



LEARNING-BASED APPROACH IN MEDICAL IMAGING: APPLICATION IN RETINAL IMAGES

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Medical Image and Signal Processing Research Center



EMORY
WINSHIP
CANCER
INSTITUTE

National Cancer Institute-Designated
Comprehensive Cancer Center

NCI

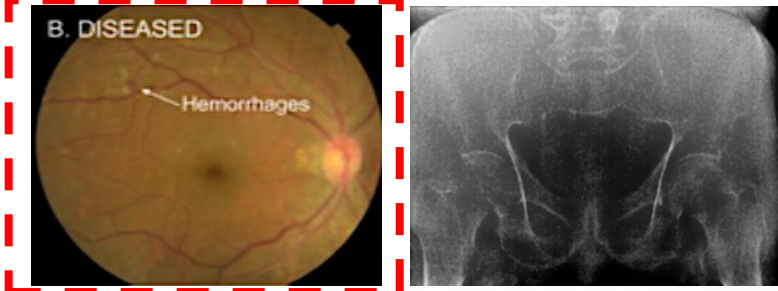
Designated
Comprehensive
Cancer Center

OUTLINE

1. Background
2. Computer Aided Diagnosis
3. Preprocessing
4. Landmarks detection
5. Supervised Classification
6. Results
7. Conclusion

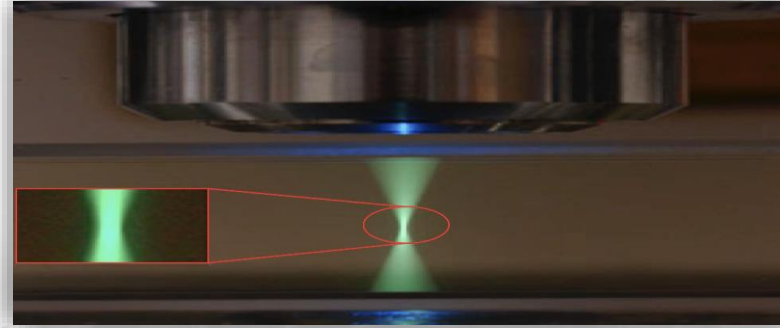
PROJECTS

Medical image processing



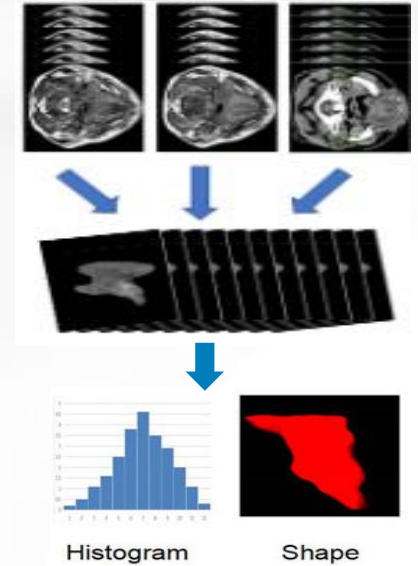
- 2019: IEEE-SPIE Medical Imaging Conference
- 2020: IET Image Processing
- 2021: IEEE Access, Pattern Recognition
- 2022: Medical Physics

Inference in biophysical systems



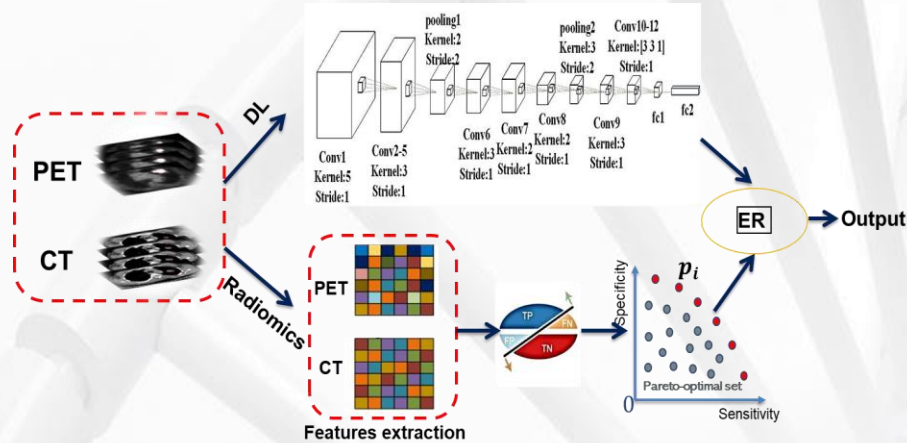
- 2019: The Journal of Physical Chemistry B
- 2020: Physical Review X
- 2021: Cell Report
- 2024: Nature Communication under revision

Radiomics



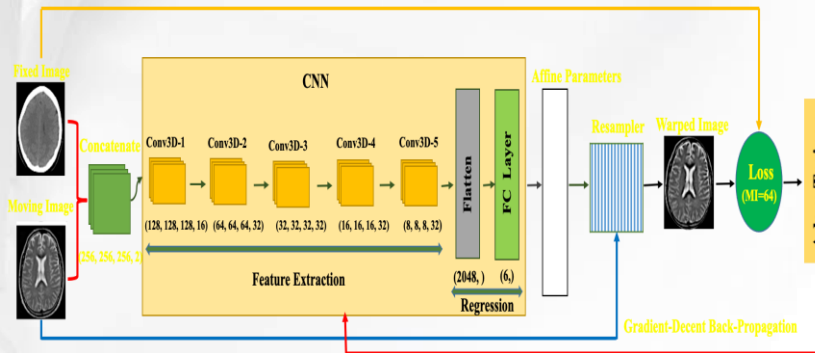
Histogram Shape

Treatment outcome

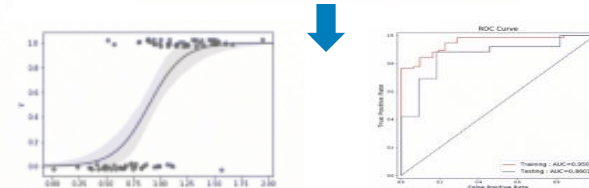


- 2024: Medical Physics under revision

Image registration

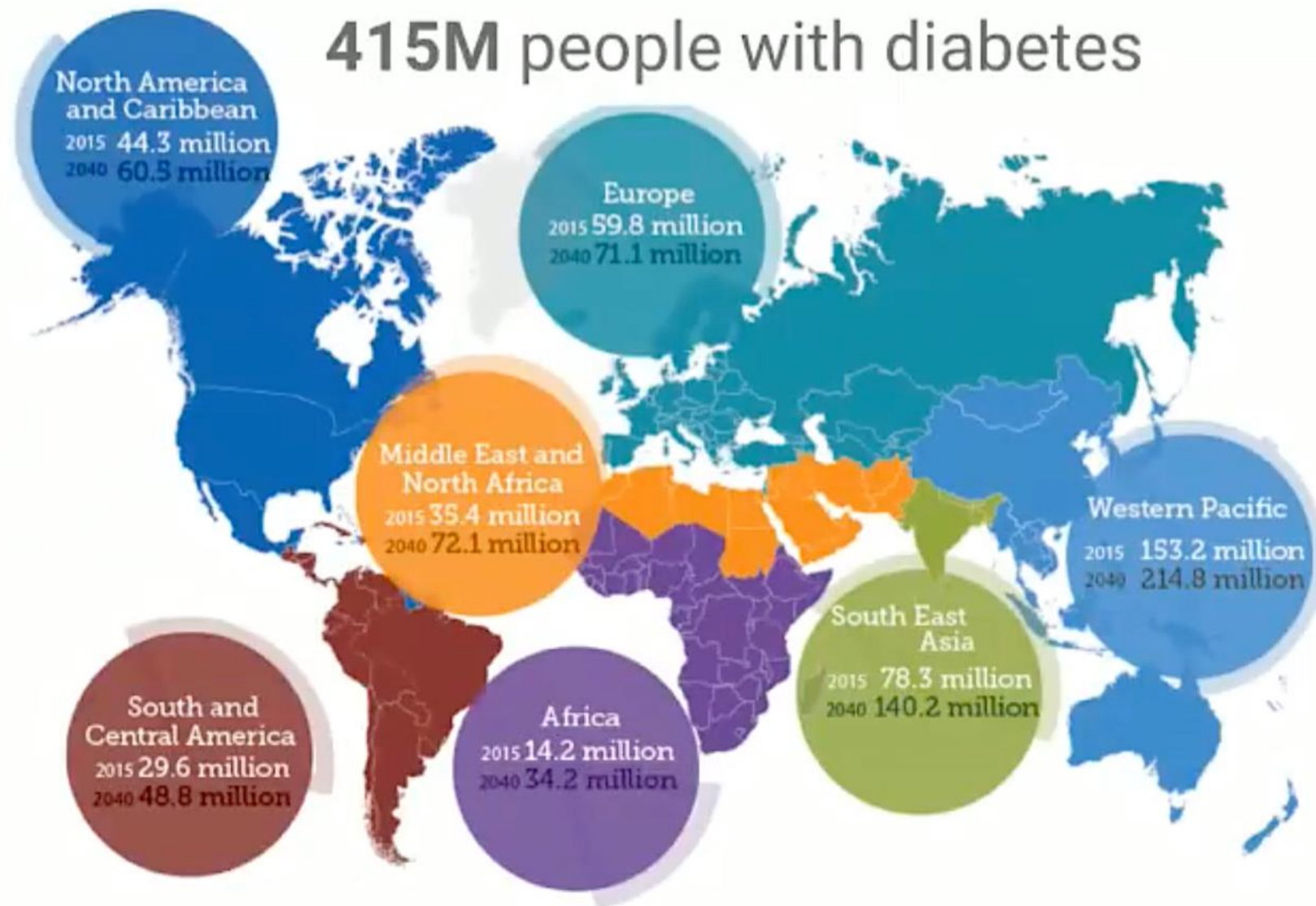


- 2022: Biomed Signal Process Control
- 2023: Journal of Applied Clinical Medical Physics (best paper award)



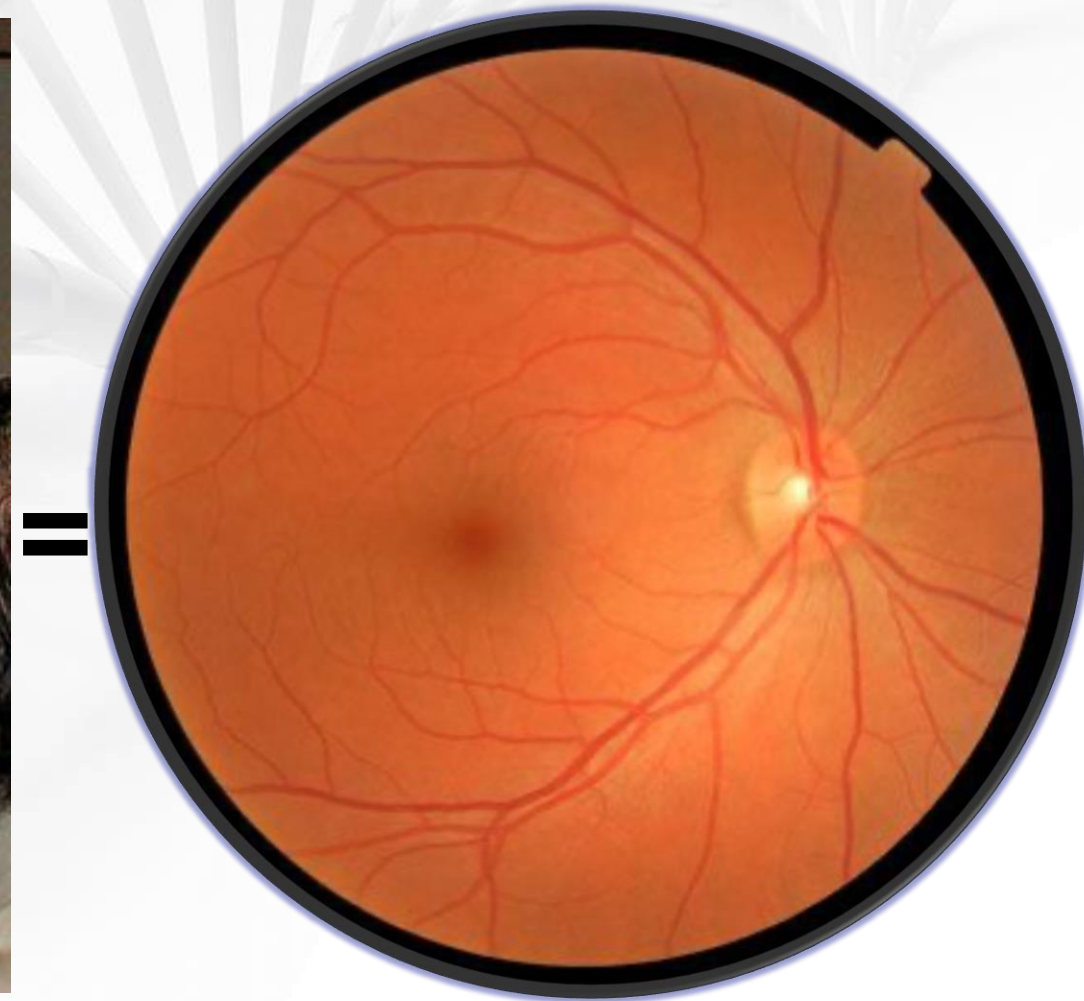
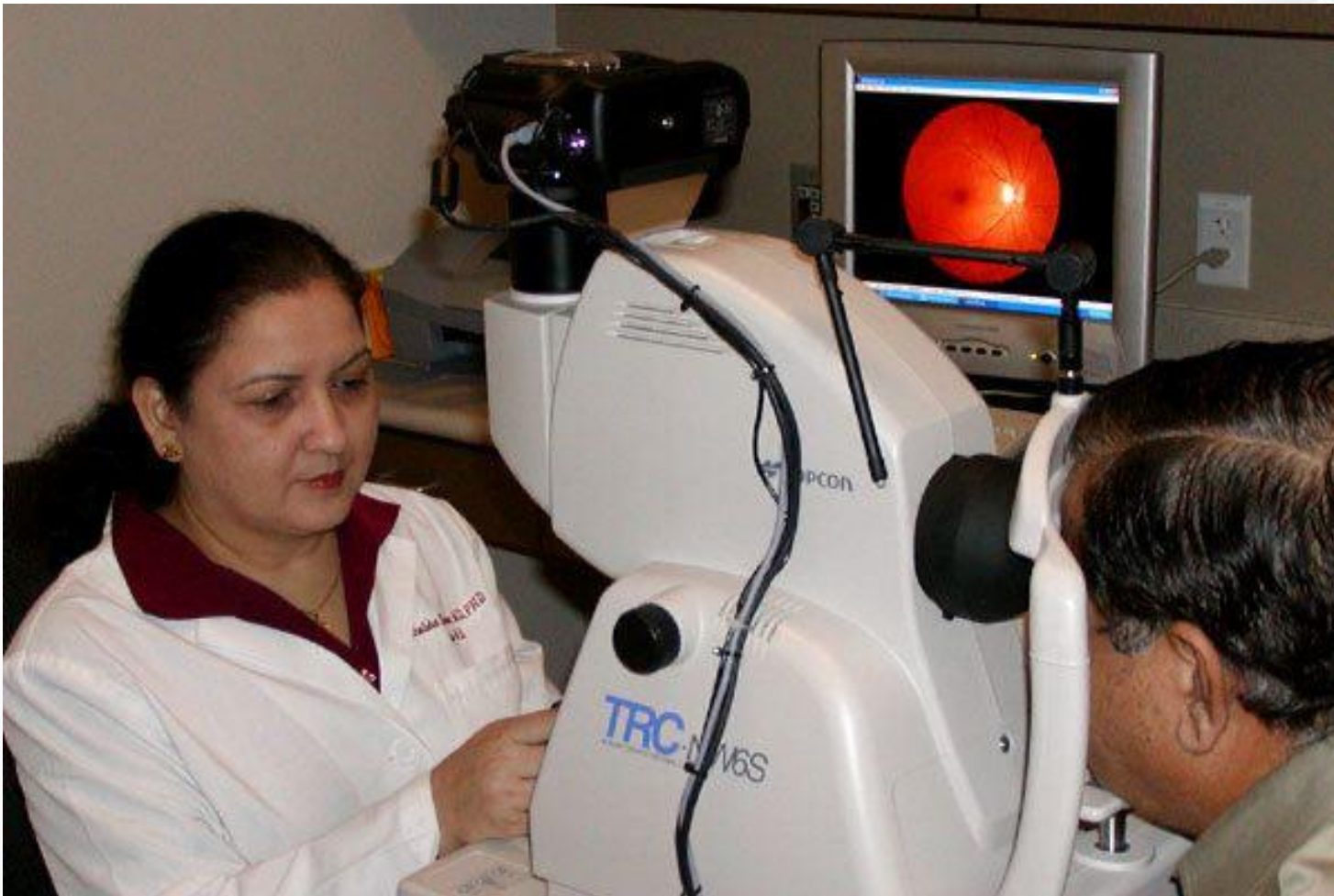
- 2023: Biomedical Physics & Engineering Express
- 2024: Scientific Report under revision

