International Conference on
Sensitivity Analysis of Model Output

SAMO

April 23-25, 2025 in Grenoble, France

Contents

1 SAMO conference, April 23, 2025

1.1 Keynote 1

Chairwoman: Clémentine Prieur

Sergei Kucherenko, Imperial College London

Title: Derivative Based Global Sensitivity Measures: Past, Present and Future

Abstract: Derivative-based global sensitivity measures (DGSM) is a technique used in global sensitivity analysis to identify the importance of different subsets of input variables to variation in model output. It has a strong link with the Morris screening method and Sobol' sensitivity indices and has several advantages over them. One of the key advantages of DGSM is its comparatively lower computational cost compared to estimating Sobol' sensitivity indices, making it a practical option for sensitivity analysis, especially in high-dimensional models. In this talk we present a history of development and a survey of recent advances in DGSM. In particular, we discuss a link between DGSM and the active subspace method, extension of DGSM for models with dependent inputs and Shapley values based on DGSM.

1.2 Sessions 1a/1b

Session 1a
Chairman: Bruno Sudret

Global sensitivity analysis for time-variant reliability, Papaioannou Iason [et al.]

Optimized clustering of model input samples based on sensitivity indices, Roux Sébastien [et al.]

Kernel-based parameter screening for conditional Bayesian calibration, Baldé Oumar [et al.]

Session 1b
Chairman: Julien Reygner

Ensemble weather forecasting? Sensitivity analysis would help., Aleksovska Ivana [et al.]

Global Sensitivity Analysis of Gamma-Ray Spectra in Uranium Logging, Arthur Pellet-Rostaing [et al.]

1.3   Sessions 2a/2b

Session 2a
Chairman: Bertrand Iooss

Quantile oriented Shapley effect via projected random forest, Wang Ri [et al.]

Reliability-oriented sensitivity analysis with multiple importance sampling, Mboko Jonathan [et al.]

Overcoming challenges in sensitivity analysis for complex models in nuclear and renewable energy applications, Gabriel Sarazin [et al.]

Session 2b
Chairwoman: Sidonie Lefebvre

A Machine Learning Approach to compute Sobol' sensitivity indices with Given Data – ADAM model study, Ivano Azzini [et al.]

On the use of sensitivity analysis for a game-theoretic approach of environmental management problem, Dutang Christophe [et al.]

1.4   Keynote 2

Chairwoman: Claire Lauvernet

Francesca Pianosi, University of Bristol

Title: Global Sensitivity Analysis: who, when and why

Abstract: Global Sensitivity Analysis is increasingly used to investigate the propagation of uncertainties through environmental and infrastructure models. Knowledge of model outputs' sensitivity can be used to guide the model calibration and diagnostic evaluation, and the use of model outputs for informing decisions under uncertainty. However, despite significant advances in the availability of methods, tools and application examples, the uptake of GSA widely varies within and across modelling communities. In this talk, I will discuss two "GSA paradoxes". First, that the very complex models that would most benefit from scrutiny through GSA are the ones to which this methodology is least frequently applied. Second, that the versatility of GSA – i.e. its ability to be adapted to different tasks, from prioritising efforts for model improvement, to model evaluation, to improving our understanding of systems' behaviour – makes it more difficult (rather than less)

to communicate its value to potential users. Drawing on a range of recent examples from the water, natural risk and energy sector, I will present some ideas on how we can move forward past these paradoxes and better support model developers and users to conceptualise GSA experiments, and identify who, when and why can benefit from it.

1.5 Sessions 3a/3b

Session 3a Chairwoman: Christophette Blanchet-Scalliet

Barycentre of Models, Pesenti Silvana [et al.]

Knockoff'ed Total Indices, Plischke Elmar [et al.]

Combining Counterfactuals and Sensitivity Analysis: A New Approach to Explaining Black-Box Models, Lu Xuefei [et al.]

Session 3b Chairman: Sébastien Roux

Effect of forcing uncertainty in the sensitivity and calibration of a pesticide transfer model, Radišić Katarina [et al.]

Sensitivity analysis of multi-scale energy power system models, Stefano Tarantola

Sensitivity Analysis in Systems Biology Research: New Perspectives and Considerations, Saxton Harry [et al.]

1.6 Sessions 4a/4b

Session 4a Chairman: Olivier Zahm

Co-active subspace methods for adjacent computer models, Rumsey Kellin [et al.]

On one dimensional weighted Poincaré inequalities for Global Sensitivity Analysis, Heredia David [et al.]

Gradient-enhanced surrogate modelling and sensitivity analysis with chaos expansions, Lüthen Nora [et al.]

Session 4b Chairwoman: Silvana Pesenti

Multi-output excursion set estimation applied to the calibration of a wind turbine numerical model, Duhamel Clément [et al.]

Reduced-space Bayesian optimization of process flowsheets, Triantafyl-lou Niki [et al.]

Sample Average Approximation for Portfolio Optimization under CVaR constraint in an (re)insurance context, Lelong Jérôme [et al.]

