Technical University of Lodz
Institute of Electronics

UNIVERSITY OF BERGEN

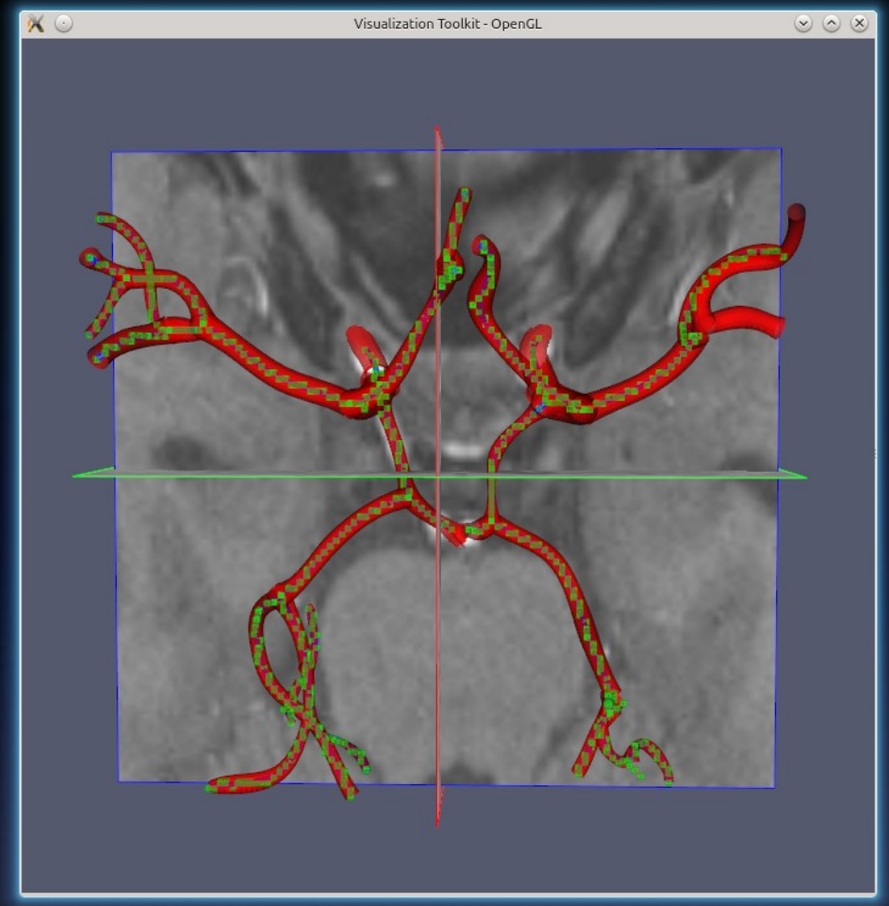
Quantitative analysis of 3D MR images

Marek Kociński

2024.08.22 IMR

Home institution

Institute of Electronics
Medical Electronics Division



Scientific interests (Biomedical engineering)

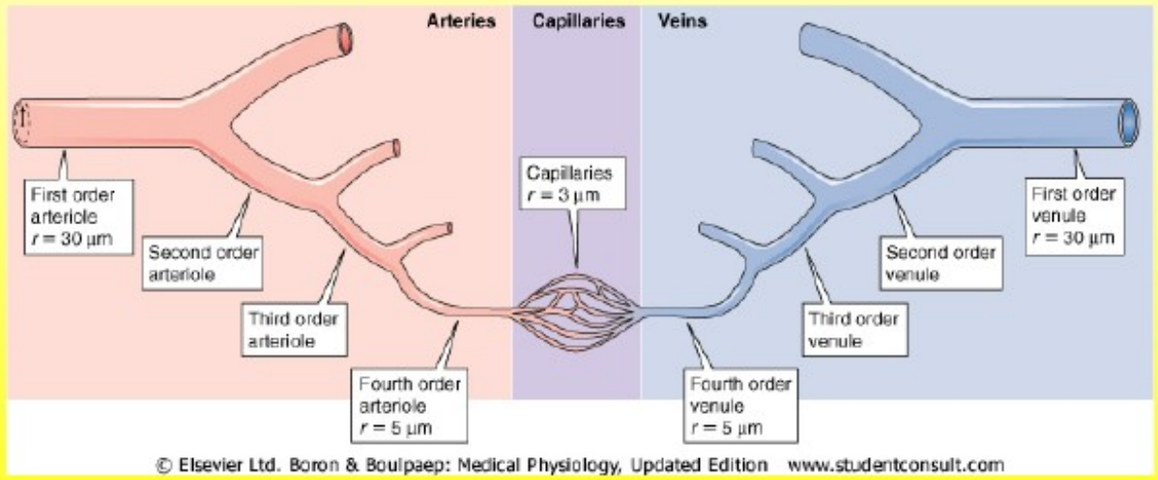
Algorithms and software for quantitative analysis of medical images

- multi-scale brain vasculature modeling

Nature of vascular system

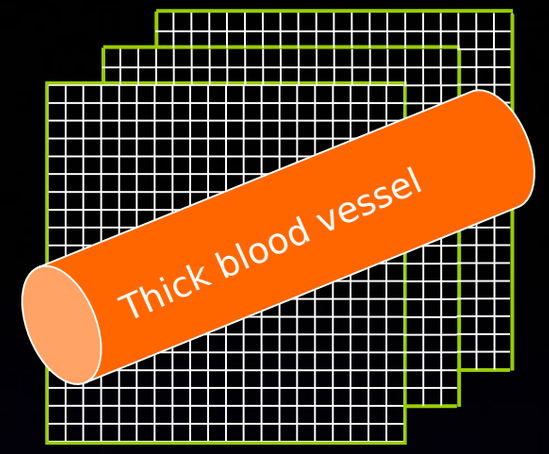
Circulation Physiology
Vascular tree models (M. Kocinski, TUL)
Tumor vasculature and angiogenesis (K. Oppedal, UiB)

Blood vessels:



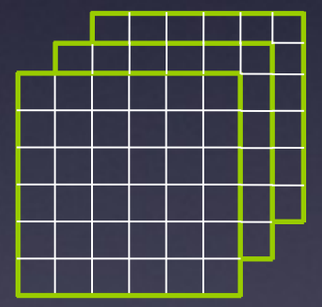
Arvid Lundervold & Marek Kocinski | Vascular model generation - COST B21 WG4, Lodz