DIABETIC RETINOPATHY (DR): FASTEST GROWING CAUSE OF BLINDNESS



Hostalek, Clinical diabetes and endocrinology, 2020

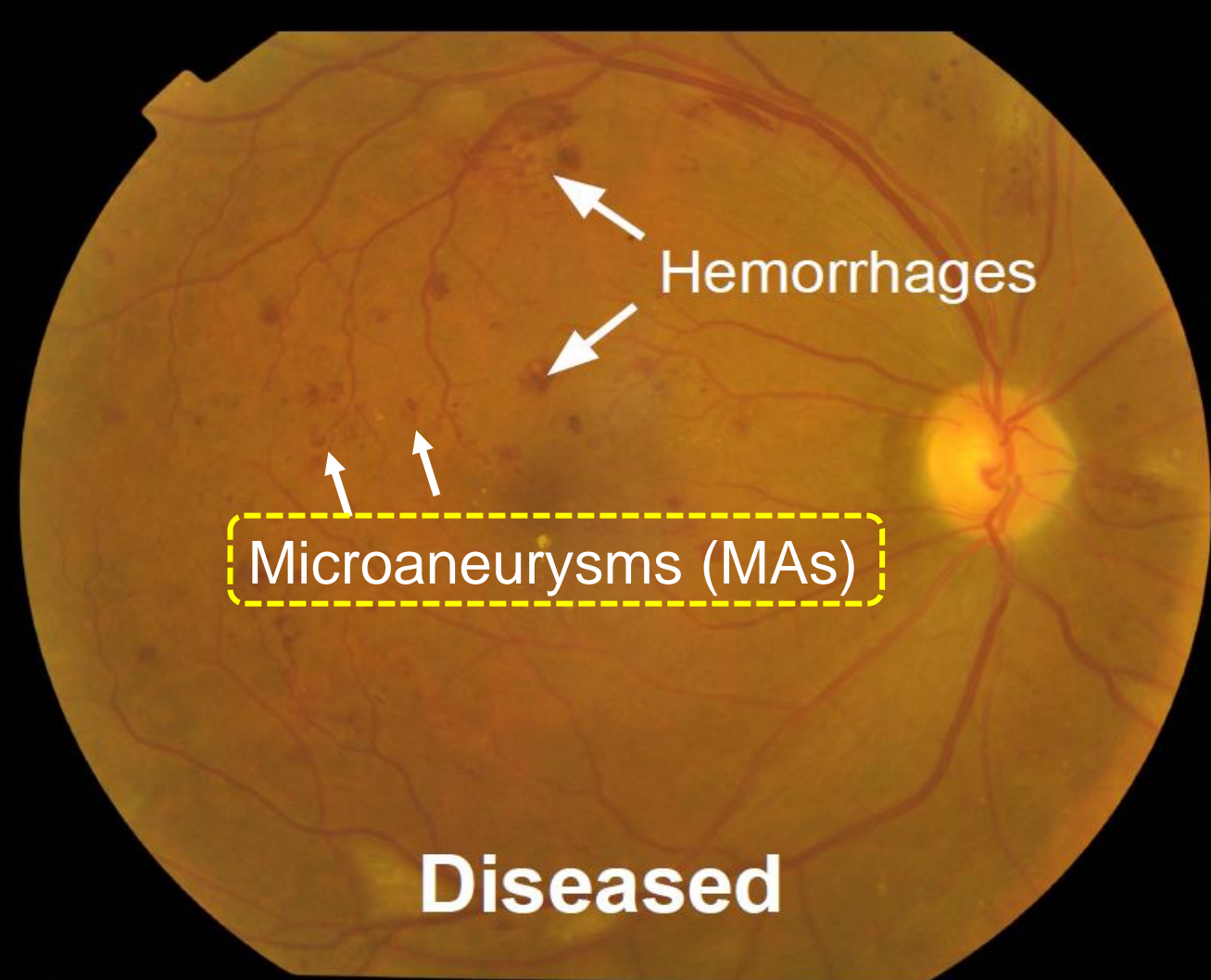
REGULAR SCREENING DR IS KEY TO PREVENT VISION LOST AND BLINDNESS



<https://www.neovisioneyecenters.com/services/diabetic-retinopathy/>



Healthy



Diseased



No DR

Mild DR

Moderate DR

Severe DR

Proliferative DR

1

2

3

4

5

LACK OF EYE DOCTORS!!!





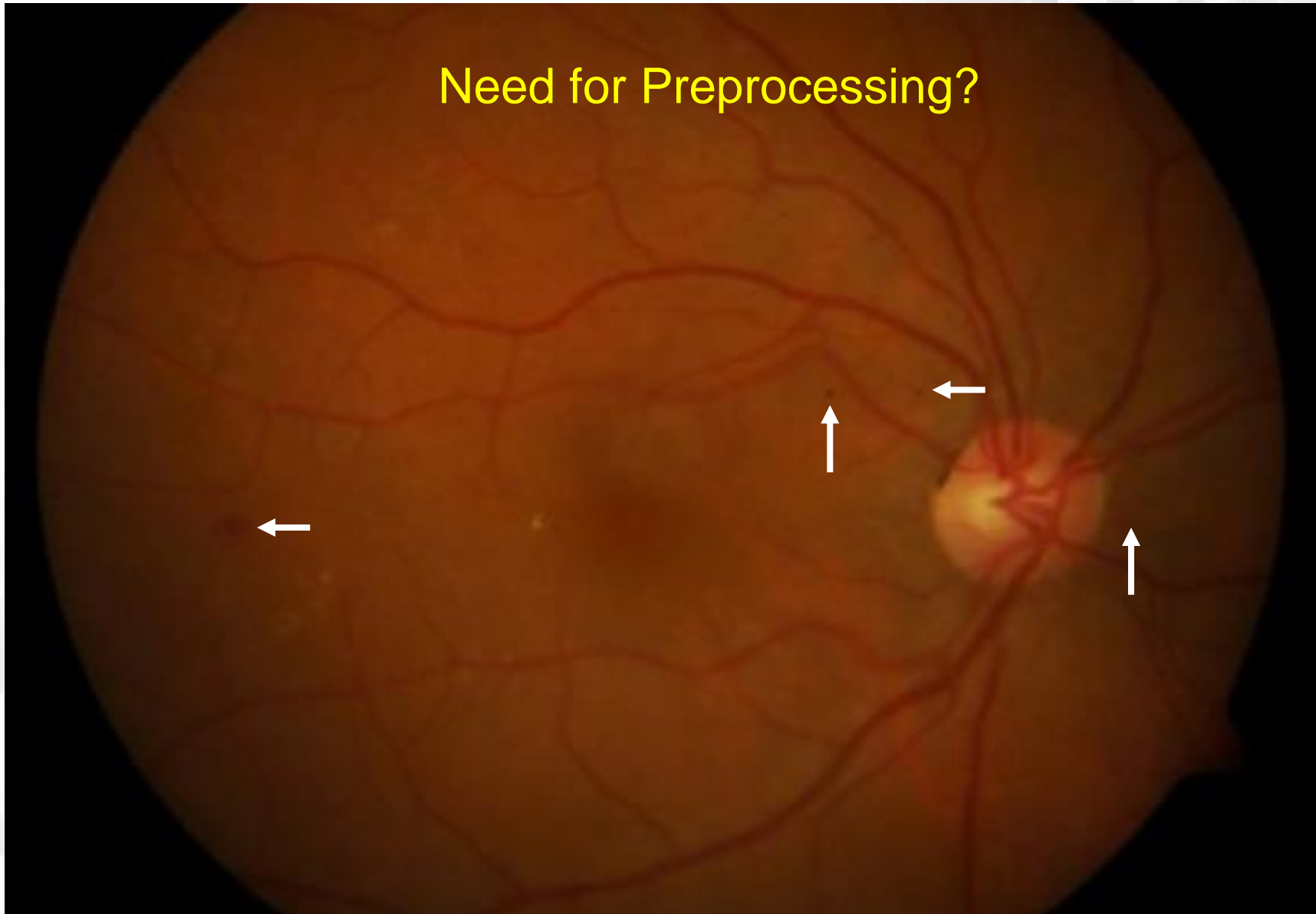
About half of diabetic people suffer vision lost before diagnosis.

NEED COMPUTER AIDED DIAGNOSIS SYSTEMS

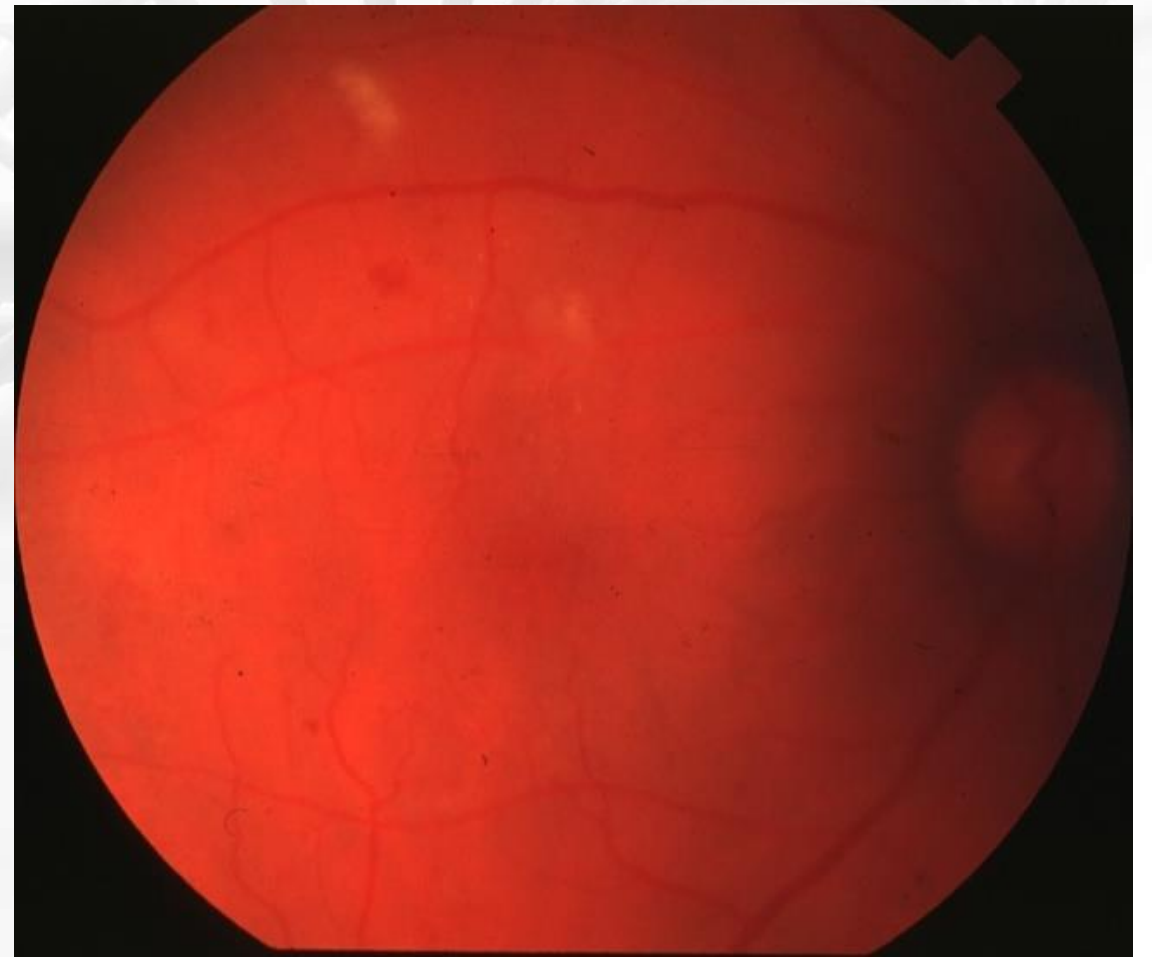


METHOD

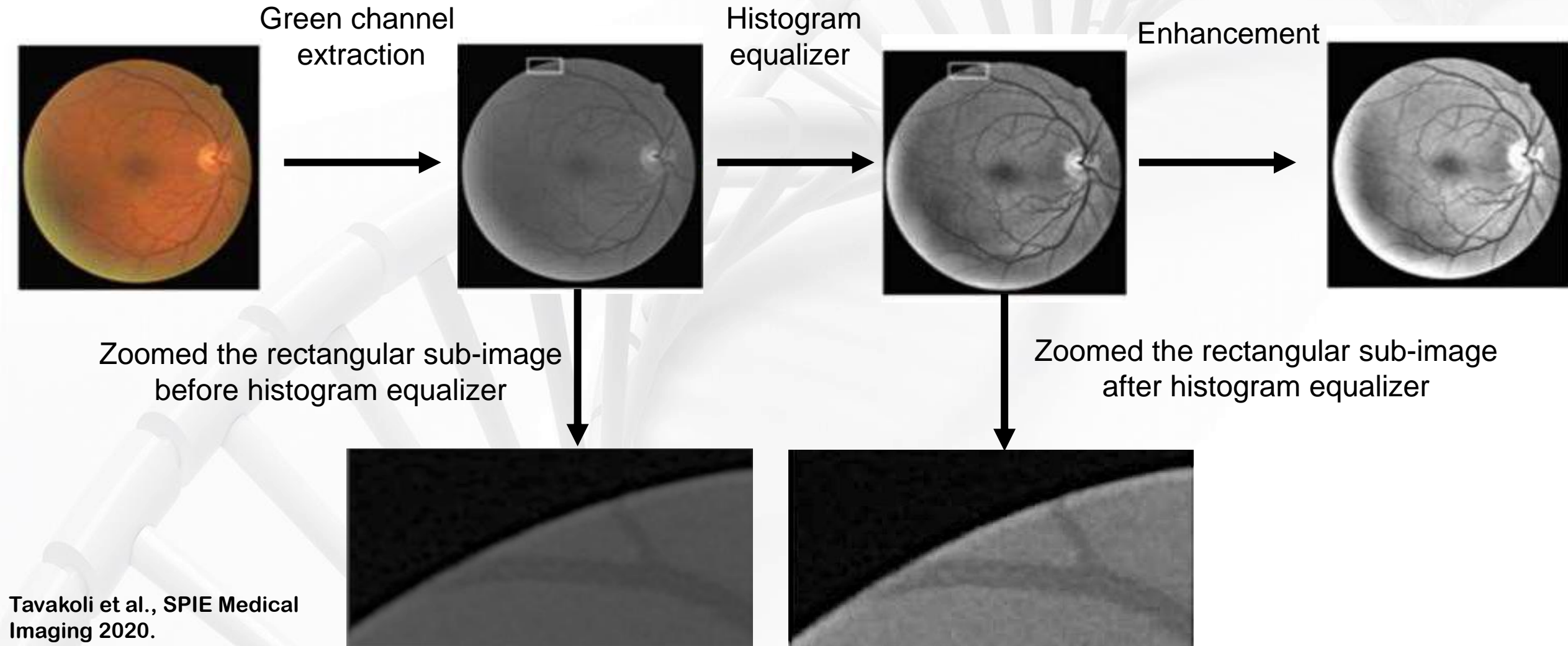
WHERE ARE THE LESIONS?



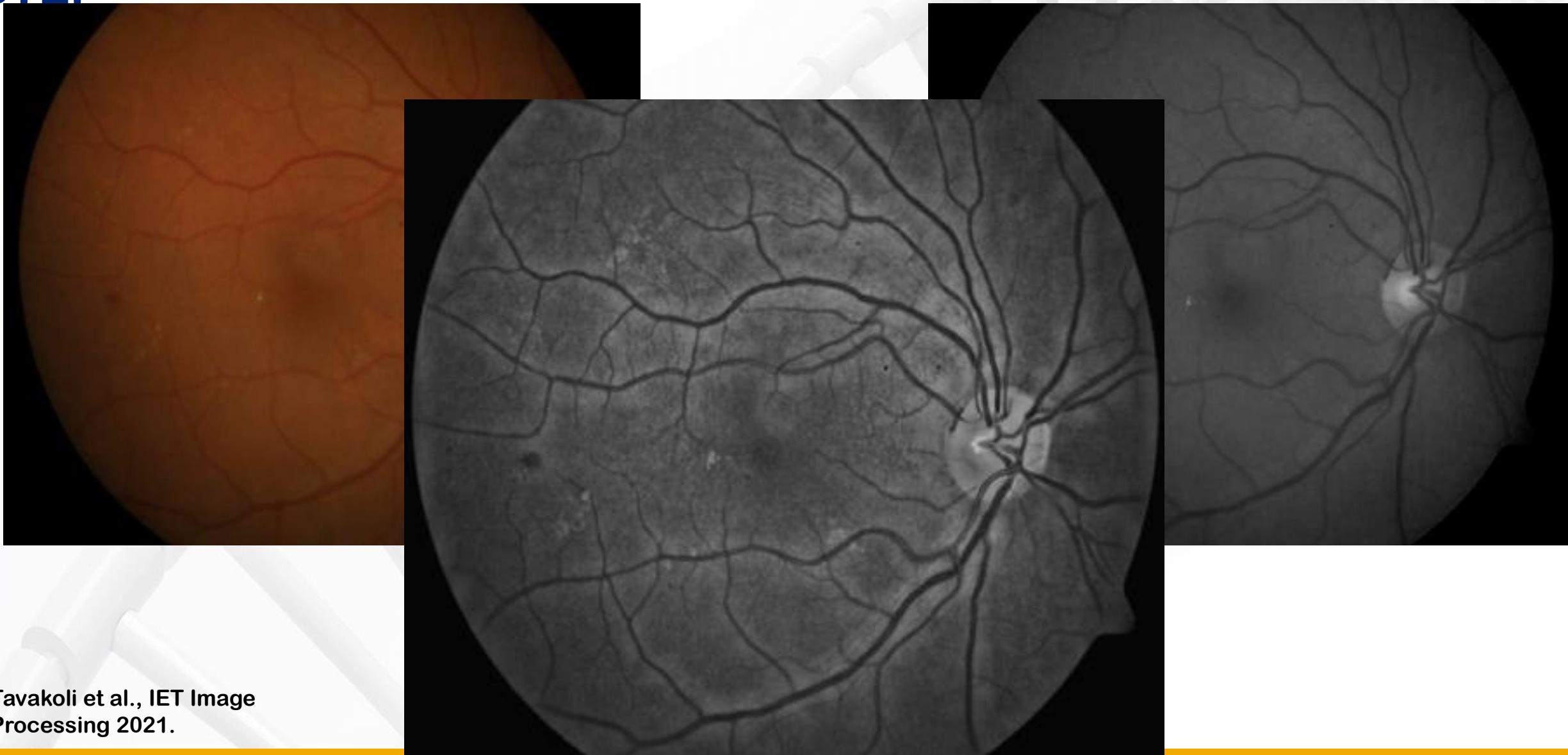
WHY WE NEED PREPROCESSING?



