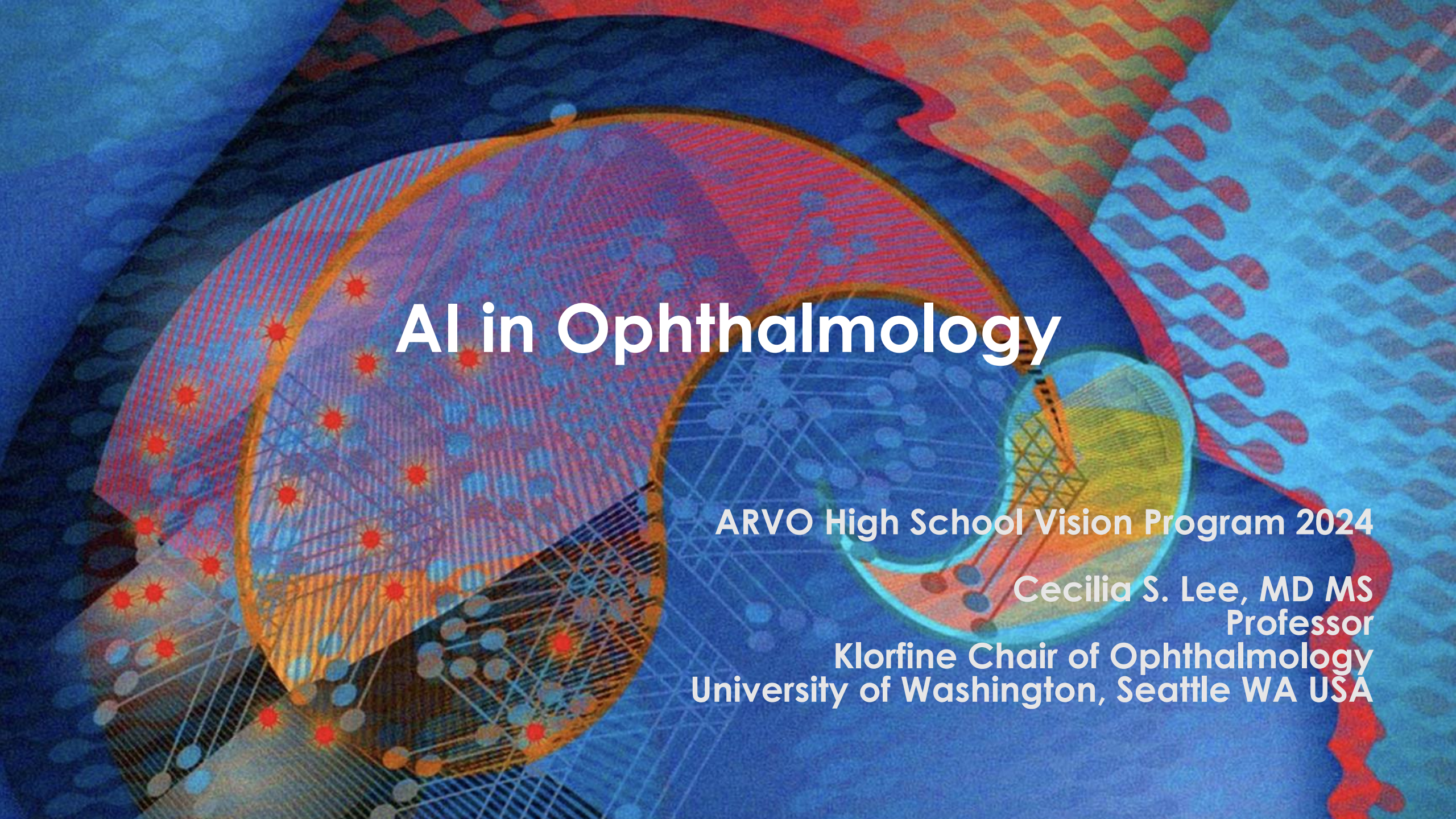


AI in Ophthalmology

ARVO High School Vision Program 2024

Cecilia S. Lee, MD MS
Professor
Klorfine Chair of Ophthalmology
University of Washington, Seattle WA USA

Disclosures

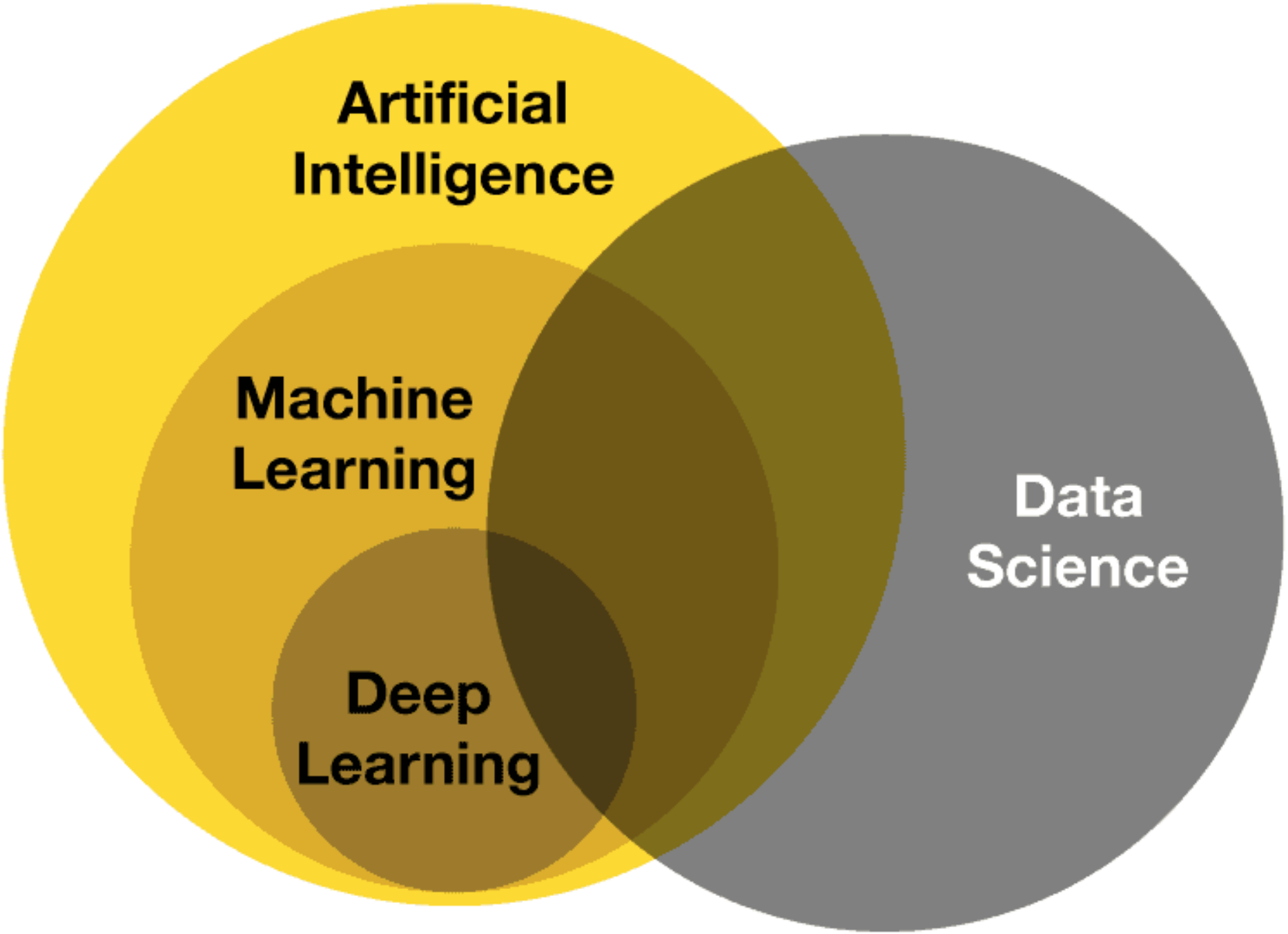
- NIH, Gates Ventures, Alzheimer's Disease Drug Discovery Foundation, the Lowy Medical Research Institute, Research to Prevent Blindness, Ferry Foundation (F)
- Boehringer International (C)