I. Thick



II. Meso scale

III. Capillary



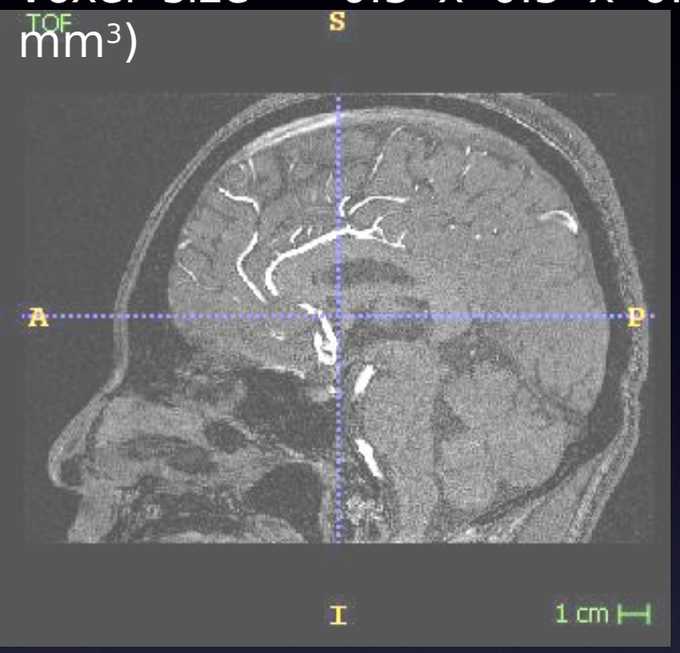
Problem

Reliable quantitative analysis each part of vasculartree

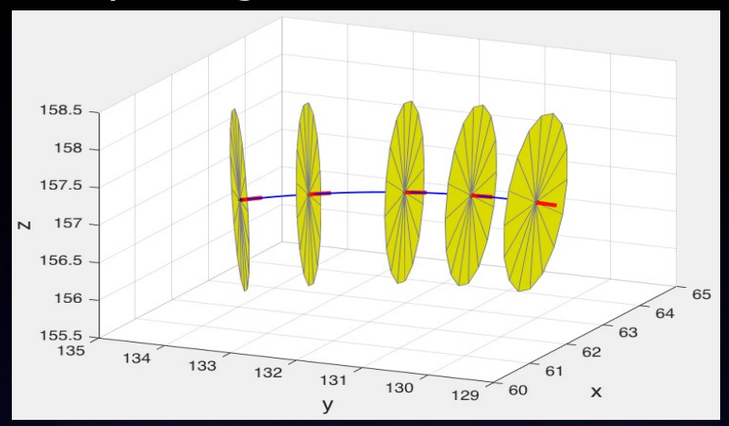
Thick vessels: reconstruct the surface vascular tree given its 3D MRA image - to aid medical diagnosis (blood flow simulation, detection of stenosis and aneurysms).

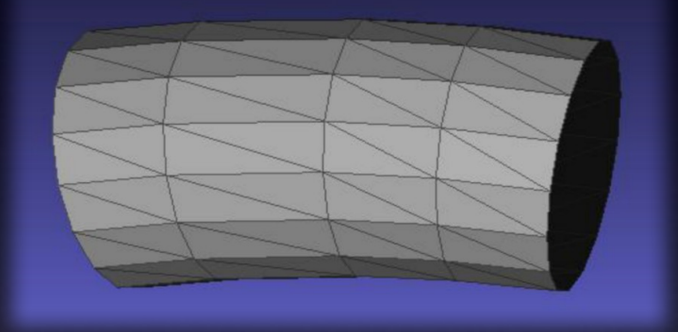
Modeling of thick blood vessels

Cross-section of3D ToF-MRI (346 x 448 x 319 voxels, voxel size = 0.5 x 0.5 x 0.5 mm^3)



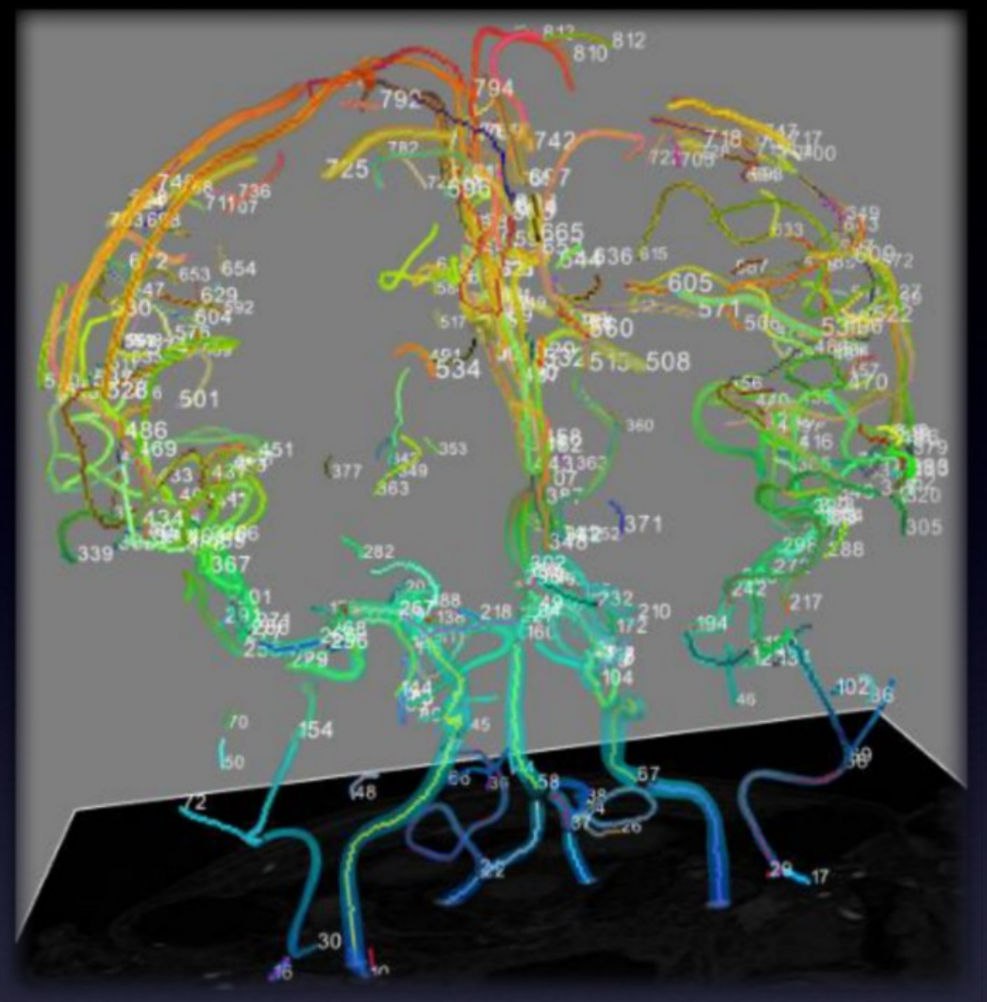
Short tubular segment comprising *K=5 voxels.*

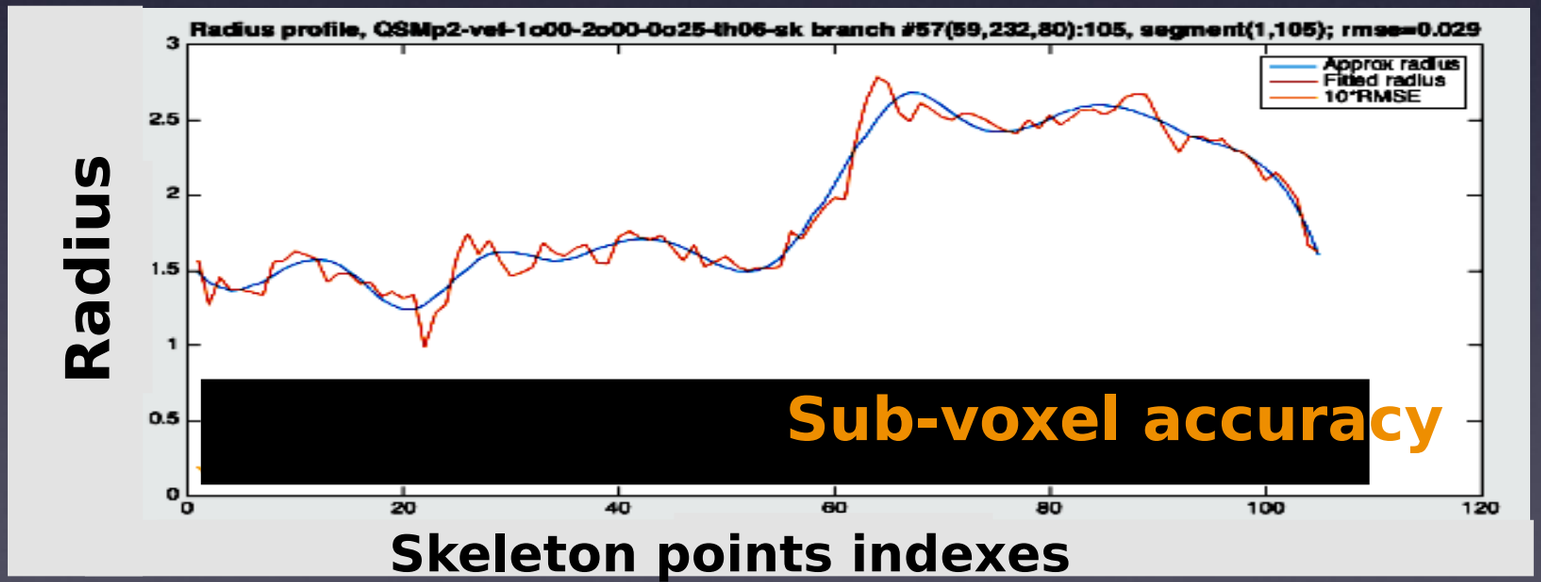




Wireframe model (STL)

