

# **Vesselvio: a novel and open-source application for vasculature dataset analysis and visualization**

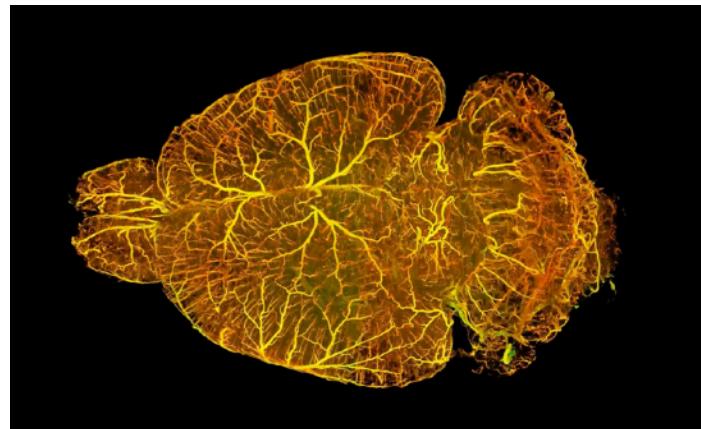
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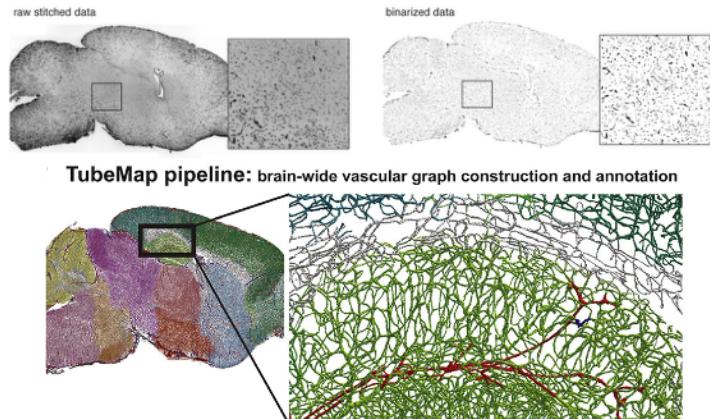
# Background

- Advancements in preclinical imaging technologies & powerful segmentation software enable collection of large-scale vasculature datasets
  - Modern analysis software can be difficult to navigate or costly
- **Our goal:** Complement recently developed and open-source segmentation software (i.e., VesSAP, TubeMap) with an open-source and user-friendly application for vasculature dataset analysis and visualization

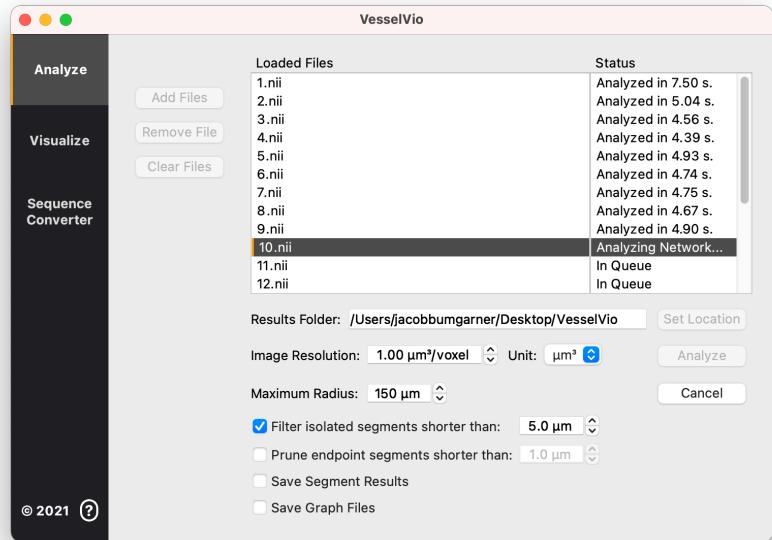
**VesSAP**  
(Todorov et. al, 2020)



