

Retina.AI

**Artificial Intelligence in the
Diagnosis of
Diabetic Retinopathy**

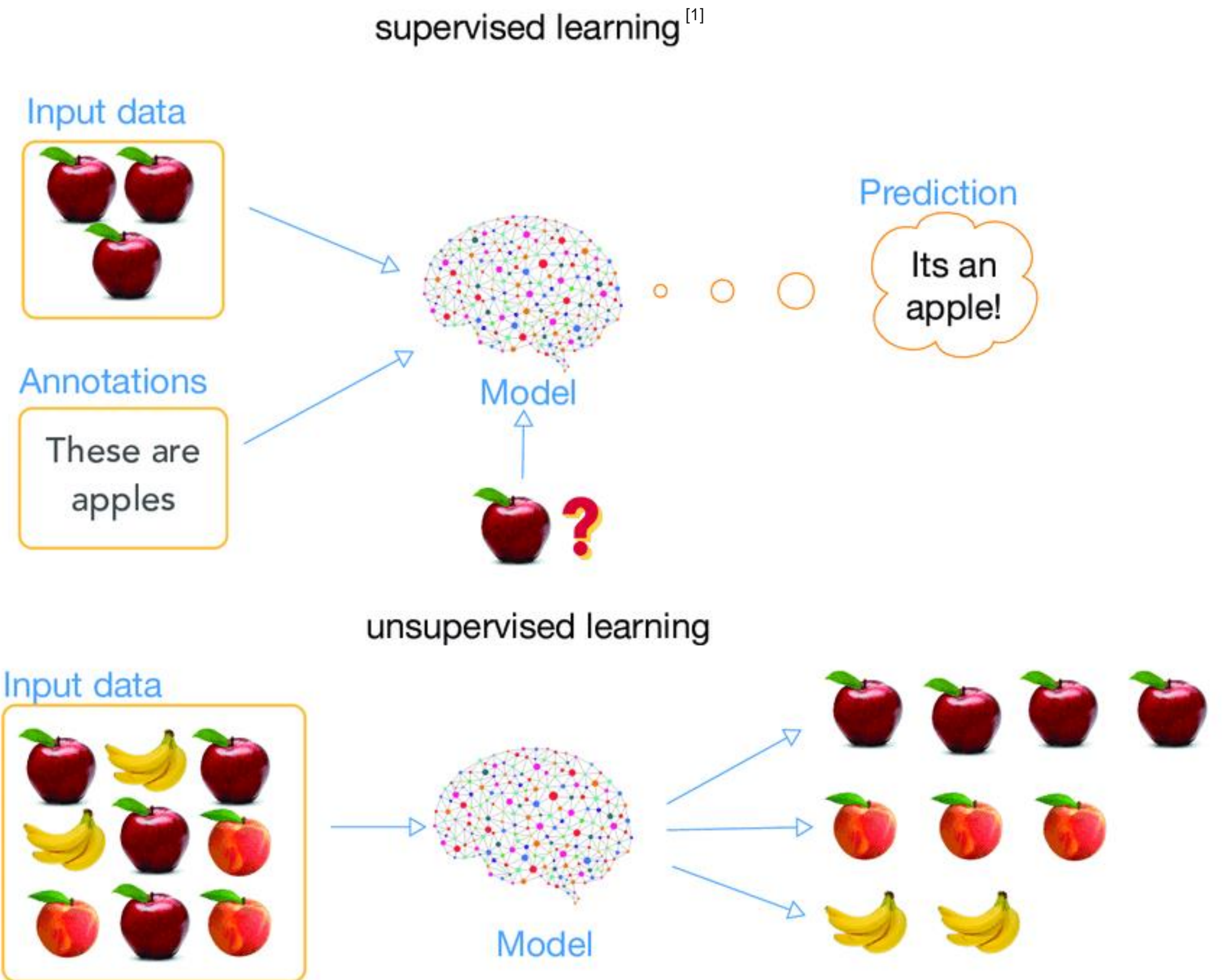
Dr.Evgenia Katalevskaya

Ophthalmologist, Retina Specialist, PhD, Scientific
Director of the RETINA AI Project

What is Artificial Intelligence (AI)?

AI is a computer program that can imitate some functions of human thinking

- ✓ the perception of visual information (computer vision)
- ✓ the ability to learn (machine learning)
- ✓ the ability to make decisions (potentially)



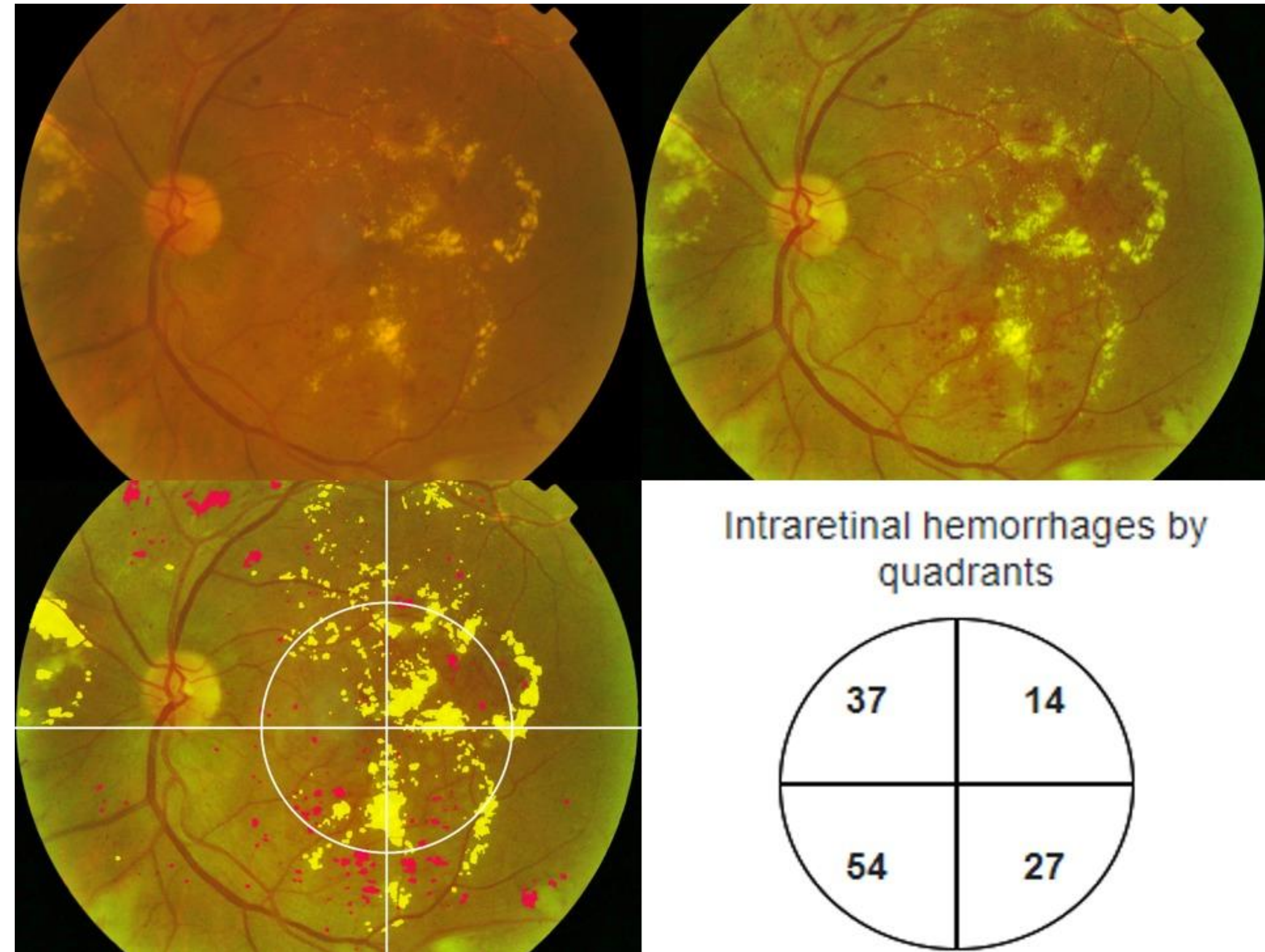
AI publications in the diagnosis of diabetic retinopathy (DR)

