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Data-enabled approaches to sensitivity analysis and calibration in high-dimensional spaces

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This talk focuses the exploitation of large databases of realizations for assessing model sensitivities to uncertain inputs and for model parameter calibration. Attention is focused on detailed chemical kinetics simulations, involving thousands to tens of thousands of uncertain rate parameters. While the sampling of the high-dimensional space of random inputs can be efficiently performed using state-of-the-art stiff solvers, analysis of selected quantities of interest (QOIs) faces two challenges. On one hand, specification of realization coordinates leads to very large datasets, which may be substantially larger than those associated with the QOIs. A related challenge concerns the functional representation of the QOIs in terms of the stochastic coordinates. To address these challenges, sparse functional representation methods are developed, and combined with efficient regression, compressed sensing, and low-rank methods for the determination of uncertain parameters. Implementation of these methods is illustrated in the light of large-scale applications to octane oxidation, based on a detailed kinetic model involving 4000 random parameters.

Biography

Omar M Knio received his PhD from MIT in 1990. He held a Post-doctoral position at MIT, before joining the Mechanical Engineering Faculty at Johns Hopkins University in 1991. In 2011, he joined the Mechanical Engineering and Materials Science Department at Duke University, where he was named the Edmund T Pratt, Jr., Professor of Mechanical Engineering and Materials Science. In 2013, he joined AMCS Program at KAUST, where he served as Deputy Director of the SRI Center for Uncertainty Quantification in Computational Science and Engineering. He has co-authored over 100 journal papers, two books, and is an Inventor of 12 patents.

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