Sampling Grid Shifting Algorithm: A Non-ergodic Spatial Bootstrap Technique for Regular and Irregular Sampling Patterns

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Abstract

Accounting for uncertainty in statistical model parameters is an essential part of geostatiscal reservoir characterization. While parameter uncertainty may be assessed in its ergodic form; the non-ergodic is a better characterization of the variability in the random field. Assessing non-ergodic parameter uncertainty requires re-sampling (bootstrapping) techniques. Existing techniques for such non-ergodic re-sampling are plagued with some limitations/complications. This paper therefore presents a spatial bootstrap algorithm that overcomes the limitations/complication. For a discretized field, the algorithm implements simultaneous displacements (shiftings) of all sampling points through the same distance vector. The shiftings are done across the dimensions of the field subject to the dimensionality of the sampling. In each dimension, the sampling points are shifted successively through a distance equivalent to the gridblock length in

that dimension. At each shifting, a shifted sampling grid, of similar configuration as the original sampling grid, is generated. Using the shifted sampling grid, the algorithm re-samples a full-grid simulated realization of the field. The assumption of second-order stationarity implies that a sample from a shifted sampling grid is considered a repeated sample of the original sample. The algorithm has been scripted in R statistical computing environment and applied to an irregularly-sampled 3-D field with satisfactory results.

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