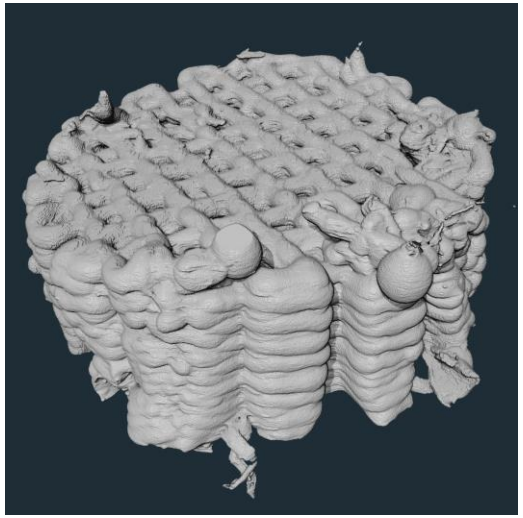
The International Conference on Biofabrication
Biofabrication 2023
Saskatoon, Canada • Sept. 17 - 20

Automatic 3D Segmentation of Hydrogel Scaffolds Based on PBI-μCT

Xiao Fan Ding, X. Duan, N. Li, D. Chen, and N. Zhu

Segmenting hydrogel scaffolds

- Morphology of scaffolds to quantify:
  - Volume
  - Cross-section area
  - Porosity and pore size distribution
- 3D morphology could reveal mechanical properties
- But hydrogels exhibit very poor image contrast making 3D characterization difficult

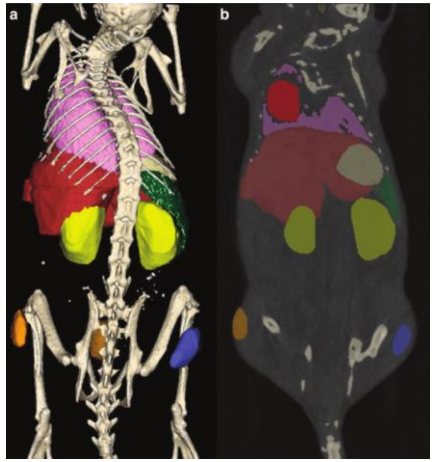


What is segmentation?

- Task of **categorizing each pixel** in an image

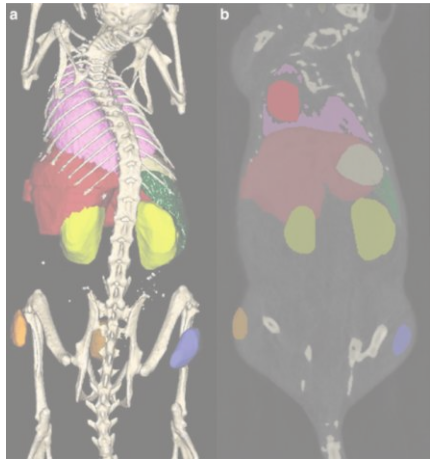
What is segmentation?

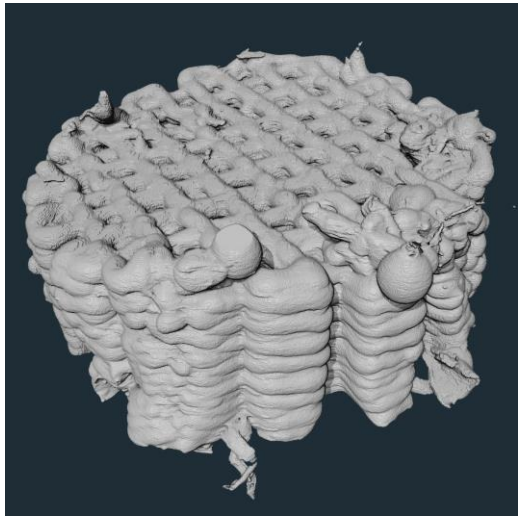
- Task of **categorizing each pixel** in an image



What is segmentation?

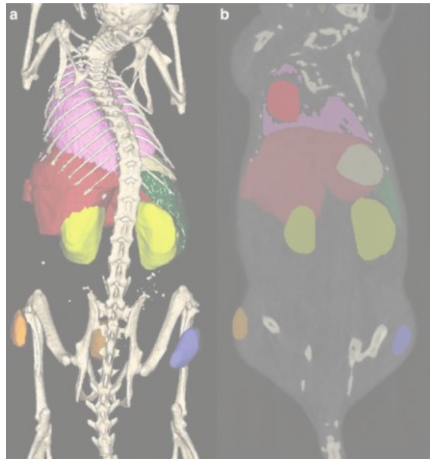
- Task of **categorizing each pixel** in an image
- Used to visualize and **study morphology**

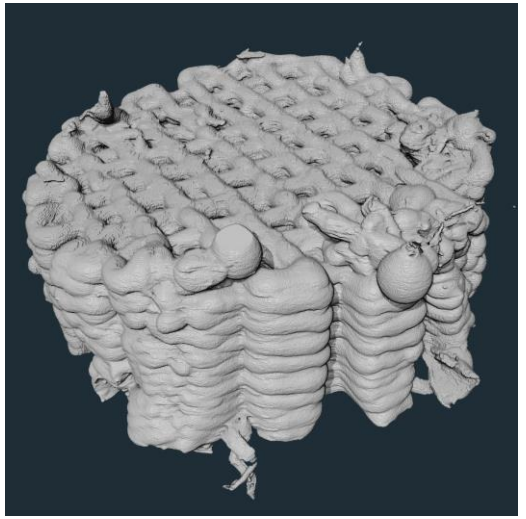




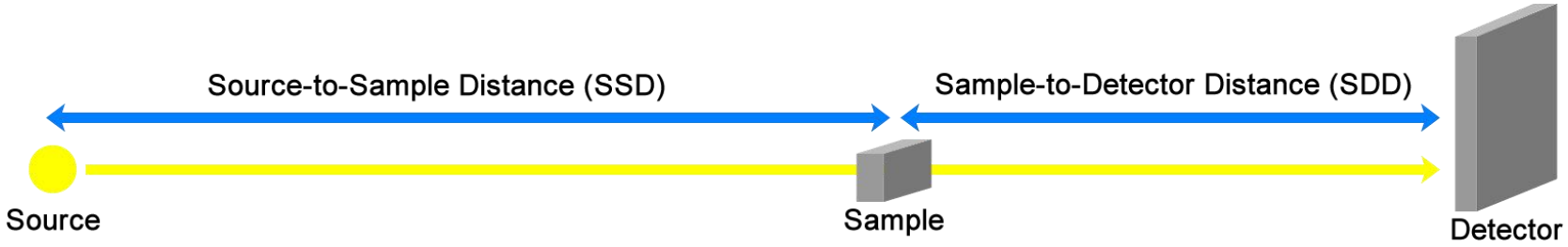
What is segmentation?

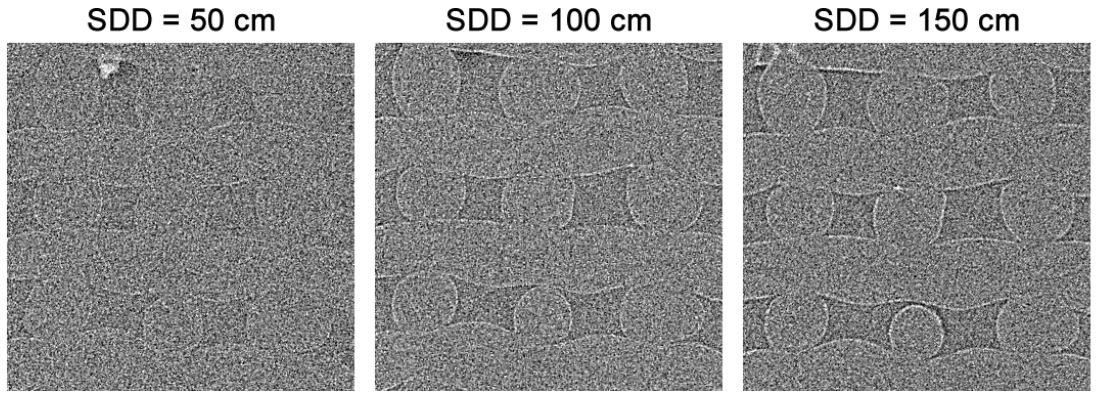
- Task of **categorizing each pixel** in an image
- Used to visualize and **study morphology**
- **Laborious, time consuming, expensive, and variable**

