# Introduction to Scientific Visualization
## with Avizo – Hands-on Sessions

Thomas Theußl

22 October 2023
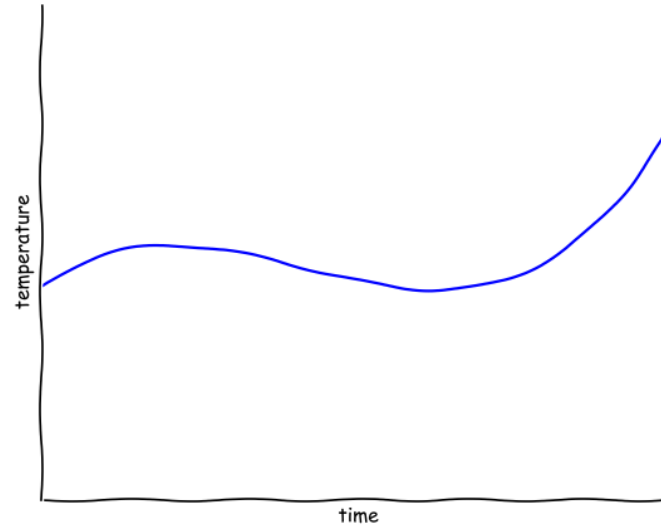
# Scalar Field Visualization
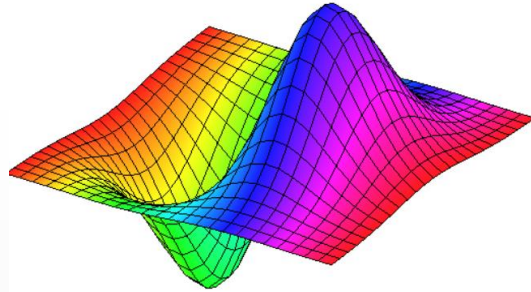
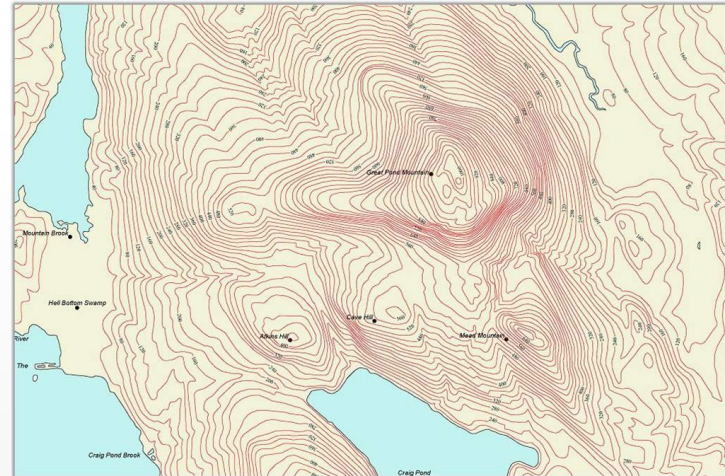# Scalar Fields