Computational Ophthalmology

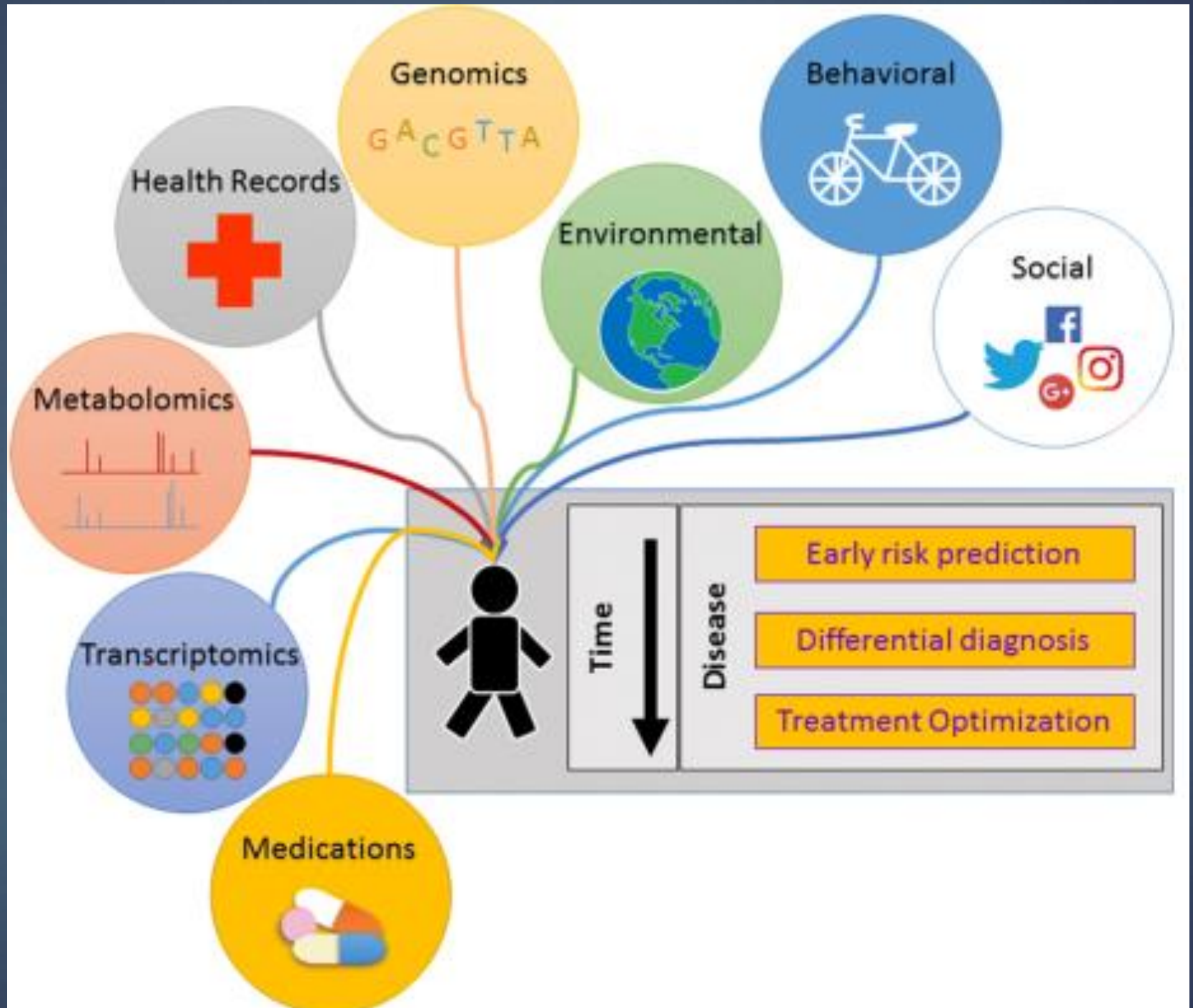
Outline

- AI and big data basics
- Examples
- Future directions

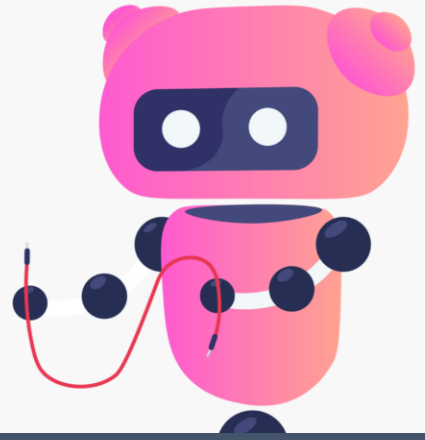
Computational Ophthalmology


Artificial Intelligence
Machine Learning
Deep Learning
Data Science

What is Big Data?


Genomics
GACGTTA
Behavioral
Health Records
Environmental
Social
Metabolomics
Transcriptomics
Medications
Time
Disease
Early risk prediction
Differential diagnosis
Treatment Optimization

Artificial Intelligence (AI) is the ability for a computer to think and learn.