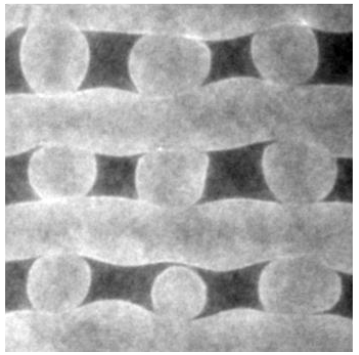




Phase Contrast and Phase Retrieval



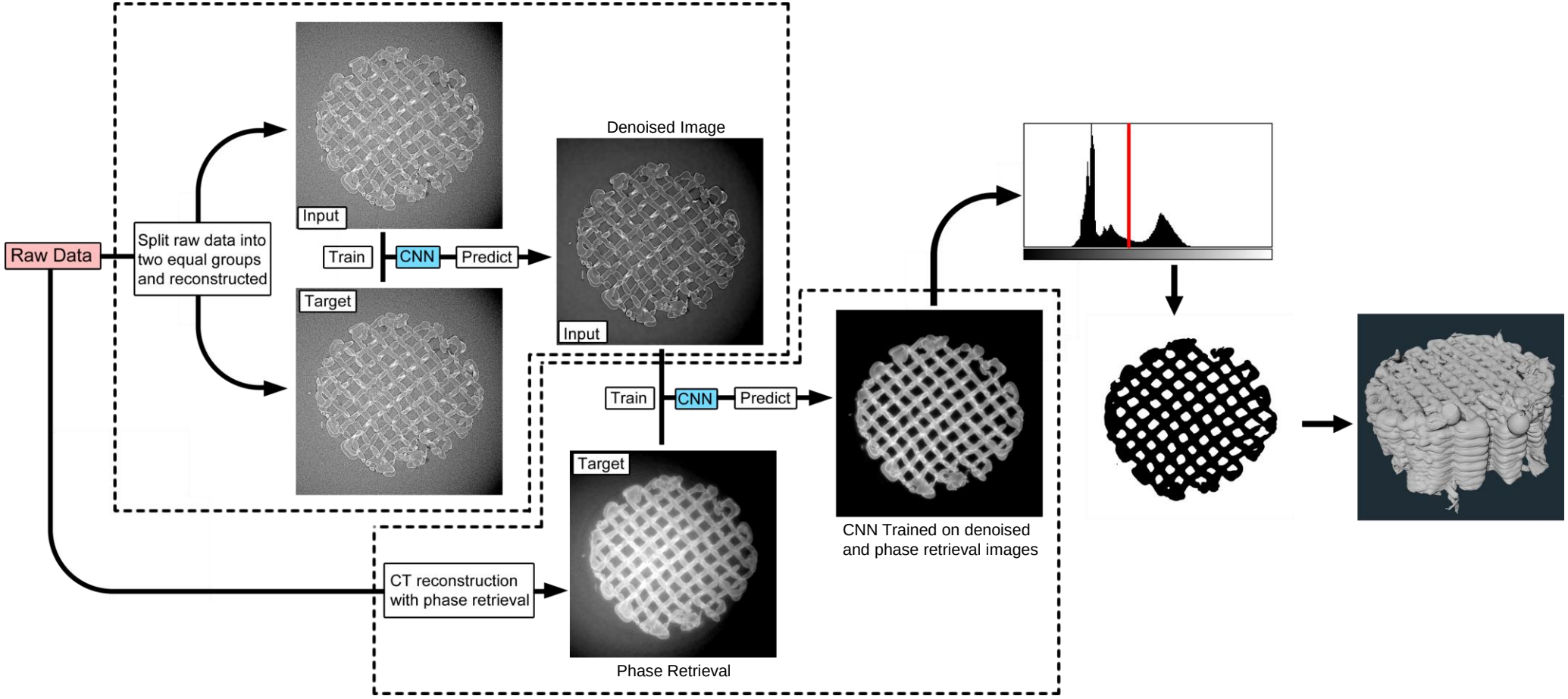




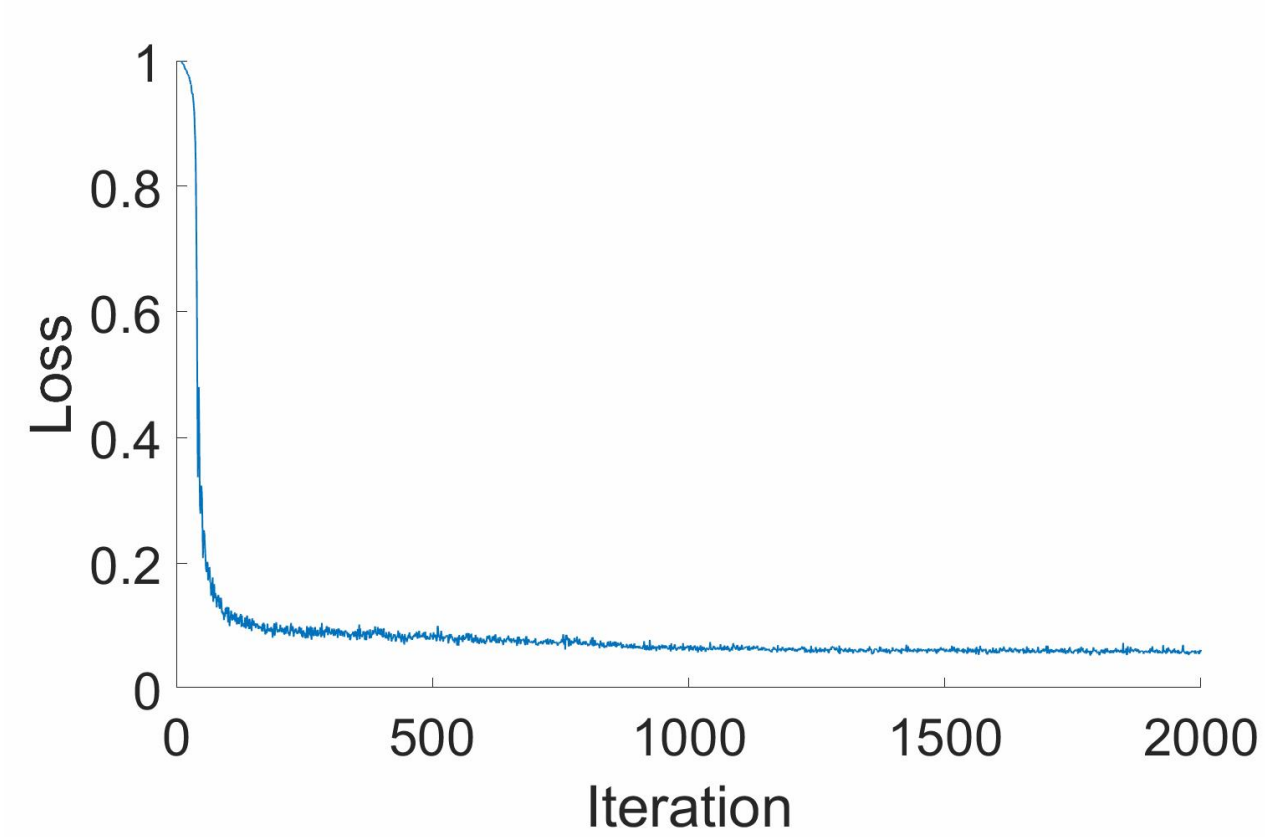
Phase Retrieval

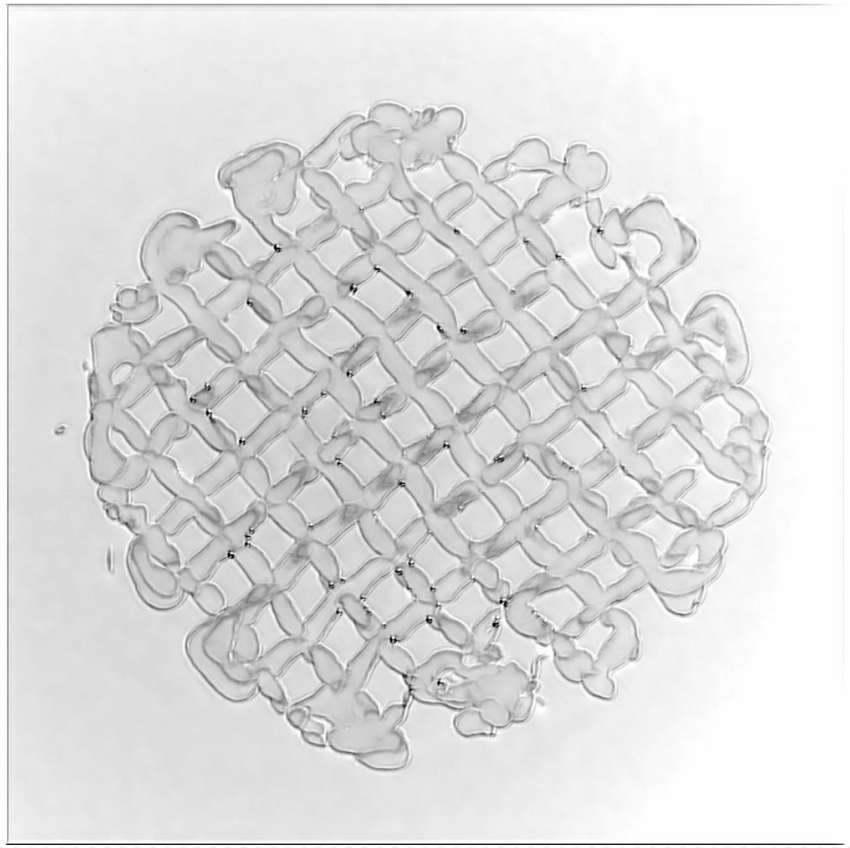
- X-ray energy
- Propagation distance
- Detector pixel size
- Attenuation coefficient of the material
- Phase shift coefficient of the material

