

GLAUCOMA DETECTION WITH DEEP NEURAL NETWORKS

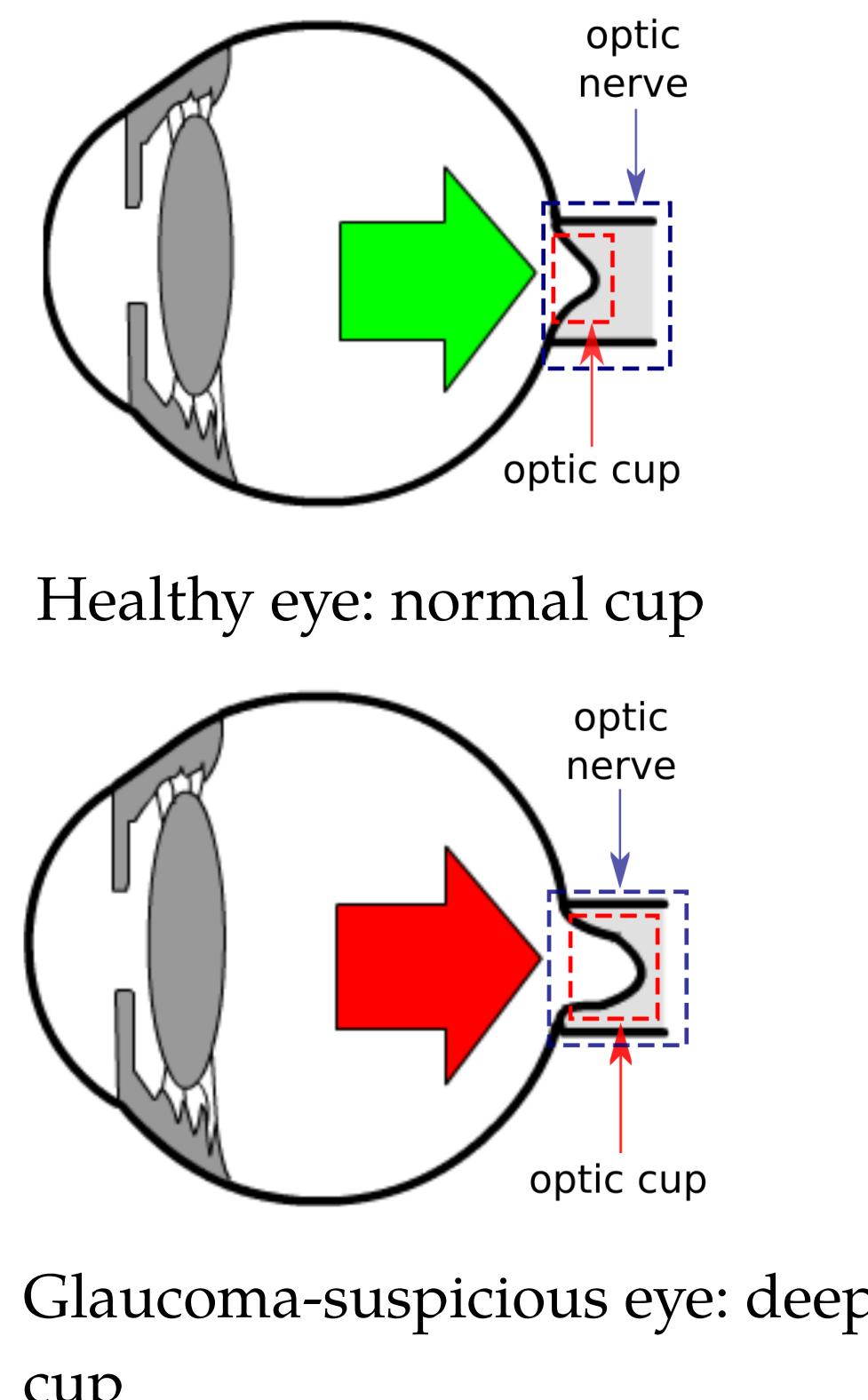
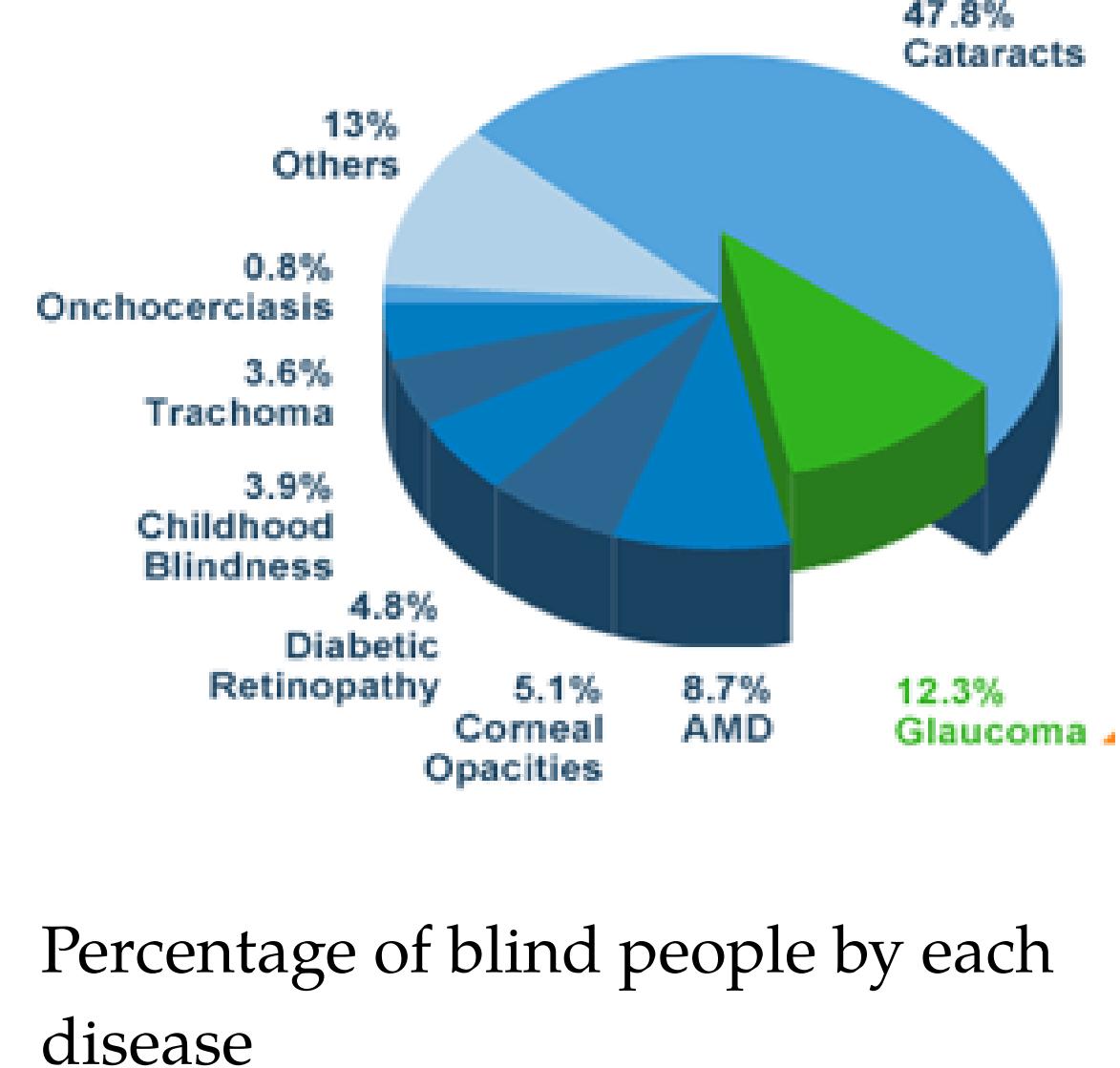