ILLUMINATION EQUALIZATION, AND CONTRAST ENHANCEMENT

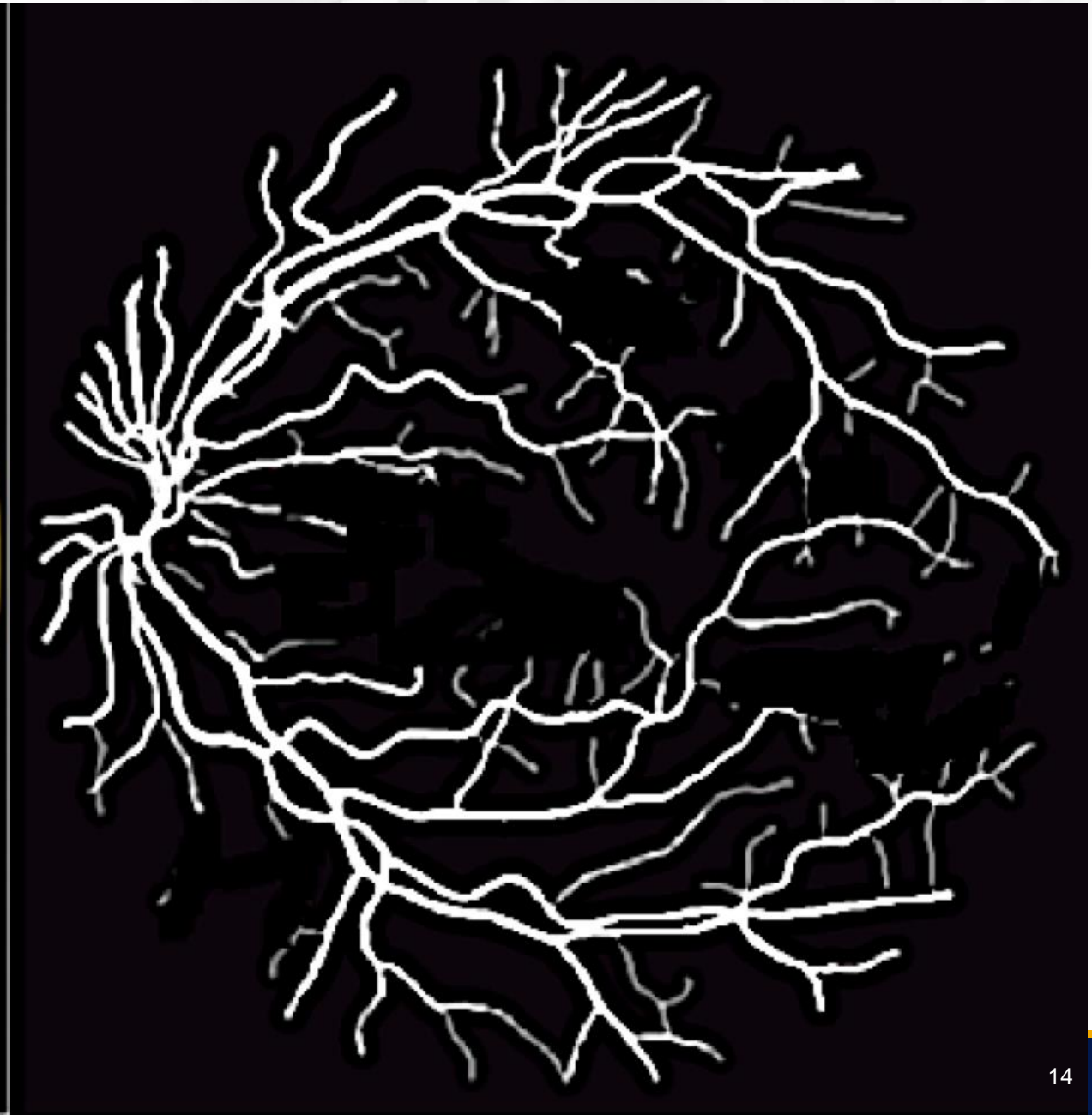


FINAL RESULTS FOR PREPROCESSING AND OUR INPUT FOR NEXT STEP

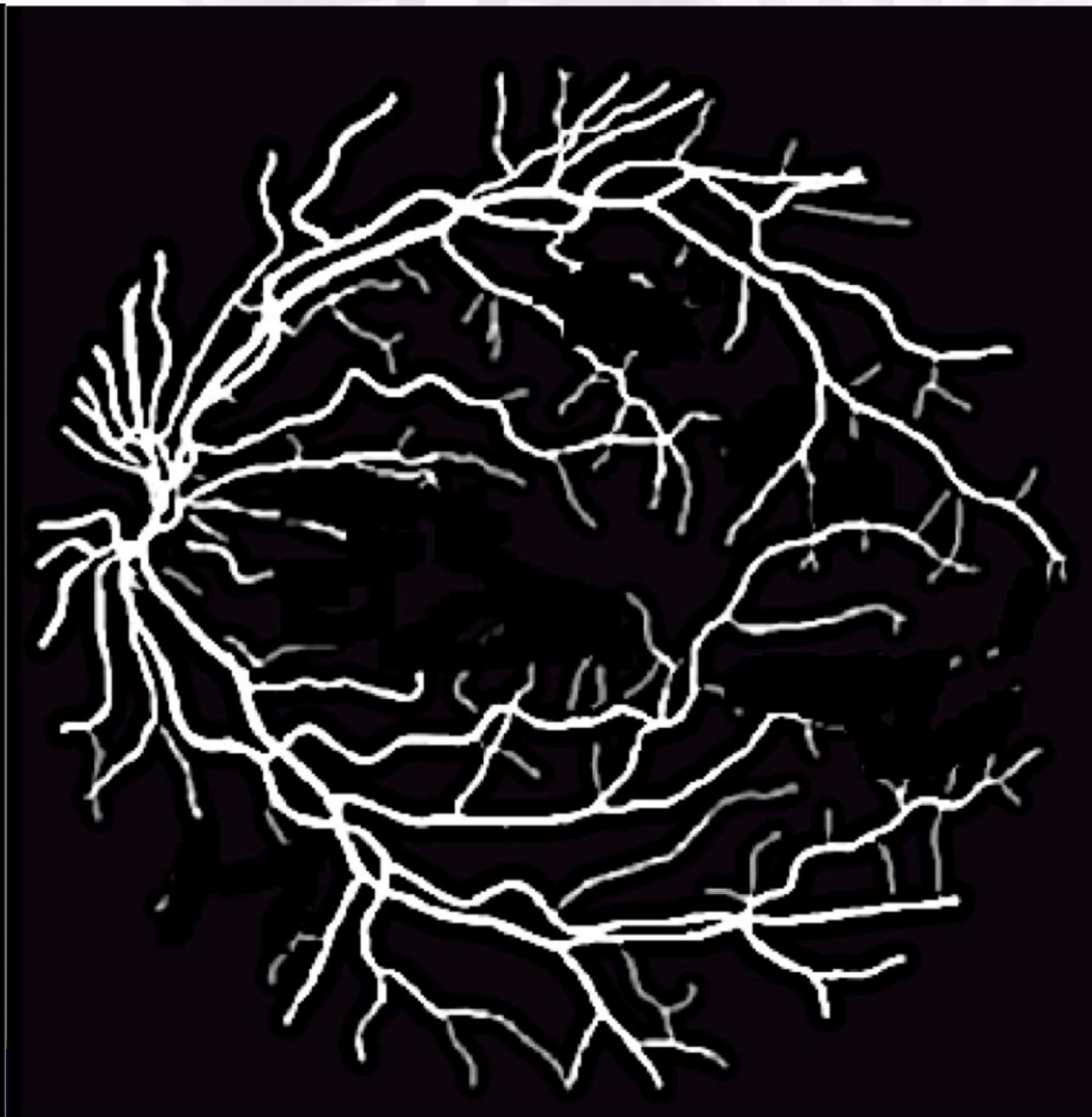
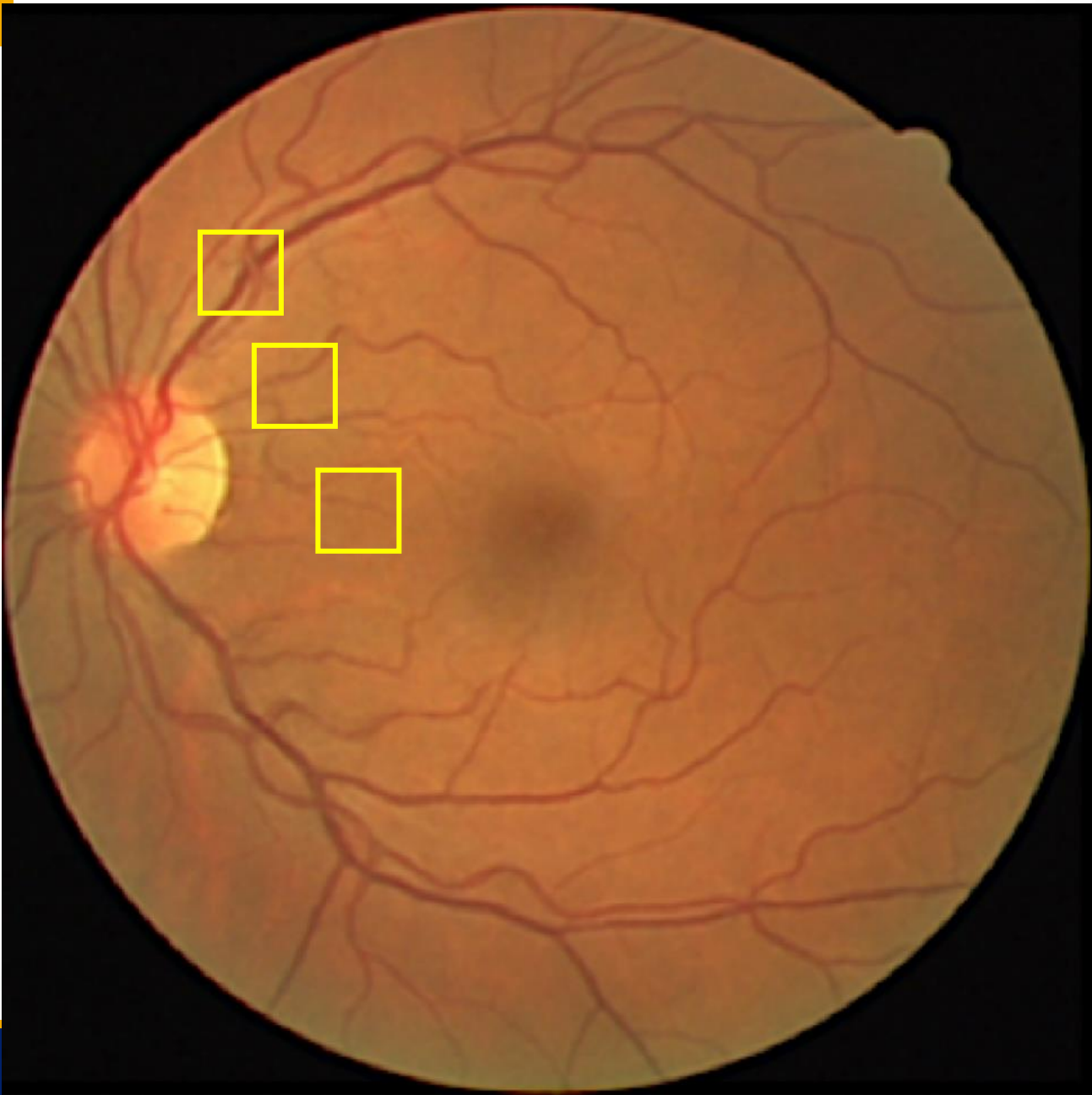


Tavakoli et al., IET Image Processing 2021.