The Proposed Method



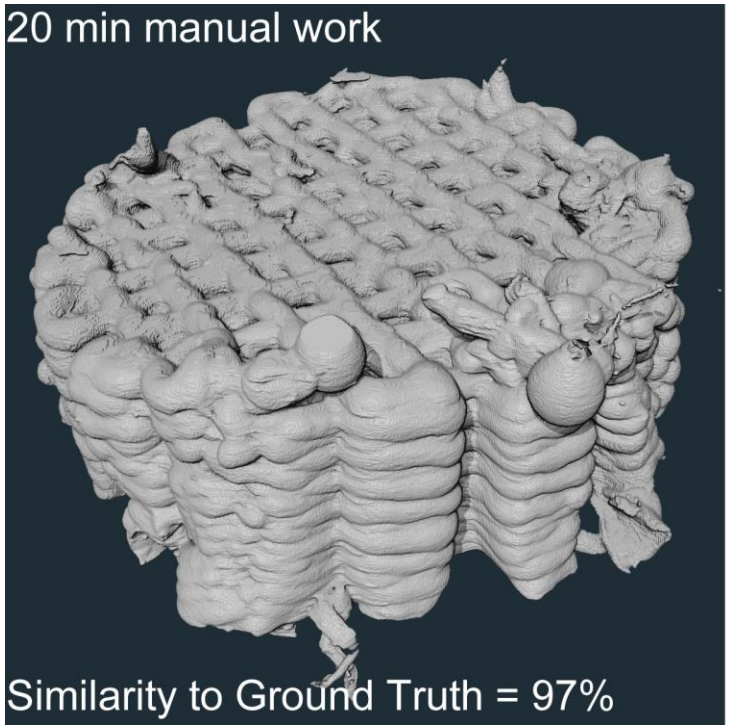
Training on Edge and Area



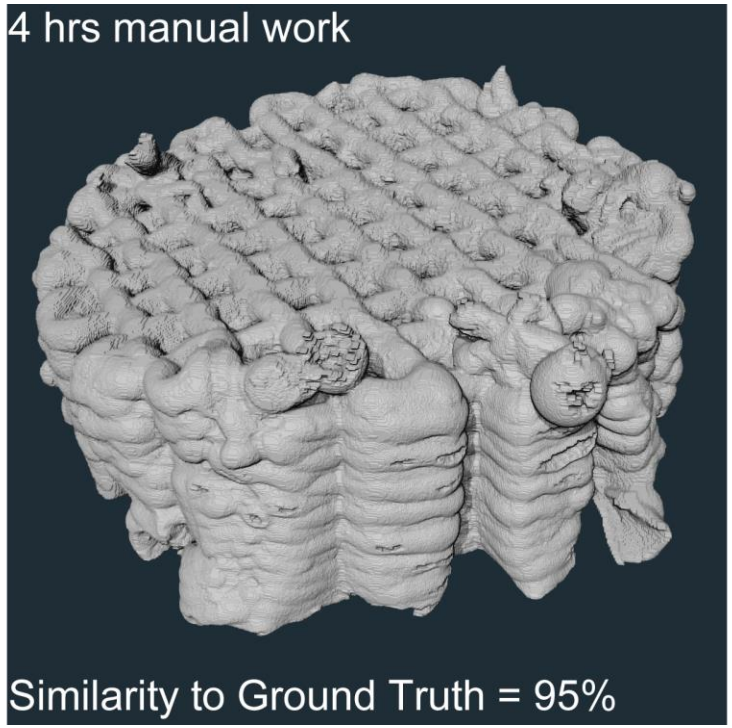


Compare Segmentation

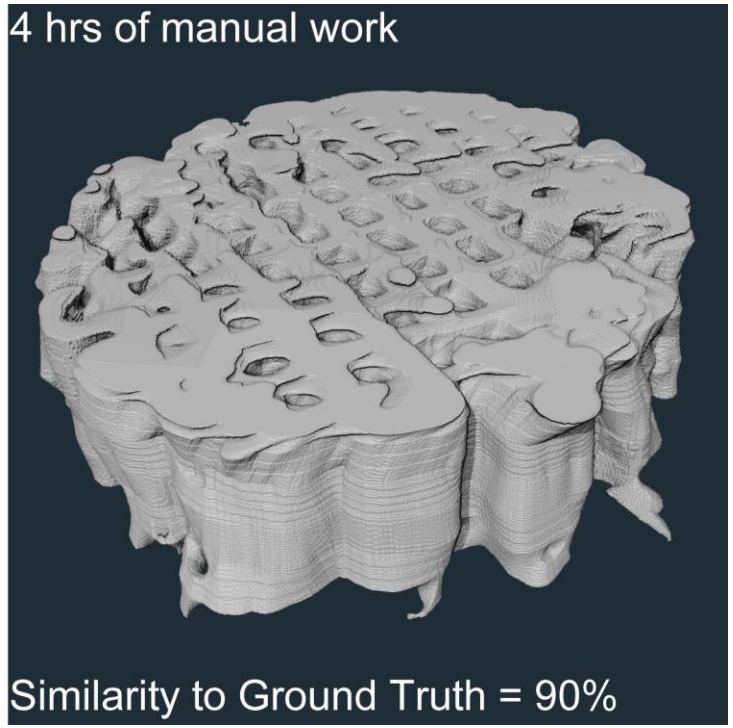
Proposed Method



Biomedisa

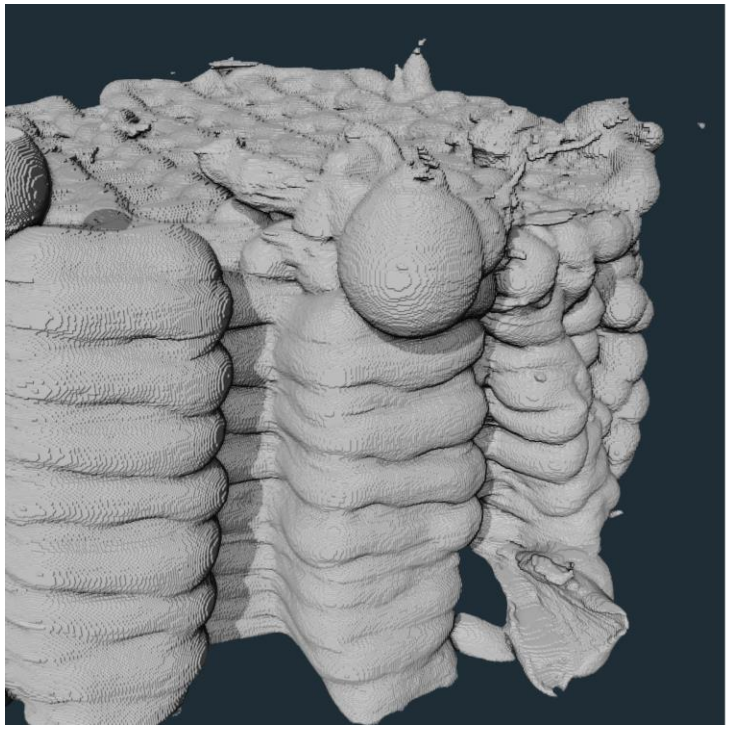


Amira-Avizo

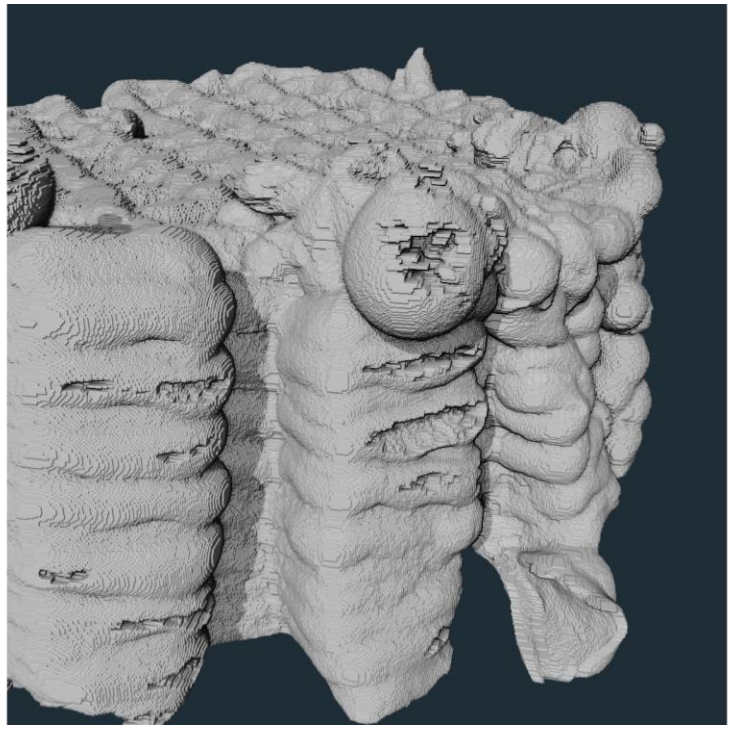


Compare Segmentation

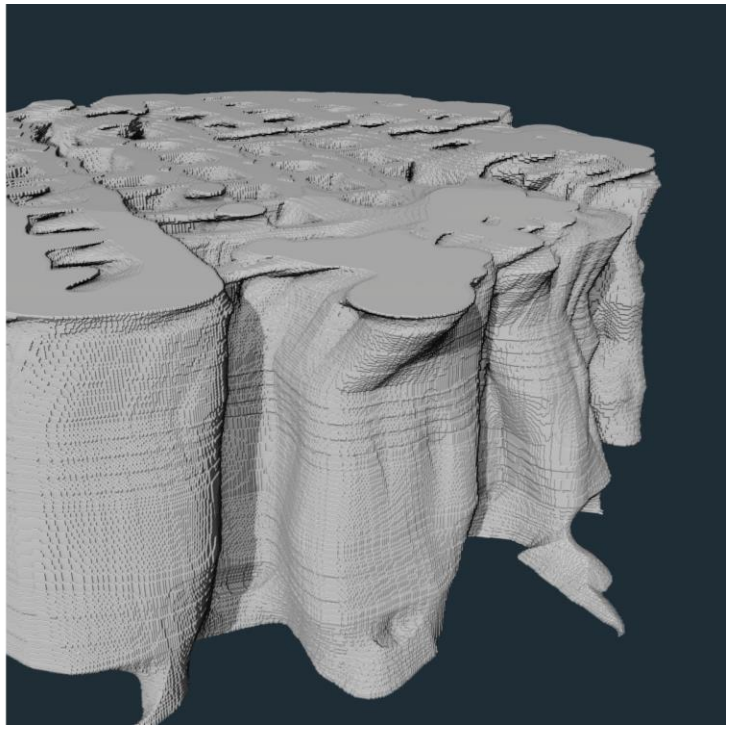
Proposed Method



