



CAO THẮNG
INTERNATIONAL EYE HOSPITAL



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Multilabel Dataset of Retinal Images for Detection of Multiple Ocular Disease

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Financial Disclosure: Nil

I do not have any affiliation (financial or otherwise) with a commercial organization that may have a direct or indirect connection to the content of my presentation

EYEPACS - DR 0



Drusen on macular



Drusen on peripheral area



Vascular tortuosity



Large cup



“I’m sorry, you’re not having Diabetic Retinopathy but we don’t know if you’re having other eye disease either.”

The Problem

Current public datasets:

- Limited number of eye diseases
- Limited on multiple diseases per fundus image.

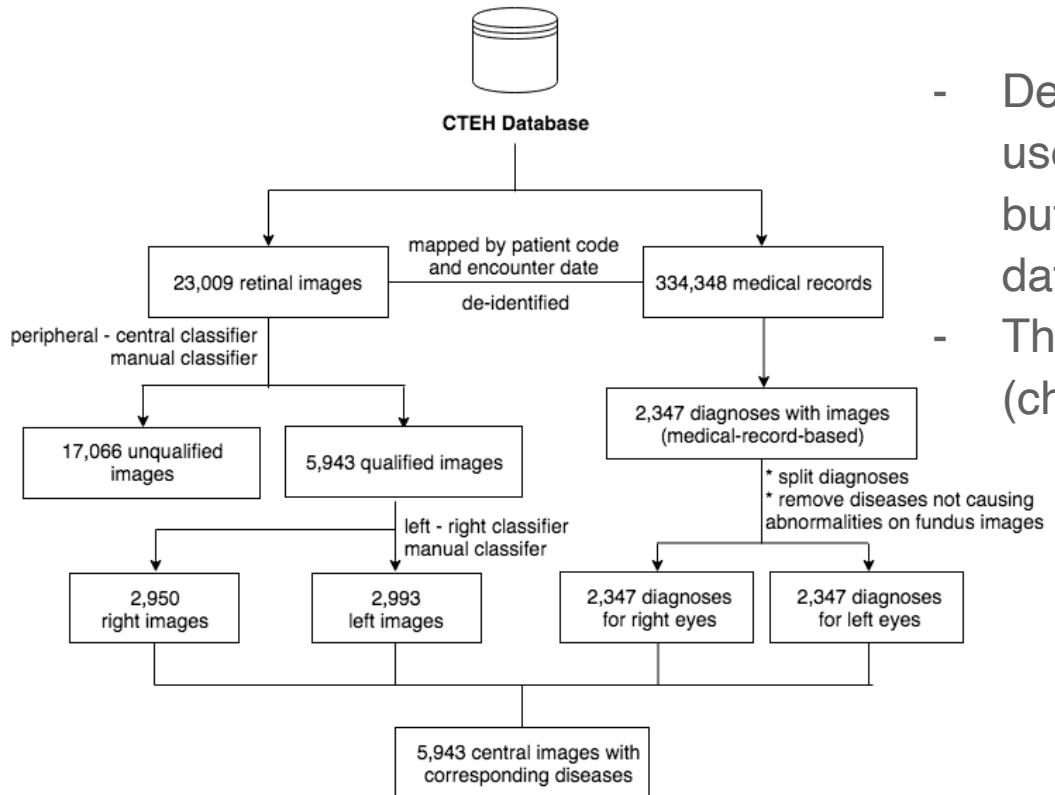
We need datasets that

- Have more diseases
- Have multiple diseases per image

Objective: build a dataset

- Cover more eye diseases
- Have multiple diseases per image

Method - Building dataset

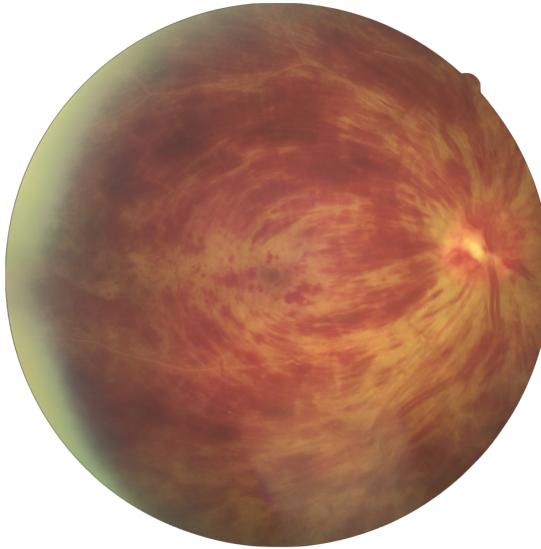


- Deep Neural Networks can be useful not only to classify diseases but also to process and to clean the datasets.
- There are human interventions (checks) along the pipeline.

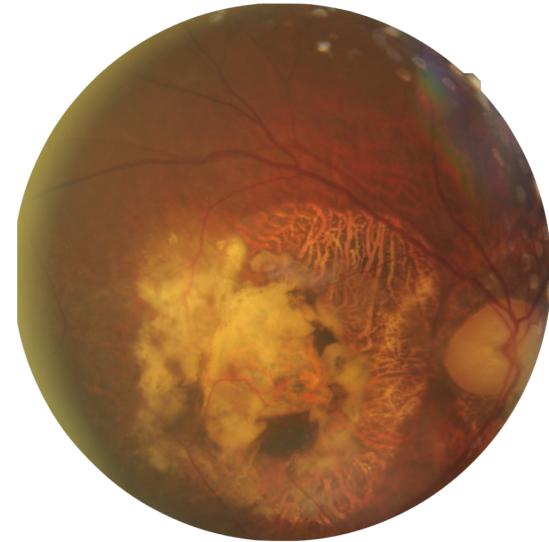
Results



