

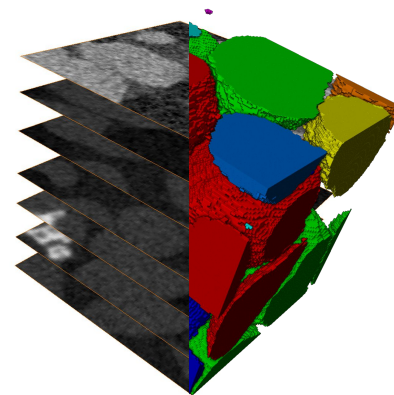


Scientific Visualization 101

Image Segmentation, 3D Analysis and Rendering

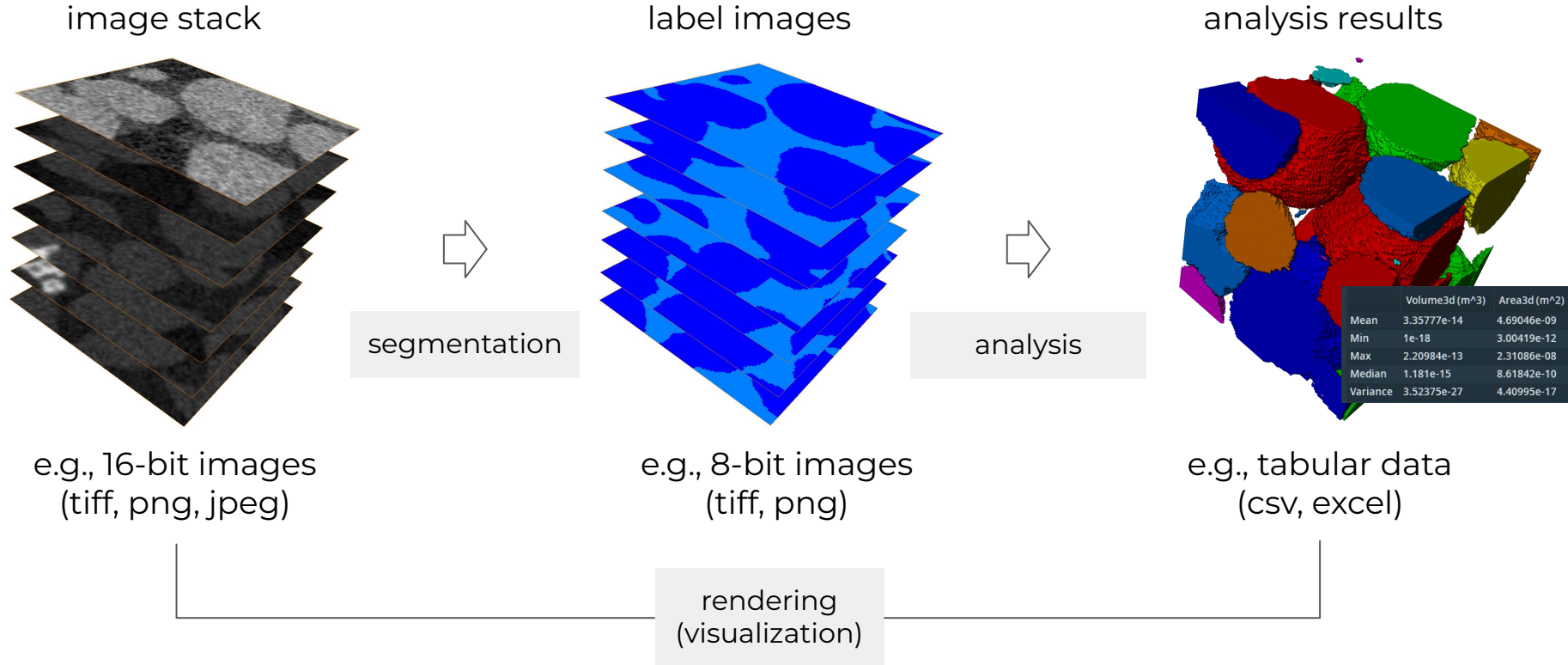
KAUST Visualization Core Lab

Ronell Sicat

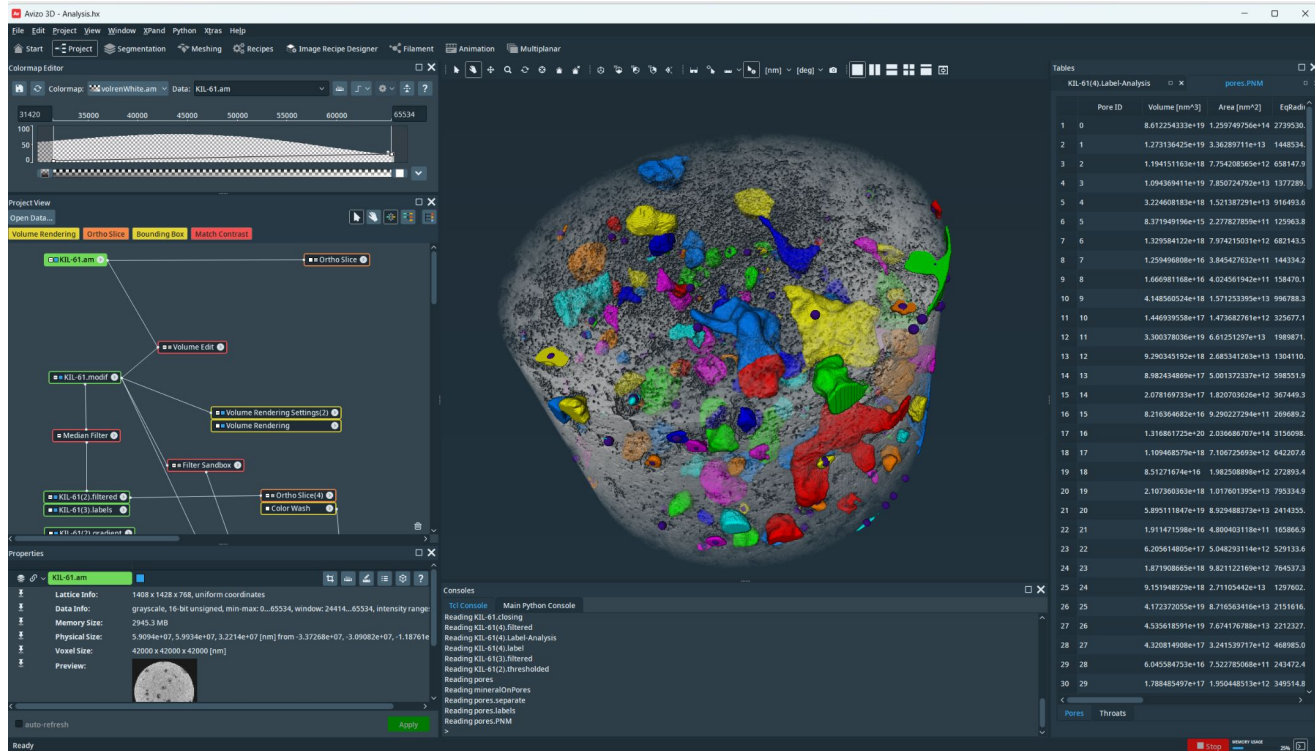


KAUST
VISUALIZATION
CORE LAB

Overview

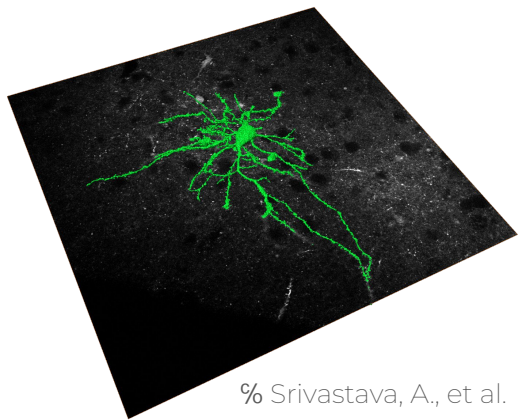


Avizo 2024.2

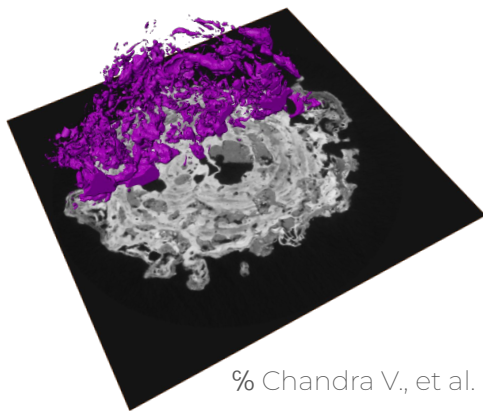


<https://it.kaust.edu.sa/software/avizo>

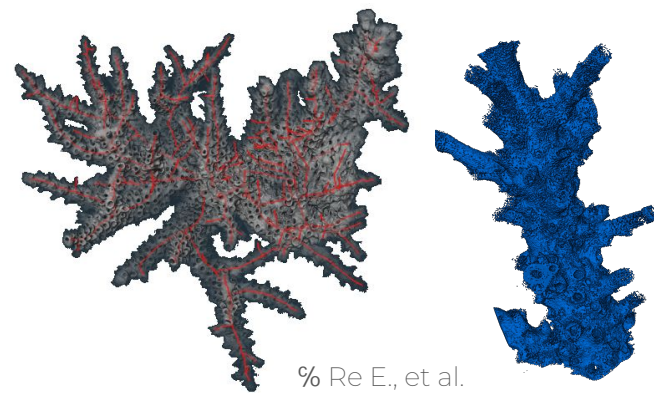
Examples



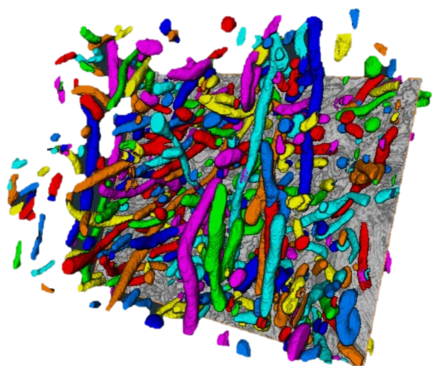
% Srivastava, A., et al.



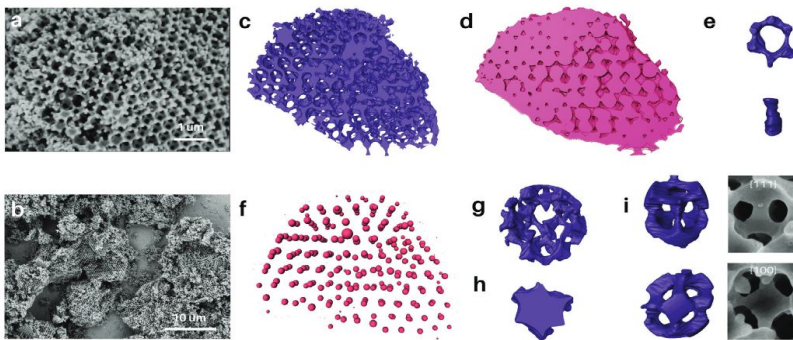
% Chandra V., et al.



% Re E., et al.



% Lucchi A., et al.



% Poloneeva D., et al.

KAUST Visualization Core Lab (KVL) Introduction

KAUST Core Labs

CORE LABS SHARED RESEARCH INFRASTRUCTURE



Core Labs Mission

To deliver impact through stewardship and development of state-of-the-art facilities and technical expertise. We offer research support, we enhance human capabilities, and we provide foundational and innovative solutions to our users at KAUST and in the Kingdom.



ANALYTICAL CHEMISTRY

21 Staff



BIOSCIENCE

25 Staff



IMAGING AND CHARACTERIZATION

26 Staff



PLANT GROWTH

10 Staff



SUPERCOMPUTING

18 Staff



ANIMAL RESOURCES

1 Staff



COASTAL AND MARINE RESOURCES

50 Staff



NANOFABRICATION

19 Staff



PROTOTYPING AND PRODUCT DEVELOPMENT

38 Staff



VISUALIZATION

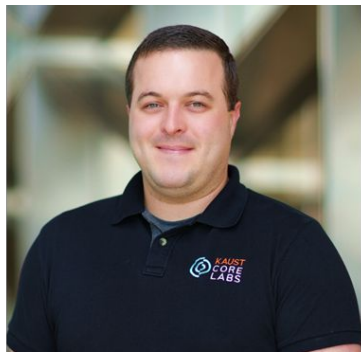
6 Staff

KVL provides expertise in **data visualization** and **data science**



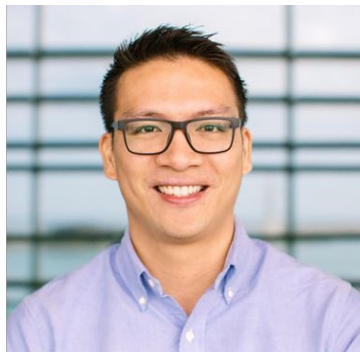
Dr. Sohaib Ghani
(LEAD STAFF SCIENTIST)

- VISUAL ANALYTICS
- INFORMATION VIS
- STATISTICAL ANALYSIS



Dr. James Kress
HPC SCIVIS

- VISUALIZATION SOFTWARE
- HPC INSITU VISUALIZATION
- DISTRIBUTED VISUALIZATION



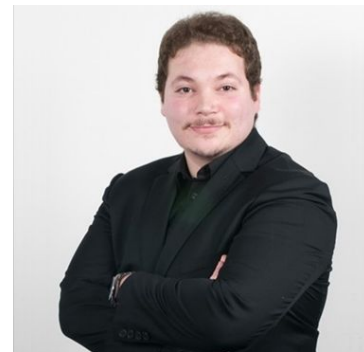
Dr. Ronell Sicat
SCIVIS, AR/VR

- SCIENTIFIC VISUALIZATION
- SEGMENTATION & 3D ANALYSIS
- AR/VR DEVELOPMENT



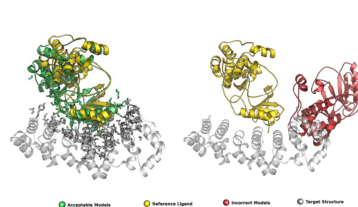
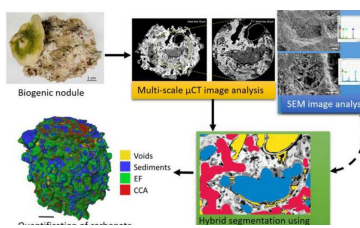
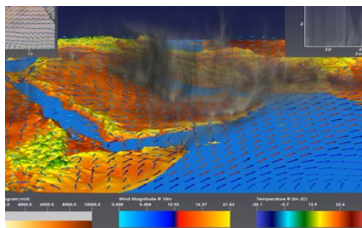
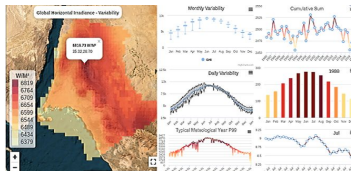
Dr. Didier Barradas
DATA SCIENTIST

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING



Dr. Abdelghafour Halimi
DATA SCIENTIST

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING





Ronell Sicat

Visualization Scientist @ Visualization Core Lab, King Abdullah University of Science and Technology

Verified email at kaust.edu.sa - Homepage

Scientific Visualization Large-scale Images and Vo... Augmented/Virtual Reality Segmentation

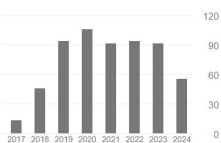
FOLLOWING

TITLE	CITED BY	YEAR
A novel multi-scale μCT characterization method to quantify biogenic carbonate production V Chandra, R Sicat, F Benzoni, V Vahrenkamp, V Bracchi Geoscience Frontiers 15 (6), 101883	2024	