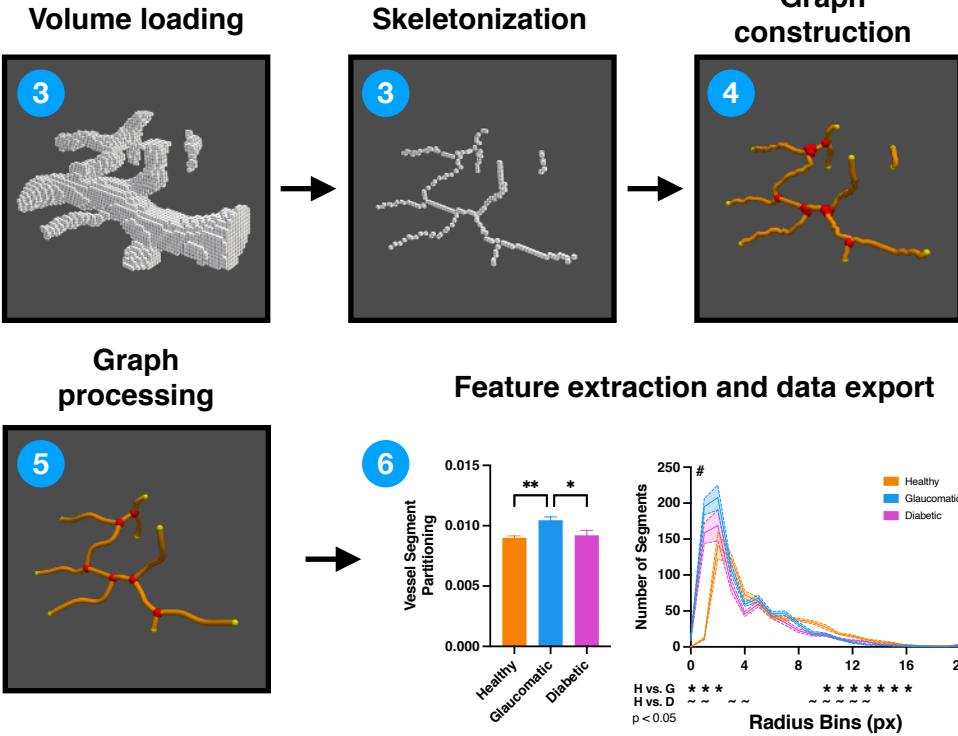
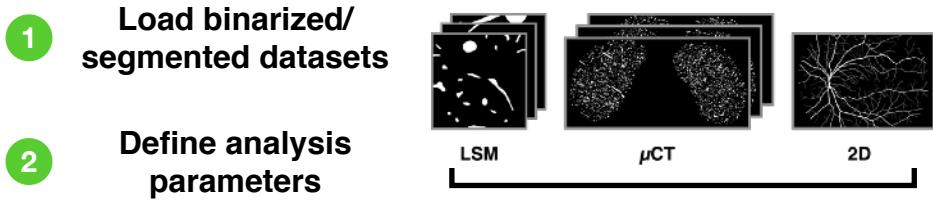
**TubeMap**  
(Kirst et. al, 2020)



