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Hierarchical Soil Classification using Gaussian Processes

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The goal of this work is to perform soil classification with uncertainty quantification for a structured treatment of the output classes. Uncertainty can help in this setting to make predictions more informative with regard to class relationships. This is of particular interest due to the often highly related nature of the distinguished soil types. Incorporating knowledge about class structure into the model also provides opportunity for improving the model accuracy. Our main focus, however, is to enable modellers to better understand and work with this structure during analysis.
For example, post-hoc aggregation of class labels into supersets facilitates applications such as letting the model choose an ontological level on which it can confidently distinguish the output class. It can likewise be used to determine the combined probability of specified classes that share a property of interest.
Technically, this works by learning a latent Gaussian distribution, for example using a Gaussian Process model, and mapping it to a distribution over the class probabilities. We demonstrate this approach, explore possible applications for exploiting uncertainty information, in particular with regard to the class hierarchy, and compare the performance of different model variants in terms of accuracy and calibration.