Biomedisa

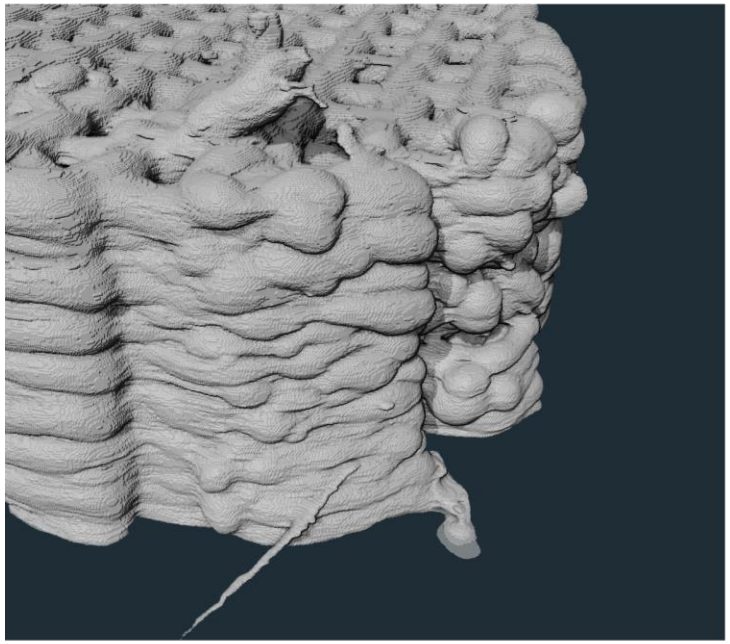


Amira-Avizo

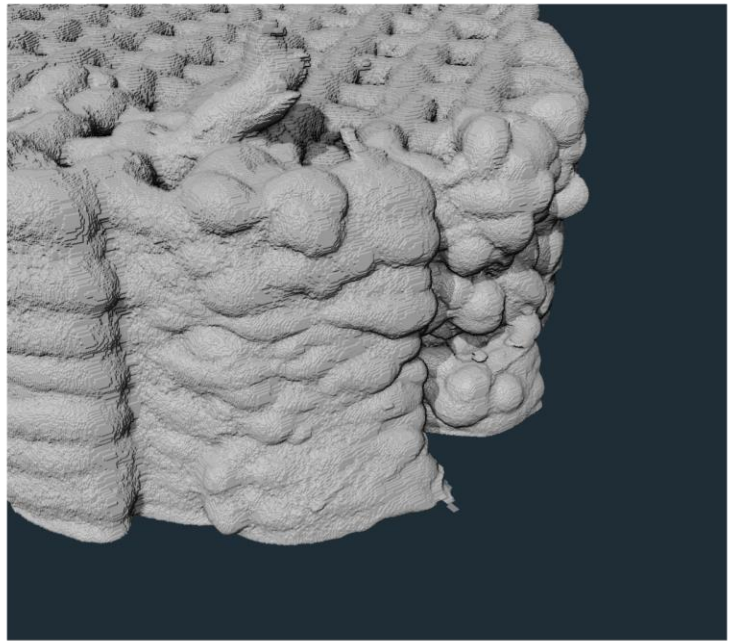


Compare Segmentation

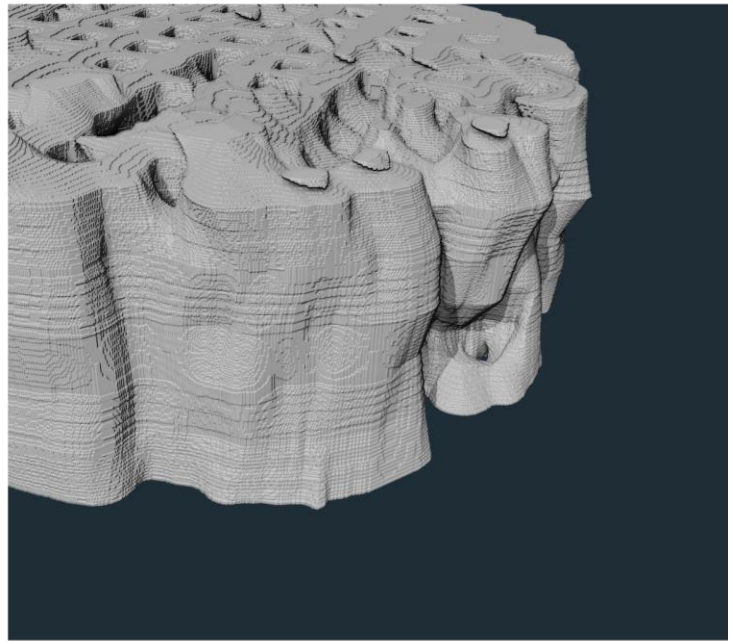
Proposed Method



Biomedisa

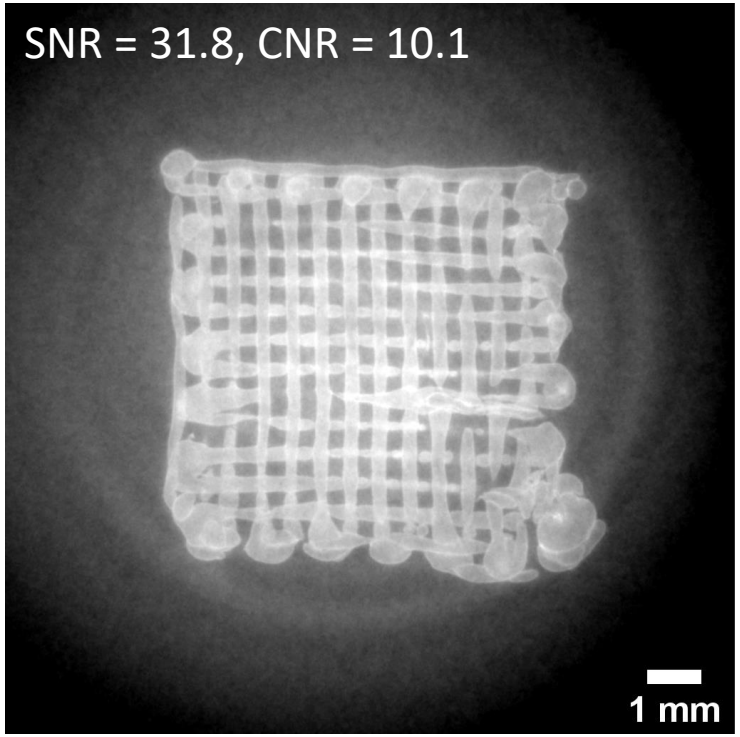


Amira-Avizo

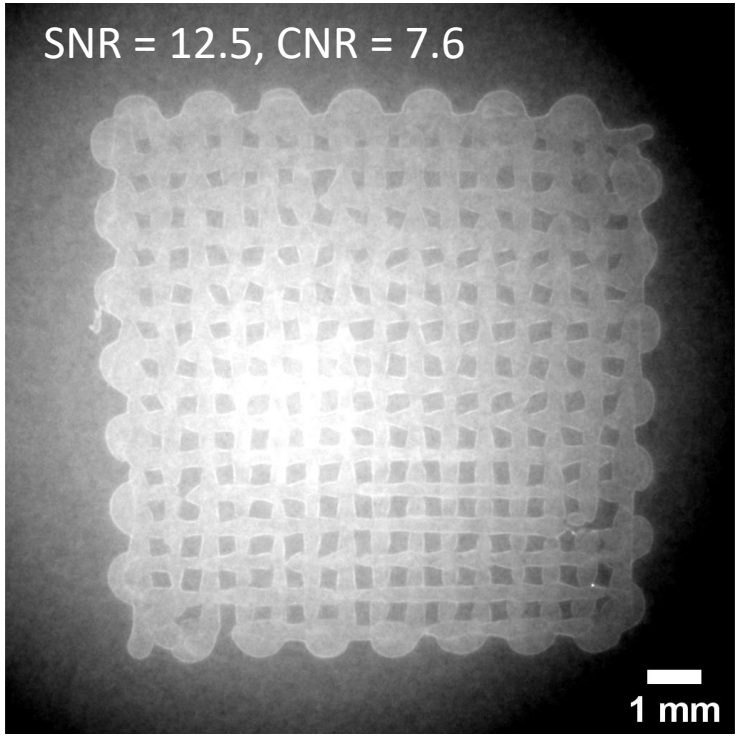


Demonstrations

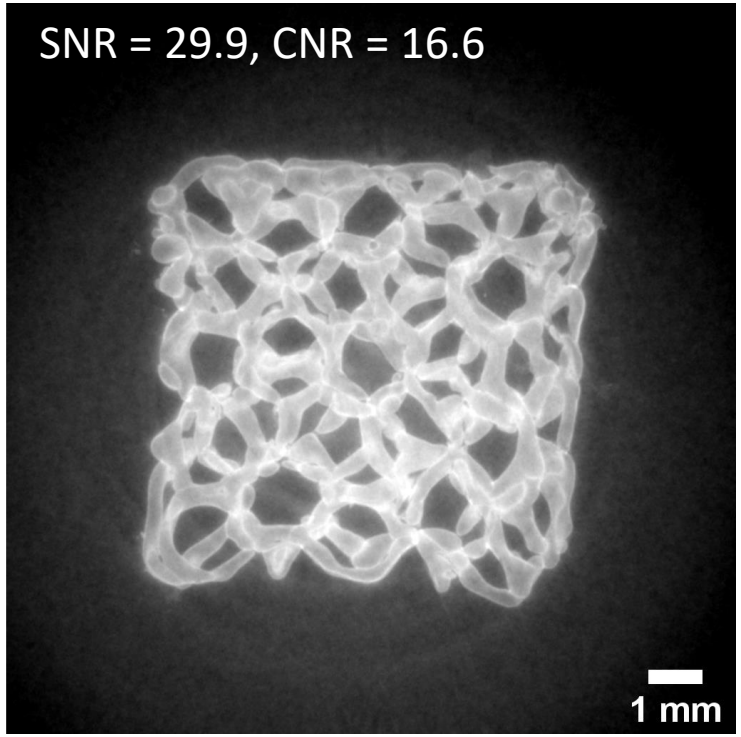
Demonstration #1 – Pore size



