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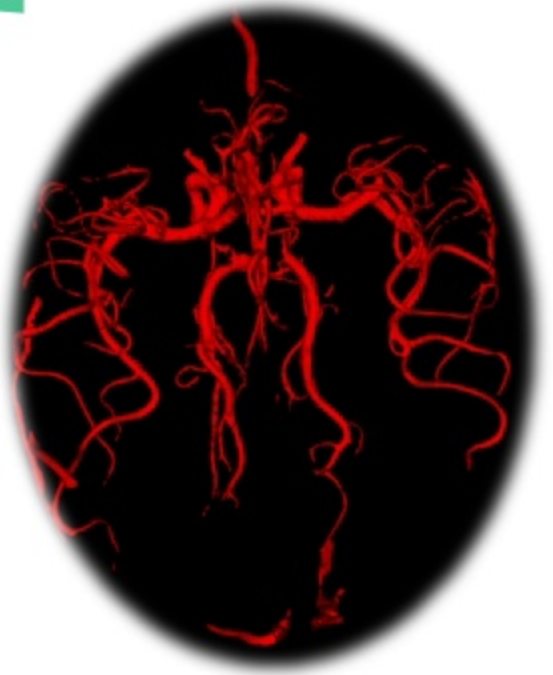

PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR

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I-VESSEG:

Interactive and Collaborative Learning for Vessel Segmentation

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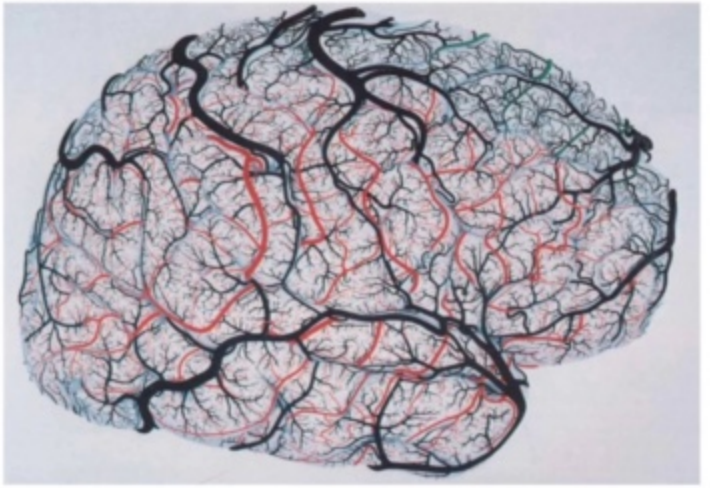
Did you know that…

The **cerebrovascular system** is a **complex network** of arteries and veins supplying the brain with nutrients and oxygen.



[Uludağ & Blinder, NeuroImage 2018]

- It has up to **1294 bifurcations** and **2031 segments**
- Vessel **diameters** go from **6 – 7 mm** to **5 – 10 µm**
- It can be imaged with more than **15 image modalities**
- Current studies can **only cover ~10-20 segments**

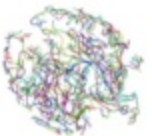
Analysis Pipeline

Segmentation → Modelling → Simulation (CFD) → Visualization

[Livne et al. Front Neurosci 2019; Hilbert et al. Front in AI 2020; Ni et al CIBM 2020; Tetteh et al. 2020; Mou et al, MedIA 2021; Dang et al 2021]

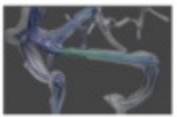
[Ghaffari et al. ESC 2015]

[Morconi et al. IEEE TMI 2018]

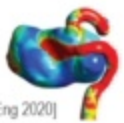


[Decroocq et al. IEEE EMBS 2022]

[Miraucourt et al. ISBMS 2014]



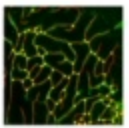
[Ghaffari et al. CIMB 2017]



[Rayz et al. Ann Rev Biom Eng 2020]

[Pandey et al. IEEE TVCG. 2019]

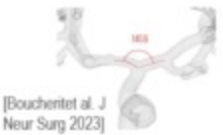
[Burngarner & Nelson, CRM 2023]



[Montoya-Zegarra et al. J Ang 2018]

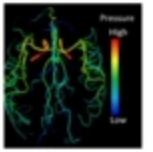
No successful end-to-end pipeline

Analysis Pipeline



[Bouchentet al. J Neur Surg 2023]

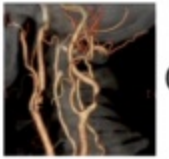
Geometric & intensity patterns



[Ghaffari et al. CIMB 2017]

