Chiraag Kaushik

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RESEARCH INTERESTS

- Generalization, robustness, and interpretability in modern representation learning
- Mathematical foundations of machine learning and statistical signal processing
- Design and application of ML systems to gain insight in imaging, health, and the natural sciences

EDUCATION

Georgia Institute of Technology Atlanta, GA
Ph.D. Electrical and Computer Engineering, M.S. Mathematics August 2021 - May 2026 (expected)
- Advisors: Vidya Muthukumar and Justin Romberg
- Concentration: Digital Signal Processing and Machine Learning

Rice University Houston, TX
B.S. Electrical and Computer Engineering, *summa cum laude, research distinction* August 2017 - May 2021
- Concentration: Signal Processing and Data Science

PUBLICATIONS

Conference articles and preprints

1. Brighton Ancelin, Yenho Chen, Alex Saad-Falcon, Peimeng Guan, **C. Kaushik,** Nakul Singh, Belen Martin-Urcelay: "MANGO: Disentangled Image Transformation Manifolds with Grouped Operators," at *Sampling Theory and Applications (SampTA),* 2025.

2. **C. Kaushik,** Justin Romberg, Vidya Muthukumar: "Precise asymptotics of reweighted least-squares algorithms for linear diagonal networks," at *Neural Information Processing Systems (NeurIPS),* 2024.

3. **C. Kaushik***, Ran Liu*, Chi-Heng Lin, Amrit Khera, Matthew Jin, Wenrui Ma, Vidya Muthukumar, Eva L. Dyer: "Balanced Data, Imbalanced Spectra: Unveiling Class Disparities with Spectral Imbalance," at *International Conference on Machine Learning (ICML)*, 2024.

4. **C. Kaushik,** T.M. Roddenberry, Santiago Segarra: "Network topology change-point detection from graph signals with prior spectral signatures," at *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)* 2021.

Journal articles

1. Chi-Heng Lin, **C. Kaushik**, Eva L. Dyer and Vidya Muthukumar: "The good, bad and ugly sides of data augmentation: An implicit spectral regularization perspective," in *Journal of Machine Learning Research (JMLR)*, 2024.

2. **C. Kaushik**, Andrew McRae, Mark Davenport and Vidya Muthukumar: "New equivalences between interpolation and SVMs: Kernels and structured features," in *SIAM Journal on Mathematics of Data Science (SIMODS)*, 2024.

PROFESSIONAL EXPERIENCE

Dolby Laboratories San Francisco, CA
PhD Research Intern - Machine Perception and Reasoning team May 2025 - August 2025
- Designed an improved sparse autoencoder (SAE) architecture for interpretability and steering of multimodal models.

- Applied proposed model to audio/text embeddings and showed improved semanticity and modality alignment compared to standard SAEs.
  - Work in preparation for conference submission.

Samsung Austin Semiconductor (Samsung Electronics)
Infrastructure Innovation Intern

Austin, TX
May 2019 - August 2019

  - Led development of a new internal application for data tracking and visualization during maintenance day in the semiconductor fab, leading to minimized downtime of the plant. Nominated by Samsung executives for a high-impact intern project award.

Scalable Health/Computational Imaging Labs
Undergraduate Researcher

Houston, TX
January 2018 - December 2019

  - Developed image processing algorithms to improve the robustness of photoplethysmography (PPG) detection in wearable devices.
  - Designed the illumination system for a wearable implementation of FlatCam (a lensless camera designed at Rice University based on compressive measurements) for use in health imaging applications

RESEARCH EXPERIENCE

Georgia Institute of Technology
Interpretable representation learning for generative image transformations 2024

  - Proposed and tested a novel autoencoder-based model which jointly learns latent image representations and a set of operators that can be used to generate transformed images in an interpretable way.

Metrics for class bias in modern pre-trained models 2023-2024

  - Identified the concept of "spectral imbalance" as an important contributor to performance gaps in modern classification models. Proved corresponding generalization bounds in the high-dimensional regime.
  - Helped conduct empirical investigations of this phenomenon for 11 real-world encoders for vision data, and developed a metric to predict the bias of a given pre-trained model without any additional downstream training.

