Sai Niranjan Ramachandran

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A first-principles researcher and PhD candidate at TU Munich, specializing in understanding the emergence of structure in complex systems. My work focuses on finding non-obvious connections between different theoretical domains (e.g., statistical physics and machine learning) to build novel insights. I am driven to translate these foundational insights into practical, high-impact applications and robust, engineerable systems.

Education

- **Technical University of Munich** — Munich, Germany
  PhD, Mathematics Advisor : Suvrit Sra, Professor EECS, MIT and TUM — *July 2024- 2027 (Expected)*
- **Indian Institute of Science** — Bangalore, India
  Master of Science - Mathematics; — *Aug 2022-Aug 2023*
- **Indian Institute of Science** — Bangalore, India
  Bachelor of Science - Mathematics; First Class — *Aug 2018-July 2022*

Research Publications

- **Cross-fluctuation phase transitions reveal sampling dynamics in diffusion models**: **Sai Niranjan Ramachandran** (TU Munich), M. Lal (TU Munich), S. Sra (TU Munich)
  Conference on Neural Information Processing Systems (**Neurips**), 2025.
- **The Information Game: Active Inference as Bilevel Optimization and a Game-Theoretic Benchmark for LLM Inquiry**: S. Dutta (UC Davis), **Sai Niranjan Ramachandran** (TU Munich) (**Core framework**), S. Sra (TU Munich)
  Under Review
- **Understanding the Generalization of Pretrained Diffusion Models on Out-of-Distribution Data**: **Sai Niranjan Ramachandran** (IISc); M. Aggarwal (IIIT-H), R. Mukhopadhyay (IIIT-H), V. Namboodiri (Univ. of Bath), C.V. Jawahar (IIIT-H) AAAI Conference on Artificial Intelligence (**AAAI**), 2024. **Oral Presentation (Top 5% of submissions)**
- **Towards disease-aware image editing of chest X-rays**: A. Saboo (CARING Research); **Sai Niranjan Ramachandran** (IISc); K. Dierkes (Pupil Labs); H. Y. Keles (Ankara Univ.) NeurIPS Workshop on Medical Imaging (**MedNeurIPS**), 2019

Invited Talks

- **QuantMinds International** — London, UK
  Invited PhD Poster Presenter — *November 2025*
  - **Selected by the QuantMinds Advisory Board as one of 16 PhDs globally to present at the main conference.**: My poster will showcase my research on modeling the emergent structure of complex systems, from foundational theory in my NeurIPS paper to practical, high-performance systems engineering.
- **Google DeepMind** — Bangalore, India
  Invited Speaker — *August 2025*
  - **Delivered a talk to the Foundational Research Team on my work, Cross-fluctuation phase transitions reveal sampling dynamics in diffusion models**: Invited by Prateek Jain, Director / Senior Research Scientist. Discussed the utility of the framework for Google's scale involving millions of images.

Research Experience

- **Resource Aware Machine Learning Lab, MIT/TU Munich** — Onsite
  Doctoral Researcher — *July 2024 - Present*
  - **Exploring the fundamental structure of machine learning systems, including *embeddings, inference, and geometric representations.***: Applying interdisciplinary tools to analyze system complexity under the supervision of Professor Suvrit Sra.
- **Audio Visual Lab, CVIT, IIIT Hyderabad** — Remote
  Research Fellow — *Oct 2021 - May 2024*
  - **Focused on generative modeling and multi-modal synthesis with a specialization in audio-visual data.**: Concentrated on the *mathematical dissection of representations* and developing theoretical frameworks to explain observed model behaviors. Supervised by Prof. CV Jawahar and Prof. Vinay Namboodiri (University of Bath).
- **Cognition Lab, IISc** — Remote
  Student Researcher (Intern) — *May 2021 - Aug 2021*
  - **Engineered Variational Autoencoders (VAEs) and Vector Quantized-VAEs (VQ-VAEs) for anomaly detection and predictive brain aging from MRI scans.**: This work aimed to identify factors leading to neurological pathologies and understand age-related changes in neural connectivity.
- **Quest Lab, IISc** — Remote
  Student Researcher (Intern) — *May 2019 - May 2021*
  - **Designed and implemented a novel Bayesian Optimization (BO) framework to enhance rainfall detection from sparse meteorological data.**: Utilized the *Botorch* library and the Expected Improvement (EI) framework as an innovative alternative to conventional data assimilation techniques. Mentored by Prof. Deepak Subramani.