- 1D scalar field: $\Omega \subset R \rightarrow R$



- 2D scalar field: $\Omega \subset R^2 \rightarrow R$



- 3D scalar field: $\Omega \subset R^3 \rightarrow R$
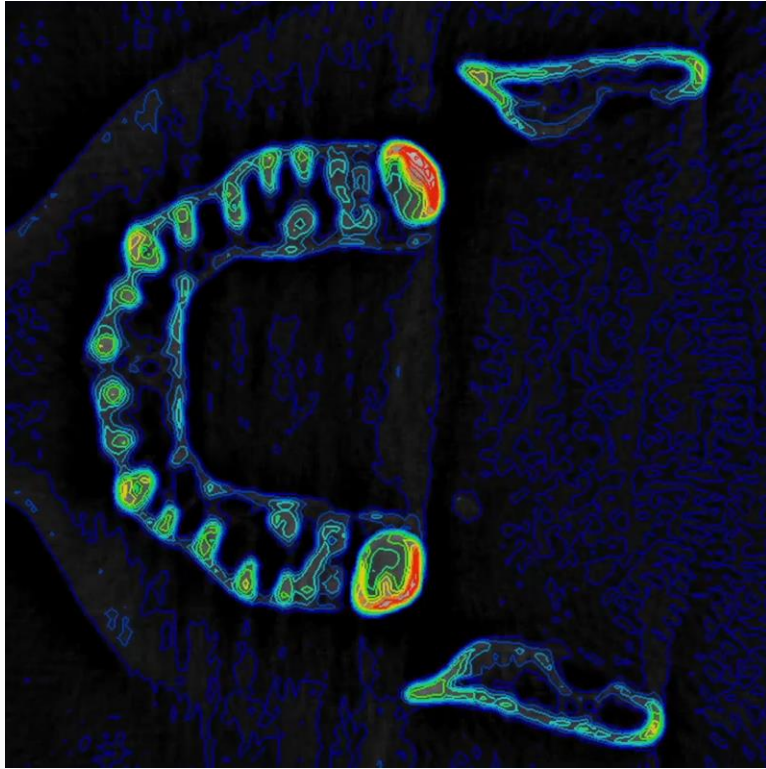  i.e., temperature in a room
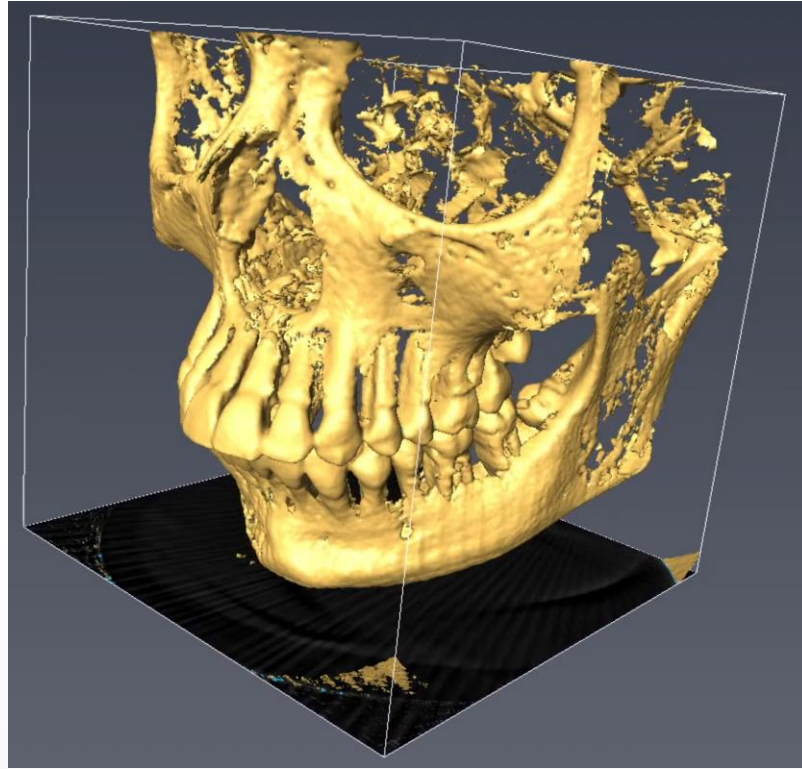  **→ volume visualization**
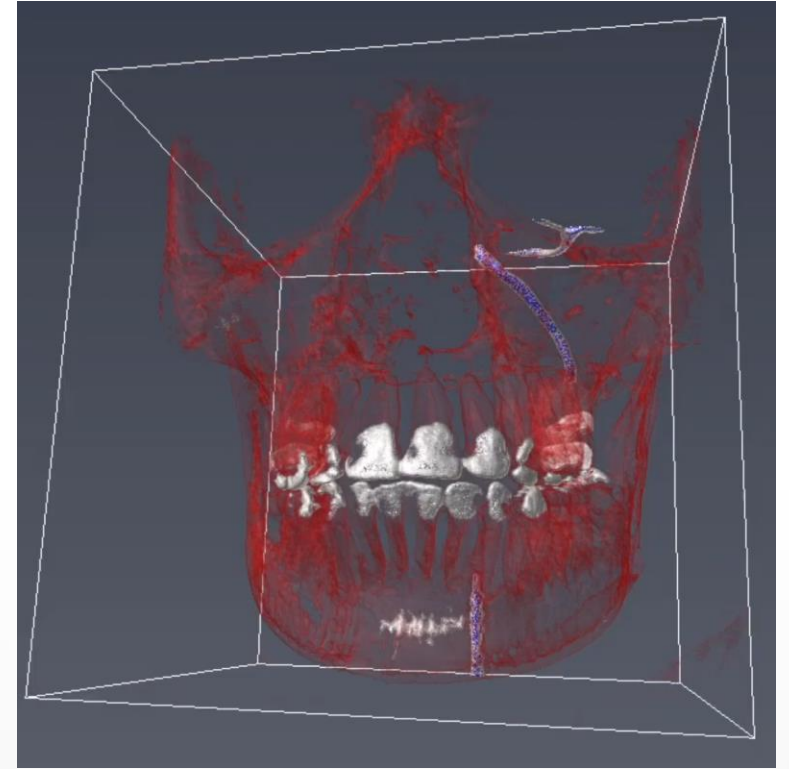
source: wikipedia

# Volume (3D Scalar) Visualization

Basic 3D scalar visualization techniques:



Slicing



Isosurfacing



Raycasting
(direct volume rendering)

