# OSHIMA LAB.

## Medical Image x Simulation x AI

### Department of Mechanical and Biofunctional Systems

Bio-microfluidics

Department of Mechanical Engineering, Graduate School of Engineering
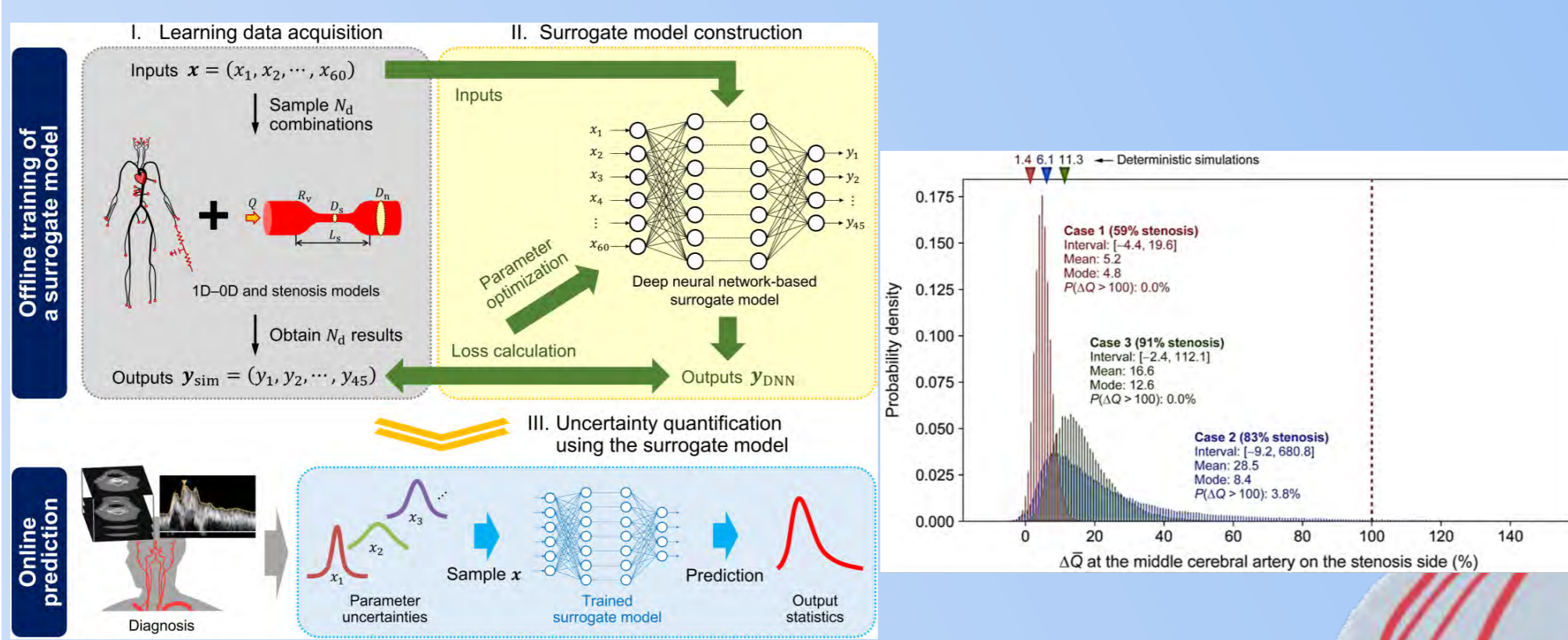Interfaculty Initiative in Information Studies

https://www.oshimalab.iis.u-tokyo.ac.jp/japanese/

# Investigation of Bio/Micro-fluid Mechanics

## ◆Objectives

❑ To investigate the influences of vascular geometry on hemodynamics
❑ To develop a numerical simulation system for clinical diagnosis

## Experiment

● **Flow measurement for droplet formation inside microchannel using digital holography**



3D interfacial geometry between water and oil

3D flow inside droplet

● **Simultaneous measurement of the motion of a single Red Blood Cell and surrounding flow using multicolor confocal micro-PIV**



