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Estimation of Coal Reserves: Comparison of the Stochastic Local Interaction Model and Ordinary Kriging with an Application to a Coal Deposit in Wyoming, USA

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Coal is still an important energy resource, contributing significantly to the energy budget of several countries around the world. Accurate estimation of coal reserves is essential for the long-term planning of mines and for the development of regional economic strategy and energy utilization planning. Coal thickness and quality characteristics vary greatly in a coal mine due to geological heterogeneities, which creates difficulties for deterministic prediction models. The heterogeneities include possible faults, the presence of multiple coal seams of variable thickness, tectonic deformations, and interburden layers. Kriging and simulation methods can, to some extent, overcome these challenges, and lead to more reliable estimates of reserves. However, such methods require the inversion of the data covariance matrix, which is a computationally expensive procedure especially for large data sizes.

In this paper, we present a new, less computationally intensive method for reserves estimation, which is based on the stochastic local interaction (SLI) model. The SLI method constructs a spatial interaction matrix that accounts for the data values, their locations, and the sampling density variations. This construct does not require matrix inversion for parameter estimation and spatial prediction, and it thus leads to computational procedures that are less intensive than kriging. SLI provides an uncertainty measure analogous to the kriging variance. Calculation of this measure, however, requires the inversion of the SLI precision matrix.

We compare SLI with ordinary kriging (OK) in terms of estimation performance using cross-validation analysis and computational time requirements. The comparison is conducted using approximately 13,000 drill-hole data of coal reserves from Campbell County, Wyoming, USA. To apply SLI, we divided the entire area in two overlapping spatial domains, while for OK we used a search neighbourhood of 1.1 km. SLI required about half the computational time needed for OK. The leave-one-out cross-validation measures have similar values without clearly favouring one method over the other.

References:

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