The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Geosteering using Deep Learning

Mostafa Shahriari[1], David Pardo[2,3,4*] and Jon Ander Rivera[2,3]

[1] Software Competence Center Hagenberg GmbH (SCCH), Hagenberg, Austria
[2] University of the Basque Country (UPV/EHU), Leioa, Spain.
[3] Basque Center for Applied Mathematics (BCAM), Bilbao, Spain
[4] Ikerbasque (Basque Foundation for Sciences), Bilbao, Spain

Keywords: *borehole resistivity measurements, real-time inversion, deep learning, measurement acquisition system, automated machine learning*

Geosteering requires the real-time inversion of borehole resistivity measurements. Traditional inversion methods (such as gradient-based methods or statistics-based methods) are often computationally expensive [1]. Deep neural networks (DNNs) require a large dataset for the training of the neural network, but they approximate the forward and the inverse problems offline. Thus, once the training process is completed, online prediction (evaluation) in the field takes a fraction of a second, making the use of DNNs suitable for performing geosteering.

In [2], we propose the use of a two-step loss function to approximate both, the forward function and the inverse operator using DNNs. However, [2] does not discuss the optimal selection of the DNN architecture, and it uses a large DNN to achieve its goal. In this work, we discuss a proper selection of DNN architecture to approximate the NNs involved in the aforementioned two-step training. Here, we employ automated machine learning (AutoML) algorithms, specifically DNN architecture search algorithms, to build quasi-optimal DNN architectures that balance size and accuracy of the networks.

Moreover, we propose a DNN-based iterative algorithm to design a borehole measurement acquisition system such that the inverse solution is unique for a given earth parametrization. For that, we select a large set of electromagnetic measurement systems routinely employed in logging operations, and our proposed DNN algorithm selects a subset of them that is suitable for inversion purposes.

REFERENCES

[1] Tarantola, A. Inverse problem theory and methods for model parameter estimation. *Society for Industrial and Applied Mathematics*, (2005).

[2] M. Shahriari, D. Pardo, J. A. Rivera, C. Torres-Verdín, A. Picon, J. Del Ser, S. Ossandón, and V. M. Calo. Error control and loss functions for the deep learning inversion of borehole resistivity measurements. *International Journal for Numerical Methods in Engineering*, (2020) **122**(6): 1629-1657.