Abràmoff MD, Folk JC, Han DP, Walker JD, Williams DF, Russell SR, Massin P, Cochener B, Gain P, Tang L, Lamard M, Moga DC, Quellec G, Niemeijer M. Automated analysis of retinal images for detection of referable diabetic retinopathy. JAMA Ophthalmol. 2013 Mar;131(3):351-7. doi: 10.1001/jamaophthalmol.2013.1743. PMID: 23494039

Bhaskaranand M, Ramachandra C, Bhat S, et al. The Value of Automated Diabetic Retinopathy Screening with the EyeArt System: A Study of More Than 100,000 Consecutive Encounters from People with Diabetes. Diabetes Technol Ther. 2019;21(11):635-643. doi:10.1089/dia.2019.0164

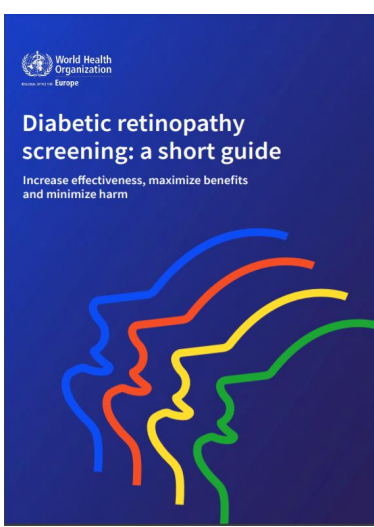
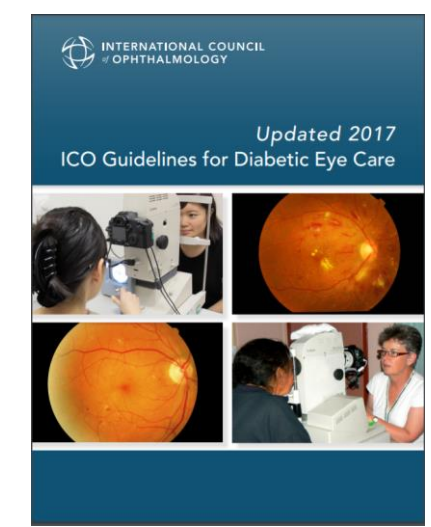
Heydon P, Egan C, Bolter L, et al Prospective evaluation of an artificial intelligence-enabled algorithm for automated diabetic retinopathy screening of 30 000 patients British Journal of Ophthalmology Published Online First: 30 June 2020. doi: 10.1136/bjophthalmol-2020-316594

Wang Y, Shi D, Tan Z, Niu Y, Jiang Y, Xiong R, Peng G, He M. Screening Referable Diabetic Retinopathy Using a Semi-automated Deep Learning Algorithm Assisted Approach. Front Med (Lausanne). 2021 Nov 25;8:740987. doi: 10.3389/fmed.2021.740987. PMID: 34901058; PMCID: PMC8656222.

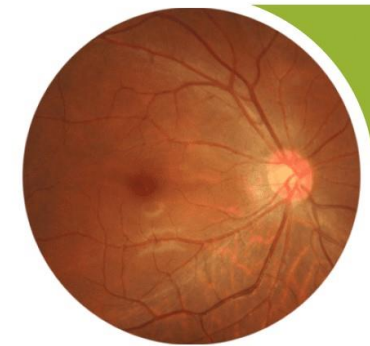


Classification of Diabetic Retinopathy

International Classification

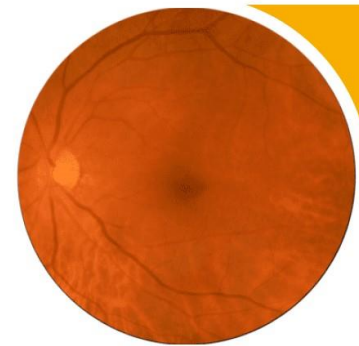


Diabetic retinopathy



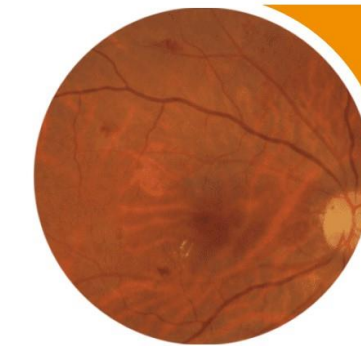
No apparent retinopathy

No abnormalities



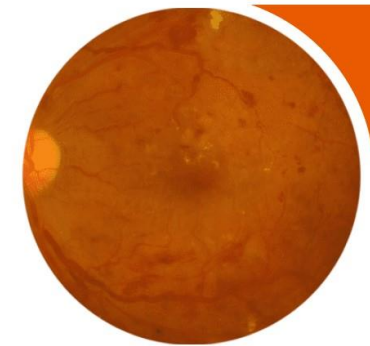
Mild NPDR

Microaneurysms only



Moderate NPDR

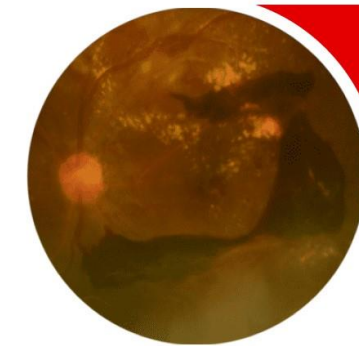
Microaneurysms and other signs (such as dot and blot hemorrhages, hard exudates, cotton wool spots), but less than severe NPDR



Severe NPDR

Moderate NPDR with any of the following:

- Intraretinal haemorrhages (≥ 20 in each quadrant);
- Definite venous beading (in 2 quadrants);
- IRMA (in 1 quadrant);
- and no signs of PDR

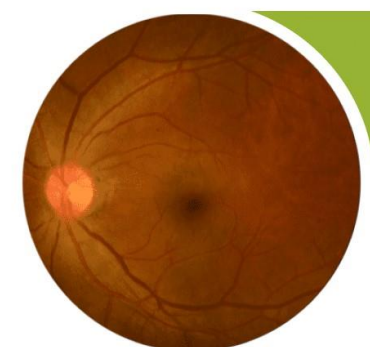


PDR

Severe NPDR and 1 or more of the following:

- Neovascularization
- Vitreous/preretinal hemorrhage

Diabetic macular edema



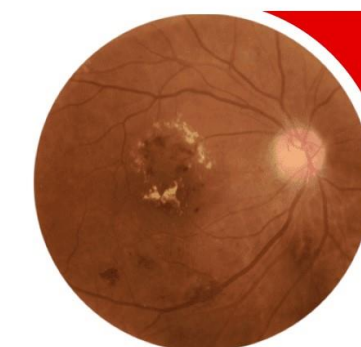
DME absent

No retinal thickening or hard exudates in the macula



Noncentral-involved, diabetic macular edema

Retinal thickening in the macula that does not involve the central subfield zone that is 1 mm in diameter

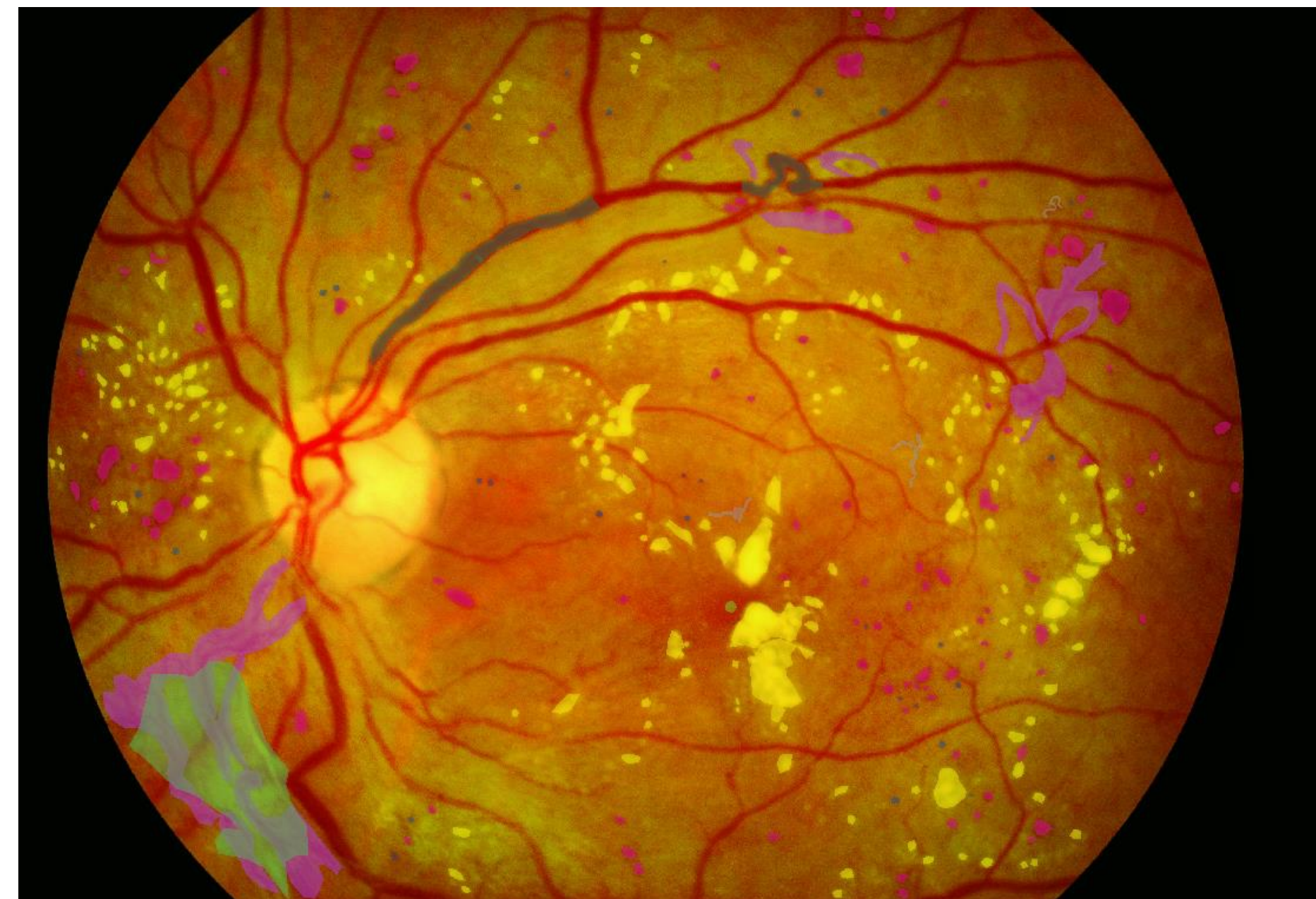
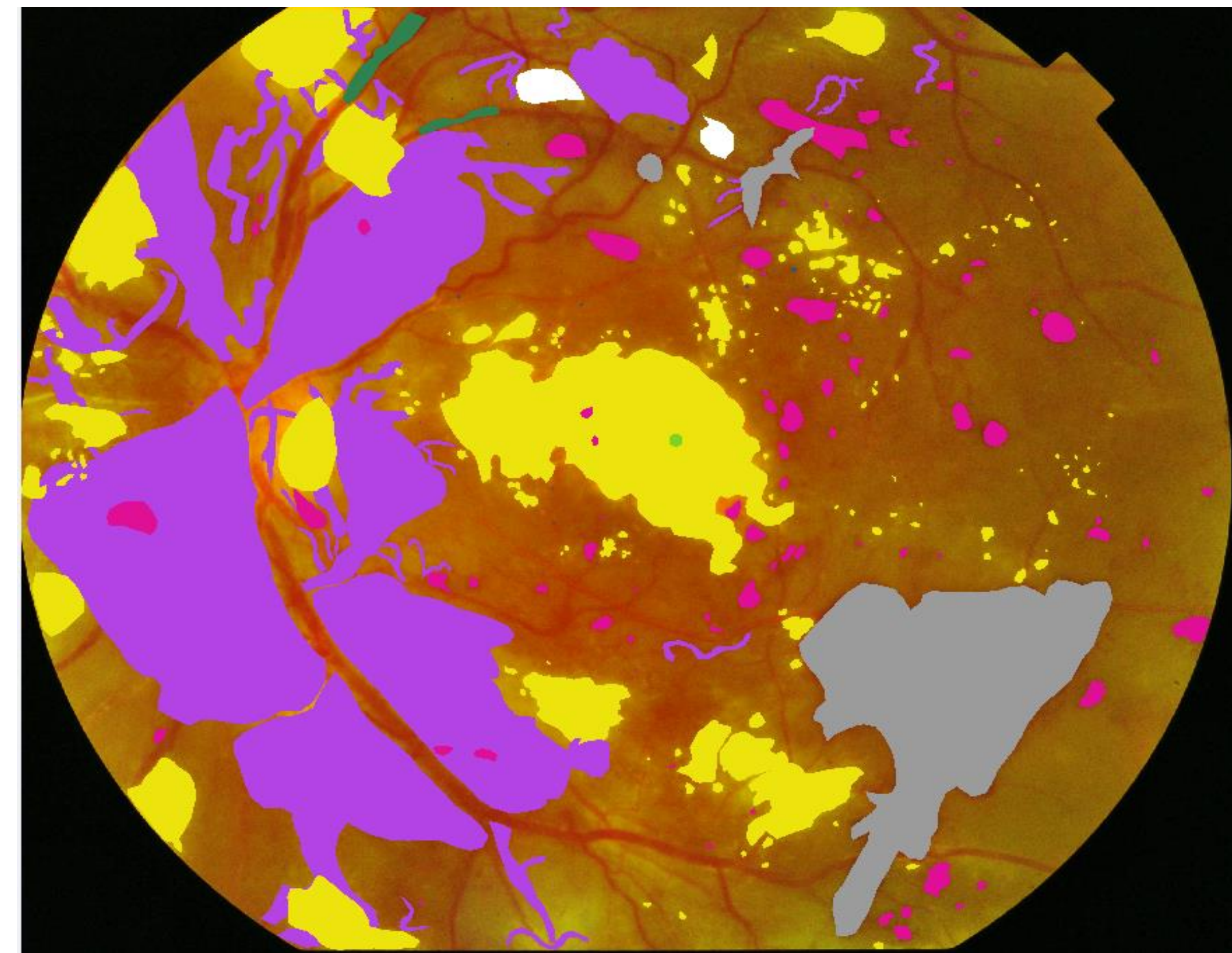