Tank-treading motion and surrounding velocity distribution of a single RBC
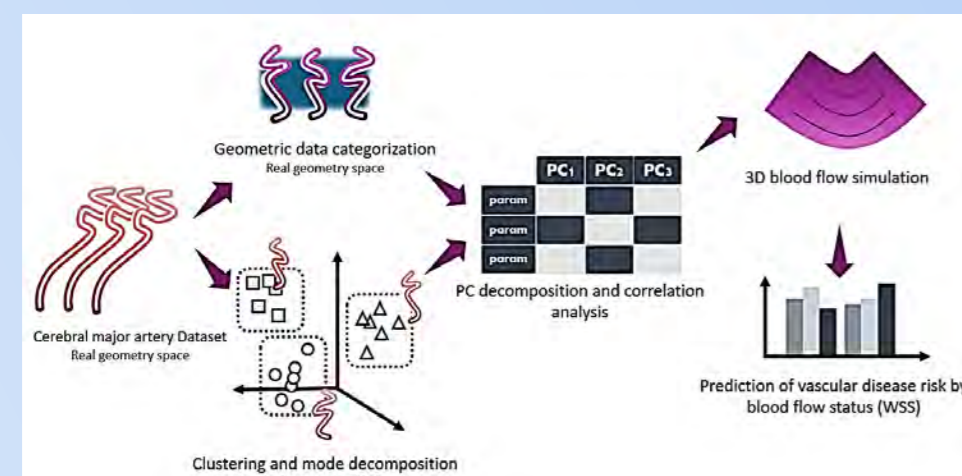
## Simulation

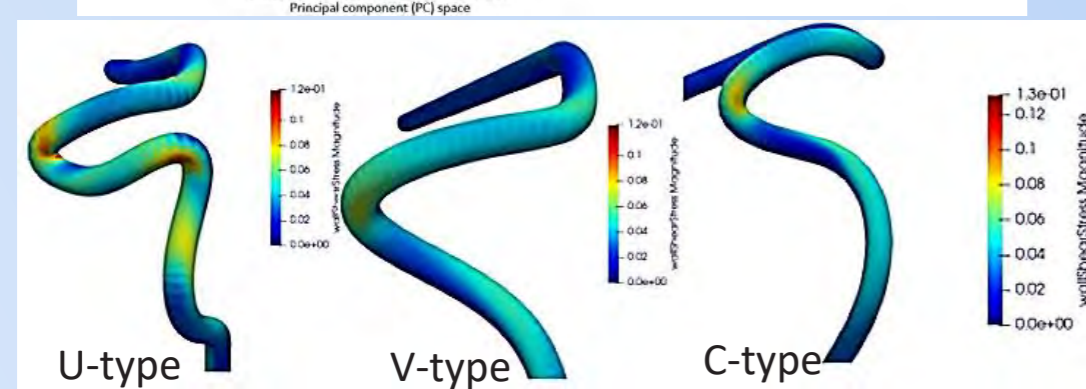● **Uncertainty quantification of hyperperfusion after carotid revascularisation**



Develop a surrogate model that quickly predicts cerebral circulation for a given condition by machine learning

Overperfusion risk distribution by uncertainty analysis

● **3D blood flow simulation for clinical study**



Pipeline of shape analysis by PCA & bloodflow simulation

Wall shear stress distribution various geometry classification based on 104 Internal carotid arteries in BraVa database

U-type    V-type    C-type

● **Multiscale fluid-particle analysis of drug-encapsulated micelles in abdominal aortic aneurysms**

● **Influence of curvature on flow performance inside patient specific femoral artery**
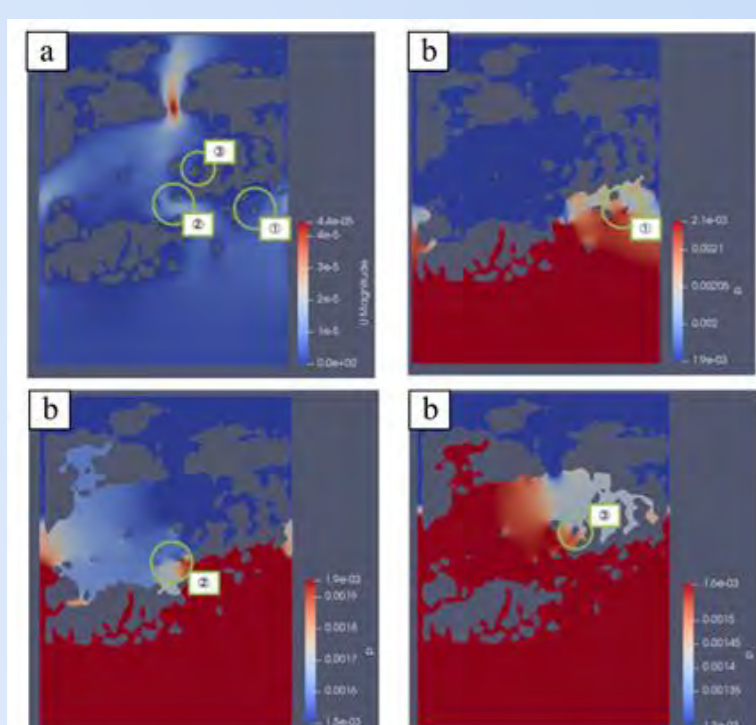