Model of pipe-like arteries

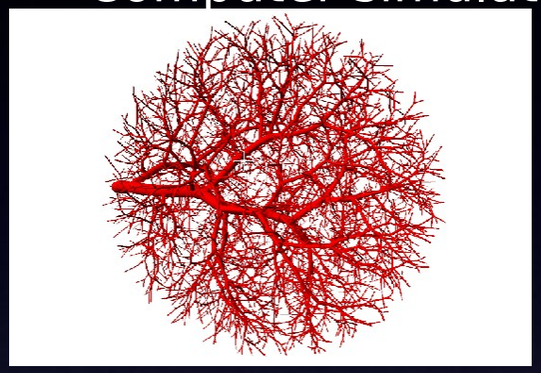


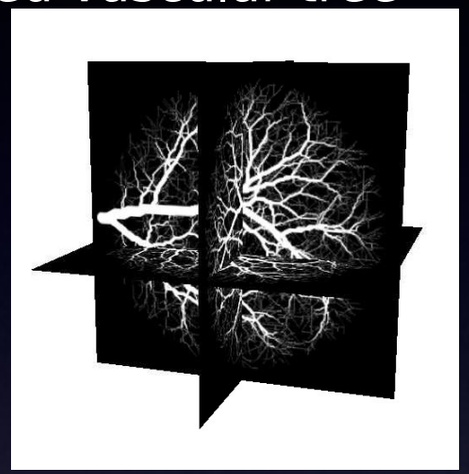


Validation of modeling algorithms

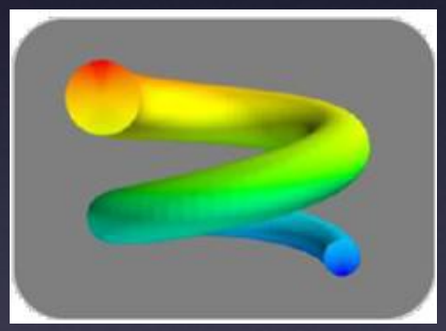
Numerical phantoms with noise and artifacts

Computer simulated vascular tree

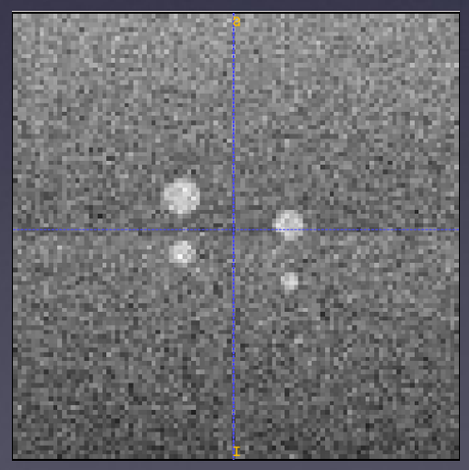


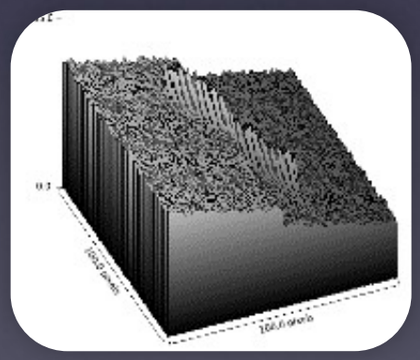


Helix

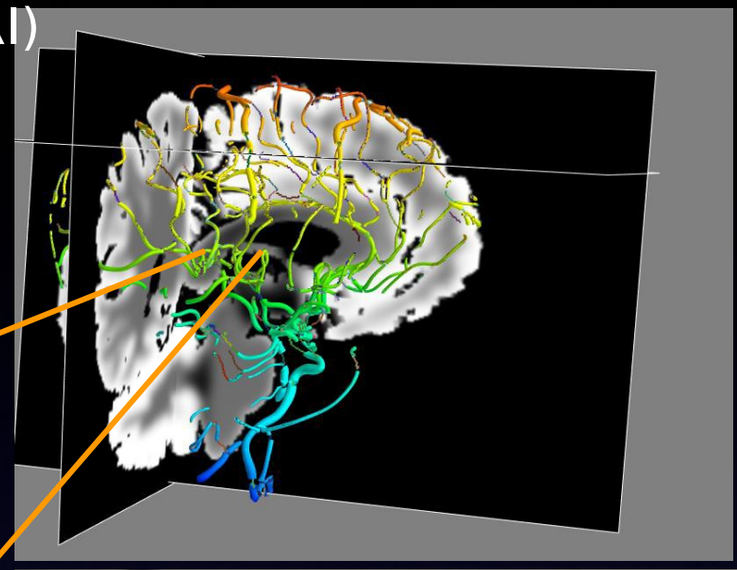


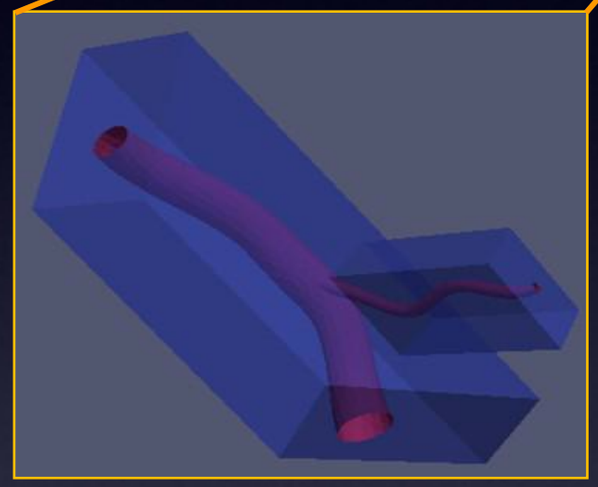
Tube





Model of arteries (from ToF MRI)





Geometry of selected branches (STL file)

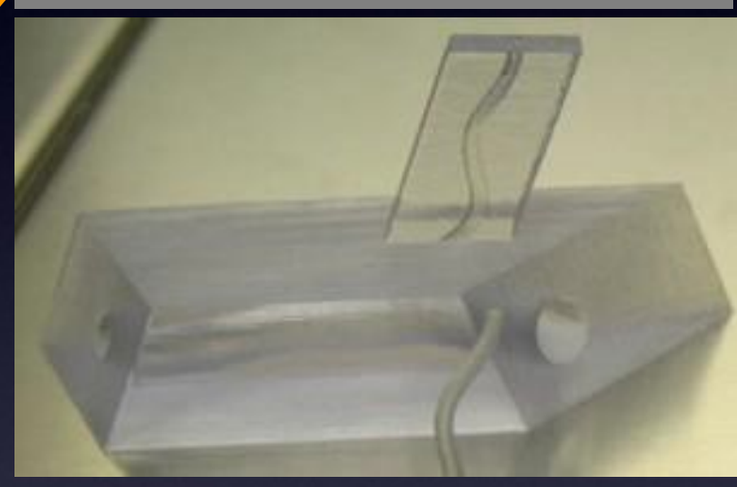
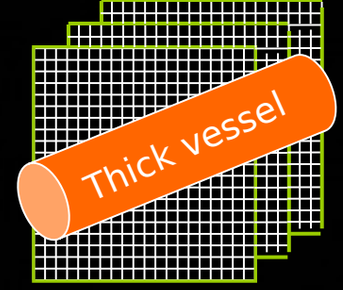