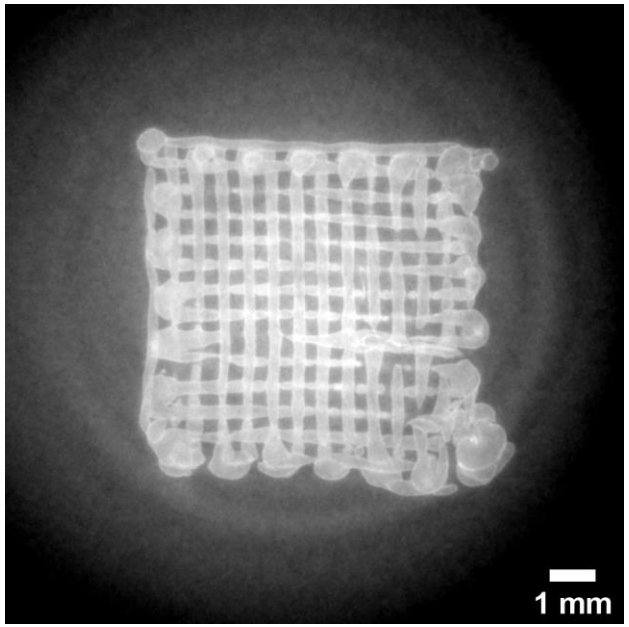
Demonstration #2 – Material

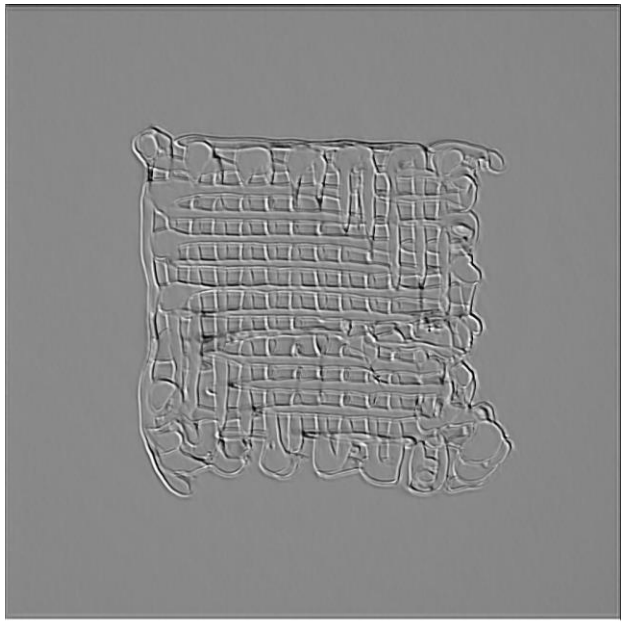


Demonstration #3 – Structure



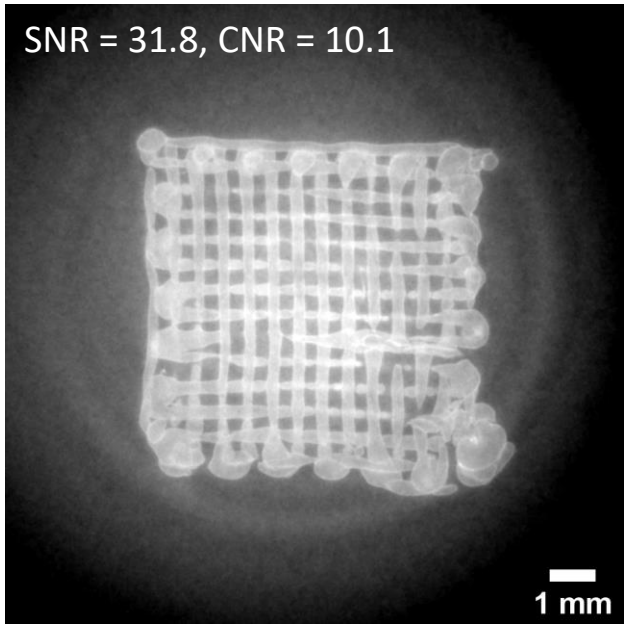
Demonstration #1 – Pore size

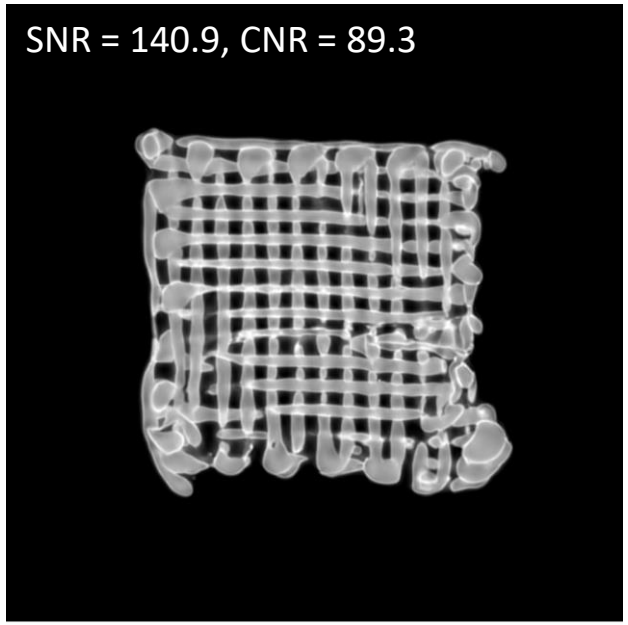




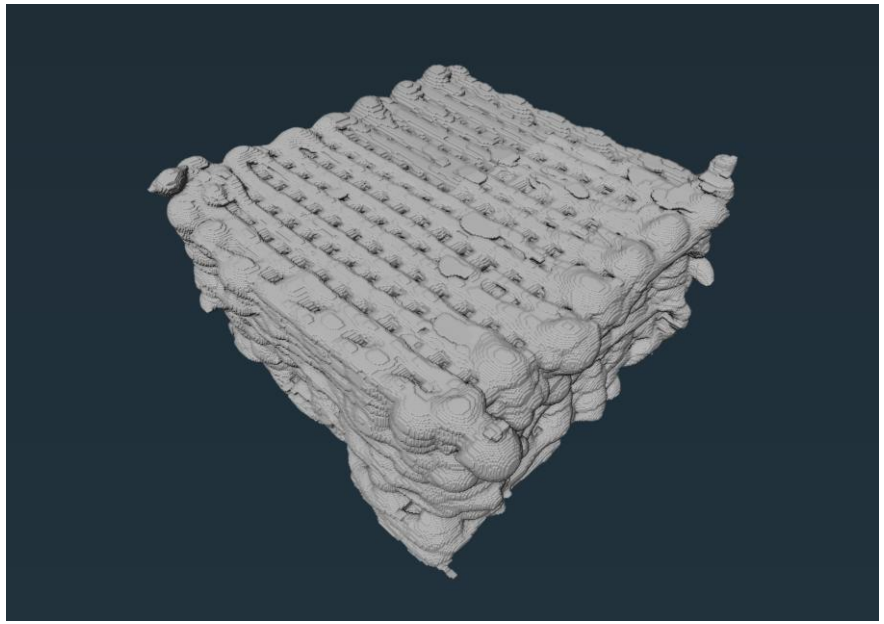
Iteration #0

Demonstration #1 – Pore size



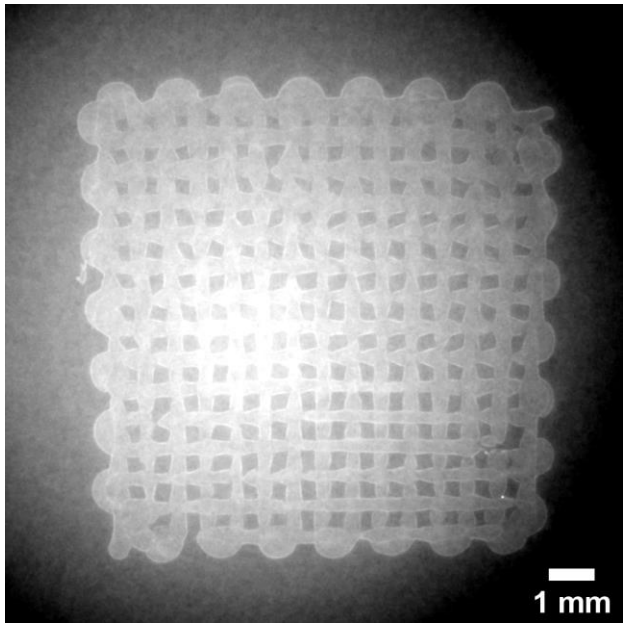


