Artificial Intelligence
dedicated to ophthalmology

OphtAI

Scientific Information

July 2021

Our R&D Partners and organization

OphtAI, is a Joint-Venture between two experts' companies. **Evolucare** and **ADCIS**.

Evolcuare is a french leader of Health Information System specialized in Patient Data Management and Healthcare organization.

30 Years of experience, 300 employees, 4 500 customers, more than 160 000 patients followed-up on a daily basis.

ISO 9001, ISO 13485, CE Medical Device Software

ADCIS is a French image analysis expert with a specialization in ophthalmology.

25 Years of experience including collaboration with major companies such as Abbvie, Alcon, Allergan, Novartis, Pfizer…

Our R&D is done in a common Public & Private Research Department (called ADMIRE) between OphtAI and two major public institutions. Paris Hospital (AP-HP) and INSERM.

Paris Hospital (AP-HP) a network of 41 public hospitals including Lariboisière University Hospital specialized in ophthalmology with its tele ophthalmologic association called ophDiat dedicated to Diabetic Retinopathy screening.

INSERM the French Institute for Medical Research with the Latim its laboratory specialized in Artificial Intelligence.

Specificities of our technology

Exclusive Database
Our more than 800 000 image worth database was built from the OphDiaT screening Network, which include high level of training and expertise as well as quality insurance, ensuring the best input data to our algorithms. This data is constantly improving and is used to train further versions of our algorithms

Deep Convolutional Neural Networks
Such systems « learn » to perform task by using examples instead of being programmed with complex rules like “expert systems”.

Such systems are used by some of our competitors, while other use “shallow” CNN, with much less layers, hence ability to discriminate complex data

Weakly supervised algorithms
Our algorithms were only trained on the final diagnosis, while most of our competitors use fusion of networks specialized in the detection of discrete lesions, hence obtaining strongly supervised algorithms, since they learnt the lesions based on medical diagnosis, while lesion recognition in ours was totally the product of “difference acquisition”, that is, learning what discriminates two categories

A different approach to grading problem
Most grading solutions are multiclassifiers that output a probability for each class. We took a different approach by combining binary classifiers, hence obtaining a solution which is more easily repurposed and reach higher performances by simplification of each classification problem.

Lesion mapping
Our algorithms were specially trained so that determining the image areas deemed important in their decision is possible, allowing to produce heatmaps of such areas, that are shown to cover actual disease lesions.

Interpretable results
Our score can be interpreted by comparison to our reference populations, hence allowing to go beyond the abstract sensitivity and specificity performances to apply more specifically to a given score, allowing to determine relative positive/negative predictive values and thus, the certainty of diagnosis. This is not the case of competition, which mostly provide a probability of disease in a monotonous way, not allowing to adapt to various reference populations

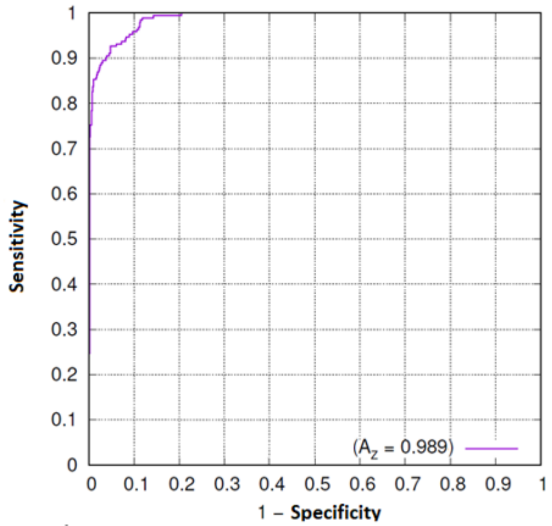
Recommendations
Our results integrate some clinical data and match grading and diagnoses with medically recommended courses of action.