Photo of 3D printed model

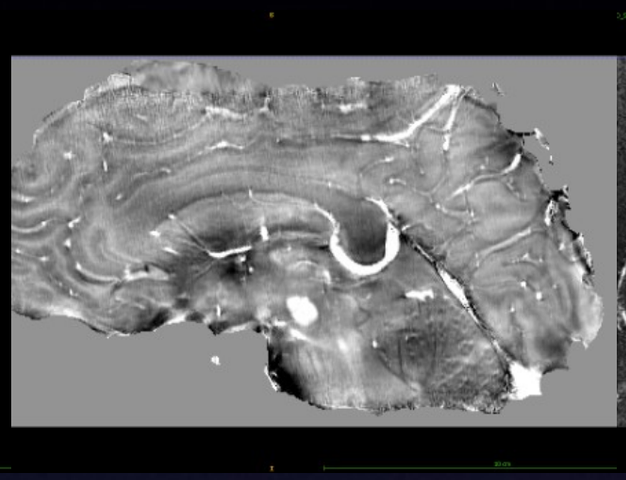
T2 weighted MRI slice of 3D printed model

Modeling of thick blood vessels

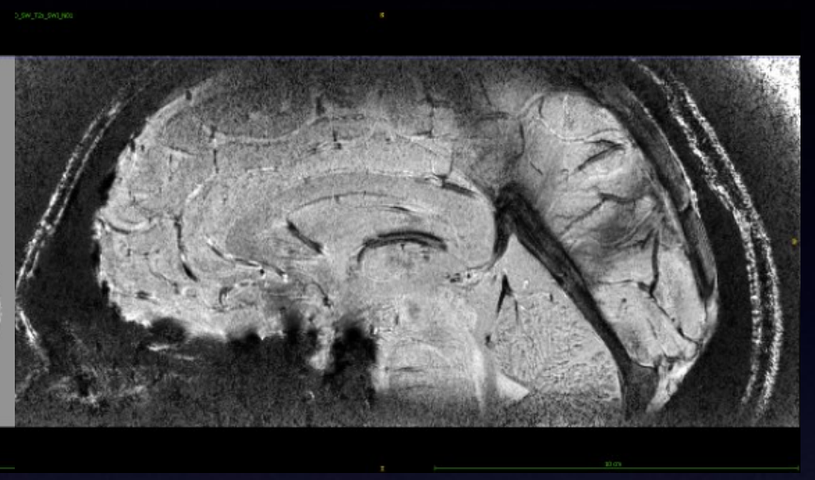


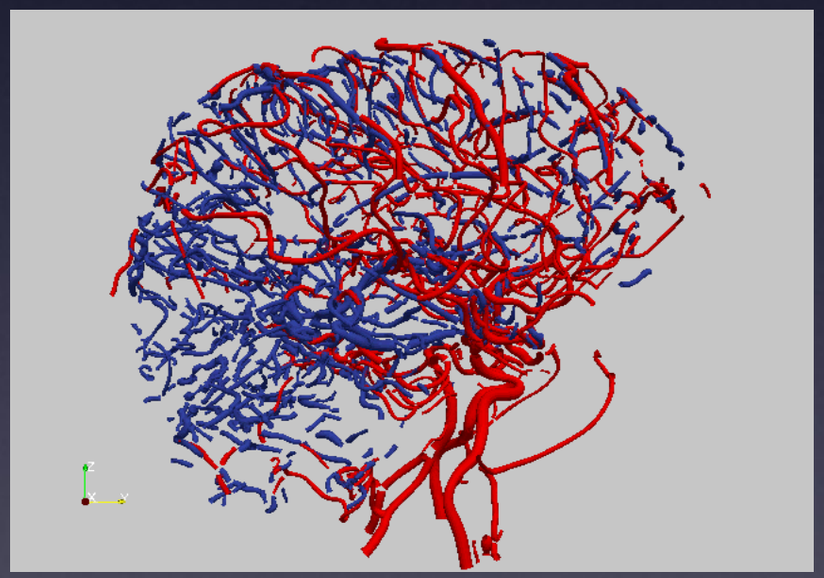
ToF (Arteries)

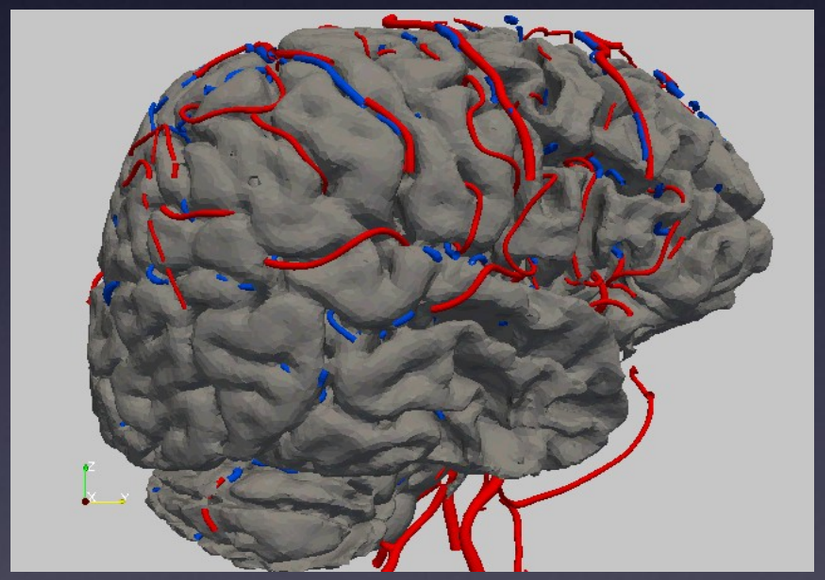
QSM (Veins)



SWI (Veins)