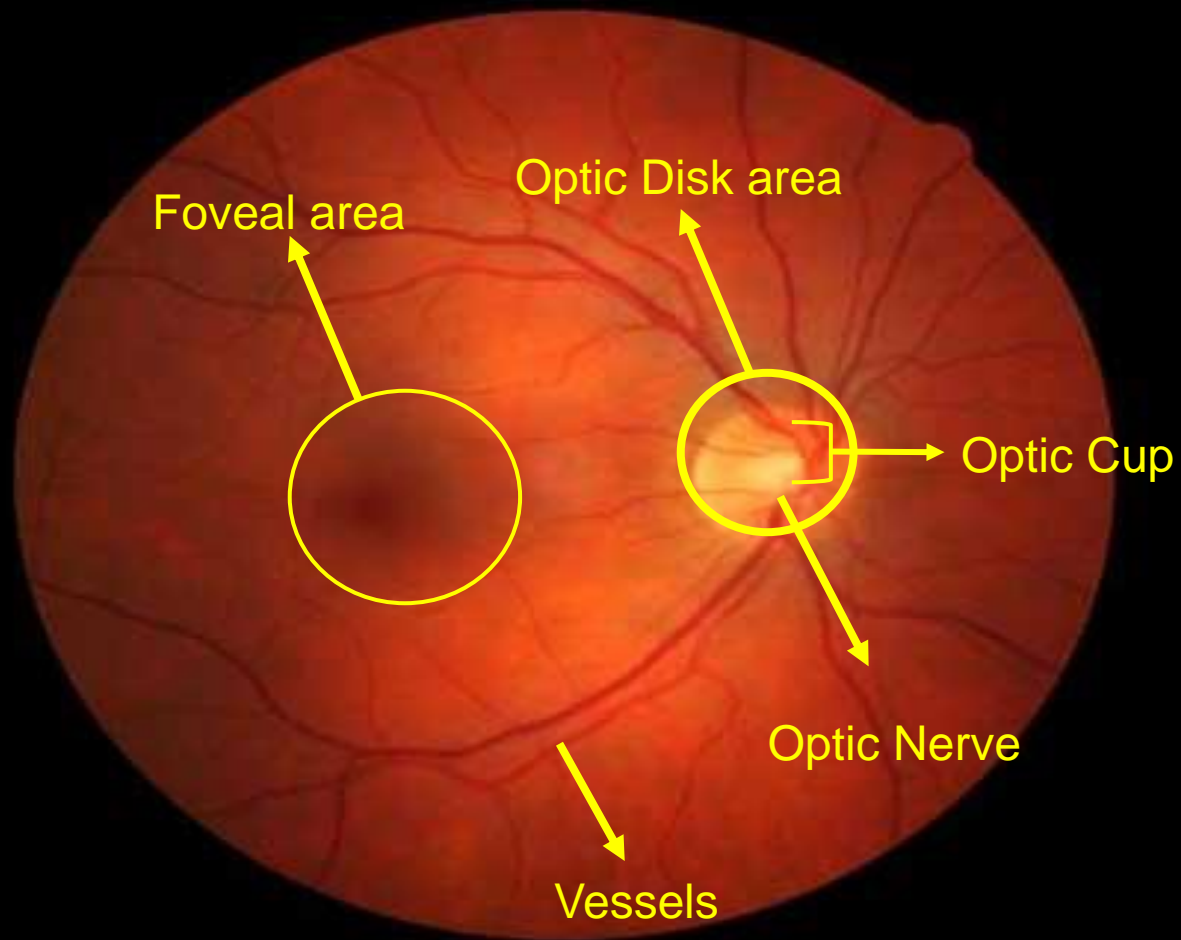
VESSEL SEGMENTATION



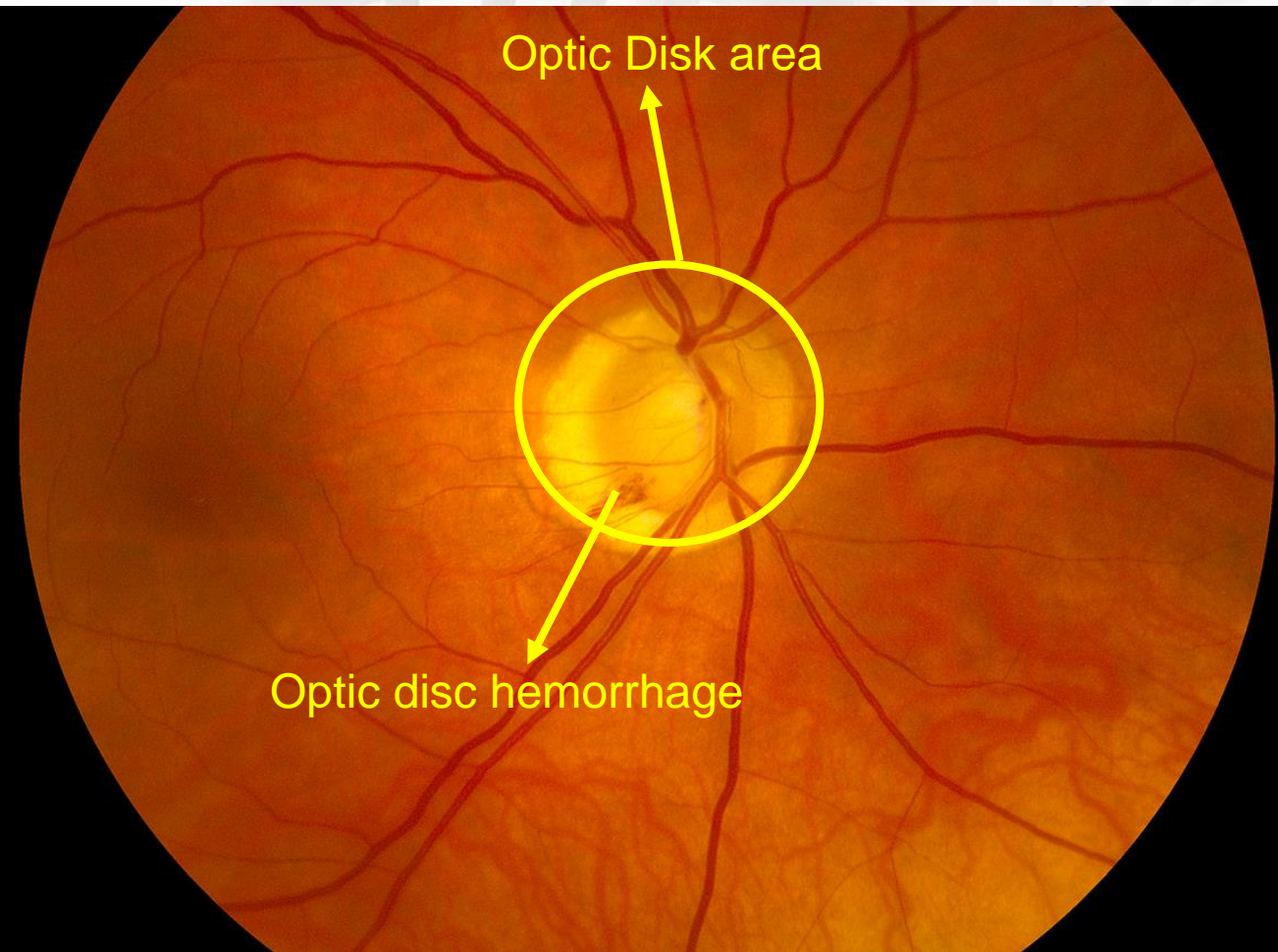
VESSEL SEGMENTATION



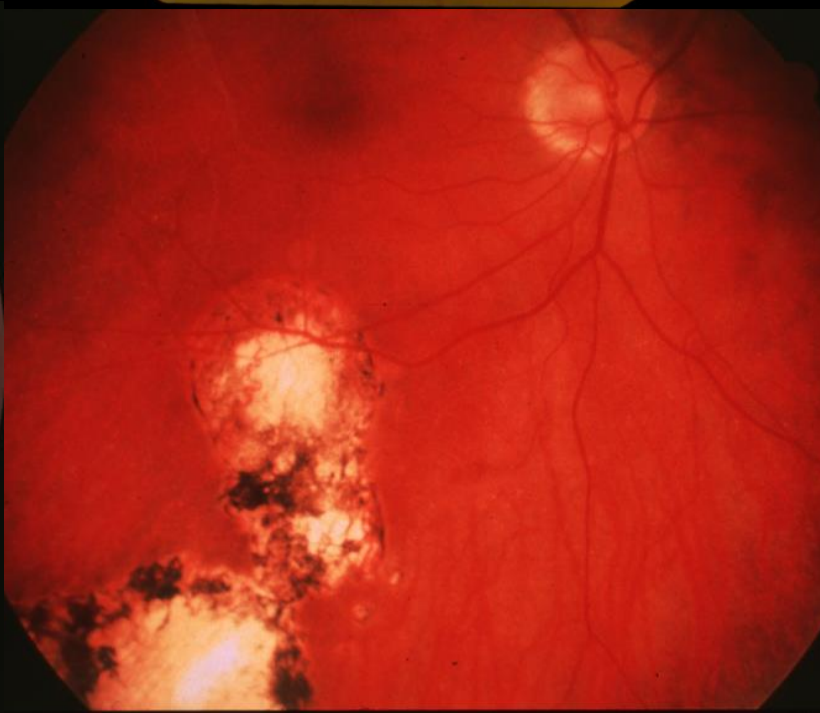
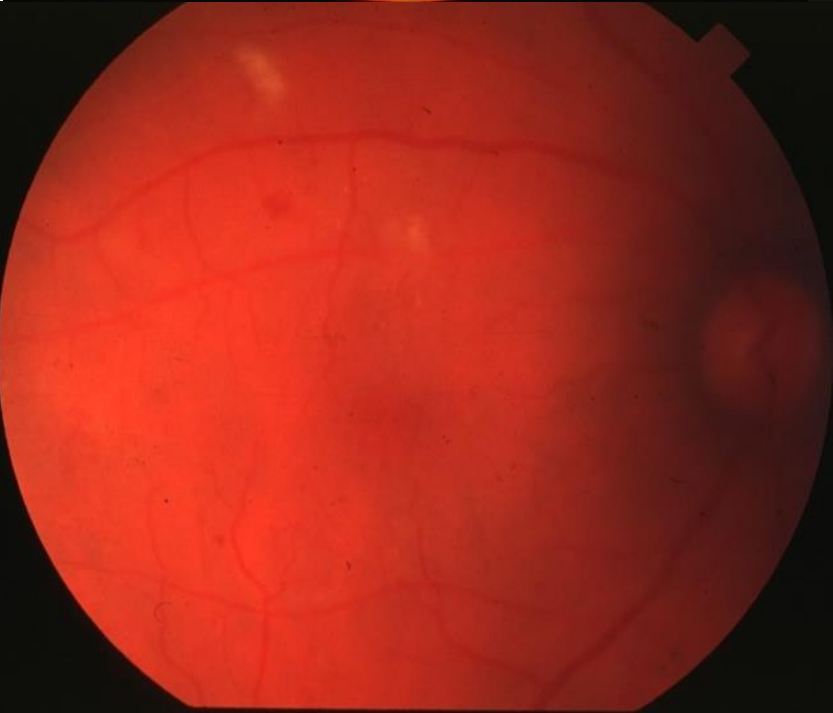
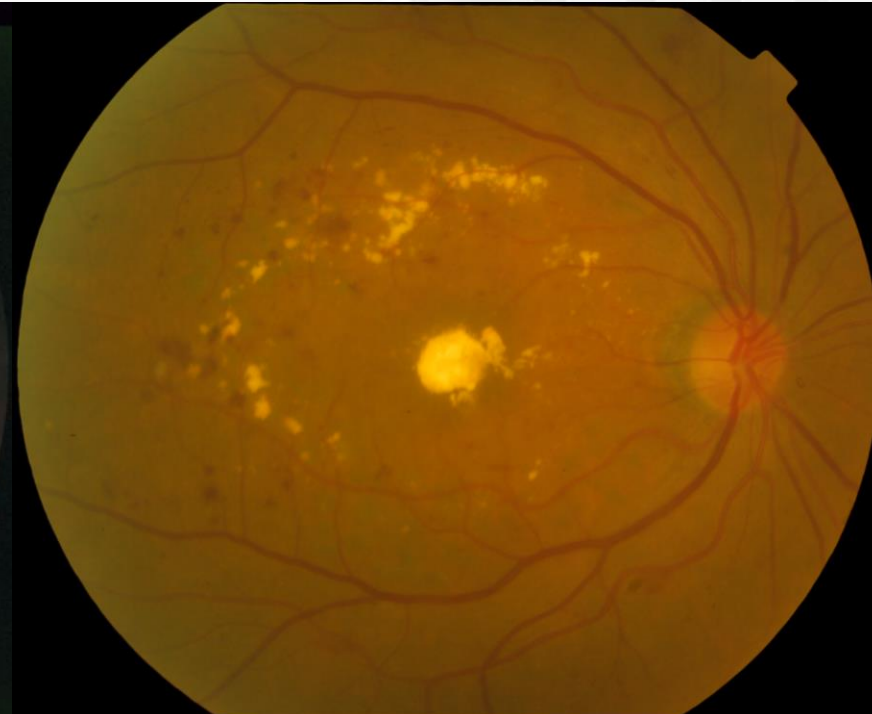
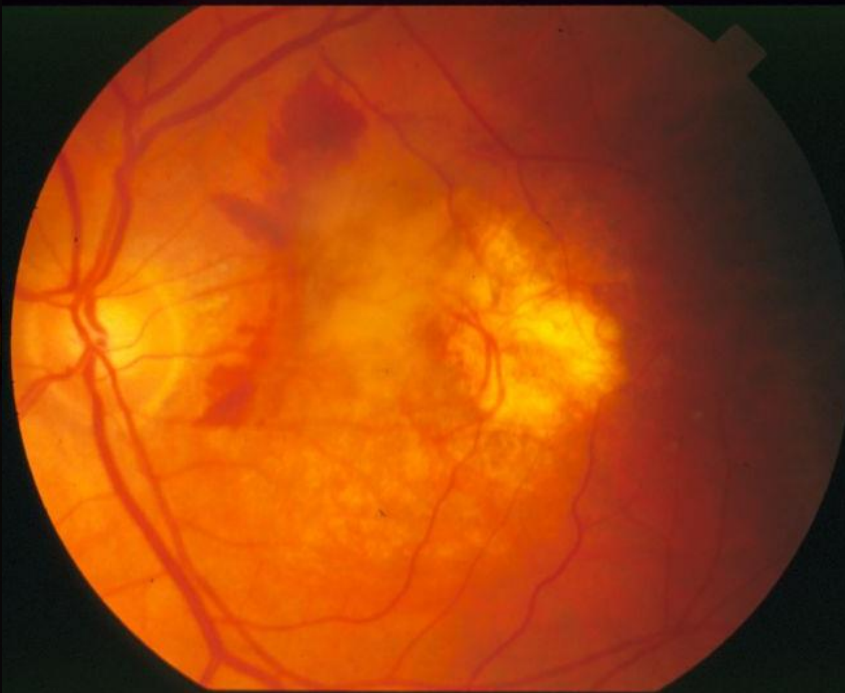
OPTIC DISK SEGMENTATION



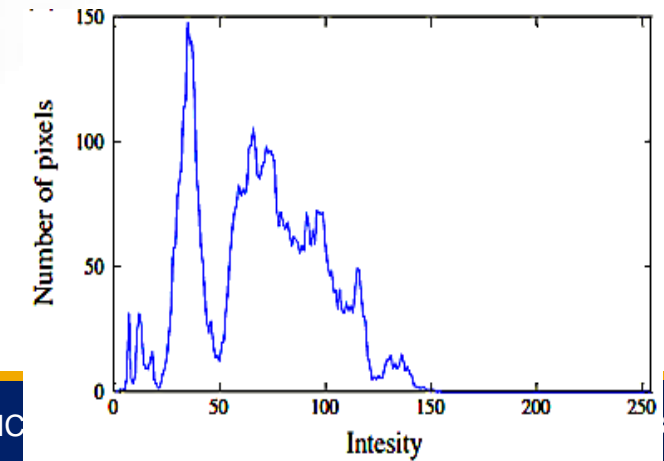
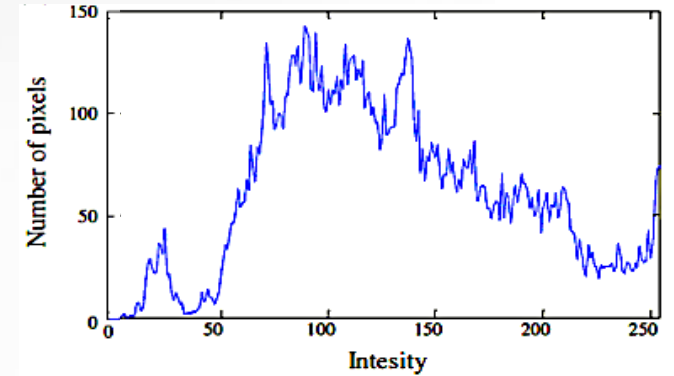
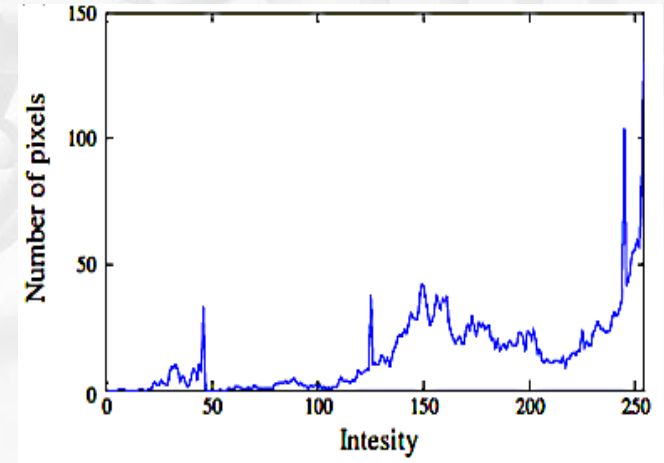
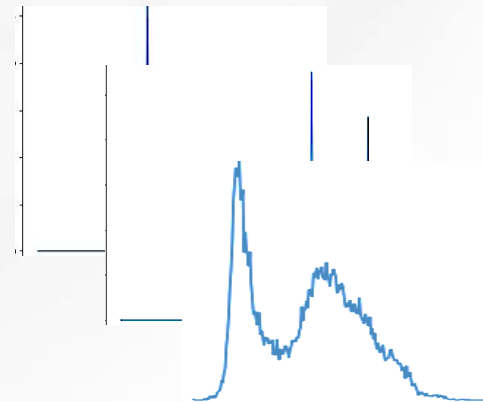
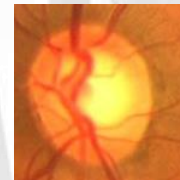
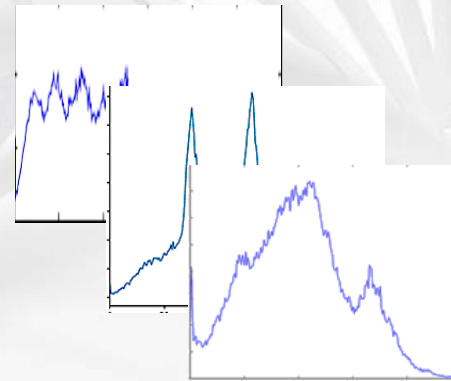
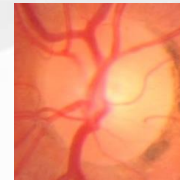
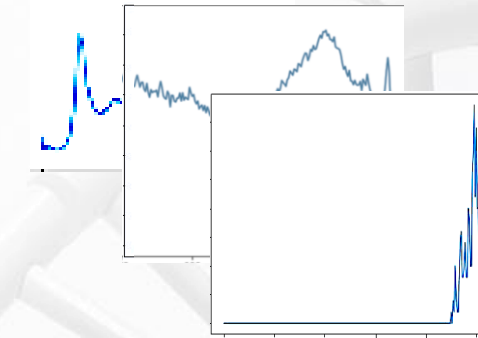
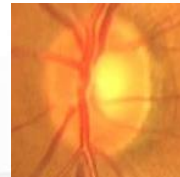
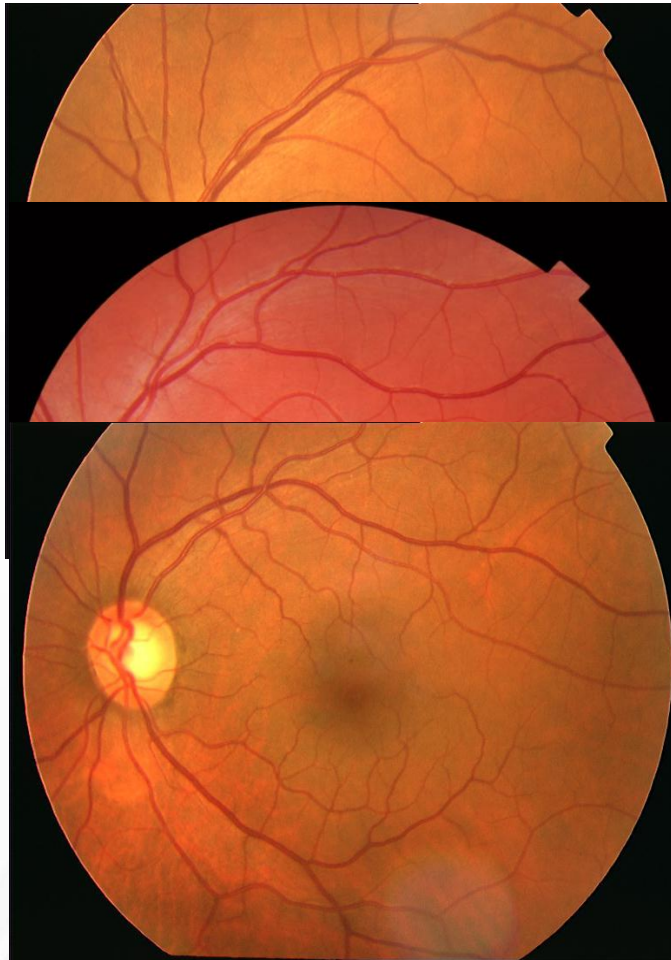
Normal Retina and Optic Nerve