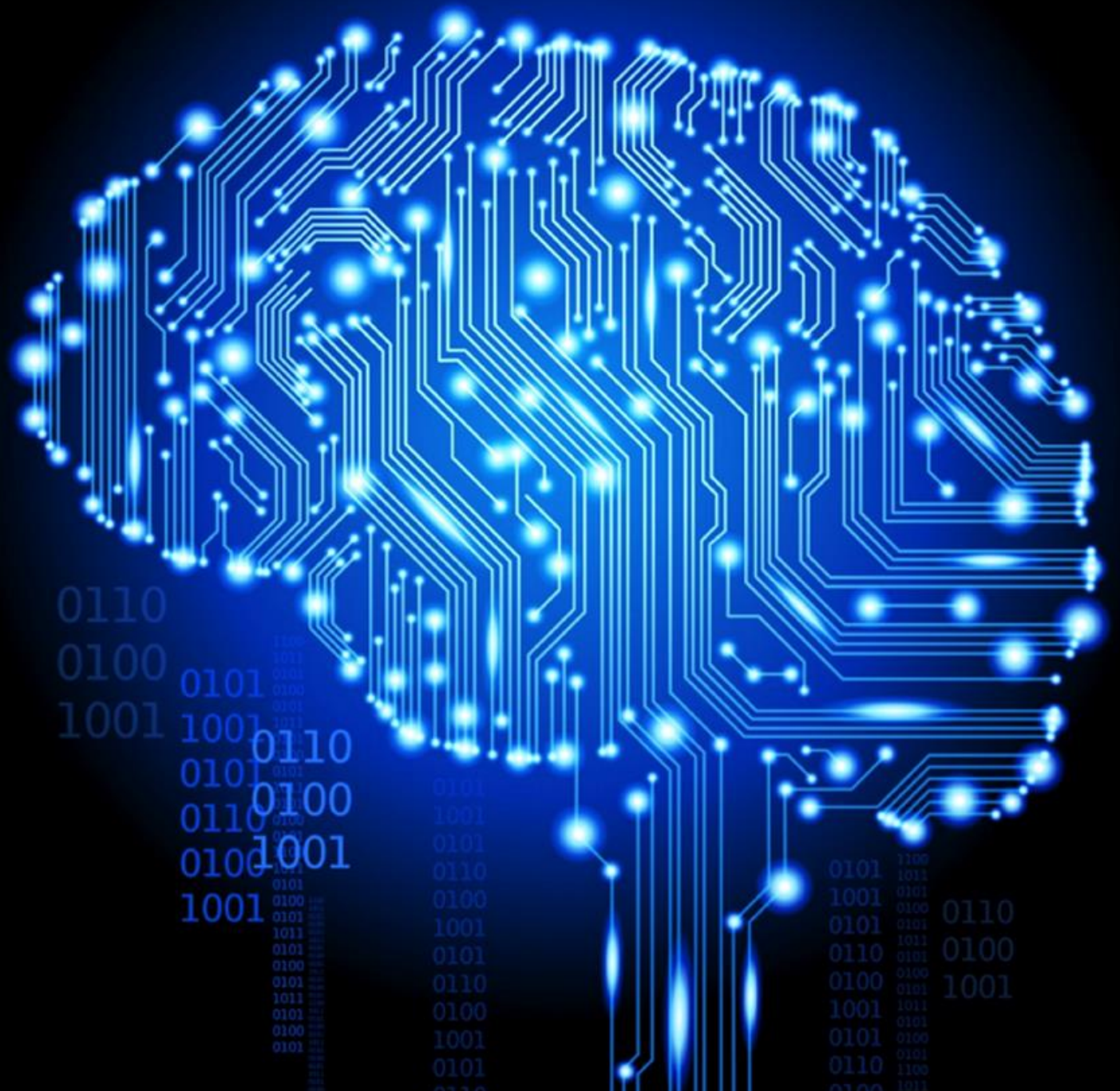


A NEW COMPUTING MODEL

Algorithms that Learn from Examples

Traditional Approach

- Requires domain experts
- Time consuming
- Error prone
- Not scalable to new problems



Era of Big data and Machine Learning has arrived

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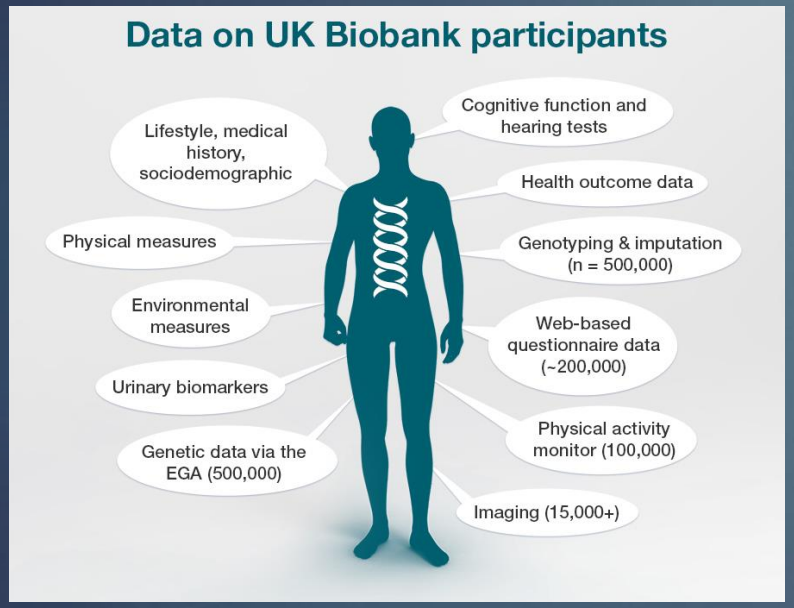
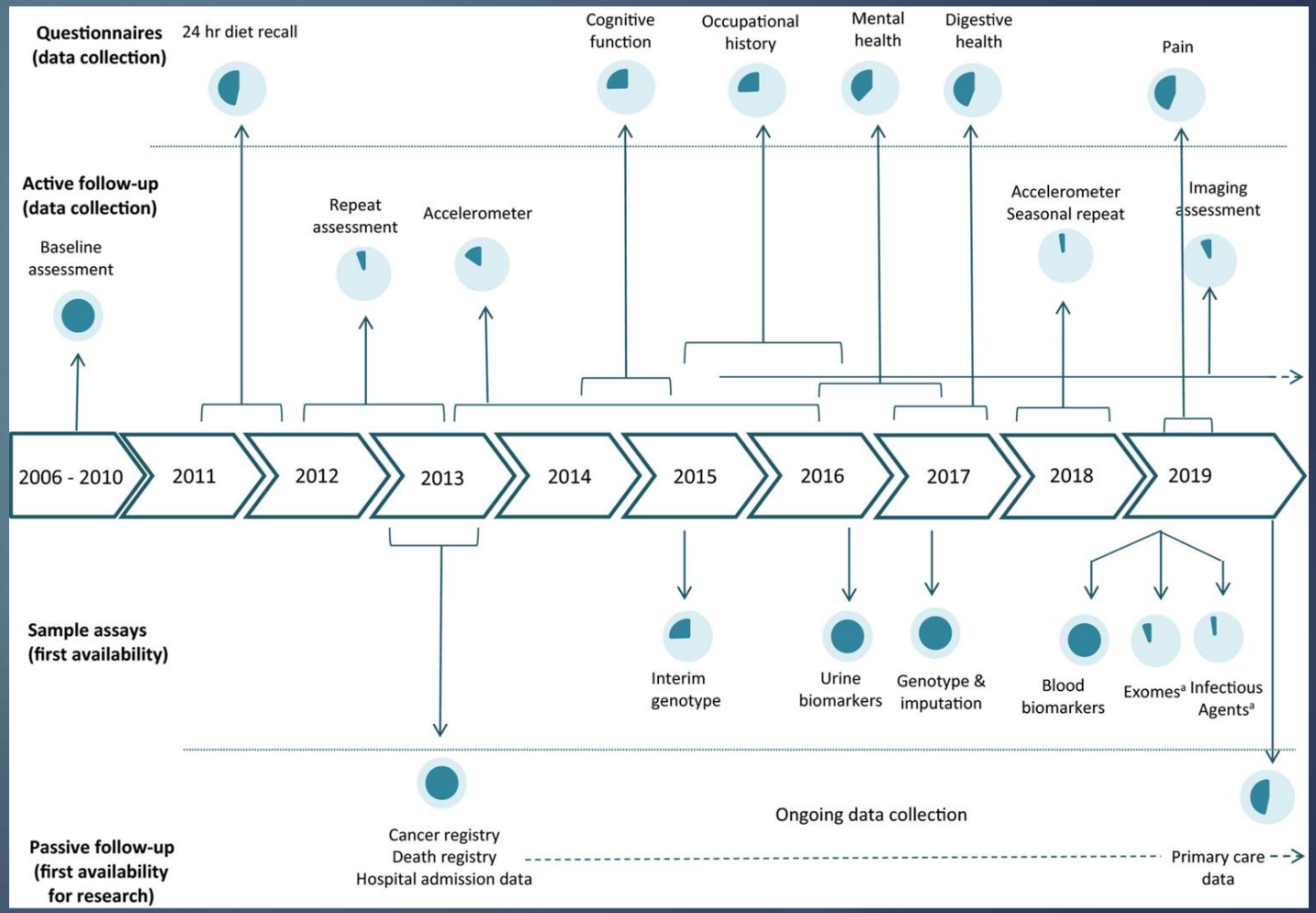
Computational Ophthalmology