Cataract,
Diabetic Retinopathy



Cataract,
Macular Edema,
Retinal Vein Occlusion



Glaucoma,
Macular Degeneration

Results

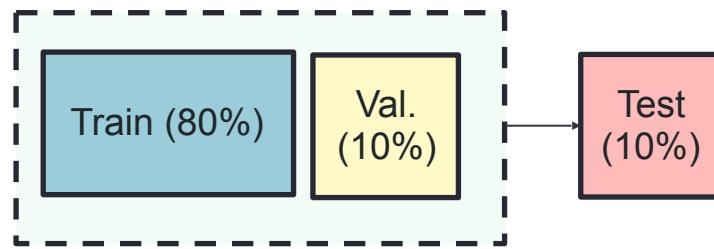
Condition	Occurrences
Cataract	2,258
Diabetic Retinopathy	1,085
Glaucoma	812
Macular Edema	760
Macular Degeneration	757
Retinal Vascular Occlusion	592
Optic Neuritis/Neuropathy	580
Normal???	2,153
Others	

“Other”

- Less than 500 occurrences
- Includes: Posterior Uveitis, Eye Infections, Macular Pucker, Vitreous/Retinal Hemorrhage, Posterior Capsular Opacification, Retinal Detachment/Breaks, Laser Scars, Hereditary Retinal Dystrophy, Myopia, Other Disorders On Fundus, Central Serous Chorioretinopathy, Glaucoma Suspect, Hypertensive Retinopathy, Chorioretinal Atrophy, Large Cup, Chorioretinal Neovascularization

Building a multilabel classifier

Overview of train and validation set		
Dataset Name	Partition (train/set)	No. of Images
CTEH	train	5351
CTEH	test	592
Messidor	train	988
Messidor	test	113
Total: 7048 images		



	Train	Validation	Test
Cataract	1,823	202	233
Diabetic retinopathy	1,353	150	168
Glaucoma	662	74	76
Macular edema	765	85	104
Macular degeneration	508	68	81
Retinal vascular occlusion	468	52	72
Optic neuritis/Neuropathy	470	52	58
Others	1,800	200	199
Normal	415	46	54