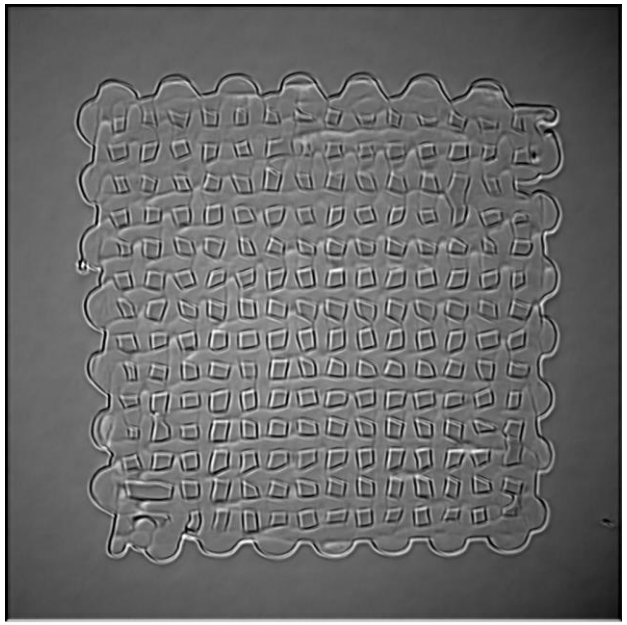
Iteration #5800



94% Similarity to Ground Truth

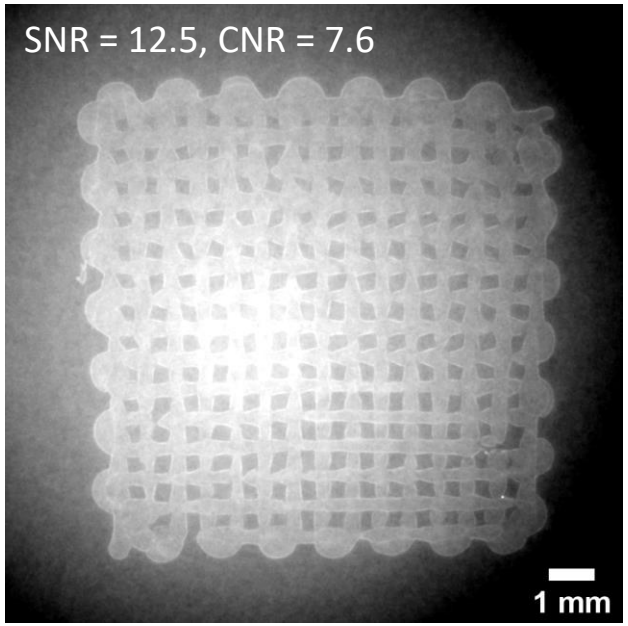
Demonstration #2 – Different material

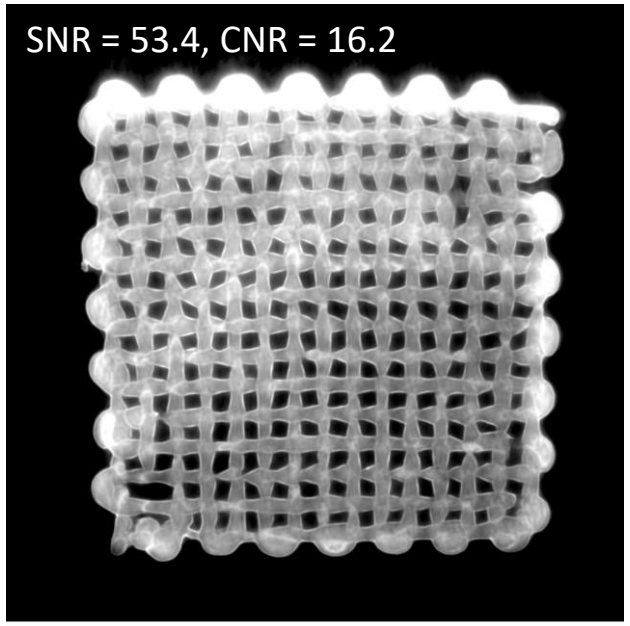




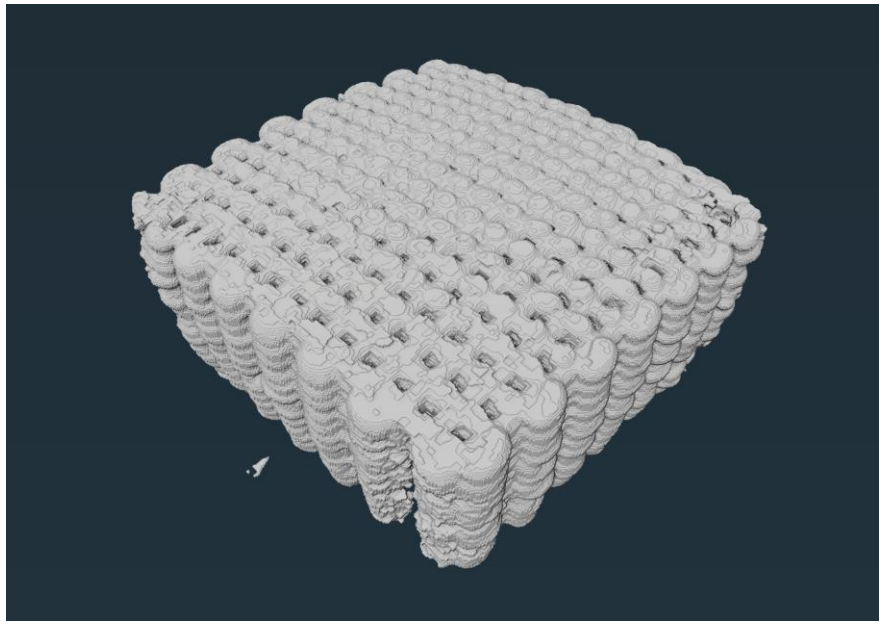
Iteration #0

Demonstration #2 – Different material



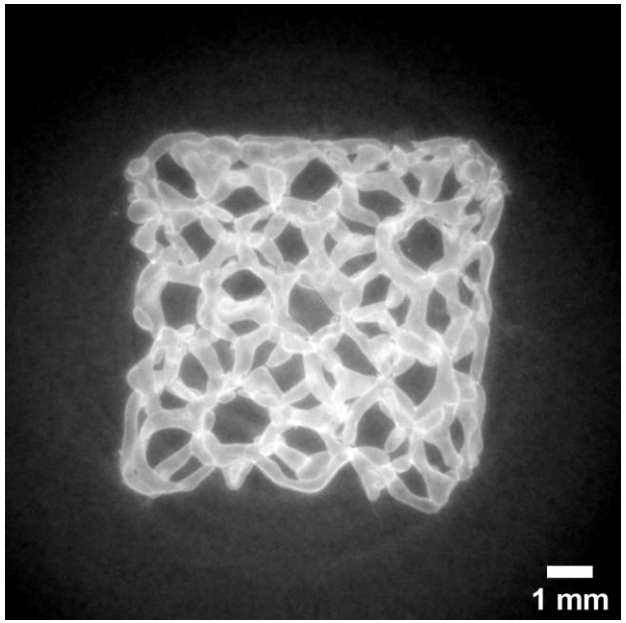


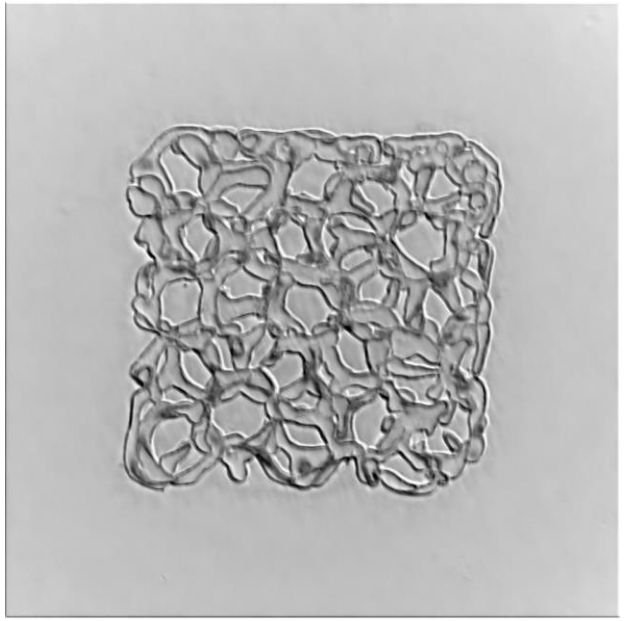
Iteration #7700