# Design - Pipeline overview

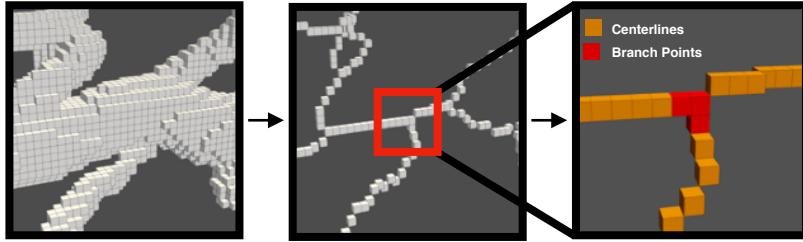


- # Front-end workflow
- # Back-end workflow

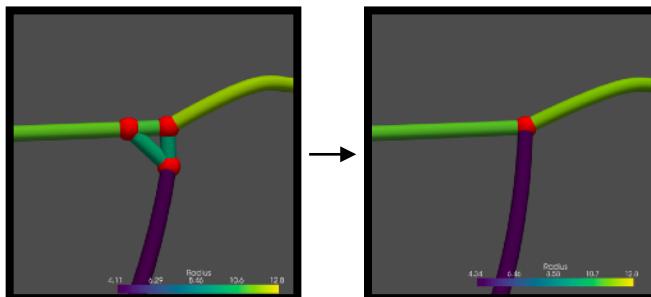


# Design - Branch point corrections

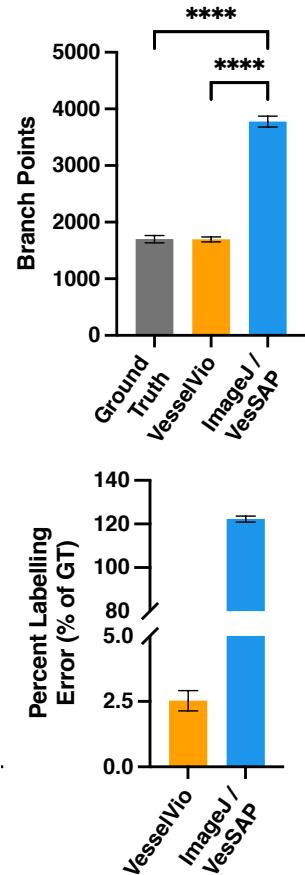
- Graph construction based on 26-connectivity leads to overestimated branch point density
- We eliminate spuriously labeled branch points using radius- and connectivity-weighted filtering algorithms



Edge detection based on  
26-connectivity



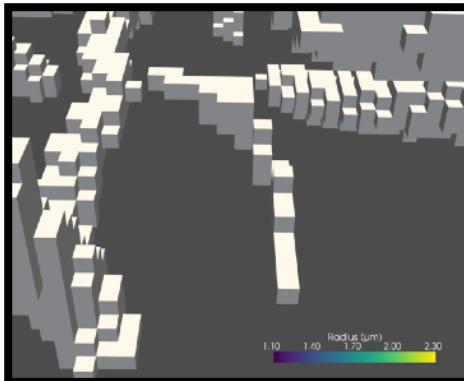
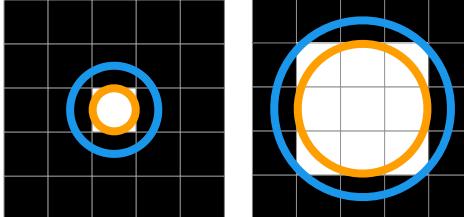
Spurious branch point removal based  
on parent and point radii



# Design - Modified radius detection

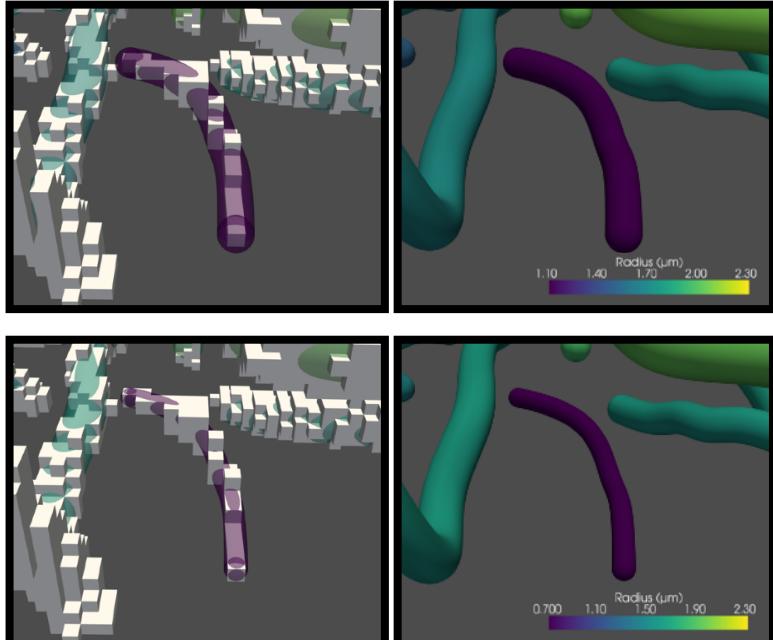
- Traditional radius estimations based on Euclidean distance transformations (EDTs) lead to overestimated radius sizes
- Our modified method enables the analysis of at-resolution vessels

