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Abstract Title: ParaFIND: Learning PDE Parameter Fields on Irregular Geometries from Sparse Observations

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ParaFIND: Learning PDE Parameter Fields on Irregular Geometries from Sparse Observations

Introduction
Real-world physical phenomena are often governed by Partial Differential Equations (PDEs) influenced by spatially distributed properties/parameters. While many deep learning techniques offer reasonable parameter estimation results for simple cases, they struggle to generalize to irregular geometries, limiting their applicability to a narrow range of problems [1].

Objective
To address this limitation, we propose **ParaFIND**, a novel approach for estimating unknown PDE parameter fields distributed on non-uniform domains from scarce observations of the system's response.

Methods
Our method leverages the Finite Element Method (FEM) for space discretization and learns parameters modeled as functions of space from their mesh representation. This innovative approach enables accurate parameter estimation even in complex geometrical settings.

Results
We demonstrate the robustness of our model under limited sparse data constraints using as few as 108 data samples. Our numerical simulations validate the effectiveness of ParaFIND in handling various irregularities in a given geometry.

Significance
This work showcases the potential of ParaFIND for broader applications in real-world scientific computing and engineering tasks where domain complexity and data scarcity are major challenges.

Acknowledgements

References
[1] Xuyang Li, Mahdi Masmoudi, Nizar Lajnef, and Vishnu Boddeti. "Estimating field parameters from multiphysics governing equations with scarce data." *ICLR 2024 Workshop on AI4DifferentialEquations in Science*, 2024.