Dhruv V. Patel

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Education

- **University of Southern California** *Los Angeles, CA*
  PhD. in Mechanical Engineering (Computational Mechanics) *2016-present*
  - Thesis topic: "Physics-guided data-driven modeling for efficient inference"
  - Supervisor: Prof. Assad Oberai
- **Indian Institute of Technology, Delhi** *New Delhi, India*
  M.Tech. in Applied Mechanics *June 2016*
  - Thesis title: "Modeling of a supercoiled DNA using elastic rod model employing self-contact phenomena"
  - Supervisor: Prof. Ajeet Kumar
- **L.D. College of Engineering** *Ahmedabad, India*
  B.Tech. Mechanical Engineering *June 2013*
  - Thesis title: "Optimal design and analysis of power screw"
  - Supervisor: Prof. Shahnawazkhan Pathan

Research Interests

Physics-guided data-driven modeling, deep learning, Bayesian inference, PDE-constrained optimization, computer vision, medical imaging, inverse problems, deep generative modeling, finite element analysis.

Selected Honors and Awards

- The Honorable Mention of *2019 Karel Urbanek Best Student Paper Award*, SPIE Advanced Lithography, San Jose, CA [Feb. 2019] (2nd place).
- Finalist of the best student poster competition, 13th World Congress on Computational Mechanics, New York City, NY [July 2018].
- *Prof. Karunes Memorial Award for **Best Master's Thesis*** - Applied Mechanics Department, IIT Delhi [June 2016].
- Ministry of Human Resource and Development, Government of India fellowship for M.Tech. degree, IIT Delhi [2014 – 2016].
- Merit-based scholarship from Ministry of Human Resource and Development, Government of India for undergraduate studies [2009 – 2013].

Research Experience

- **Graduate Research Assistant** *June 2018 – Present*

  Computational and Data-driven Discovery (CD^3) group, USC *Los Angeles, CA*

  - **Bayesian Inference using Generative Adversarial Network Priors**:
    - Proposed a novel algorithm and developed a general-purpose framework for solving Bayesian inference problem using Generative Adversarial Network (GAN) priors.
    - Demonstrated the effectiveness of proposed algorithm in diverse uncertainty quantification and active learning tasks arising in physics and computer vision applications and developed a new software framework for solving hybrid problems involving PDE and learning-based models.
  - **Improved defect detection, classification, and localization using deep learning**:

    (in collaboration with IBM AI Research Center, Albany, NY)
    - Developed and implemented a deep learning-based workflow to automatically detect, classify, and locate defects in manufactured semi-conductor chips in a *weakly supervised* fashion.
    - Developing pattern invariant models for defect classification in limited data regime.
  - **Probabilistic recovery of missing phase in contrast-enhanced CT**:

    (in collaboration with Keck school of medicine - USC, LA, CA)

    Leading a team of masters' students for developing probabilistic deep learning models for recovery of missing phase in contrast-enhanced CT data using GAN-based priors.

- **Graduate Research Assistant** *June 2017 – May 2018*

  Scientific Computation Research Center (SCOREC), RPI *Troy, NY*

  - ***Mechanical classification* of breast tumors using deep learning**:
    - Developed and implemented a deep learning-based elasticity imaging workflow in TensorFlow for breast tumor classification based on mechanical properties of tissue.
    - First demonstration of domain randomization in bio-mechanical imaging.
  - **Adjoint-based solution of PDE-constrained optimization problems**: Derived and implemented adjoint based algorithms for inference of visco-elastic properties of tissue from interior time-harmonic data (MRI), by posing the inverse problem as a PDE-constrained optimization problem.
  - **Non-overlapping domain decomposition methods for parallel solution of large-scale optimization problems**: Derived and implemented a novel non-overlapping domain decomposition method for parallel solution of large-scale PDE-constrained optimization problems using Coupled Adjoint State Equation (CASE) method.

Journal Publications[J], Peer-Reviewed Conference Publications[C], and Invited Talks[T]

