Deep learning-based retinal vessel segmentation with cross-modal evaluation

Luisa Sanchez Brea[1]
Danilo Andrade De Jesus[1]
Stefan Klein[1]
Theo van Walsum[1]

[1]Biomedical Imaging Group Rotterdam, Department of Radiology and Nuclear Medicine, Erasmus MC, Rotterdam, The Netherlands

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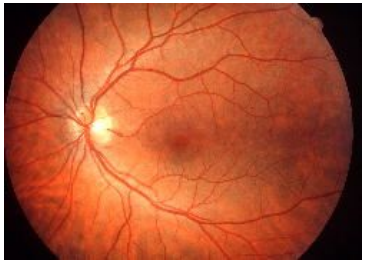
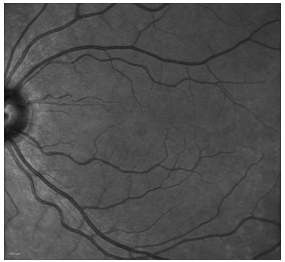
Clinical context

Why is it relevant to segment the retinal vessel tree?

Fundus photography (FP)



Scanning laser ophthalmoscopy (SLO)

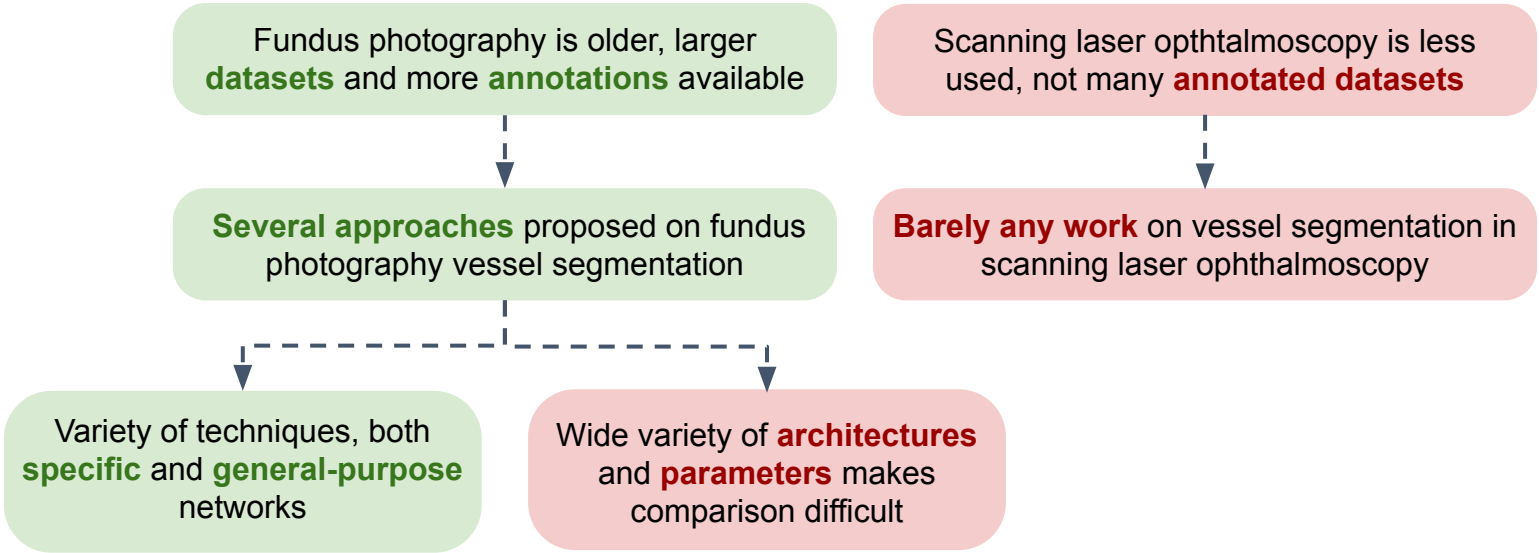


Pathologies: hypertensive retinopathy, diabetic retinopathy

Biomarkers: vascular wall changes, arteriolar constriction, arterio venous nicking, changes in tortuosity

Assist the clinician providing **automatic**, **quantitative**, and **repeatable** measurements