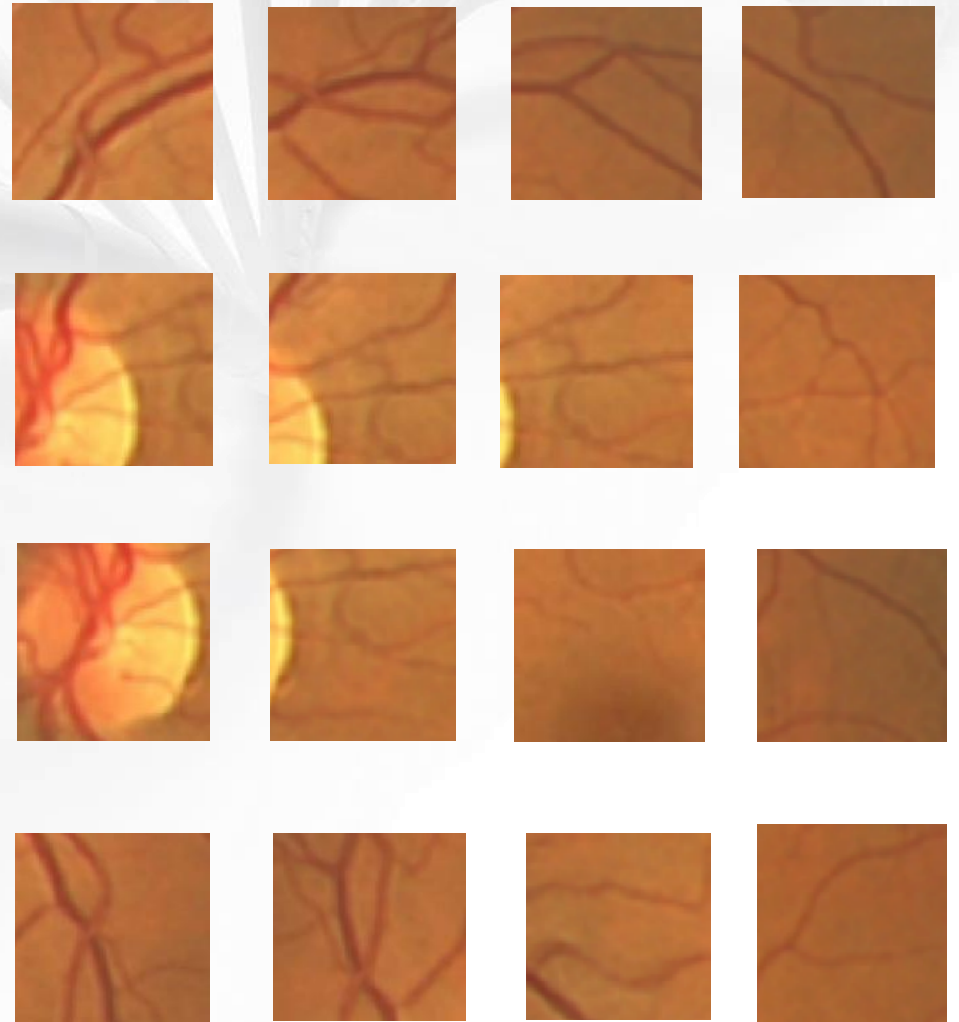
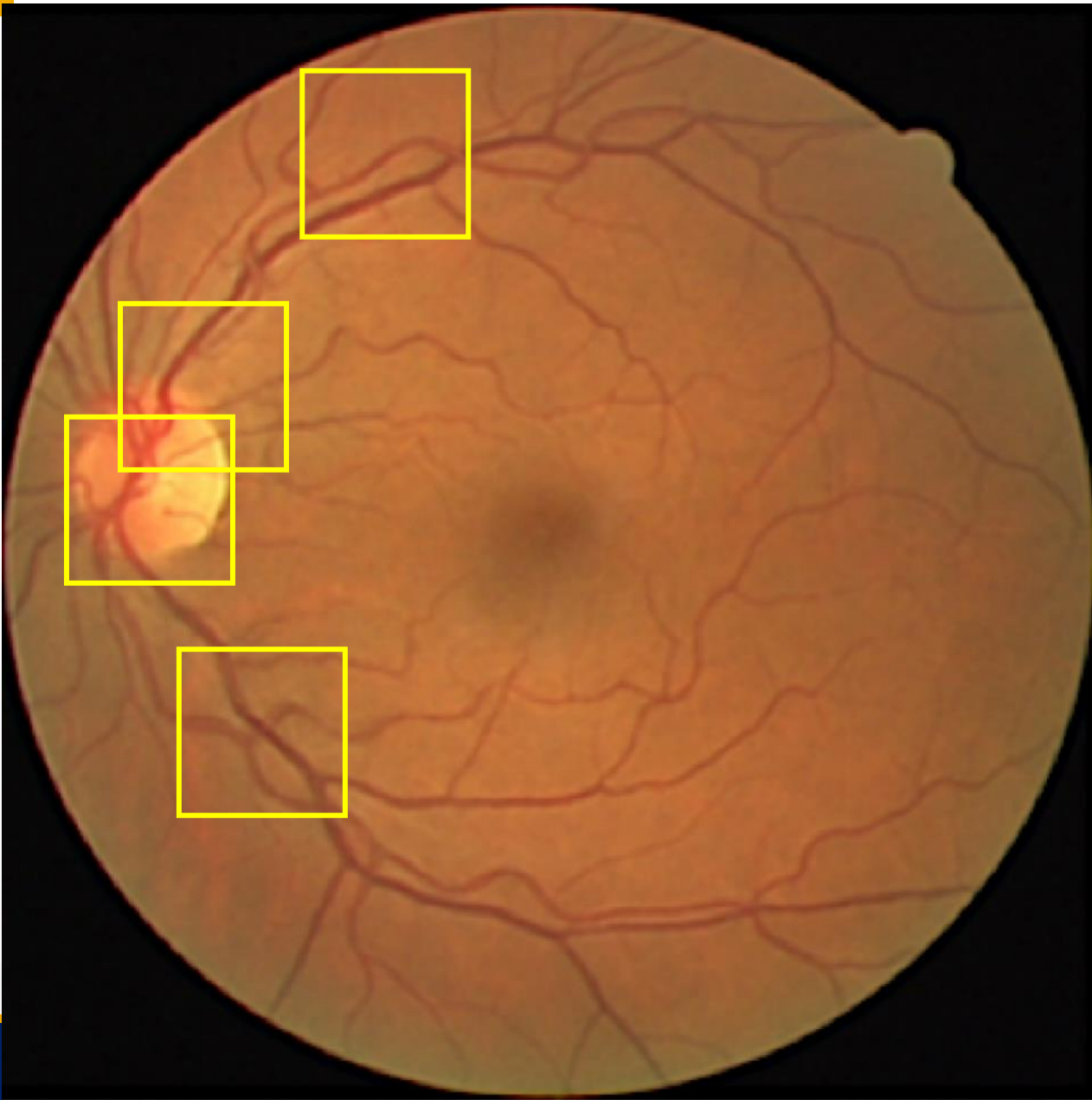
DR and Optic Nerve



HISTOGRAM MATCHING



HISTOGRAM MATCHING



HISTOGRAM MATCHING ALGORITHM

Extract the histograms from each RGB component of each sub-images
Find the parameter c for each channel:

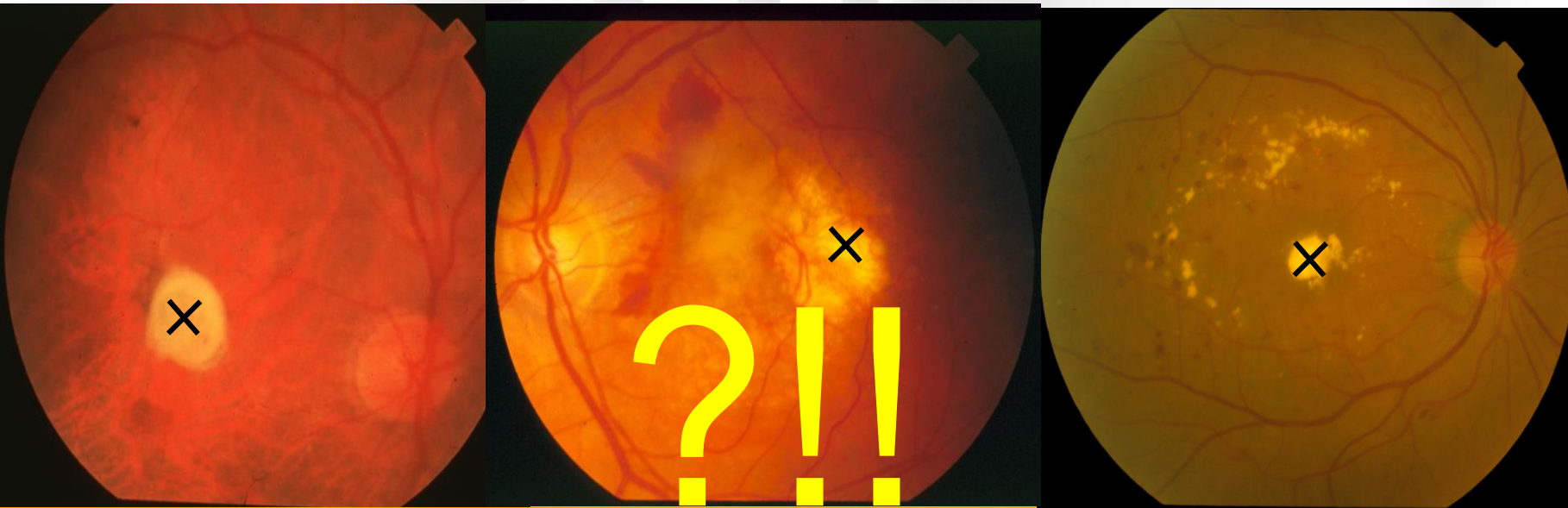
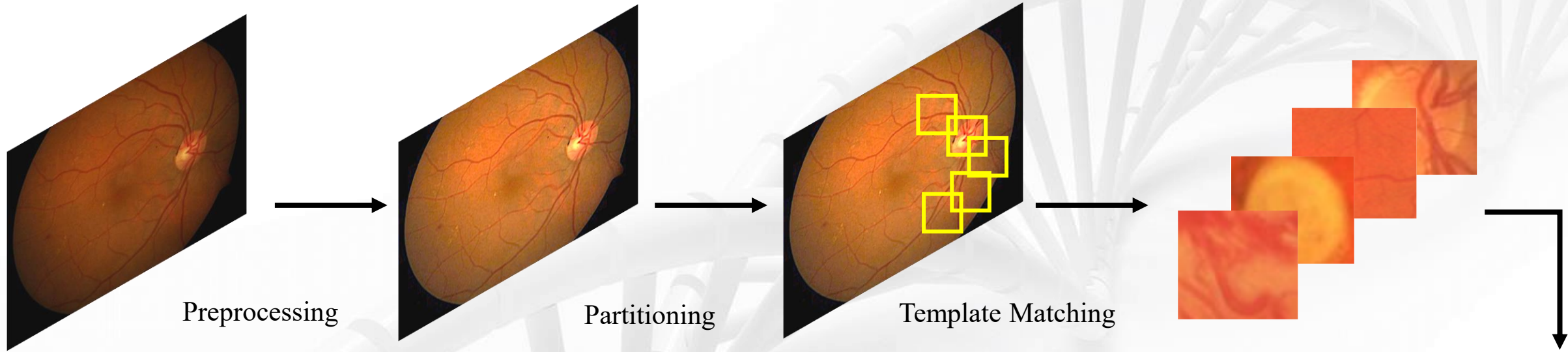
$$c = \frac{1}{(1 + \sum_i (a_i - b_i)^2)}$$

- Find the combined c for all channels:

$$c(i, j) = t_r \times c_r + t_g \times c_g + t_b \times c_b$$

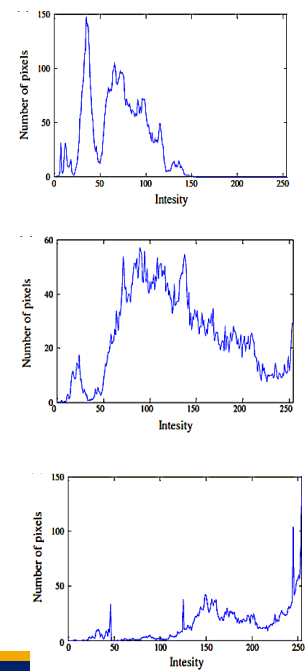
- Max value of c is the Center of the OD

GRAPHICAL ABSTRACT

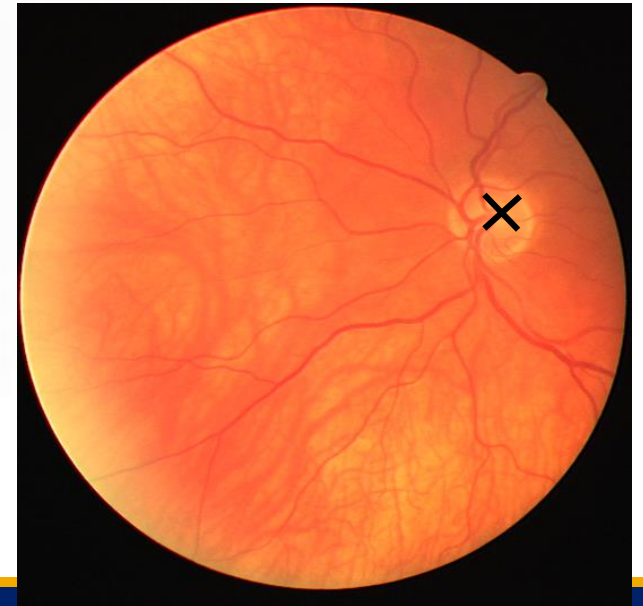
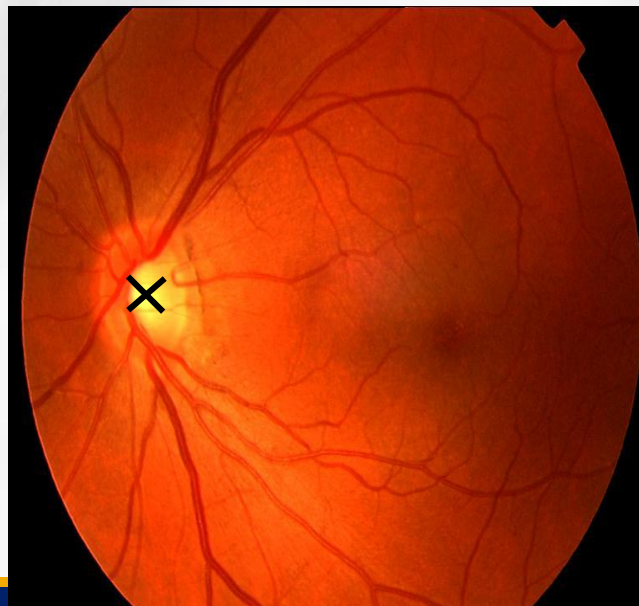
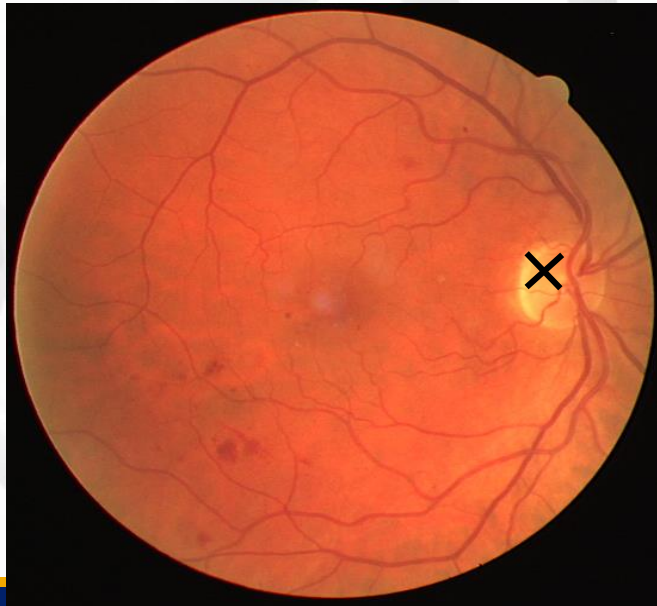
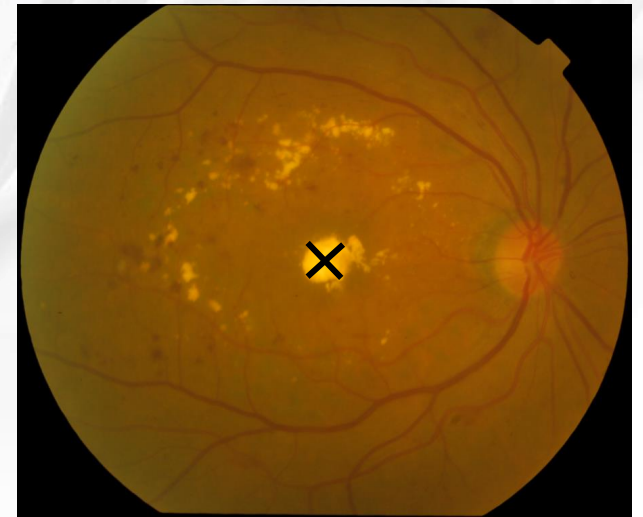
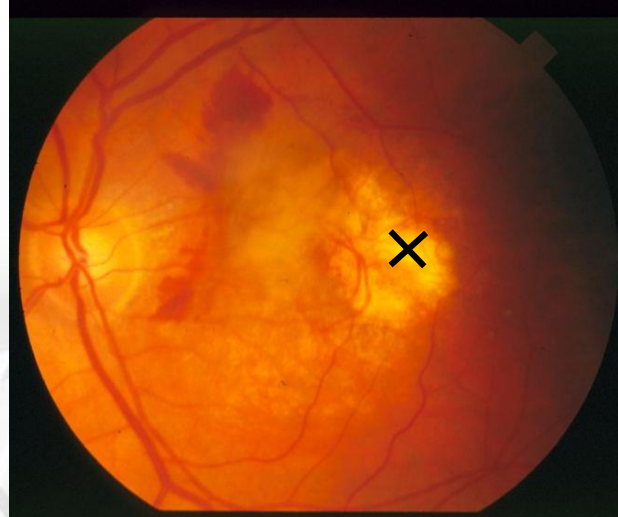


$$c = \frac{t_r \times c_r + t_g \times c_g + t_b \times c_b}{1 + \sum_i (a_i - b_i)^2}$$