Central-involved diabetic macular edema

Retinal thickening in the macula that does involve the central subfield zone that is 1 mm in diameter

Training Database

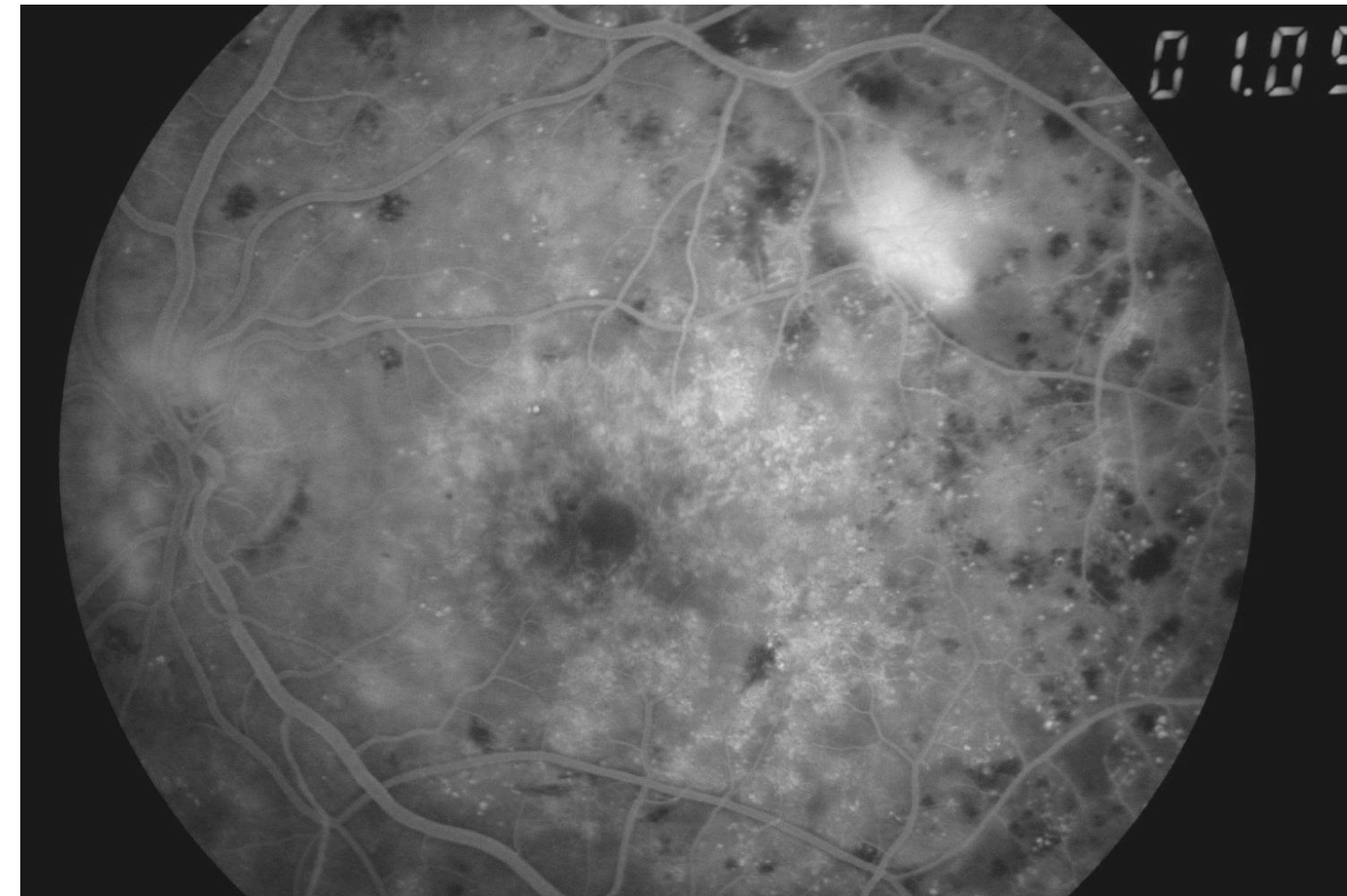
- ✓ a set of examples on which the AI algorithm is trained
- ✓ each image must be labeled by ophthalmologists