State of the art



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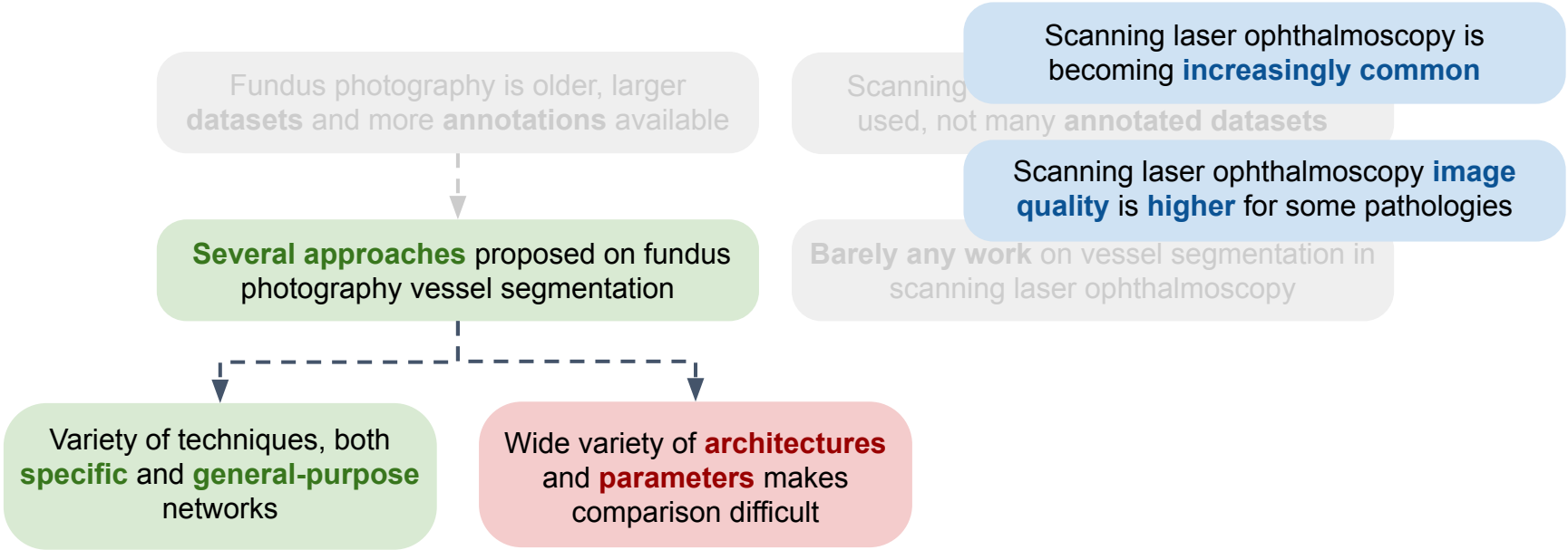
State of the art



