Core Fracture Segmentation in CT Images by Transfer Learning

Ryan Antle*, Mackenzie* Dreese

Abstract. Fracture characterization by computer vision (CV) techniques using X-ray computed tomographic (CT) images of reservoir cores was improved by training a high accuracy (>90%) deep convolutional neural network (CNN) model for classifying images with fractures and transferring the learning to a fully convolutional network (FCN) for fracture segmentation. The analyses utilized manually feature-classified CT cross sectional images, themselves distributed sub-millimeter voxels of density- and atomic number-sensitive CT Numbers, as inputs to the CNN model for automated slice-wise classification of fractures in reservoir cores. The network layers were trained and validated using these classified images to assign probabilities of classes to subsequent images, with e.g. 'fracture' or 'no fracture' classes assigned based on corresponding class probability. The whole image classification was then extended to a pixel-wise classification by transferring the hyperparameters in the fully connected layer to a fully convolutional layer. Layers were added to the new FCN model to upscale class probabilities back to the original image dimensions, resulting in a change from an image classification output to a heatmap of object classes via a single pass pixel-wise class prediction. The transferred hyperparameters were then further refined by iteratively minimizing error between known and predicted labels in annotated images. Results showed transferred learning from CNN to FCN for fracture labeling improved accuracy (>60%) regardless of class imbalance. The improved accuracy allowed for further automation of fracture characterization including aperture and length measurements.