# Raycasting



*Image order approach:*

Data Set

Image Plane

Eye
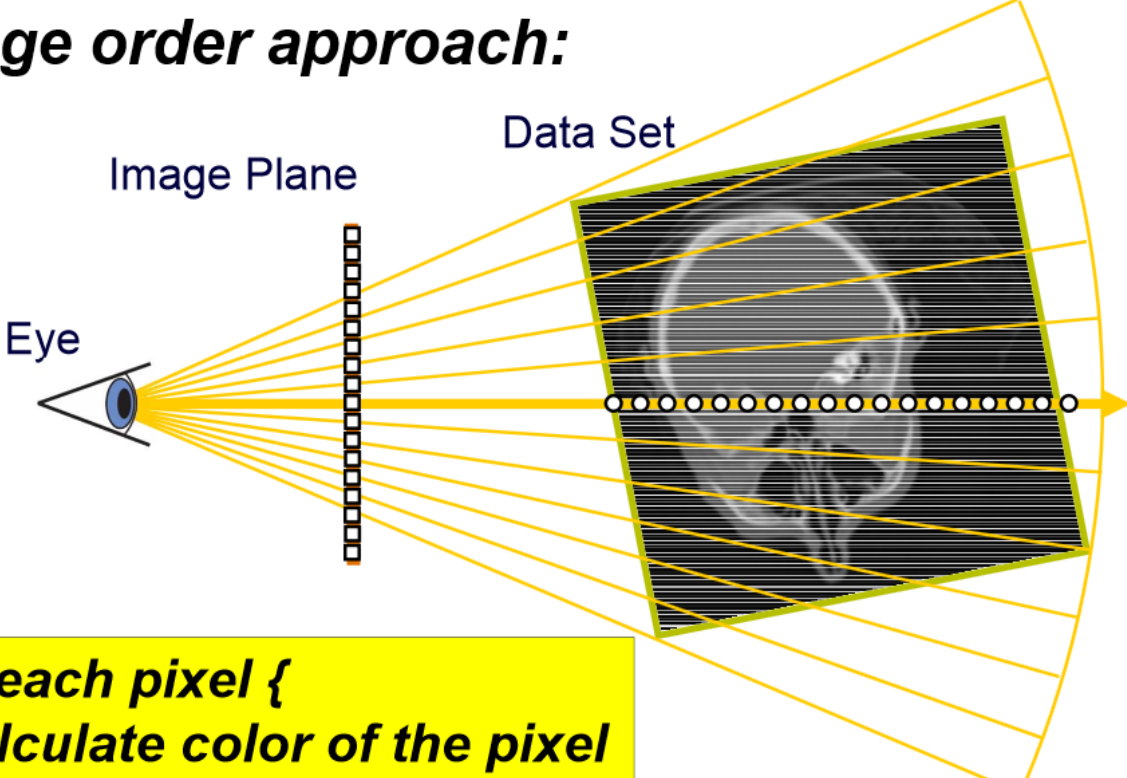
For each pixel {
   calculate color of the pixel
}
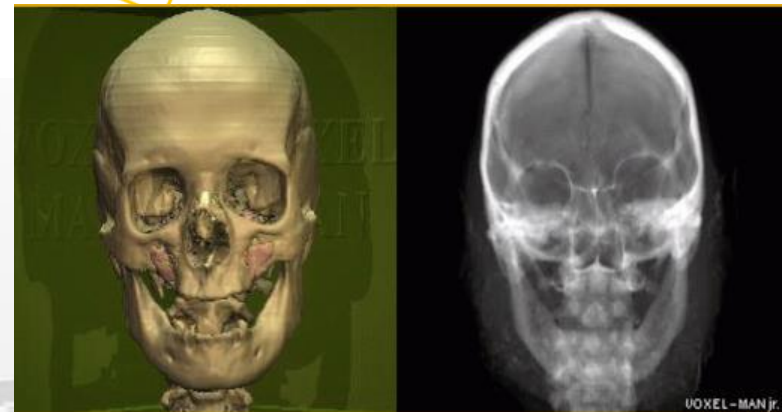
# Videos

- Loading Scalar Data in Avizo

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=728s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=728s)

- Slicing and Isosurfacing

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=1308s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=1308s)