biobank uk


Data on UK Biobank participants
Lifestyle, medical history, sociodemographic
Cognitive function and hearing tests
Health outcome data
Physical measures
Genotyping & imputation (n = 500,000)
Environmental measures
Web-based questionnaire data (~200,000)
Urinary biomarkers
Physical activity monitor (100,000)
Genetic data via the EGA (500,000)
Imaging (15,000+)


Questionnaires (data collection)
24 hr diet recall
Cognitive function
Occupational history
Mental health
Digestive health
Pain
Active follow-up (data collection)
Baseline assessment
Repeat assessment
Accelerometer
Accelerometer Seasonal repeat
Imaging assessment
2006 - 2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Sample assays (first availability)
Interim genotype
Urine biomarkers
Genotype & imputation
Blood biomarkers
Exomes[a]
Infectious Agents[a]
Ongoing data collection
Passive follow-up (first availability for research)
Cancer registry
Death registry
Hospital admission data
Primary care data

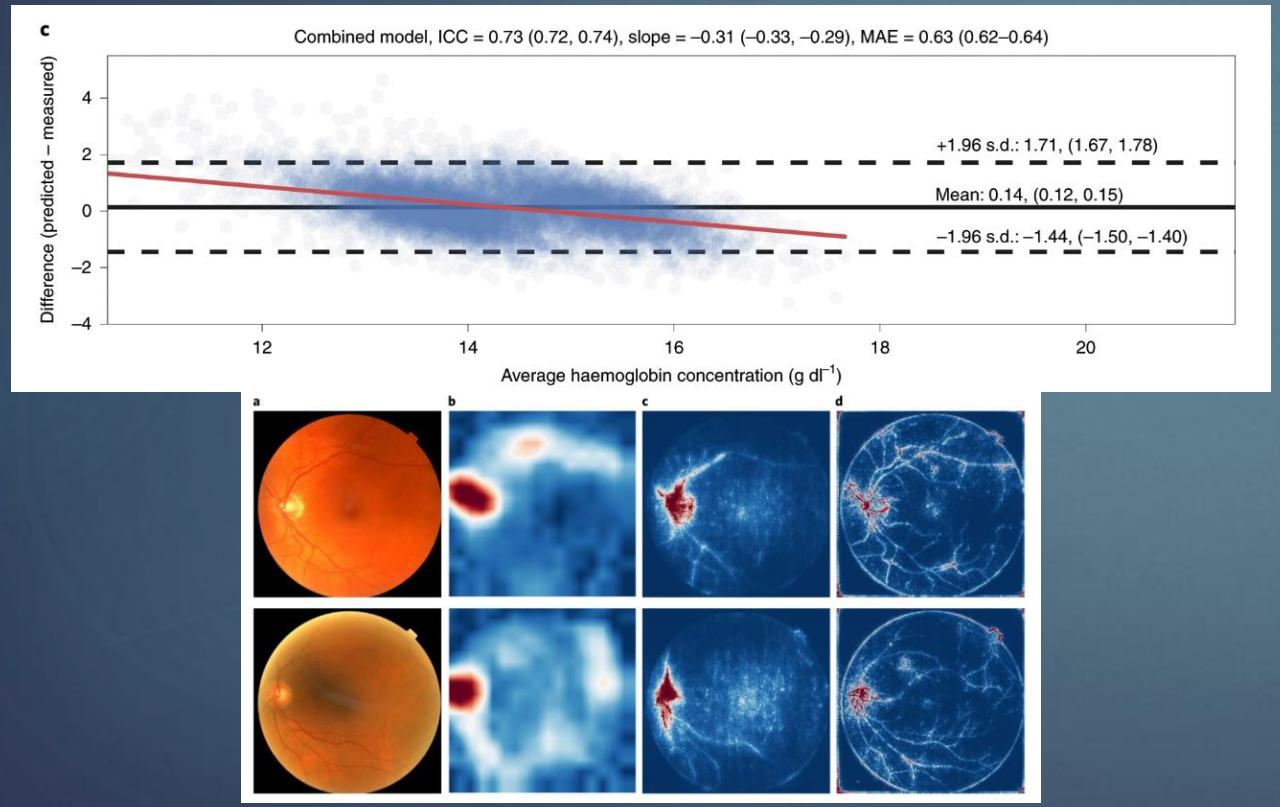
nature biomedical engineering

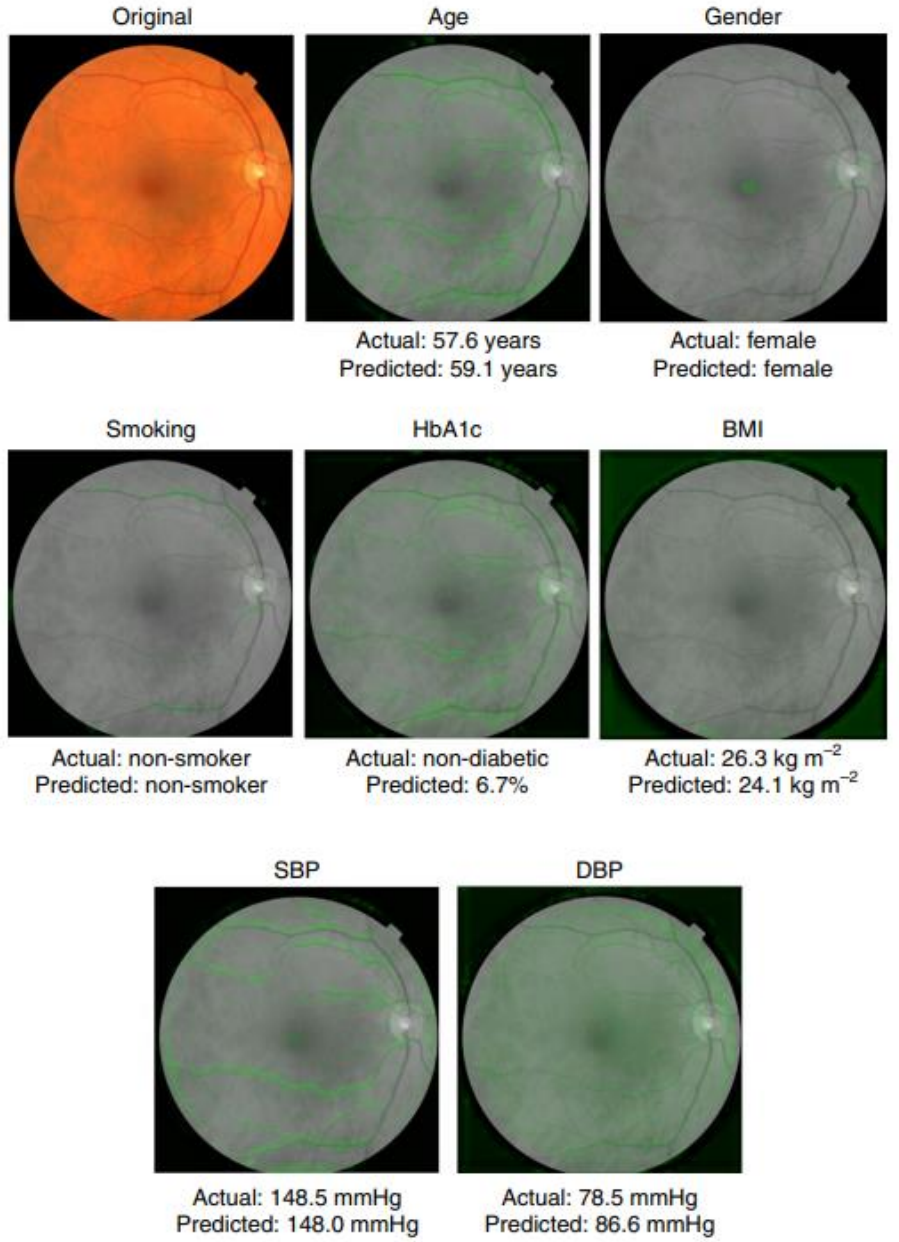
ARTICLES

https://doi.org/10.1038/s41551-018-0195-0

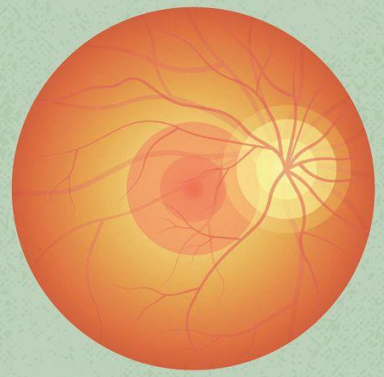
Prediction of cardiovascular risk factors from retinal fundus photographs via deep learning

Ryan Poplin[1,4], Avinash V. Varadarajan[1,4], Katy Blumer[1], Yun Liu[1], Michael V. McConnell[2,3], Greg S. Corrado[1], Lily Peng[1,4]* and Dale R. Webster[1,4]



