Lu Lu

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Education

Brown University 8/2014–5/2020

- **Ph.D.** in Applied Mathematics
- **M.Sc.** in Computer Science
- **M.Sc.** in Applied Mathematics
- **M.Sc.** in Engineering
- Advisor: George Em Karniadakis

Tsinghua University, Beijing, China 8/2009–7/2013

- **B.Eng.** in Energy, Power System and Automation
- **B.Ec.** in Economics
- **Minor** in Computer Technology and Application

Appointments

Yale University 8/2023–present

- Assistant Professor, Department of Statistics and Data Science
- Faculty, Institute for Foundations of Data Science
- Faculty, Wu Tsai Institute

University of Pennsylvania 8/2023–present

- Adjunct Assistant Professor, Department of Chemical and Biomolecular Engineering

University of Pennsylvania 9/2021–7/2023

- Assistant Professor, Department of Chemical and Biomolecular Engineering
- Faculty, Graduate Group in Applied Mathematics and Computational Science
- Faculty, Penn Institute for Computational Science

Massachusetts Institute of Technology 9/2020–5/2021

- Applied Mathematics Instructor, Department of Mathematics

Publications

- Research areas: Scientific machine learning, Multiscale modeling, High performance computing
- Google Scholar: Citations: > 10,000, h-index: 27
- †Corresponding author. *These authors contributed equally to this work.

Preprints

1. C. Moya, A. Mollaali, Z. Zhang, **L. Lu**, & G. Lin. Conformalized-DeepONet: A distribution-free framework for uncertainty quantification in deep operator networks. *arXiv preprint arXiv:2402.15406*, 2024.

2. W. Wu, M. Daneker, K. T. Turner, M. A. Jolley, & **L. Lu**[†]. Identifying heterogeneous micromechanical properties of biological tissues via physics-informed neural networks. *arXiv preprint arXiv:2402.10741*, 2024.
3. M. Yin, N. Charon, R. Brody, **L. Lu**, N. Trayanova, & M. Maggioni. DIMON: Learning solution operators of partial differential equations on a diffeomorphic family of domains. *arXiv preprint arXiv:2402.07250*, 2024.
4. P. Rathore, W. Lei, Z. Frangella, **L. Lu**, & M. Udell. Challenges in training PINNs: A loss landscape perspective. *arXiv preprint arXiv:2402.01868*, 2024.
5. J. Hayford, J. Goldman-Wetzler, E. Wang, & **L. Lu**[†]. Speeding up and reducing memory usage for scientific machine learning via mixed precision. *arXiv preprint arXiv:2401.16645*, 2024.
6. Y. Yin, C. Kou, S. Jia, **L. Lu**, X. Yuan, & Y. Luo. PF-DMD: Physics-fusion dynamic mode decomposition for accurate and robust forecasting of dynamical systems with imperfect data and physics. *arXiv preprint arXiv:2311.15604*, 2023.
7. Z. Zhang, C. Moya, **L. Lu**, G. Lin, & H. Schaeffer. D2NO: Efficient handling of heterogeneous input function spaces with distributed deep neural operators. *arXiv preprint arXiv:2310.18888*, 2023.
8. Z. Hao, J. Yao, C. Su, H. Su, Z. Wang, F. Lu, Z. Xia, Y. Zhang, S. Liu, **L. Lu**, & J. Zhu. PINNacle: A comprehensive benchmark of physics-informed neural networks for solving PDEs. *arXiv preprint arXiv:2306.08827*, 2023.
9. B. Fan, E. Qiao, A. Jiao, Z. Gu, W. Li, & **L. Lu**[†]. Deep learning for solving and estimating dynamic macro-finance models. *arXiv preprint arXiv:2305.09783*, 2023.
10. Z. Jiang, M. Zhu, D. Li, Q. Li, Y. O. Yuan, & **L. Lu**[†]. Fourier-MIONet: Fourier-enhanced multiple-input neural operators for multiphase modeling of geological carbon sequestration. *arXiv preprint arXiv:2303.04778*, 2023.
11. A. Jiao, H. He, R. Ranade, J. Pathak, & **L. Lu**[†]. One-shot learning for solution operators of partial differential equations. *arXiv preprint arXiv:2104.05512*, 2021.

Journal Papers

1. Y. Zhang, Y. Qiang, H. Li, G. Li, **L. Lu**, M. Dao, G. E. Karniadakis, A. S. Popel, & C. Zhao. Signaling-biophysical modeling unravels mechanistic control of red blood cell phagocytosis by macrophages in sickle cell disease. *PNAS Nexus*, 3 (2), pgae031, 2024.
2. X. Liu, M. Zhu, **L. Lu**, H. Sun, & J. Wang. Multi-resolution partial differential equations preserved learning framework for spatiotemporal dynamics. *Communications Physics*, 7 (1), 31, 2024.
3. H. Wang, **L. Lu**, S. Song, & G. Huang. Learning specialized activation functions for physics-informed neural networks. *Communications in Computational Physics*, 34 (4), 869–906, 2023.
4. **L. Lu**[†], Y. Qian, Y. Dong, H. Su, Y. Deng, Q. Zeng, & H. Li. A systematic study of the performance of machine learning models on analyzing the association between semen quality and environmental pollutants. *Frontiers in Physics*, 11, 1259273, 2023.
5. M. Zhu, S. Feng, Y. Lin, & **L. Lu**[†]. Fourier-DeepONet: Fourier-enhanced deep operator networks for full waveform inversion with improved accuracy, generalizability, and robustness. *Computer Methods in Applied Mechanics and Engineering*, 416, 116300, 2023.
6. W. Wu, M. Daneker, M. A. Jolley, K. T. Turner, & **L. Lu**[†]. Effective data sampling strategies and boundary condition constraints of physics-informed neural networks for identifying material properties in solid mechanics. *Applied Mathematics and Mechanics*, 44 (7), 1039–1068, 2023.
7. S. Mao, R. Dong, **L. Lu**, K. M. Yi, S. Wang, & P. Perdikaris. PPDONet: Deep operator networks for fast prediction of steady-state solutions in disk-planet systems. *The Astrophysical Journal*

