X International Conference on Computational Methods for Coupled Problems, COUPLED 2023
June 5-7, 2023, Chania, Crete, Greece

ADVANCES IN ANALYSIS, ALGORITHMS, AND SOFTWARE FOR THE COUPLING OF CONVENTIONAL AND DATA-DRIVEN MODELS FOR HETEROGENEOUS MULTI-SCALE, MULTI-PHYSICS SIMULATIONS

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ABSTRACT

Non-conventional, physics-informed data-driven methods are rapidly becoming a mainstay in computational science and engineering. Approaches such as Physics Informed Neural Networks (PINNs), projection-based Reduced Order Models (ROMs), Dynamic Mode Decomposition (DMD) and other similar techniques can expand the power of traditional numerical methods by improving their predictiveness (through data-driven hidden physics discovery) and efficiency (enabling multi-query analyses, e.g., optimization, UQ).

However, these methods are still largely used as stand-alone simulation tools and their coupling to conventional methods and other data-driven methods for multi-scale, multi-physics simulations remains underdeveloped both mathematically and algorithmically. The goal of this session is to bring together researchers working on mathematical, and software challenges involved in the rigorous and agile coupling of arbitrary combinations of data-driven and conventional methods. The topics discussed will include mathematical foundations for rigorous couplings such as heterogenous domain decomposition, optimization-based couplings and generalized alternating Schwarz methods, software frameworks for coupling of data-driven and conventional models and applications involving such couplings.