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Train Deep Learning Models using subsurface geological images datasets

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Machine learning is being presented as a new solution for a wide range of geoscience problems. Primarily machine learning has been used for 3D seismic data processing, seismic facies analysis and well log data correlation. The rapid development in technology with open-source artificial intelligence libraries and the accessibility of affordable computer graphics processing units (GPU) makes the application of machine learning in geosciences increasingly tractable. However, the application of artificial intelligence in structural interpretation workflows of subsurface datasets is still ambiguous. This study aims to use machine learning techniques to classify images of folds and fold-thrust structures. Here we show that convolutional neural networks (CNNs) as supervised deep learning techniques provide excellent algorithms to discriminate between geological image datasets. Four different datasets of images have been used to train and test the machine learning models. These four datasets are a seismic character dataset with five classes (faults, folds, salt, flat layers and basement), folds types with three classes (buckle, chevron and conjugate), fault types with three classes (normal, reverse and thrust) and fold-thrust geometries with three classes (fault bend fold, fault propagation fold and detachment fold). These image datasets are used to investigate three machine learning models. One Feedforward linear neural network model and two convolutional neural networks models (Convolution 2d layer transforms sequential model and Residual block model (ResNet with 9, 34, and 50 layers)). Validation and testing datasets forms a critical part of testing the model's performance accuracy. The ResNet model records the highest performance accuracy score, of the machine learning models tested. Our CNN image classification model analysis provides a framework for applying machine learning to increase structural interpretation efficiency, and shows that CNN classification models can be applied effectively to geoscience problems. The study provides a starting point to apply unsupervised machine learning approaches to sub-surface structural interpretation workflows.