Advancing Membrane Technology: Ordered Macroporous ZIF-67 as a Filler in Mixed Matrix Membranes for Enhanced Propylene/Propane Separation D Poloneeva, SJ Datta, R Sicat, R Khairova, L Garzon-Tovar, A Bavykina, Small, 2309127	1	2024
Natural variation in salt-induced changes in root: shoot ratio reveals SR3G as a negative regulator of root suberization and salt resilience in Arabidopsis MR Ishika, H Sussman, Y Hu, MD Algahtani, E Craft, R Sicat, M Wang, bioRxiv, 2024.04.09.588564	2024	
Multivariate Probabilistic Range Queries for Scalable Interactive 3D Visualization A Agueli, A Jiespe-Villanueva, R Sicat, F Mannuss, P Rautek, M Hadwiger IEEE Transactions on Visualization and Computer Graphics 29 (1), 646-656	1	2022
Real-Time Visualization of Large-Scale Geological Models With Nonlinear Feature-Preserving Levels of Detail R Sicat, M Ibrahim, A Agueli, F Mannuss, P Rautek, M Hadwiger IEEE Transactions on Visualization and Computer Graphics 29 (2), 1491-1505	2	2021
Virtual reality framework for editing and exploring medial axis representations of nanometric scale neural structures D Boges, M Agus, R Sicat, PJ Magistretti, M Hadwiger, C Cali Computers & Graphics 91, 12-24	11	2020
Virtual environment for processing medial axis representations of 3D nanoscale reconstructions of brain cellular structures D Boges, C Cali, PJ Magistretti, M Hadwiger, R Sicat, M Agus Proceedings of the 25th ACM Symposium on Virtual Reality Software and ...	2	2019
Immersive environment for creating, proofreading, and exploring skeletons of nanometric scale neural structures D Boges, C Cali, PJ Magistretti, M Hadwiger, RB Sicat, M Agus Eurographics Association	3	2019
DXR: A toolkit for building immersive data visualizations R Sicat, J Li, J Choi, M Cordell, WK Jeong, B Bach, H Pfister IEEE transactions on visualization and computer graphics 25 (1), 715-725	201	2018
Drawing into the AR-CANVAS: Designing embedded visualizations for augmented reality B Bach, R Sicat, H Pfister, A Quigley Workshop on Immersive Analytics, IEEE Vis 4	51	2017
The hologram in my hand: How effective is interactive exploration of 3D visualizations in immersive tangible augmented reality? B Bach, R Sicat, J Beyer, M Cordell, H Pfister IEEE transactions on visualization and computer graphics 24 (1), 457-467	270	2017
Comparative Visual Analysis of Structure-Performance Relations in Complex Bulk-Heterojunction Morphologies A Aboulhassan, R Sicat, D Baum, O Wodo, M Hadwiger Computer Graphics Forum 36 (3), 329-339	7	2017
Large-Scale Multi-Resolution Representations for Accurate Interactive Image and Volume Operations RB Sicat	2015	
Sparse PDF Volumes for Consistent Multi-Resolution Volume Rendering R Sicat, J Krueger, T Moeller, M Hadwiger IEEE	39	2014