mEDT 0.5 units  
EDT 1.0 units



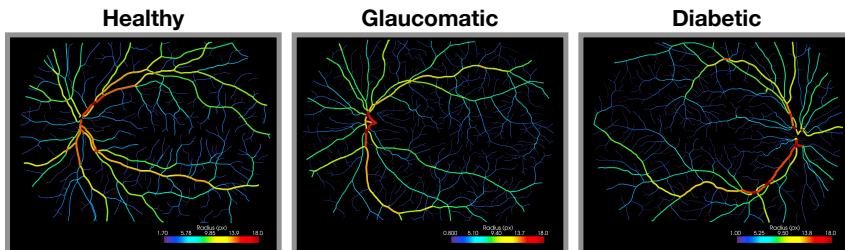
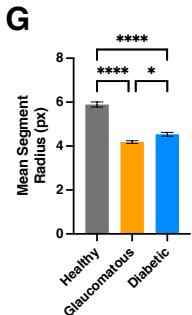
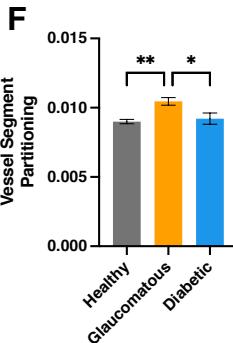
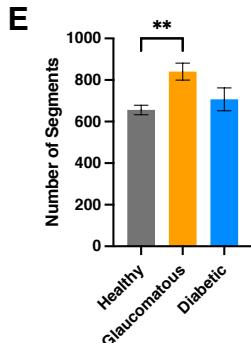
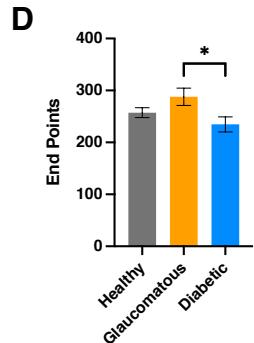
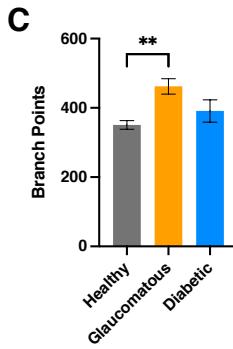
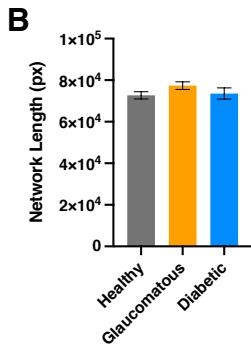
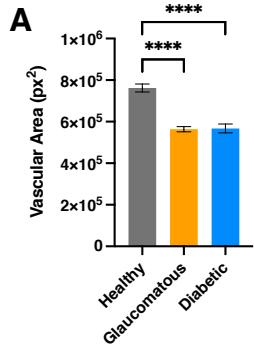
EDT

