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Uncertainty Quantification for predictive modeling and simulation: Motivation, challenges and future expectations

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Abstract As computing platforms become increasing cheaper and more powerful, predictive modeling and simulation is becoming a dominant framework in both science and engineering to study target physical systems under varying conditions and at unprecedented spatial and time scales. Every simulation has two key components: a mathematical model and a numerical method. The latter has experienced in the past a relatively fast improvement and has ``converged", by now, towards several well-established and widely accepted methods. The same does not hold true for physical models. Every physical model is, to some degree, wrong, and improving these models is still a very active field. Uncertainty quantification (UQ) is an emerging field focusing on the quantitative estimation of uncertainty in a computational study of a physical process of interest. It is particularly relevant for complex non-linear systems, where small uncertainties and errors can be amplified and can strongly affect the predictions. In general, UQ plays a key role when a high-fidelity model-based prediction analysis is of central importance. In this talk, we will review some of the fundamental concepts, like Polynomial Chaos expansions and Bayesian inference, and discuss some examples of its application to real problems.

CV Dr. Francesco Rizzi has a diversified educational background ranging from engineering, to applied math and computational physics. He holds a Ph.D. in Mechanical Engineering awarded by The Johns Hopkins University. He has experienced working and collaborating with government labs (including an experience as staff member at Sandia National Labs California), industries, and universities worldwide. Broadly speaking, his profile lies at the intersection of applied math, engineering and high-performance computing (HPC). His main interests and expertise include uncertainty quantification, HPC, resilience and fault-tolerance, task-based programming models, continuum and discrete physics, programming languages, Bayesian inference, and inverse problems.