Letters, 950 (2), L12, 2023.
   - Highlighted on AAS Nova
8. M. Zhu, H. Zhang, A. Jiao, G. E. Karniadakis, & **L. Lu**[†]. Reliable extrapolation of deep neural operators informed by physics or sparse observations. *Computer Methods in Applied Mechanics and Engineering*, 412, 116064, 2023.
9. J. Wang, H. Jiang, G. Chen, H. Wang, **L. Lu**, J. Liu, & L. Xing. Integration of multi-physics and machine learning-based surrogate modelling approaches for multi-objective optimization of deformed GDL of PEM fuel cells. *Energy and AI*, 14, 100261, 2023.
10. P. C. Di Leoni, **L. Lu**, C. Meneveau, G. E. Karniadakis, & T. A. Zaki. Neural operator prediction of linear instability waves in high-speed boundary layers. *Journal of Computational Physics*, 474, 111793, 2023.
11. C. Wu, M. Zhu, Q. Tan, Y. Kartha, & **L. Lu**[†]. A comprehensive study of non-adaptive and residual-based adaptive sampling for physics-informed neural networks. *Computer Methods in Applied Mechanics and Engineering*, 403, 115671, 2023.
12. P. Jin, S. Meng, & **L. Lu**[†]. MIONet: Learning multiple-input operators via tensor product. *SIAM Journal on Scientific Computing*, 44 (6), A3490–A3514, 2022.
13. B. Deng, Y. Shin, **L. Lu**, Z. Zhang, & G. E. Karniadakis. Approximation rates of DeepONets for learning operators arising from advection-diffusion equations. *Neural Networks*, 153, 411–426, 2022.
14. **L. Lu**[†], R. Pestourie, S. G. Johnson, & G. Romano. Multifidelity deep neural operators for efficient learning of partial differential equations with application to fast inverse design of nanoscale heat transport. *Physical Review Research*, 4 (2), 023210, 2022.
15. J. Yu, **L. Lu**[†], X. Meng, & G. E. Karniadakis. Gradient-enhanced physics-informed neural networks for forward and inverse PDE problems. *Computer Methods in Applied Mechanics and Engineering*, 393, 114823, 2022.
16. **L. Lu**, X. Meng, S. Cai, Z. Mao, S. Goswami, Z. Zhang, & G. E. Karniadakis. A comprehensive and fair comparison of two neural operators (with practical extensions) based on FAIR data. *Computer Methods in Applied Mechanics and Engineering*, 393, 114778, 2022.
17. **L. Lu**[†], R. Pestourie, W. Yao, Z. Wang, F. Verdugo, & S. G. Johnson. Physics-informed neural networks with hard constraints for inverse design. *SIAM Journal on Scientific Computing*, 43 (6), B1105–B1132, 2021.
18. H. Li, Z. L. Liu, **L. Lu**, P. Buffet, & G. E. Karniadakis. How the spleen reshapes and retains young and old red blood cells: A computational investigation. *PLoS Computational Biology*, 17 (11), e1009516, 2021.
19. Z. Mao, **L. Lu**, O. Marxen, T. A. Zaki, & G. E. Karniadakis. DeepM&Mnet for hypersonics: Predicting the coupled flow and finite-rate chemistry behind a normal shock using neural-network approximation of operators. *Journal of Computational Physics*, 447, 110698, 2021.
20. Y. Deng[*], **L. Lu**[*], L. Aponte, A. M. Angelidi, V. Novak, G. E. Karniadakis, & C. S. Mantzoros. Deep transfer learning and data augmentation improve glucose levels prediction in type 2 diabetes patients. *npj Digital Medicine*, 4, 109, 2021.
21. G. E. Karniadakis[*], I. G. Kevrekidis[*], **L. Lu**[*], P. Perdikaris[*], S. Wang[*], & L. Yang[*]. Physics-informed machine learning. *Nature Reviews Physics*, 3 (6), 422–440, 2021.
    - $>$ 2,000 Citations
22. S. Cai, Z. Wang, **L. Lu**, T. A. Zaki, & G. E. Karniadakis. DeepM&Mnet: Inferring the electro-convection multiphysics fields based on operator approximation by neural networks. *Journal of Computational Physics*, 436, 110296, 2021.
23. **L. Lu**, P. Jin, G. Pang, Z. Zhang, & G. E. Karniadakis. Learning nonlinear operators via DeepONet based on the universal approximation theorem of operators. *Nature Machine Intelligence*, 3 (3),