mEDT



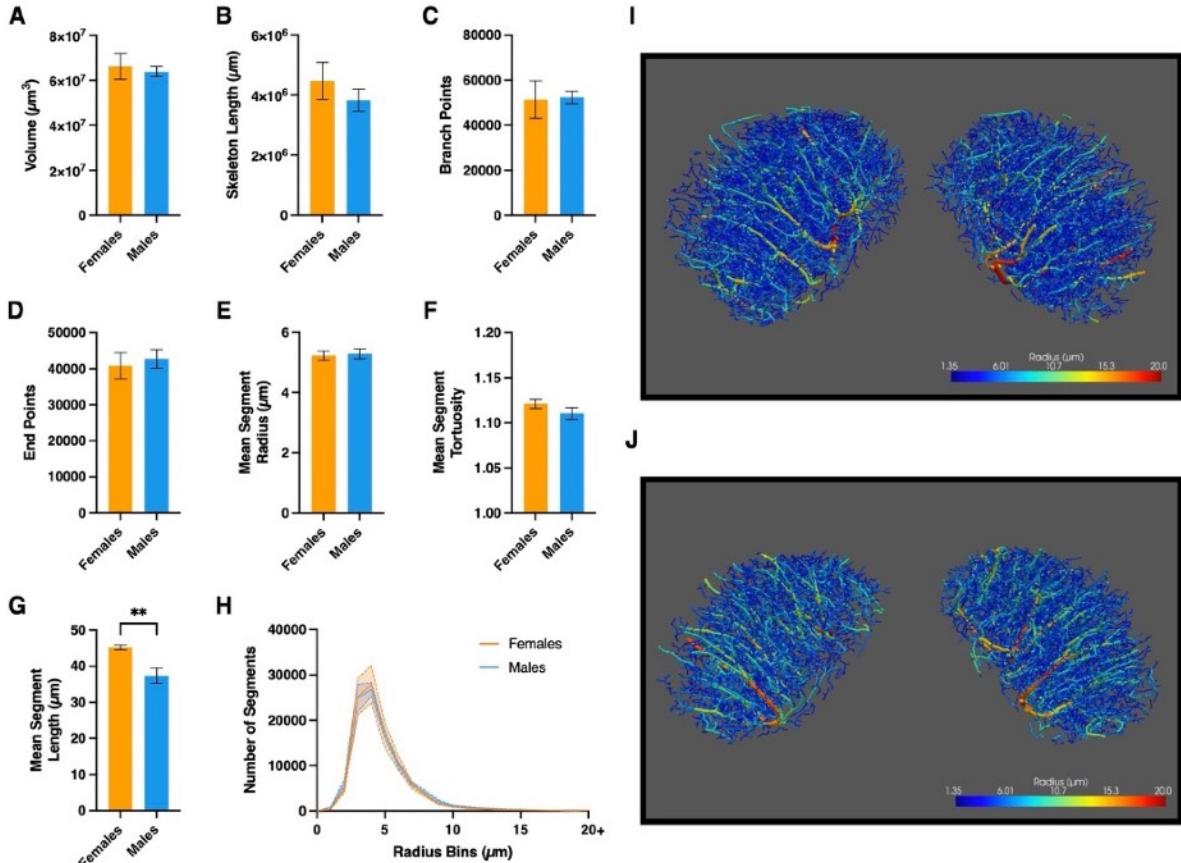
# Results

- Retinograph images from HRF Image Database were analyzed and compared (Budai et al., 2013).
- Analysis reveals numerous vascular alterations between healthy, glaucomatous, and diabetic patients



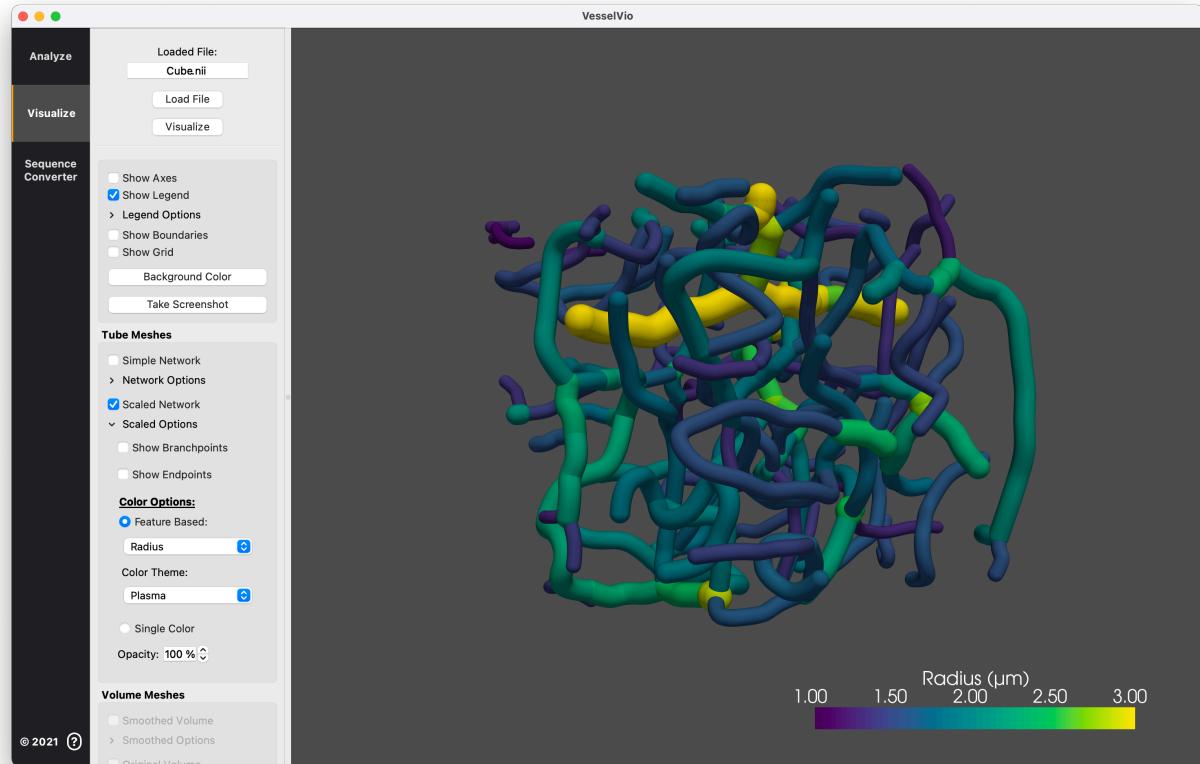
# Results

- Analysis of male and female CFW mouse inferior colliculus segmentations reveals minimal network differences
- Analysis of individual segment characteristics demonstrates shorter mean segment length in males compared to females