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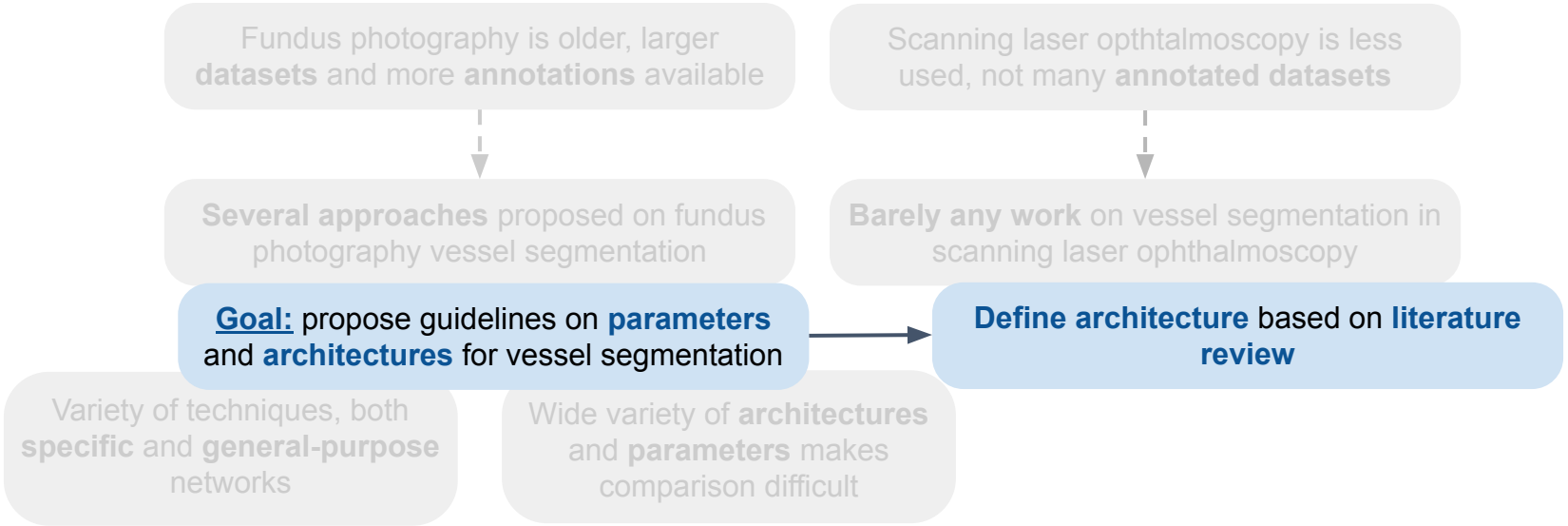
Motivation



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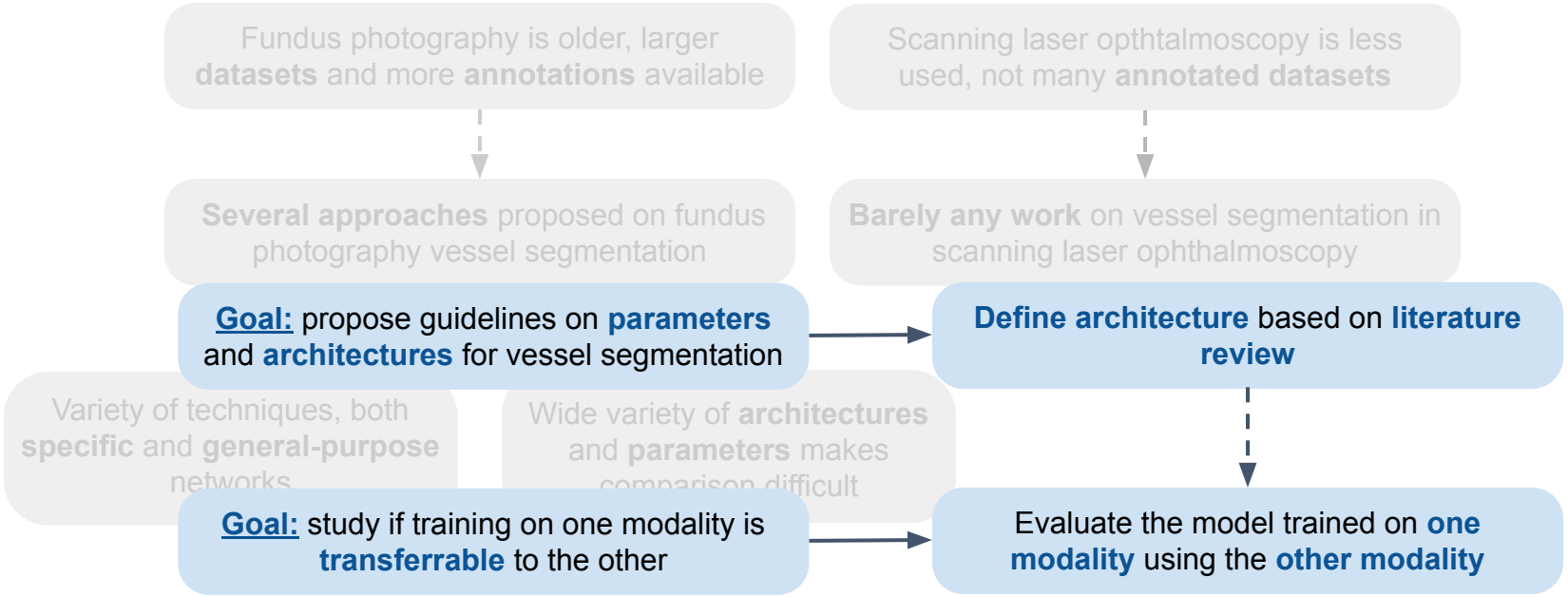
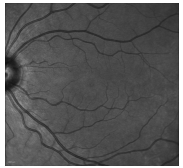
Motivation