Testing Database



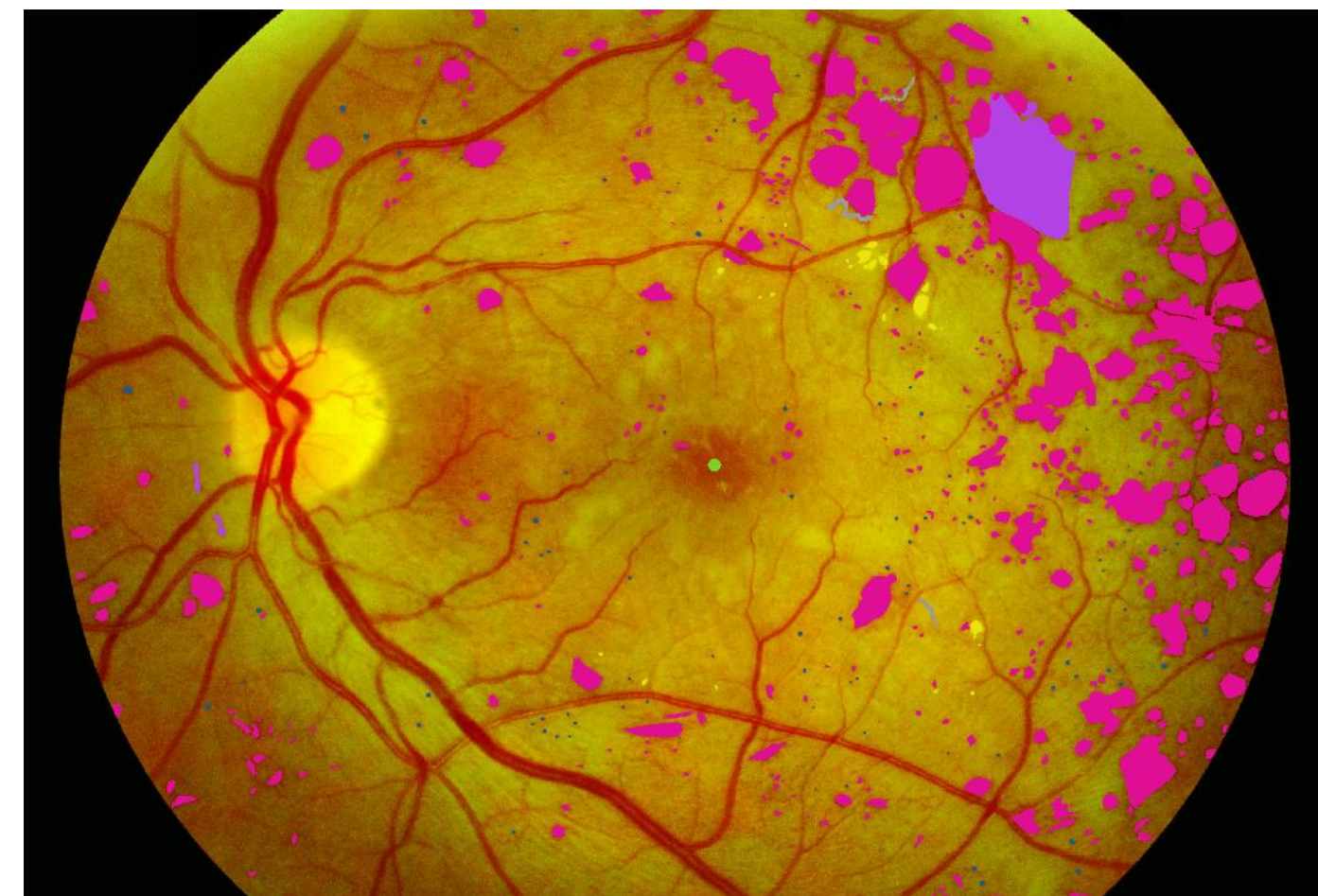
1) Original fundus image



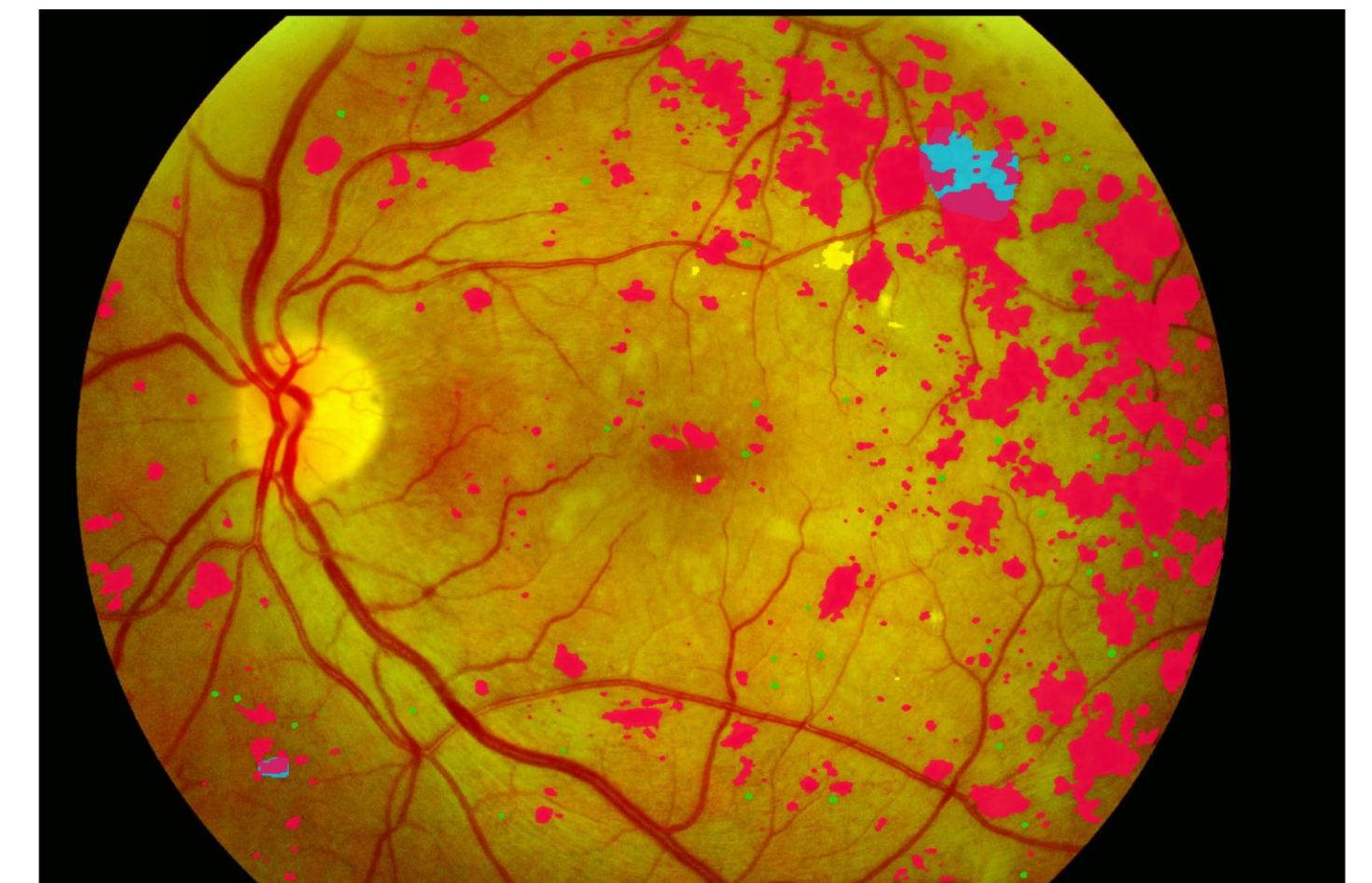
2) Fluorescein angiography



3) Fundus image after preprocessing



4) Fundus image labeled by ophthalmologist



5) Fundus image labeled by AI algorithm

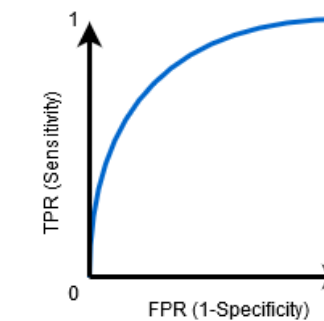
Sensitivity (Recall)

$$\text{Recall} = \frac{TP}{TP+FN}$$

Specificity

$$\text{Specificity} = \frac{TN}{TN+FP}$$

AUC ROC (Area Under Curve Receiver Operating Characteristic)



Sorensen-Dies index

$$DSC = \frac{2|A \cap B|}{(|A| + |B|)}$$

Our website

Retina.AI v0.9

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Retina.AI

Cloud Platform for diagnosing retinal diseases

*Note: The service is under development.
Cannot be used for diagnosis.*

<https://www.screenretina.com/>

Fundus Image Analysis Module

 > Diabetic Retinopathy



**Diabetic Retinopathy
Learning Block**



**Fundus
Image Processing**



**Fundus
Image Analysis**



OCT Analysis



**Share Fundus
Image / OCT scan**



Support



F.A.Q.