- Volume Rendering

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=2598s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=2598s)
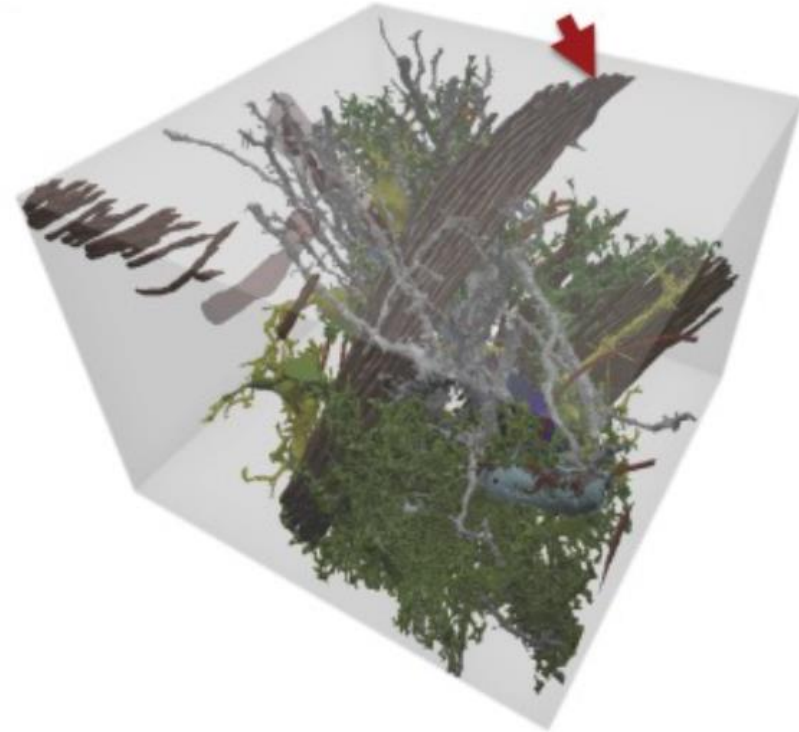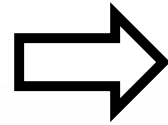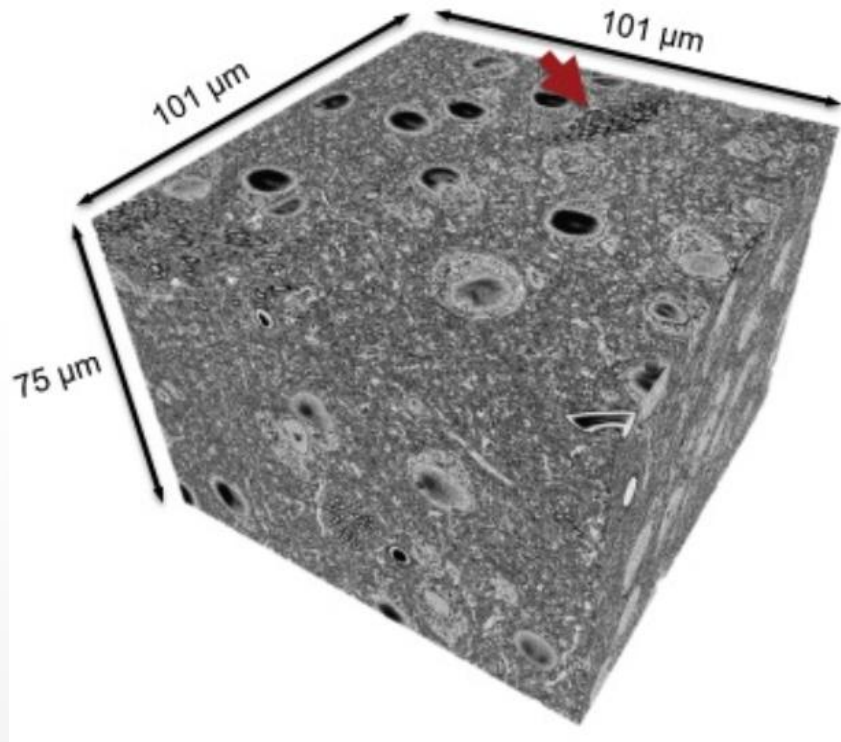
# Volume Segmentation

# Volume Segmentation (1/2)

- the process of partitioning a volume into multiple segments (sets of voxels, objects)
- to simplify a volume to something that is more meaningful and easier to analyze
- the process of assigning a label to every voxel in a volume



Corrado Calì, Marco Agus, Kalpana Kare, Daniya J Boges, Heikki Lehväslaiho, Markus Hadwiger, Pierre J Magistretti (2019) **3D cellular reconstruction of cortical glia and parenchymal morphometric analysis from Serial Block-Face Electron Microscopy of juvenile rat** *Progress in neurobiology* 183.

# Volume Segmentation (2/2)

Basic volume segmentation techniques:
- Thresholding
- Watershed algorithm
- Segmentation editor
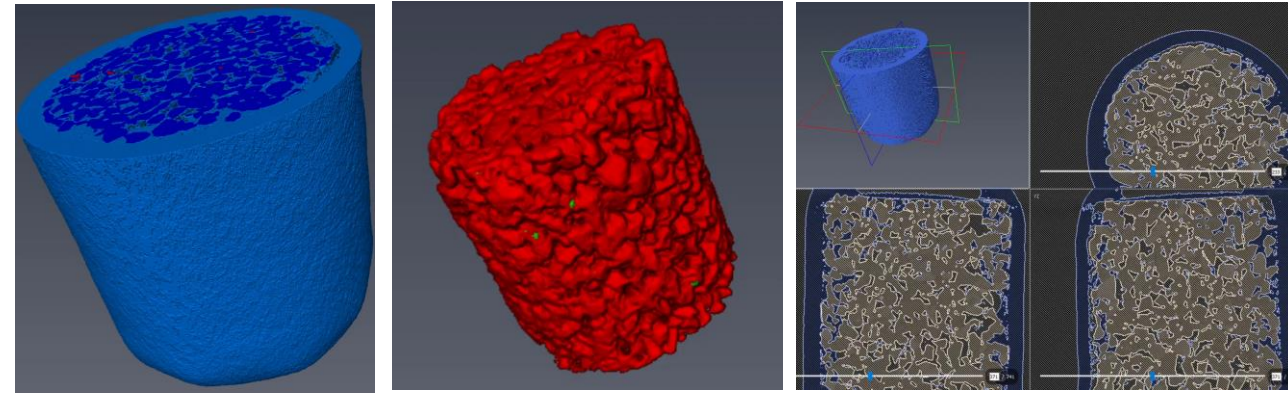