218–229, 2021.
   - Highlighted on *Nature Machine Intelligence*, 3, 192–193, 2021, Tech Xplore, Quanta Magazine
   - > 1,000 Citations
24. C. Lin, Z. Li, **L. Lu**, S. Cai, M. Maxey, & G. E. Karniadakis. Operator learning for predicting multiscale bubble growth dynamics. *The Journal of Chemical Physics*, 154 (10), 104118, 2021.
25. **L. Lu**, X. Meng, Z. Mao, & G. E. Karniadakis. DeepXDE: A deep learning library for solving differential equations. *SIAM Review*, 63 (1), 208–228, 2021.
   - Most Read article in *SIAM Review*
   - > 1,000 Citations
26. A. Yazdani*, **L. Lu***, M. Raissi, & G. E. Karniadakis. Systems biology informed deep learning for inferring parameters and hidden dynamics. *PLoS Computational Biology*, 16 (11), e1007575, 2020.
   - Highlighted on *Nature Computational Science*, 1, 16, 2021
27. **L. Lu***, Y. Shin*, Y. Su, & G. E. Karniadakis. Dying ReLU and initialization: Theory and numerical examples. *Communications in Computational Physics*, 28 (5), 1671–1706, 2020.
28. P. Jin*, **L. Lu***, Y. Tang, & G. E. Karniadakis. Quantifying the generalization error in deep learning in terms of data distribution and neural network smoothness. *Neural Networks*, 130, 85–99, 2020.
29. Y. Chen, **L. Lu**, G. E. Karniadakis, & L. Dal Negro. Physics-informed neural networks for inverse problems in nano-optics and metamaterials. *Optics Express*, 28 (8), 11618–11633, 2020.
   - Top-downloaded articles on deep learning in *Optics Express*, 2020
30. **L. Lu***, M. Dao*, P. Kumar, U. Ramamurty, G. E. Karniadakis, & S. Suresh. Extraction of mechanical properties of materials through deep learning from instrumented indentation. *Proceedings of the National Academy of Sciences*, 117 (13), 7052–7062, 2020.
   - MIT News, Brown News, NTU News
31. G. Pang*, **L. Lu***, & G. E. Karniadakis. fPINNs: Fractional physics-informed neural networks. *SIAM Journal on Scientific Computing*, 41 (4), A2603–A2626, 2019.
32. **L. Lu***, Z. Li*, H. Li*, X. Li, P. G. Vekilov, & G. E. Karniadakis. Quantitative prediction of erythrocyte sickling for the development of advanced sickle cell therapies. *Science Advances*, 5 (8), eaax3905, 2019.
   - Highlighted on *Science Advances* homepage, SIAM News, eHealthNews.eu, Brown News, Brown Daily Herald
33. D. Zhang, **L. Lu**, L. Guo, & G. E. Karniadakis. Quantifying total uncertainty in physics-informed neural networks for solving forward and inverse stochastic problems. *Journal of Computational Physics*, 397, 108850, 2019.
34. H. Li*, **L. Lu***, X. Li, P. A. Buffet, M. Dao, G. E. Karniadakis, & S. Suresh. Mechanics of diseased red blood cells in human spleen and consequences for hereditary blood disorders. *Proceedings of the National Academy of Sciences*, 115 (38), 9574–9579, 2018.
35. H. Li, D. Papageorgiou, H. Chang, **L. Lu**, J. Yang, & Y. Deng. Synergistic integration of laboratory and numerical approaches in studies of the biomechanics of diseased red blood cells. *Biosensors*, 8 (3), 76, 2018.
36. **L. Lu***, Y. Deng*, X. Li, H. Li, & G. E. Karniadakis. Understanding the twisted structure of amyloid fibrils via molecular simulations. *The Journal of Physical Chemistry B*, 122 (49), 11302–11310, 2018.
37. H. Li, J. Yang, T. T. Chu, R. Naidu, **L. Lu**, R. Chandramohanadas, M. Dao & G. E. Karniadakis. Cytoskeleton remodeling induces membrane stiffness and stability changes of maturing reticulocytes. *Biophysical Journal*, 114 (8), 2014–2023, 2018.
   - Highlighted on *Biophysical Journal* homepage

38. H. Li, H. Chang, J. Yang, **L. Lu**, Y. Tang, & G. Lykotrafitis. Modeling biomembranes and red blood cells by coarse-grained particle methods. *Applied Mathematics and Mechanics*, 39 (1), 3–20, 2018.
39. **L. Lu**, H. Li, X. Bian, X. Li, & G. E. Karniadakis. Mesoscopic adaptive resolution scheme toward understanding of interactions between sickle cell fibers. *Biophysical Journal*, 113 (1), 48–59, 2017.
    - Cover Article, DOE Science News Source, OLCF News, Brown News, Brown Daily Herald, Brown Graduate School News
40. Y. Tang*, **L. Lu***, H. Li, C. Evangelinos, L. Grinberg, V. Sachdeva, & G. E. Karniadakis. OpenRBC: A fast simulator of red blood cells at protein resolution. *Biophysical Journal*, 112 (10), 2030–2037, 2017.
    - Highlighted on *Biophysical Journal* homepage
41. **L. Lu**, X. Li, P. G. Vekilov, & G. E. Karniadakis. Probing the twisted structure of sickle hemoglobin fibers via particle simulations. *Biophysical Journal*, 110 (9), 2085–2093, 2016.
    - Highlighted on *Biophysical Journal* homepage
42. **L. Lu**, X. Zhang, Y. Yan, J. Li, & X. Zhao. Theoretical analysis of natural-gas leakage in urban medium-pressure pipelines. *Journal of Environment and Human*, 1 (2), 71–86, 2014.

