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Advances in Reduced Order Modeling for Multiscale Problems

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Many problems in engineering and science involve solving problems on multiple time- and length-scales. Numerous techniques have been developed with the aim to concurrently solve for the relevant physics on two or more length-scales. Examples of such techniques are the Homogenization techniques (Computational homogenization, “finite element square”, etc.), subgrid techniques (the Variational MultiScale method, Multi-Scale FEM, Localized Orthogonal Decomposition, etc,) and other coarse graining techniques (e.g. the Quasi-Continuum Method) to name a few examples. In common for most of these procedures is the solution of a local problem. For data stemming from the higher scale, a fine-scale problem is solved for, and effective outputs are returned to the higher scale. Such implicit procedures, with a high number of evaluations of the fine-scale models, results in a high computational cost.

To make on-the-fly multi-scale analysis feasible for practical problems, reduced order modeling has become a popular means to reduce the cost of the fine-scale problems. Reduced order models (or surrogates) can either be constructed based purely on input-output data, or in terms of reducing the problem size. It is imperative to control the accuracy of such procedures, and to balance the accuracy of the overall computation against the computational cost.

The purpose of this mini symposium is to disseminate and discuss recent advances in reduced order modeling approaches (primarily) within the scope of multiscale modeling. More specifically, such procedures will be discussed in view of balancing the accuracy vs. computational effort. Topics include, but are not limited to

- Adaptive multiscale methods
- Error estimation for multiscale-problems and/or reduced order models
- Novel ROM techniques
- Application of established ROM techniques to novel applications (e.g., coupled problems)
- Adaptive basis enrichment
- Adaptive quadrature (Hyper-reduction)
- Training of reduced models (for, e.g., Neural Networks or POD-based models)