The Role of Generative AI in Computer Vision Tasks for Subsurface Analysis

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Abstract

Generative Artificial Intelligence (Generative AI) is a branch of machine learning that leverages the statistical distribution of complex and often unstructured dataset to generate new instances that are similar but not the same as the training data. Generative AI can be applied to images, sound, and textual information. In this presentation, we will focus on the generation of visual data for subsurface analysis.

We will address two common problems when using subsurface data. The first problem is the sampling bias when recovering cores or cuttings from the subsurface. In our case study of carbonate cores from north-eastern Australia, we encountered label imbalance: the Floatstone and Rudstone textures were far less represented than other Dunham textures. This led us to explore whether generative AI could be leveraged to create synthetic images of cores to improve training of a deep neural network. We tested several generative adversarial network (GAN) architectures to identify the most appropriate for our task. We then generated new instances of Dunham textures using our trained GAN. In parallel, we also experimented with traditional augmentation methods (rotation, brightness change, blur, etc…). After augmenting our training set threefold, we not only demonstrate that the set augmented by GAN outperforms the set that was not augmented, but we also show that Generative AI outperforms traditional augmentation methods.

The second problem we tackle with Generative AI is the lack of specialised expertise in human teams. Formation Micro Scanner (FMS) logs are borehole resistivity images that should capture the texture of carbonate rocks. The problem with FMS images is that they are much harder to interpret for non-expert geologists than core images. We take advantage of the GAN architecture here as well by exploring both unpaired and paired image-to-image translation algorithms. Our results show that when using paired image-to-image translation, we manage to generate synthetic images of cores from FMS images that look authentic. In a blind test with geologists, we demonstrate that our synthetic images allow geologist to improve their accuracy when describing Dunham textures by up to 4 times compared to interpreting the FMS data directly.
In conclusion, Generative AI is a more advanced topic in deep learning, but it holds many promises for subsurface applications in academia as well as in industry.