Artem Sevastopolsky¹

¹Lomonosov Moscow State University



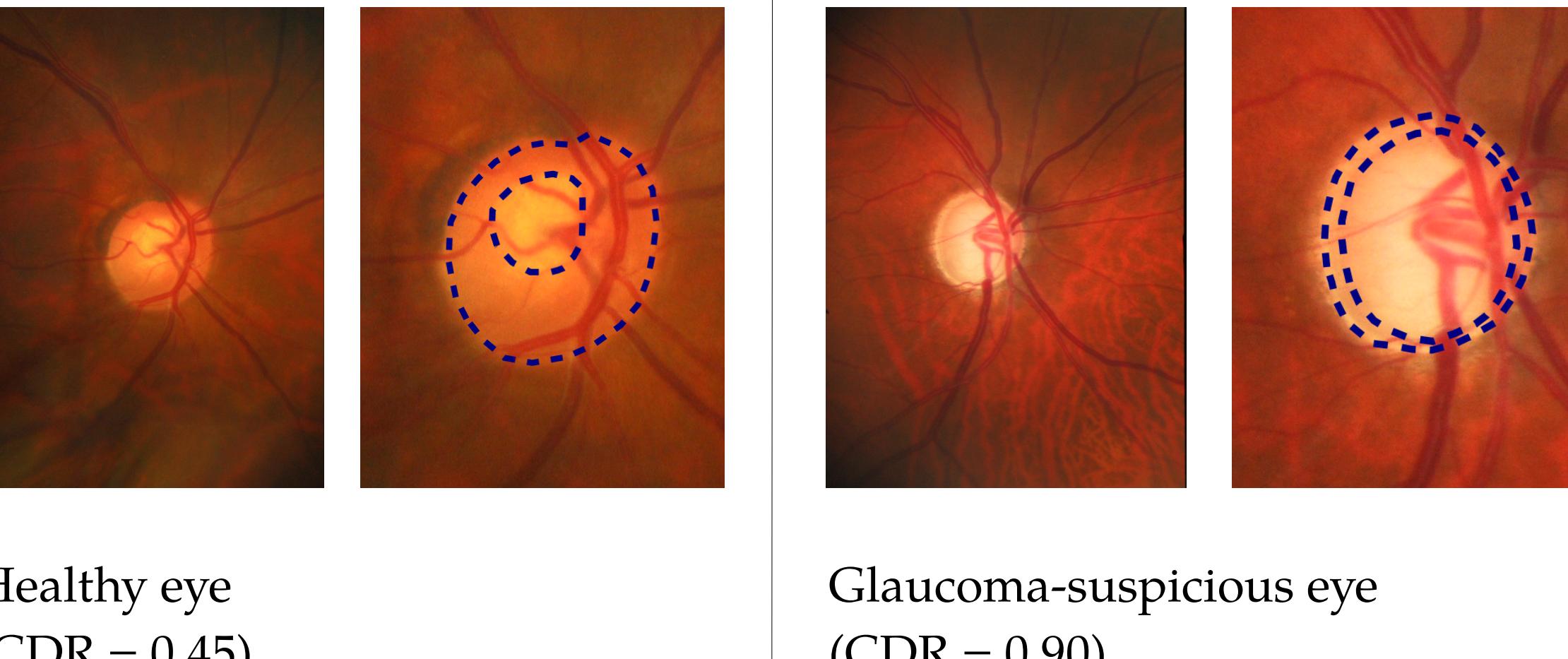
TASK



Glucoma is best characterized by an increase of *optic cup* - a special deepening in an *optic nerve*. To detect an increase, eye fundus is photographed through eye pupil. On an image, deep optic cup becomes more in diameter.

Cup-to-disc ratio (CDR) — a ratio between heights of cup and nerve. If $CDR \geq 0.65$, it is usually considered in clinical practice to be glaucoma-suspicious.

Medical doctor needs to find the borders of the optic nerve and the optic cup on an eye fundus image, which is very time-consuming and hard due to subtle borders of regions.



GOAL

Building of image segmentation engine for glaucoma screening with modern computer vision algorithms.

