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Adaptive Hybrid Domain Decomposition-Based Modeling via Operator Inference and the Schwarz Alternating Method

Irina Tezaur*,#, Eric Parish*, Anthony Gruber*, Ian Moore*,†, Chris Wentland*, Alejandro Mota*

* Sandia National Laboratories
Albuquerque, NM and Livermore, CA, USA.
email: ikalash@sandia.gov, url: www.sandia.gov/~ikalash

† Virginia Polytechnic Institute
Blacksburg, Virginia, USA.

ABSTRACT

This talk will describe 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 (BCs). 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 [1] and non-overlapping [2] coupling of non-intrusive ROMs constructed via Operator Inference (OpInf). 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 & simulation (mod/sim) process, and by enabling the "plug-and-play" integration of data-driven models into mod/sim workflow. Time permitting, we will additionally discuss some possible mechanisms for enabling on-the-fly switching between subdomain-local models of varying fidelities within the SAM framework.

REFERENCES

[1] I. Tezaur, E. Parish, A. Gruber, I. Moore, C. Wentland, A. Mota. "Hybrid coupling with Operator Inference and the Schwarz alternating method", ArXiv pre-print, 2025. https://arxiv.org/abs/2511.20687

[2] C. Rodriguez, I. Tezaur, A. Mota, A. Gruber, E. Parish, C. Wentland. "Transmission Conditions for the Non-Overlapping Schwarz Coupling of Full Order and Operator Inference Models", Computer Science Research Institute Summer Proceedings 2025, Sandia National Laboratories, 2025. https://arxiv.org/abs/2509.12228