2 SAMO conference
April 24, 2025

2.1 Keynote 3

Chairwoman: Clémentine Prieur

Frances Kuo, University of New South Wales, Sydney

Title: Lattice rules, kernel methods, DNNs, and how to connect them

Abstract: Lattice rules are my favorite family of quasi-Monte Carlo methods. They are proven to be effective for high dimensional integration and multivariate function approximation in a number of settings. They are extremely easy to implement thanks to their very simple formulation — all we require is a "good" integer vector of length matching the dimensionality of the problem. We know how to construct such good vectors tailored to applications in different areas, e.g., in PDEs with random coefficients, both for computing expected values (integrals) of quantities of interest as well as in obtaining surrogates of the PDE solution using lattice-based kernel interpolants. In recent years there has been a burst of research activities on the application and theory of Deep Neural Networks (DNNs). We explore how lattice rules can be used in the framework of DNNs.

This is based on joint work with Alexander Keller (NVIDIA), Dirk Nuyens (KU Leuven) and Ian H. Sloan (UNSW Sydney).

2.2 Poster blitz

Chairman: Olivier Zahm

Mostafa Abdelhafiz "Checkerboard Partitioning for Third-Order Sensitivity Analysis: Application in Reactive Transport Modeling for Nuclear Waste Disposal"

Trevor Barnes "High-Impact Options to Achieve Near-Term Emission Targets in the USA"

Elena Bastianon "Sensitivity Analysis of a Biogermorphological Model for Predicting Landscape Evolution"

Manal Benaissa "Sensitivity analysis for sizing an Autonomous Datacenter Powered by Renewable Energy"

Denis Brizard "Global Sensitivity Analysis in the context of crashworthiness: is Morris analysis suitable?"

Alexandra Duckstein "Sensitivity analysis for nuclear waste repository safety assessment considering heterogeneities of the host rock"

Joel Pascal Soffo Wambo "An adaptive method for nonlinear model order reduction using sparse polynomials"

Sarah Juricic "Bayesian approach to assessing the overal counter-performance of housing block fabric"

Quentin Laporte-Chabasse "Extensive development of a Bayesian calibration approach for building energy models using an innovative case study: a shipping container building."

Sidonie Lefebvre "Kernel based sensitivity analysis applied to crop monitoring with hyperspectral remote sensing"

Nabir Mamnun "Global sensitivity analysis of a one-dimensional ocean biogeochemical model"

Lucas Palazzolo "Parametric Shape Optimization of Flagellated Micro-Swimmers Using Bayesian optimization techniques"

Sabine M. Spiessl "Sensitivity Analysis (SA) Comparisons on Geologic Case Studies: An International Collaboration"

Yipeng Yao "Uncertainty in Life Cycle Assessment: Sources, Types, Propagation, Evaluation, Mitigation and Reporting"

2.3   Sessions 5a/5b

Session 5a Chairman: Tony Jakeman

Greedy packing algorithms with relaxation, Pronzato Luc

Efficient estimation of Sobol' indices of any order from a single input/output sample, Da Veiga Sébastien [et al.]

Sensitivity analysis using multilevel Monte Carlo and surrogate-based control variates, De Lozzo Matthias [et al.]

Session 5b Chairman: Thierry Mara

Democratizing global sensitivity analysis with a no-code web dashboard., Roy Pamphile [et al.]

A comparison of variance-based estimations of sensitivity indices for models with dependent variables, Rossana Rosati [et al.]

Novel Sensitivity Analysis Using SHAPLEY for PROMETHEUS Resilience Modelling, Montanari Elias

2.4   Sessions 6a/6b

Session 6a Chairman: Giray Okten

General Sensitivity Indices for Hilbert Space-Valued Random Variables, Lopez Leonid [et al.]

Sensitivity analysis for Bayesian optimization with uncertainties, Fellmann Noé [et al.]

Bayesian approach for the detection of inactive variables in Gaussian process approximation, Bartok Eniko [et al.]

Session 6b Chairman: Stefano Tarantola

A new variance-based sensitivity analysis for models with non-independent variables., Lamboni Matieyendou

A new paradigm for global sensitivity analysis, Mazo Gildas

Hoeffding HDMR, Sobol' HDMR and the Shapley Value, Mara Thierry

2.5   Sessions 7a/7b

Session 7a Chairwoman: Céline Helbert

Enabling Time Series Sensitivity Analysis with Iterative Variance Orthogonal Decomposition, Yachouti Mouad [et al.]

Surrogate GSA with categorical and continuous inputs., Milton Robert [et al.]

Application of HSIC-Lasso for high-dimensional feature selection in shapelet-based decomposition, Pelamatti Julien [et al.]

Session 7b Chairman: Luc Pronzato

Bayesian Adaptive Spline Surfaces: An Emulator Made For Sensitivity Analysis, Francom Devin [et al.]

Variance-based importance measures for high-dimensional linear model via Johnson indices: Insights and comparisons, Clouvel Laura [et al.]

