

COMPUTATIONAL MECHANICS-INSPIRED MACHINE LEARNING FOR FORWARD AND INVERSE PROBLEMS

TRACK NUMBER 600 DATA SCIENCE, MACHINE LEARNING, AND ARTIFICIAL
INTELLIGENCE

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ABSTRACT

Recent breakthroughs in machine learning (ML) and artificial intelligence (AI) have sparked a paradigm shift across scientific disciplines, pushing the boundaries of computational science and redefining how physical systems are modeled and understood. No longer confined to traditional software development based on explicit task-specific coding, research is increasingly embracing optimization-driven, autonomous methodologies that demand scalability, interpretability, and memory efficiency. These requirements are critical for tackling large-scale, high-dimensional, and multiphysics problems found in modern science and engineering. In this evolving landscape, the computational mechanics community—long known for its rigorous numerical methods and physically grounded models—offers a rich source of inspiration. Emerging ML architectures now draw from these principles to develop efficient, physics-aware algorithms capable of solving both forward simulations and complex inverse design problems. These hybrid approaches not only enable reduced-order modeling of intricate phenomena but also leverage the power of differentiable programming and modern AI hardware for optimization and control tasks.

This mini-symposium invites original contributions that explore this exciting fusion of data science, ML, and computational mechanics. Topics of interest span scalable and interpretable neural architectures, intelligent modeling and control of multiscale and multiphysics systems, computer vision, inverse design strategies, and differentiable solvers that tightly couple physics and learning. We aim to provide a vibrant forum for researchers, spanning academia and industry, to share ideas, showcase innovations, and shape the future of mechanistically inspired AI. The symposium will feature keynote lectures from distinguished thought leaders and offer a platform for early-career investigators to gain visibility and mentorship. With growing momentum in fields like advanced manufacturing, robotics, and digital twin technologies, this gathering will serve as a nexus for collaboration among scientists, engineers, and technologists working at the frontier of intelligent scientific computing.