Building a multilabel classifier

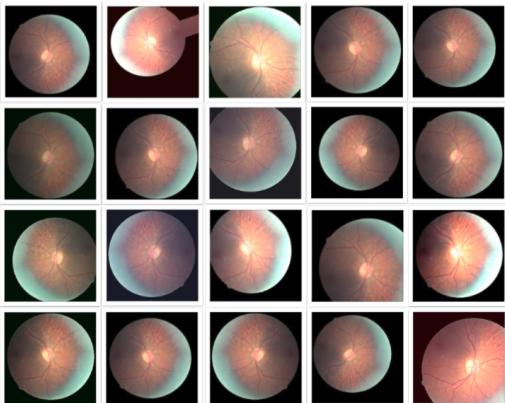
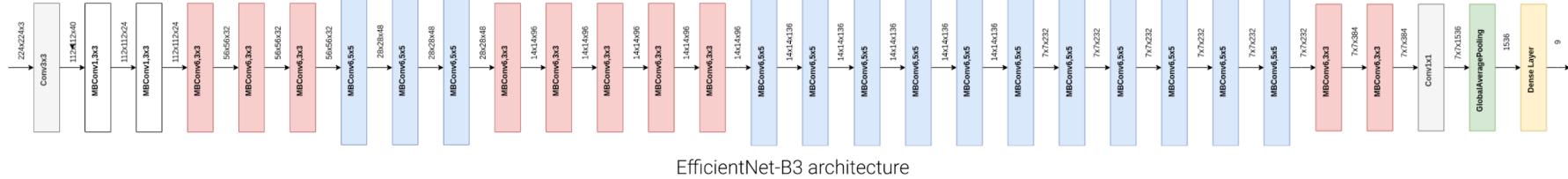
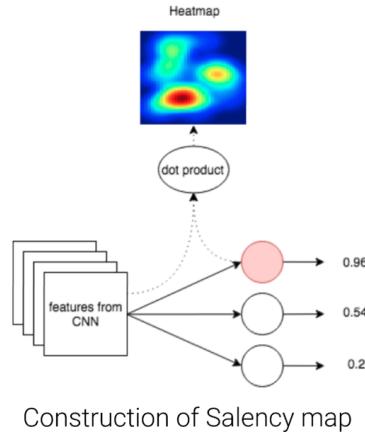


Image Augmentation



Construction of Saliency map

The last layer of **EfficientNet-B3** (Tan and Le, 2019) pretrained on ImageNet is replaced with a 9-node fully connected layer

Realtime augmentation is applied to prevent overfitting
The **loss function is modified** to solve the imbalancing of the dataset

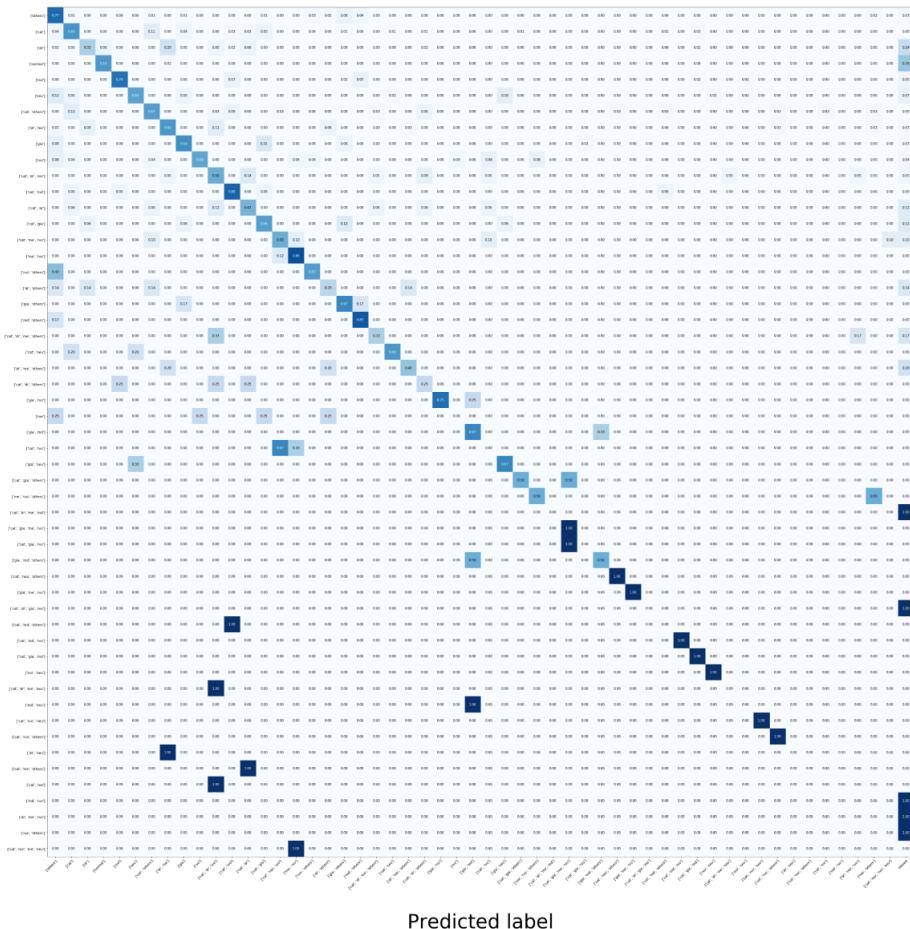
The **saliency map** is provided to ophthalmologists for better feedback