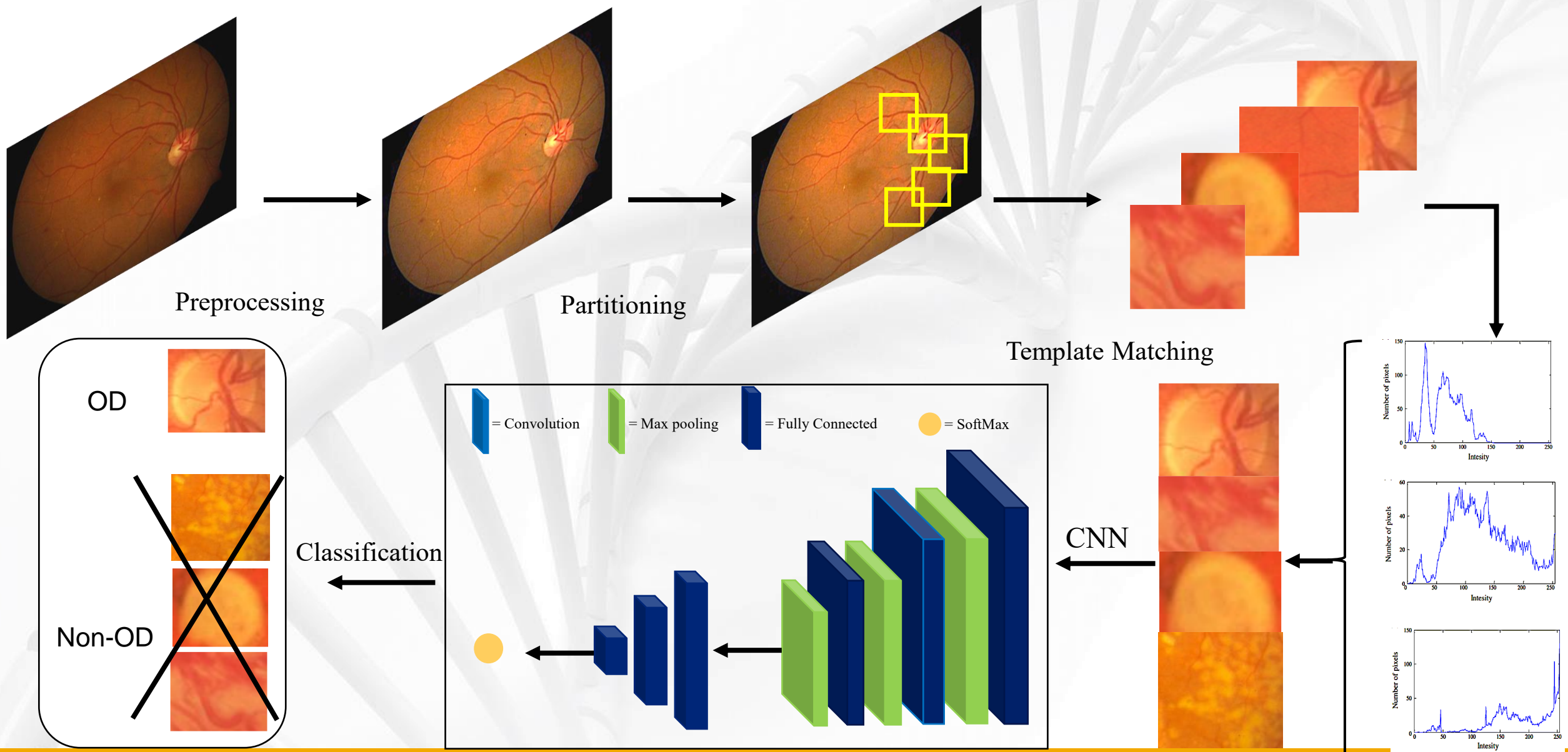
$$c(i, j) = t_r \times c_r + t_g \times c_g + t_b \times c_b$$



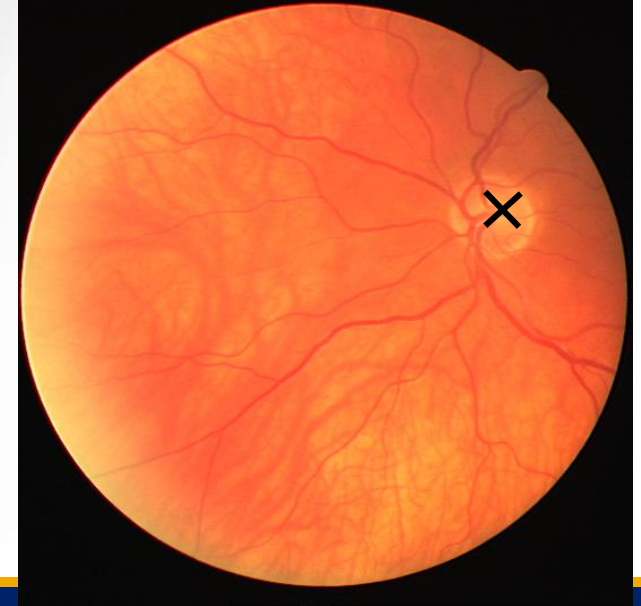
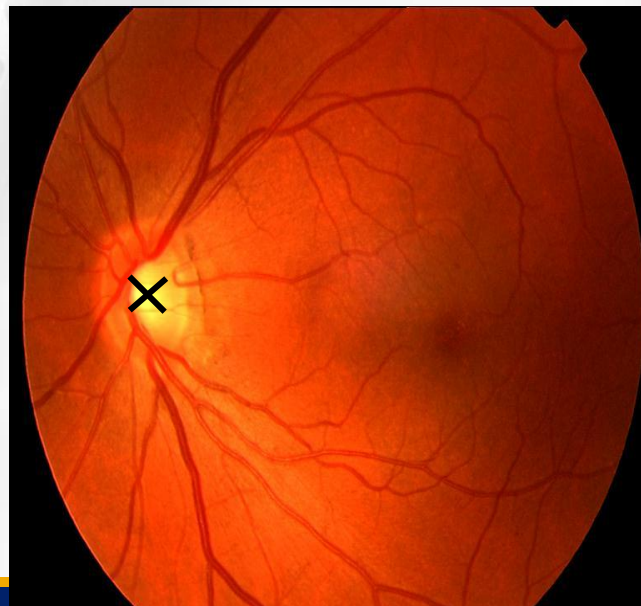
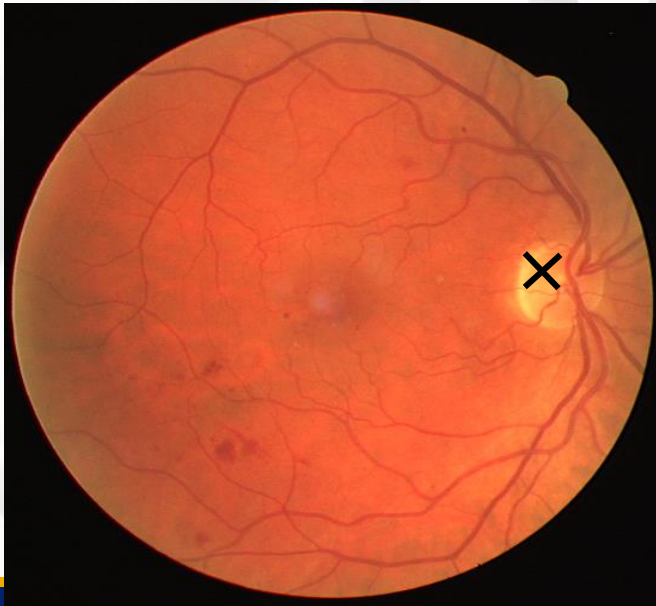
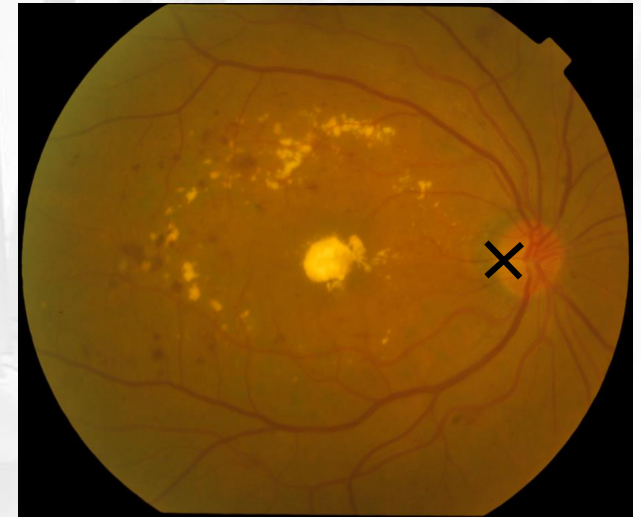
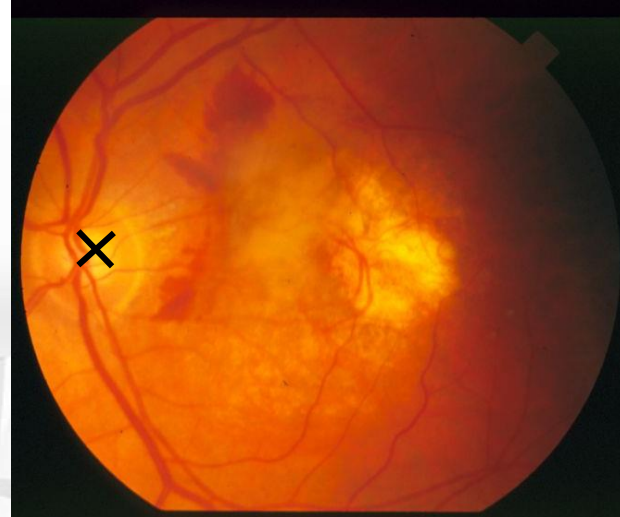
RESULTS OF HISTOGRAM MATCHING



OPTIC DISK GRAPHICAL ABSTRACT

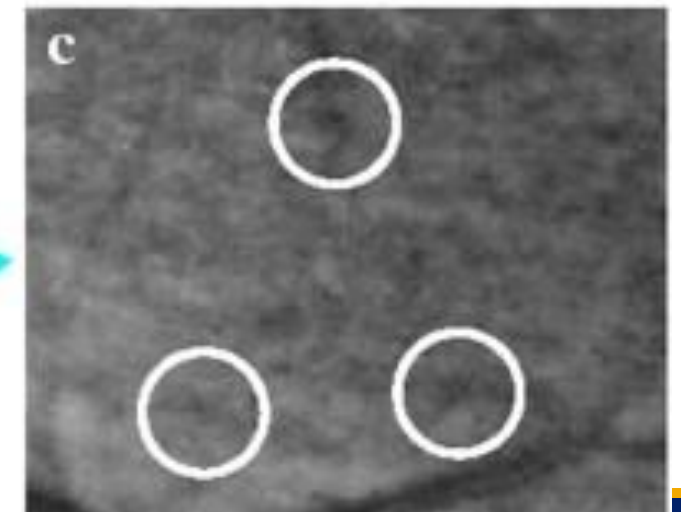
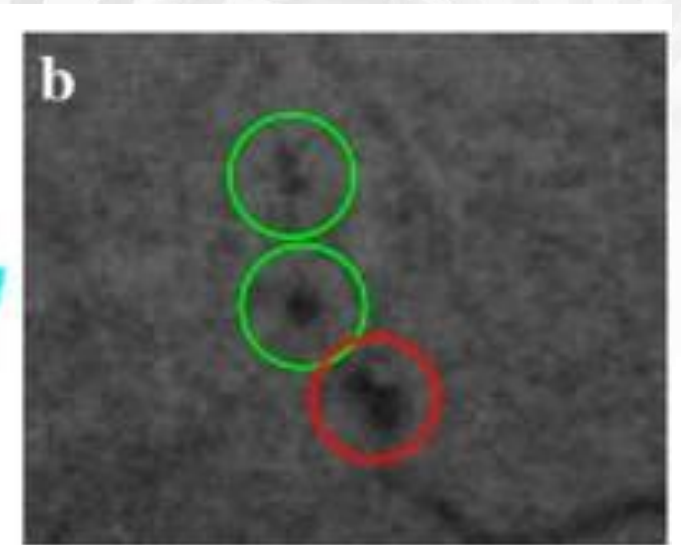
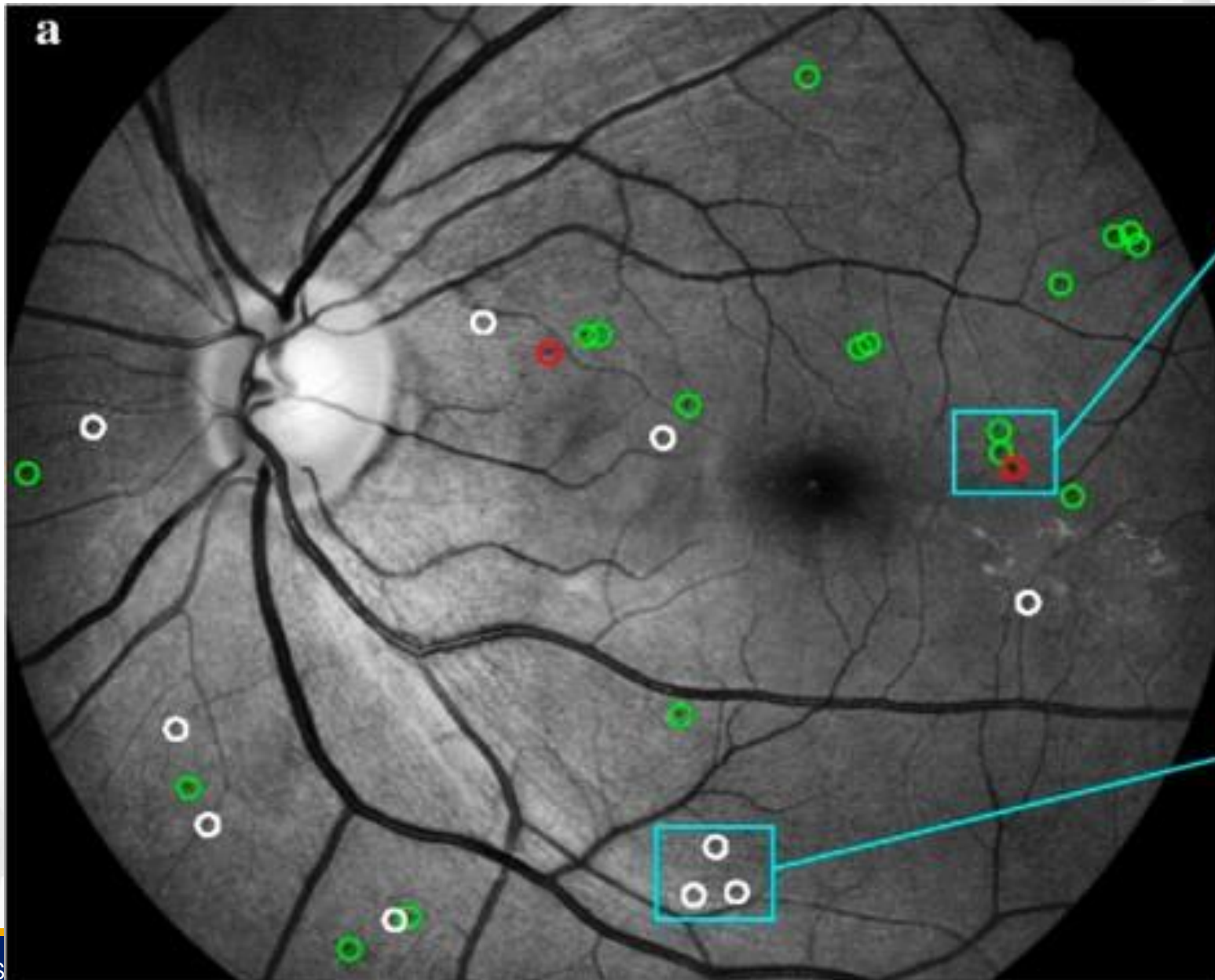


