Xuyang Li, Ph.D.

Postdoctoral Researcher, Pennsylvania State University

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Education

Dual Ph.D. in Civil Engineering & Computer Science, Michigan State University	*Sept 2019 - Sept 2024*
M.S. in Civil Engineering, Michigan State University	*Sept 2017 - Aug 2019*
B.S. in Civil Engineering, Wuhan University of Technology, China	*Sept 2013 - Aug 2017*

Professional Highlights

- Published in high-impact journals (***Nature Communications***) and top machine learning conferences, Best Paper Award at SMASIS 2022 (ASME).
- Interdisciplinary research expertise in both Engineering Mechanics and Machine Learning, which led to the development of:
  - (1) Novel physics-based models and ML parameter estimation applied to structural identification and other scientific problems (thermal runaway, porous media flow, cardiac electrophysiology, etc.)
  - (2) Unique diagnostic and monitoring methods for damage detection in civil and mechanical structures (NSF-funded in support of future resilient infrastructure systems).
  - (3) Advanced machine learning algorithms to deliver high quality, fast, and cost-effective solutions for response analysis and assessment of infrastructure assets (i.e., roads, bridges) under highly disruptive loading conditions (i.e., hurricanes, earthquakes, flooding, etc.).
- Advised and co-advised many undergraduate students and M.Sc. students in their research projects.
- Member of ASCE Committee on Data Sensing and Analytics & reviewer for professional journals.

Research Interests

- Scientific Machine Learning (SciML), Physics-Informed Machine Learning, Reinforcement Learning.
- Structural Health Monitoring, System Identification.
- Parameter Estimation & Inverse Problems.
- Numerical Methods, Finite Element Analysis & Reduced Order Modeling.

Publications (Google Scholar)

1. *Li, Xuyang*, Bolandi, H., Masmoudi, M., Salem, T., Lajnef, N., Boddeti, V. "Mechanics-Informed Autoencoder Enables Automated Detection and Localization of Unforeseen Structural Damage." ***Nature Communications*** 2024. [GitHub] [Link]
2. *Li, Xuyang*, Masmoudi, M., Bolandi, H., Lajnef, N., Boddeti, V. "Building Bespoke Physical Models from Scarce Observations." under review by *Nature*.

3. *Li, Xuyang*, Masmoudi, M., Lajnef, N., Boddeti, V. "Estimating Field Parameters in Multiphysics Governing Equations from Scarce Observations." **ICLR** 2024 Workshop on AI4DifferentialEquations in Science 2024. [Link]
4. Masmoudi, M., *Li, Xuyang*, Lajnef, N., Boddeti, V. "ParaFIND: Parameter Field Inference on Non-uniform Domains using Neural Network." **NeurIPS** 2024 Workshop on Data-driven and Differentiable Simulations, Surrogates, and Solvers.
5. *Li, Xuyang*, Bolandi, H., Salem, T., Lajnef, N., Boddeti, V. "NeuralSI: Structural Parameter Identification in Nonlinear Dynamical Systems." European Conference on Computer Vision–**ECCV** 2022 Workshops, (2023). [GitHub] [Link]
6. *Li, Xuyang*, Salem, T., Bolandi, H., Boddeti, V., Lajnef, N. "Methods for the Rapid Detection of Boundary Condition Variations in Structural Systems." Smart Materials, Adaptive Structures and Intelligent Systems. Vol. 86274. American Society of Mechanical Engineers (2022). Best Paper Award in SMASIS 2022. [Award] [Link]
7. *Li, Xuyang*, Masmoudi, M., Bolandi, H., Lajnef, N., Boddeti, V. "Structural Parameter Field Identification in Nonlinear Dynamic Systems." under review.
8. *Li, Xuyang,* Jin, W., Klinger, J., Saha, N., Lajnef, N. "Data-driven Mechanical Behavior Modeling of Granular Biomass Materials." under review by Computers and Geotechnics.
9. Bolandi, H., *Li, Xuyang*, Salem, T., Boddeti, V., Lajnef, N. "Bridging Finite Element and Deep Learning: High-Resolution Stress Distribution Prediction in Structural Components." Frontiers of Structural and Civil Engineering (2022). [Link]
10. Bolandi, H., *Li, Xuyang*, Salem, T., Boddeti, V., Lajnef, N. "Deep learning paradigm for prediction of stress distribution in damaged structural components with stress concentrations." Advances in Engineering Software 173 (2022): 103240. [Link]
11. Bolandi, H., Sreekumar, G., *Li, Xuyang*, Lajnef, N., Boddeti, V. "Neuro-DynaStress: Predicting Dynamic Stress Distributions in Structural Components." arXiv preprint arXiv:2301.02580 (2022). [Link]
12. Bolandi, H., Sreekumar, G., *Li, Xuyang*, Lajnef, N., Boddeti, V. "Physics Informed Neural Network for Dynamic Stress Prediction." Applied Intelligence 53.22 (2023): 26313-26328. [Link]
13. Salem, T., Jiao, P., Zaabar, I., *Li, Xuyang*, Zhu, R., Lajnef, N. "Functionally graded materials beams subjected to bilateral constraints: Structural instability and material topology." International Journal of Mechanical Sciences 194 (2021): 106218. [Link]
14. Salem, T., Lajnef, N., Jiao, P., *Li, Xuyang*, Zaabar, I. "Postbuckling of multi-direction anisotropic constrained functionally graded material beams." Behavior and Mechanics of Multifunctional Materials XV. Vol. 11589. SPIE, (2021). [Link]