Fundus photography is older, larger datasets and more annotations available
Scanning laser opthtalmoscopy is less used, not many annotated datasets
Several approaches proposed on fundus photography vessel segmentation
Barely any work on vessel segmentation in scanning laser ophthalmoscopy
Goal: propose guidelines on parameters and architectures for vessel segmentation
Define architecture based on literature review
Variety of techniques, both specific and general-purpose networks
Wide variety of architectures and parameters makes comparison difficult
Goal: study if training on one modality is transferrable to the other
Evaluate the model trained on one modality using the other modality

Methods



SLO public DB

RCSLO

IOSTAR

FP public DB

DRIVE

STARE

CHASE DB1

HRF

Available ground truth

N = 1

N = 10

N = 20

Amount

32x32

64x64

128x128

256x256

Size

Sample patches

U-Net

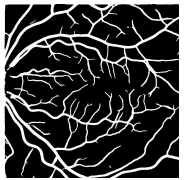
Train

Train FP Test FP

Train SLO Test SLO

Train FP Test SLO

Train SLO Test FP



Accuracy

Sensitivity

Specificity

Dice score

Evaluate

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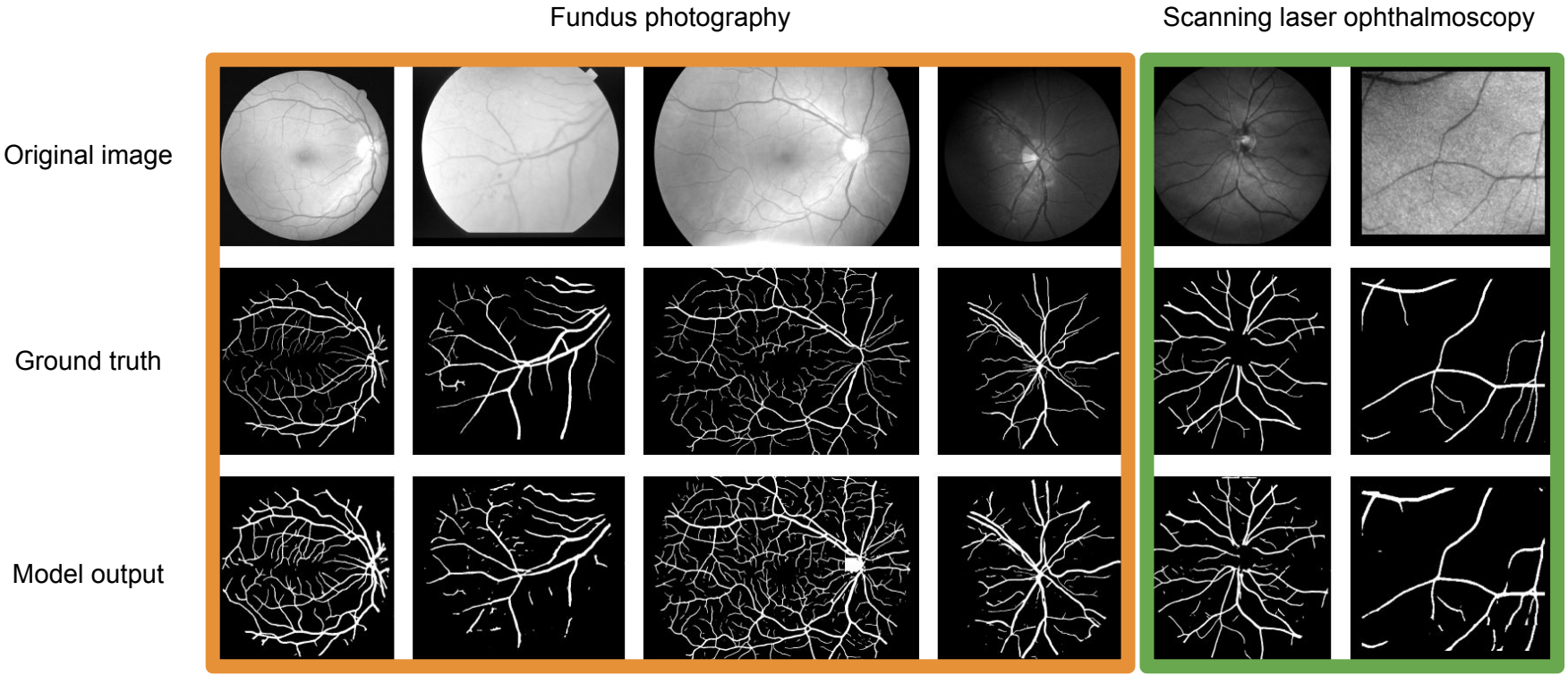
Results