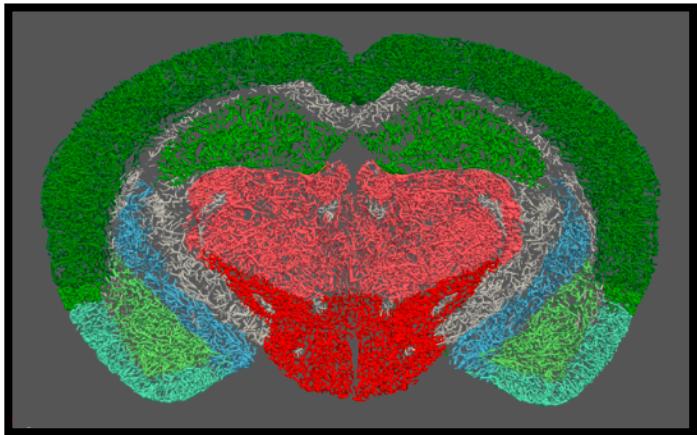
# Design - Dataset Visualization

- Colorized feature mapping
  - Radius, length, tortuosity, volume, surface area
- Multiple visualization options
  - Scaled view (as shown)
  - Network view
  - Reduced graph (large dataset analysis)
- Original volume visualization for accuracy confirmations and analysis parameter fine-tuning

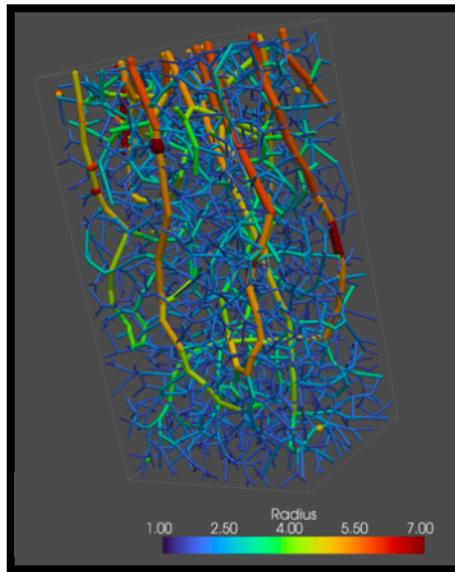


# Design - Additional features

CCFv3 Allen brain atlas  
annotation-based analysis  
and visualization



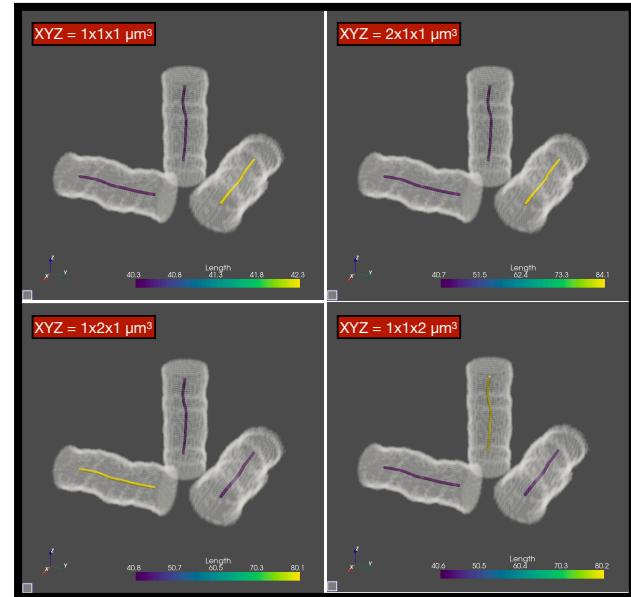
Compatible with  
pre-constructed graphs



Synthetic graph from VesselGraph  
(Paetzold et. al, 2021, *Preprint*)

Compatible with Windows & MacOS

Compatibility with  
anisotropic datasets



Visualization of varying segment length  
with varying anisotropic resolutions

# Nelson Lab



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Graduate Student



**Randy J. Nelson**  
PI



[jacobbumgarner.github.io/VesselVio/](https://github.com/JacobBumgarner/VesselVio)  
<https://github.com/JacobBumgarner/VesselVio>



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## Funding



NCCIH  
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