Global sensitivity analysis with distance correlation and energy statistics

Elmar Plischke, Emanuele Borgonovo

In scientific modeling, it is often impossible to grasp the response of the output of a numerical model to variations in the model inputs based on sole intuition. For this, sensitivity analysis comes at hand, allowing to analyze the influence of input factors on the model output. Interpreting these sensitivity measures as distances to certainty, one arrives at sensitivity measures based upon tests for stochastic independence. Recently, a number of omnibus tests for this purpose have been suggested in the statistics and machine learning literature, based on distance covariance, energy statistics or the Hilbert-Schmidt independence criterion.

We consider the appropriateness of these measures for sensitivity analysis purposes. In particular, we study the energy statistics. Its one-dimensional analogon is known as Gini mean distance. We embed it into a sensitivity framework recently established by the authors and derive simple estimators so that a cheap method for extracting moment-independent sensitivity information from given data is obtained. Links to reliability theory and to variance-based first order effects can also be established, allowing an interpretation of Gini sensitivity as a mean output quantile sensitivity.