Dhruv Patel

Curriculum Vitae

Stanford University, CA
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Research Interests

Computational mechanics, Scientific machine learning, Inverse problems, Uncertainty quantification, Bayesian inference, Multi-fidelity modeling, PDE-constrained optimization, Deep learning.

Academic History

May 2021 – Present	**Timoshenko Distinguished Postdoctoral Fellow**, *Stanford University*, Stanford, USA. Mechanics and Computation Group
Aug 2016 – August 2021	**PhD, Computational Mechanics**, *University of Southern California (USC)*, Los Angeles, USA. Thesis: Physics-based data-driven inference. Advisor: Prof. Assad Oberai
July 2014 – June 2016 :	**MTech, Appled Mechanics**, *Indian Institute of Technology - Delhi*, New Delhi, India. Thesis: Modeling of a supercoiled DNA using elastic rod model employing self-contact phenomena.
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)* (accepted). [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", (in review). [Link]

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

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 talks

[1] **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]

[2] **D. Patel**, A. Oberai "Efficient Bayesian inference using deep generative modeling", *Mechanics and Computation group, Stanford, CA*, 2020 - virtual **(Invited talk)**.

[3] **D. Patel**, A. Oberai "Solution of Bayesian inverse problems and uncertainty quantification in deep learning using deep generative modeling", *Combustion Research Facility, Sandia National Lab, Livermore, CA*, 2020 - virtual **(Invited talk)**.

[4] **D. Patel**, A. Oberai "Solution of Bayesian inverse problems and uncertainty quantification in deep learning using deep generative modeling", *Mechanics of materials department, Sandia National Lab, Livermore, CA*, 2020 - virtual **(Invited talk)**.

[5] **D. Patel**, A. Oberai "Physics-based data-driven deep generative models for efficient Bayesian inference", *Climate Modeling Aliance (CliMA), Caltech, Pasadena, CA*, 2020 **(Invited talk)**.

[6] **D. Patel**, A. Oberai "To know what we don't know: quantifying uncertainty using sample-based priors", *Mechanics seminar series, Department of Aerospace and Mechanical Engineering, USC, Los Angeles, CA*, 2020.

[7] **D. Patel**, R. Bonam, A. Oberai "Engineering neural networks for improved defect detection, classification, and localization", *SPIE Advanced Lithography, San Jose, CA*, 2019.

[8] **D. Patel**, R. Tibrewala, A. Vega, L. Dong, N. Hugenberg, A. Oberai "Circumventing the solution of inverse problems in mechanics through deep learning", *13th World Congress on Computational Mechanics (WCCM), NYC, NY*, 2018.

[9] **D. Patel**, A. Boquet, C. Bi, H.A. Arguedas "Hessian-free inexact Newton conjugate gradient method for efficient solution of inverse elasticity problems", *9th Gene Golub SIAM summer school on inverse problems and ucnertainty quantification, Breckenridge, CO*, 2018.

Teaching Experience

Winter 2023   **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*, [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.

Research Advising

PhD. candidates

Fall 2021 – Present   *Jason Liang (Stanford)*
Learning disentangled representation of physical data using progressive variational autoencoders.

Spring 2019 – Fall 2020   *Ragheb Raad (USC)*
Probabilistic recovery of missing images in Contrast-Enhanced Ultrasound (CEUS) imaging using deep generative priors.

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.

Professional Membership and Service

o 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.*

o Reviewer, *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; AAAI conference on Artificial Intelligence.*

o Central team placement coordinator, *IIT Delhi.*

Computer Skills

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