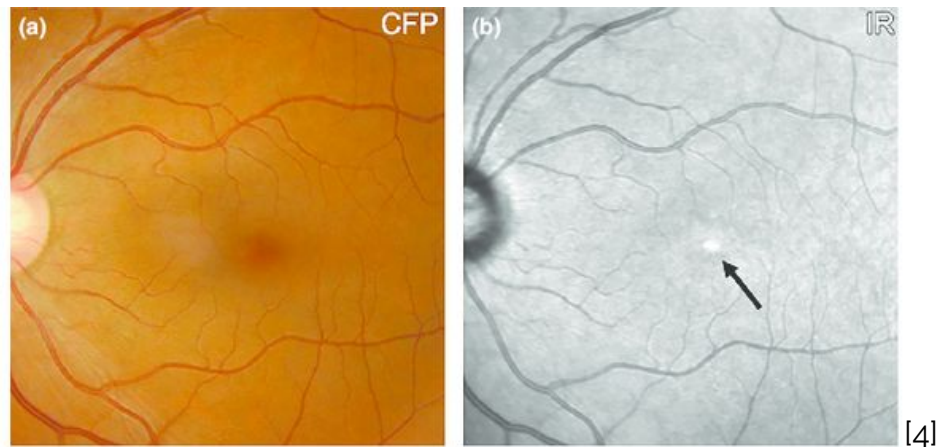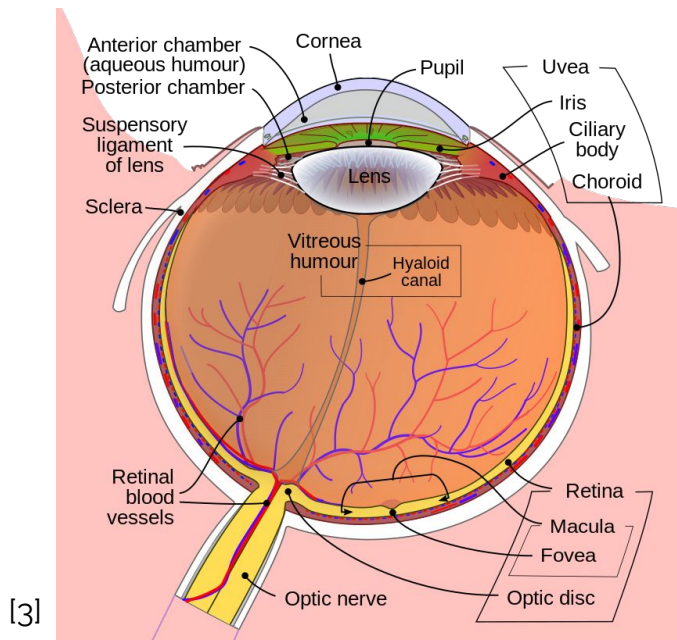# RAVIR: Retinal Arteries and Veins in Infrared Reflectance (IR)

Axel Romero Antolin
28/11/2023
Master in Artificial Intelligence - DLMIA Course

[3]

[4]

Retinal Vasculature

Diseases

- Hypertension
- Diabetes
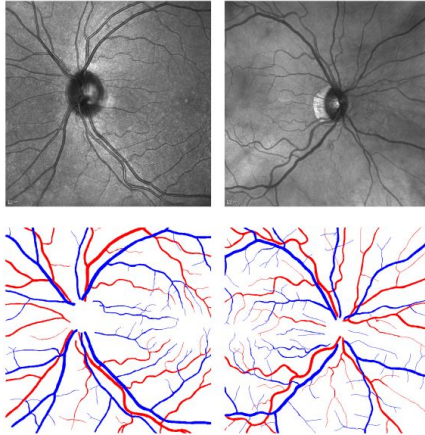- Neurodegenerative disorders

Biomarkers

Use changes in retinal vasculature to detect some diseases at early stage.

Drawbacks

Hard to detect changes due to the non-quantitative techniques in clinical practice.

