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Global soil mapping with Neural Networks

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High quality global soil maps are crucial to face several challenges such as reducing soil erosion, climate change adaptation and mitigation, ensuring food and water security, and biodiversity conservation planning. To obtain accurate and robust soil properties maps, research and development are necessary to identify the most appropriate prediction models and to develop efficient and robust workflows. A few recent studies used Artificial Neural Networks (ANN) in Digital Soil Mapping, in some cases improving the accuracy of the predicted maps compared to other methods like Random Forest (RF). In this study we tested different ANN architectures on a global top-soil dataset of ca. 110 000 samples, comparing the results for the different architectures with the more traditional approach of RF. The target variables considered are pH, Soil Organic Carbon, Sand, Silt, and Clay. We selected 40 environmental covariates from a pool of over 400 to represent the most important soil forming factors. We tried simpler architectures (single input – single target) using point observations for one target variable with corresponding raster cell values for spatially explicit environmental covariates. We also used more complex architectures (multi input - multi target) incorporating contextual information surrounding an observation (convolutional) and with multiple target variables. Preliminary results show that increasing the number of hidden layers in the neural network does not significantly influence the results, while changing the type of architecture can play a bigger role in the overall accuracy of the model. The overall prediction accuracy of the ANN was comparable with the RF model. We conclude that ANN are a promising, relatively new, approach for Global Digital Soil Mapping and that further research is needed to improve performance.