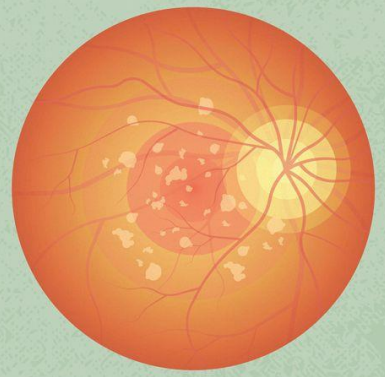


NORMAL EYE



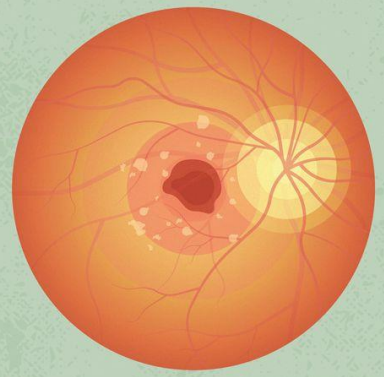
Clear vision of normal eyes

DRY MD



Unusually fuzzy or distorted vision

WET MD



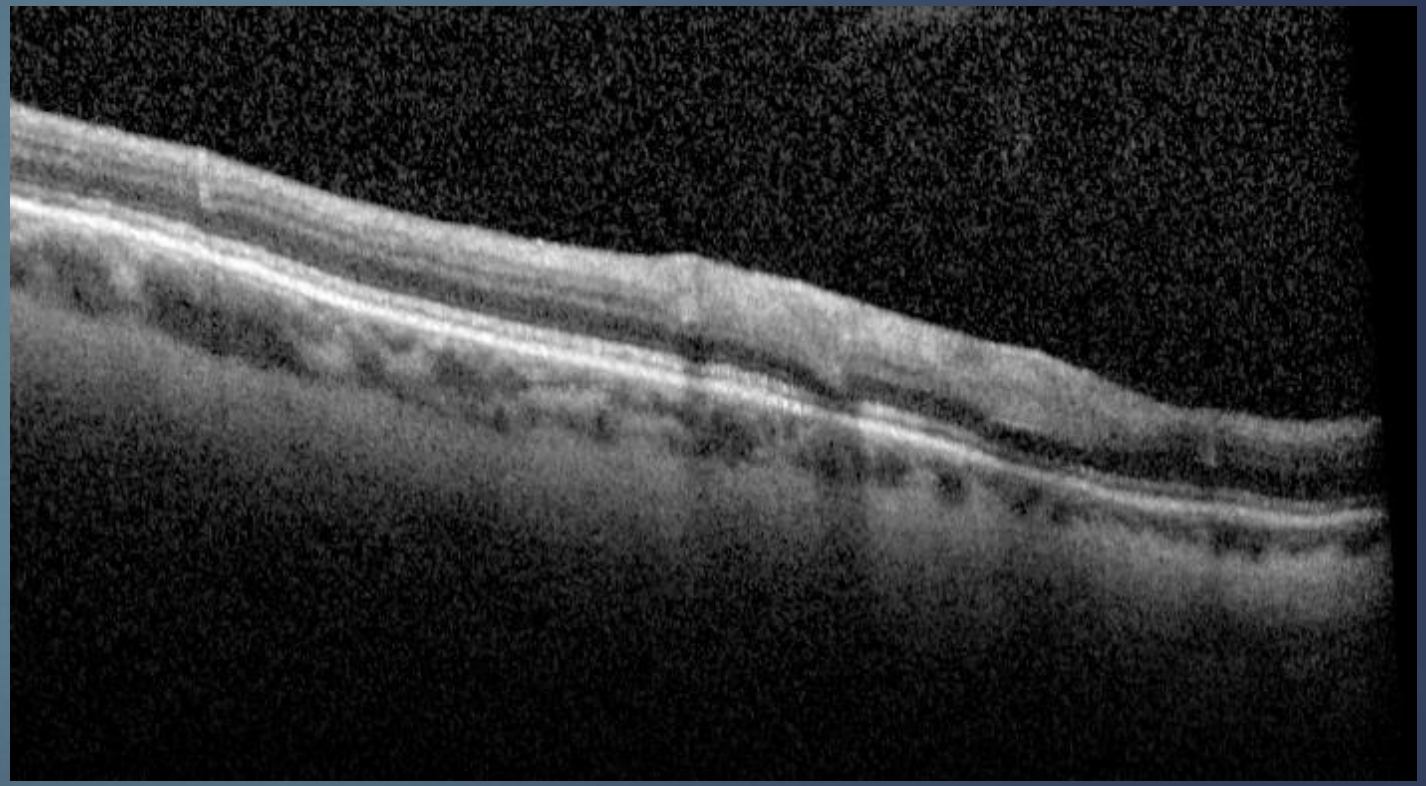
Blind spot in center of field of vision

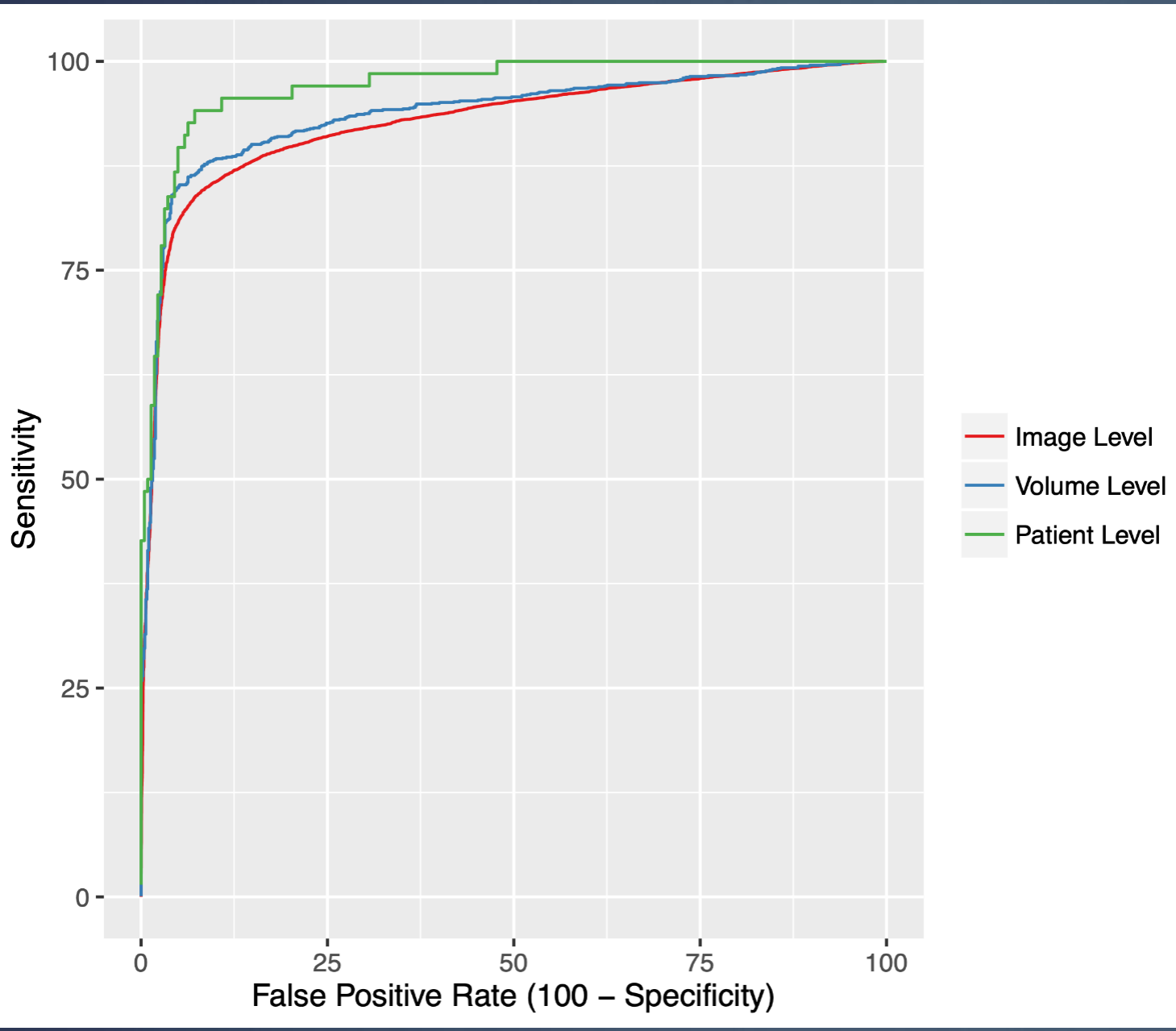
Stages of AMD

As important as knowing the risk factors, patients need to know how to care for themselves if they have AMD.