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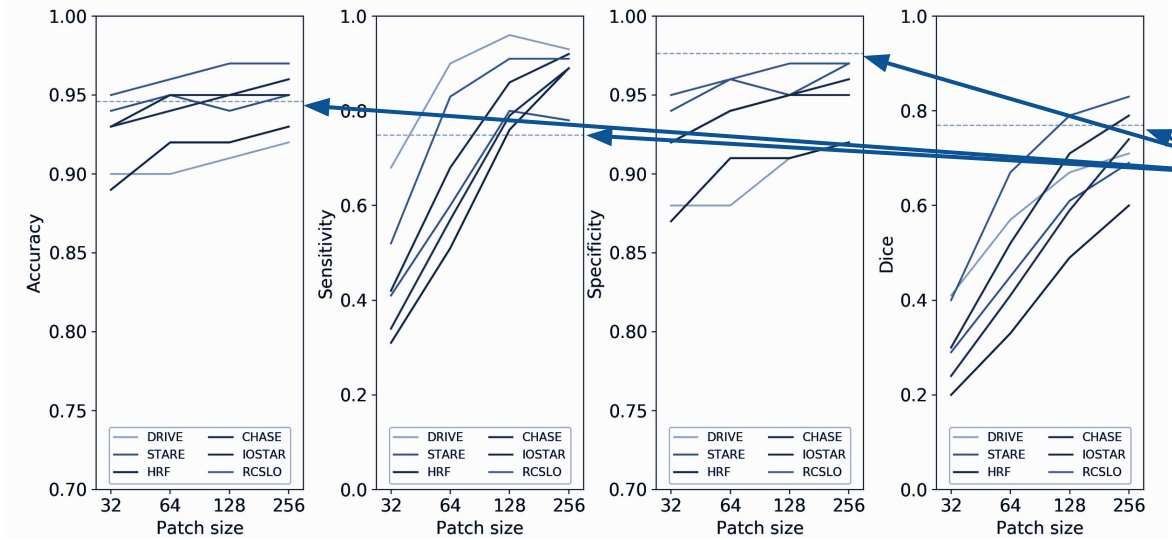
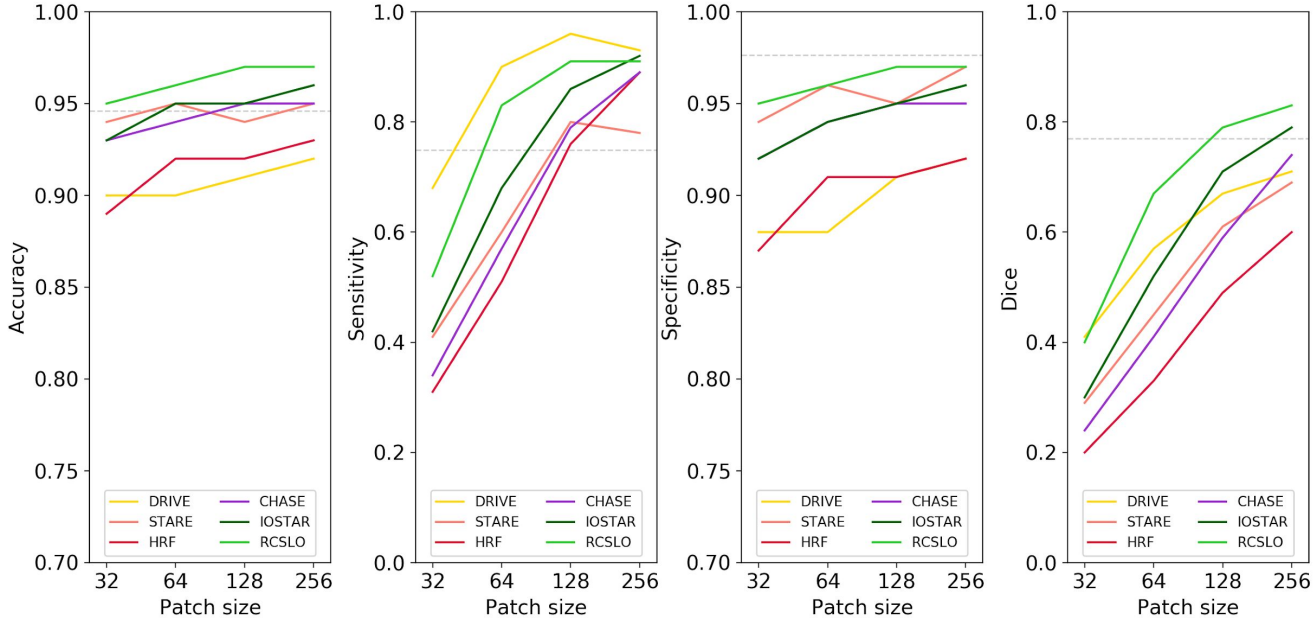
Results