Blood flow

Segmentation → Modelling → Simulation (CFD) → Visualization



From Radiopaedia [1]

Occlusions

[Pandey et al. IEEE TVCG. 2019]

Visual assessment

Common to all stages there is image segmentation

(an open problem)

[1] https://radiopaedia.org/articles/carotid-artery-stenosis

I-VESSEG Framework

Our hypothesis:

Understanding **the cerebrovascular tree** architecture requires of **advanced tools** that **quantify and characterize** it in a **reliable, reproducible** and **efficient way**

I-VESSEG Framework

Our hypothesis:

Understanding **the cerebrovascular tree** architecture requires of **advanced tools** that **quantify and characterize** it in a **reliable, reproducible** and **efficient way**

Our goal:

To develop **learning-based tools** that **ease the analysis** of the cerebrovascular tree in a **seamless way**

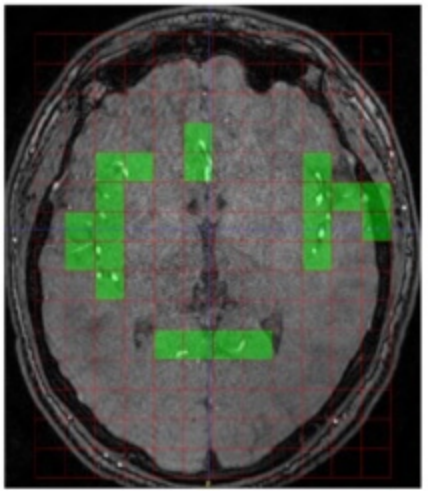
Where to start?

Segmentation → Modelling → Simulation (CFD) → Visualization

- **Critical to all the stages** of the analysis pipeline
- Remains an **open problem**
- Learning-based methods have **not reached maximal performance** yet

How we do it?

We ease the annotations using the Vessel-CAPTCHA



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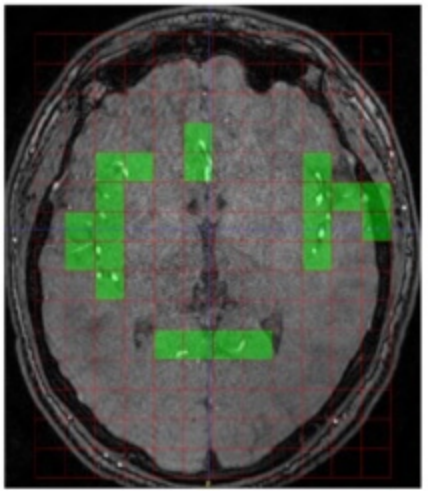
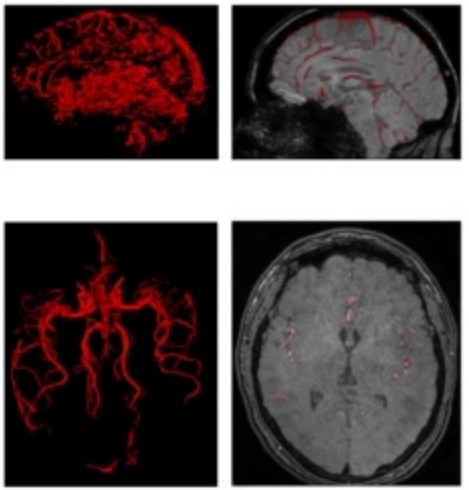
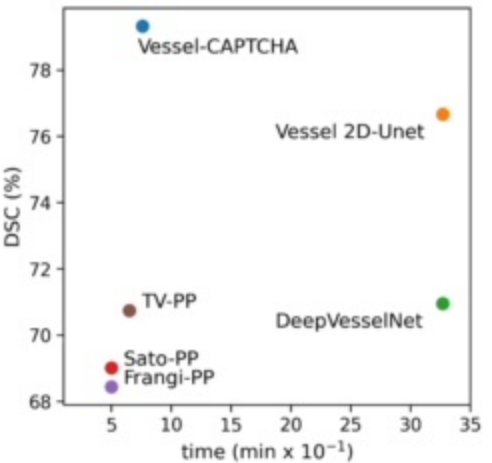


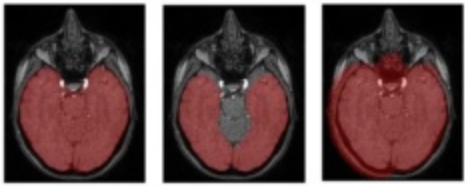




How we do it?

