

## Machine Learning-Enhanced Solvers for Partial Differential Equations in Computational Science

600

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### ABSTRACT

This minisymposium focuses on recent advances in integrating Machine Learning (ML) techniques with classical numerical methods to enhance the solution of Partial Differential Equations (PDEs), which are at the core of computational science and engineering. Traditional PDE solvers often face significant challenges in handling nonlinear, high-dimensional, multi-scale, and multi-physics problems, particularly in extreme-scale applications. Machine learning provides novel opportunities to overcome these limitations, offering new pathways to improve efficiency, scalability, and predictive power.

The session will explore a wide spectrum of approaches, including physics-informed neural networks (PINNs) and operator learning methods for directly approximating PDE solutions, ML-accelerated iterative solvers for large-scale systems, and hybrid frameworks where ML components are seamlessly embedded into finite element, finite volume, or spectral methods. Contributions addressing the role of ML in model reduction, adaptivity, preconditioning, and multi-grid methods are particularly welcome. Special attention will be given to methods that preserve physical consistency, generalize across problem classes, and integrate naturally with high-performance computing environments.

By bringing together experts in numerical analysis, computational science, and machine learning, this minisymposium aims to foster interdisciplinary dialogue and highlight emerging methodologies that will shape the future of PDE-based simulations across science and engineering. Topics of interest include, but are not limited to:

- Physics-informed neural networks (PINNs) and variants
- Operator learning approaches (DeepONets, Fourier neural operators, etc.)
- ML-accelerated iterative solvers and preconditioners
- Hybrid PDE solvers combining ML and classical methods
- Reduced-order modeling with ML
- ML-based multigrid and domain decomposition methods
- Uncertainty quantification with ML-enhanced PDE solvers
- Integration of ML-enhanced solvers with HPC