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Multivariate sensitivity analysis for risk analysis with spatial outputs: a comparison exercise

Maps play a key role in many applications to facilitate decision-making for risk analysis, such as in assessing natural hazards, soil pollution, water quality, and so on. Performing global sensitivity analysis in a spatial context can benefit from multiple approaches adapted to multivariate outputs, namely: 1. the combination of variance-based sensitivity indices and functional principal component analysis (PCA); 2. the use of the Hilbert-Schmidt Independence Criterion (HSIC) with kernels adapted to functional outputs; 3. a recently-developed moment-independent method grounded in the theory of optimal transport (OT). In this communication, we aim to compare these different approaches by considering three types of criteria. Firstly, we analyse their practical implementation, that is, their ability to handle complex types of output data and to estimate measures of importance directly from a dataset containing a limited number of samples. Secondly, we analyse their interpretability in relation to the objective of risk analysis. Finally, we examine their robustness with respect to their parameterisation by analysing the stability of the results in the face of different modelling choices, more specifically the amount of variance retained in PCA, the definition of the kernel for the HSIC method, and the estimator used to calculate the Wasserstein distance for the OT method. This comparative exercise is based on a simple synthetic function, namely the Campbell2D function, as well as on real-world environmental studies for assessing soil pollution and groundwater quality.

Special/ Invited session

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