Advanced training course:

## Scientific Visualization 210: Avizo and Ilastik for Image Segmentation and 3D Analysis

**📅 Date**
- Sunday November 5, 2023
- 1:30pm - 4:00pm

**📖 Venue**
- Auditorium between Bldgs. 3 and 5

**🌐 Organizer**
- Ronell Sicat
- Visualization Core Laboratory
- ronell.sicat@kaust.edu.sa

**Register**
- Register here!

https://wiki.vis.kaust.edu.sa/training/scivis/2023/avizoilastik

جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
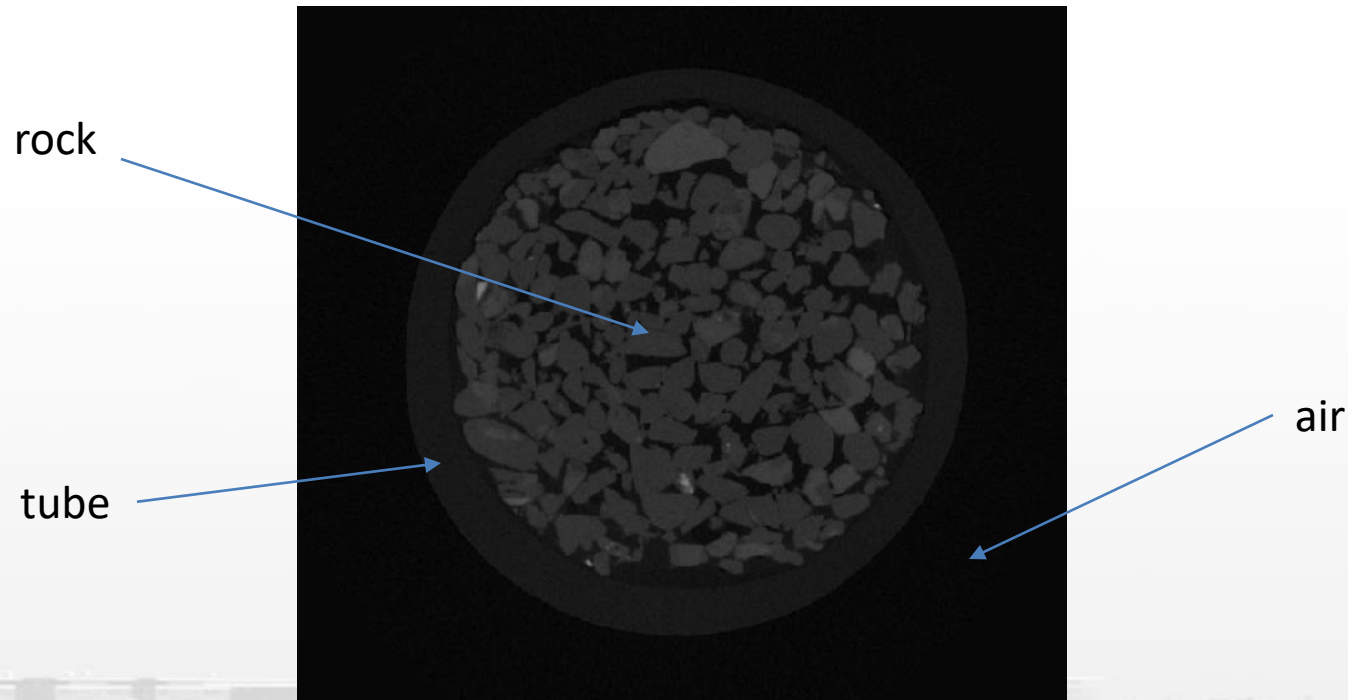Science and Technology
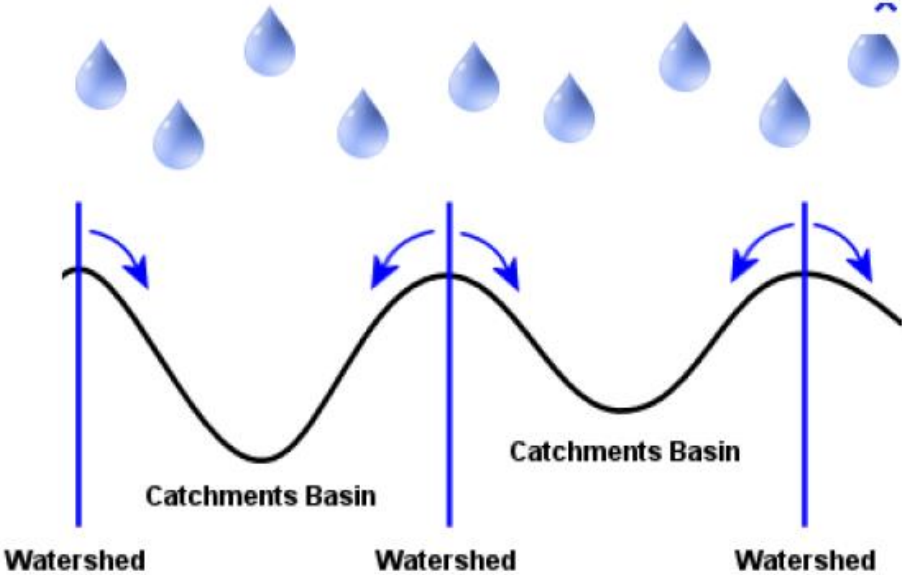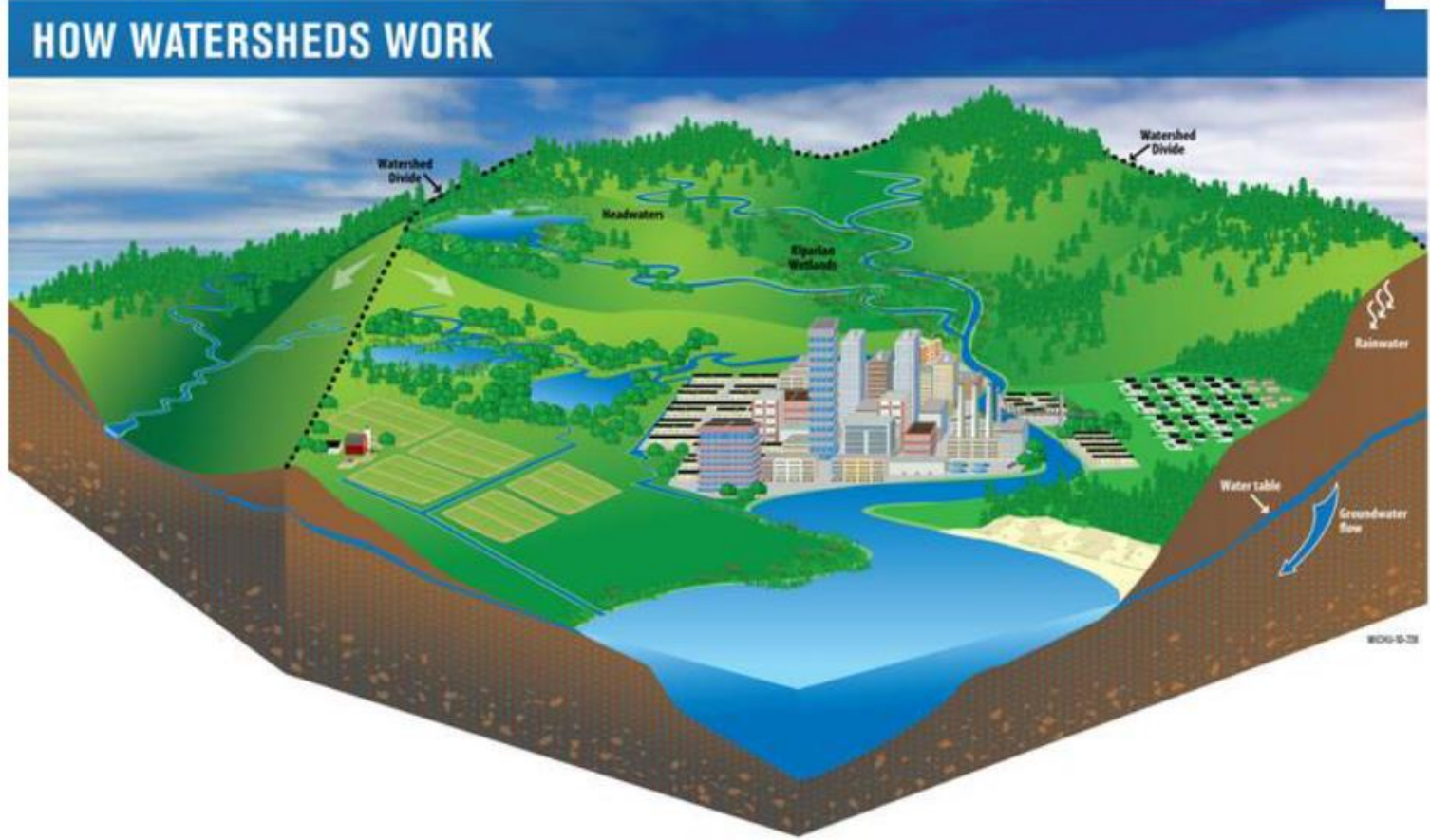
# Dataset

