

Noise Reduction by M-Factorial Kriging

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Factorial kriging is a classical variogram-based filtering technique developed by Georges Matheron in 1982 [1]. It relies on a simple additive model where the spatial variable under study is modeled by a random function, $Z(\mathbf{x})$, which is parted in terms of independent factors:

$$Z(\mathbf{x}) = Z_1(\mathbf{x}) + Z_2(\mathbf{x}) + \dots$$

Noise reduction issues can be easily handled into the framework of this model, as far as the noise part of a data set can be considered independent of a complementary signal part:

$$Z(\mathbf{x}) = Z_{\text{NOISE}}(\mathbf{x}) + Z_{\text{SIGNAL}}(\mathbf{x})$$

In such a way, factorial kriging, by estimating $Z_{\text{SIGNAL}}(\mathbf{x})$, allows to filter out the noisy component of a data set.

During recent years in the petroleum industry, factorial kriging has been extensively applied to seismic data in various noise reduction contexts. Although the technique proved to be efficient for reducing noise globally, it appeared limited when faced with non-stationary phenomena affecting the data.

M-GS (Moving-GeoStatistics) is an innovative technology which is fully dedicated to the local optimization of parameters involved in variogram-based models. By optimizing spatially varying model parameters, M-GS guarantees a better adequacy between geostatistical model and data, leading consequently to more precise results.

This paper demonstrates how M-GS technology, combined with factorial kriging process, provides an optimal way for reducing the noise of a seismic amplitude data set. In particular, it is shown that the M-factorial kriging solution, by taking into account of non-stationary effects such as signal absorption, geological structuration, spatial variations of signal-to-noise ratio or varying geometrical features of noise, optimizes noise reduction while preserving signal information. The approach is compared to a conventional factorial kriging approach for filtering out the noise of a PSTM amplitude section. The gain in quality is finally quantified.