RAVIR Dataset

- Train → 26 images
- Test → 20 images

- Image size → 768 x 768

[2]

IR IMAGING MANIFESTATIONS OF STUDY POPULATION IN RAVIR

Clinical Finding	#Eyes	Imaging Manifestation
Retinal vein occlusion	10	Venous tortuosity, retinal hemorrhage
Hypertensive retinopathy	10	Vessel narrowing, arteriovenous nicking
Peripapillary Atrophy	8	Increased background reflectivity
Diabetic Retinopathy	3	Intraretinal hemorrhage, vessel sclerosis
Isolated vessel tortuosity	3	Abnormal vessel tortuosity
High Myopia	2	Transmission of choroidal vessels
Media opacities	1	Retinal haziness

[1]

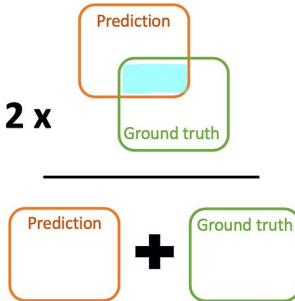RAVIR DATASET DEMOGRAPHICS

Statistics	Quantity
Average Age (years)	55 ± 18
Age Range (years)	$19 - 88$
Number of Males	29
Number of Females	17
Number of Right Eyes	24
Number of Left Eyes	22

[1]

4
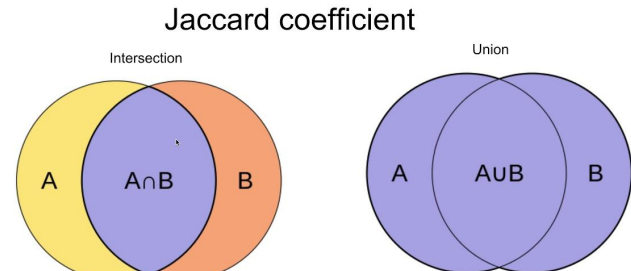
Produce a segmentation mask of shape [768, 768, 1]

- Background → 0
- Arteries → 128
- Veins → 256

Jaccard coefficient

Intersection

Union

A   A∩B   B

A   A∪B   B

Prediction

Ground truth

2 x

Prediction   **+**   Ground truth

$$\text{Dice} = \frac{2 \; X \; Area \; of \; overlap}{Total \; area} = \frac{}{}$$

$$J(A, B) = \frac{|A \cap B|}{|A \cup B|}$$

SegRAVIR Architecture

Input
$H \times W \times 1$

$H \times W \times 16$

$\frac{H}{2} \times \frac{H}{2} \times 32$

$\frac{H}{4} \times \frac{H}{4} \times 64$

$\frac{H}{8} \times \frac{H}{8} \times 128$

$\frac{H}{16} \times \frac{H}{16} \times 256$

Output
$H \times W \times 3$

Reconstruction
$H \times W \times 1$

$\frac{H}{8} \times \frac{H}{8} \times 128$

$\frac{H}{4} \times \frac{H}{4} \times 64$

$\frac{H}{2} \times \frac{H}{2} \times 32$

$H \times W \times 16$

| | Conv 1 × 1, Softmax | | Conv 1 × 1, ReLU | | Conv 3 × 3 | | Conv 2 × 2 | | TrConv 2 × 2 | | ResBlock |
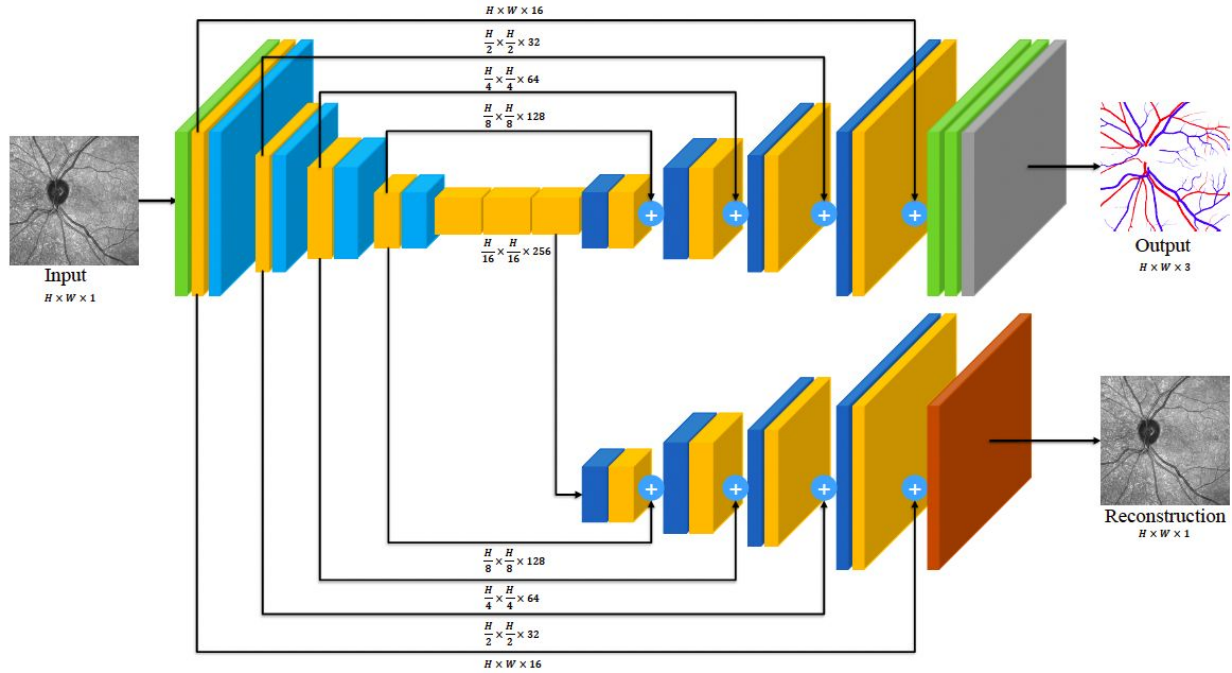
[1]

