# Rahul Singh

https://rahulsinghchandraul.github.io
https://scholar.google.com/citations?user=HF_VfkMAAAAJ&hl=en

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## EDUCATION

**Georgia Institute of Technology** — Atlanta, GA
*PhD in Machine Learning* — *May 2023*

**Iowa State University** — Ames, IA
*Master of Engineering in Electrical Engineering* — *December 2018*

**Indian Institute of Space Science and Technology** — Trivandrum, India
*Master of Technology in Digital Signal Processing* — *July 2015*

**KIIT University** — Bhubaneswar, India
*Bachelor of Technology in Electronics and Telecommunication Engineering* — *July 2013*

## RESEARCH EXPERIENCE

**Yale University** — New Haven, CT
*Wu Tsai Neuroscience Postdoctoral Fellow* — *July 2023 - present*

- Machine Learning and signal processing applications in biomedical imaging data.
- Multimodal representation learning for live interactive neuroscience.

**Georgia Institute of Technology** — Atlanta, GA
*Graduate Research Assistant* — *August 2018 - May 2023*

- Research and publications on (i) generative modeling including probabilistic graphical models (PGMs) and generative adversarial networks (GANs), (ii) learning for graph structured data, (iii) graph neural networks (GNNs).
- Proposed graph neural networks for signed graphs with positive as well as negative links.
- Multi-marginal optimal transport (MOMT) approach for development of fast and convergent algorithms for inference from aggregate population-level data generated by a PGM.
- Proposed convergent algorithms for learning hidden Markov models (HMMs) from aggregate population-level data.
- Utilized GANs for learning actor-critic algorithms in distributional reinforcement learning (DRL) framework resulting in robust and sample efficient policies.

**Intel AI** — San Diego, CA
*Intern* — *May 2022 - August 2022*

- Graph Neural Networks (GNNs) for molecular property prediction.

**Mitsubishi Electric Research Lab (MERL)** — Boston, MA
*Intern* — *May 2021 - August 2021*

- Reinforcement Learning (RL) for partial differential equation (PDE) control.
- Design of heating, ventilating, air conditioning (HVAC) control policy based on RL algorithms.

**Iowa State University** — Ames, IA
*Graduate Research Assistant* — *August 2016 - July 2018*

- Research and publications on machine vision assisted electrohydrodynamic printing (E-jet) and manifold learning.
- Real-time information extraction (diameter and tilt-angle) from the images of the filament in the air.

**Indian Institute of Space Science And Technology** — Trivandrum, India
*Senior Project Fellow* — *August 2015 - July 2016*

- Research and publications on signal processing over complex networks.
- Redefined Graph Fourier Transform (GFT) by utilizing the eigendecomposition of the directed Laplacian of a graph.

## AWARDS & RECOGNITION

- Trainee professional development award, Society for Neuroscience (SfN). *(2024)*
- Wu Tsai postdoctoral fellowship, Yale University. *(July 2023-June 2026)*
- Teaching excellence award, Iowa State University. *(May 2018)*
- Best paper award, International Conference on Signal Processing and Communications (SPCOM). *(2016)*
- Graduate study scholarship from Department of Space, Government of India. *(August 2013 - June 2016)*

## PUBLICATIONS

- **Book**

  - B. S. Manoj, A. Chakraborty, and **R. Singh**, "Complex Networks: A Networking and Signal Processing Perspective," *Prentice Hall PTR, New Jersey, USA,* 2018. (<https://complexnetworksbook.github.io/>)

- **Journals**

  - **R. Singh**, Y. Zhang, D. Bhaskar, V. Srihari, C. Tek, X. Zhang, J Adam Noah, S. Krishnaswamy and J. Hirsch, "Deep Multimodal Representations and Classification of First-Episode Psychosis via Live Face Processing," *Frontiers in Psychiatry, 2024. (under revision)*

  - X. Zhang, J Adam Noah, **R. Singh**, J. McPartland and J. Hirsch, "Support Vector Machine Prediction of Individual Autism Diagnostic Observation Schedule (ADOS) scores based on Neural Responses during Live eye-to-eye Contact," *Scientific Reports, 2024.*

  - **R. Singh** and Y. Chen, "Signed Graph Neural Netowrks: A Frequency Perspective," *Transactions on Machine Learning Research, 2023.*

  - **R. Singh** and Y. Chen, "Learning Gaussian Hidden Markov Models From Aggregate Data," *IEEE Control Systems Letters, 2023.*

  - **R. Singh**, I. Hassler, Q. Zhang, J. Karlsson, and Y. Chen, "Inference with Aggregate Data in Probabilistic Graphical Models: An Optimal Transport Approach," *IEEE Transaction on Automatic Control, 2022.*

  - Q. Zhang\*, **R. Singh**\*, and Y. Chen, "Inference of Aggregate Hidden Markov Models with Continuous Observations," *IEEE Control Systems Letters, 2022.*