Disease detection (v3)
We have patented two different solutions to solve the screening problem by taking two opposite approaches to eye disease detection, for the ultimate screening tool.

These will be implemented in our v3 version. Competitors for now are still looking to extend their solutions to more than one to three diseases.

Our solution will be able to detect 37 signs and symptoms, as well as generally abnormal eyes, including even rare diseases and covering more than 90% of eye diseases cases.

Performances



Comparison with FDA marked solution

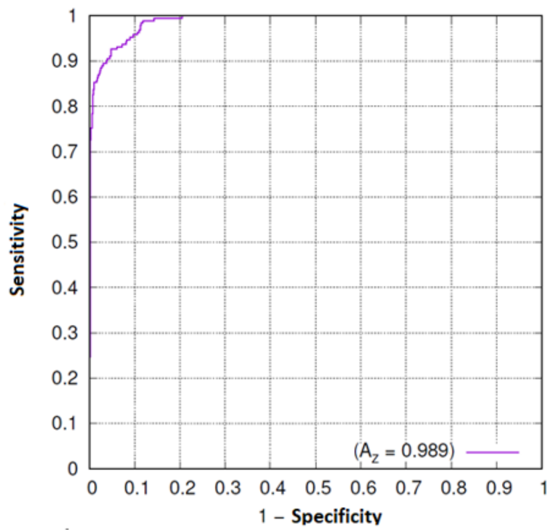
Sensitivity:
For fixed Specificity: 87%
-OphtAI Sensitivity 99%
-X solution Sensitivity 96.9%

False Positive divided by 3

Automated sorting:
Less positive patients sent home with further exam

Quellec G, Charrière K, Boudi Y, Cochener B, Lamard M. *Deep image mining for diabetic retinopathy screening*. Med Image Anal. 2017 Jul;39:178-193.

Quellec, Gwenole & Lamard, Mathieu & Lay, Bruno & Guilcher, Alexandre & Erginay, Ali & Cochener, Béatrice & Massin, Pascale. (2019). Instant automatic diagnosis of diabetic retinopathy.



Comparison with FDA marked solution

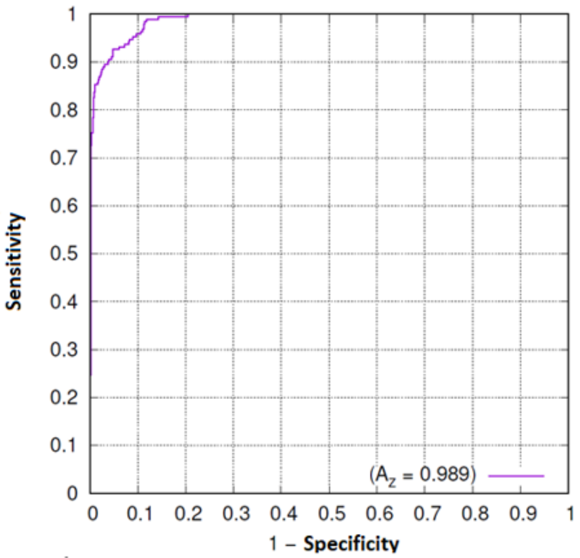
Specificity:
For fixed Sensitivity : 96.8%
-OphtAI Specificity 90,2%
-X Solution Specificity 87%

False Negative Reduction by 25%

Automated sorting:
Less positive patients needlessly sent for further exam

Quellec G, Charrière K, Boudi Y, Cochener B, Lamard M. *Deep image mining for diabetic retinopathy screening*. Med Image Anal. 2017 Jul;39:178-193.

Quellec, Gwenole & Lamard, Mathieu & Lay, Bruno & Guilcher, Alexandre & Erginay, Ali & Cochener, Béatrice & Massin, Pascale. (2019). Instant automatic diagnosis of diabetic retinopathy.