CONTRIBUTION

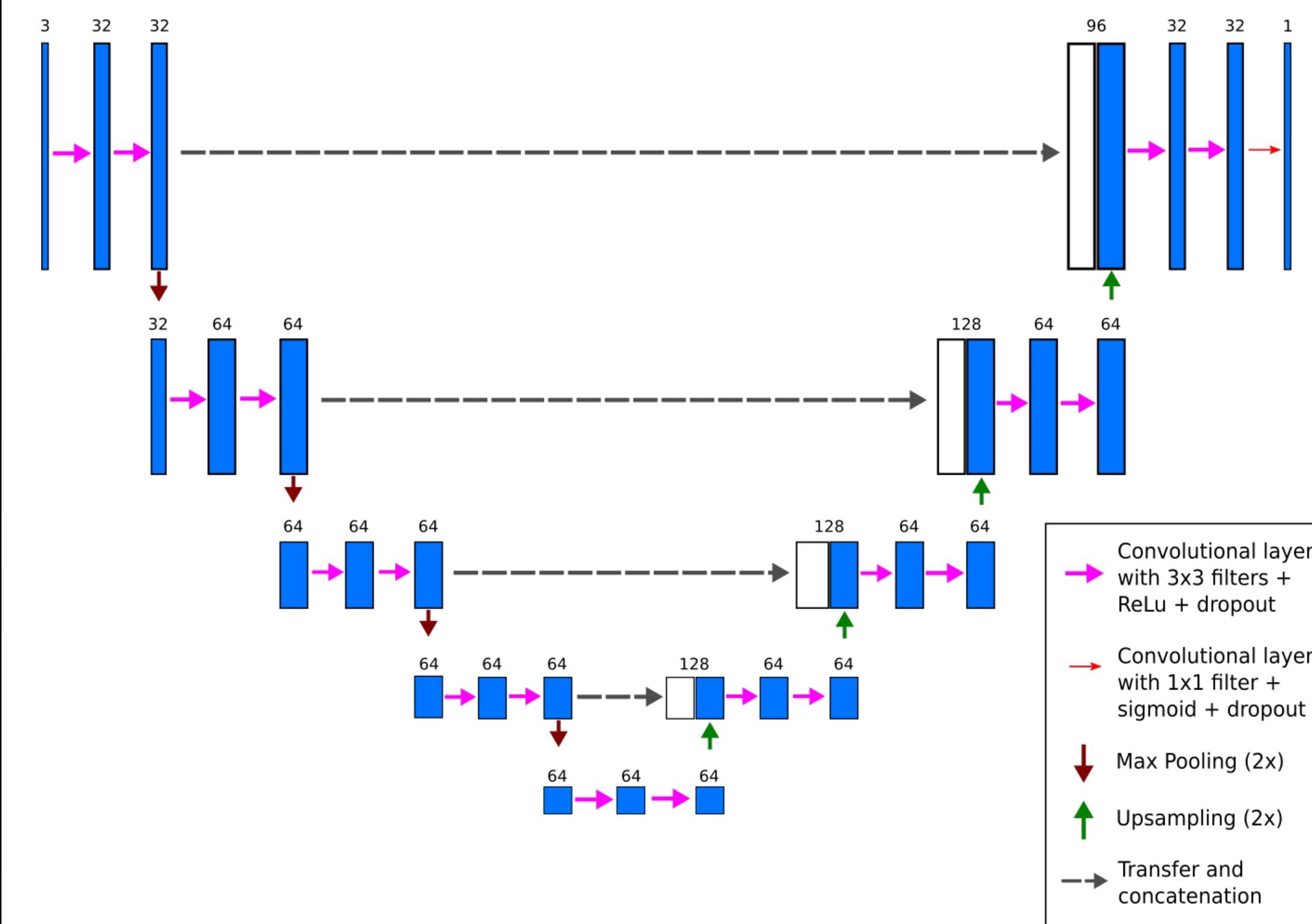
We have developed a universal method for segmentation of optic nerve and optic cup on eye fundus images. The method lowers computational requirements without loss of quality compared to the state-of-the-art methods for both tasks.

MOTIVATION

- to make automatic glaucoma screening more available,
- to reduce subjectivity of eye fundus image analysis and diagnosis,
- to make mass screening possible by significantly reducing segmentation time.

METHOD

A modification of U-Net fully-convolutional neural network was employed and trained with specific loss function (minus log-Dice for real-valued maps).



Contrast is first equalized with CLAHE algorithm. For optic cup segmentation, we first crop images by optic nerve area.

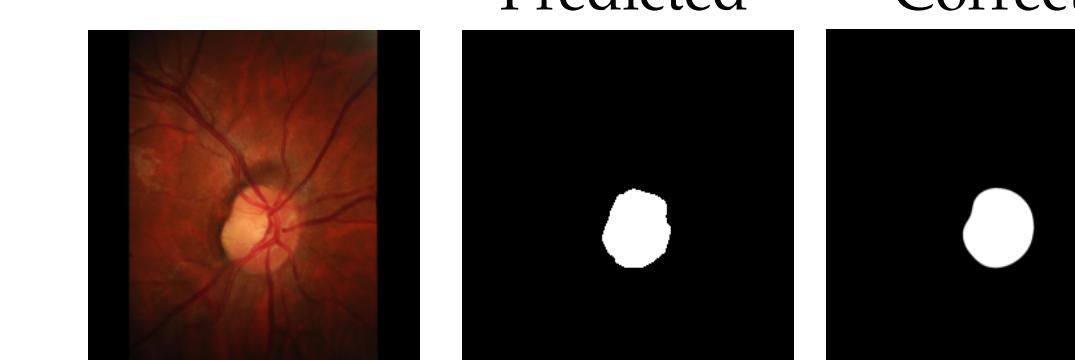
RESULTS

On DRIONS-DB, RIM-ONE v. 3 and DRISHTI-GS data sets we have achieved:

- superior or similar quality compared to state-of-the-art methods,
- highest possible speed (0.1 s for optic nerve, 0.06 s for optic cup) and lowest GPU memory consumption (433 MB)

