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# EFFICIENT NUMERICAL METHODS FOR CFD AND FSI SIMULATIONS

*Pasquale Claudio Africa*[*1] and Michele Girfoglio[1] and Gianluigi Rozza[1]*

*[1]SISSA mathLab*

## MINISYMPOSIUM

In the realm of scientific and engineering simulations, the quest for enhanced accuracy, computational efficiency, and robustness remains paramount. This mini-symposium aims to delve into recent developments in numerical methods and algorithms, specifically tailored for Computational Fluid Dynamics (CFD) and Fluid-Structure Interaction (FSI) problems across diverse fields. The symposium emphasizes crucial aspects, covering advanced discretization techniques, reduced order models, high-performance computing strategies, and the integration of machine learning for data-driven simulations. These advancements hold the potential to revolutionize simulation efficiency and fidelity across aerospace, automotive, energy, biomedical, and environmental engineering domains, among others.

The mini-symposium will provide a platform for researchers to exchange insights on novel discretization schemes that transcend traditional methods. Innovations in finite element, finite volume, spectral, meshless, and non-matching methods will be explored, demonstrating their efficacy in capturing complex flow phenomena and accurately resolving fluid-structure interactions.

Reduced order models (ROMs) constitute another critical facet of this symposium. State-of-the-art ROM methodologies enable rapid yet accurate approximations of high-dimensional systems, significantly accelerating simulations while maintaining reliability. The discussions will encompass techniques like Proper Orthogonal Decomposition (POD), Dynamic Mode Decomposition (DMD), and more.

Given the escalating demand for simulation realism and expedited analyses, high-performance computing (HPC) strategies have assumed paramount importance. Presentations within this symposium will expound on domain decomposition techniques, inexact solvers and preconditioners, parallelization, GPU utilization, and other HPC paradigms that amplify computational throughput without compromising solution quality.

Furthermore, this symposium recognizes the metamorphic role of machine learning in simulation. Data-driven techniques powered by machine learning algorithms are reshaping how simulations are performed, leveraging real-world data to enhance accuracy and optimize computational resources. Researchers will share insights into integrating machine learning models with simulations, addressing challenges, and harnessing the power of neural networks, reinforcement learning, and generative adversarial networks in driving simulations to new frontiers.

In summary, the mini-symposium underpins the convergence of computational mechanics, fluid dynamics, structural analysis, and machine learning, across many vital fields. By spotlighting advanced discretization techniques, reduced order models, high-performance computing strategies, and data-driven simulations, this symposium offers a forum to explore transformative techniques that transcend existing approaches.