Dhruv Patel

Curriculum Vitae

Stanford University, CA
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Research Skills

Deep learning, Generative modeling, Probabilistic sequence modeling, Computer vision, Bayesian inference, Computational science and engineering, Medical imaging, PDE-constrained optimization, Foundation models for scientific machine learning.

Computer Skills

Programming Languages	Python, C, C++, Fortran, MATLAB, Bash scripting.
Scientific tools and libraries	PyTorch, JAX, TensorFlow, TensorFlow Probability, LangChain, FEniCS, MPI, OpenMP, data analysis packages in python (Scikit-learn, pandas, Scipy), ParaView, Ansys, NX, Creo, LaTeX, version control with GitHub.

Research and Academic Experience

May 2021 – Present	**Timoshenko Distinguished Postdoctoral Fellow**, *Stanford University*, Stanford, USA.
Aug 2016 – August 2021	**PhD, Mechanical Engineering (Computational Mechanics)**, *University of Southern California (USC)*, Los Angeles, USA. Thesis: Physics-based data-driven inference.
July 2014 – June 2016 :	**MTech, Applied Mechanics**, *Indian Institute of Technology - Delhi*, New Delhi, India.
July 2009 – June 2013 :	**BE, Mechanical Engineering**, *L. D. College of Engineering (LDCE)*, Ahmedabad, India.

Selected Honours & Awards

2022	Best Dissertation Award, Department of Mechanical Engineering, USC.
2022	Runner up of the William F. Ballhaus Jr. Award for Best Dissertation in Viterbi School of Engineering, USC.
2021	Stephen Timoshenko Distinguished Postdoctoral Fellowship, Stanford University. [USC Blog post]
2019	The Honourable Mention of 2019 Karel Urbanek Award for Best Student Paper, SPIE Advanced Lithography, San Jose, CA (2nd place).
2018	Finalist of the best student poster competition, 13th World Congress on Computational Mechanics, New York City, NY.
2018	9th Gene Golub SIAM summer school on inverse problems and uncertainty quantification scholarship, Breckenridge, CO.
2016	Prof. Karunes Memorial Award for *Best Master's Thesis* - Applied Mechanics department, IIT Delhi.
2015	Ministry of Human Resource and Development, Government of India fellowship - M.Tech., IIT Delhi.
2009 – 2013	Ministry of Human Resource and Development, Government of India, national merit scholarship, B.E., LDCE.

Publications [Google Scholar Profile]

Journal Articles

[1] **D. Patel**, R. Tibrewala, A. Vega, L. Dong, N. Hugenberg, A. Oberai "Circumventing the solution of inverse problems in mechanics through deep learning: Application to elasticity imaging", *Journal of Computer Methods in Applied Mechanics and Engineering (CMAME).* [Link]
   ◦ Selected media highlights: 1, 2, 3, 4, 5

[2] **D. Patel**, R. Bonam, A. Oberai "Deep learning-based detection, classification, and localization of defects in semiconductor processes", *Journal of Micro/nanolithography, MEMS, and MOEMS.* [Link]
   ◦ Selected media highlights: 1, 2

[3] **D. Patel**, V. Kher, B. Desai, L. Xiaomeng, S. Cen, N. Nanda, A. Gholamrezanezhad, V. Duddalwar, B. Varghese, A. Oberai "Machine learning-based predictors for COVID-19 disease severity", *Scientific Reports.* [Link]

[4] **D. Patel**, A. Oberai "GAN-based priors for quantifying uncertainty in supervised learning" *SIAM/ASA Journal of Uncertainty Quantification.* [Link]

[5] **D. Patel**, D. Ray, A. Oberai, "Solution of physics-based Bayesian inverse problems with deep generative priors", *Journal of Computer Methods in Applied Mechanics and Engineering (CMAME).* [Link]

[6] R. Raad, **D. Patel**, C. Hsu, D. Ray, B. Varghese, S. Cen, D. Hwang, I. Gill, V. Duddalwar, A. Oberai "Probabilistic medical image imputation via deep adversarial learning", *Journal of Engineering with Computers.* [Link]

[7] D. Ray, H. Ramaswamy, **D. Patel**, A. Oberai "The efficacy and generalizability of conditional GANs for posterior inference in physics-based inverse problems", *Numerical Algebra Control and Optimization special issue on Inverse problems.*[Link]

[8] G. Cacciamani, Y. Xue, U. Durairaj, S. Roberts, **D. Patel**, R. Raad, G. Miranda, S. Sadeghi, A. Hung, I. Gill, M. Desai, P. Kuhn, J. Mason, A. Oberai "Machine learning framework-based prognostic classifier for predicting recurrence-free survival for patients undergoing radical cystectomy for urothelial bladder cancer", *Journal of Clinical Oncology.* [Link]

