INTERPOLATION AND ESTIMATION USING MULTIPLE POINT STATISTICS

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Abstract

In the last decades a number of geostatistical simulation techniques have appeared that allow taking into account complex structural information, by quantifying a multiple-point statistical (MPS) model. The higher order statistics are typically informed from a training image, sample model, or geological exposure. Typically, such MPS models are used to simulate subsurface models with high(er) order of realism than is possible using for example the widely used 2-point statistical models (such as sequential Gaussian simulation).

Typically more information than the MPS model is available, such as well log data and geophysical information in form of inverted information for a point, profile or an area. Such information (arbitrarily complex) can be combined using Monte Carlo sampling methods, that are computationally very demanding, to a point when they can become intractable to apply. Instead we propose a method that allow MPS simulation algorithms, such as the widely used SNESIM algorithm, to take into account such geophysical data, when inversion results have been transformed into probabilistic quantities describing the property that one wishes to simulate. This leads to a simulation algorithm that can generate realizations that represent the same variability as compared to using the Monte Carlo approach, only using a fraction of CPU (and computation time).

Then we consider the case when the end user is not interested in the set of produced realizations themselves, but rather in a statistical property derived from the samples, such as the pointwise most probably model, the mean model, or the pointwise quantile. In order to obtain these, one would typically generate a larger number of independent realizations, and the compute some point-wise statistics of these. We propose to instead estimate such properties directly using MPS based estimation. This potentially allows for a much faster algorithm, compared to simulation followed by computing the statistics.

In effect we propose to use multiple-point statistical models for ‘estimation’ rather than ‘simulation’. This is equivalent to the use of kriging for estimation and sequential Gaussian for simulation, in the case of using a Gaussian statistical model. Therefore we open up the possibility to use MPS for estimation/interpolation, which allows for using an arbitrarily complex statistical model as the base of interpolation, as opposed to the common of the Gaussian model implicit in any kriging.

We demonstrate the methods through examples where we compare the different methods to estimate the probability of a locating subsurface buried valley around Kasted, Denmark.