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PHYSICS-INFORMED MACHINE LEARNING (PIML) FOR INTERFACE PROBLEMS IN MECHANICS

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ABSTRACT

Interfaces govern critical behaviors in systems ranging from heat transfer, material failure and fluid flow in heterogeneous microstructures to fault slip in geophysical systems. Such problems frequently involve discontinuous solutions and moving boundaries, presenting significant challenges for traditional mesh-based numerical methods such as the finite element method.

Recent advances in physics-informed machine learning (PIML) offer powerful tools to complement and enhance conventional computational approaches by embedding measured data into models grounded in first-principles physics. PIML methods have demonstrated potential in both forward and inverse interface problems, although important challenges remain. This minisymposium will highlight recent developments in PIML methods and their applications to interface problems in mechanics, with the goal of fostering collaboration among researchers in computational mechanics, applied mathematics, and machine learning.

Topics of Interest include, but are not limited to:

- Methodological advances in PIML for interface problems *(e.g., physics-informed neural networks (PINNs), physics-informed neural operators (PINO), Fourier neural operators (FNO), deep operator networks (DeepONet))*
- Applications to multiphase flow, heterogeneous material systems, poromechanics, and fracture mechanics (including crack propagation)

- Handling discontinuities, moving boundaries, and complex geometries with PIML
- Inverse problems and system identification involving interfaces
- Hybrid computational frameworks combining PIML with traditional FEM or other numerical methods
- Benchmarking, validation, optimization and uncertainty quantification in PIML for interface problems

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