New results on Generalized Hoeffding decomposition of numerical models, Il Idrissi Marouane [et al.]

2.6 Keynote 4

Chairman: Andrea Saltelli

Arnald Puy, University of Birmingham

Title: Smoke and mirrors in water modelling

Abstract: In this keynote I will survey our recent work on uncertainties in water modelling. I will show that knowledge claims in water modelling are as assertive and even more quantified than those in physics-based disciplines, yet their numeric inferences lack an uncertainty and sensitivity analysis (UA/SA). I will show what happens when one of the most spread claims, that humans have exceeded the freshwater planetary boundaries, is examined through a stringent UA/SA. Finally, I will zoom into irrigation modelling to highlight some consequences derived from this cursory approach to uncertainties and sensitivities: delusive accuracy in global irrigation water withdrawal estimates, excess of model complexity given epistemic and empirical limitations, and poor reflective stance, leading to a purely technical treatment of uncertainties. I will conclude by discussing why we should dispel the accuracy conjuring trick in water modelling and by offering some possible ways forward.

3 SAMO conference, April 25, 2025

3.1 Sessions 8a/8b

Session 8a Chairwoman: Clémentine Prieur

Sensitivity Analysis with Optimal Transport: Wasserstein Shapley and the Wasserstein Gap, Borgonovo Emanuele [et al.]

Fast pick-freeze estimation of sensitivity maps using basis decomposition, Sao Yuri [et al.]

Recent advances in the understanding and implementation of the HSIC-ANOVA decomposition, Sarazin Gabriel [et al.]

Session 8b Chairman: Bertrand Iooss

Robust Bayesian Analysis with information geometry and Perturbed-Law based sensitivity Indices, Rossat Donatien

Third Moment Method for Sensitivity Estimation of Failure Probability with respect to Distribution Parameter, Zhang Xuan-Yi [et al.]

Robustness analysis of gaussian process metamodels using Fisher density perturbations, Sueur Roman [et al.]

3.2 Sessions 9a/9b

Session 9a Chairman: Sergei Kucherenko

Derivative-based Global Sensitivity Analysis for Energy System Optimization Models via Implicit Differentiation, Mayer Patricia

Derivative-based upper bound for entropic total effect sensitivity with high dimensional and dependent inputs, Yang Jiannan [et al.]

Constructing Quasi-Monte Carlo Points With and Without Sensitivity Analysis, Pierre L'Ecuyer

Session 9b Chairman: Nicolas Bousquet

Enhanced Metamodeling and Sensitivity Analysis for Complex Models Using Tree-PCE. Applications to Hydro-Morphodynamics Modeling., Ben Said Faten [et al.]

Epistemic uncertainty management in risk assessment: connections between robustness and sensitivity analysis tools, Ajenjo Antoine [et al.]

Global sensitivity analysis unveils the hidden universe of uncertainty in multiverse studies, Saltelli Andrea [et al.]

3.3   Sessions 10a/10b

Session 10a Chairman: Adrien Spagnol

Global activity scores, Okten Giray

Variance-based selection of variables to improve prediction capability of innovative sensors in uncontrolled environment, Dumon Marine [et al.]

Towards Methodological Refinement of Power System Protection Testing via Statistical Design of Experiments, Ginocchi Mirko [et al.]

Session 10b Chairwoman: Véronique Maume-Deschamps

Decision sensitivity for engineering applications with epistemic uncertainty, Straub Daniel [et al.]

Forward Sweep Interval Sensitivity in Neural Network Functional Approximation, Ochnio Dawid [et al.]

Global Sensitivity Analysis based on Multi-resolution Polynomial Chaos Expansion: Method and Example Application to Coupled Flow Problems, Ilja Kröker [et al.]

3.4   Keynote 5

Chairman: Olivier Gaudoin

Tim Bedford, University of Strathclyde, Glasgow

Title: Expertise, Uncertainty, and Modelling

Abstract: Recent calls for "Responsible modelling" (for example in Saltelli, A., G. Bammer, et al (2020). "Five ways to ensure that models serve society: a manifesto." Nature 582(7813): 482-484; and, Saltelli, A. and M. Di Fiore (2023). The politics of modelling: Numbers between science and policy.) from people with wide expertise in modelling and policy making, have set out challenges to the modelling community that

require a conceptual response alongside a purely technical one. While the challenges they set out are wide ranging, we collectively need to make a start to constructively address some of these issues.

Here, we argue that conventional uncertainty frameworks offer a mechanism for communication, between scientists about the possible forms of modelling and the state of the art, and with policy makers about the state of the (currently) possible, but do not provide an operational and formative approach for problem owners. They do not give an adequate framework to include the different types of knowledge available or take account of Box's famous view that "All models are wrong but some are useful". Here we develop a different approach which acknowledges the many roles of expertise alongside the possibilities of using multiple models of different types. These contribute to the form and content of modelling and hence impact on the reproducibility of the modelling process.