Automated Screening for Referable Diabetic Retinopathy with Deep Learning

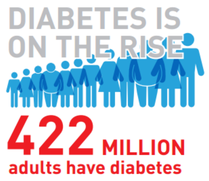
Evaluation of Iflexis on Population Data

Patrick De Boever[1], Rayaz A. Malik[2], Nahla Afifi[3], Bart Elen[1]

[1] VITO, Flemish Institute for Technological Research, Mol, Belgium
[2] Weill Cornell Medicine – Qatar, Doha, Qatar
[3] Qatar Biobank, Doha, Qatar

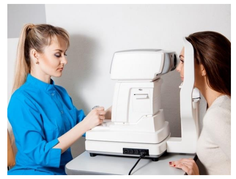
PB102

Purpose



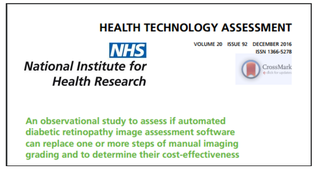
One third has signs of diabetic retinopathy (DR). For about 30 million, DR is vision-threatening.

The WHO advises annual screening eye exams for diabetes patients without retinopathy



"Automated Retinal Image Analysis Systems (ARIAS) can achieve **acceptable sensitivity** for referable retinopathy and appear to be **cost-effective alternatives** to a manual grading approach."

Tufail A, et al.; 2016. Health Technology Assessment, No. 20.92.



No signs of DR or further investigation needed

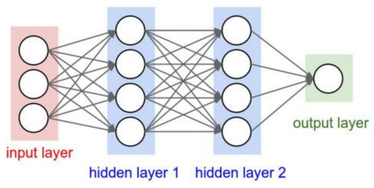
High performance informatics technologies, such as deep learning, arise. These technologies can increase reliability of automated DR screening and support eye health care professionals for large-scale, cost-effective DR screening.

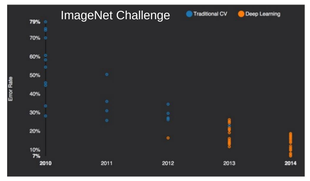
Informatics technology allows to do this work in a performant way. Automated image analysis challenges are currently won by deep learning. The technology is used for image recognition, face recognition, etc.

The purpose of this work was to develop a deep learning computer model and test its performance on population data.

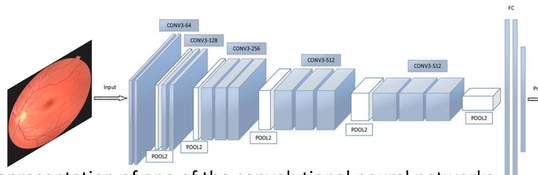
Methods

Deep learning is part of a family of machine learning methods based on learning representations of data. It uses a cascade of many layers of non-linear processing units for feature extraction and transformation. Each successive layer uses the output from the previous layer as input. The algorithms can be supervised or unsupervised.





We have trained an **ensemble of two deep convolutional neural networks** (resp. 25 and 26 layers; high resolution (512x512 pixels); different filter sizes) with tens of thousands of labeled fundus images to detects the presence of signs of DR.



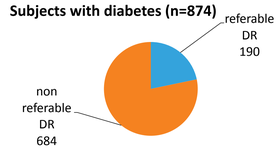
Representation of one of the convolutional neural networks

The Iflexis model has been evaluated with the **public Messidor-2 dataset** for referable DR. Fundus images were graded by consensus for referable DR by three US board certified retinal specialists independently. Laboratoire de Traitement de l'Information Médicale (LaTIM -INSERM U650). Messidor-2 dataset (Méthodes d'Evaluation de Systèmes de Segmentation et d'Indexation Dédiées à l'Ophtalmologie Rétinienne). 2011.

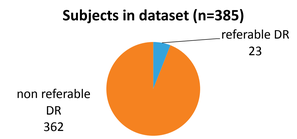
Next, the model has been evaluated "in the field" with **fundus images from the Qatar Biobank**. Qatar Biobank is a center that enables medical research on health issues that prevail in Qatar. Study participants undergo fundus imaging. These images have been graded by retinal specialists.

Results & Conclusions

Messidor-2



Qatar Biobank



Confusion matrix comparing Iflexis screening vs. manual screening in Messidor-2

	No signs of DR found	Signs of DR found
No referable DR	444	240
Referable DR	0	190

Sensitivity 100% (95% CI: 98,1%-100%)

Specificity 65% (95% CI: 61,2%-68,5%)

Confusion matrix comparing Iflexis screening vs. manual screening in Qatar Biobank

	No signs of DR found	Signs of DR found
No referable DR	319	43
Referable DR	0	23

Sensitivity 100% (95% CI: 85,2%-100%)

Specificity 88% (95% CI: 84,3%-91,3%)

The Iflexis model for referable DR is based on deep learning and obtains high sensitivity combined with a good specificity. The model is conservative while screening for the presence of referable DR, allowing users to focus their attention on patients in which signs of referable DR are detected by the automated screening.

We envision that deep learning technology can be developed in a valuable tool to assist eye healthcare professionals for future large-scale DR screening.

VITO NV | Boeretang 200, BE-2400 Mol | Tel. + 32 14 33 51 45 | patrick.deboever@vito.be | www.vito.be