- **Caring Research** Remote
  Student Researcher (Intern) *May 2020 - Dec 2020*
  - **Developed an efficient GAN-inversion paradigm for fine-grained editing of chest X-rays, enabling manipulation of disease-specific features to address data skew.**: Authored a **first-author publication** on this work, accepted at the **Medical Imaging meets NeurIPS (2020)** workshop.
- **Strand Life Sciences** Remote
  Student Researcher (Intern) *May 2019 - Sep 2019*
  - **Developed a deep learning classifier using genomic markers for the prediction of Autism Spectrum Disorder (ASD).**: The project focused on pinpointing potential genomic indicators for ASD under the supervision of Prof. Ramesh Hariharan.

Practical Experience

- **EY India** Gurugram, India
  Strategic Consultant *May 2023 - Oct 2023*
  - **Tasked with developing a strategic proposal for integrating AI-powered radiology tools into national public health services.**: My analysis focused on mitigating key adoption barriers, outlining a *clinician-centric workflow* and a framework for safe implementation in **resource-constrained environments**.
- **Campus Fund** Bangalore, India
  Associate VC *Jun 2022 - May 2023*
  - **As a member of the Investment Committee, personally led due diligence and investment rounds for early-stage startups.**: Specialized in evaluating *deep tech* and *AI-centric ventures*, leveraging a research-grounded perspective to assess technical viability and long-term market potential.
- **EntIISc (Entrepreneurship Society of IISc)** Bangalore, India
  Vice President *Aug 2020 - Mar 2022*
  - **Directed initiatives to foster a culture of innovation and commercialization of research at one of India's premier science institutes.**: Actively bridged the gap between academic theory and business application by organizing mentorship programs and facilitating the transition from *lab-based research to market-ready solutions.*

Selected Projects

- **Formal Geometry Specification in Lean**:
  - **Developing a formal specification of Euclidean and incidence geometries using the Lean theorem prover and a Geometric Algebra framework.**: The goal is to firmly ground geometry from a foundational perspective. This work provides a potential path towards the *formal verification* of AI networks that utilize non-standard geometries. The code is available on GitHub.
- **Causal Modelling for a Course Project**:
  - **As part of a final project for a *Topics in AI* course, investigated the use of causal mechanisms to better understand AI model behavior.**: The work involved an initial attempt to apply causal principles in an **RL** setting, followed by an investigation into the causal behavior of **RL** models to understand their biases and failure modes.

Honors and Awards

- **Siemens Healthineers Innovation Think Tank Award (Winner, Asia Region)** **2022**
  Recognized for a proposed AI solution to enhance diagnostic outcomes in pathology and radiology.
- **Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship** **2017**
  Prestigious Govt. of India fellowship providing full funding for Bachelor's and Master's degrees.
- **National Talent Search (NTS) Scholarship** **2015**
  National-level Govt. of India scholarship for students with exceptional research aptitude.
- **Junior Talent Search (JSTS) Scholarship** **2014**
  State-level Govt. of Delhi scholarship recognizing outstanding young science talent.

References

- Suvrit Sra suvrit@mit.edu,s.sra@tum.de TU Munich (on leave from MIT)
- CV Jawahar jawahar@iiit.ac.in, IIIT Hyderabad
- Vinay Namboodiri, vpn22@bath.ac.uk, University of Bath, UK