Early results

Example-based metrics

- Exact match ratio: 0.59
 - Accuracy: 0.76
 - Recall: 0.89
 - Specificity: 0.95
 - Precision: 0.79
 - F1-score: 0.82

Confusion matrix of label combinations with normalization



Early results

	accuracy	specificity	precision	recall
cataract	0.89	0.93	0.86	0.84
diabetic retinopathy	0.91	0.96	0.87	0.87
glaucoma	0.87	0.97	0.74	0.76
macular edema	0.85	0.96	0.76	0.73
macular degeneration	0.90	0.98	0.83	0.83
retinal vascular occlusion	0.88	0.99	0.93	0.76
optic neuritis/neuropathy	0.88	1.00	0.96	0.76
others	0.84	0.89	0.75	0.79
normal	0.94	0.99	0.84	0.89

Early results

AI-Assisted Diagnosis System admin@a2ds.net [Sign out](#)

FILE NAME
CTEH-011512.jpg

RESULT

EYE SIDE: LEFT

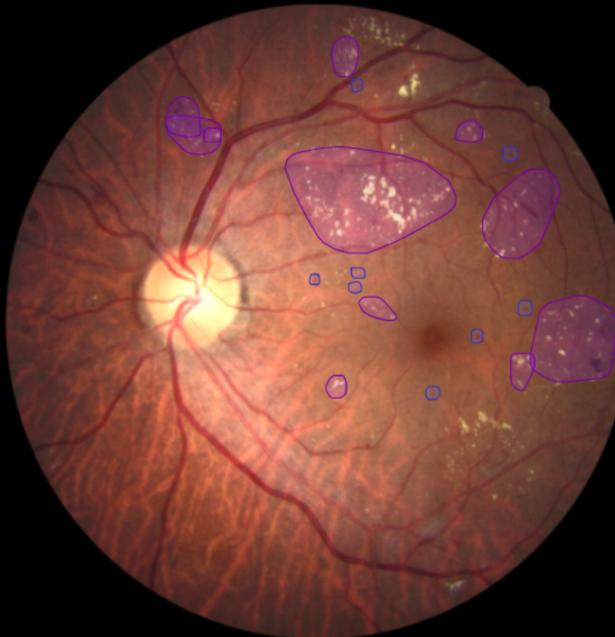
DIABETIC RETINOPATHY 100% ▶

MACULAR EDEMA 99.89% ▶

Comment

Type your comment here...

Red Free: OFF + Brightness - + Contrast - Revert



The fundus photograph shows the retina with several pathologies highlighted by the AI. Purple outlines indicate exudates, which appear as yellowish, fluid-filled spots. Blue outlines indicate microaneurysms, which are small, dilated blood vessels. The central area of the retina is bright yellow, representing the macula. The overall image is reddish-brown, characteristic of fundus photography.

