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CERTIFICATION OF SIMULATIONS AND MODEL ADAPTATION IN COMPUTATIONAL SCIENCE AND ENGINEERING

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MINISYMPOSIUM

Advances in computational science and engineering have allowed scientists to contemplate numerical simulations of increasingly complex multiphysics and multiscale problems. However, an essential task for reliable predictions and suitable decision-making is to assess the accuracy of the predictions and design suitable adaptive strategies to control errors.

The topic of error estimation and adaptation, globally referred to as model verification, today extends far beyond classical discretization error assessment and mesh refinement. It also encompasses adaptive modeling, whose main objective is to adaptively control and enrich surrogate models derived, for instance, from homogenization techniques, model reduction, or response surface techniques. It further involves novel topics relevant to engineering applications, such as goal-oriented procedures, the assessment of errors due to the modeling of uncertainty, the control of the simulation complexity to enable real-time simulations for optimization or online systems control, model adaptation from experimental data, or error control for scientific machine learning applications.

The objectives of the mini-symposium will be to discuss the latest fundamental contributions to error estimation and adaptive methods, as well as recent developments in broad aspects of computational mechanics and applied mathematics dealing with emerging applications in which model adaptivity and modeling error control are of primal importance. We anticipate contributions on the following topics:

- Estimation of discretization and modeling errors for linear, nonlinear, coupled, or time-dependent problems;
- Stability, convergence, and optimality analysis of adaptive methods;
- Goal-oriented approaches;
- Control of hierarchical, reduced-order, and multiscale modeling strategies;
- Error estimation and adaptive schemes for uncertainty quantification and optimal control;
- Adaptive model enrichment from experimental inputs (e.g., full-field measurements and data assimilation);
- Error estimation and control for machine learning techniques, including deep learning methods such as PINNs;

- Use of adaptive techniques in the industrial context and for specific applications such as biomedical engineering or real-time system monitoring.