Sampling Strategies for Uncertainty Reduction in Categorical Random Fields: Formulation, Mathematical Analysis and Application to Multiple-Point Simulations

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The task of optimal sampling for the statistical simulation of a discrete random field is addressed from the perspective of minimizing the posterior uncertainty of non-sensed positions given the information of the sensed positions. In particular, information theoretic measures are adopted to formalize the problem of optimal sampling design for field characterization, where concepts such as information of the measurements, average posterior uncertainty, and the resolvability of the field are introduced. The use of the entropy and related information measures are justified by connecting the task of simulation with a source coding problem, where it is well known that entropy offers a fundamental performance limit. On the application, a one-dimensional Markov chain model is explored where the statistics of the random object are known, and then the more relevant case of multiple-point simulations of channelized facies fields is