HEMI Seminar

Physics-informed Polynomial Chaos Expansions for Localized Uncertainty Quantification

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Abstract: Physical systems are typically represented by costly mathematical models and contain various uncertain variables. The crucial task is thus to propagate the uncertainty of the input parameters through a mathematical model. Therefore, it is often necessary to use surrogate models as computationally cheap approximations to quantify the uncertainty of quantity of interest. Standard surrogate models treat the original model as a black-box and fit the model from several deterministic simulations at given data points in the design domain. Their practical use requires a sufficient number of data points covering the space of input random variables. However, surrogate modeling of costly mathematical models representing physical systems is challenging since it is typically not possible to create a large experimental design. Thus, it is beneficial to constrain the approximation to adhere to the known physics of the model. The recently proposed physics-informed polynomial chaos expansion offers unique possibilities for uncertainty quantification of models containing deterministic and random input variables (e. g stochastic PDEs). It is shown that the constrained PCEs can be easily applied for statistical and sensitivity analysis through analytical post-processing of a reduced PCE filtering out the influence of all deterministic space-time variables. Obtained local sensitivity measures play important role in identification of most influential random parameters or the most important Eigenmodes of input stochastic processes in specific locations of space-time domain.

Bio: Lukáš Novák is an assistant professor at the Brno University of Technology, Faculty of Civil Engineering. He holds a Ph.D. in Structural Mechanics and a Master's degree in Civil Engineering. His research interests lie within the field of uncertainty quantification and structural reliability. He is particularly interested in polynomial chaos expansion, statistical sampling, sensitivity analysis, and semi-probabilistic methods for the design and assessment of concrete structures.

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