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Comparison with FDA marked solution

Processing Speed

-OphtAI <3s ; <0.5s GPU

-X : a few minutes

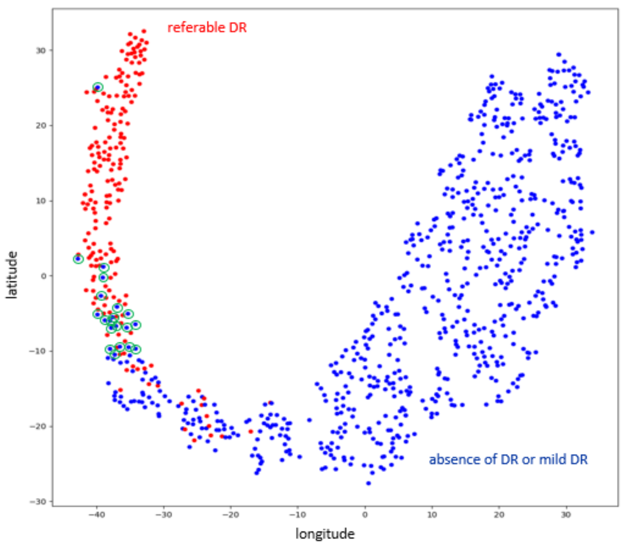
300000 images:

-OphtAI: 10 days

-X solution: 6 months

Quellec G, Charrière K, Boudi Y, Cochener B, Lamard M. *Deep image mining for diabetic retinopathy screening*. Med Image Anal. 2017 Jul;39:178-193.

Quellec, Gwenole & Lamard, Mathieu & Lay, Bruno & Guilcher, Alexandre & Erginay, Ali & Cochener, Béatrice & Massin, Pascale. (2019). Instant automatic diagnosis of diabetic retinopathy.



Comparison between AI & human expert

- Each point represent an image from Messidor-2 database in AI perception space (t-SNE representation)
- Couleur match consensus diagnosis by 3 american retina experts

In discordant cases (green circles), a new image interpretation by two retina specialists concurs with AI for 95% of cases

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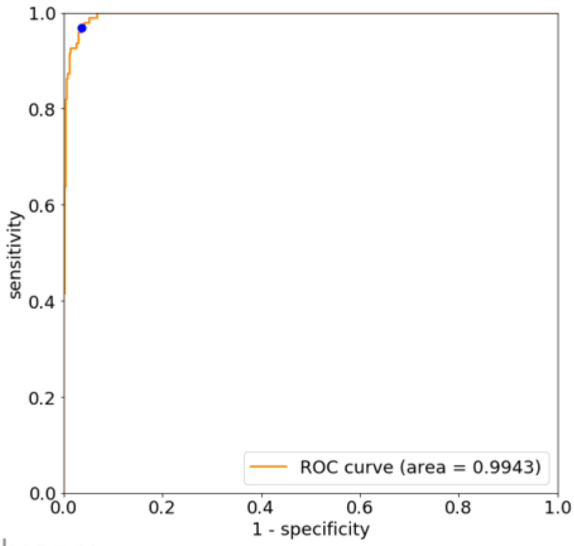

Diabetic Macular Edema

"Receiver Operating Characteristic" (ROC) DME AI Curve
Blue point highlights recommended setting (Sensitivity 96,81%; Specificity 96,34%)

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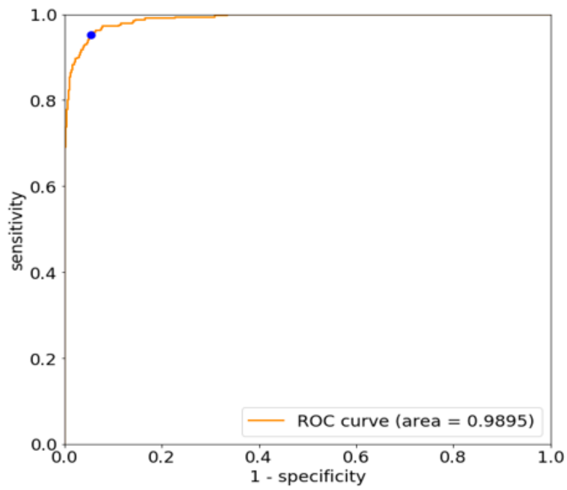

