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PROJECTION-BASED AND DATA-DRIVEN APPROACHES TO REDUCED ORDER MODELING

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ABSTRACT

Reduced Order Methods (ROMs) aim at constructing surrogate models that approximate complex parametric systems with reduced computational cost, enabling efficient simulations in real-time and many-query scenarios.

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.

Combining physics-based and data-driven methodologies offers a promising pathway to overcome these limitations. Hybrid strategies 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. Particular attention will be devoted to emerging methodologies that integrate ROMs with machine learning and advanced data-driven paradigms, including physics-informed approaches, hybrid modeling strategies, and surrogate models in a broader sense.