Reviews

Fundus Image Analysis Module: drop zone

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🏠 > Diabetic Retinopathy > Fundus Image Analysis

Preview version.

Attention, please!

The Retina.AI service does not provide any diagnosis. Only a doctor can make a diagnosis. The aim of our service is to alert a doctor about any deviations from the norm indicating potential eye pathology.



To upload a fundus image drag it to this window or use the button

Upload


TIFF images (.tiff, .tif) are not supported.

Attention: it may not work correctly in Internet Explorer, Safari browsers. We recommend using Google Chrome.

<https://www.screenretina.com/>

Fundus Image Analysis Module

Diabetic retinopathy




Signs of macular edema

Detected

Intraretinal hemorrhages by quadrants

46	45
32	40



International Council of Ophthalmology Guidelines for Diabetic Eye Care


Report

Export images

Original Image

Processed Image

+ Upload new image



-

+

Macula

Quadrants

Microaneurysms

Soft Exudates

Neovascularization

Laser Coagulation

Intraretinal Hemorrhages

Preretinal Hemorrhages

Hard Exudates

Retinal Venous Changes

Epiretinal Fibrosis

Found errors?

FAQ

Fundus Image Analysis Module

🏠 > Diabetic Retinopathy > Fundus Image Analysis

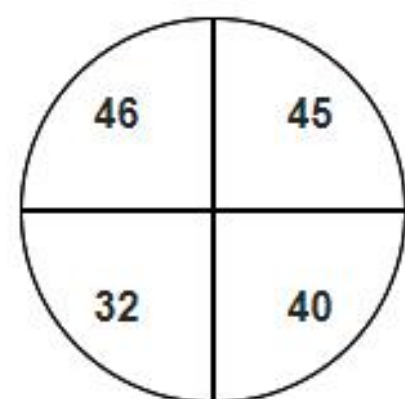
Diabetic retinopathy



Signs of macular edema

Detected

Intraretinal hemorrhages by quadrants



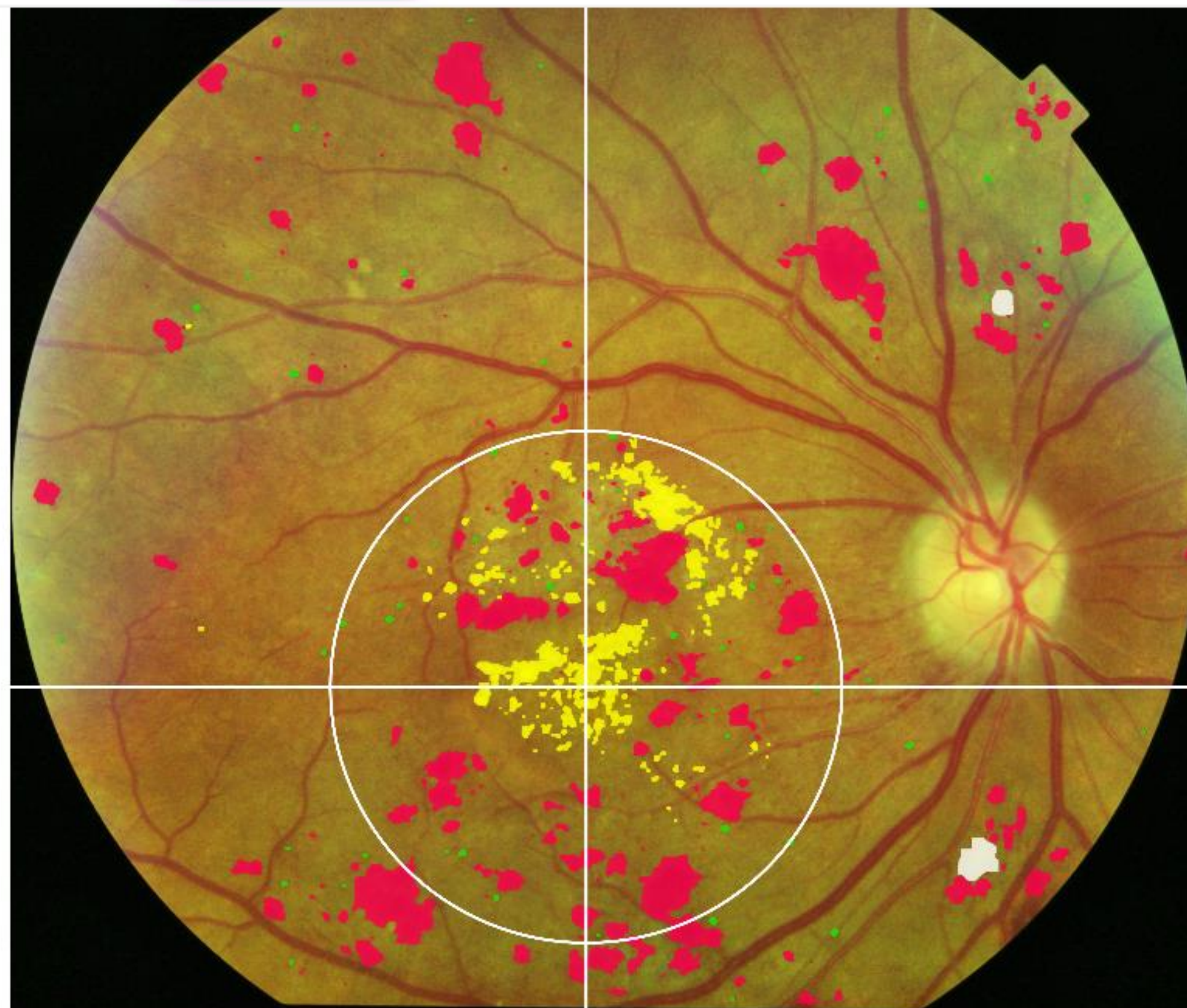
Report

Export images

Original Image

Processed Image

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Macula



Quadrants

Microaneurysms



Soft Exudates



Neovascularization



Laser Coagulation



Intraretinal Hemorrhages



Preretinal Hemorrhages



Hard Exudates



Retinal Venous Changes



Epi-retinal Fibrosis



Found errors?