Conference Papers

1. A. W. C. do Lago, L. C. Sousa, D. H. B. de Sousa, **L. Lu**, & H. V. H. Ayala. Pose estimation of robotic manipulators using deep transfer learning towards video-based system identification. *Brazilian Symposium on Intelligent Automation*, 2023.

Book Chapters

1. M. Daneker, Z. Zhang, G. E. Karniadakis, & **L. Lu**†. Systems biology: Identifiability analysis and parameter identification via systems-biology-informed neural networks. *Computational Modeling of Signaling Networks*, Springer, 87–105, 2023.

Patents

1. G. E. Karniadakis, & **L. Lu**. Deep operator network. *U.S. Application* No. 63/145,783, *International Application* No. PCT/US2022/015340, filed on February 4, 2021.
2. **L. Lu**, M. Dao, S. Suresh, & G. E. Karniadakis. Machine learning techniques for estimating mechanical properties of materials. *U.S. Patent* No. 11,461,519, filed on June 24, 2019, and issued on June 30, 2022.
3. X. Dong, J. M. Li, Y. Yan, H. Zhang, **L. Lu**, J. Wang, & H. Xiao. A test device and method for simulating natural gas leakage in soil. *China Invention Patent* CN103712755A, filed on June 14, 2013, and issued on April 9, 2014.

Softwares

- DeepXDE
  - A library for scientific machine learning and physics-informed learning.
  - >600,000 downloads, >2,100 GitHub Stars, >60 Contributors. Used in hundreds of papers published by a diverse range of scientists from >200 universities, national labs, and industry.
- OpenRBC
  - A coarse-grained molecular dynamics code for simulating entire human red blood cells at the protein resolution.
  - Third Prize, IBM OpenPOWER Developer Challenge contest, 2016.

- Source code of research papers: Lu Group's GitHub, Lu Lu's GitHub

Awards and Honors

Selected Awards and Honors

- U.S. Department of Energy Early Career Award, 2022.
- Chinese Government Award for Outstanding Self-financed Students Abroad, 2020.
- Joukowsky Family Foundation Outstanding Dissertation Award, Brown University, 2020.
- David Gottlieb Memorial Award, Division of Applied Mathematics, Brown University, 2020.
- Luis W. Alvarez Fellowship, Lawrence Berkeley National Laboratory, 2020. (declined)
- Lawrence Fellowship, Lawrence Livermore National Laboratory, 2020. (declined)
- Stephen Timoshenko Fellowship, Stanford University, 2020. (declined)
- Eugene P. Wigner Fellowship, Oak Ridge National Laboratory, 2020. (declined)
- J. H. Wilkinson Fellowship, Argonne National Laboratory, 2020. (declined)
- J. Robert Oppenheimer Fellowship, Los Alamos National Laboratory, 2019. (declined)
- Open Graduate Education Program, Brown University, 2017.
- Provincial Outstanding Graduates, Beijing, China, 2013.
- Provincial Merit Student, Beijing, China, 2013.
- Outstanding Graduates, Tsinghua University, 2013.
- Outstanding Undergraduate Graduation Thesis, Tsinghua University, 2013.
- December Ninth Scholarship, Tsinghua University, 2012.

Other Awards and Honors

- Early Career Travel Award, SIAM Conference on Uncertainty Quantification, 2022.
- Early Career Travel Award, SIAM Conference on Applications of Dynamical Systems, 2021.
- Early Career Travel Award, SIAM Conference on Computational Science and Engineering, 2021.
- Full Member, Sigma Xi, 2020.
- Student Travel Award, SIAM Conference on Mathematics of Data Science, 2020.
- Conference Travel Fund, Brown University, 2020.
- Travel Grant, Physics Informed Machine Learning Workshop, 2020.
- Travel Support Award, Machine Learning and the Physical Sciences workshop (NeurIPS), 2019.
- Open Graduate Education Travel Award, Brown University, 2019.
- International Conference Travel Fund, Brown University, 2019.
- Associate Member, Sigma Xi, 2018.
- George Irving Hopkins Fellowship, Brown University, 2017.
- Third Prize, IBM OpenPOWER Developer Challenge contest, 2016.
- Fellowship for graduate students, Brown University, 2015.
- Excellent Student Cadre, Tsinghua University, 2013.
- Summer Research Scholarship, Chinese Undergraduate Visiting Research Program, Stanford University, 2012.
- Outstanding Volunteer, Tsinghua University learning center, 2012.
- Member of "Spark" Innovative Talent Cultivation Program, Tsinghua University, 2011.
- Tsinghua Friend–Kai Feng Fellowship, Tsinghua University, 2011.
- Best Paper Award, 10^{th} National Symposium on Refrigerators, Air Conditioners and Compressors, Shandong, China, 2011.
- Third Prize, 29^{th} "Challenge Cup" Tsinghua University Students' Extracurricular Academic

Science and Technology Works Contest, 2011.