Average of inter-rater agreement

Results



Larger patch sizes work better!

Sensitivity and Dice are the most affected parameters

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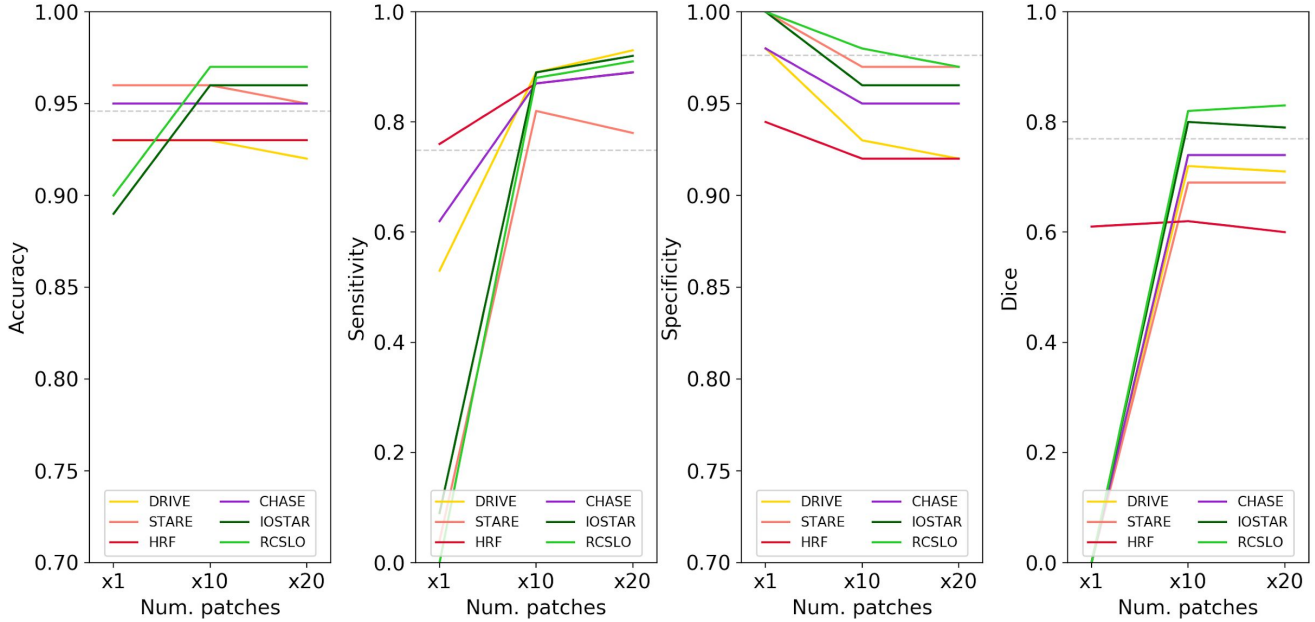
Results