[9] **D. Patel**, D. Ray, M. Abdelmalik, T. Hughes, A. Oberai "Variationally mimetic operator networks", *Journal of Computer Methods in Applied Mechanics and Engineering (CMAME).* [Link]

[10] A. Dasgupta, **D. Patel**, D. Ray, E. Johnson, A. Oberai "A dimension-reduced variational approach for solving physics-based inverse problems using generative adversarial network priors and normalizing flows", *Journal of Computer Methods in Applied Mechanics and Engineering (CMAME).* [Link]

[11] **D. Patel**, J. Lee, M. Farthing, P. Kitanidis, E. Darve "Multi-fidelity Hamiltonain Monte Carlo", (in review). [Link]

[12] **D. Patel**, J. Lee, M. Farthing, P. Kitanidis, E. Darve "High-dimensional Bayesian inversion woth black-box simulators", (in review). [Link]

Book chapter

[1] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "Bayesian Inference in Geo-mechanics", in a book on Machine Learning in Geo-mechanics. (in press)

Peer-reviewed Conference and Workshop Articles

[1] **D. Patel**, R. Bonam, A. Oberai "Engineering neural networks for improved defect detection and classification", *Proc. SPIE 10959, Metrology, Inspection, and Process Control for Microlithography XXXIII, SPIE Advanced Lithography, San Jose, CA*, 2020. [Link]

[2] **D. Patel**, A. Oberai "Generative Adversarial Network priors for Bayesian inference", *Deep inverse workshop, 33rd conference on Neural Information Processing System (NeurIPS), Vancouver, BC*, 2019. [Link]

[3] **D. Patel**, D. Ray, H. Ramaswamy, A. Oberai "Bayesian inference in physics-driven problems with adversarial priors", *Deep inverse workshop, 34th conference on Neural Information Processing System (NeurIPS), virtual*, 2020. [Link]

[4] **D. Patel**, C. Hsu, B. Varghese, S. Cen, D. Hwang, I. Gill, V. Duddalwar, A. Oberai "Probabilistic recovery of missing phase images in contrast-enhanced CT", *Medical imaging workshop, 34th conference on Neural Information Processing System (NeurIPS), virtual*, 2020. [Link]

[5] D. Ray, **D. Patel**, H. Ramaswamy, A. Oberai "Efficient posterior inference and generalization in physics-based Bayesian inference with conditional GANs", *Deep inverse workshop, 35th conference on Neural Information Processing System (NeurIPS), virtual*, 2021. [Link]

[6] **D. Patel**, J. Lee, M. Forghani, M. Farthing, T. Hesser, P. Kitanidis, E. Darve "Multi-Fidelity Hamiltonian Monte Carlo Method with Deep Learning-based Surrogate", *Second symposium on science-guided AI, AAAI Fall Symposium Series (FSS), virtual*, 2021. [Link]

[7] A. Dasgupta, **D. Patel**, D. Ray, E. Johnson, A. Oberai "GAN-Flow: A dimension-reduced variational framework for physics-based inverse problems", *Machine Learning and the Physical sciences workshop, 36th conference on Neural Information Processing System (NeurIPS)*, New Orleans, LA, 2022. [Link]

[8] **D. Patel**, J. Lee, M. Farthing, T. Hesser, P. Kitanidis, E. Darve "Improved Black-box Variational Inference for High-dimensional Bayesian Inversion involving Black-box Simulators", *Deep inverse workshop, 37th conference on Neural Information Processing System (NeurIPS)*, New Orleans, LA, 2023. [Link].

Selected Recent Talks

[1] **D. Patel** "Efficient, Scalable, and Accurate Bayesian Inference with Deep Generative Multi-fidelity Modeling", *Pacific Northwest National Laboratory (PNNL)*, 2024 **(Invited talk)**.

[2] **D. Patel** "Efficient, Scalable, and Accurate Bayesian Inference with Deep Generative Multi-fidelity Modeling", *Lawrence Berkeley National Laboratory (LBNL)*, 2024 **(Invited talk)**.

[3] **D. Patel** "Bayesian inference and scientific computing in the era of Generative AI", *5th International Conference on Mathematical Techniques and Applications (ICMTA), Chennai, India*, 2024 **(Invited talk)**.

[4] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "High-dimensional Bayesian inversion with black-box solvers", *Stanford Thermal Fluids Science Affiliate Conference*, 2024 **(Invited talk)**.

[5] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "Overcoming challenges of practical Bayesian inference", *Advances in Computational Mechanics (ACM), Austin, TX*, 2023 **(Invited talk)**.