- Three-star Volunteer, Tsinghua University, 2011.
- Tsinghua Friend–Kai Feng Fellowship, Tsinghua University, 2010.
- First Prize, 27th Annual National Physics Contest for College Students, Beijing, China, 2010.
- Second Prize, 4th Intelligent Car Competition, Tsinghua University, 2010.
- First Prize, Chinese Physics Olympiad, Jiangsu, China, 2008.
- First Prize, Chinese Mathematical Olympiad, Jiangsu, China, 2008.
- Third Prize, Chinese Chemistry Olympiad, Jiangsu, China, 2008.
- Second Prize, Chinese Physics Olympiad, Jiangsu, China, 2007.

Research Grants

Current Grants

1. DOE EERE SETO SIPS — 5/2024–4/2025
   Role: Co-PI — $250,000 (Lu: $50,000)
   Title: Mitigating performance degrading defects in gallium-doped Czochralski silicon solar cells with data-informed modeling
2. DOE SC Early Career Research Program — 7/2022–6/2027
   Role: Sole PI — $750,000
   Title: Physics-informed neural operators for fast prediction of multiscale systems

Completed Grants

1. ExxonMobil Research and Engineering Company — 5/2022–12/2023
   Role: Sole PI — $75,000
   Title: Surrogate modeling for large-scale reservoir simulations for geological carbon sequestration
2. Penn's Center for Undergraduate Research and Fellowships, Grants for Faculty Mentoring Undergraduate Research — 6/2023–5/2024
   Role: Sole PI — $8,000
   Title: Reducing the cost of MRI scanning via physics-informed neural networks
3. Penn's Center for Undergraduate Research and Fellowships, Penn Undergraduate Research Mentorship award — Summer 2023
   Role: Sole PI — $10,000
   Title: Physics-informed machine learning for solving differential equations
4. Penn's Center for Undergraduate Research and Fellowships, Penn Undergraduate Research Mentorship award — Summer 2022
   Role: Sole PI — $10,000
   Title: Physics-informed neural networks for solving differential equations

Talks and Presentations

Invited Keynote and Plenary Talks

1. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *Mathematical and Scientific Machine Learning*, Beijing, China, Aug. 2022.

Invited Seminar Talks

1. Accurate, efficient, and reliable learning of deep neural operators for multiphysics and multiscale problems. *FM Global*, Jan. 2024.
2. Accurate, efficient, and reliable learning of deep neural operators. *Stanford University, Department of Mechanical Engineering, Mechanics and Computation Seminar*, Dec. 2023.
3. Accurate, efficient, and reliable learning of deep neural operators. *National Yang Ming Chiao Tung University, Department of Applied Mathematics, Webinar on Scientific Machine Learning*, Nov. 2023.
4. Deep neural operators with reliable extrapolation for multiphysics, multiscale & multifidelity problems. *University of Notre Dame, Department of Aerospace and Mechanical Engineering*, Oct. 2023.
5. Deep neural operators with reliable extrapolation for multiphysics, multiscale & multifidelity problems. *University of Illinois Urbana-Champaign, Department of Computer Science, Machine Learning Seminar*, Sept. 2023.
6. Deep neural operators with reliable extrapolation for multiphysics, multiscale & multifidelity problems. *Lawrence Livermore National Laboratory, Data-Driven Physical Simulation Webinar*, Sept. 2023.
7. Deep neural operators with reliable extrapolation for multiphysics, multiscale & multifidelity problems. *Illinois Institute of Technology, Center for Stochastic Dynamics*, July 2023.
8. Physics-informed deep learning: Blending data and physics for learning functions and operators. *Yale University, Department of Statistics and Data Science*, Feb. 2023.
9. Physics-informed deep learning: Blending data and physics for learning functions and operators. *University of California Santa Barbara, Department of Mathematics*, Feb. 2023.
10. Deep neural operators with reliable extrapolation for multiphysics, multiscale & multifidelity problems. *ExxonMobil Technology and Engineering Company*, Jan. 2023.
11. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *CCF Advanced Disciplines Lectures*, Dec. 2022.
12. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Pennsylvania State University, Department of Mathematics, Computational and Applied Mathematics Colloquium*, Dec. 2022.
13. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Xi'an Jiaotong University, School of Mechanical Engineering*, Nov. 2022.
14. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Texas Tech University, Department of Mathematics and Statistics, Applied Mathematics Seminar*, Nov. 2022.
15. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Ansys*, Oct. 2022.
16. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Yanqi Lake Beijing Institute of Mathematical Sciences and Applications, BIMSA-Tsinghua Seminar on Machine Learning and Differential Equations*, Oct. 2022.
17. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *e-Seminar on Scientific Machine Learning*, Sept. 2022.
18. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *Los Alamos National Laboratory, Center for Nonlinear Studies, Physics-Informed Machine Learning Seminar*, Aug. 2022.
19. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *Beijing Jiaotong University, Institute for Artificial Intelligence*, Aug. 2022.
20. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *East China Normal University, Data Science and Engineering Summer School*, July 2022.