Between x10 and x20 there is no difference in some datasets

Sensitivity and Dice are the most affected parameters

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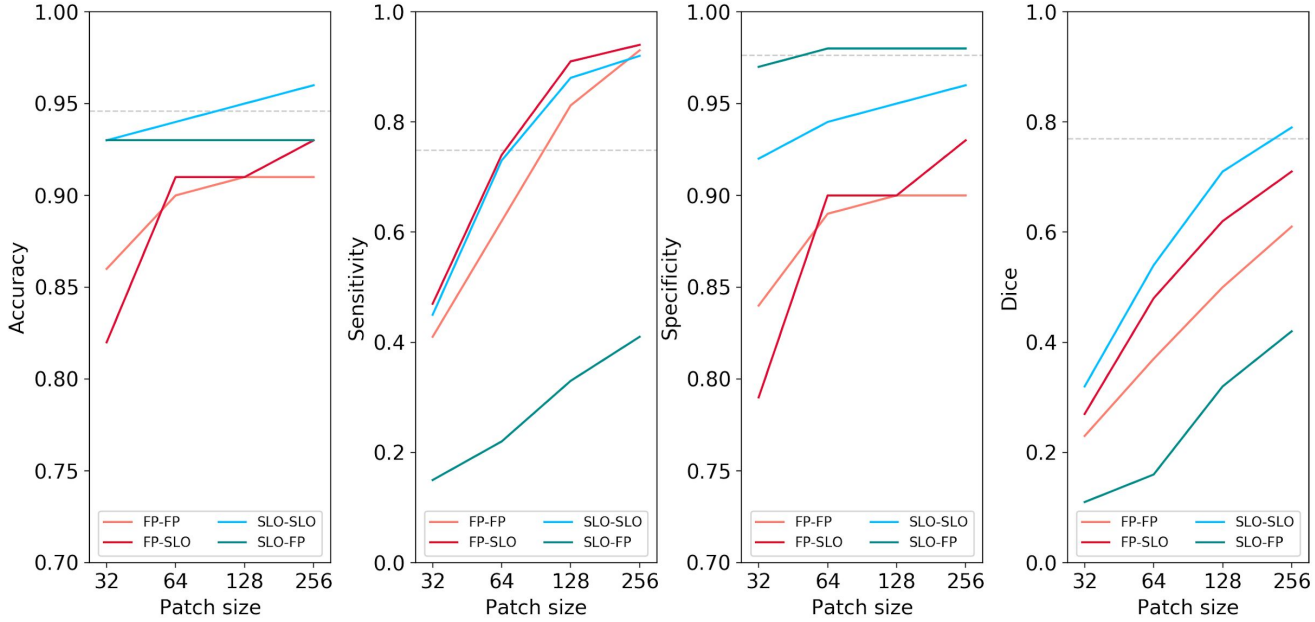
Results



Tests using N = x20

Fundus photography knowledge is transferrable to scanning laser opthalmoscopy

Scanning laser ophthalmoscopy knowledge is not transferrable to fundus photography

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Conclusions

A **state-of-art CNN** is able to obtain results comparable to previous approaches from the literature

Sensitivity, **specificity**, and **accuracy ~90%** for all but one of the individual datasets

A model **trained** on **fundus photography** is able to **segment scanning laser ophthalmoscopy accurately**

A model **trained** on **scanning laser ophthalmoscopy** has a **significant drop in sensitivity** when segmenting **fundus photography**

Sensitivity, **specificity**, and **accuracy ~90%** for the model trained on fundus photography and tested on scanning laser opthtalmoscopy

Sensitivity below 50% for the model trained on scanning laser ophthalmoscopy tested on fundus photography

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Thank you!

m.sanchezbrea@erasmusmc.nl