Results – Semantic Segmentation

Method	Artery					Vein					Average
	SE	SP	Acc	AUC	Dice	SE	SP	Acc	AUC	Dice	Dice
U-Net [21]	0.7275	0.9788	0.9670	0.9665	0.7510	0.7389	0.9795	0.9685	0.9713	0.7674	0.7592
Dense U-Net [54]	0.7296	0.9795	0.9681	0.9673	0.7584	0.7410	0.9808	0.9691	0.9736	0.7704	0.7644
Residual U-Net [25]	0.7375	0.9828	0.9697	0.9689	0.7602	0.7455	0.9839	0.9701	0.9773	0.7768	0.7685
R2U-Net [25]	0.7408	0.9810	0.9706	0.9727	0.7621	0.7492	0.9842	0.9728	0.9802	0.7826	0.7723
Recurrent U-Net [25]	0.7389	0.9833	0.9718	0.9749	0.7690	0.7478	0.9849	0.9735	0.9810	0.7898	0.7794
U-Net++ [55]	0.7406	0.9827	0.9729	0.9772	0.7781	0.7527	0.9837	0.9743	0.9821	0.7909	0.7845
DU-Net [26]	0.7432	0.9854	0.9750	0.9785	0.7833	0.7569	0.9870	0.9762	0.9840	0.7972	0.7902
AG-Net [28]	0.7426	0.9860	0.9751	0.9792	0.7854	0.7562	0.9879	0.9768	0.9844	0.7983	0.7918
IterNet [34]	0.7431	0.9863	0.9765	0.9820	0.7898	0.7586	0.9895	0.9779	0.9852	0.8009	0.7953
CE-Net [30]	0.7501	0.9881	0.9771	0.9834	0.7928	0.7682	0.9908	0.9786	0.9871	0.8053	0.7990
SegRAVIR	**0.7772**	**0.9925**	**0.9815**	**0.9902**	**0.8287**	**0.8086**	**0.9951**	**0.9829**	**0.9916**	**0.8301**	**0.8294**

[1]

References

[1] A. Hatamizadeh et al., "RAVIR: A Dataset and Methodology for the Semantic Segmentation and Quantitative Analysis of Retinal Arteries and Veins in Infrared Reflectance Imaging," in IEEE Journal of Biomedical and Health Informatics, vol. 26, no. 7, pp. 3272-3283, July 2022, doi: 10.1109/JBHI.2022.3163352.

[2] https://ravirdataset.github.io/data/

[3] https://en.wikipedia.org/wiki/Fovea_centralis

[4] Ly, Angelica & Nivison-Smith, Lisa & Assaad, Nagi & Kalloniatis, Michael. (2016). Infrared reflectance imaging in age-related macular degeneration. Ophthalmic and Physiological Optics. 36. 303-316. 10.1111/opo.12283.

Thanks!

ANY QUESTIONS?