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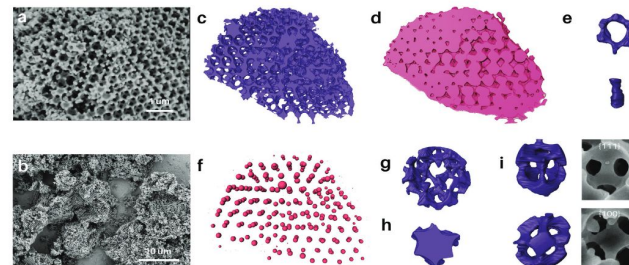
Markus Hadwiger
Professor of Computer Science, ...

RESEARCH ARTICLE

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Advancing Membrane Technology: Ordered Macroporous ZIF-67 as a Filler in Mixed Matrix Membranes for Enhanced Propylene/Propane Separation

Daria Poloneeva, Shuvojit Datta, Ronell Sicat, Rushana Khairova, Luis Garzon-Tovar, Anastasiya Bavykina, Mohamed Eddaoudi,* and Jorge Gascon*



OM-ZIF-67 particles at low magnification. c) Surface-rendered part of OM-ZIF-67: pore aperture. d) Surface-rendered part of OM-ZIF-67: missing pillar and h) missing pore. SEM images.

Advances in this type of membrane, e.g. modification of a polymer to make it more similar to a polymer to increase the affinity for functionalization to improve compatibility,^[4] and morphology modification, such as nanoparticles^[5] 2D sheets,^[6] particles,^[7] etc. additional challenge, the lack of processability in the manufacture of these composite membranes, was recently overcome by processing MOFs through a porous liquid (PL) state.^[8] We

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King Abdullah University of Science and Technology
23955, Saudi Arabia

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Research Paper

A novel multi-scale μ CT characterization method to quantify biogenic carbonate production

V. Chandra^{a,c,*}, R. Sicat^b, F. Benzoni^c, V. Vahrenkamp^a, V. Bracchi^d

^aPhysical Sciences and Engineering, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia
^bVisualization Core Lab, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia
^cBiological and Environmental Science and Engineering, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia
^dDepartment of Earth and Environmental Sciences, University of Padova, Italy

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 μ CT

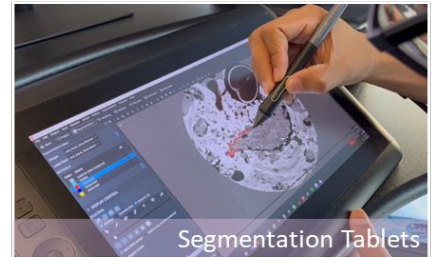
Figure showing grayscale cross-section (A) and corresponding labeled image (B) segmented into voids, sediments, EF, and CCA. (C) shows the ground-truth segmentation method applied to the sub-volume HRCT image of the sample. Scale bars are 0.5 cm and 1 cm.

KVL offers state-of-the-art **visualization facilities**

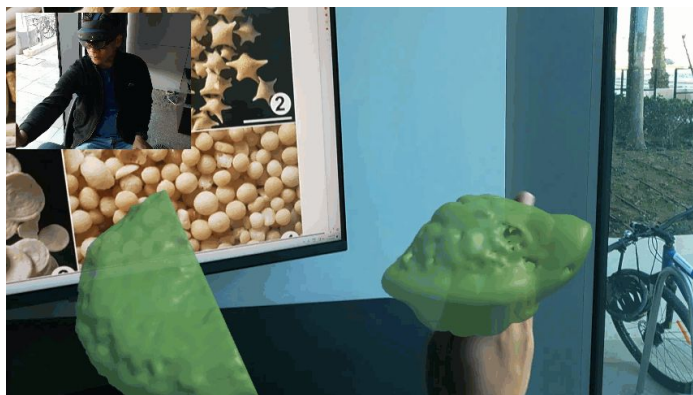
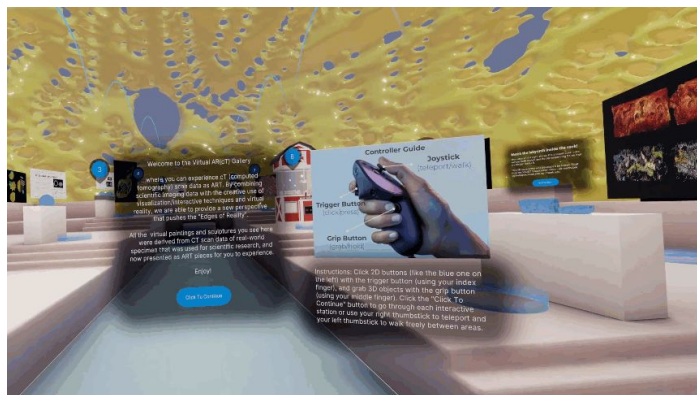
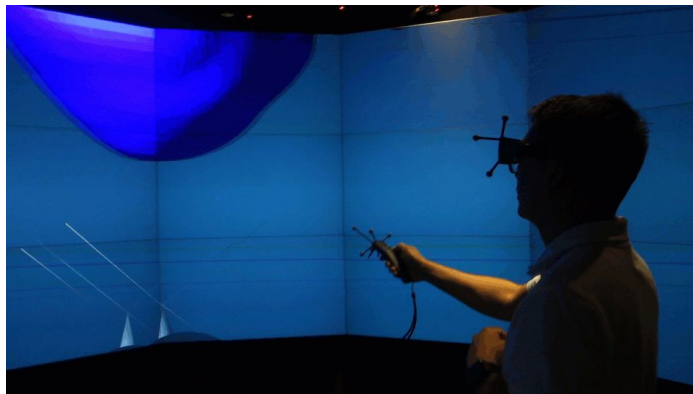
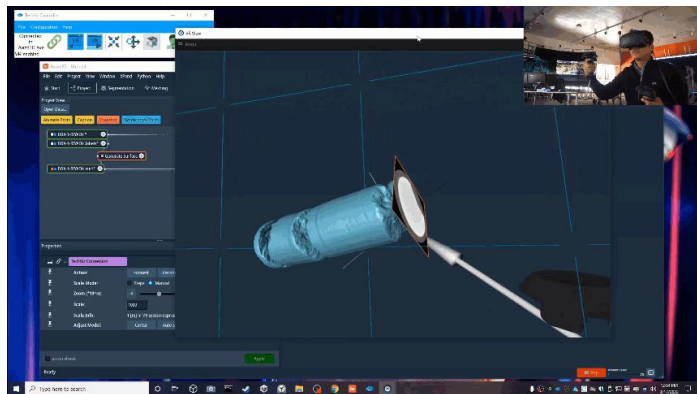
Display Walls



AR/VR Hub



AR/VR Data Visualization



KVL offers technical **trainings** and **workshops**

Scientific Visualization Workshop Series Fall 2025

Date	Training Event	Speaker	Registration
October 14, 2025	Scientific Visualization 101: Visit – An Introductory Hands-On Workshop	James Kress	Closed
October 28, 2025	Scientific Visualization 101: ParaView – An Introductory Hands-On Workshop	Thomas Theussl	Register Here
November 4, 2025	Scientific Visualization 101: Introduction to Image Segmentation, 3D Analysis and Rendering	Ronell Sicat	Register Here