- **[J] D. Patel**, A. Oberai, R. Bonam "Deep learning-based detection, classification, and localization of defects in semiconductor processes", *Journal of Micro-nanolithography, MEMS and MOEMS, 2020* [Link] - Media highlight: 1.
- **D. Patel**, A. Oberai "GAN-based priors for quantifying uncertainty". [Link].
- **[J] D. Patel**, R. Tibrewala, A. Vega, N. Hugenberg, L. Dong, A. Oberai "Circumventing the solution of inverse problems in mechanics through deep learning: an application to elasticity imaging", *Computer Methods in Applied Mechanics and Engineering*, 2019.. [Link]
    - Selected media highlights**:** 1 , 2, 3 , 4 , 5
- **D. Patel**, A. Oberari "Generative Adversarial Network Priors for Bayesian Inference", *Deep-inverse workshop, NeurIPS 2019*, Vancouver, BC [Link].
- **[C] D. Patel**, A. Oberai, R. Bonan "Engineering neural networks for improved defect detection, classification, and localization", *Metrology, Inspection, and Process Control for Microlithography XXXIII* Feb 2019 [Link].
- **[T] D. Patel,** E. Gupta, A. Oberai "Bayesian Inference using Generative Adversarial Network Priors (BI-GANP)", *15th U.S. National Congress on Computational Mechanics (USNCCM)*, Austin, TX [2019].
- **[T] D. Patel**, A. Oberai, R. Bonan "Engineering neural networks for improved defect detection, classification, and localization", *SPIE Advanced Lithography*, San Jose, CA [2019].
- **[T]** A. Oberai, **D. Patel**, E. Gupta "Regularization of inverse problems with data-based priors", Research challenges and opportunities at the intersection of Machine Learning and Uncertainty Quantification, USC, Los Angeles, CA [2019].
- **[T]** A. Oberai, **D. Patel,** E. Gupta "Regularizing via Adversarial Learning", Applied inverse problems conference, Grenoble, FR [2019].
- **[T] D. Patel**, A. Boquet, C. Bi, H.A. Arguedas "Efficient solution of inverse elasticity imaging problem using Hessian-free inexact Newton conjugate gradient method", *9th Gene Golub SIAM summer school on inverse problems and uncertainty quantification*, Breckenridge, CO. [2018].
- **[T] D. Patel**, R. Tibrewala, A. Vega, N. Hugenberg, L. Dong, A. Oberai "Circumventing the solution of inverse problems in mechanics through deep learning", *13th World Congress on Computational Mechanics (WCCM)*, NYC, NY [2018].
- **[T]** L. Dong, N. Hugenberg, **D. Patel**, T. Seidl, P. Barbone and A. Oberai "Adaptive mesh refinement and domain decomposition techniques in elasticity imaging", *14th U.S. National Congress on Computational Mechanics (USNCCM),* Montreal, QC [2017].

- **[T] D. Patel**, R. Tibrewala, A. Vega, L. Dong, N. Hugenberg, A. Oberai "Mechanical classification of tumors using deep learning", *Computational Science & Engineering seminar series*, SCOREC, RPI, Troy, NY [2017].
- **[T] D. Patel**, R. Tibrewala, A. Vega, L. Dong, N. Hugenberg, A. Oberai "Mechanical classification of tumors using deep learning", *Graduate Research Symposium*, RPI, Troy, NY [2017].
- **[T] D. Patel,** A. Kumar "Modeling of a supercoiled DNA using elastic rod model employing self-contact phenomena", *Applied Mechanics seminar*, IIT Delhi, New Delhi [2016].

Teaching Experience

- **Teaching Assistant [Department of Mechanical, Aerospace and Nuclear Engineering, RPI]**
  - *Engineering graphics and CAD (ENGR 1200):* *Fall 2016*
    - Conducted lab sessions and office hours as a lead TA for this undergraduate course with around 150 students.
    - Graded assignments and final projects of around 100 students.
  - *Introduction to Engineering Design (ENGR 2050):* *Spring 2017*
    - Conducted studio session and assisted students in conceptual and detail design of the project.

Research Mentorship

- **MS research supervision, USC** *(Vijay Kothapalli, Chiao-Chih Hsu)* *August 2018 – Present*
  - Developing learning-based probabilistic model to infer and classify renal lesions from Contrast-enhanced ultrasound (CEUS) data.
  - A conference and journal paper in preparation.
- **Undergraduate research supervision**

  Vikram Kher (USC) *Summer 2020*
  - Developing ML-based tools for prediction of clinical prognosis and disease severity in COVID-19 patients.

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

  Adriana Vega and *Raghav Tibrewala (RPI)* *Summer 2017*
  - Developed deep learning-based elasticity imaging workflow to classify breast tumors based on its mechanical properties while circumventing the need of solving expensive inverse problems.
  - Resulted in one journal publication.
- **High-school summer research supervision, USC** *(Jacqueline Wang)* *Summer 2018*
  - Developed data processing and visualization pipelines for tumor classification project.

Computer Skills

- **Programming languages and OS**:
  - Python, C, C++, Fortran, Linux, Windows.
- **Scientific tools and libraries**:
  - TensorFlow, PyTorch, FEnics, Non-Linear Adjoint based Coefficient Estimator (NLACE) (an adjoint-based optimization library), MATLAB, Ansys, NX, Catia.