Macular and Optic Disc
Microaneurysms
Exudates
Heatmap: OFF

Clear Predict

Early results

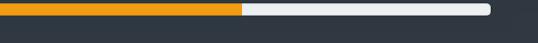
AI-Assisted Diagnosis System nnquang122@gmail.com [Sign out](#)

FILE NAME
623_left.jpeg

RESULT

EYE SIDE: LEFT

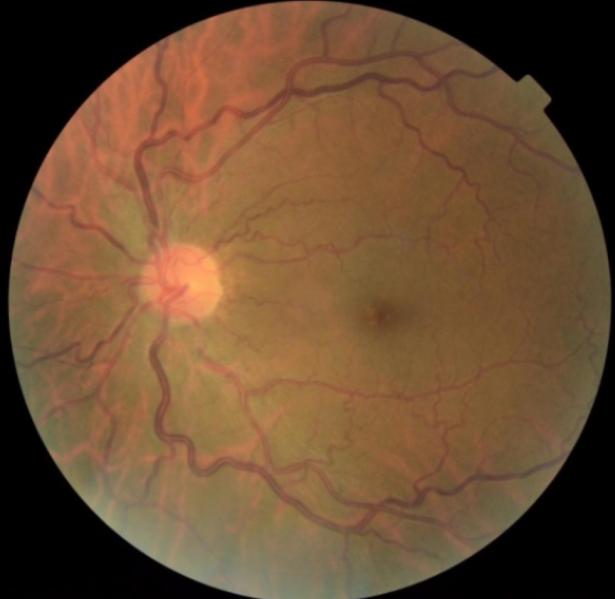
RETINAL VASCULAR OCCLUSION 73.18%  [X](#)

MACULAR EDEMA 50.73%  [X](#)

[See more](#)

Comment

Type your comment here... [SEND](#)



Red Free: OFF + Brightness - + Contrast - [Revert](#)

[Clear](#) [Predict](#)

- Macular and Optic Disc
- Hemorrhage
- Microaneurysms

Early results

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FILE NAME

783_right.jpeg

RESULT

EYE SIDE: RIGHT

GLAUCOMA

96.44% ➔

See more

Comment

Type your comment here...

SEND

Clear

Predict

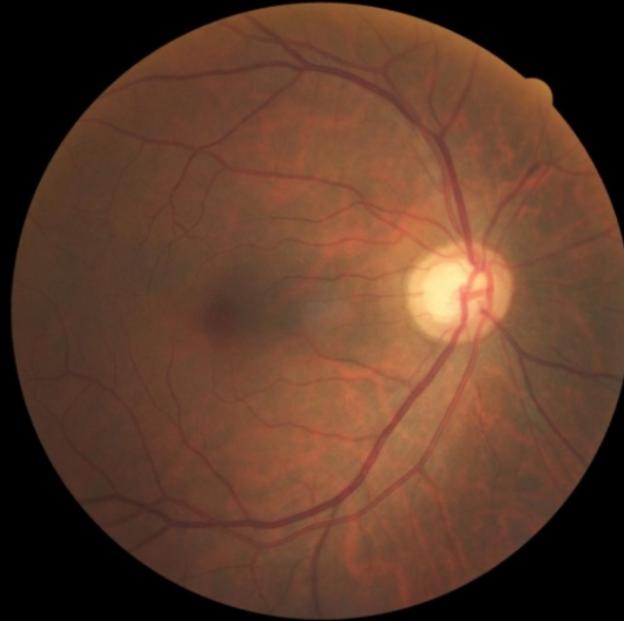
- Macular and Optic Disc
- Heatmap: OFF

Red Free: OFF

+ Brightness -

+ Contrast -

Revert



Early results

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FILE NAME
645_left.jpeg

RESULT

EYE SIDE: LEFT

NORMAL 80.43% ▶ X

[See more](#)

Comment

Type your comment here... SEND

Red Free: OFF + Brightness - + Contrast - Revert

● Macular and Optic Disc



Clear Predict

Conclusion

- Multilabel dataset allows building classifiers able to detect *multiple ocular diseases* in a single fundus image.
- “Normal” and “Others” class are critical.

Discussion

- Early stage of development
- Show some promises
- However, need more evaluation:
 - Performance and Generalization
 - Reference Standards
 - Explainability

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THANK YOU

Q&A

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