provided by
Jamal AlAamri, Ali I. Al-Naimi Petroleum Engineering Research Center (ANPERC)

- mini core plug isolated inside a shrink tube
- the rock represents a sandstone, a type of rock found in oil and gas reservoirs
- 466 png images of 742x742 resolution
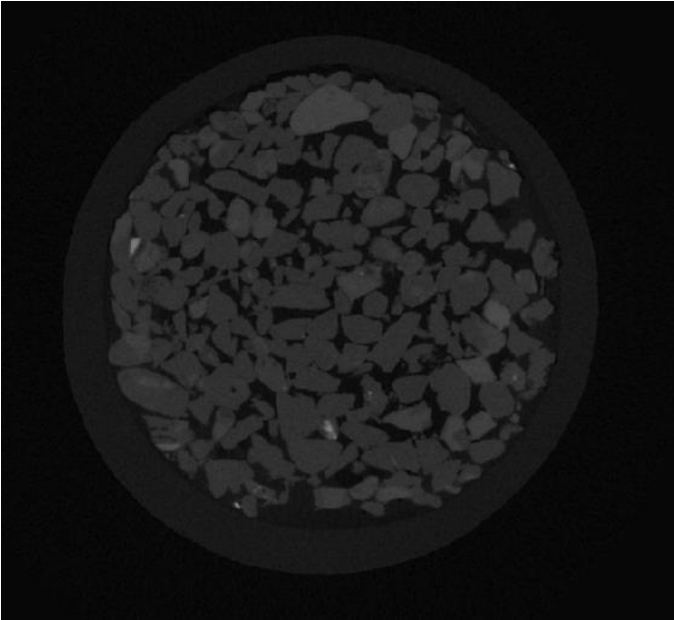
# Watershed Algorithm (1/2)



slide by Gwenole Tallec, ThermoFisher
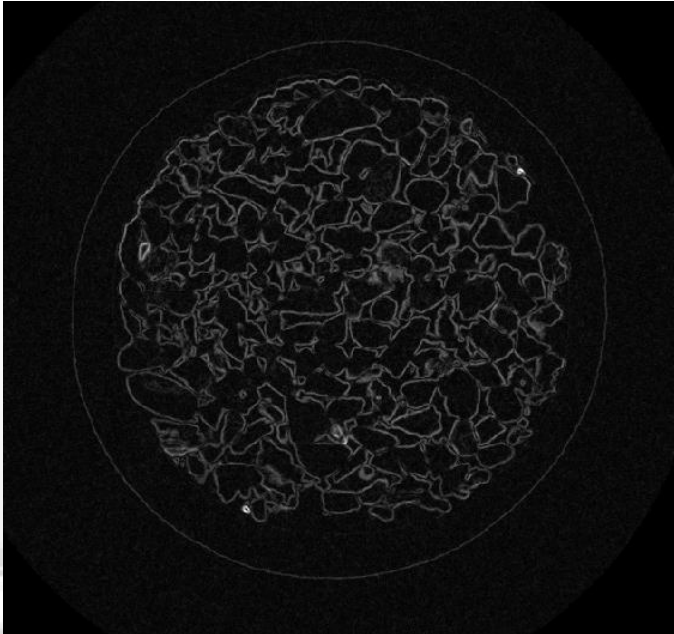
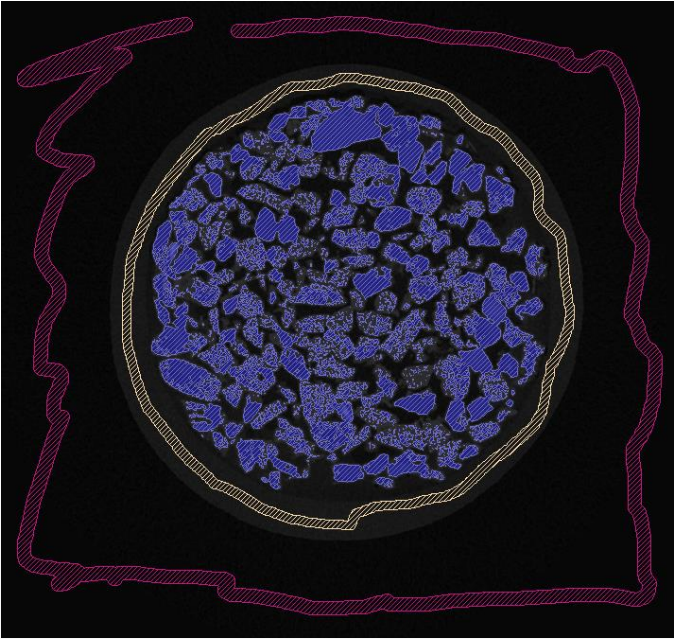# Watershed Algorithm (2/2)



