Deep Learning Applied For Estimating Permeability of Carbonate Rock Samples on Raw micro-CT

Júlio de C. V. Fernandes, Carlos E. M. dos Anjos, Thais F. de Matos, Manuel R. V. Avila, Igor R. Cartucho, Felipe B. F. Guimaraes, Rodrigo Surmas and Alexandre G. Evsukoff

Abstract

The digital sample analysis using X-ray computed microtomography (micro-CT) has become a standard technique in reservoir characterization workflows. Recent artificial intelligence algorithms can make use of those images to improve the characterization process. This study presents the combination of micro-CT and deep learning models creating an end-to-end workflow for permeability prediction of plug samples. Compared to the original workflow that usually takes months for a set of samples, the proposed approach offers a fast and reliable permeability estimation. The dataset consists of 37.600 slices from 376 plug samples extracted from Brazilian presalt and their laboratory determined absolute permeability. Two convolutional neural network models (CNN and CNNSPP) and an ImageNet pretrained model (Densenet161) were tested. The models were trained with/without data augmentation and two loss functions were compared (MSE and Huber). A 10-fold cross-validation was performed for all experiments. The Densenet161 model surpassed the other topologies used. It was possible to infer that pretrained models are less influenced by data augmentation and the loss function. The results show that the proposed workflow can be used to speed up and automate the reservoir characterization.