

Vivek Gopalakrishnan

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I am an first-year PhD student in Medical Engineering and Medical Physics at the Harvard-MIT Program in Health Sciences and Technology. My current research interests lie in the development of machine learning methods for the diagnosis and treatment of cardiovascular and neurovascular disease. My past research has focused on the development of computational methods to analyze multi-subject neuroimaging and cardiovascular data. Most recently, I developed statistical graph theory algorithms to perform biomarker discovery in network-valued maps of the brain. I also led a Design Team of undergraduate biomedical engineers to build a dynamic fusion image guidance system for minimally invasive heart surgery.

Education

- 8/21 – present **Massachusetts Institute of Technology and Harvard Medical School**, Cambridge, MA.
Doctor of Philosophy (Ph.D.) in Medical Engineering and Medical Physics.
○ **Advisor:** Professor Polina Golland.
○ **Concentration Area:** Computer Science.
- 8/20 – 5/21 **Johns Hopkins University**, Baltimore, MD.
Master of Science and Engineering (M.S.E.) in Biomedical Engineering.
○ **Advisors:** Professors Joshua T. Vogelstein (primary) and Carey E. Priebe (secondary).
○ **Concentration Area:** Biomedical Data Science.
○ **Thesis:** *Multiscale Statistical Hypothesis Testing for k-Sample Graph Inference*.
- 8/17 – 5/21 **Johns Hopkins University**, Baltimore, MD.
Bachelor of Science (B.S.) in Biomedical Engineering.
○ **Advisor:** Professor René Vidal.
○ **Concentration Area:** Biomedical Data Science.

Research and Engineering Experience

- 1/20 – 5/21 **Design Team Leader**, *Dept. of Biomedical Engineering*, Johns Hopkins University.
○ Team leader and project manager for a team of eight undergraduate engineers.
○ Developed a multi-modal spatiotemporal registration algorithm to power a dynamic fusion image guidance system for minimally invasive heart surgery.
○ **Skills used:** *Computer vision, image registration, cardiology, Python, and Git*.
- 9/18 – 5/21 **Undergraduate Research Assistant**, *Neurodata Lab*, Johns Hopkins University.
○ Developed novel machine learning methods for analyzing populations of graph-valued objects [3, 1].
○ Discovered neuro-connectively similar subtypes of autism using joint embeddings of multi-network connectomes [4, 7].
○ **Skills used:** *Graph theory, statistics, machine learning, Python, and Git*.
- Summer 2018 **Summer Student Researcher**, *Ghebremichael Lab*, Ragon Institute of MGH, MIT and Harvard.
○ Developed predictive models of disease progression and immune recovery in HIV-positive children with TB co-infection [2].
○ Identified biomarkers for antiretroviral toxicity by applying machine learning methods to HIV-patient data [5].
○ **Skills used:** *Survival analysis, ROC models, R, and Git*.

- 12/17 – 5/18 **Design Team Member**, *Dept. of Biomedical Engineering*, Johns Hopkins University.
- Designed and implemented a clinical machine learning algorithm to predict the onset of lung failure in pediatric patients.
 - **Skills used:** *Representation learning, sparse dictionary learning, Python, and Git.*
- 6/17 – 7/17 **Summer Researcher**, *Fondazione Bruno Kessler*, Trento, Italy.
- Implemented a deep learning algorithm to quantitatively assess crop damage from images taken by farmers.
 - **Skills used:** *Computer vision, Keras, Python, and Git.*
- 6/16 – 6/17 **High School Researcher**, *Tufts University BioSeq Program*, Tufts University.
- Used next-generation sequencing (NGS) to generate a novel human oral microbiome data set.
 - Analyzed sequence data using dimensionality reduction and hidden Markov models to identify microbial biomarkers of oral health.
 - Presented at the 2017 Intel International Science and Engineering Fair, Los Angeles, CA.
 - **Skills used:** *DNA library construction, next-generation sequencing, dimensionality reduction, hidden Markov models, and R.*

Publications and Preprints

- [1] Jaewon Chung, Eric Bridgeford, Jesus Arroyo, Benjamin D. Pedigo, Ali Saad-Eldin, **Vivek Gopalakrishnan**, Liang Xiang, Carey E Priebe, and Joshua T Vogelstein. “Statistical Connectomics”. *Annual Review of Statistics and Its Application* (Mar. 2021). DOI: <https://doi.org/10.1146/annurev-statistics-042720-023234>.
- [2] **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](https://doi.org/10.1186/s12879-020-05458-w).
- [3] **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. “Multiscale Comparative Connectomics”. *arXiv:2011.14990* (Nov. 2020). arXiv: [2011.14990](https://arxiv.org/abs/2011.14990).
- [4] 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](https://doi.org/10.1016/j.neuroimage.2020.117274).
- [5] 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](https://doi.org/10.1186/s12874-019-0848-z).

Conference Presentations

- [6] **Vivek Gopalakrishnan** and Joshua T Vogelstein. “Statistical Methods for Multiscale Comparative Connectomics”. *NeuroMatch*. Oct. 2020. URL: https://www.neuromatch.io/abstract?submission_id=recARY71P6SjXY3xK.
- [7] **Vivek Gopalakrishnan** and Joshua T Vogelstein. “Towards Discovering Heterogeneity in Autism via Multi-Network Connectomics”. *Biomedical Engineering Society (BMES)*. Philadelphia, PA, Oct. 2019.

Skills

Programming Python, R, Julia, git, L^AT_EX

APIs Python Data Science Stack, Tensorflow
Bioinformatics Microbiome and B-/T-cell repertoire analysis
Wet Lab Microfabrication, 3D tissue culture, NGS library construction

Teaching

Spring '21 **Head TA – NeuroData Design II**, *EN.BME.438/638*, Johns Hopkins University.
Fall '20 **Head TA – NeuroData Design I**, *EN.BME.437/637*, Johns Hopkins University.
Fall '20 **TA – Linear Algebra**, *AS.MATH.201*, Johns Hopkins University.
Fall '20 **TA – Computational Cardiology Lab**, *EN.BME.487*, Johns Hopkins University.
Fall '18 **Head PILOT Leader**, *Dept. of Academic Support*, Johns Hopkins University.
to Spring '20

- Led group tutoring sessions (≈ 10 students/group), and wrote weekly problem sets and lectures.
- Led weekly meetings to train junior PILOT leaders in mathematics and pedagogy.

Fellowships and Awards

2020 **Provost's Undergraduate Research Award**, *Office of Undergraduate Research*, Johns Hopkins University.
2019 **INBT Research Award**, *Institute for NanoBioTechnology*, Johns Hopkins University.
2019 **Joseph C. Pistrutto Research Fellowship**, *Dept. of Computer Science*, Johns Hopkins University.
2018 **AWS Cloud Credits for Research Grant**, *Dept. of Computer Science*, Johns Hopkins University.
2017 **Second Place Winner**, *Intel International Science and Engineering Fair (ISEF)*, Category: Microbiology.
2017 **Internship Award**, *Intel ISEF Special Award*, Fondazione Bruno Kessler.
2017 **Semi-Finalist**, *Regeneron Science Talent Search*, Microbiology.
2017 **Second Place Winner**, *Massachusetts State Science & Engineering Fair*.
2016 **Second Place Winner**, *Massachusetts State Science & Engineering Fair*.