



Contribution ID: 701

Type: **Poster (+) Presentation**

## Deep-learning-based Image Segmentation Techniques for Porous Media Property Estimation

*Thursday, 3 June 2021 20:00 (1 hour)*

Recent advances in image data science, data storage and high-performance computing have enabled the application of machine learning and data-driven approaches to a wide range of disciplines. Image data analysis in the geosciences and phase identification from core analysis have allowed significant developments in the characterization of structural, compositional, storage and transport properties. We present a deep-learning based approach for automated segmentation of solid, brine and CO<sub>2</sub> phases in a porous media sample imaged by X-ray microCT. The porous sample consisted of a sintered glass frit, 12mm diameter, 25.36mm long, 30% porosity and 630mD permeability. The sample was subject to multiple injection cycles of brine and CO<sub>2</sub> at supercritical conditions. MicroCT images were acquired at two quality levels, high and low (fast scan), both at a voxel resolution of 15 $\mu$ m. In order to train a machine learning model to perform automated segmentation on both high-quality and low-quality images, ground truth segmentation examples are needed as training data. We obtain the training data by utilizing an interactive segmentation method based on a Random Forest classifier, which takes user-input examples of voxels from different phases and generates a full-segmentation map that labels every voxel in an image. The interactive segmentation of high-quality images provides us with ground-truth segmentation maps. Once the ground truth annotations are acquired, we prepare training data, which consist of image and annotation pairs: high-quality image and segmentation annotation, low-quality image and segmentation annotation. High- and low-quality images are different scans from the same experiment, thus correspond to the same ground-truth. To accurately segment the images, we experimented with several supervised and semi-supervised neural networks, including U-Net, SegNet, and DenseUNet, which are deep learning models that can be trained to take a raw image as input and generate the segmentation map as output. We report our findings that compare several state-of-the-art segmentation models using cross validation and demonstrate that a deep learning model trained for automatically segmenting microCT images can achieve high accuracy and is generalizable to segmenting images of different quality, resolution and from different porous media samples. Based on the segmentation results, we also calculate sample properties such as pore topology, porosity and saturation, and compare such estimates from high-quality vs. low-quality images. In our future work, we will investigate the training of machine learning models that can reliably identify and segmentation different phases in rock samples that have different mineral composition and structural features. We will also study machine-learning-based super resolution algorithms that can generate super high-resolution images from low-resolution images.

### Time Block Preference

Time Block B (14:00-17:00 CET)

### References

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