University of Colorado at Boulder

AEROSPACE ENGINEERING SCIENCES

Seminar

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On Model Reduction Techniques for Scalable Uncertainty Propagation

Realistic analysis and design of multi-disciplinary engineering systems require not only a fine understanding and modeling of the underlying physics and their interactions but also recognition of intrinsic uncertainties and their influences on the quantities of interest. Uncertainty Quantification (UQ) is an emerging discipline that attempts to address the latter issue: It aims at a meaningful characterization of uncertainties from the available measurements, as well as efficient propagation of these uncertainties through the governing equations, e.g., PDEs or ODEs, for a quantitative validation of model predictions. The development of efficient uncertainty propagation strategies for complex engineering systems is a subject of growing interest in UQ, especially for applications where a large number of uncertain sources are present or when the legacy physics codes cannot be altered.

This presentation provides a high level introduction to recent work performed by the UQ Group at CU Boulder on the development of scalable numerical methods for uncertainty propagation. Following a brief discussion of the role of UQ in computational sciences, the talk will focus on polynomial chaos expansions, a widely used probabilistic approach to uncertainty propagation, along with their numerical challenges and recent solution strategies within the compressive sampling framework. It will be demonstrated how sparsity in such representations may be exploited to drastically reduce the cost of uncertainty propagation. As another approach to reduced order modeling for uncertainty propagation, a low-rank approximation technique will then be presented. In particular, a bi-fidelity approach will be introduced that relies primarily on low-fidelity (cheap) simulations of a physical system to guide the construction of a reduced order representation of high-fidelity (expensive) simulations of the same system. Application examples will be presented to highlight the efficiency of these model reduction approaches and their wide applicability to a broad range of problems.

Friday, October 9, 2015
2:00 PM
DLC Bechtel Collaboratory

Refreshments!