

# Improving Automated Diabetic Retinopathy Detection with Deep Convolutional Neural Networks

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Disclaimer: IDx-DR is investigational in the US and has not yet been approved by the US FDA.



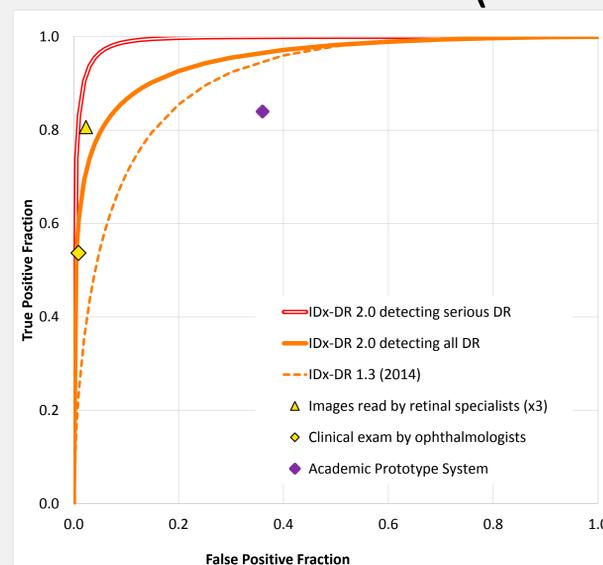
## Motivation

Diabetic Retinopathy (DR) is a complication of diabetes caused by damage to the small vessels in the back of the eye (retina) that commonly leads to blindness if left untreated. Diabetic Retinopathy is the leading cause of blindness in the working population of the western world. In patients younger than 30 at time of diagnosis of diabetes the prevalence of diabetic retinopathy was 97% at 15 years post diagnosis.

Diabetic Retinopathy can be successfully treated by laser surgery or ocular injection. **Early detection is vital for effective treatment.** The presence of diabetic retinopathy can be detected by examining the retina for **characteristic features including: microaneurysms, hemorrhages, hard exudates, cotton wool spots, and neovascularizations.**

**Screening for diabetic retinopathy is important.** The American Diabetes Association recommends an eye exam once per year. Despite this, **only about 50% of people with diabetes undergo a yearly eye examination.**

## IDx-DR Performance (N=5000)



## IDx-DR 2.0 Improvements

**IDx-DR 2.0 improves upon IDx-DR 1.3 by incorporating NVIDIA GPU-based deep convolutional neural networks (CNNs) into the device.** The device contains a number of detectors for signs of DR and to detect the location of the normal anatomical landmarks. CNNs were used to enhance the performance of the following detectors:

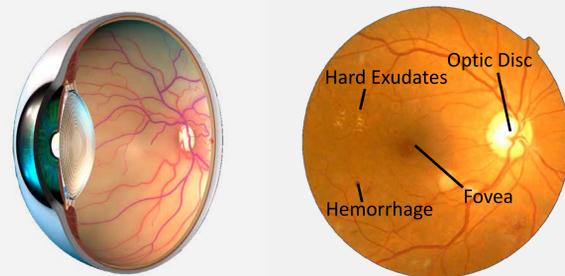
- 1) The optic disc position
- 2) The fovea position
- 3) The orientation of the images (left or right eye)
- 4) Large hemorrhage presence
- 5) Hard exudate presence

In addition, some of the image processing algorithms were replaced by GPU-based versions. **This resulted in a computational time reduction of 25% per exam.** As more algorithms are implemented on the GPU we expect further, and more pronounced, reductions in run-time.

## IDx-DR Approach

IDx-DR is a medical device for DR screening that automatically generates a DR detection result from retinal images. IDx-DR 1.3 has been available in Europe since 2014 and has processed more than 15,000 exams. IDx has recently launched IDx-DR 2.0 in Europe.

