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REDUCED ORDER MODELS AND SCIENTIFIC MACHINE LEARNING FOR ADVANCED APPLICATIONS

E. TEMELLINI[1], M. STRAZZULLO[2], M. G. CARLINO[3], F. PICHI[4]

[1] MOX-Department of Mathematics, Politecnico di Milano, Piazza L. da Vinci 32, 20133, Milano, Italy
erika.temellini@polimi.it

[2] FAST Computing srl & Simplifica srl Officine Grandi Riparazioni, Corso Castelfidardo 22, Torino, Italy
maria.strazzullo@fastcomputing.net

[3] MONHADE, Equipe Inria-ONERA, DAAA, ONERA, Institut Polytechnique de Paris, 8 Rue des Vertugadins, Meudon, F-92190, France
michele-giuliano.carlino@inria.fr

[4] mathLab, Mathematics Area, SISSA, via Bonomea 265, Trieste, I-34136, Italy
fpichi@sissa.it

ABSTRACT

Advanced engineering and industrial applications often involve complex computational models, whose high computational costs may limit their use in real-time and many-query scenarios. Reduced Order Methods (ROMs) address these challenges by constructing efficient surrogate models that approximate complex parametric systems at a significantly reduced computational effort.

In particular, intrusive approaches, such as Galerkin methods, rely on the explicit knowledge of the governing equations to derive reduced models. While they typically ensure high accuracy and strong physical consistency, their efficiency may deteriorate when dealing with nonlinear dynamics or strongly coupled systems.

On the other hand, non-intrusive approaches, often based on data-driven and machine learning techniques, exploit data from experiments or high-fidelity simulations to extract underlying patterns. These methods are flexible and broadly applicable, but they may require large datasets, extensive training, and often lack rigorous error estimation, physical interpretability, and structure preservation.

To overcome these limitations, hybrid strategies that combine physics-based and data-driven methodologies offer a promising pathway. Such approaches can enhance both predictive accuracy and computational efficiency, while improving model interpretability and robustness for complex systems.

This mini-symposium aims to stimulate discussion on intrusive and non-intrusive ROMs, providing a comparative perspective on their strengths, limitations, and applicability across academic, industrial, and engineering contexts. Topics of interest include both advances in reduced-order modeling and emerging methods integrating ROMs with machine learning and data-driven approaches. Contributions on practical applications in industry are also welcome, emphasizing the role of these strategies in addressing real-world challenges and fostering technological innovation.