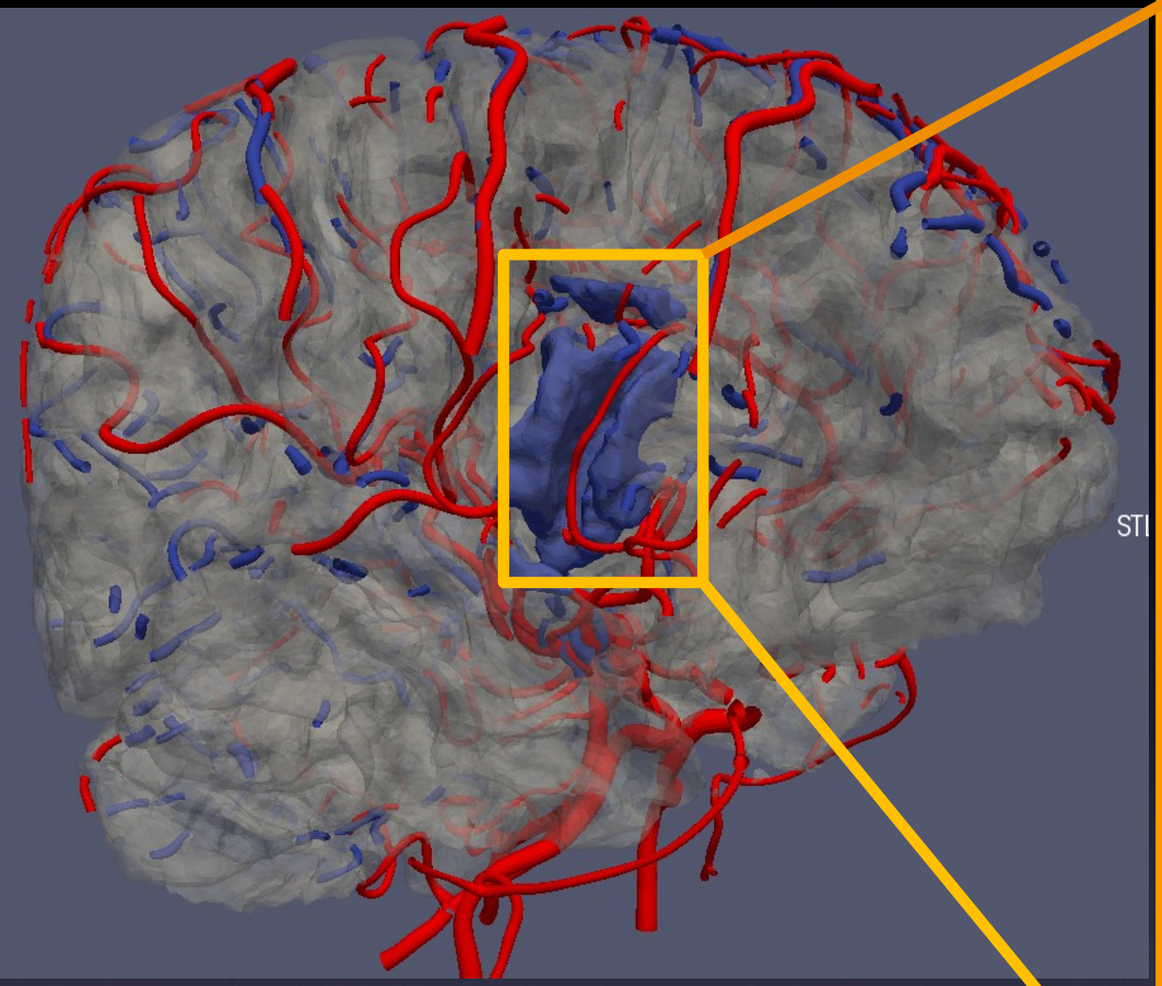




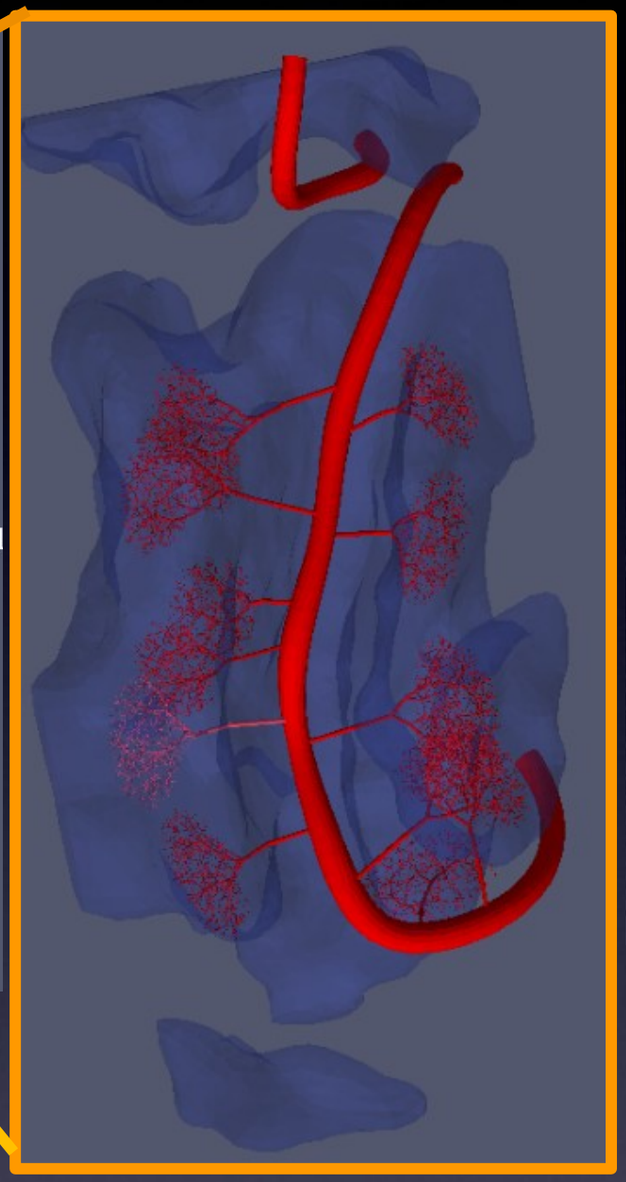


3D model of arteries (red, ToF) and veins (blue, QSM), grey matter (grey, T1).

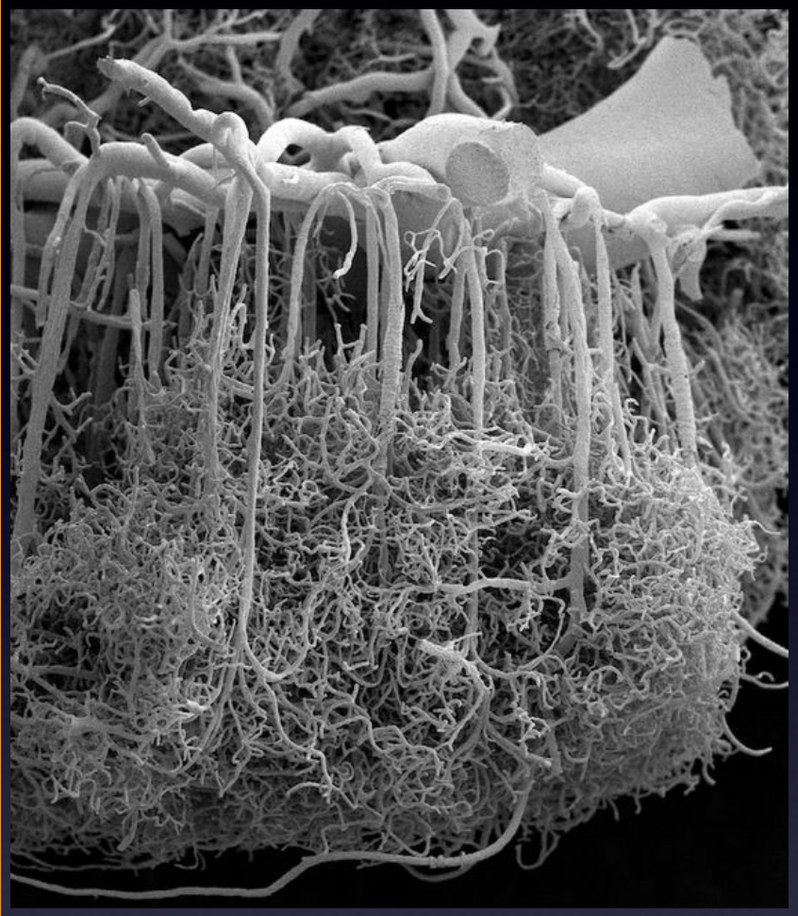
Towards multi-scale personalized modeling



Visualization of geometric models of tubular sections of the arterial (red) and venous (blue) trees superimposed over the surface of gray matter (right hemisphere)

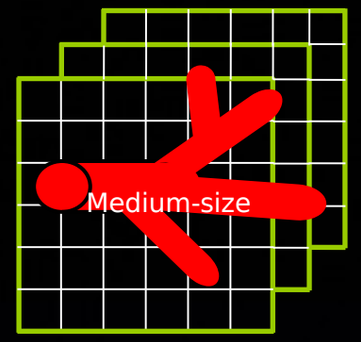


Synthesized mesoscopic scale trees build upon cortex penetrating arteries which bifurcate from the segmented selected brain artery