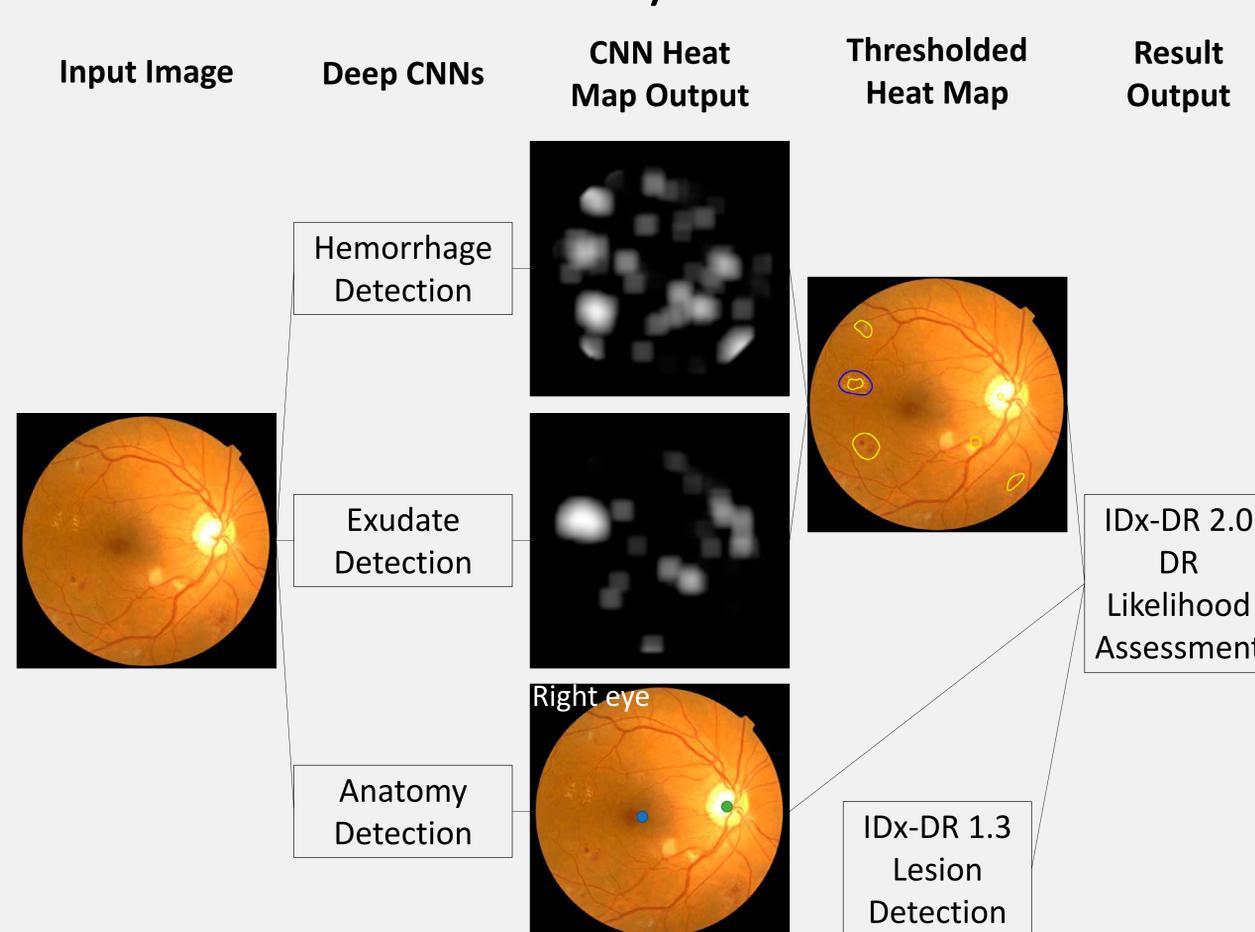
IDx-DR takes, as input, two retinal images of each eye acquired according to a pre-specified protocol. As output it provides an indication of the severity of diabetic retinopathy in the patient. A healthcare provider, using the device output, then makes the final referral decision.



## Objective

**Demonstrate the impact of NVIDIA GPU-based deep convolutional neural networks that form the basis for the performance improvement between IDx-DR 1.3 and IDx-DR 2.0**

## IDx-DR Analysis Process



## Performance Improvement

Performance improvement for a 2-class classification is typically measured with the "area under the receiver operator characteristic curve" (AUC). This curve plots the true positive fraction (fraction of positive disease cases successfully detected) versus the false positive fraction (fraction of healthy cases incorrectly detected as having DR). The AUC varies between 0.5 (random guessing) and 1.0 (perfect classification). The performance differences are shown in the table below:

Product and Output	AUC on ROC (n=5,000)
IDx-DR 1.3, all DR	0.90
IDx-DR 2.0, all DR	<b>0.94</b>
IDx-DR 2.0, serious DR	<b>0.98</b>

## Conclusions

NVIDIA GPUs are an enabling technology for the integration of deep learning algorithms in medical devices. These algorithms significantly improved the efficiency of IDx-DR (decreased false positive rate) with the added benefit of improved computational times. IDx is currently exploring additional avenues of device improvement using GPU enabled technology.