(a) Micelle accumulation points and velocity distribution.
(b) Micelle accumulation points and pressure distribution.
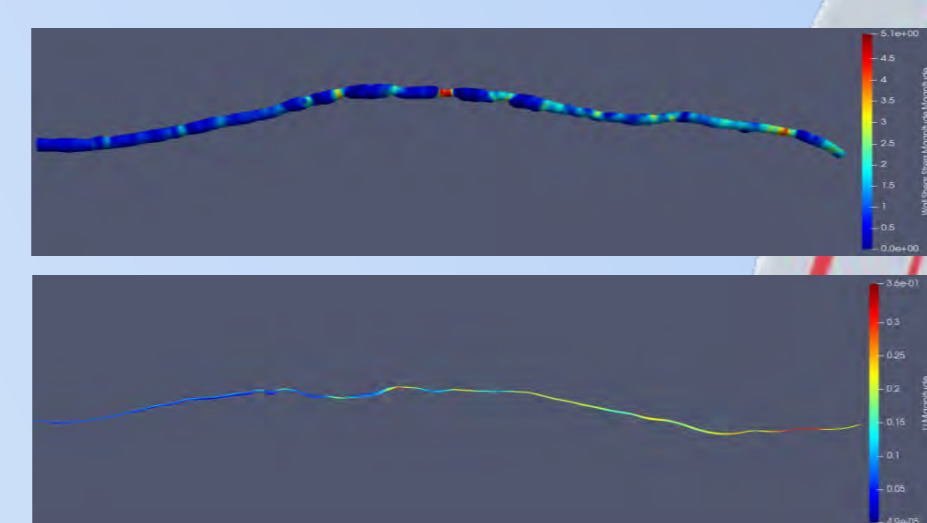
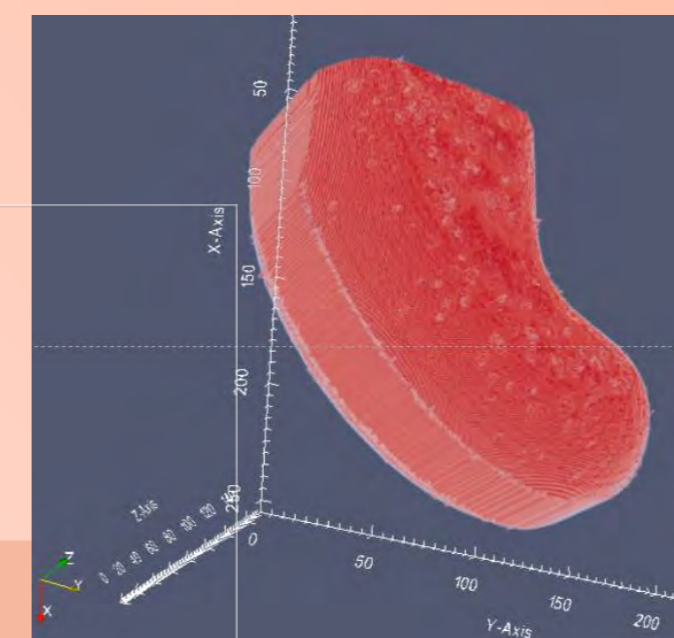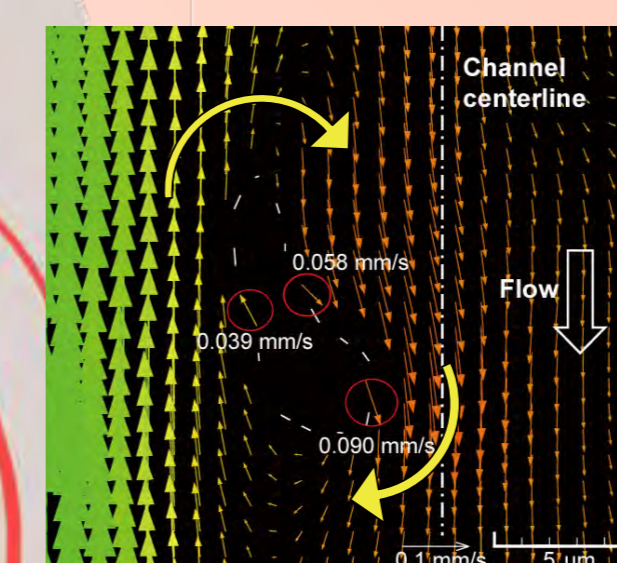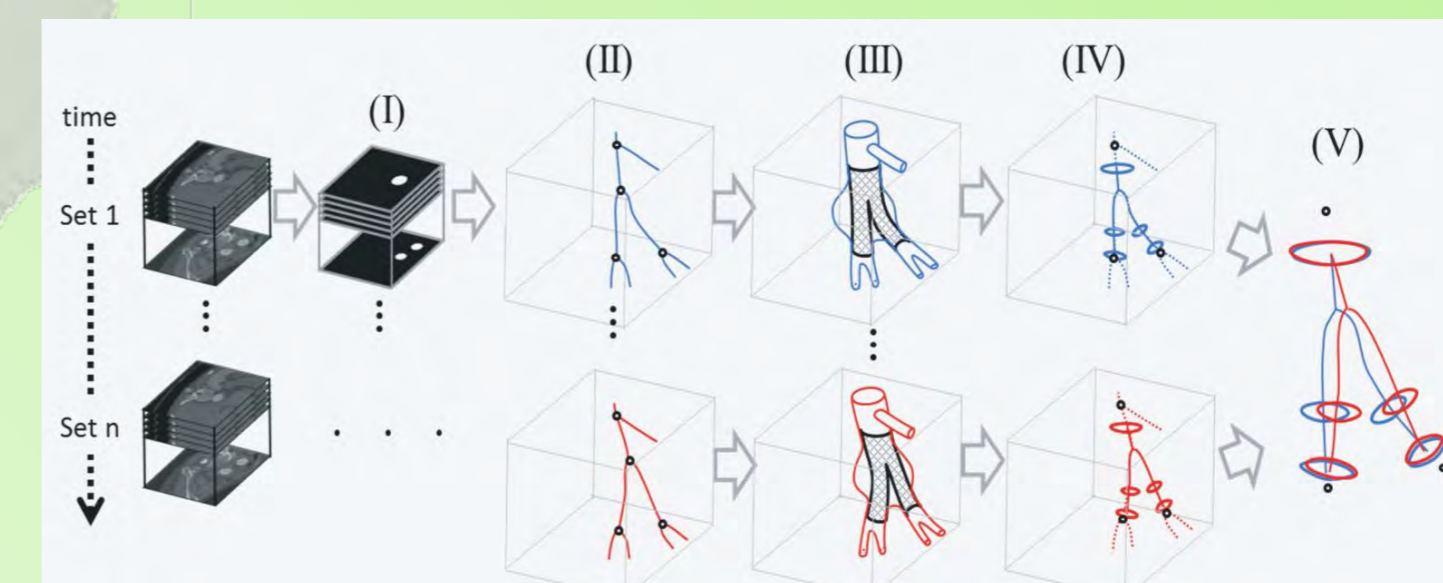Top: Wall shear stress distribution
Bottom: Streamline

## Data processing

● **Designing of modelling system V-modeler**



(I) Segmentation of the vascular lumen
(II) Centerline extraction
(III) Surface shape reconstruction
(IV) Shape parameters calculation (curvature and torsion);
(V) Alignment and position tracking

● **Vessel Segmentation, Centerline Extraction,** and **Bifurcation Detection** in cerebral medical images using deep learning-based approaches



Medical images          input          output          Brain vessel segmentation

Convolutional Neural Network

Institute of Industrial Science, The University of Tokyo