Model calibration using deterministic sampling.

Background

Model calibration and inverse uncertainty quantification (UQ) is essential in all aspects of science and technology. This project is performed in collaboration with SSM (Strål Säkerhets Myndigheten). However, the significance is not limited to the area of nuclear technology.

An important part of establishing a safety case in an industry is based on model calculations. In many cases, experiments and measured data can only be used to verify and validate the used models and not be used directly to infer the full information of vital engineering parameters. Hence modeling is paramount. [Hessling17]

The models used are generally calibrated with experiments, and methods are available also to quantify model uncertainties. This is referred to inverse uncertainty quantification (IUQ). IUQ can, in many cases, be computationally heavy, and there is a need to find more efficient methods to determine the uncertainty.

Deterministic sampling (DS) has previously been used for propagation of uncertainties [Hessling13] [Sahlber16] [Sahlberg18]. DS is significantly more computationally efficient than traditional random sampling. The aim of this work is to explore if deterministic sampling can be used for IUQ, and to compare its performance to other IUQ methods.

Candidate

We are looking for a candidate with an interest in mathematics, statistics, and computational methods. The project will involve programming.

With the growing need for expertise in advanced mathematical modeling and data handling in society, particularly coupled to the onset of Machine Learning and Artificial Intelligence in many fields, we believe that this project will provide the student with a valuable skill set for the future. The project can be completed by one or more students.

Contact: henrik.sjostrand@physics.uu.se

References

[Hessling13] P. Hessling, “Deterministic Sampling for Propagating Model Covariance,” SIAM/ASA J. Uncertainty Quantification, vol. 1, no. 1, pp. 297–318, Jan. 2013, doi: 10.1137/120899133.

[Hessling17] P. Hessling, “Kalibrering för bestämning av optimal beräkningsmode,” 2017:23, p. 72, 2017.

[Sahlber16] A. Sahlberg, “Ensemble for Deterministic Sampling with positive weights,” Master Thesis, Uppsala University, 2016.

[Sahlberg18] A. Sahlberg, C. Hellesen, J. Eriksson, S. Conroy, G. Ericsson, and D. K. and, “Propagating transport-code input parameter uncertainties with deterministic sampling,” Plasma Phys. Control. Fusion, vol. 60, no. 12, p. 125010, Nov. 2018, doi: 10.1088/1361-6587/aae80b.