

Statistical surrogates for uncertain systems: from atomistic to macroscale, and updating from small and incomplete datasets using probabilistic learning

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Abstract: The presentation highlights the construction of statistical surrogate models for uncertain systems across various scales. At the nano scale, we investigate the nonlinear dynamics of atomistic collisions involving random control and latent variables. At the micro-meso-macro scale, we explore concurrent multiscale modeling of nonlinear random materials described by a random field without scale separation. At the macro scale, we focus on the nonlinear stochastic dynamics of a nozzle with stochastic excitation and random material properties. This construction is based on the Probabilistic Learning on Manifolds (PLoM), which is used for managing and updating statistical surrogates in stochastic systems with uncertainties. Two cases for the random mapping between the random quantity of interest and the random control variable are considered: random manifolds arising from uncertainties and random manifolds arising from latent variables. Updated statistical surrogates are constructed using joint probability measures learned from small training and target datasets, employing either conditional statistics or Polynomial Chaos Expansion, where the random control variable serves as random germs.

Biographical Sketch: Christian Soize is an Emeritus Professor at the Multi-Scale Modeling and Simulation Laboratory (MSME) at Université Gustave Eiffel in France, renowned for his pioneering work in stochastic modeling in mechanics. His contributions to the fields of computational mechanics and uncertainty quantification have had a profound impact, with around 9,000 citations on Scopus and over 15,000 citations in Google Scholar. Soize's influential research has been recognized with prestigious honors, including the Prix Madame Victor Noury from the French Academy of Sciences, the title of Fellow of the Acoustical Society of America, the Chevalier dans l'Ordre National du Mérite, the Officier dans l'Ordre des Palmes Académiques, and the IACM Award in Computational Mechanics.



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