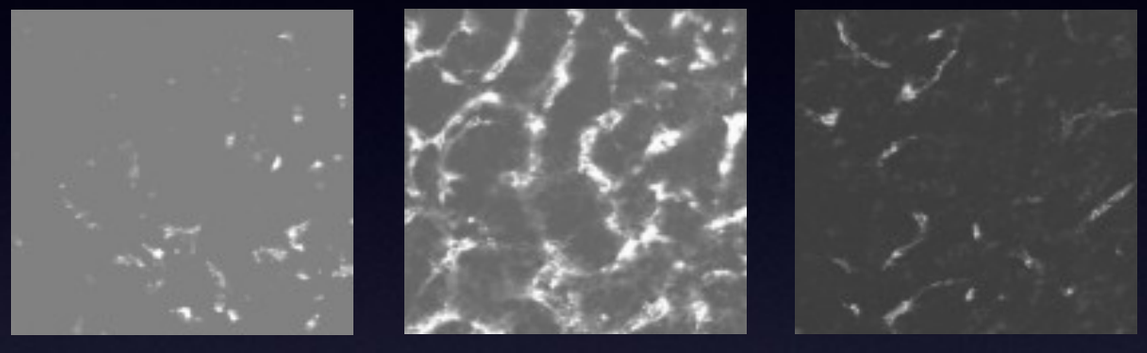
A photomicrograph of microscopic blood vessels from “Portrets of the Mind”, 2010, pp. 216-217. Reproduced with a kind permission of the authors: Alfonso Rodríguez-Baeza and Marisa Ortega-Sánchez from Department of Morphological Sciences, Medicine Faculty at the Universitat Autònoma de Barcelona, Spain

Medium size blood vessels



PhD thesis (in the field of computer science)
Quantitative analysis of vascular trees represented by digital images

3D confocal microscope data – rat brain (UiB, 2006)

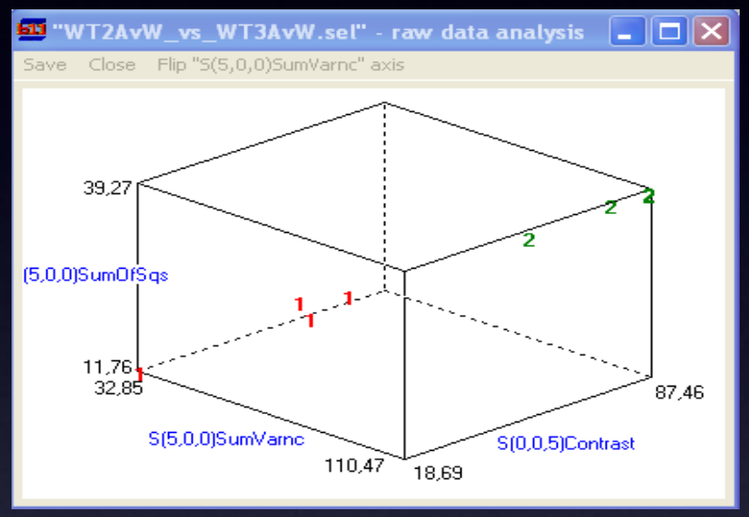


Tumor cells:

transfected with empty vector

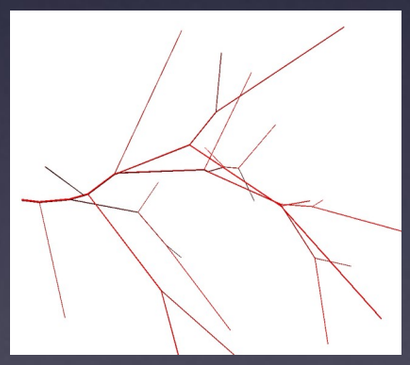
native state, unmanipulated

transfected with CDNA for Neuron glial-2 proteoglycan

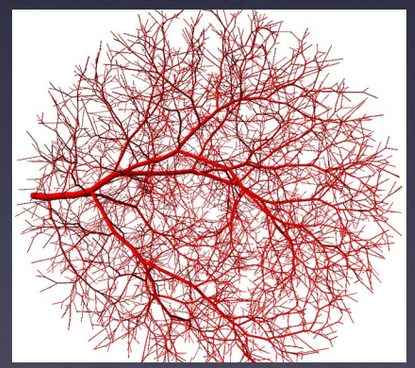


3D texture features

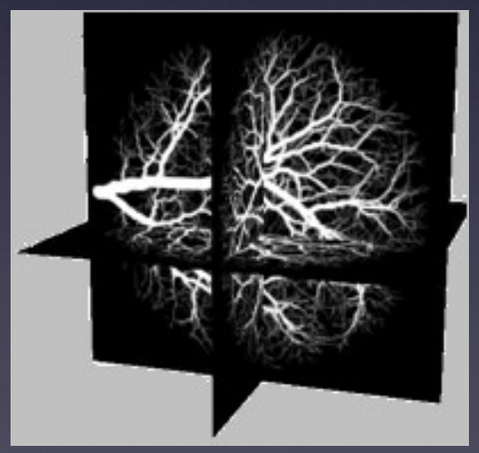
20 outlets



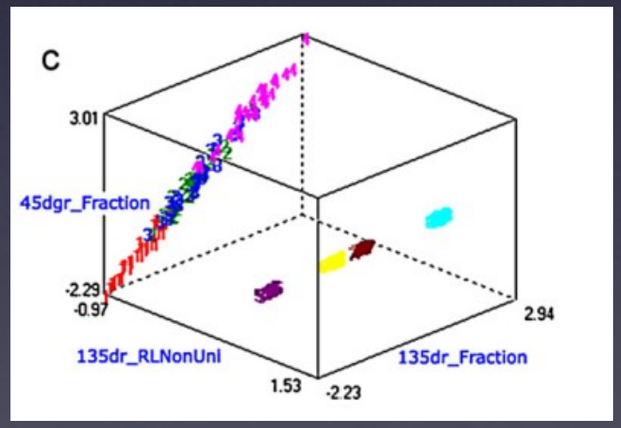
4000 outlets



Vascular tree growth computer simulation.
Parameters: blood viscosity; nr of branches; inflow; outflow (vector model)



3D raster image

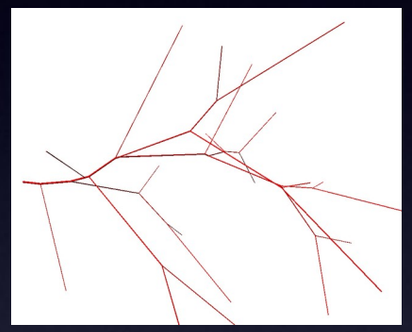


2D & 3D texture features

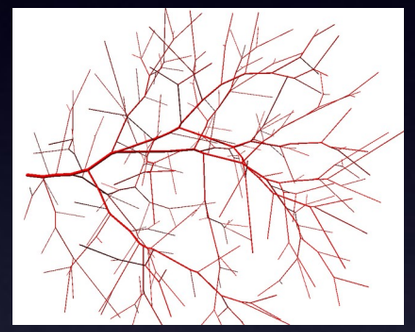
PhD thesis (in the field of computer science)

