Global Sensitivity Analysis of Models with Correlated Inputs

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Abstract Global sensitivity analysis is an important tool used in many domains of computational science to either gain insight into the mathematical model and interaction of its parameters or study the uncertainty propagation through the input-output interactions. This work introduces a comprehensive framework for conducting global sensitivity analysis on models with correlated inputs. Traditional sensitivity analysis methods assume independence between inputs and can provide misleading results when this assumption is violated. The proposed approach addresses parameter correlations using Rosenblatt transformation, which are incorporated into a polynomial surrogate model. The sensitivity analysis requires numerous execution of the target application, which requires significant computational resources. The numerical experiments are executed using HPC platforms equipped with metaschedulers and workflow automation tools.

Why Sensitivity Analysis

SA is now considered a requirement for good modelling (e.g. “Better regulation toolbox” by European Commission, 2015).

SA helps to get insights about:
- How the outputs of a system are related to, and are influenced by, its inputs
- Identify uninformative factors in a system that may be redundant and fixed or removed
- Identify parameters that dominantly control a system, for which new data acquisition reduces uncertainty the most
- Quantify the sensitivity of an expected outcome to different decision options, constraints, assumptions and/or uncertainties

Sensitivity Analysis

In many applications, the inputs are stochastically dependent, which violates one of the essential assumptions in the state-of-the-art sensitivity analysis methods. Consequently, the SA results obtained ignoring the correlations values which do not reflect the true contributions of the input parameters.

Application - Delta Hedging

Sensitivity = Hedge Ratios

In the presence of parameter correlations, the resulting power price sensitivity changes compared to the base case. Note the pronounced impact of the natural gas input and reduced sensitivity of the coal. This impacts the financial instrument such as hedges of power price with respect to the aforementioned fuels.

Collaborations and Projects

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