21. Physics-informed neural networks: Algorithms, applications, and software. *East China Normal University, Data Science and Engineering Summer School*, July 2022.
22. Learning operators using deep neural networks for multiphysics, multiscale, & multifidelity problems. *Hohai University, Mechanics and Artificial Intelligence Lecture Series*, July 2022.
23. Physics-informed neural network: Algorithms, applications, and software. *Swansea University, Zienkiewicz Centre for Computational Engineering*, June 2022.
24. Learning operators using deep neural networks for diverse applications. *Vision and Learning Seminar*, June 2022.
25. Physics-informed deep learning. *Imperial College London, DataLearning Working Group Seminar*, May 2022.
26. Learning operators using deep neural networks for diverse applications. *Xinjiang University, School of Future Technology*, May 2022.
27. Multifidelity deep neural operators for efficient learning of partial differential equations with application to fast inverse design of nanoscale heat transport. *Brown University, Division of Applied Mathematics, Crunch Seminar*, May 2022.
28. Integrating machine learning & multiscale modeling in biomedicine. *University of Pennsylvania, Center for Engineering MechanoBiology*, Apr. 2022.
29. Physics-informed deep learning. *Synced & Chinese Academy of Sciences, Institute of Automation*, Apr. 2022.
30. Learning operators using deep neural networks for diverse applications. *The University of Hong Kong, Department of Mathematics, Optimization and Machine Learning Seminar*, Apr. 2022.
31. Learning operators using deep neural networks for diverse applications. *Florida State University, Department of Mathematics, Machine Learning Seminar*, Apr. 2022.
32. Physics-informed deep learning. *Tsinghua University, Department of Automation*, Mar. 2022.
33. Learning operators using deep neural networks for diverse applications. *ExxonMobil Research and Engineering Company*, Feb. 2022.
34. Learning operators using deep neural networks for diverse applications. *Southern Methodist University, Department of Mathematics, Clements Scientific Computing Seminar*, Feb. 2022.
35. Deep learning and scientific computing. *Tianyuan Mathematical Center in Southeast China*, Dec. 2021.
36. Learning nonlinear operators using deep neural networks for diverse applications. *Chinese Academy of Sciences, Institute of Systems Science*, Dec. 2021.
37. Physics-informed neural network: Algorithms, applications, and software. *Chinese Academy of Sciences, Institute of Systems Science*, Dec. 2021.
38. Learning nonlinear operators using deep neural networks for diverse applications. *The University of Southern Mississippi, School of Mathematics and Natural Sciences*, Oct. 2021.
39. Learning nonlinear operators using deep neural networks for diverse applications. *Towson University, Department of Mathematics*, Oct. 2021.
40. Physics-informed neural network: Algorithms, applications, and software. *Central China Normal University, QCD School*, Oct. 2021.
41. Learning nonlinear operators using deep neural networks for diverse applications. *Southeast University, School of Mathematics*, Oct. 2021.
42. Learning nonlinear operators using deep neural networks for diverse applications. *The University of Texas at El Paso, Department of Mechanical Engineering, Advanced Modeling & Simulations Seminar*, Oct. 2021.
    - Minority-serving institution (MSI)
43. Physics-informed deep learning. *Synced*, Aug. 2021.
44. DeepONet: Learning nonlinear operators. *University of Iowa, Department of Mathematics, Numer-*

ical Analysis Seminar, May 2021.

45. Integrating machine learning & multiscale modeling. *Purdue University, Department of Mathematics*, Feb. 2021.
46. Integrating machine learning & multiscale modeling in biomedicine. *Queen's University, Department of Mechanical and Material Engineering, Intelligent and Bio-inspired Mechanics Seminar*, Feb. 2021.
47. Integrating machine learning & multiscale modeling in biomedicine. *University of Pennsylvania, Department of Chemical and Biomolecular Engineering*, Feb. 2021.
48. Physics-informed deep learning. *Emory University, Scientific Computing Group*, Apr. 2020.
49. Scientific machine learning. *Lawrence Berkeley National Laboratory, Computing Sciences*, Mar. 2020.
50. Scientific machine learning. *Lawrence Livermore National Laboratory*, Feb. 2020.
51. Scientific machine learning. *Worcester Polytechnic Institute, Mathematical Sciences Department, Numerical Methods Seminar*, Feb. 2020.
52. Scientific machine learning. *Oak Ridge National Laboratory*, Jan. 2020.
53. Scientific machine learning. *Argonne National Laboratory, Mathematics and Computer Science Division*, Jan. 2020.
54. Scientific machine learning. *University of Pittsburgh, Department of Mechanical Engineering and Materials Science*, Nov. 2019.
55. Scientific machine learning. *University of North Carolina at Charlotte, Department of Mathematics and Statistics*, Nov. 2019.