Quantitative analysis of vascular trees represented by digital images

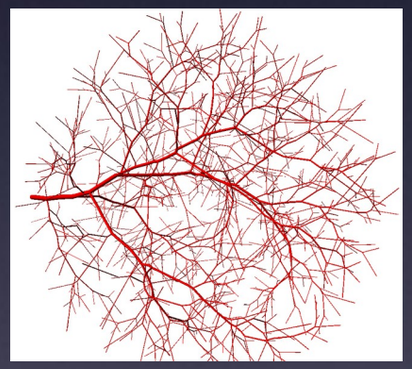
20 outlets



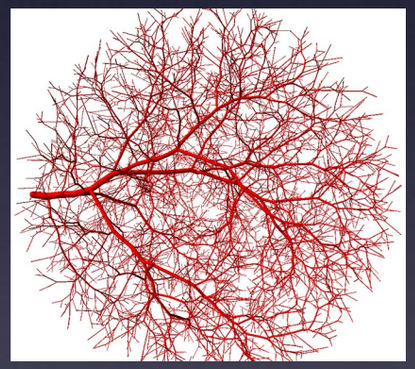
200 outlets



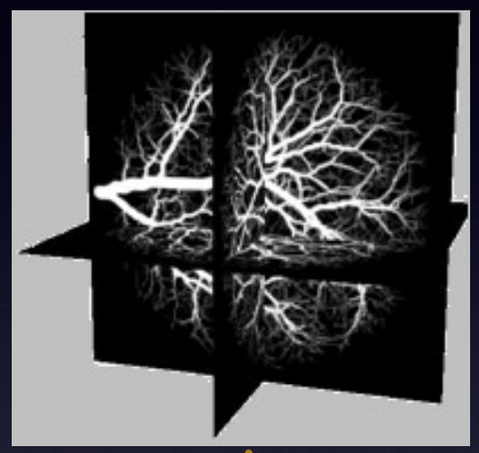
1000 outlets

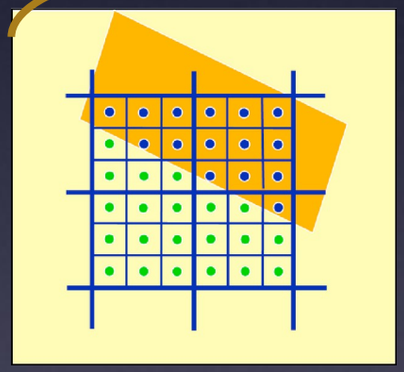


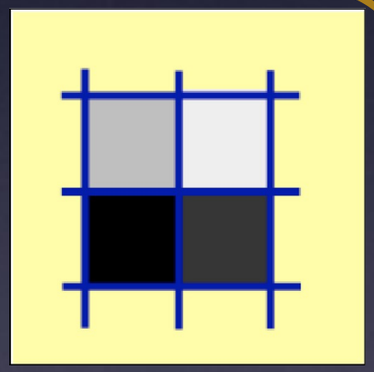
4000 outlets



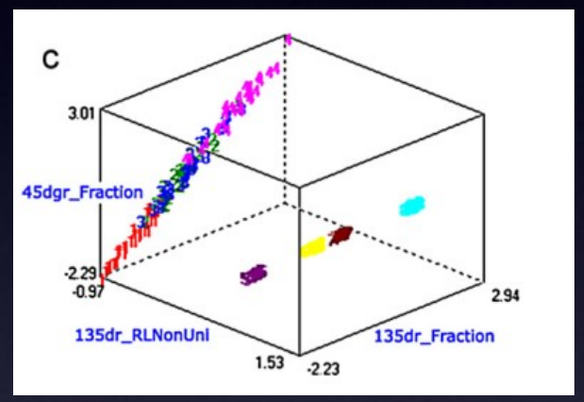
Vascular tree growth computer simulation. (Vector model)







Convertion model to 3D raster image

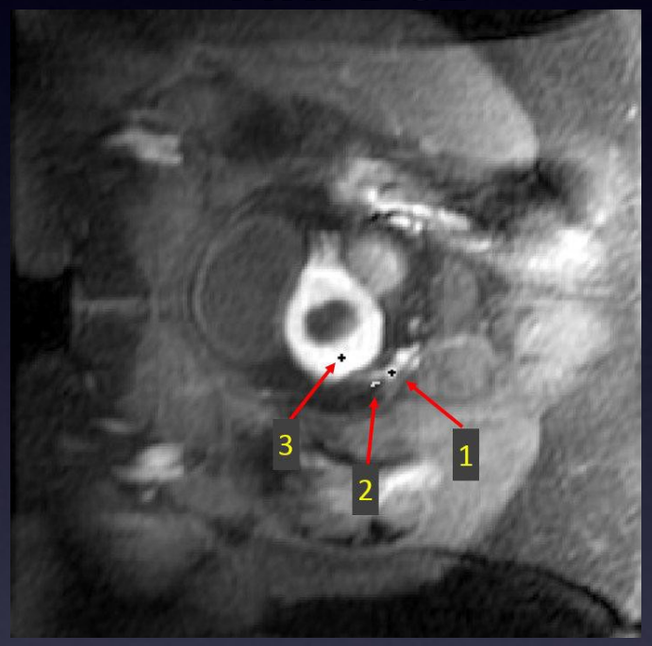


2D & 3D texture features

DCE-Derived Blood Pharmacokinetic Maps (UiB, 2015)

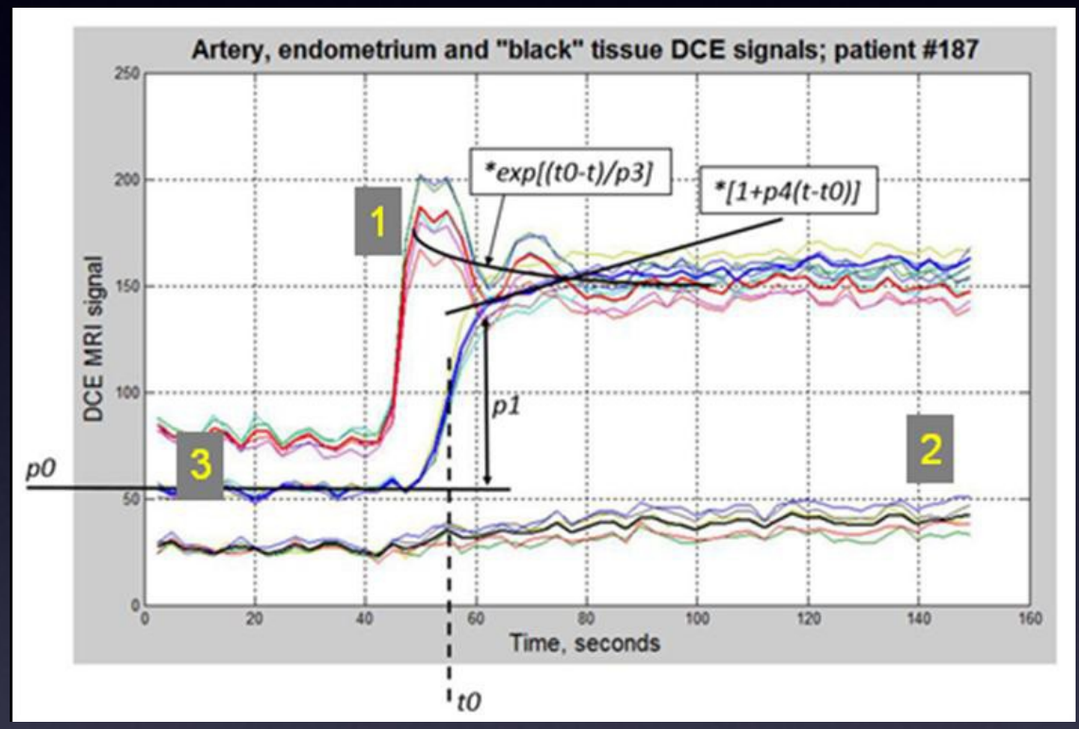
Quantitative analysis and modeling of DCE images for tissue characterization of endometrial carcinoma (grade classification)