Introduction to Data Science Workshop Series Fall 2025

Date	Training Event	Speaker	Registration
September 28, 2025	Introduction to Conda & FAIR for (Data) Scientists	Didier Barradas & Julien Gorenflot	Closed
October 02, 2025	Introduction to Python for (Data) Scientists	Didier Barradas	Closed
October 05, 2025	Data Science on-boarding on Ibx	Didier Barradas	Closed

Hands-on AI Tools and Techniques Workshop Series Fall 2025

Date	Training Event	Speaker	Registration
October 06, 2025	Introduction to Machine Learning	Abdelghafour Halimi	Closed
October 13, 2025	Introduction to Deep Learning	Abdelghafour Halimi	Closed
October 27, 2025	Introduction to Docker	Abdelghafour Halimi	Closed

<https://wiki.vis.kaust.edu.sa/training/overview>

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Visualization Laboratory Wiki

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Welcome to the KVL

Welcome to the KAUST Visualization Core Lab (KVL)

Who We Are

Core Services

Mission

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Location

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People

Training Events

Facilities

Highlights

KVL Documentation

Frequently Asked Questions

Visualization Tools User Guides

VR Tools User Guides

Data Science Tools User Guides

Facility User Guides

Docs » start

Welcome to the KAUST Visualization Core Lab (KVL)

Who We Are

The KAUST Visualization Core Laboratory is a state-of-the-art facility within the Core Labs that offers students, faculty, researchers, and university collaborators a unique opportunity to utilize one-of-a-kind visualization, interaction, and computational resources for the exploration and analysis of scientific data.

Core Services

Our mission is to support the data visualization and data science needs of KAUST researchers and In-Kingdom entities. To that end we have a varied range of expertise across the team. Contact us with your questions, project requests, or collaboration requests that fall within our service areas:

- 2D/3D Visualization Facilities**
 - We provide a unique set of [visualization and meeting facilities](#) on campus.
 - 📩 [Contact us](#) for inquiries or use your KAUST credentials to [create a booking](#).
- Data Visualization and Data Science Workflows**
 - We support KAUST users with [visualization workflows](#), [VR workflows](#), and [data science/machine learning](#).
 - Contact us for [additional information](#), to [submit a general request](#), or [request a collaboration](#).
- Training and Workshops**
 - We have a wide variety of trainings available on our [YouTube Channel](#) 📺 as well as select trainings performed [in-person each semester](#).

Mission

To support the needs of KAUST researchers and In-Kingdom entities by:

- Developing and maintaining an effective and efficient environment for data exploration and analysis
- Providing advanced visualization and data analysis services
- Providing training on state-of-the-art visualization hardware and software for scientific discovery
- Developing new capabilities to remain at the cutting edge of visualization and data science

Contact Us

✉ help@vis.kaust.edu.sa
📺 [KVL YouTube Channel](#)
🐦 [KVL Twitter](#)
🌐 [Core Labs Website](#)
🌐 [KVL Core Labs Main Website](#)

Location

Our main showcase facility is located @:
Building 1 (seaside), Level 2, Showcase



KAUST Visualization Core Lab

🔍 Zoom to 📧 Email Map 📍 Direction

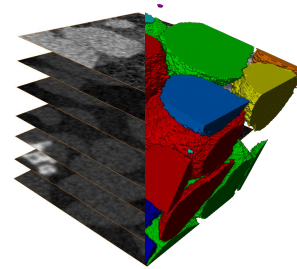


KVL website

Schedule

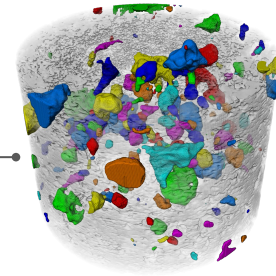
- 10 mins: Introduction

- 40 mins: Avizo Basics ————●



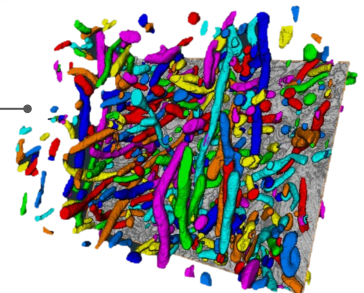
- 5 mins: Break

- 30 mins: Porosity in Rock CT Images ————●



- 5 mins: Break

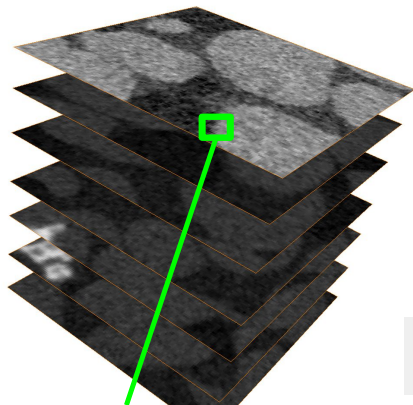
- 30 mins: Mitochondria in Brain EM Images ————●



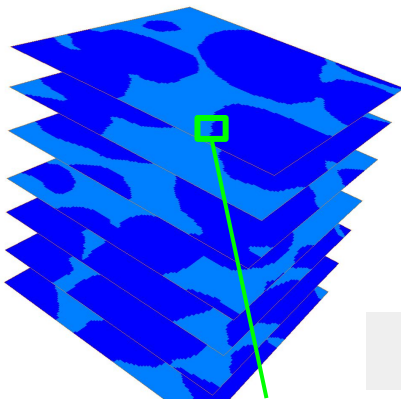
Avizo Basics

Important Concepts

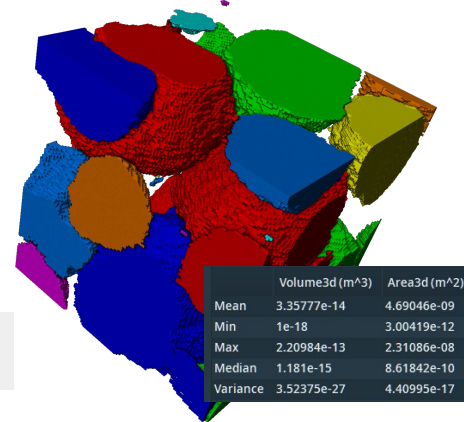
image stack



label images

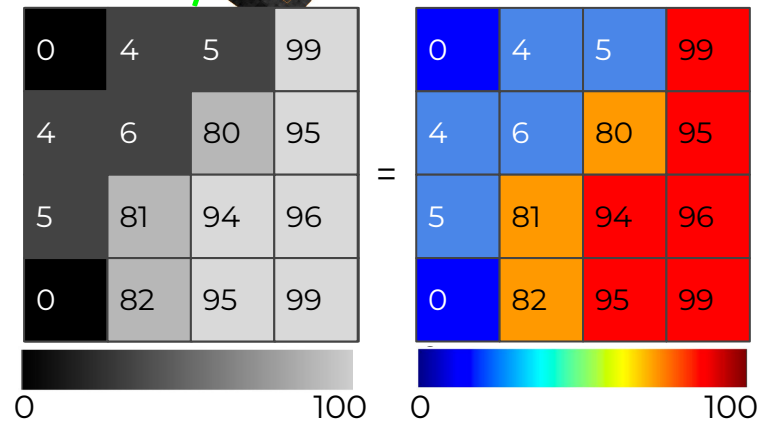


analysis results



segmentation

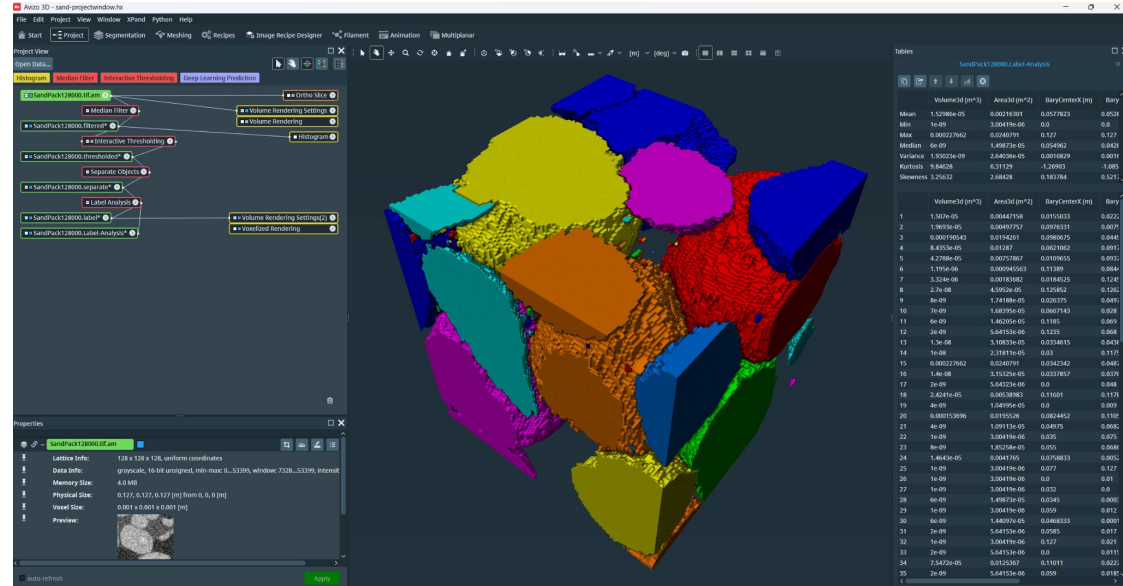
analysis



	air	sand
count	7	9
fraction	0.44	0.56

Demo: Sand - Avizo Basics

- Orthoslice
- Volume Rendering
- Interactive Thresholding
- Filter Sandbox
- Median Filter
- Voxelized Rendering
- Volume Fraction
- Separate Objects
- Label Analysis
- Export Table
- Screenshots



