A Matrix Approach to Reproduce a Correlation Matrix in Multivariate Sequential Gaussian Simulation

Olena Babak* and Clayton V. Deutsch
Centre for Computational Geostatistics, University of Alberta
*Currently employed with Total E&P Canada Ltd.

Abstract

When dealing with several attributes in spatial modeling it is desirable to reproduce the collocated correlation among them. An example target global collocated correlation matrix between four random variables is shown below.

Reproduction of the correlation between multiple variables can be achieved by using variants of cokriging, in particular, simple cokriging; however, this requires fitting a model of coregionalization that becomes intractable in the case of many variables.

An alternative is to perform multiple univariate sequential simulations with correlated residuals. This approach performs a matrix simulation with LU decomposition of the correlation matrix at each step of sequential simulation. The modeling of each random variable is performed independently. Thus, this type of simulation is primarily aimed at simulation of multiple primary variables. In simulation, the data on each individual random variable are used to calculate the mean and variance of the local conditional distribution for that variable using simple kriging; no inference of the joint model for spatial continuity is needed. The target mean and variance as well as target variogram models are well reproduced; however, an unfortunate feature of this technique is that the target correlation matrix is not reproduced because of conditioning to local data and the variable ordering in the sequential/LU decomposition.

A correction to reproduce the correlation between random variables at lag 0 is proposed. The proposed approach supplements other well founded techniques for reproducing lag 0 correlation matrix such as kriging or cokriging of principal components or minmax autocorrelated factors. The advantage of the multiple univariate sequential Gaussian simulation reproducing correlation between variables at lag 0 over these other techniques is that it ensures reproduction of the variogram models and covariances. The proposed approach is illustrated with two examples where significant improvement in the reproduction of correlation matrices over the conventional method of SGS with correlated residuals is shown.