Data augmentation in overparameterized models 2021-2023

  - Developed generalization bounds for overparameterized models trained with various common stochastic data augmentations, including Gaussian noise injection and random mask.
  - Designed new ensembled augmentation procedures to help mitigate robustness failures during neural network training, including for vision-transformer and ResNet-based image encoders.

Rice University
Network topology change-point detection from graph-supported data 2020-2021

  - Developed a novel sequential change-point detection algorithm to predict changes in underlying graph topology by using spectral information obtained from data.
  - Implemented algorithm on synthetic and real world (social network) datasets, demonstrating favorable performance in terms of average run length.

Early detection of cardiac electrical instability (with Texas Children's Hospital) 2020-2021

  - Designed and implemented an online anomaly detection algorithm (based on a novel Wasserstein-CUSUM statistic derived from a personalized autoencoder model) for early detection of electrical instability from cardiac signals in post-operation pediatric patients.
  - Voted 1st place at Rice Data Science Showcase by a panel of industry executives and professors

Awards

- Herbert P. Haley Fellowship   2024-2025
- NSF Graduate Research Fellowship   2021-2026
- Georgia Tech President's Fellowship   2021-2026
- Simons Institute Deep Learning Theory Workshop travel award   2022
- 1st place - Rice Data Science Showcase   2021
- Rice Engineering Alumni (REA) Outstanding Senior Award   2021
- Phi Beta Kappa, member   2021 –present
- Eta Kappa Nu, member   2020 –present
- NUS Faculty of Engineering Annual Prize   2020
- Elizabeth D. Williams Fellowship for Study Abroad   2019
- President's Honor Roll   2018–2020
- Louis J. Walsh Engineering Scholarship   2018–2020

Leadership and Teaching

- **Innovation Ecosystem Coordinator**   August 2019 - January 2020
  Student leader for the NSF PATHS-UP (Precise Advanced Technologies and Health Systems for Underserved Populations) Engineering Research Center
- **Teaching Assistant**   Fall 2020
  Signals, Systems, and Learning (ELEC 301 at Rice)
- **Teaching Assistant**   Fall 2025
  Machine Learning Theory (CS 7545 at Georgia Tech)

Posters and Presentations

1. **C. Kaushik***, Ran Liu*, Chi-Heng Lin, Amrit Khera, Matthew Jin, Wenrui Ma, Vidya Muthukumar, Eva L. Dyer: "Balanced Data, Imbalanced Spectra: Unveiling Class Disparities with Spectral Imbalance," poster presented at ML@GT Conference, Atlanta, GA. Aug. 2024.

2. **C. Kaushik**, Justin Romberg, and Vidya Muthukumar: "Precise asymptotics of reweighted least-squares algorithms for linear diagonal networks," poster presented at *IEEE Symposium on Information Theory (ISIT)*, Athens, Greece. July 2024.

3. Chi-Heng Lin, **C. Kaushik**, Eva L. Dyer, and Vidya Muthukumar: "The good, bad and ugly sides of data augmentation: An implicit spectral regularization perspective," poster presented at *DeepMath* conference, San Diego, CA. Nov. 2022.

4. **C. Kaushik**, B. Songong, V. Boominathan, A. Veeraraghavan, and A. Sabharwal, "Optical Design for Motion Compensation in Wearable Devices," poster presented at ECE Corporate Affiliates Day, Houston, TX. Apr. 2019.

5. B. Songong, **C. Kaushik**, V. Boominathan, A. Veeraraghavan, and A. Sabharwal, "Optical Design for Motion Compensation in Wearable Devices," poster presented at NSF Site Visit for PATHS-UP consortium, Texas A&M University, TX. Mar. 2019.

Skills

- **Technical skills:** Python, PyTorch, Numpy, Scikit-Learn, CVXPY, Matlab, LaTeX
- **Languages:** Spanish, Portuguese, Hindi