Invited Conference Talks

1. Accurate, efficient, and reliable learning of deep neural operators. *RTX Physics Informed Machine Learning Workshop*, Virtually, Nov. 2023.
2. Fourier-DeepONet: Fourier-enhanced deep operator networks for geophysics. *SIAM New York-New Jersey-Pennsylvania Section*, New Jersey Institute of Technology, Oct. 2023.
3. Deep neural operators with reliable extrapolation for multiphysics, multiscale, & multifidelity problems. *BIRS Workshop on Scientific Machine Learning*, Banff, Canada, June 2023.
4. Deep neural operators with reliable extrapolation for multiphysics, multiscale, & multifidelity problems. *CBMS Conference: Deep Learning and Numerical PDEs*, Morgan State University, June 2023.
5. Deep neural operators for carbon neutrality. *iCANX Youth Talks*, Virtually, June 2023.
6. Deep neural operators with reliable extrapolation for multiphysics, multiscale, & multifidelity problems. *Mathematical and Scientific Machine Learning*, Providence, RI, June 2023.
7. Multifidelity deep neural operators for efficient learning of partial differential equations with application to fast inverse design of nanoscale heat transport. *SIAM Conference on Optimization*, Seattle, WA, May 2023.
8. Reliable extrapolation of deep neural operators informed by physics or sparse observations. *SIAM Conference on Applications of Dynamical Systems*, Portland, OR, May 2023.
9. Fourier-MIONet: Fourier-enhanced multiple-input neural operators for accurate and efficient surrogate modeling for geological carbon sequestration. *Carbon Capture, Utilization, and Storage*, University of Houston, Apr. 2023.
10. Deep neural operators with reliable extrapolation for multiphysics, multiscale, & multifidelity problems. *Inaugural Workshop on Scientific Machine Learning*, Oden Institute, University of Texas at Austin, Apr. 2023.
11. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *AAAI Fall Symposium on Knowledge-guided Machine Learning*, Arlington, VA, Nov. 2022.

12. Physics-informed neural networks: Algorithms, applications, and software. *Applied Analysis Day*, Ottawa, Canada, Nov. 2022.
13. Deep neural operators for multiphysics, multiscale, & multifidelity problems. *Symposium on Intelligent Simulation and Control for Multiscale Mechanics*, Beijing, China, Oct. 2022.
14. Physics-informed neural networks with hard constraints for inverse design. *SIAM Conference on Mathematics of Data Science*, San Diego, CA, Sept. 2022.
15. Physics-informed deep learning. *Wave Summit*, Beijing, China, May 2022.
16. DeepONet: Learning nonlinear operators. *Conference on the Numerical Solution of Differential and Differential-Algebraic Equations*, Martin Luther University Halle-Wittenberg, Germany, Sept. 2021.
17. DeepONet: Learning nonlinear operators. *SIAM Conference on Applications of Dynamical Systems*, Virtually, May 2021.
18. DeepONet: Learning nonlinear operators based on the universal approximation theorem of operators. *SIAM Conference on Computational Science and Engineering*, Virtually, Mar. 2021.
19. DeepONet: Learning nonlinear operators based on the universal approximation theorem of operators. *SIAM Conference on Mathematics of Data Science*, Virtually, June 2020.
20. DeepXDE: A deep learning library for solving differential equations. *SIAM Conference on Mathematics of Data Science*, Virtually, June 2020.
21. DeepONet: Learning nonlinear operators for identifying differential equations based on the universal approximation theorem of operators. *Joint Mathematics Meetings*, Denver, CO, Jan. 2020.
22. Collapse of deep and narrow neural nets. *ICERM Scientific Machine Learning*, Providence, RI, Jan. 2019.
23. OpenRBC: A fast simulator of red blood cells at protein resolution. *SIAM Annual Meeting*, Pittsburgh, PA, July 2017.

Supervision

Ph.D. Students

1. Joel Hayford, Chemical and Biomolecular Engineering, 2022–present
2. Jonathan Lee, Chemical and Environmental Engineering, 2022–present
3. Langchen Liu, Statistics and Data Science, 2022–present
4. Anran Jiao, Statistics and Data Science, 2021–present
5. Min Zhu, Statistics and Data Science, 2021–present
6. Mitchell Daneker, Chemical and Biomolecular Engineering, 2021–present

Master's Students

1. Helen Chen, Statistics and Data Science, 2023–present
2. Dili Maduabum, International and Development Economics, 2023–present
3. Ziyi Huang, Chemical and Biomolecular Engineering, 2022–present
4. Handi Zhang, Applied Mathematics and Computational Science, 2021–present
5. Chenxi Wu, Chemical and Biomolecular Engineering, 2021–2022 → Ph.D. student, Brown University
6. Shuai Meng, Data Science, 2021–2022 → Ph.D. student, University of California, Berkeley

Undergraduate Students

1. Andy Yang, Statistics and Data Science, 2023–present
2. Shivesh Mehrotra, Statistics and Data Science, 2023–present
3. Stephen Xia, Mathematics & Computer Science, 2023–present
4. Nitish Kaza, Mathematics & Economics, 2023–present
5. Mishael Majeed, Chemical and Biomolecular Engineering & Economics, 2023–present
6. Wendy Deng, Computational Biology & Computer Science, 2023–present
7. Caroline Chen, Computer Science, 2022–present

High School Students

1. Alex Huang, MIT's PRIMES-USA program, 2024–present
2. Kartik Ramachandrula, MIT's PRIMES-USA program, 2024–present
3. Agniv Sarkar, MIT's PRIMES-USA program, 2024–present
4. Uma Xin Shukla, La Canada High School, 2023–present
5. Eric Wang, MIT's PRIMES-USA program, 2023–present
6. Jacob Goldman-Wetzler, Hastings High School, 2023–present
7. Benjamin Fan, MIT's PRIMES-USA program, 2022–2023 → Undergraduate student, Massachusetts Institute of Technology
8. Edward Qiao, MIT's PRIMES-USA program, 2022–2023 → Undergraduate student, Massachusetts Institute of Technology
9. Jeremy Yu, MIT's PRIMES-USA program, 2021–2022 → Undergraduate student, Massachusetts Institute of Technology