FAQ

<https://www.screenretina.com/>


Fundus Image Analysis Module: report

✔ According to the International Classification of Diabetic Retinopathy



<https://www.screenretina.com/>

Retina.AI

DIGITAL
VISION
SOLUTIONS

Patient information

Information about the doctor

Full name

Full name

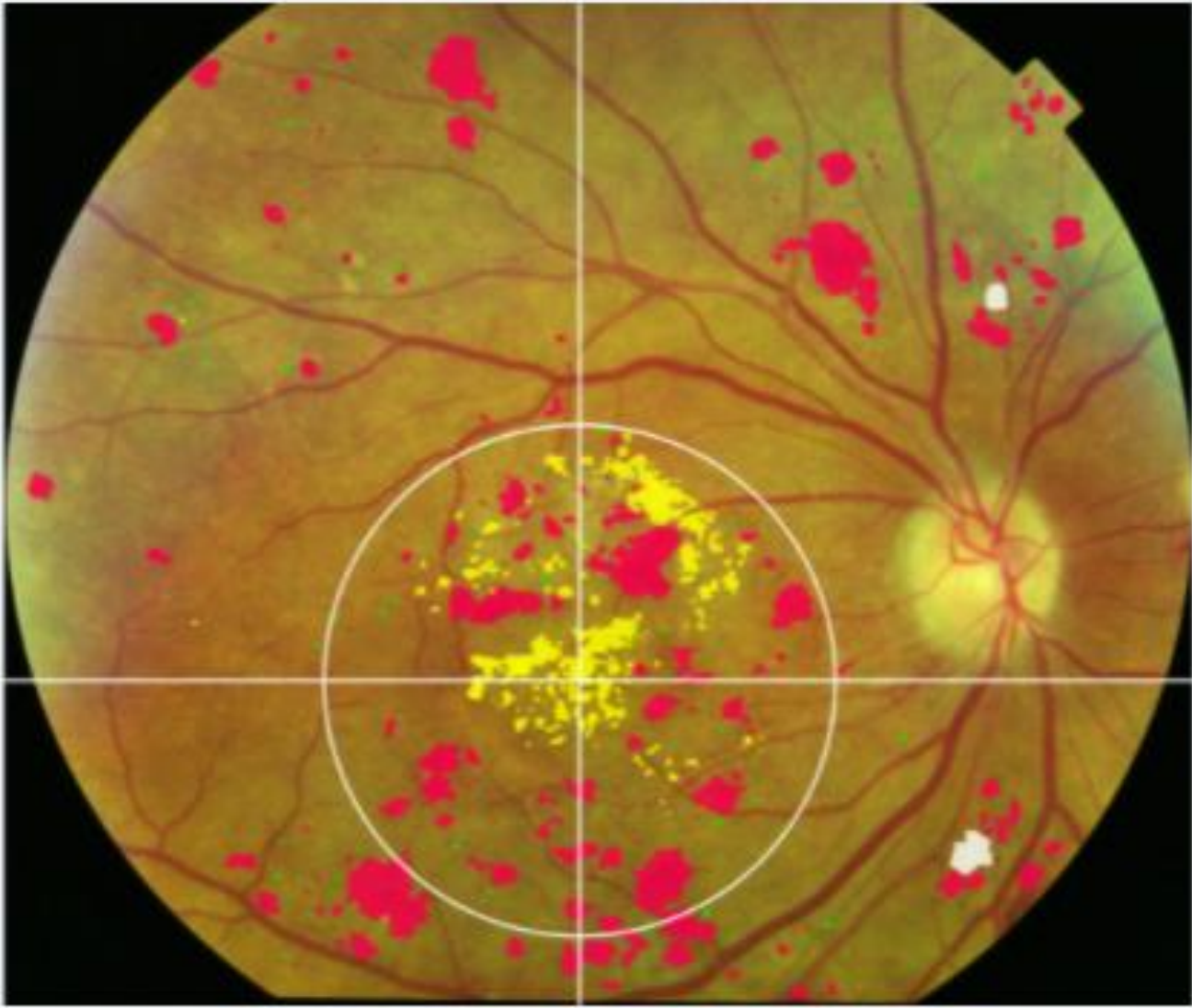
Sex:

☐ Male

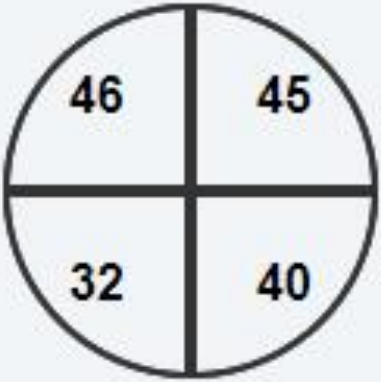
☐ Female

age

Date:







Number of hemorrhages by quadrants



Sign of diabetic macular edema

Hard exudates at the macula

Detected

Stage	Features	Detection
 Mild NPDR	Microaneurysms	Detected
 Moderate NPDR	Soft exudates	Detected
	Hard exudates	Detected
	Intraretinal hemorrhages	Detected
 Severe NPDR	Intraretinal hemorrhages	46/45/40/32
	Venous abnormalities	Analysis was not carried out
	IRMA	Analysis was not carried out
 PDR	Neovascularization	Not detected
	Preretinal hemorrhages	Not detected
	Epiretinal fibrosis	Not detected
	Laser coagulates	Not detected

Interactive Diabetic Retinopathy Guide

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Management plan

DR0

DR1

DR2

DR3

PDR

DME

Complete

>

Abbreviations

DR

Diabetic retinopathy

DME

Diabetic macular edema

NPDR

Nonproliferative diabetic retinopathy


PDR

Proliferative diabetic retinopathy

IRMA

Intraretinal microvascular abnormalities


Standard



International Council of Ophthalmology Guidelines for Diabetic Eye Care


International Classification

Diabetic retinopathy




No apparent retinopathy

No abnormalities




Mild NPDR

Microaneurysms only



Moderate NPDR


Microaneurysms and other signs (such as dot and blot hemorrhages, hard exudates, cotton wool spots), but less than severe NPDR



Severe NPDR

Moderate NPDR with any of the following:

- Intraretinal haemorrhages (≥20 in each quadrant);
- Definite venous beading (in 2 quadrants);
- IRMA (in 1 quadrant);
- and no signs of PDR




PDR

Severe NPDR and 1 or more of the following:


- Neovascularization
- Vitreous/preretinal hemorrhage

Diabetic macular edema



DME absent


No retinal thickening or hard exudates in the macula



Noncentral-involved, diabetic macular edema

Retinal thickening in the macula that does not involve the central subfield zone that is 1 mm in diameter

Download



Central-involved diabetic macular edema

Retinal thickening in the macula that does involve the central subfield zone that is 1 mm in diameter

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Classification

Management plan

DR0

DR1

DR2

DR3

PDR

DME

Complete

>

Diabetic retinopathy

Severe NPDR: moderate NPDR with any of the following:

• Intraretinal hemorrhages (≥ 20 in each quadrant);

• Definite venous beading (in 2 quadrants);

• IRMA (in 1 quadrant);

• and no signs of PDR

Very severe NPDR: two or more of severe NPDR features.

Venous abnormalities – venous beading (the most common change), venous looping, venous reduplication.

IRMA – fine, irregular, red intraretinal lines, that are often seen adjacent to areas of capillary hypoperfusion. IRMA often appear as small squiggles in areas between major vessels. IRMA is a sign of an imminent start of neovascularisation.


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Original photo

Processed

<



>

-

+

Quadrants

Intraretinal hemorrhages in each quadrant

17

27

36

25

Microaneurysms

Intraretinal hemorrhages

IRMA

Hard exudates

Venous abnormalities

<https://www.screenretina.com/>

Interactive Diabetic Retinopathy Guide: Self-Test

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Diabetic Retinopathy

Learning Block

Self-Test

Online Diabetic Retinopathy Test

Question 1: What is the stage of DR?