  - **R. Singh**, Q. Zhang, and Y. Chen, "Learning Hidden Markov Models from Aggregate Observations," *Automatica, 2022.*

  - I. Hassler\*, **R. Singh**\*, Q. Zhang, J. Karlsson, and Y. Chen, "Multi-marginal Optimal Transport and Probabilistic Graphical Models," *IEEE Transaction on Information Theory, 2021.*

  - **R. Singh**, I. Haasler, Q. Zhang, J. Karlsson, Y. Chen, "Incremental Inference of Collective Graphical Models," *IEEE Control Systems Letters, 2021.*

  - **R. Singh**, A. Chakraborty, and B. S. Manoj, "GFT Centrality: A New Node Importance Measure for Complex Networks," *Physica A: Statistical Mechanics and its Applications, 2017.*

- **Conferences**

  - A. Afrasiyabi, D. Bhaskar, E. Busch, L. Caplette, **R. Singh**, G. Lajoie, N. Turk-Browne, and S. Krishnaswamy, "SAMBA: Latent Representation Learning for Multimodal Brain Activity Translation," *International Conference on Acoustics, Speech, and Signal Processing (ICASSP) , 2025.*

  - **R. Singh**, K. Lee, and Y. Chen, "Sample-based Distributional Policy Gradient," *$4^{th}$ Conference on Learning for Dynamics and Control (L4DC), 2022.*

  - **R. Singh** and Y. Chen, "Inference of Collective Gaussian Hidden Markov Models," *IEEE Conference on Decision and Control (CDC), 2021.*

  - **R. Singh**, Q. Zhang, and Y. Chen, "Improving Robustness via Risk Averse Distributional Reinforcement Learning," *$2^{nd}$ Conference on Learning for Dynamics and Control (L4DC), 2020.*

  - S. Lu, **R. Singh**, X. Chen, Y. Chen, and M. Hong, "Alternating Gradient Descent Ascent for Nonconvex Min-Max Problems in Robust Learning and GANs," *$53^{rd}$ Asilomar Conference on Signals, Systems, and Computers, 2019.*

  - **R. Singh**, A. Chakraborty, and B. S. Manoj, "Graph Fourier Transform based on Directed Laplacian," *$11^{th}$ International Conference on Signal Processing and Communications (SPCOM)*, 2016. [**BEST paper award**]

  - **R. Singh**, A. Chakraborty, and B. S. Manoj, "On Spectral Analysis of Node Centralities," *IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)*, 2016.

- **Posters**

  - "Slepians for Directed Signed Graphs," SIAM Conference on Mathematics of Data Science 2024.

  - "Classification of first-episode psychosis patients using brain activity and behavioral response during live face processing, " Society for functional near-infrared spectroscopy (SfNIRS) 2024.

  - "Geometrical and topological motifs of first-episode psychosis in live dyadic interactions," Society for Neuroscience (SfN) 2024.

## Teaching and Mentoring

- Summer 2024: Mentor at London Geometry and Machine Learning (LOGML) - mentored a group of 4 PhD students on the project "Spectral Signed GNNs for fMRI Connectomes"
- Summer 2024: Co-organized workshop on "A Primer on Topological Data Analysis and Graph Signal Processing for Neuroimaging Data" as part of MAPs program at Yale University
- Summer 2024: Lead organizer of workshop on "Understanding Human Brain" as part of Yale Pathways to science program - group of 16 high school students
- Fall 2021: TA for AE 3530 - System Dynamics and Vibration, Georgia Institute of Technology.
- Spring 2019: TA for AE 4610- Dynamics and Control Laboratory, Georgia Institute of Technology.
- Fall 2016, Spring 2017: TA for EE 224 - Signals and Systems I, Iowa State University.
- Fall 2017: TA for EE 324 - Signals and Systems II, Iowa State University.

## Review Service

IEEE Transactions on Signal Processing, IEEE Transactions on Automatic Control, IEEE Transactions on Signal and Information Processing over Networks, IEEE Conference on Decision and Control (CDC), American Control Conference (ACC), International Symposium on Mathematical Theory of Networks and Systems (MTNS), SIAM Journal on Imaging Sciences, NeuRIPS, ICML, ICLR.

## References

- **Yongxin Chen** (PhD Advisor), Associate Professor, Georgia Institute of Technology, Atlanta, GA
  contact: yongchen@gatech.edu

- **B. S. Manoj** (Master's Advisor), Professor, Indian Institute of Space Science and Technology, Trivandrum, India
  contact: bsmanoj@iist.ac.in

- **Joy Hirsch** (Postdoctoral Mentor), Professor, Yale University, New Haven, CT
  contact: joy.hirsch@yale.edu

- **Smita Krishnaswamy** (Postdoctoral Mentor), Associate Professor, Yale University, New Haven, CT
  contact: smita.krishnaswamy@yale.edu