[6] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "Improved black-box variational inference for high-dimensional Bayesian inversion", *17th U. S. National Congress on Computational Mechanics, Albuquerque, New Mexico, NM*, 2023

[7] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "Multi-fidelity Hamiltonian Monte Carlo", *SIAM MDS, San Diego, CA*, 2022.

[8] **D. Patel**, J. Lee, P. Kitanidis, E. Darve "Multi-fidelity Hamiltonian Monte Carlo", *USACM thematic conference on UQ for ML-integrated Physical Modeling, Crystal City, VA*, 2022 **(Invited talk)**.

[9] **D. Patel** "Accelerating Scientific Machine Learning via Multi-fidelity Modeling", *Stanford ICME Xpo, Stanford, CA*, 2022 **(Invited talk)**.

[10] **D. Patel** "Efficient Bayesian Inference using Deep Generative Priors and Multi-fidelity Modeling", *Energy Resources Engineering (ERE) graduate seminar series, Stanford, CA*, 2021 - virtual **(Invited talk)**.[Link]

Teaching Experience

Winter 2023
Winter 2024
ME 343/CME 216: Machine Learning in Computational Engineering, *Stanford*, [Instructor and course developer].
- Designed and taught a graduate level course on Machine Learning for students with computational engineering and applied mathematics background.
- Designed homework assignments and conducted office hours.

Fall 2020
AME 599: Machine Learning and Computational Physics, *USC*, [Lead TA and course co-developer].
- Assisted my advisor in preparing course material for the first offering of this graduate level course and delivered guest lectures on deep generative modeling and uncertainty quantification.
- Conducted office hours and graded assignments.

Spring 2017
ENGR 2050: Introduction to Engineering Design, *RPI*, [TA].
- Conducted studio sessions and assisted students in conceptual and detailed design of the project for this project-based undergraduate course.

Fall 2016
ENGR 1200: Engineering graphics and CAD, *RPI*, [Lead TA].
- Conducted lab sessions as a lead TA for the undergraduate course with 250+ students.
- Conducted office hours, graded assignments, and assisted 50+ students with final CAD project.

Spring 2016
Advanced Solid Mechanics, *IIT Delhi*, [TA].
- Conducted office hours and tutorials.

Spring 2015
Experimental Methods for Solids and Fluids, *IIT Delhi*, [TA].
- Conducted lab sessions and graded assignments in this experiment-focused undergraduate course.

Research Advising

MS candidates

Fall 2019 – Fall 2020
Chiao-Chih Hsu (USC)
Implementing learning-based models to infer missing phase image of renal lesions from partially visible Contrast-Enhanced Computed Tomography (CECT) data.

Fall 2018 – Summer 2019
Vijay Kothapalli (USC)
Designed and developed deep learning-based models for time series data with application to Contrast-Enhanced Ultrasound (CEUS) imaging.

Undergraduate candidates

Summer 2020 – Fall 2020
Vikram Kher (USC)
Developing ML-based tools for prediction of clinical prognosis and disease severity in COVID-19 patients. **Winner**: Best USC Viterbi summer undergraduate research project.

Summer 2019
Eeshan Gupta (USC)
Developed software tools for solving physics-driven Bayesian inverse problems using GAN priors.

Summer 2017
Adriana Vega, Raghav Tibrewala (RPI)
Developed deep learning-based elasticity imaging workflow to classify breast tumors based on its mechanical properties.

High-school student

Summer 2018
Jacqueline Wang (USC)
Developed data processing and visualization pipeline for the tumor classification project.

Service and Outreach Activities

Organizer
- Mini-symposium on ML-driven model order reduction and inverse problems, SIAM Mathematics of Data Science (MDS), San Diego, CA, Sept. 2022.
- Mini-symposium on Recent developments in Operator Networks, USNCCM, Albuquerque, NM, 2023.

Reviewer International Conference on Learning Representation (ICLR); Neural Information Processing System (NeurIPS); AAAI conference on Artificial Intelligence; Journal of Computer Methods in Applied Mechanics and Engineering (CMAME); Journal of Computational Physics (JCP); International Journal for Numerical Methods in Engineering (IJNME); International Journal for Uncertainty Quantification (IJUQ); Journal of Computational Statistics and Data Analysis (CSDA); Journal of Geosciences; Journal of Numerical Algebra, Control, and Optimization (NACO); Journal of Hydrology; Journal of Geoenergy Science and Engineering.

K-12 STEM Outreach Mentor of Summer High School Intensive in Next-Generation Engineering (SHINE) program at USC.

Placement Coordinator Orchestrated successful on-campus recruitment drives at IIT Delhi, fostering robust industry connections, and ensuring seamless execution of placement operations, leading to high employment rates for my classmates.