5-minute Break

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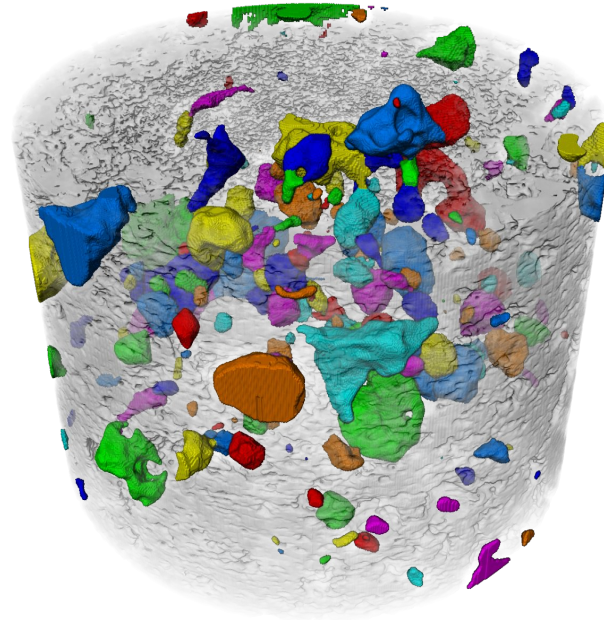
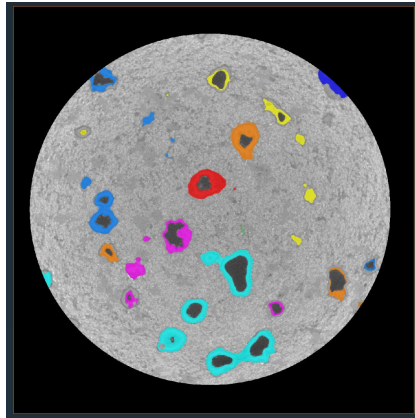
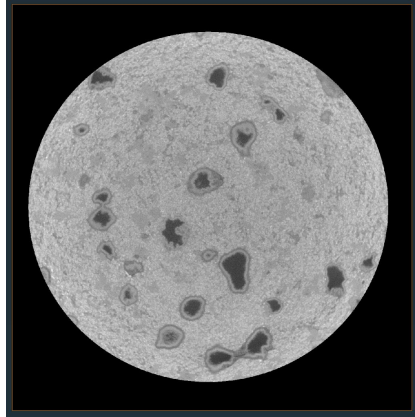


Avizo Installer and Data Download

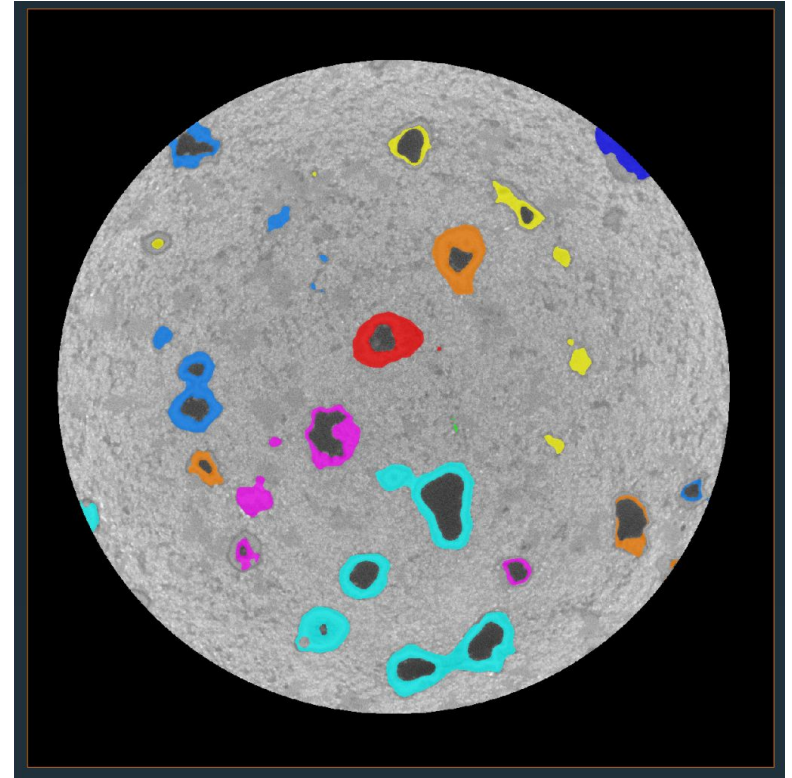
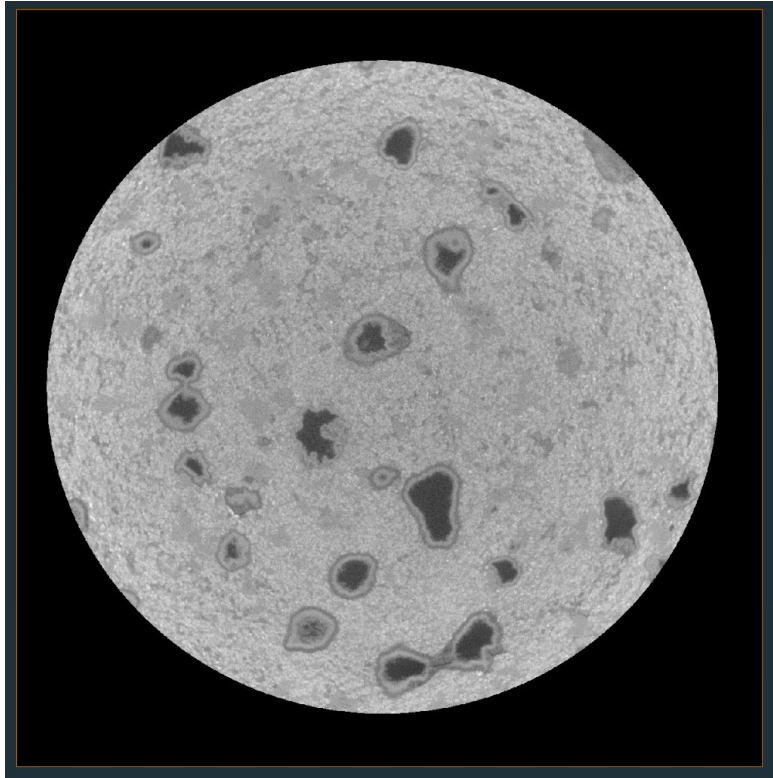
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Porosity in Rock CT Images

