

Adaptive Hybrid Modeling via Schwarz Alternating Coupling and Operator Inference Reduced Order Models

Irina Tezaur¹, Eric Parish¹, Anthony Gruber¹, Ian Moore², Chris Wentland³, Alejandro Diaz¹, Cameron Rodriguez⁴, and Alejandro Mota¹

¹Sandia National Laboratories, Albuquerque, NM and Livermore, CA, USA

²Rice University, Houston, TX, USA

³Ford Motor Company, Dearborn, MI USA

⁴Columbia University, New York, NY USA

This talk describes a novel domain decomposition-based approach for creating adaptive hybrid models with the help of the Schwarz alternating method (SAM). In this approach, the solution on the full domain is obtained via an iterative process in which a sequence of subdomain-local problems are solved, with information propagating between subdomains through transmission boundary conditions (Figure 1). The models being coupled can be subdomain-local full order models (FOMs) and/or subdomain-local reduced order models (ROMs). We will present some recent extensions of SAM to enable the overlapping [3] and non-overlapping [2] coupling of non-intrusive polynomial and neural network- (NN-)based Operator Inference (OpInf) ROMs. The latter NN-OpInf approach enables stable long-time predictive simulations through the incorporation of structure preservation constraints [1].

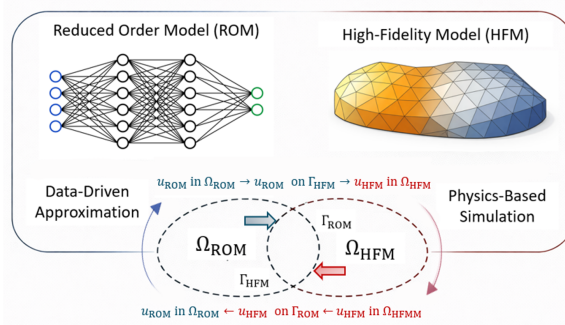


Figure 1: Illustration of SAM for hybrid high-fidelity model/reduced order model coupling

Focusing on several complex 3D solid dynamic examplars, we will showcase numerical results that demonstrate SAM’s potential to accelerate analyst workflows by simplifying the meshing step of the modeling and simulation (mod/sim) process, and by enabling the “plug-and-play” integration of data-driven models into mod/sim workflow. Time permitting, we will showcase some recent work involving on-the-fly switching between subdomain-local models of varying fidelities within the SAM framework¹.

References

- [1] E. Parish, A. Gruber, P. Blonigan, and I. Tezaur. NN-Opinf: an operator inference approach using structure-preserving composable neural networks. *ArXiv pre-print*, 2026.
- [2] C. Rodriguez, I. Tezaur, A. Mota, A. Gruber, E. Parish, and C. Wentland. Transmission conditions for the non-overlapping schwarz coupling of full order and operator inference models. *ArXiv pre-print*, 2025.
- [3] I. Tezaur, E. Parish, A. Gruber, I. Moore, C. Wentland, and A. Mota. Hybrid coupling with Operator Inference the Schwarz alternating method. *ArXiv pre-print*, 2025.

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