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Constraining geostatistical models with hydrological data to improve prediction realism

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Geostatistical models reproduce spatial correlation based on the available on site data and more general concepts about the modelled patters, e.g. training images. One of the problem of modelling natural systems with geostatistics is in maintaining realism spatial features and so they agree with the physical processes in nature. Tuning the model parameters to the data may lead to geostatistical realisations with unrealistic spatial patterns, which would still honour the data. Such model would result in poor predictions, even though although fit the available data well. Conditioning the model to a wider range of relevant data provide a remedy that avoid producing unrealistic features in spatial models.

For instance, there are vast amounts of information about the geometries of river channels that can be used in describing fluvial environment. Relations between the geometrical channel characteristics (width, depth, wave length, amplitude, etc.) are complex and non-parametric and are exhibit a great deal of uncertainty, which is important to propagate rigorously into the predictive model. These relations can be described within a Bayesian approach as multi-dimensional prior probability distributions.

We propose a way to constrain multi-point statistics models with intelligent priors obtained from analysing a vast collection of contemporary river patterns based on previously published works. We applied machine learning techniques, namely neural networks and support vector machines, to extract multivariate non-parametric relations between geometrical characteristics of fluvial channels from the available data. An example demonstrates how ensuring geological realism helps to deliver more reliable prediction of a subsurface oil reservoir in a fluvial depositional environment.