Professional Experience

Postdoctoral Researcher, Pennsylvania State University *Oct 2024 - present*

Advisor: Prof. Romit Maulik

- Exploring scientific reinforcement learning (RL) on interpretability and physics-informed methods.
- Applying RL to nuclear fusion dynamics to mitigate runaway electron effects.

Research Assistant, Michigan State University *Sept 2019 - Sept 2024*

Advisors: Prof. Nizar Lajnef & Prof. Vishnu Boddeti

- Developed parameter estimation and optimization methods for Multiphysics modeling in composite materials, flow problems, EV batteries thermal runaways, and cardiac electrophysiology.
- Designed novel framework for fast structural health monitoring & PINN-based dynamic predictions.
- Contributed to research proposals on Artificial Intelligence for Highway Transportation (2022) & RFID and wireless technologies in highway construction and asset management (2019).
- Published in Nature Communications [1] and in scientific machine learning tracks of top AI conferences in ICLR [3], NeurIPS [4], and ECCV [5], with a Best Paper Award [8]. Paper under review at Nature [2].

Teaching Assistant, Michigan State University *Sept 2020 - Aug 2024*

- CE221: Statics (2020 - 2024).
- CE461: Computational Methods in Civil Engineering (Spring 2020, 2022, and 2024).

Research Intern, Idaho National Laboratory (INL) *Jul 2023 - Aug 2023*

Advisor: Dr. Wencheng Jin

- Developed data-driven ML models to characterize nonlinear plastic behavior in granular biomass.
- Paper under review at Computers and Geotechnics [4].

Awards

- Dissertation Completion Fellowship, Michigan State University *2024*
- Best Student Paper Award at Smart Materials, Adaptive Structures, and Intelligent Systems (SMASIS) Conference. Organized by ASME. [Link] *2022*
- Graduate School Travel Fellowship, Michigan State University *2022 & 2023*
- Engineering Recruitment Fellowship, Michigan State University *2019 & 2020*
- Graduate Office Fellowship, Michigan State University *2019*

Contributed Funded Research Projects

- "Internet of Self-powered Sensors - Towards a Scalable Long-term Condition-based Monitoring and Maintenance of Civil Infrastructure", National Science Foundation.
- "Monitoring of Runway and Taxiway Pavement Structures Instrumentation – procuring, and installing self-powered wireless sensors at NAPMRC", Federal Aviation Administration.
- Smart Geogrids, Tensar International Co.
- Novel Data-Driven Condition-Based Maintenance Approaches for Bridges Monitoring, Targeted Support Grant for Technology Development.

Professional Service

- Member of the American Society of Civil Engineers (ASCE) Committee on Data Sensing and Analytics [Link].
- Reviewer for Journal of Fluid Mechanics.
- Reviewer for the ASCE Energy Engineering Journal.
- Reviewer for the ASCE International Conference on Transportation and Development (ICTD 2023).

Mentoring

- Mahdi Masmoudi (master student −> Ph.D. student).
- Raheel Tariq (master student −> Ph.D. student).
- Hanan Ahmed (master student −> Ph.D. student).
- Rithvak Pulugu (master student).
- James Roulo (master student).
- James Morrison (undergrade student).

Membership

- American Society of Civil Engineering (ASCE).
- American Concrete Institute (ACI).
- American Institute of Steel Construction (AISC).
- National Society of Professional Engineers (NSPE).

Programming Languages

- Python (PyTorch, TensorFlow, NumPy, Pandas, Scikit-learn, CUDA).
- Julia (Flux, Lux, DiffEqFlux, DifferentialEquations).
- Mathematica.
- MATLAB (Image Processing Toolbox, Partial Differential Equation Toolbox).
- C++.
- LaTeX.
- GitHub.

Modeling Software

- ABAQUS.
- ANSYS.
- AutoCAD.
- LabVIEW.
- Autodesk Fusion 360.
- SAP200.
- Pro E