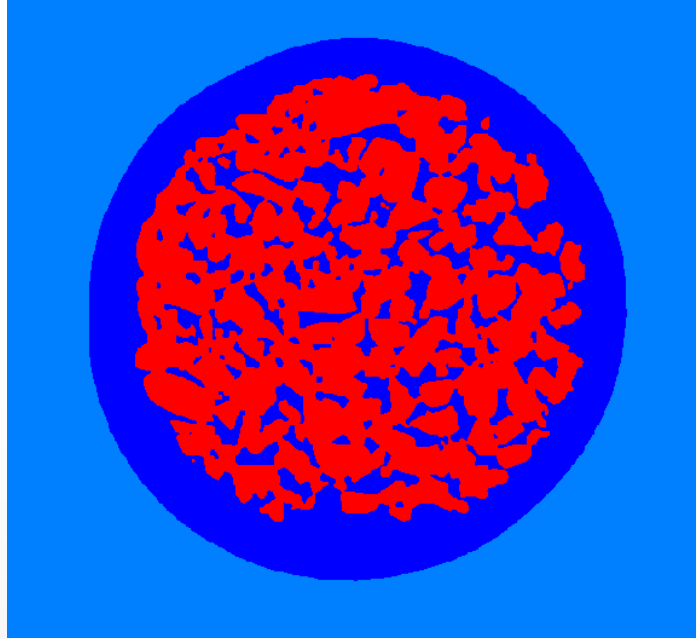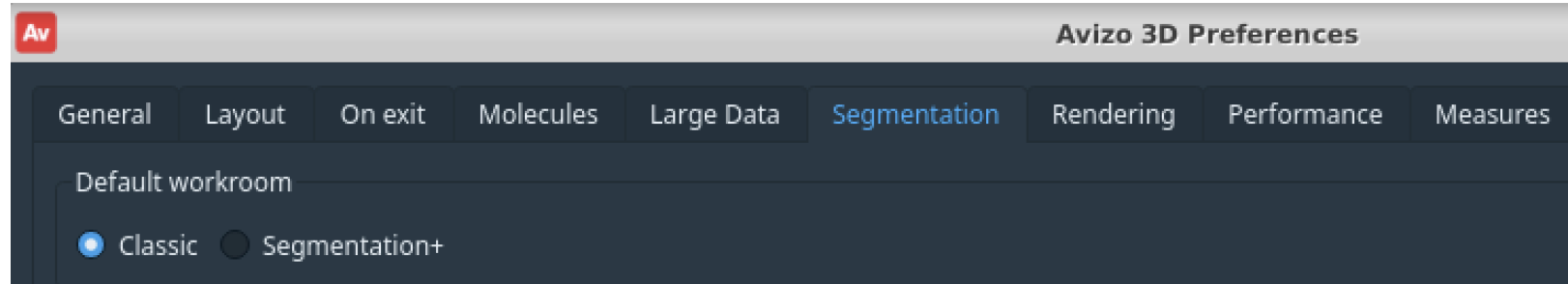Original Volume

Image Gradient

**+**

Markers

**=**

Segmentation

# Segmentation Editor

- Select Classic workroom in Edit->Preferences…:



- For Segmentation+ (Avizo 2023 or higher recommended):



https://wiki.vis.kaust.edu.sa/training/scivis/2023/avizoilastik

# Videos

- Thresholding

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=3713s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=3713s)

- Watershed Algorithm

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=5412s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=5412s)

- Segmentation Editor (Classic workroom)

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=6273s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=6273s)
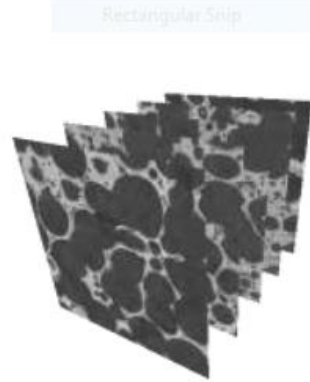
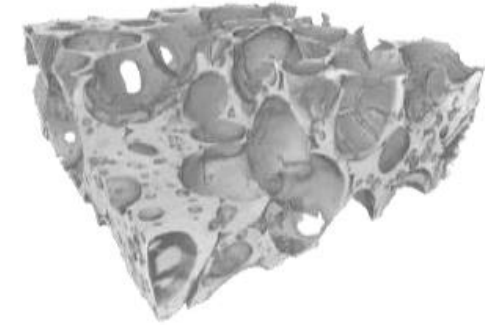# Avizo GUI and Features

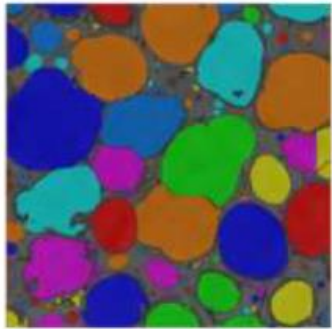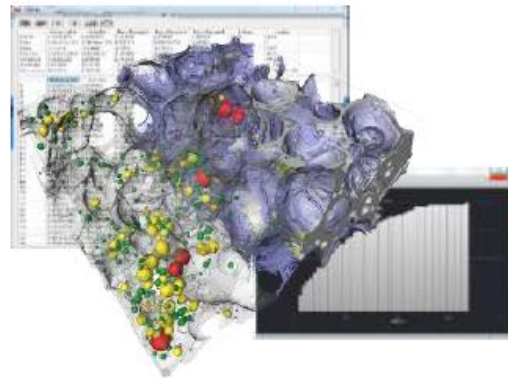# From Sample to Knowledge



| Data acquisition | Import | Filtering & pre-processing | Visualization |

| Segmentation | Measurements & analysis | Presentation |

+ Large Data Management

+ Automation

+ Customization

slide by Gwenole Tallec, ThermoFisher

ThermoFisher
SCIENTIFIC

# Videos

- Saving Projects in Avizo

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=7158s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=7158s)

- Filtering and Preprocessing

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=7819s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=7819s)

- Linked Cameras and Connections

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=8636s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=8636s)

- Avizo GUI and Help

  - [https://www.youtube.com/watch?v=AjUAyhZEG5I&t=9035s](https://www.youtube.com/watch?v=AjUAyhZEG5I&t=9035s)