EGU2020-17431
https://doi.org/10.5194/egusphere-egu2020-17431
EGU General Assembly 2020

Recognition of marine seismic data features using convolutional neural networks

Massimiliano Iurcev[1], Paolo Diviacco[1], Simone Scardapane[2], and Federico Muciaccia[2]
[1]INOGS, IRI, Sgonico - Trieste, Italy (miurcev@inogs.it)
[2]Department of Information Engineering, Electronics and Telecommunications - Sapienza University of Rome

Exploration seismics is the branch of geophysics that aims to explore the underground using the propagation, reflection and refraction of elastic waves generated by artificial sources. Seismic signals cannot be straightforward read as geological layers and features but need to be interpreted by experienced analysts that contextualize the possible meaning of a signal with the geologic model under development. It goes without saying that interpretation is an activity that is biased by background and tacit knowledge, perceptive and even sociological factors. Applications of artificial intelligence in this field gained space especially within the oil Exploration and Production (E&P) industry while less has been done in the academic sector. The main target of the E&P is the detection of Direct Hydrocarbon Indicators (DHI) highlighted as anomalies in the attribute space using mainly Principal Component Analysis (PCA) and Self-Organizing Maps (SOM) methods.
There are, however, seismic signals that can be detected in the image space that can be associated with specific geological feature. Among these we started to concentrate to the simplest forms such as seismic diffractions that can be associated with faults. The diffractor has the property that it scatters energy in all directions and plots on a seismic section as an hyperbola. It can be hard to detect the diffraction hyperbola especially when the data are contaminated with noise or if data is not homogeneous such as when they are integrated from different teams, practices or vintage.
To overcome these difficulties, a large compilation of data has been gathered and submitted to experts in order to train a prediction system. Data have been gathered from the SDLS (Antarctic Seismic Data Library System), which is a geoportal maintained by INOGS, providing open access to a big collection of multichannel seismic reflection data collected south of 60°S. An interactive application (written in Processing for GUI, open-source and multi-platform requirements) allowed a pool of geophysical researchers to mark individually the hyperbolic features onto the seismic traces, by simple mouse dragging. Further processing in Python of the collected information, based on geometric algorithms, helped to build a rich training dataset, with about 10000 classified images.
In order to investigate a first proof-of-concept for this application, we leverage recent results in deep learning and neural networks to train a predictive model for the automatic detection of the presence of the hyperbola from the image. A convolutional neural network (CNN) is trained to map the small pictures extracted beforehand to a probability describing the eventual presence of a hyperbola. We explore different designs for the CNN, using several state-of-the-art guidelines for

its architecture, regularization, and optimization. Furthermore, we augment in real-time the original dataset with noise and jittering to improve the overall performance. Using the trained CNN we built heatmaps over a set of testing images, highlighting the regions with high probability of containing a feature.