Uncertainty Quantification and Operator Splitting

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Abstract

Progress in modeling and simulation allows us to tackle ever more complex problems. However, this complexity can make it difficult to assess the accuracy of simulation-based predictions. There may be questions about how accurately a mathematical model describes the true physics, the correctness of parameters selected in model formulation, and the impact of numerical error on model outputs. Uncertainty quantification (UQ) is a systematic approach to characterizing and reducing uncertainty in a simulation. UQ proceeds by identifying sources of uncertainty in a simulation, statistically characterizing the uncertainty in the form of a probability distribution, propagating the uncertainty through the model, and evaluating the statistics of the resulting model output.

The complexity of simulations also translates into software complexity. This is often addressed with operator splitting, which is a divide-and-conquer approach that decomposes the complex problem into simpler components. Operator splitting always introduces a splitting error, which can significantly affect model outputs and contaminate the results of UQ.

This talk reports on work in progress to address this issue. We study several model reaction-diffusion problems, their solution using various operator splitting strategies, and the impact of operator splitting on UQ of these problems. Ideas for accounting for splitting errors in UQ will also be discussed.

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