

Vivek Gopalakrishnan

I am a second-year PhD student in Medical Engineering and Medical Physics in the Harvard-MIT Program in Health Sciences and Technology, advised by [Dr. Polina Golland](#). The goal of my research is to address unmet clinical needs through the development of biomedical machine learning methods that deepen our ability to understand and treat disease. My current focus is making minimally invasive neurosurgery easier for clinicians and safer for patients by designing fast 3D computer vision algorithms (neural fields) that advance the standard of intraoperative image guidance.

Education

- 2021- **Massachusetts Institute of Technology**, Cambridge, MA
PhD in Medical Engineering and Medical Physics (*Concentration*: Computer Science)
Advisor: Dr. Polina Golland
- 2020-2021 **Johns Hopkins University**, Baltimore, MD
MS in Biomedical Engineering (*Concentration*: Biomedical Data Science)
Thesis: *Multiscale Statistical Hypothesis Testing for k-Sample Graph Inference*
Advisors: Dr. Joshua Vogelstein and Dr. Carey Priebe
- 2017-2021 **Johns Hopkins University**, Baltimore, MD
BS in Biomedical Engineering (*Concentration*: Biomedical Data Science)

Research Experience

- 2021- **MIT Computer Science and Artificial Intelligence Laboratory**, Cambridge, MA
PhD student in the [Medical Vision Group](#). Developing novel neural field architectures to reconstruct 3D cerebrovasculature from latent fluid dynamic information encoded in cerebral angiograms (in collaboration with neurosurgery faculty at Harvard Medical School). Particular emphasis on fast and robust optimization methods for fitting neural fields [J5].
- 2020-2021 **Johns Hopkins University**, Baltimore, MD
Team leader and project manager for an [undergraduate design team](#). Developed a multimodal spatiotemporal registration algorithm to power a dynamic fusion image guidance system for minimally invasive heart surgery.
- 2018-2021 **Johns Hopkins University**, Baltimore, MD
Undergraduate researcher in the [Neurodata Lab](#). Developed novel machine learning algorithms to analyze populations of graph-valued objects [P2, J4]. Applied these methods to discover neuro-connectively similar subtypes of autism from multi-graph connectomics data [P1, J2].
- Summer 2018 **Ragon Institute of MGH, MIT and Harvard**, Cambridge, MA
Developed predictive models of disease progression and immune recovery in HIV-positive children with TB co-infection [J3], and identified biomarkers for antiretroviral toxicity by applying machine learning methods to HIV-patient data [J1].
- 2017-2018 **Johns Hopkins University**, Baltimore, MD
Member of an [undergraduate design team](#). Designed and implemented a clinical machine learning algorithm to predict the onset of lung failure in pediatric patients using sparse dictionary learning.
- Summer 2017 **WebValley Internship at Fondazione Bruno Kessler**, Trento, Italy
Implemented a deep learning algorithm to quantitatively assess crop damage from images taken by farmers. Supported by an internship award won at the 2017 Intel International Science and Engineering Fair (Los Angeles, CA).
- 2016-2017 **Tufts University BioSeq Program**, Somerville, MA
Proposed and conducted independent high school research using next-generation sequencing (NGS) to generate a novel human oral microbiome dataset. Analyzed NGS data using dimensionality reduction and hidden Markov models to identify microbial markers of oral health. Presented at the 2017 Intel International Science and Engineering Fair (Los Angeles, CA).

Work Experience

Summer 2021 **Brigham and Women's Hospital**, Boston, MA
Trained deep learning models to diagnose numerous cardiomyopathies from thousands of electrocardiograms and electronic health records as an intern at [One Brave Idea](#) (coronary heart disease research division).

Awards & Honors

2022 **Neuroimaging Training Program Grant**, National Institute of Biomedical Imaging and Bioengineering
2020 **Provost's Undergraduate Research Award**, Johns Hopkins University
2019 **Joseph C. Pistrutto Research Fellowship**, Johns Hopkins University
2017 **Internship Award at Fondazione Bruno Kessler**, Intel International Science and Engineering Fair
2017 **Second Place Winner**, Microbiology, Intel International Science and Engineering Fair
2017 **Semi-Finalist**, Regeneron Science Talent Search
2017 **Second Place Winner**, Massachusetts State Science & Engineering Fair
2016 **Second Place Winner**, Massachusetts State Science & Engineering Fair

Teaching Experience

JOHNS HOPKINS UNIVERSITY
Spring 2021 **Head Teaching Assistant**, [NeuroData Design II](#), *EN.BME.438/638*
Fall 2020 **Head Teaching Assistant**, [NeuroData Design I](#), *EN.BME.437/637*
Fall 2020 **Teaching Assistant**, Computational Cardiology Laboratory, *EN.BME.487*
Fall 2020 **Teaching Assistant**, Linear Algebra, *AS.MATH.201*
2018-2020 **Head PILOT Leader**, Linear Algebra and Multivariable Calculus, *Dept. of Academic Support*

