# Variance-based sensitivity analysis in the presence of correlated input variables

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## Abstract

In the assessment of computational engineering models, sensitivity analysis has played an increasing role during the last two decades. For probabilistic models, variance based sensitivity methods are very common. Based on the work of Sobol' (1993) first order indices have been extended to total indices capturing higher order coupling effects between the input variables (Homma and Saltelli 1996). Variance based sensitivity indices have become a prestigious measure to quantify higher order effects of input variables which is necessary for model simplification by variable fixing. However, the basic formulation of the variance decomposition and the common estimation procedures require so far independent input variables.

In practical applications often input variables are correlated, therefore, an increased interest in extending the classical methods for correlated inputs has been arised in the recent years. However, in all of these investigations, assumptions about the model output or approximations up to a certain degree are necessary. Complete model independent approaches for the estimation of total effect indices are not available so far. Jacques et al. (2006) uses classical estimators by grouping the correlated inputs which results in independent groups of parameters. However, even this approach is not useful for more complex models where almost all variables are coupled with each other.

In this paper we propose an extension of the classical Sobol' estimator. This approach assumes a linear correlation model between the input variables which is used to decompose the contribution of an input variable into a correlated and an uncorrelated part. This method provides sampling matrices following the original joint probability distribution which are used directly to compute the model output without any assumptions or approximations of the model response function.

## References

T. Homma and A. Saltelli. Importance measures in global sensitivity analysis of nonlinear models. *Reliability Engineering and System Safety*, 52:1–17, 1996.

J. Jacques, C. Laverge, and N. Devictor. Sensitivity analysis in presence of model uncertainty and correlated inputs. *Reliability Engineering and System Safety*, 91:1126–1134, 2006.

I. M. Sobol'. Sensitivity estimates for nonlinear mathematical models. *Mathematical Modelling and Computational Experiment*, 1:407–414, 1993.