RESULTS OF DEEP LEARNING

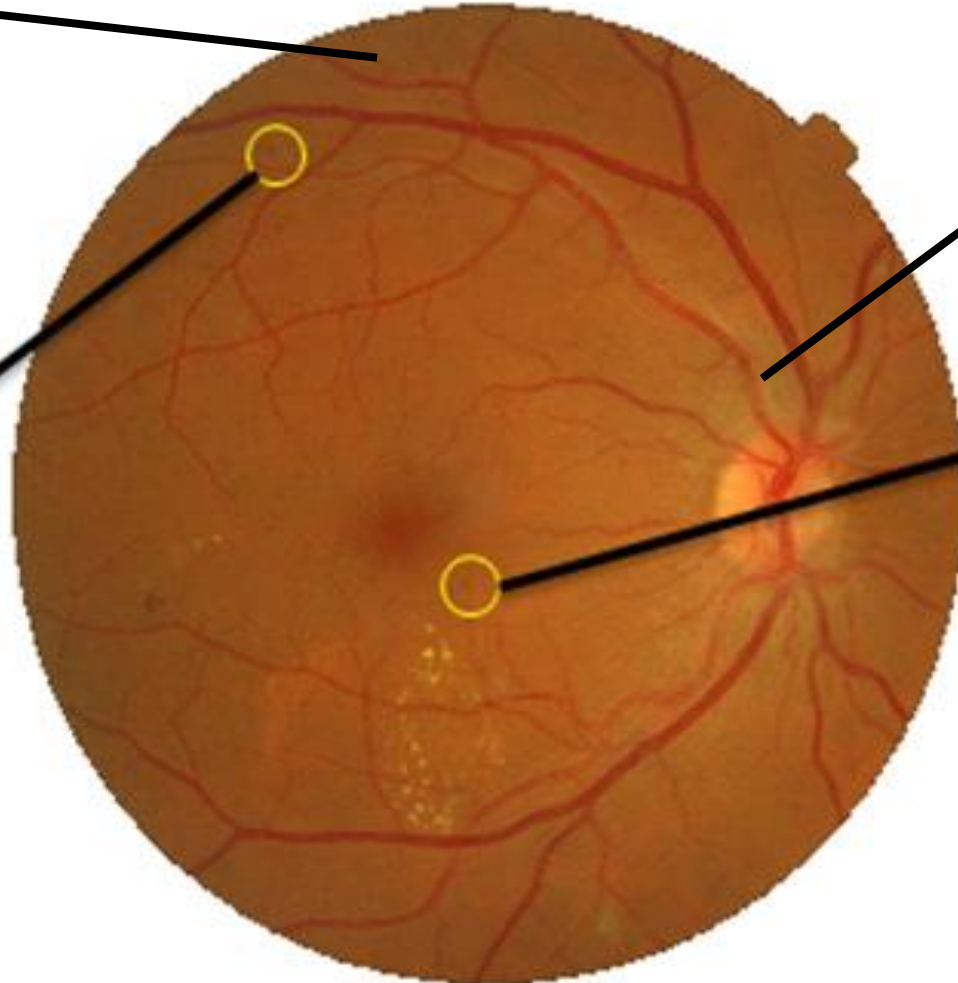
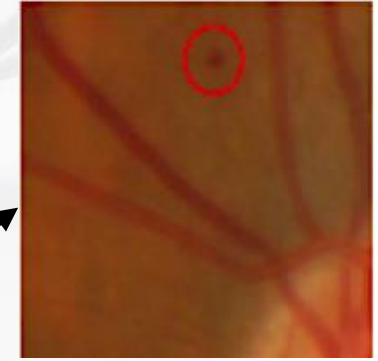


SPIE.

MICROANEURYSMS DETECTION



HOW HARD IS THIS?!!



Real

Bifurcation

Hemorrhage

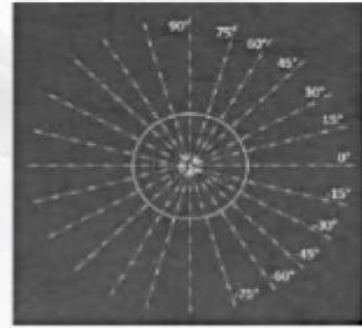
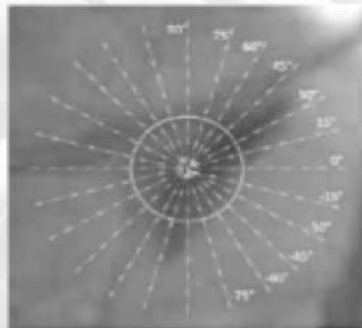
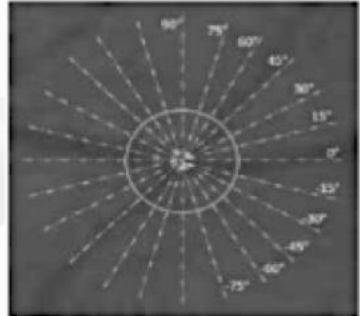
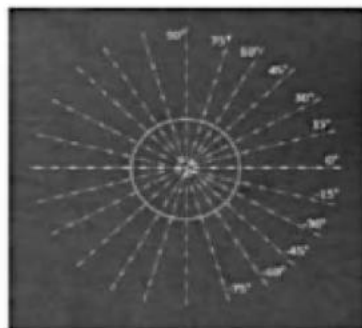
dot

**Initial detection:
Gaussian matched filter**

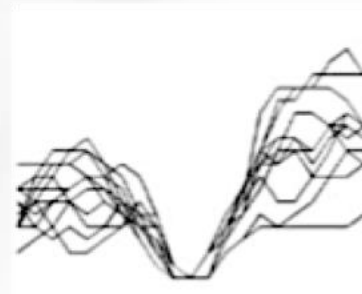
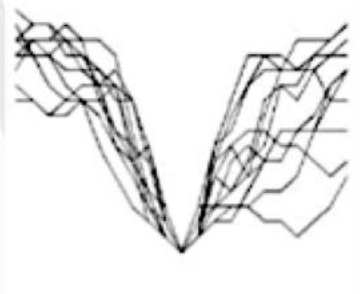
Original Image



Preprocessed



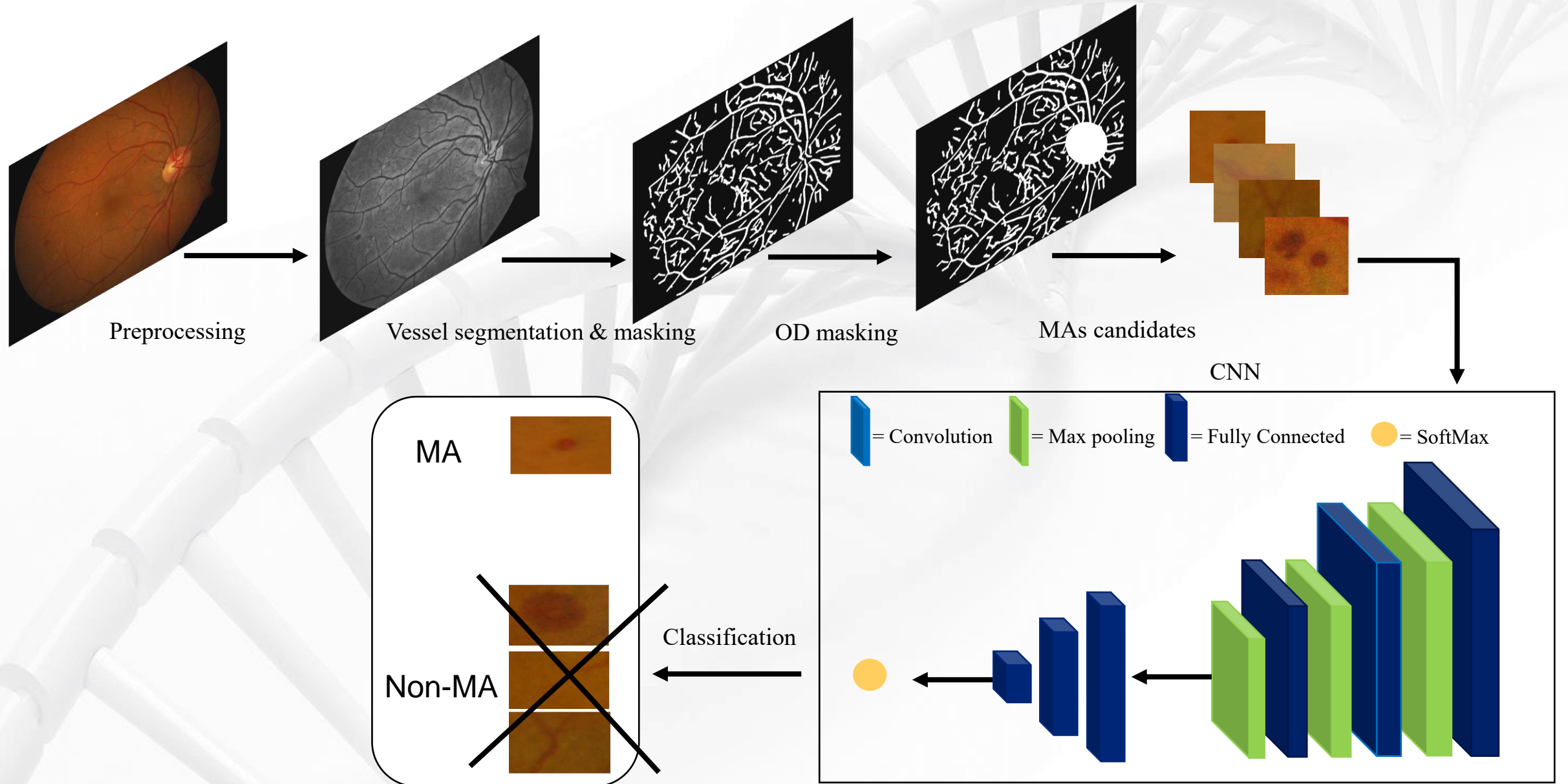
Cross-section original

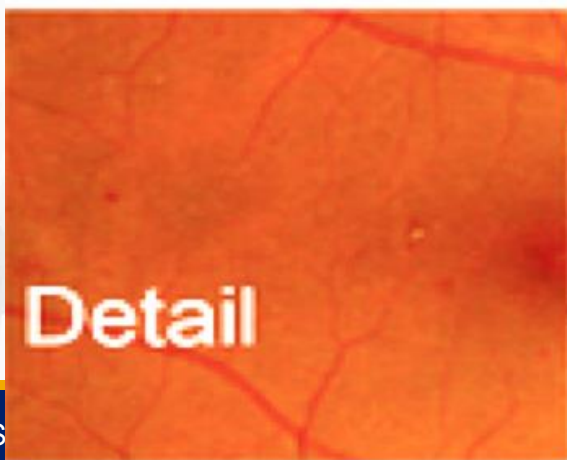
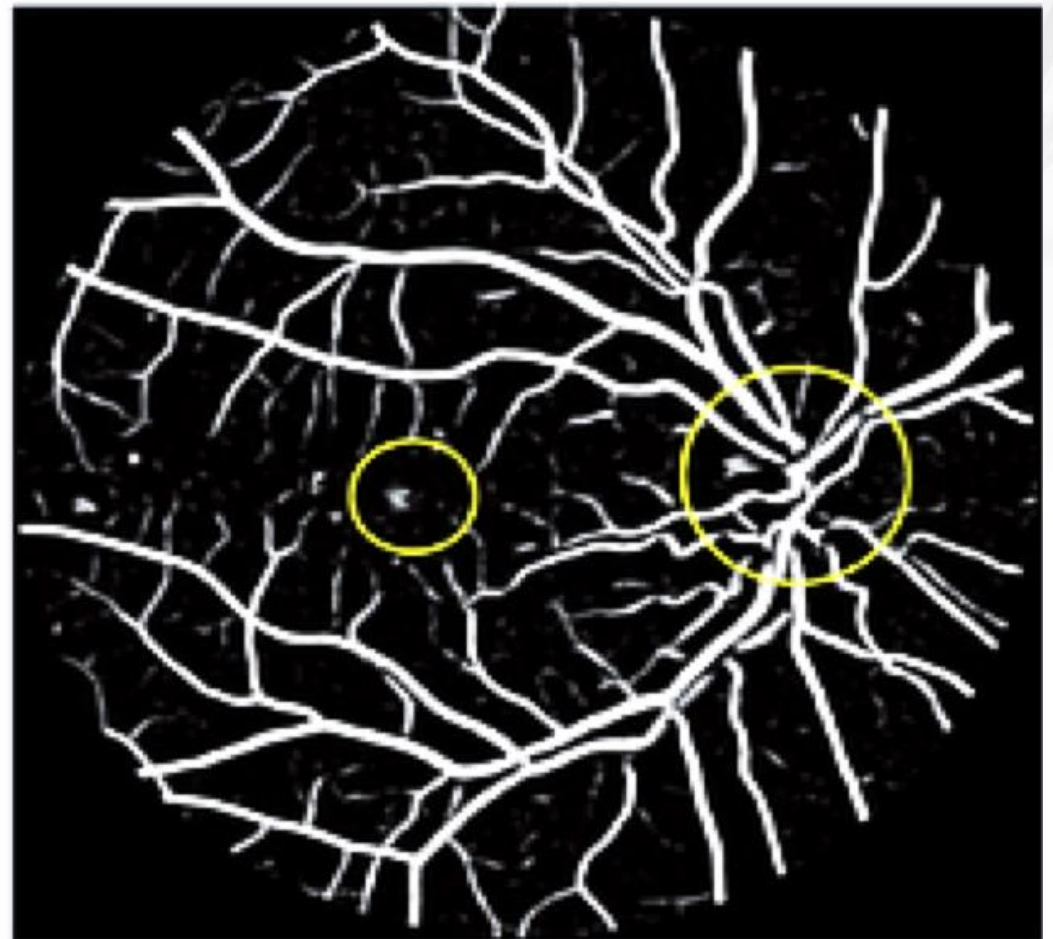