Publications

- REFEREED CONFERENCE AND JOURNAL PAPERS
- [J5] **Vivek Gopalakrishnan** and Polina Golland. "Fast Auto-Differentiable Digitally Reconstructed Radiographs for Solving Inverse Problems in Intraoperative Imaging". *Clinical Image-based Procedures: 11th International Workshop, CLIP 2022, Held in Conjunction with MICCAI 2022, Singapore, Proceedings*. (Sept. 2022) arXiv: [2208.12737](#) [cs.CV]
Nominated for Best Paper Award
- [J4] Jaewon Chung, Eric Bridgeford, Jesus Arroyo, Benjamin D. Pedigo, Ali Saad-Eldin, **Vivek Gopalakrishnan**, Liang Xi-ang, Carey E Priebe, and Joshua T Vogelstein. "Statistical Connectomics". *Annual Review of Statistics and Its Application* (Mar. 2021). doi: [10.1146/annurev-statistics-042720-023234](#)
- [J3] **Vivek Gopalakrishnan**, Eliezer Bose, Usha Nair, Yuwei Cheng, and Musie Ghebremichael. "Pre-HAART CD4+ T-Lymphocytes as Biomarkers of Post-HAART Immune Recovery in HIV-Infected Children with or without TB Co-Infection". *BMC Infectious Diseases* (Oct. 2020). doi: [10.1186/s12879-020-05458-w](#).
- [J2] Nian Wang, Robert J Anderson, David G Ashbrook, **Vivek Gopalakrishnan**, Youngser Park, Carey E Priebe, Yi Qi, Rick Laoprasert, Joshua T Vogelstein, Robert W Williams, and G Allan Johnson. "Variability and Heritability of Mouse Brain Structure: Microscopic MRI Atlases and Connectomes for Diverse Strains". *NeuroImage* (Aug. 2020). doi: [10.1016/j.neuroimage.2020.117274](#).
- [J1] Jong Soo Lee, Elijah Paintsil, **Vivek Gopalakrishnan**, and Musie Ghebremichael. "A Comparison of Machine Learning Techniques for Classification of HIV Patients with Antiretroviral Therapy-Induced Mitochondrial Toxicity from Those Without Mitochondrial Toxicity". *BMC Medical Research Methodology* (Nov. 2019). doi: [10.1186/s12874-019-0848-z](#).
- PREPRINTS AND POSTERS
- [P2] **Vivek Gopalakrishnan**, Jaewon Chung, Eric Bridgeford, Benjamin D. Pedigo, Jesús Arroyo, Lucy Upchurch, G. Allan Johnson, Nian Wang, Youngser Park, Carey E. Priebe, and Joshua T. Vogelstein. "Discovery of Multi-Level Network Differences Across Populations of Heterogeneous Connectomes". (Apr. 2022). arXiv: [2011.14990](#) [q-bio, stat].
- [P1] **Vivek Gopalakrishnan** and Joshua Vogelstein. "Towards Discovering Heterogeneity in Autism via Multi-Network Connectomics". *Biomedical Engineering Society 2019, Philadelphia*. (Oct. 2019) *Poster*.

Invited Talks

- 2022 **Boston Medical Imaging Workshop**, Brigham and Women's Hospital, Boston, MA
Fast Auto-Differentiable DRRs: Quickly Solving Intraoperative Imaging Problems
Image-Guided Neurosurgery Meeting, Boston, MA
Fast Auto-Differentiable DRRs: Quickly Solving Intraoperative Imaging Problems
Medical Image Computing and Computer Assisted Interventions CLIP, Sentosa, Singapore
Fast Auto-Differentiable DRRs: Quickly Solving Intraoperative Imaging Problems
- 2021 **Presentations by Undergraduates in Life Sciences and Engineering**, Online
Multiscale Comparative Connectomics
Co-hosted by Johns Hopkins, Morgan State and Coppin State University (faculty-selected speaker)
PathAI, Online
Multiscale Comparative Connectomics
- 2020 **Neuromatch Conference**, Online
Statistical Methods for Multiscale Comparative Connectomics (<https://youtu.be/JgnHR6Bwef8>)

Software

- 2022 **DiffDRR**: GPU-accelerated & auto-differentiable digitally reconstructed radiographs in PyTorch
Primary author and maintainer (<https://github.com/eigenvivek/DiffDRR/>)
Gershgorin.jl: Visualizing the Gershgorin discs of a matrix
Primary author and maintainer (<https://github.com/eigenvivek/Gershgorin.jl>)
- 2021 **graspologic**: Package for graph statistical algorithms
Contributor (<https://github.com/microsoft/graspologic>)