ARM/Drusen

"Receiver Operating Characteristic" (ROC) ARM/Drusen AI Curve
Blue point highlights recommended setting (Sensitivity 95,27%; Specificity 94,58%)

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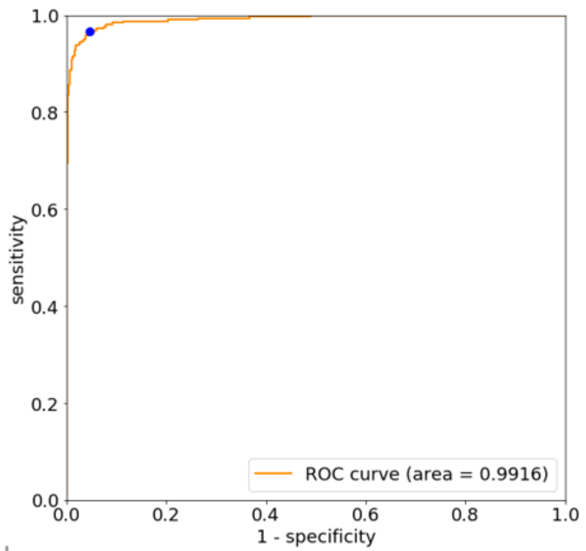

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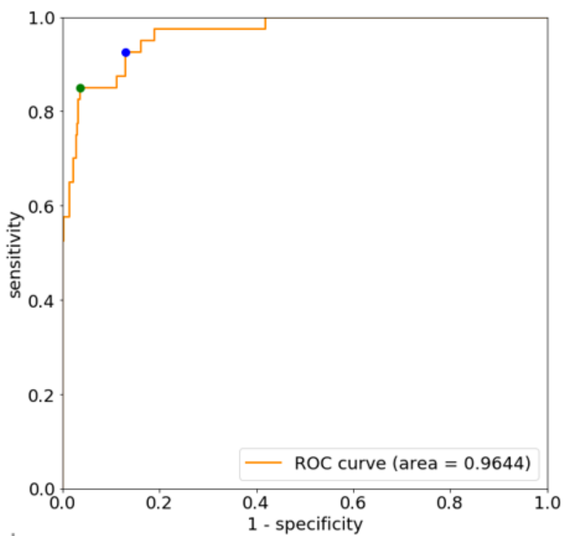
<u>ARMD</u>

"Receiver Operating Characteristic" (ROC) ARMD AI Curve
Blue point highlights recommended setting
(Sensitivity 96,5%; Specificity 95.4%)



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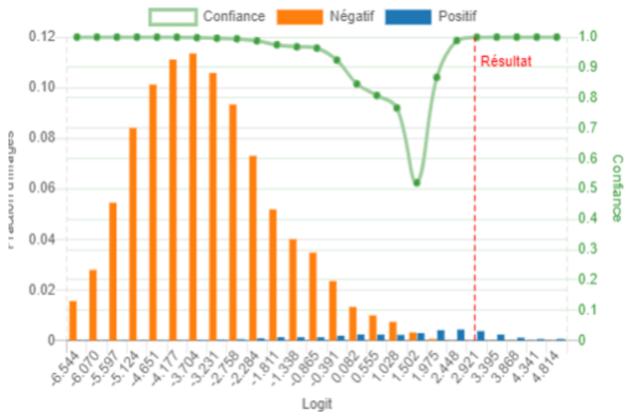
<u>Glaucoma</u>

"Receiver Operating Characteristic" (ROC) Glaucoma AI Curve
Blue point highlights recommended setting
(Sensitivity 92,5%; Specificity 86.4%)
Green point highlights recommended setting
For using Human reader sensitivity level (85 %). Then, human reader specificity is 91 %, for 96,39 % for OphtAI.