We eliminate the need of brain masks at inference

Brain segmentation methods fail on neurovascular images



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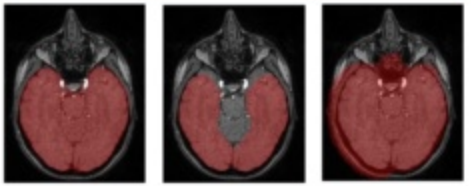
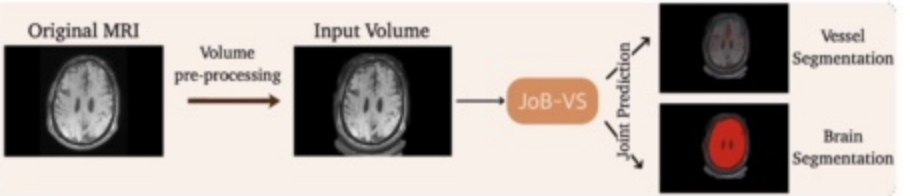


Our framework jointly segments the brain vessels and the brain



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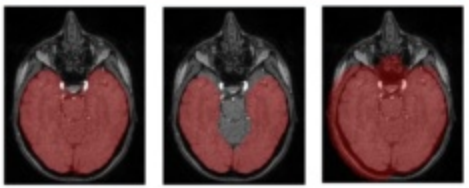

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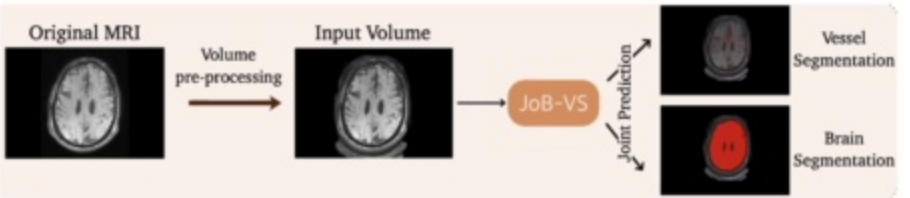
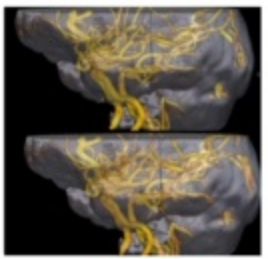
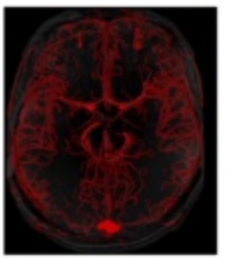


We achieve SOTA performance in different benchmarks



OASIS-3

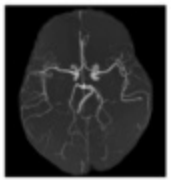
SHINY-ICARUS

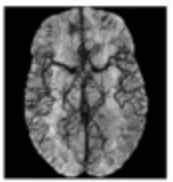


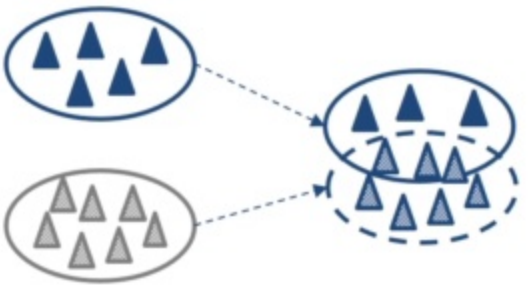
SMILE-UHURA

How we do it?

We handle any image modality with a single model







Our approach is based on the principle of domain adaptation

Our collaborators

UNIVERSITÀ DI SIENA 1240

Inria

chu de Nice

UCL

Universitat Oberta de Catalunya

MINES Grenoble Alpes

GIN Grenoble Institut Neurosciences

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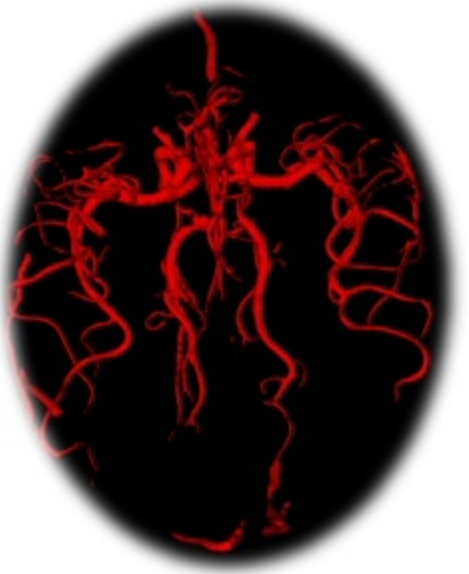

LEARN MORE- https://i-vesseg.github.io

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