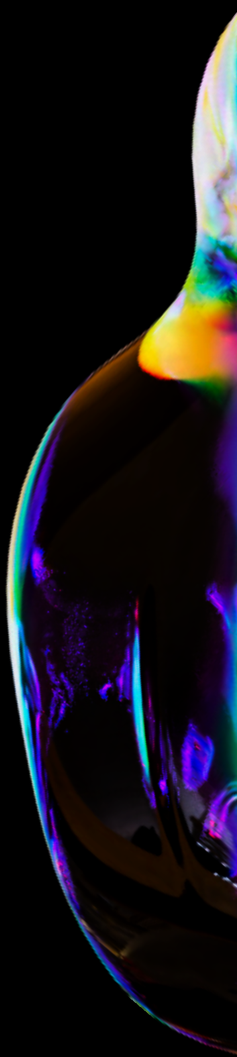
- **Precision:** Of all the "Glaucoma" predictions, how many were correct? High precision is vital to avoid overwhelming clinics with false positives.



PERFORMANCE VALIDATION

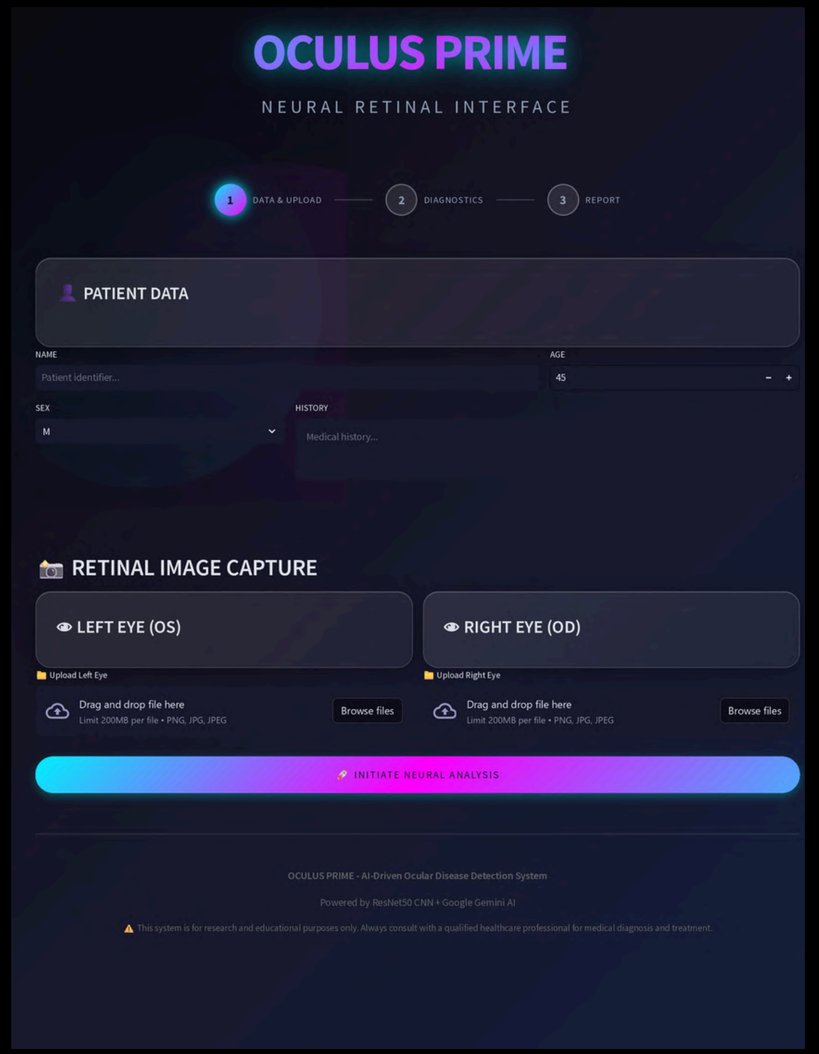
The following table is the centerpiece of the performance analysis. The table is populated with the results from the project's held-out test set to provide a direct and meaningful output

```
--- Results with Custom Thresholds ---
              precision    recall  f1-score   support

      Normal       0.78      0.86      0.82      1857
    Diabetes       0.76      0.79      0.78      1756
    Glaucoma       0.82      0.84      0.83      1139
    Cataract       0.94      0.88      0.91       928
         AMD       0.88      0.85      0.86       612
Hypertension       0.87      0.84      0.85       600
      Myopia       0.90      0.87      0.88       650
       Other       0.61      0.72      0.66      1082

   micro avg       0.79      0.83      0.81      8624
   macro avg       0.82      0.83      0.83      8624
...
Improvement: +0.49%

Multi-disease samples (true): 1018
Multi-disease samples (pred): 1469
```



MODEL DEPLOYMENT

This is a strategic framework for the project's deployment, addressing the need to move from a concept to a scalable, production-ready system.



CONCLUSION

Our model has addressed more than just a proof-of-concept. We have a robust, multi-disease screening tool, trained on the complex ODIR-5K dataset, that can identify eight distinct pathologies from a single fundus image.

More importantly, we've addressed the single biggest barrier to clinical adoption: the "black box". By implementing explainable AI like Grad-CAM, our tool doesn't just provide an answer; it provides a reason. It builds trust by showing clinicians why it suspects a certain disease, highlighting the same clinically-relevant features a human expert would look for.

RECOMMENDATIONS AND FUTURE WORK

Beyond CNNs to Vision Transformers (ViTs)

ViTs use a "self-attention" mechanism that allows processing of the entire image globally, understanding the complex relationships between different parts of the retina.

Building a National Data Alliance

The current model is good, but to be robust enough for the diverse Kenyan population, it must be trained on local, diverse patient data from Kenyan hospitals.

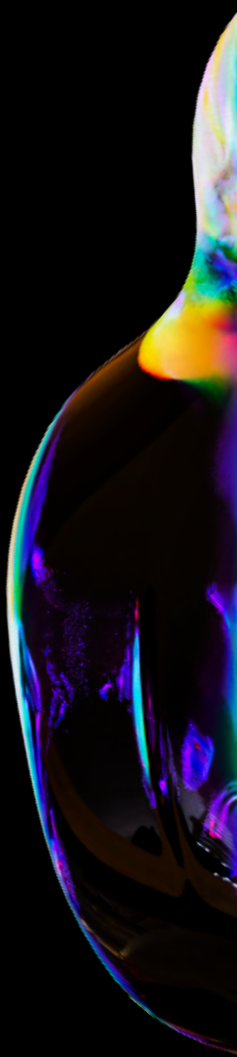
Oculomics

Emerging field that uses AI to detect systemic disease from retinal images. The retina provides a direct, real-time view of the central nervous system and vascular health.

OCULUS PRIME

Neural Retinal Interface

https://a-teamstrivetowin.streamlit.app/



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THANK YOU

for your time and attention

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