Hands-on: porosity in rock CT images



Hands-on: porosity in rock CT images



5-minute Break

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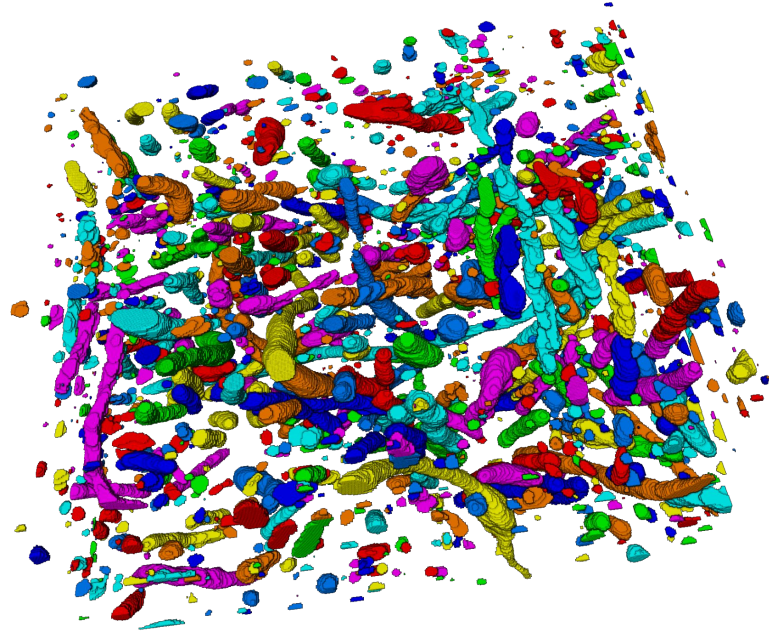
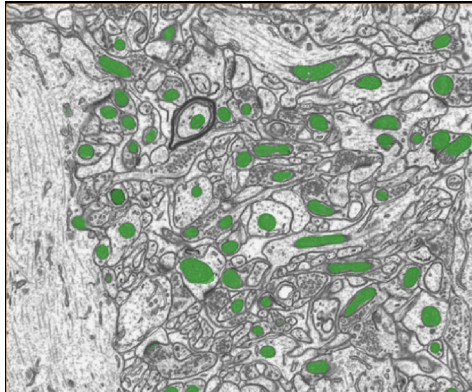
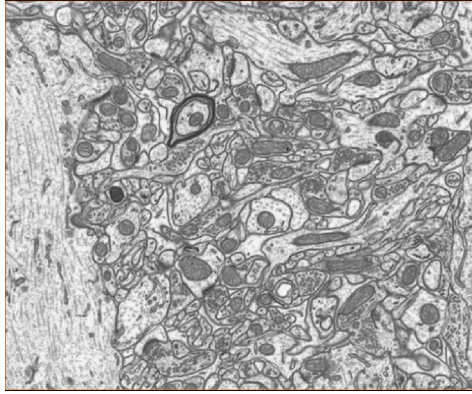
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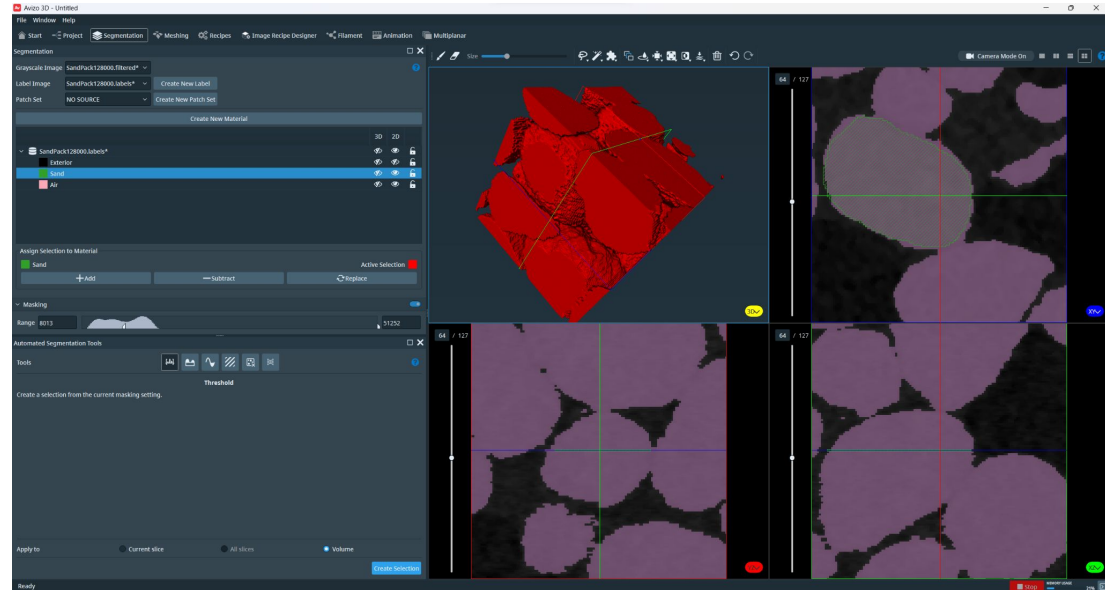
Mitochondria in Brain EM Images

Hands-on: mitochondria in brain EM images



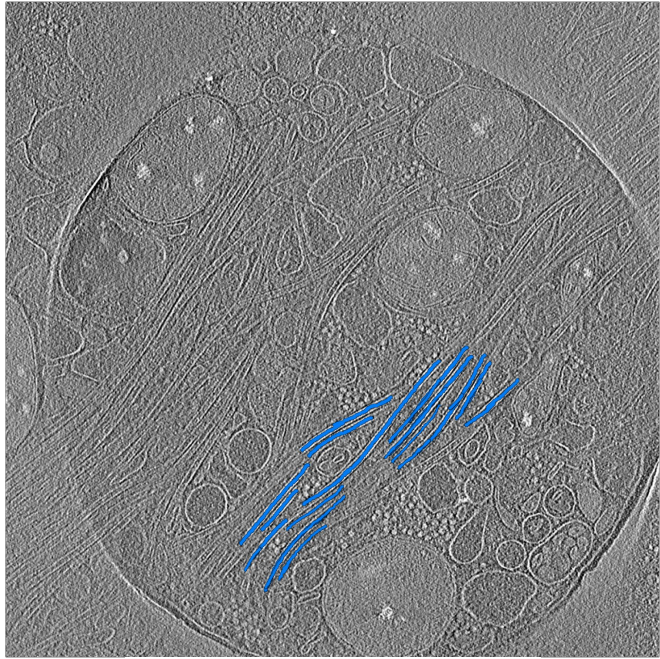
Demo: Sand - Segmentation Workflow

- Set input data (filtered)
- Create new label
- Create new materials
- Create and add selections to material:
 - Using brush
 - Using threshold tool

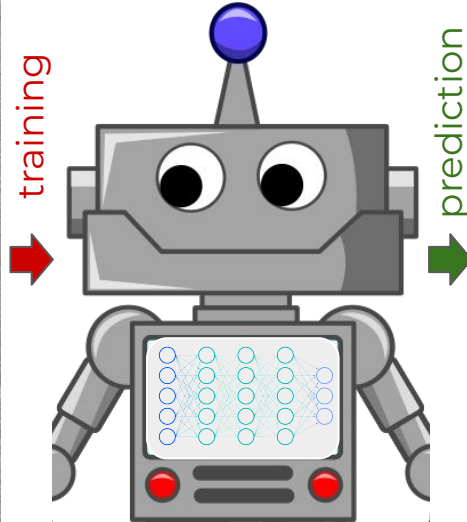


Important AI Concepts

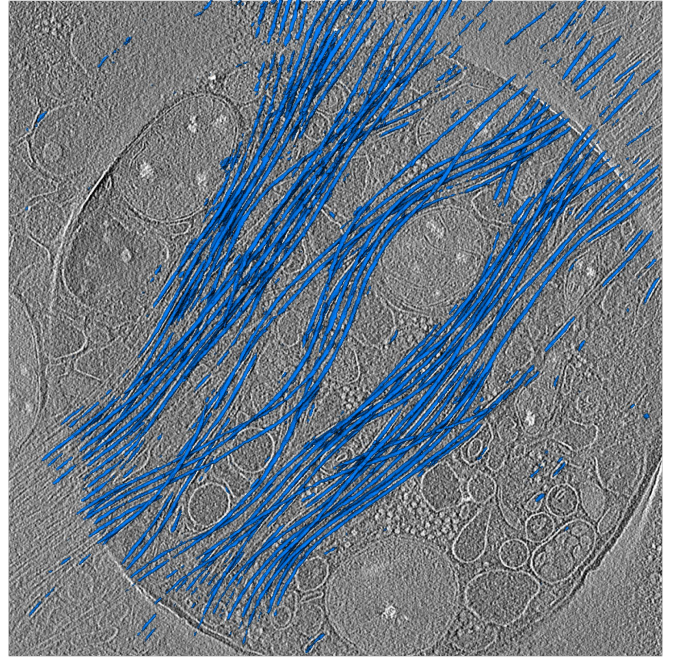
We can use **deep learning models** for segmentation.