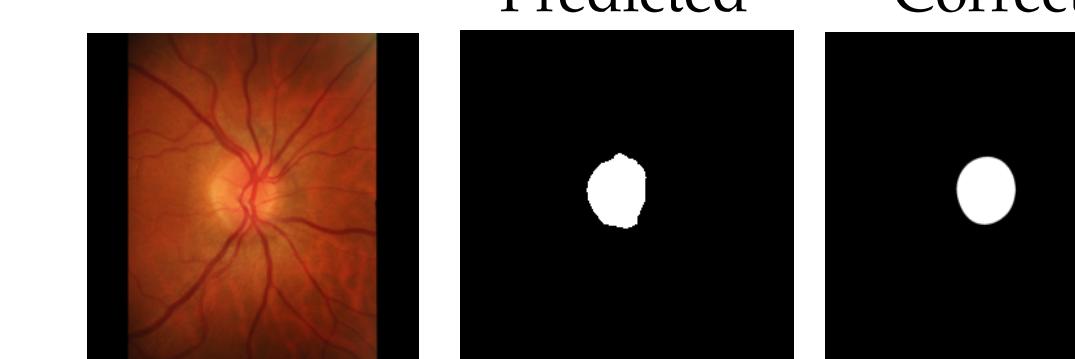
Optic nerve

Best case:



IOU = 0.93, Dice = 0.97

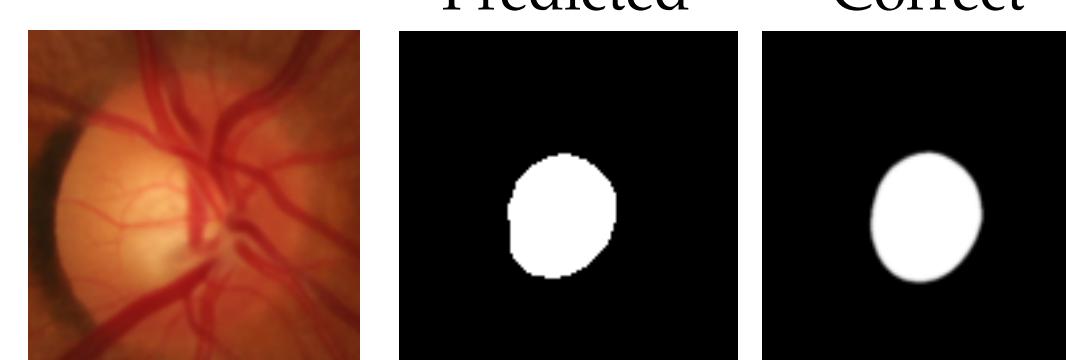
Worst case:



IOU = 0.80, Dice = 0.90

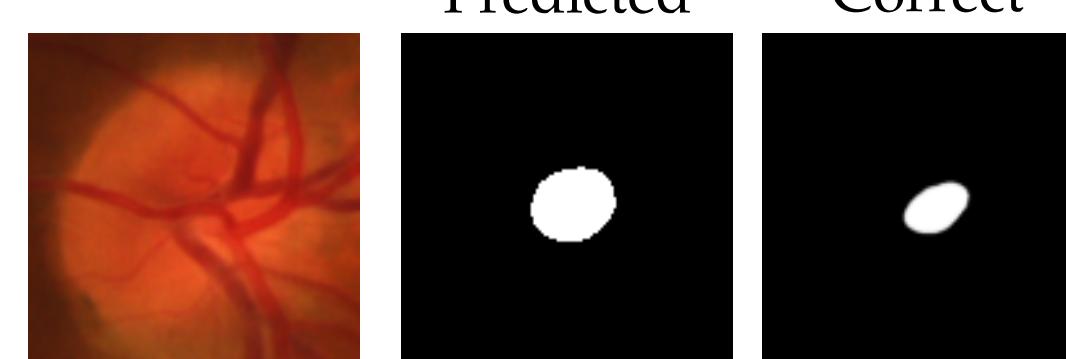
Optic cup

Best case:



IOU = 0.93, Dice = 0.97

Worst case:



IOU = 0.46, Dice = 0.64

Visual quality on RIM-ONE v. 3 data set.

Prepared method can be used in mobile devices with GPU due to its low memory consumption and high speed (e.g. in iPhones ≥ 5).

AVAILABLE RESOURCES

Sevastopolsky, Artem. "Optic Disc and Cup Segmentation Methods for Glaucoma Detection with Modification of U-Net Convolutional Neural Network." *arXiv preprint arXiv:1704.00979* (2017). accepted for publication in "Pattern Recognition and Image Analysis" journal, ISSN 1054-6618

ArXiv paper: <https://arxiv.org/abs/1704.00979>

GitHub: <https://github.com/seva100/optic-nerve-cnn>