JOHNS HOPKINS
WHITING SCHOOL of ENGINEERING

Department of Civil and Systems Engineering

GRADUATE SEMINAR

Introducing Surrogate Models for Stochastic Simulators

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Computational models, a.k.a. simulators, are used in all fields of engineering and applied sciences to help design and assess complex systems in silico. Advanced analyses such as optimization or uncertainty quantifcation, which require repeated runs by varying input parameters, cannot be carried out with brute force methods such as Monte Carlo simulation due to computational costs. Thus the recent development of surrogate models such as polynomial chaos expansions and Gaussian processes, among others.

For so-called stochastic simulators used e.g. in epidemiology, mathematical finance or wind turbine design, an intrinsic source of stochasticity exists on top of well-identified system parameters. As a consequence, for a given vector of inputs, repeated runs of the simulator (called replications) will provide different results, as opposed to the case of deterministic simulators. Consequently, for each single input, the response is a random variable to be characterized.

In this talk we present an overview of the literature devoted to building surrogate models of such simulators, which we call stochastic emulators. First we focus on a recent approach proposed in [1] that is based on generalized lambda distributions and polynomial chaos expansions. The approach can be used without the need of replicated simulations, which brings efficiency and versatility [2]. As an outlook, other recent approaches based on random process modelling will be finally introduced, together with practical applications to sensitivity analysis [3].

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References:[1] X. Zhu and B. Sudret. Replication-based emulation of the response distribution of stochastic simulators using generalized lambda distributions. Int. J. Uncertainty Quanti_cation, 10(3):249{275, 2020. [2] X. Zhu and B. Sudret. Emulation of stochastic simulators using generalized lambda models. Submitted to SIAM/ASA J. Unc. Quant., 2021. ArXiv: 2007.00996. [3] X. Zhu and B. Sudret. Global sensitivity analysis for stochastic simulators based on generalized lambda surrogate models. Submitted to Reliab. Eng. Sys. Safety, 2021. ArXiv: 2005.01309.

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