Cross-section preprocessed

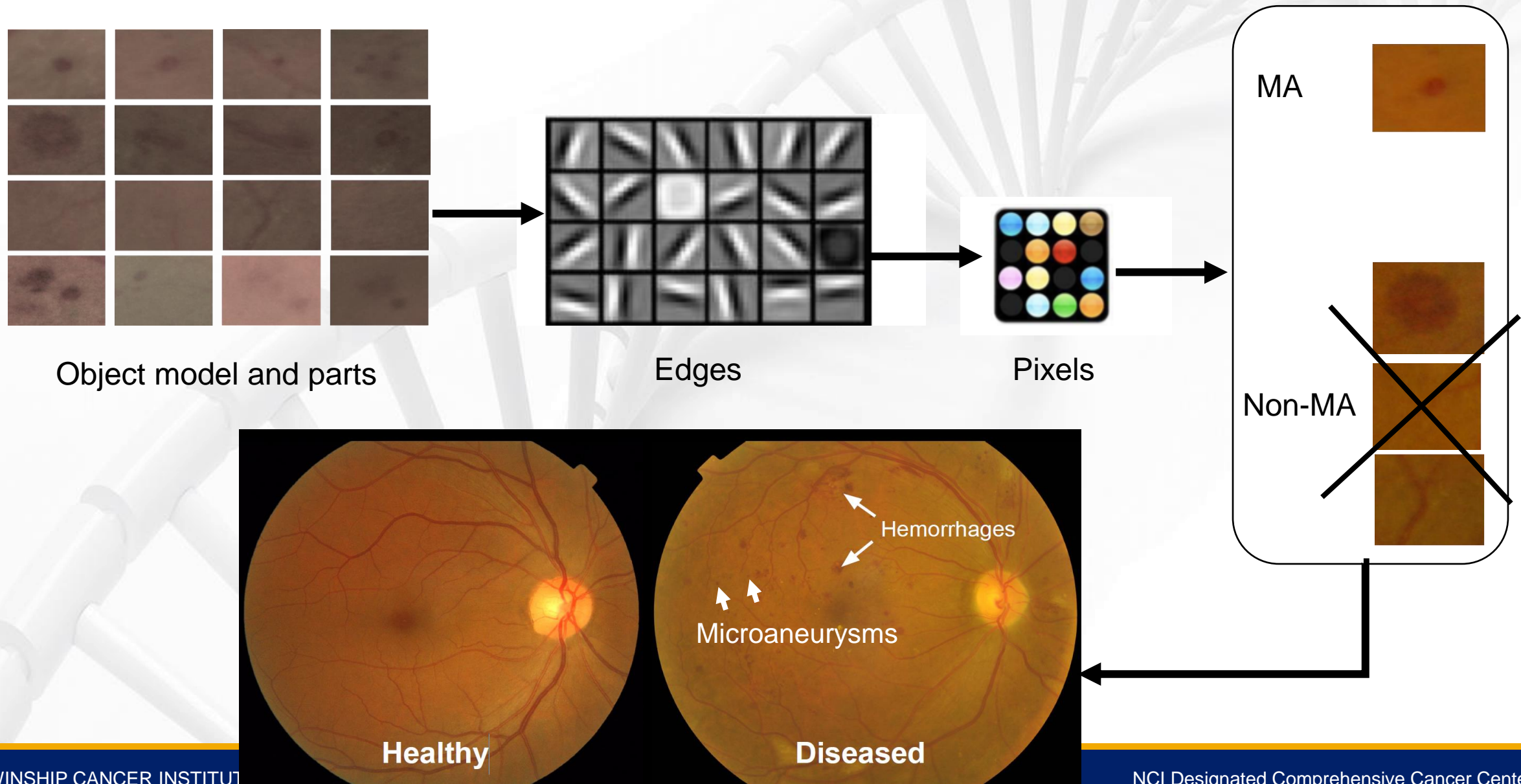


WHOLE GRAPHICAL ABSTRACT





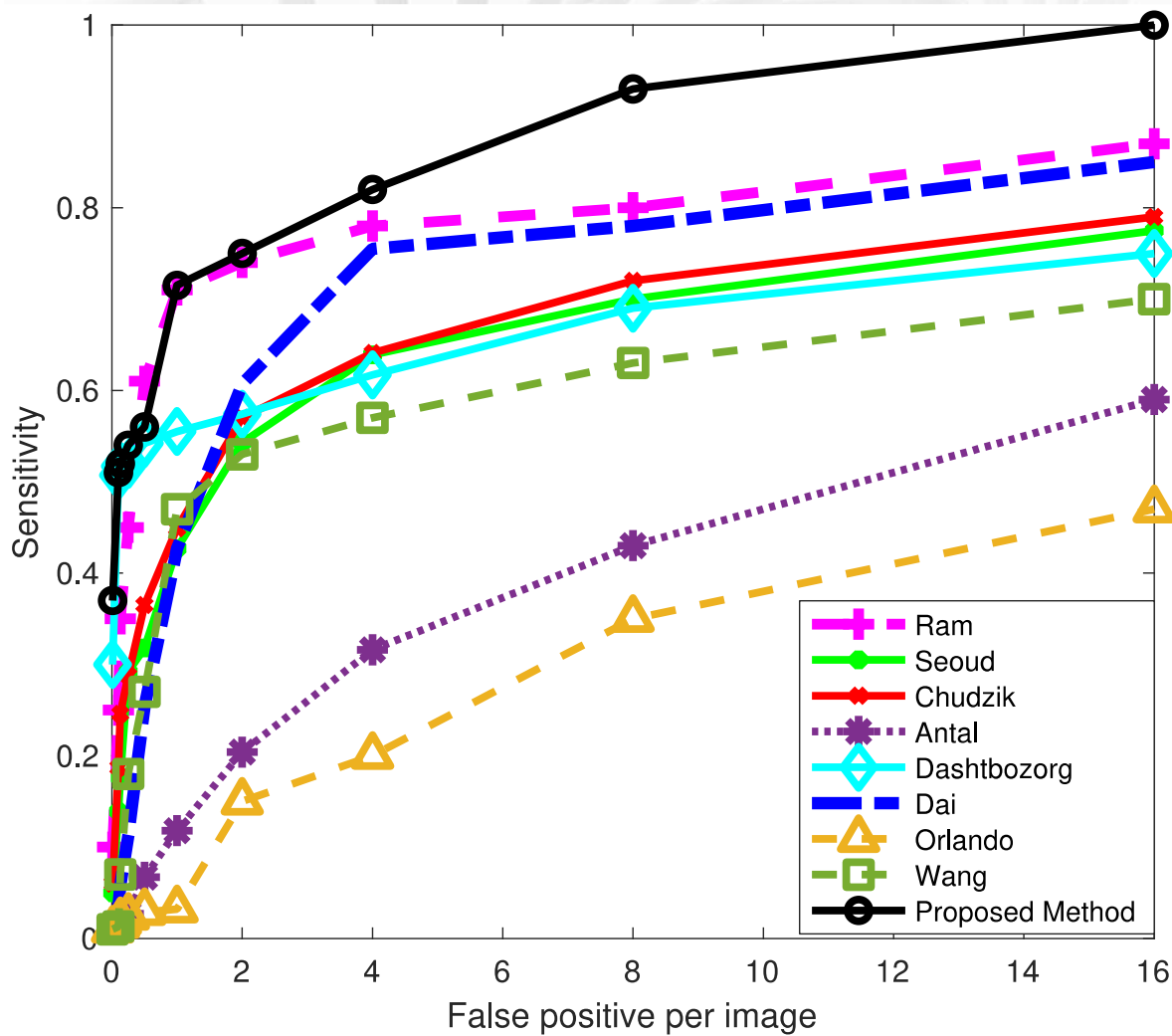
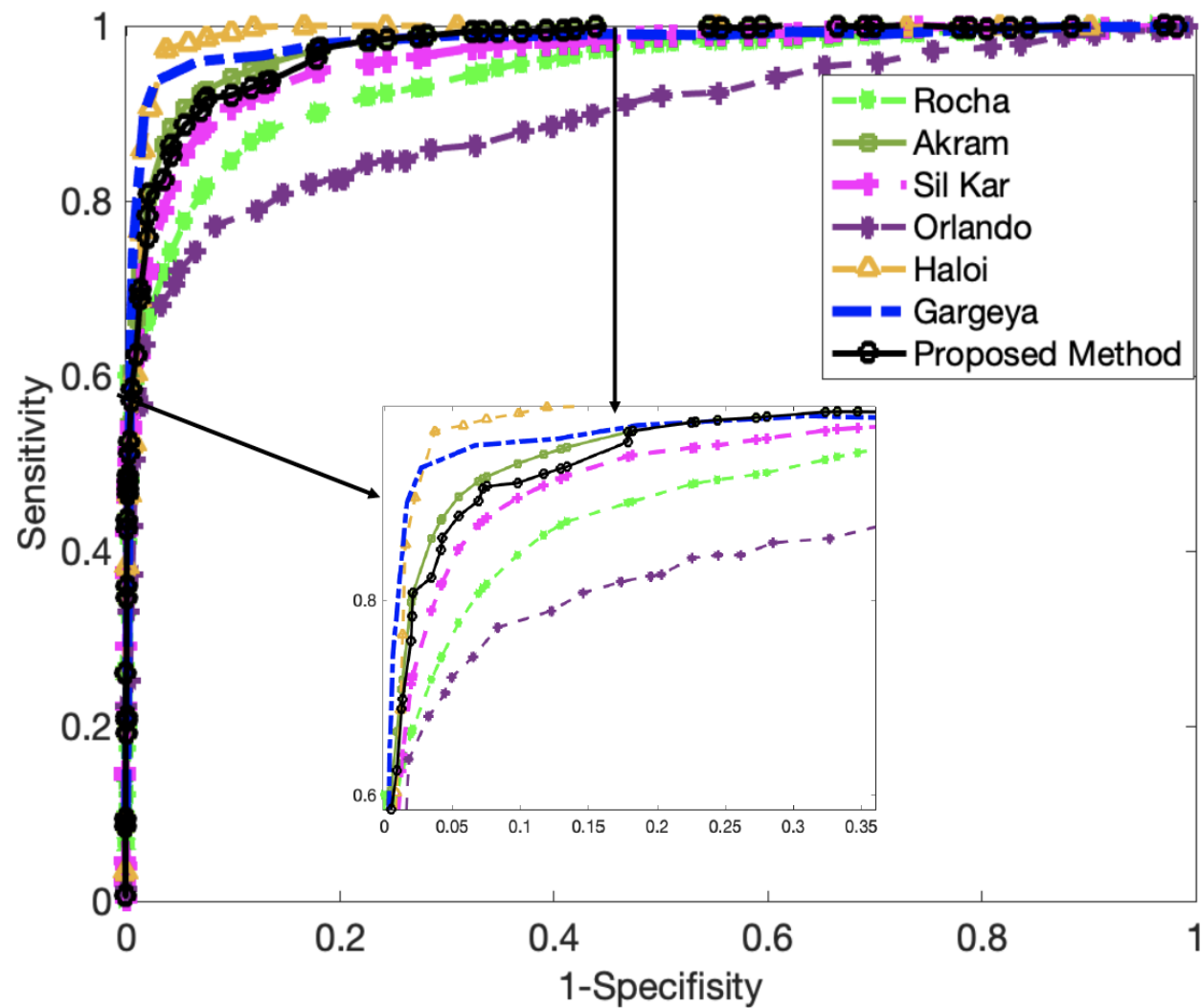
DEEP LEARNING





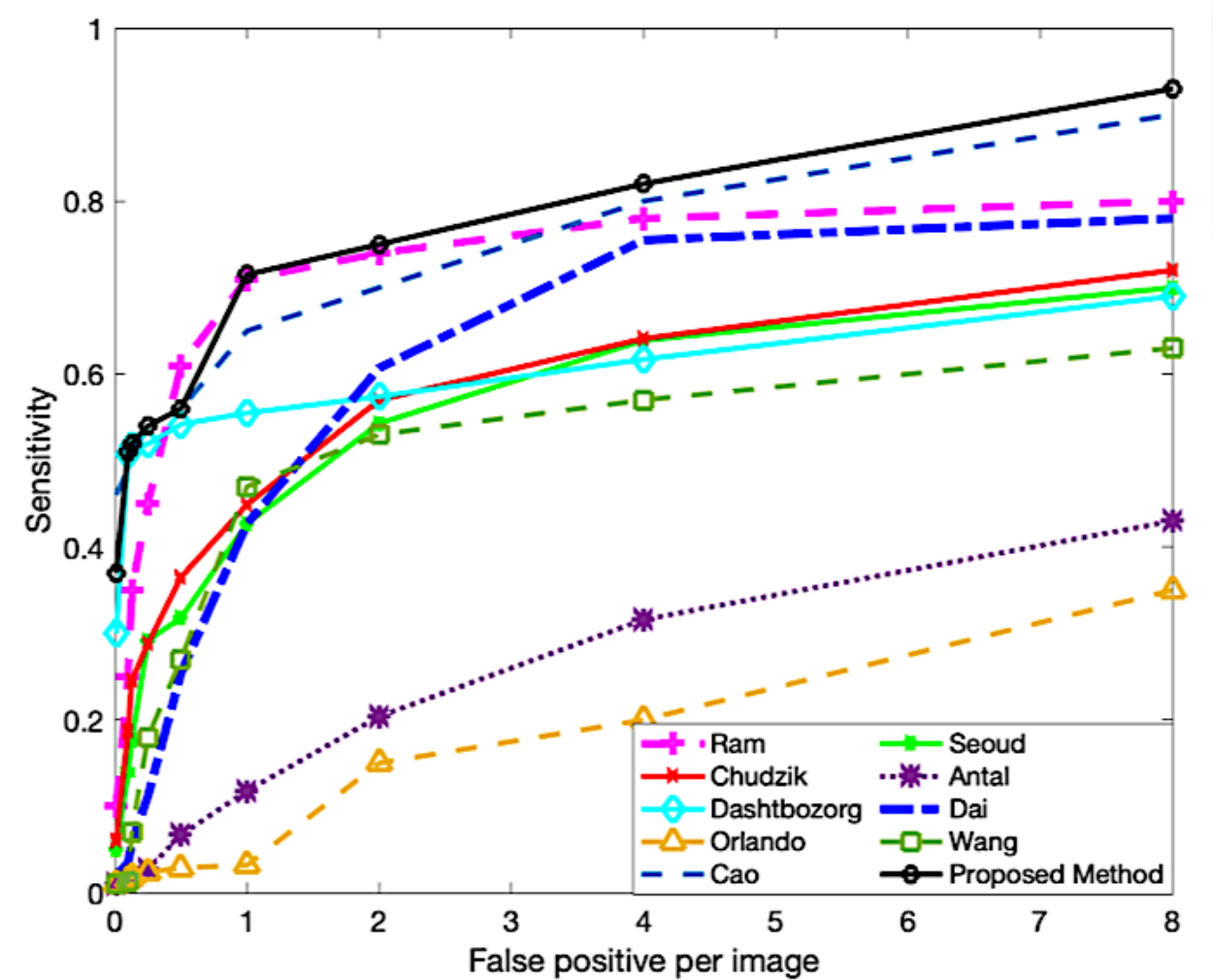
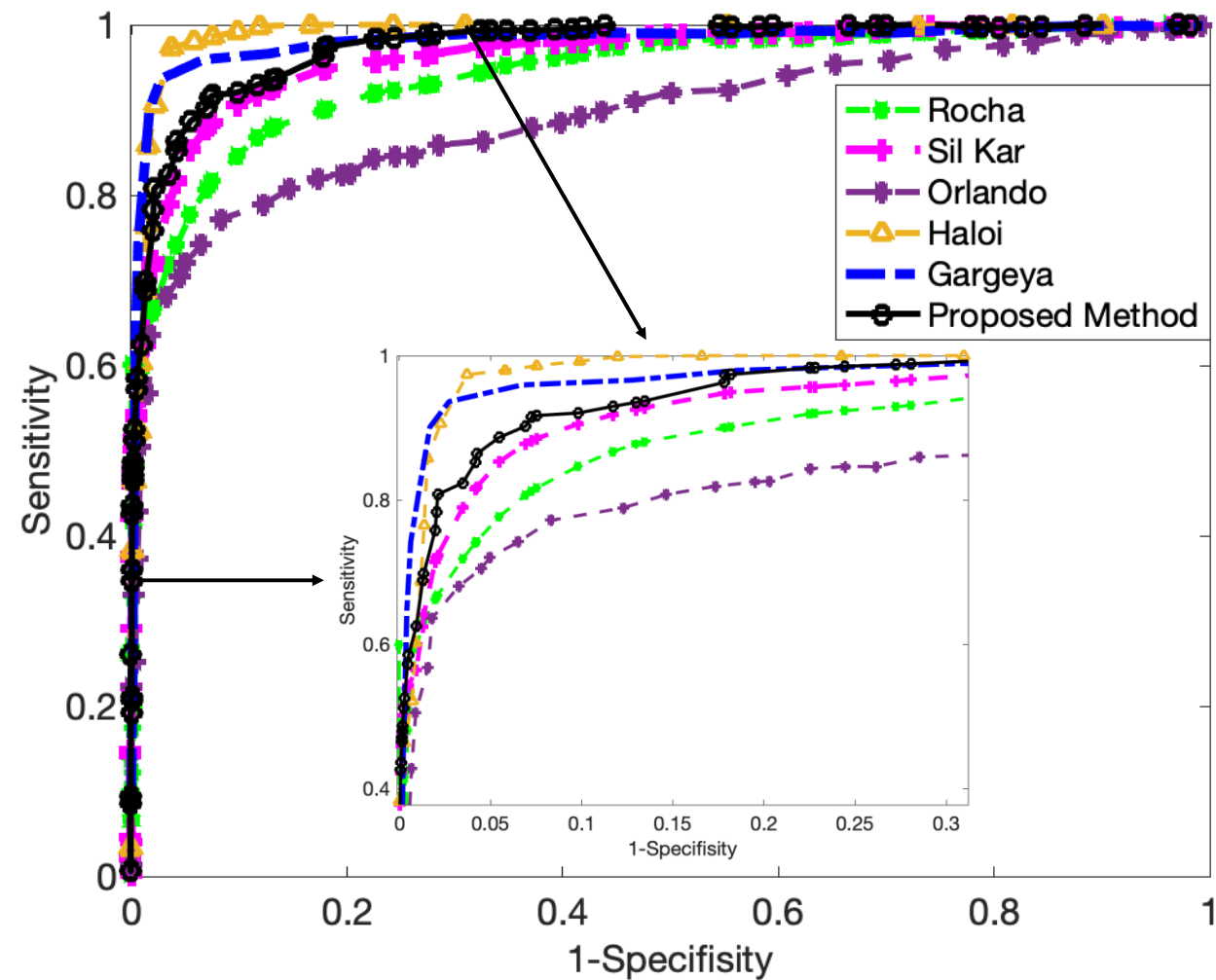
RESULTS

DEEP LEARNING RESULTS



Tavakoli et al., Pattern Recognition, under minor revision, 2021.

SVM RESULTS



Tavakoli et al., IEEE Access 2021.

CONCLUSION

Applying the concept of deep learning and CNN in segmenting object of interest such as any aneurysms, tumor volume or even normal organs.

Combining deep learning and traditional image processing method for image segmentation and classification in localization/tracking of object of interest with limited number of patients.

FUTURE PATH

Comprehensive DL-based screening system is needed.

DL-based grading of DR is another work and worth mentioning task.

Think about prediction.

ACKNOWLEDGEMENT

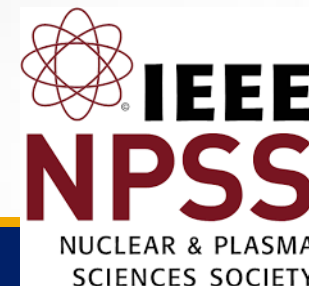
Dr. Alireza Mehdizadeh, Shiraz Medical School

Dr. Jamshid Dehmeshki, Kingston University

Dr. Tim Ellis, Kingston University

Dr. Reza Pourreza, Qualcomm Company

Dr. Staal and his colleagues, Dr. Hoover, and Dr. Fraz and his colleagues for making their retinal databases publicly available.





**THANK YOU FOR YOUR
ATTENTION AND TIME**