Teaching Experience

Yale University

- S&DS 266/566 Deep Learning for Scientists and Engineers — Spring 2024
- S&DS 689 Scientific Machine Learning — Fall 2023

NVIDIA Deep Learning Institute Teaching Kit Program

- Deep Learning for Science and Engineering — 11/2023–present

University of Pennsylvania

- ENM 6010 Deep Learning for Scientists and Engineers — Spring 2022, Spring 2023
- CBE 4100 Chemical Engineering Laboratory — Fall 2022

Massachusetts Institute of Technology

- 18.085 Computational Science and Engineering I — Spring 2021
- 18.02 Multivariable Calculus — Fall 2020

Brown University

- Teaching Assistant, APMA 2550 Numerical Solution of Partial Differential Equations I — Fall 2017, Fall 2018
- Teaching Assistant, APMA 1200 Operations Research: Probability Models — Spring 2018

- Teaching Assistant, APMA 1690 Computational Probability and Statistics — Fall 2017
- Teaching Assistant, ENGN 1860 Advanced Fluid Mechanics — Spring 2015

Professional Services

Journal Editor

- Journal of Machine Learning, Action Editor, 2024–present
- Foundations of Data Science, Guest Editor, 2024
- Frontiers in Physics, Guest Editor, 2023

Global Online Seminar Organizer

- Complex Fluids and Soft Matter Seminar, 2/2022–present

Conference Minisymposium Organizer

- SIAM Conference on Optimization – Scientific Machine Learning for PDE-constrained Optimization, 2023
- SIAM Conference on Computational Science and Engineering – Advances in Deep Neural Operators, 2023
- SIAM Conference on Uncertainty Quantification – Operator Learning for Uncertainty Quantification, 2022
- SIAM Conference on Computational Science and Engineering – Machine Learning for Physical Systems, 2021
- SIAM Conference on Mathematics of Data Science – Machine Learning for Physical Systems, 2020

Grant Reviewer

- U.S. NSF MPS DMS
- U.S. DOE SC ASCR
- Canada New Frontiers in Research Fund

Journal Reviewer

Science, Nature Machine Intelligence, Nature Computational Science, Nature Communications, Science Advances, SIAM Review, Advanced Science, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Neural Networks and Learning Systems, Acta Materialia, Mechanical Systems and Signal Processing, Communications Earth & Environment, Computer Methods in Applied Mechanics and Engineering, Journal of Hydrology, PNAS Nexus, Metabolism: Clinical and Experimental, Engineering Applications of Artificial Intelligence, Neural Networks, Computers in Biology and Medicine, Applied Mathematical Modelling, Journal of Computational Physics, SIAM Journal on Scientific Computing, Engineering with Computers, Neurocomputing, Geophysics, Journal of Computational and Applied Mathematics, Computers & Mathematics with Applications, Engineering, npj Computational Materials, Computer Physics Communications, Advances in Water Resources, IEEE Transactions on Biomedical Engineering, Scientific Reports, Applied Mathematics and Mechanics, Computational Mechanics, Engineering Analysis with Boundary Elements, Applied Numerical Mathematics, Journal of Scientific Computing, Physica D: Nonlinear Phenomena, Soft Matter, Biophysical Journal, IEEE Transactions on Emerging Topics in Computational Intelligence, Geoscientific Model Development, Mechanics of Materials, Numerical Methods for Partial Differential Equations, PLoS ONE, Computers and Fluids, Communications in Computational Physics, Multiscale Modeling & Simulation, Neural Computation, Journal of Materials Research, Canadian Journal of Chemical Engineering, European Journal of Applied Mathematics, Communications in Mathematical Sciences

Conference Reviewer

Conference on Neural Information Processing Systems, International Conference on Machine Learning, International Conference on Learning Representations, IEEE Conference on Decision and Control, Mathematical and Scientific Machine Learning

University Services

- PhD Admissions Committee, Department of Statistics and Data Science, Yale University, 2024
- Postdoctoral Search Committee, Institute for Foundations of Data Science, Yale University, 2024
- Organizer, AMCS Colloquium, University of Pennsylvania, Fall 2021–Spring 2023
- PhD Admissions Committee, Department of Chemical and Biomolecular Engineering, University of Pennsylvania, 2022–2023
- PhD Admissions Committee, Graduate Group in Applied Mathematics and Computational Science, University of Pennsylvania, 2022–2023

Services on Thesis Committees

1. Fernanda Vargas, Department of Chemical & Environmental Engineering, Yale University, 2023–present
2. Sahil Kulkarni, Department of Chemical and Biomolecular Engineering, University of Pennsylvania, 2023–present
3. Sifan Wang, Graduate Group in Applied Mathematics and Computational Science, University of Pennsylvania, 2022–2023
4. Lilia Escobedo, Department of Chemical and Biomolecular Engineering, University of Pennsylvania, 2022–present
5. Georgios Kissas, Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania, 2022–2023
6. Shunyuan Mao, Department of Physics and Astronomy, University of Victoria, 2021–present

Last updated: March 5, 2024