human segmentation

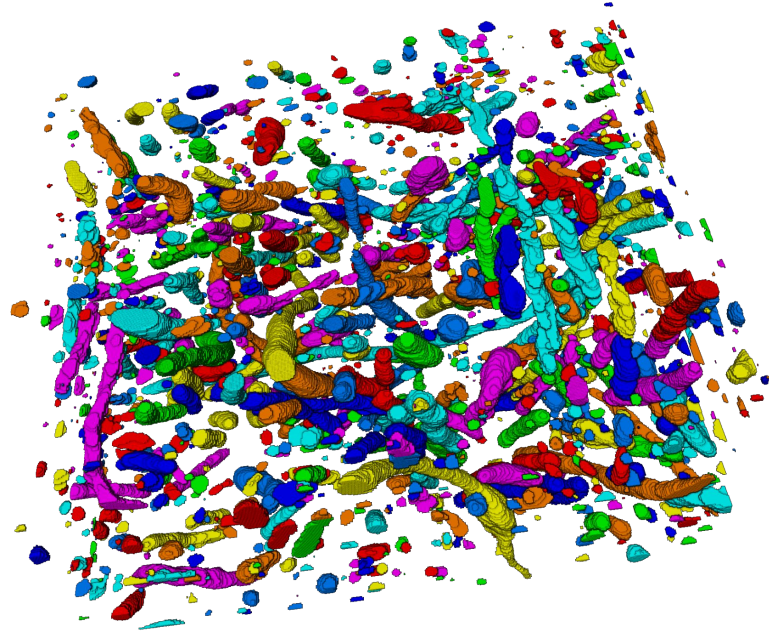
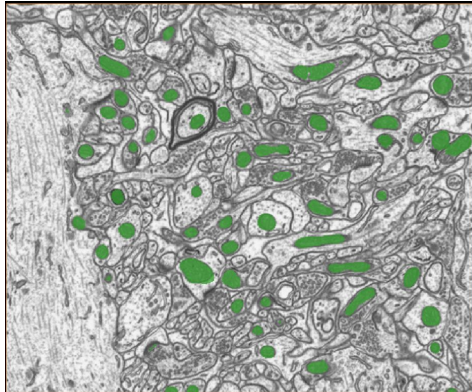
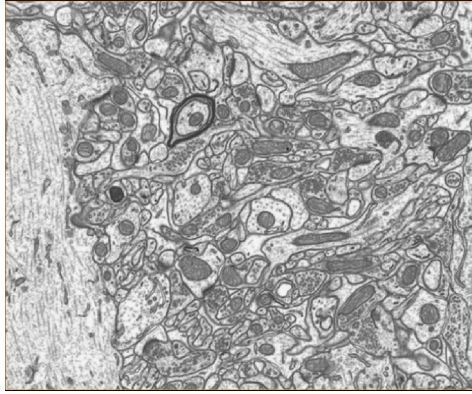


deep learning model
(AI)



AI segmentation

Hands-on: mitochondria in brain EM images



Workflow Recommendation

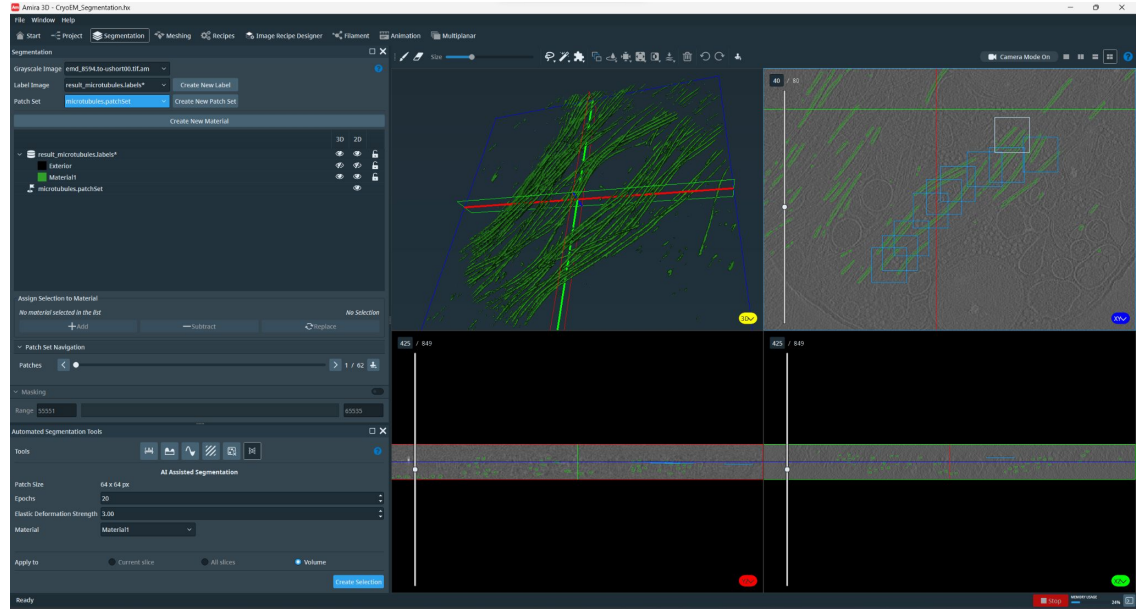
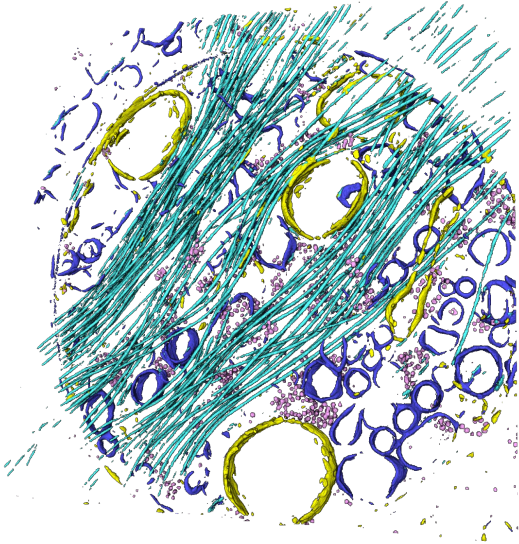
- Inspect data (orthoslice, volume rendering, histogram)
- Filter data to denoise or improve features:
 - Filter Sandbox, Median filter, Bilateral filter, Non-local means filter
- Try simple segmentation tools in Avizo:
 - Thresholding, Watershed, Texture Classification
- Try AI segmentation in Avizo
- Try other (AI) segmentation tools
- Worst case: manual segmentation (try AI as you progress)
- Not sure? Contact **help@vis.kaust.edu.sa**.

Manual Segmentation Tablets

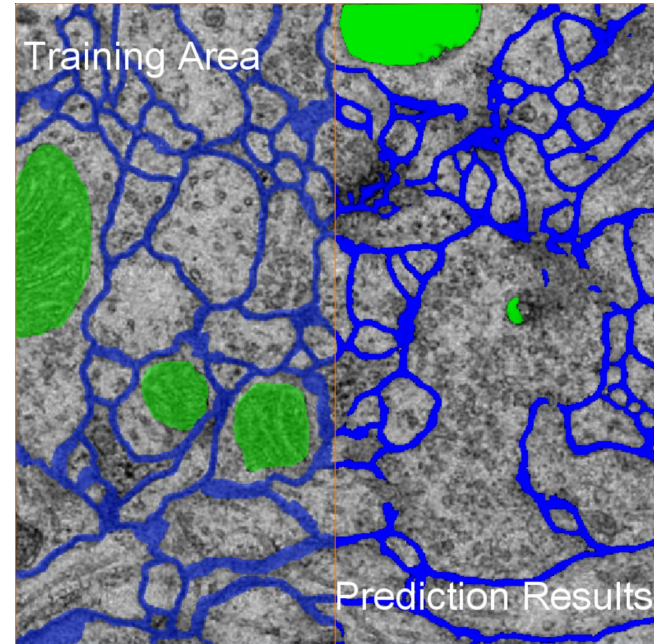
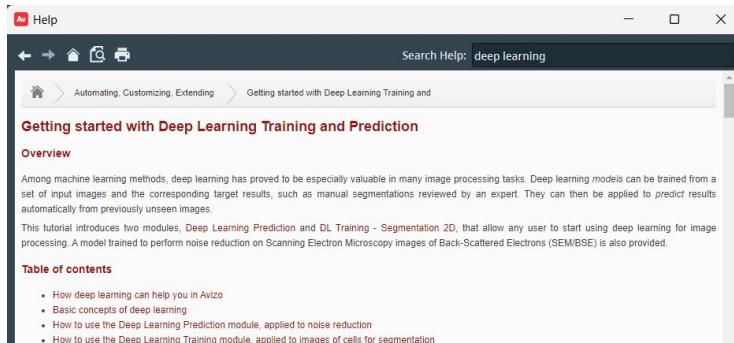
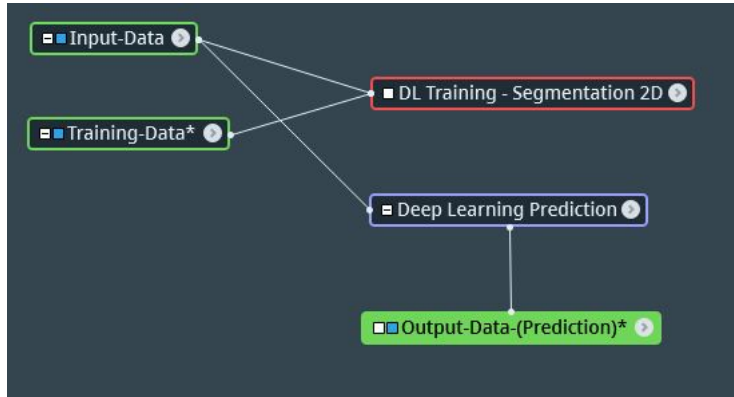


Book “AR/VR Hub” facility at
<https://wiki.vis.kaust.edu.sa/booking>.