MRI-DCE

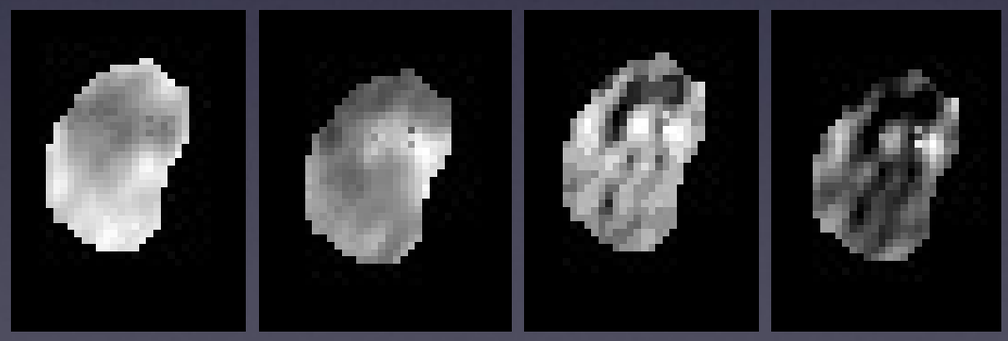


1 – an artery
2 – weak enhancement
3 – endometrium

An empirical, continuous, 6-parameter mathematical model of actual DCE-MRI signal at each ROI voxel



Pharmacokinetic parameter maps

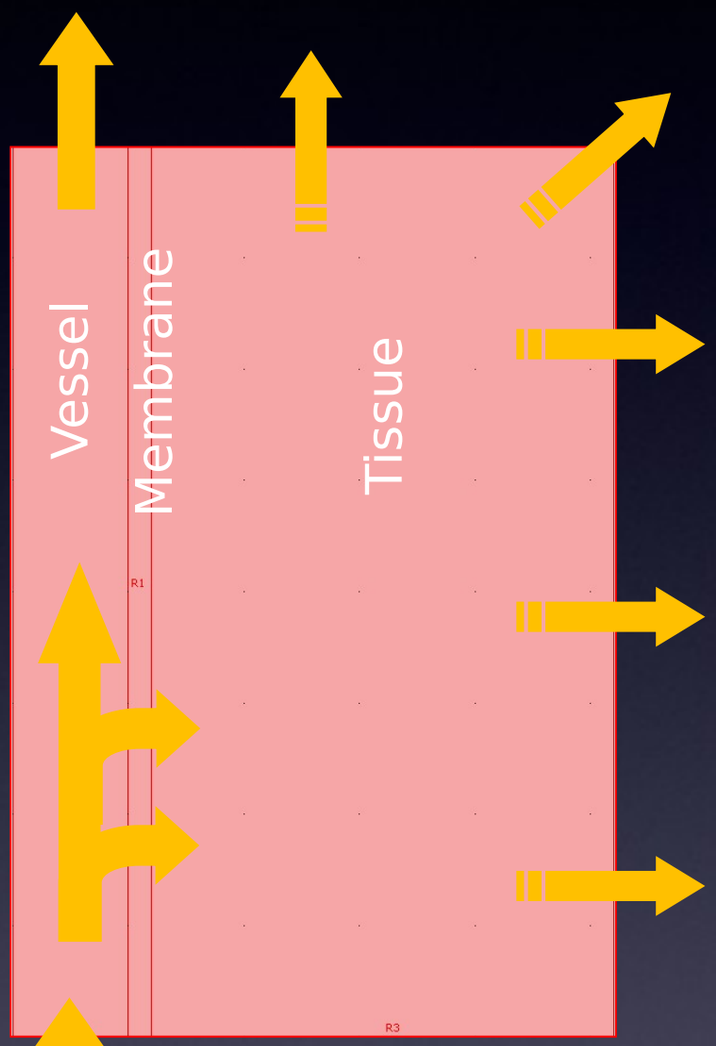


p_1 t_0 p_3 p_4

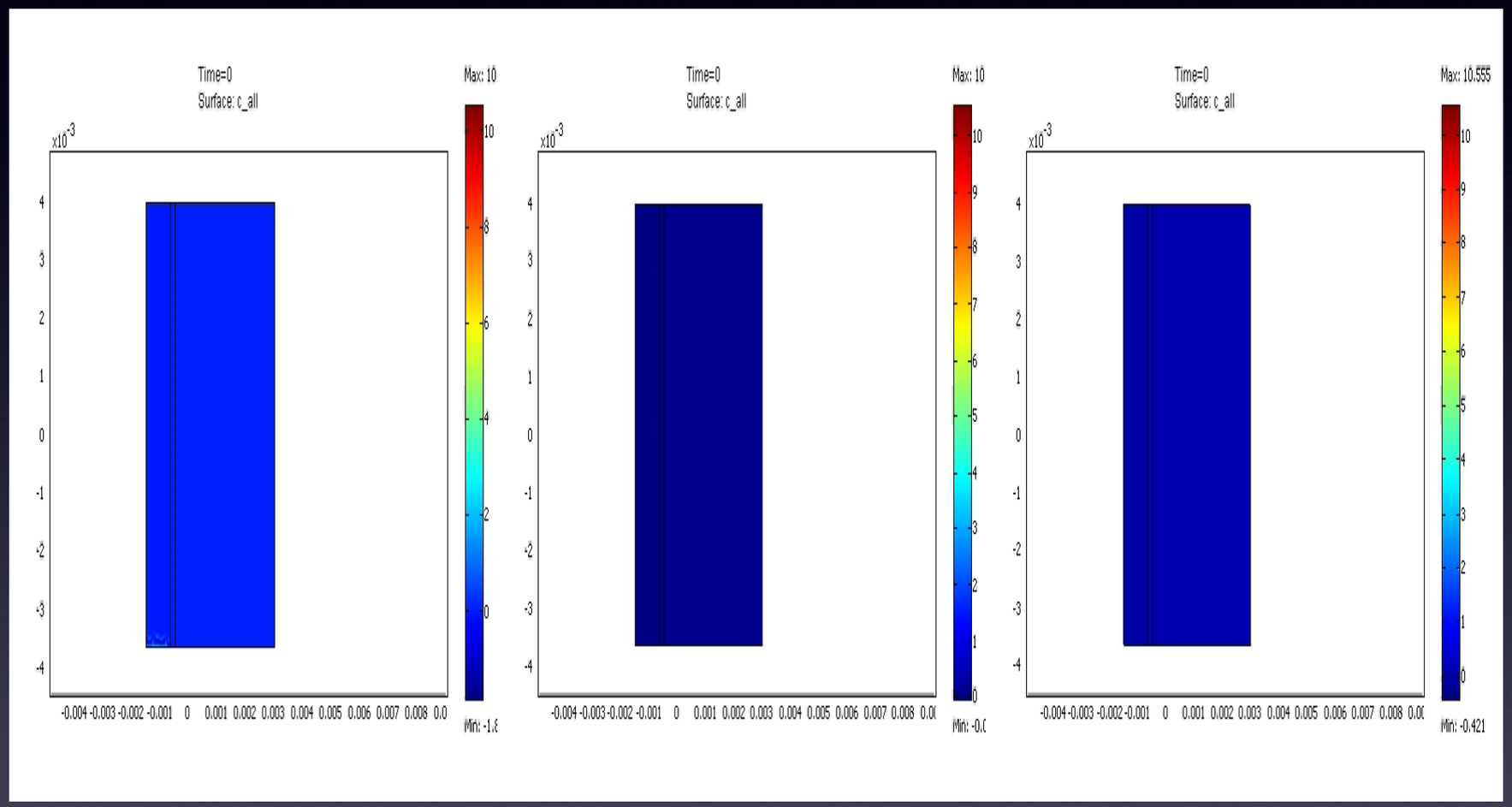
1
0

Blood vessel – tissue exchange model (UiB, 2006)

Simple multiphysics compartmental model



Inflow of fluid,
BOLUS injection



High membrane leakage.
Low tissue porosity

High membrane leakage.
High tissue porosity

Closed tissue compartment

Thank you!

Thank you!

Erasmus students from TUL in BBB, UiB, May 2015