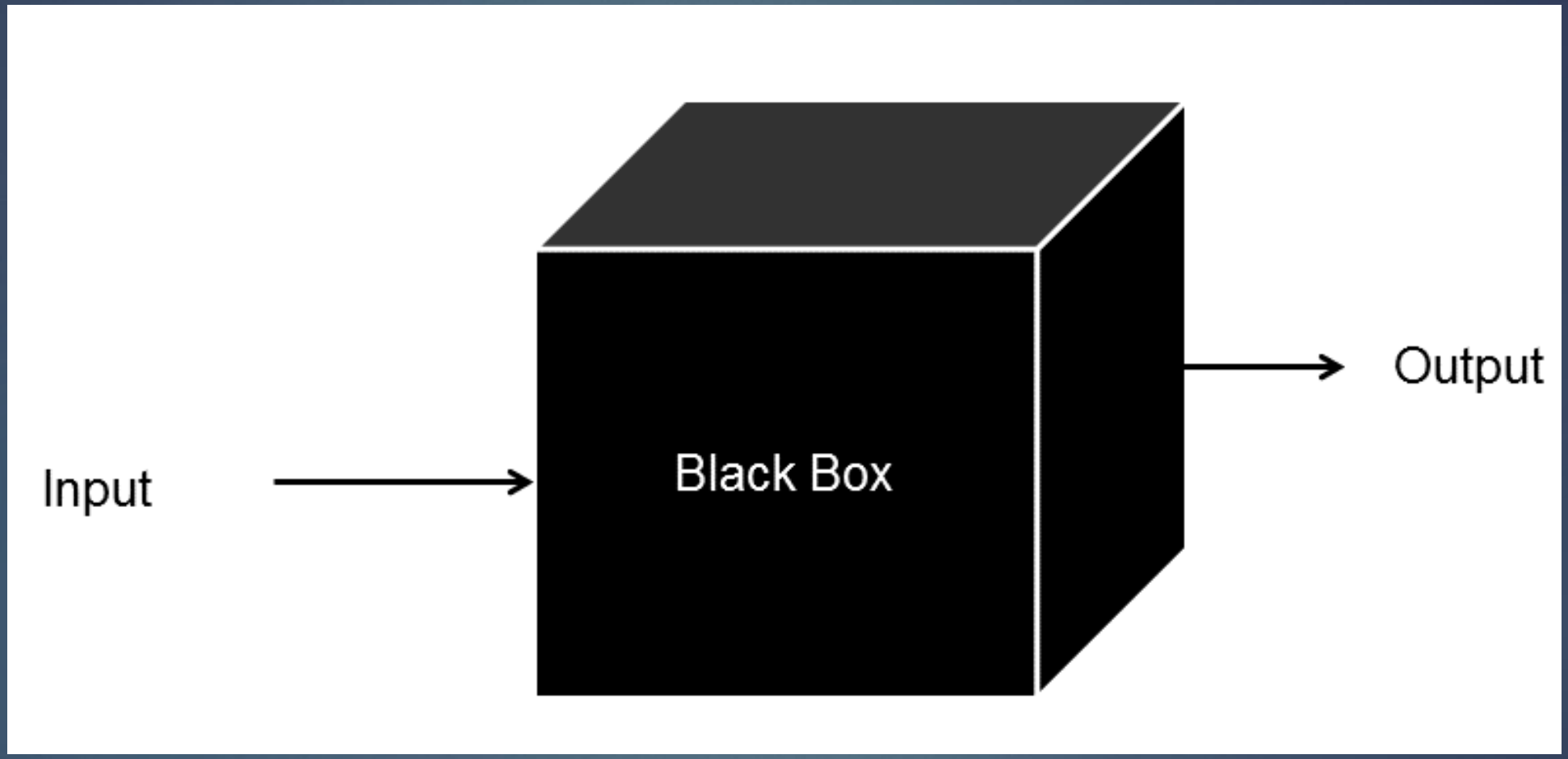
The Stages of AMD


TOPCON
3D OCT-1 Maestro2





- Image level: AUROC = 92.78%
- Volume level: AUROC = 93.83%
- Patient level: AUROC = 97.45%
- Peak sensitivity: 92.64%
- Peak specificity: 93.69%