Avizo Example: AI Assisted Segmentation

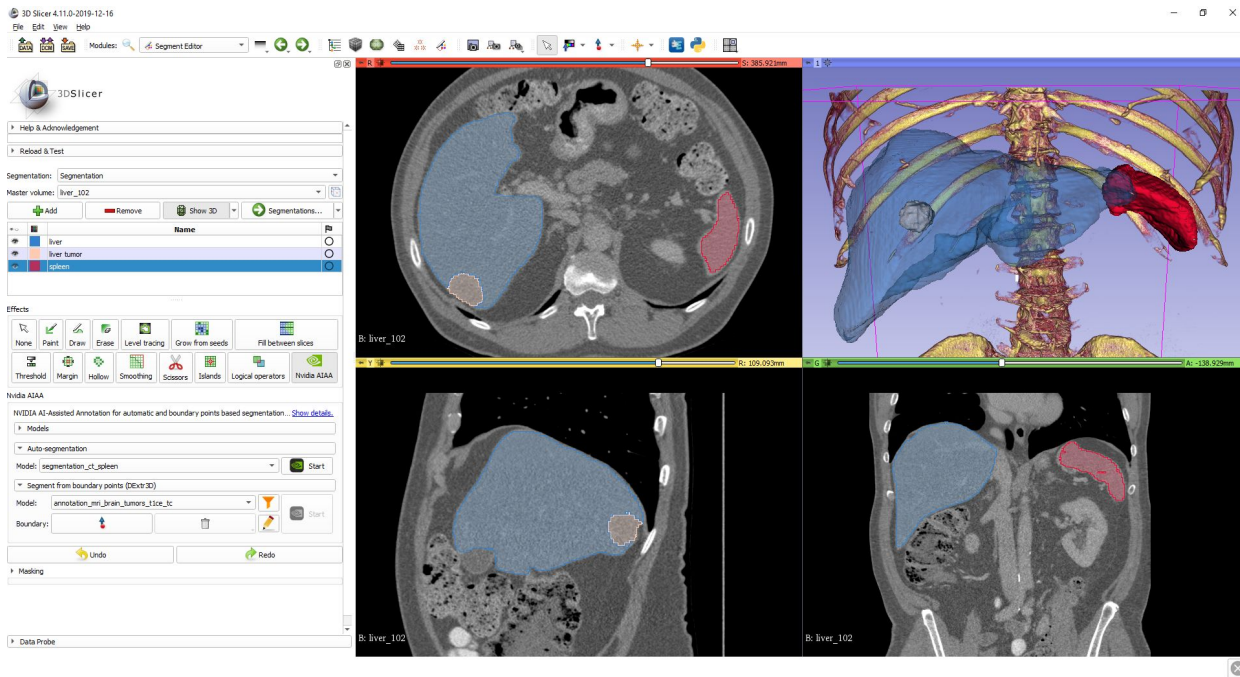


Avizo Example: Deep Learning Modules



Other Segmentation Tools

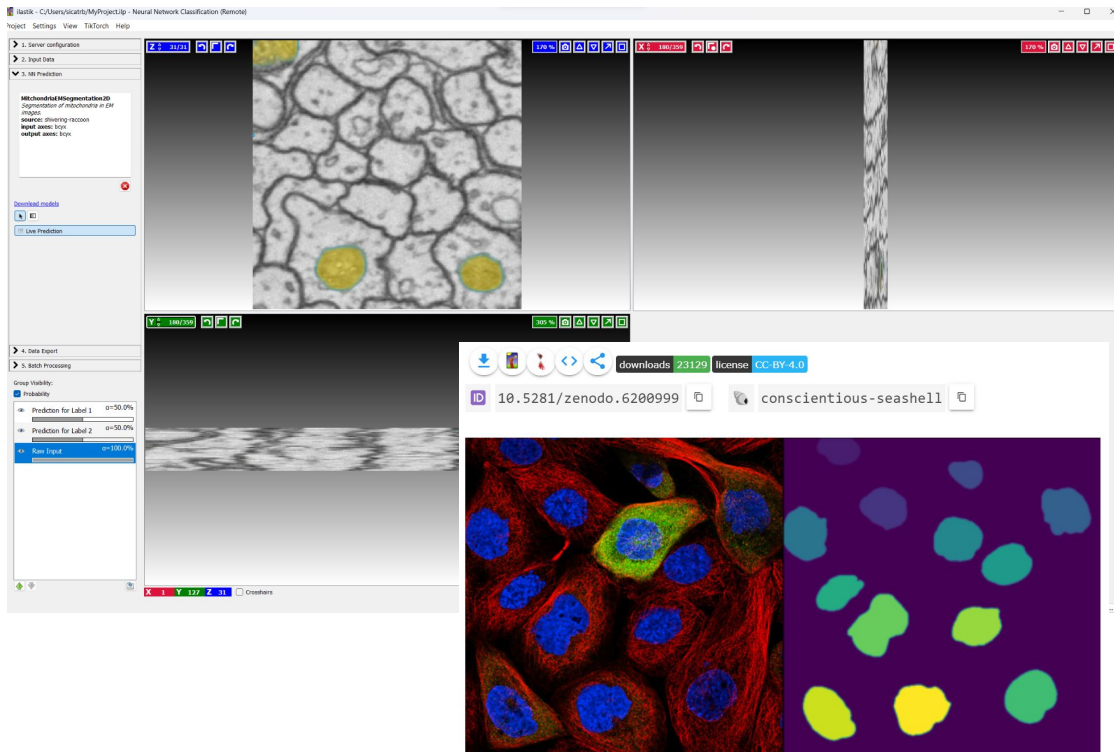
- **3D Slicer**
- ilastik
- Fiji
- Matlab
- OpenCV
- TensorFlow
- PyTorch



<https://www.slicer.org/>

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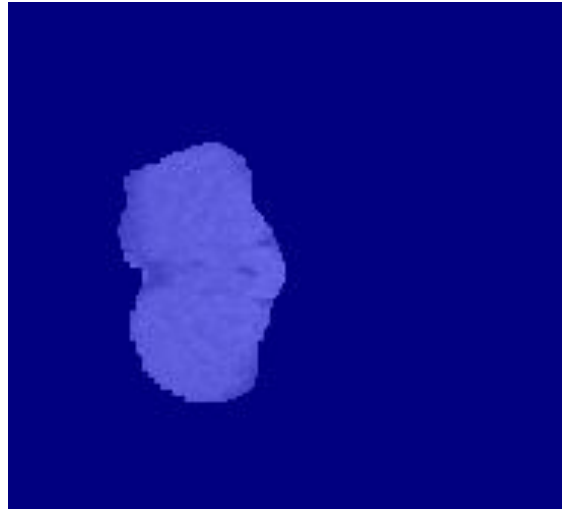
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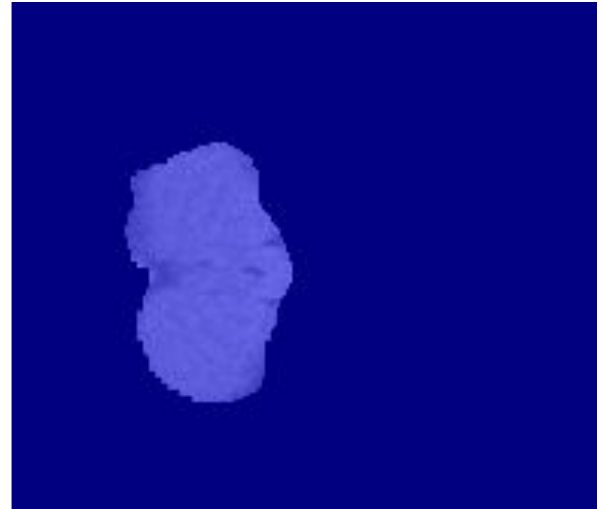


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ground truth



prediction

Thank you! Let's collaborate!

wiki.vis.kaust.edu.sa

help@vis.kaust.edu.sa



feedback form

How would you rate the overall quality of the workshop?*

☆☆☆☆☆

Please share your comments! (Confidential and for KVL use only.)

e.g., "Content was too simple.", "Topics are very useful.", "Please add more examples."

Submit

End