# A Journey in using Neural Networks for DC Resistivity Modelling and Inversion

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## SUMMARY

In recent years, Machine Learning approaches have found applications in a variety of fields. For typical applications, large amounts of data are used to train neural networks to perform tasks such as image segmentation or regression.
Particularly, Convolutional Neural Networks have shown promising results in that regard. However, for applications in physics, the classic, data-informed way of training neural networks can pose a problem. Even given large and diverse data sets, geophysical forward or inverse problems solved using neural networks do not yield solutions true to the underlying physics. This means that although conventional approaches such as traditional Convolutional Neural Networks are easy to implement and train, they often cannot be trained to generalize well enough for physical applications. Recently, so-called Physics Informed Neural Networks have been proposed that attempt to incorporate the underlying partial differential equations into the training process. This approach allows for more accurate reflection of physics in machine learning approaches, but greatly complicates training. Moreover, training results cannot be easily be re-used to solve problems in different parameter or source settings. A synthesis of both approaches lies in the use of recently developed Physics Informed Neural Operators, which aim to combine the physics information of Physics Informed Neural Networks with the re-usability and architectures of established approaches like Convolutional Neural Networks.
We present different approaches to solve DC resistivity Problems using neural networks of different architectures, including classic Convolutional Neural Network approaches, PINNs, and Neural Operators and discuss their respective advantages and drawbacks.

**Keywords:** DC Resistivity, Machine Learning, Neural Operator, Physics Informed Neural Networks