89% Similarity to Ground Truth

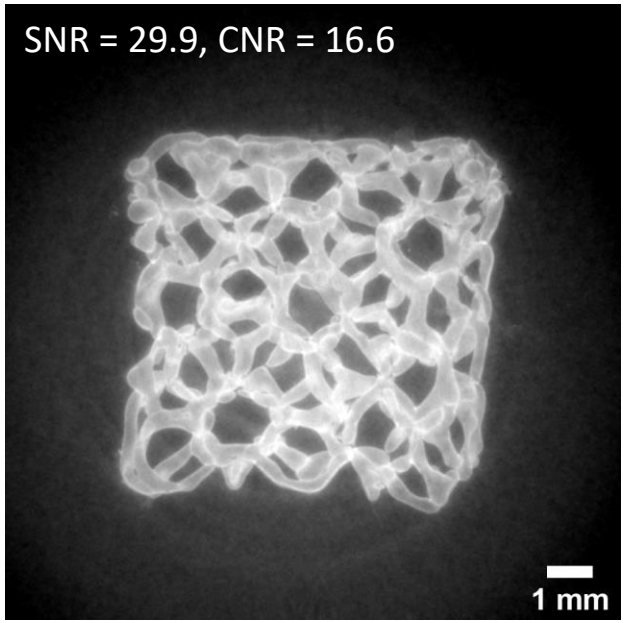
Demonstration #3 – Different structure

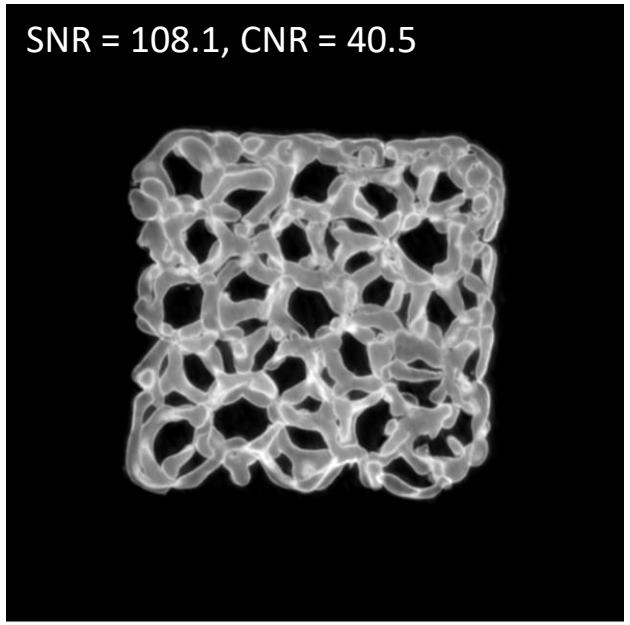




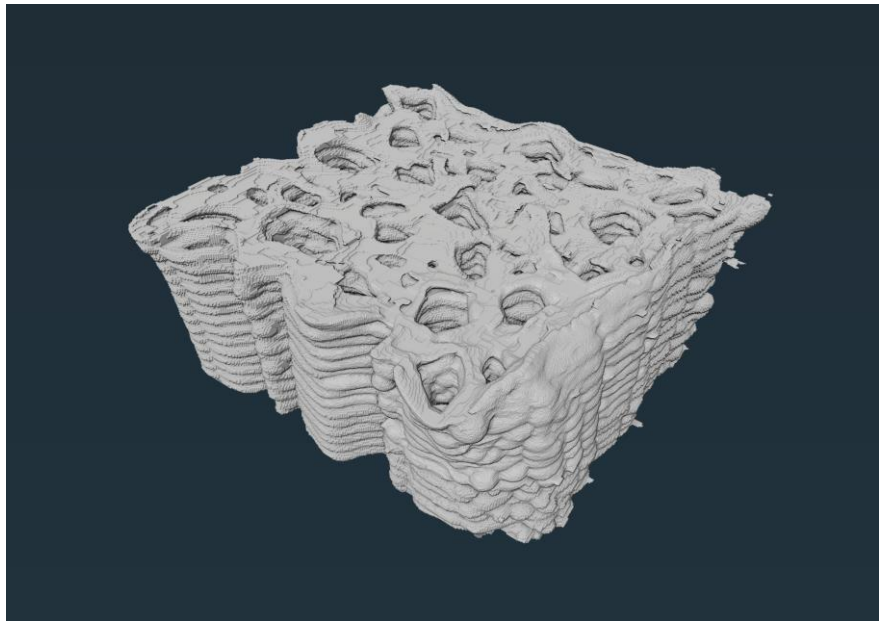
Iteration #0

Demonstration #3 – Different structure





Iteration #1430

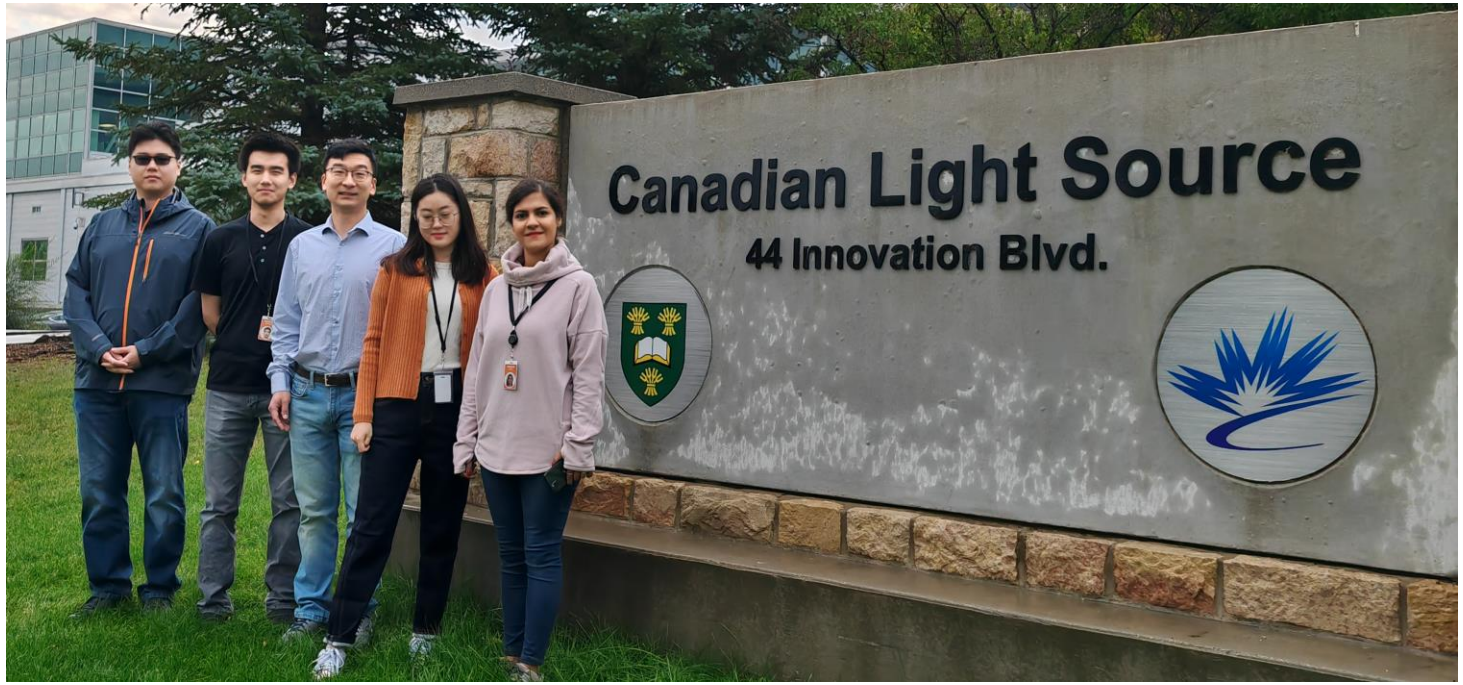


92% Similarity to Ground Truth

Conclusion

- Accurate and efficient segmentation results
- Reduced manual work
- Distill segmentation down to reusable parameters
- Customizable segmentation strategy

Acknowledgements



Dr Ning Zhu, Xiaoman Duan, Naitao Li, Samira Khoz

Dr Daniel Chen and Dr Fangxiang Wu

And to the following sources of funding:

NSERC CRSNG

INSPIRE

University of Saskatchewan

Canadian Light Source / Centre canadien de rayonnement synchrotron

Light exploring life BMIT