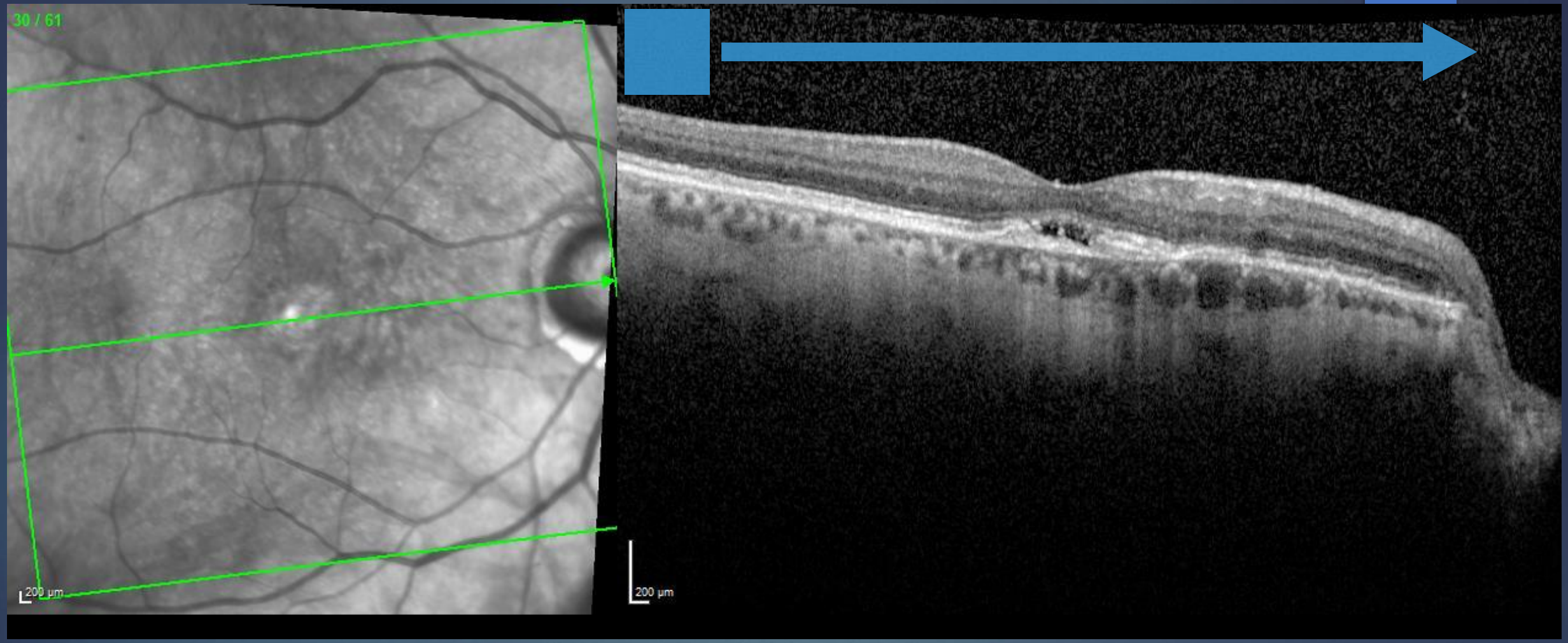

Input
Black Box
Output

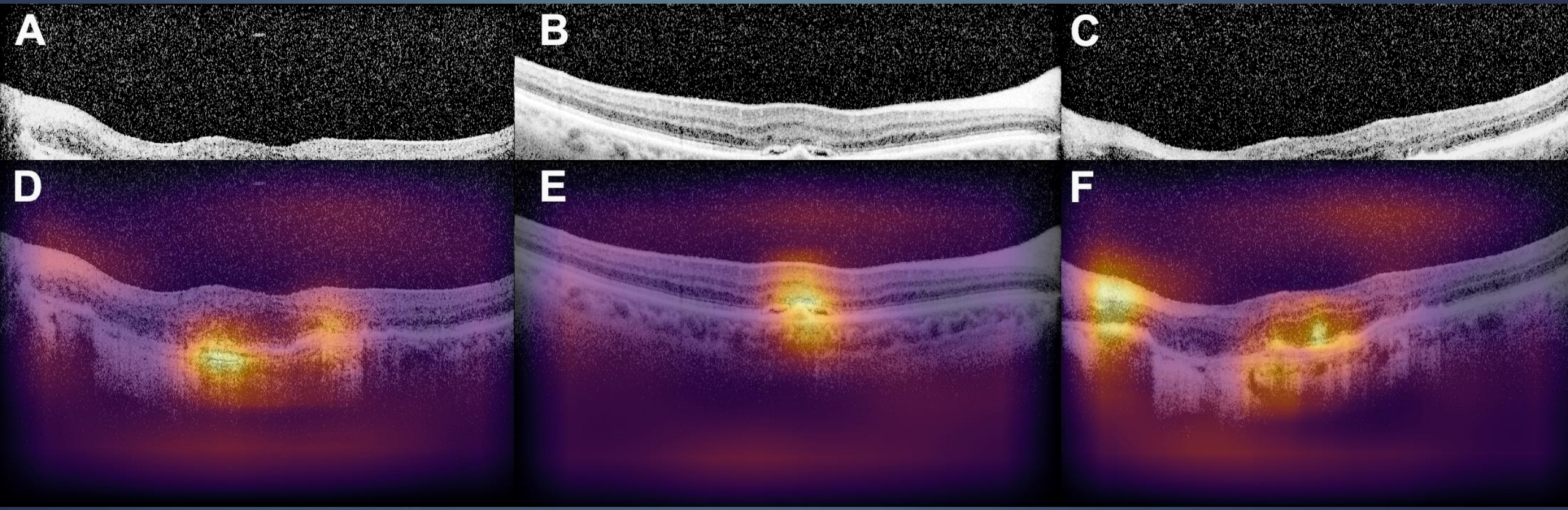
Is there a ball in this picture?

100%

Is there a ball in this picture?

???%


30 / 61
200 µm
200 µm


A
B
C
D
E
F

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OF OPHTHALMOLOGY

Deep Learning Is Effective for Classifying Normal versus Age-Related Macular Degeneration OCT Images

Cecilia S. Lee, MD, Doug M. Baughman, BS, Aaron Y. Lee, MD, MSCI

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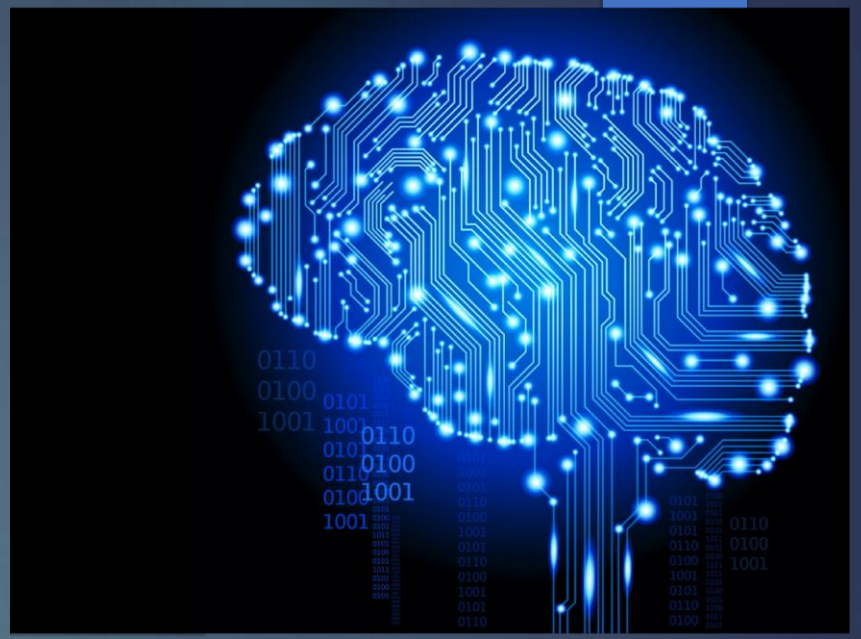

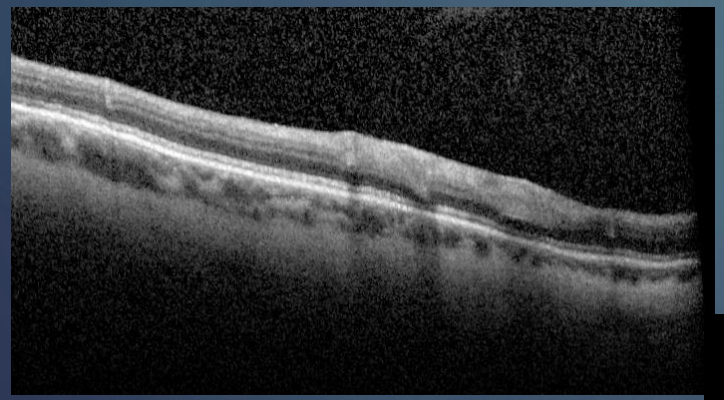

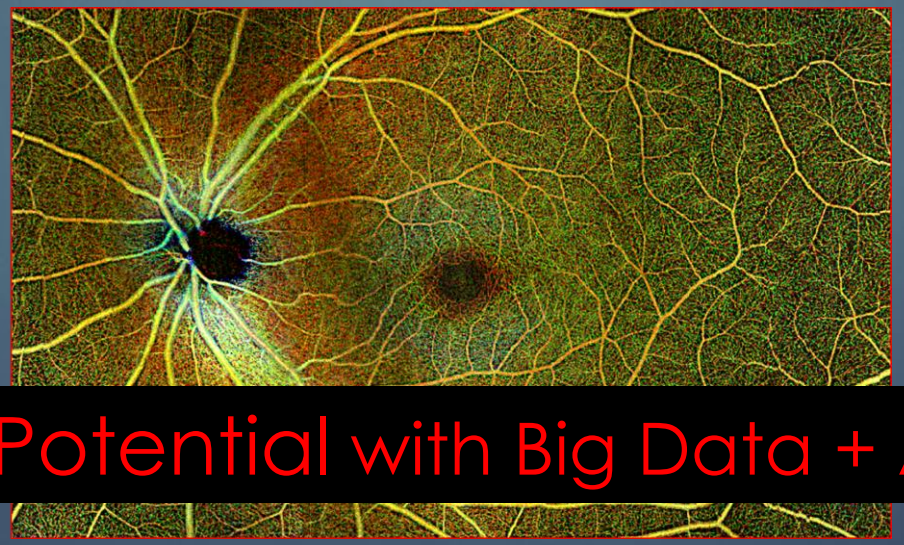

Potential with Big Data + AI

Take home points

Big Data and AI can lead to new insights in ophthalmology & novel connections with the eye.

Understanding the limitations and validations will be critical for enabling better diagnostics, therapeutics, and precision medicine.

Computational Ophthalmology

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Aaron Lee, MD MSCI

https://comp.ophthalmology.uw.edu

Julia Owen PhD
Yue Wu PhD
Scott Song BA
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Cari Drolet PhD

Marian Blazes MD
Jamie Shaffer MS
Yuka Kihara PhD
Randy Lu MD
Mira Tang

Thank you

COMP.OPHTHALMOLOGY.UW.EDU

LEECS2@UW.EDU

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