No apparent retinopathy

Mild NPDR

Moderate NPDR

Severe NPDR

PDR

Question 2: Are there hard exudates in the macula? (Sign of DMO)

Absent

Present

Response statistics:

Correct: 1

Wrong: 0

Total: 1/25

Next

Original photo

Processed Photo

Macula

Quadrants

Intraretinal hemorrhages by quadrants

48

27

28

26

DR Signs

Microaneurysms

Soft exudates

Intraretinal hemorrhages

IRMA

Hard exudates

Venous abnormalities

<https://www.screenretina.com/>

Practical benefits of the AI in the diagnosis of DR

422m

patients worldwide are suffering from diabetes mellitus (WHO)

950K

people in the European region^[2] have vision impairment and blindness caused by diabetes

Diabetic Retinopathy



is a complication of diabetes mellitus, a leading cause of preventable vision impairment and blindness;



Each patient suffering from diabetes needs ophthalmology check up from once every 2 years to 12 times a year

Consequences

- ✓ Overloaded national healthcare systems, high social coast
- ✓ Insufficient coverage by the ophthalmology healthcare services of patients with diabetes both nationally and worldwide;
- ✓ Late diagnostics is one of the major reasons of blindness and vision impairment due to diabetic retinopathy (DR) and diabetic macular edema (DME).

~640m

people aged 20-79 age will suffer from diabetes by 2040 ^[1]

[1] Ogurtsova K, da Rocha Fernandes JD, Huang Y et al. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes Res Clin Pract. 2017 Jun;128:40-50. doi: 10.1016/j.diabres.2017.03.024. Epub 2017 Mar 31. PMID: 28437734.

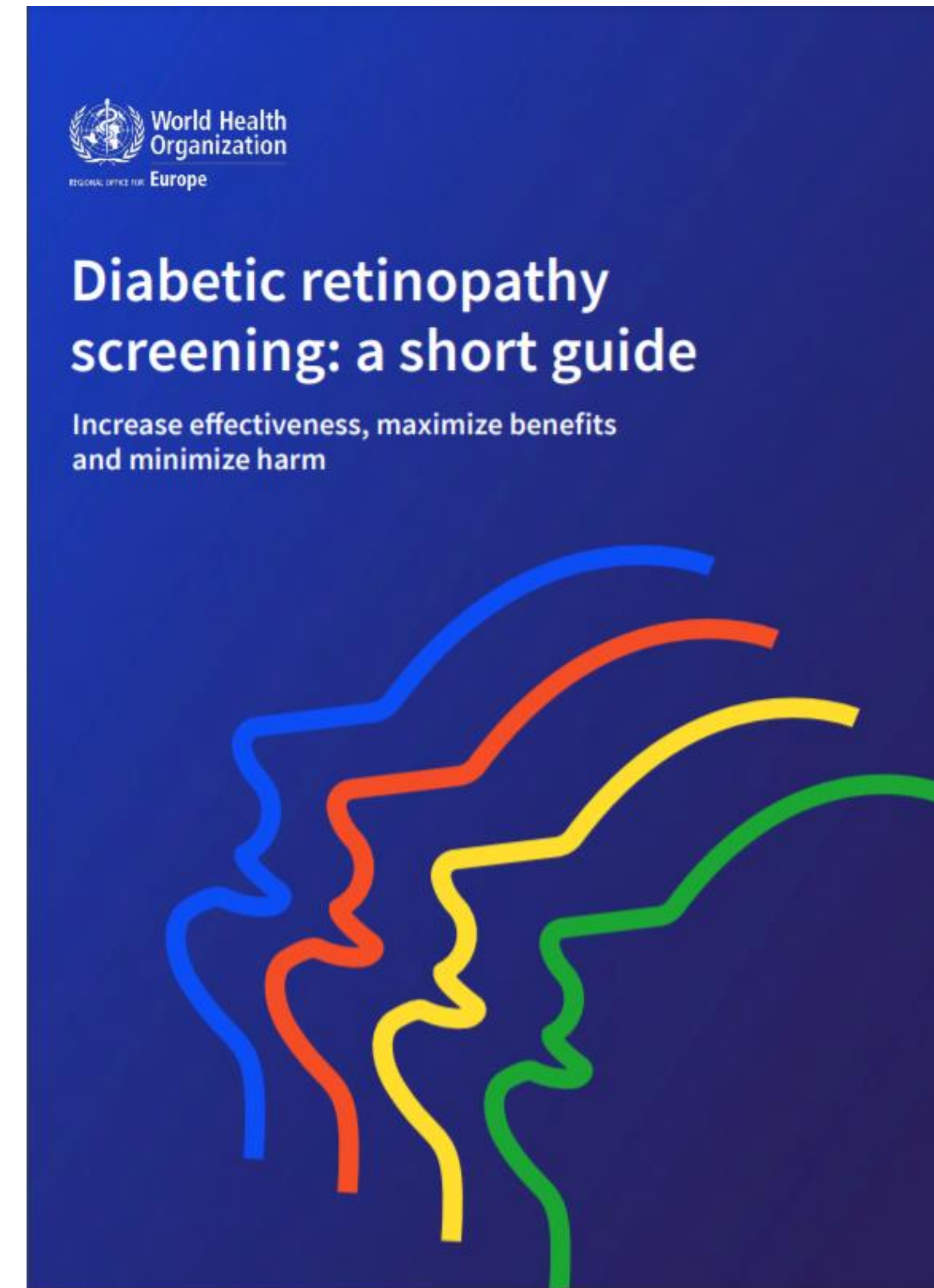
[2] World Health Organisation Diabetic retinopathy screening: a short guide (2020)

Ophthalmic screening

The most effective method for preventing blindness and low vision due to DR and DME is regular ophthalmic screening.



Diabetes Retinopathy Mobile Screening Service, Liverpool Diabetes Eye Center, UK ^[1]



[1] World Health Organisation Diabetic retinopathy screening: a short guide (2020)



Technology Trends^[3]

→ Fundus imaging becomes cheaper and more accessible

Fundus camera



Portable fundus camera



Slit lamp + adapter + smartphone



Diagnostics fundus lens + smartphone^[1]



Lens (magnifier) + smartphone^[2]



Fundus imaging technology is progressing rapidly: nowadays it's possible to make fundus images via smartphones (icluding home-based check-up)

[1] Haddock LJ, Kim DY, Mukai S. Simple, inexpensive technique for high-quality smartphone fundus photography in human and animal eyes. J Ophthalmol. 2013;2013:518479. doi:10.1155/2013/518479

[2] <https://www.aao.org/eyenet/article/a-retina-telemedicine-technique>

[3] https://www.youtube.com/channel/UCwHftYAYR9d6CXIz_oBcnTA



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РЕГИСТРАЦИЯ

ЛИЧНЫЙ КАБИНЕТ

EN RU

Retina.AI

Облачная платформа для диагностики заболеваний сетчатки

Thank you for your attention!

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support@screenretina.com