Small area estimation or simulation by using training images: the advent of multiple-point statistics

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In many earth sciences applications, the geological or physical structures to be reproduced are curvilinear, e.g., high permeability sand channels forming preferential flow paths.

Modeling of such curvilinear patterns requires measuring the connectivity in the space of the indicators of such structures; the traditional tool offered by geostatistics is the 2-point statistics covariance/variogram which relates any two points in space, for example establishing the probability that any two locations are in the same facies. Such statistics is largely insufficient to characterize the shape and spatial continuity of the structure under study. The modeling of curvilinear structures requires multiple-point statistics inolving jointly three or more points at a time. The inference of multiple-point statistics needs a vast amount of data on a regular grid, typically not available in the small area or sub-domain (subsurface). In many applications, particularly those related to mapping of categorical variables, facies or rock types distributions, critical structural information can be obtained from training images drawn from prior expertise on similar phenomena. From such training images complex statistics involving jointly values at multiple locations can be extracted.

Such training images depict the expected patterns of geological heterogeneities. The multiple-point statistics inferred from the training images are exported to the reservoir model where they are anchored to the actual subsurface data, both hard and soft, in a sequential simulation mode.
Hence, the objective of this paper/poster is to introduce this new multi-point technique in order to improve estimations/simulations on a small area.