Confidence Index

Depending on given image ratios for each possible ground truth (healthy and ill patients) in a reference database whose image distribution is balanced based on disease prevalence, confidence index is processed based on given image score.

Processed confidence translates Positive or oppositely Negative Predictive Value, depending on whether diagnosis is positive or negative.
Hence, if a patient is referred to an ophthalmologist (CNN score >= threshold), confidence equates the probability that this patient has actually such disease. Such probability is low close to the threshold, and reaches 100% when getting higher and higher.

Main publications & Patent

2008: OPHDIAT: a telemedical network screening system for diabetic retinopathy in the Ile-de-France: https://doi.org/10.1016/j.diabet.2007.12.006

2008: OPHDIAT: quality-assurance program plan and performance of the network: https://doi.org/10.1016/j.diabet.2008.01.004. PMID: 18424210 https://www.em-consulte.com/article/1169995/ophdiat-c-quality-assurance-programme-plan-and-per https://www.sciencedirect.com/science/article/abs/pii/S1262363608000542?via%3Dihub; https://europepmc.org/article/med/18424210

2009: Benefits of Ophdiat, a telemedical network to screen for diabetic retinopathy: a retrospective study in five reference hospital centers: https://doi.org/10.1016/j.diabet.2008.12.001

2012: Ophdiat(®): five-year experience of a telemedical screening program for diabetic retinopathy in Paris and the surrounding area: https://doi.org/10.1016/j.diabet.2012.05.003

2014: Feedback on a publicly distributed image database: The Messidor database: https://www.researchgate.net/publication/272989606_Feedback_on_a_publicly_distributed_image_database_The_Messidor_database/citation/download

2017: Deep Image Mining for Diabetic Retinopathy Screening: https://arxiv.org/abs/1610.07086

2018: Retinal pathology screening with a multi-image convolutional neural network: https://iovs.arvojournals.org/article.aspx?articleid=2690067

2019: RetinOpTIC - Automatic Evaluation of Diabetic Retinopathy: https://iovs.arvojournals.org/article.aspx?articleid=2744652

2019: Instant automatic diagnosis of diabetic retinopathy: https://arxiv.org/abs/1906.11875

2020: Automatic detection of rare pathologies in fundus photographs using few-shot learning: https://arxiv.org/abs/1907.09449 https://doi.org/10.1016/j.media.2020.101660.

2020: Patent n° PCT/EP2020/062762 “Automatic image analysis method for automatically recognising at least one rare feature”

2021: Multicenter, Head-to-Head, Real-World Validation Study of Seven Automated Artificial Intelligence Diabetic Retinopathy Screening Systems VETERAN AFFAIRS Contest /AARON Y LEE: OphtAI RD detection shown as most sensitive, cost effective and clinically relevant.

Diabetes Care 2021 Jan; dc201877. https://doi.org/10.2337/dc20-1877

Coming soon

The next version of ophtAI is able to detect 37 pathologies or pathologies signs :

diabetic retinopathy
glaucoma
cataract
age-related macular degeneration
drusen
diabetic macular edema
hypertensive retinopathy
laser scars
arteriosclerosis
tortuous vessels
degenerative myopia
branch retinal vein occlusion
epiretinal membrane
nevi
retinal atrophy
myelinated nerve fibers
RPE alterations
optic disc pallor
synchisis
tilted optic disc
central retinal vein occlusion
chorioretinitis
dystrophy
retinis pigmentosa
chorioretinal atrophy
dilated veins
papilledema
macular hole
maternally inherited diabetes and deafness
coloboma
anterior ischemic optic neuropathy
bear track dystrophy
pseudovitelliform dystrophy
pigmentary migration
prethrombosis
hyaloid remnant
asteroid hyalosis