

Anish K. Simhal

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I am a postdoctoral fellow at the *Child Mind Institute's* Autism Center. My research focuses on network analysis to explore brain connectivity, focusing on using Ollivier-Ricci curvature to explore changes in the brain associated with autism.

I graduated from Duke University (2019) with a PhD under the supervision of Dr. Guillermo Sapiro. There, I created novel methods for detecting and characterizing synapses in mouse brain tissue imaged via array tomography, a hyperspectral imaging method. Additionally, I developed a machine learning framework to detect cervical pre-cancers from multi-channel images collected during a colposcopy.

Professional

- 2019 – **Postdoctoral Fellow — Autism Center, Child Mind Institute. New York, NY**
Present – Researched graph theory measures to explore connectivity of networks derived from resting-state fMRI data of children with autism spectrum disorder.
– Interpreted survey data on the effects of the COVID-19 pandemic on children with neurodevelopmental disorders.
– Researched clinical factors that predict a child's ability to complete multimodal MRI session and methods to improve MRI outcomes.
– Supervised by Adriana Di Martino and Michael Milham.

Education

- 2014 – 2019 **PhD — Electrical Engineering**
Duke University, Durham, NC
Pratt School of Engineering — Dept. of Electrical Engineering
- 2014 – 2016 **Masters of Science — Electrical Engineering**
Duke University, Durham, NC
Pratt School of Engineering — Dept. of Electrical Engineering
- 2010 – 2014 **Bachelor of Science — Electrical Engineering**
University of Virginia, Charlottesville, VA
School of Engineering and Applied Sciences

Research Interests

Connectomics, image processing, machine learning/artificial intelligence, MRI, network analysis, neurodevelopmental disorders, wearable sensors

Technical Skills

- Languages* Python, MATLAB, C++
Tools Amazon Web Services, Docker, Git, LaTeX, TensorFlow

Publications

- 2020 [7] A. K. Simhal, K. L. H. Carpenter, S. Nadeem, J. Kurtzberg, A. Song, A. Tannenbaum, G. Sapiro, G. Dawson. “**Measuring Robustness of Brain Networks in Autism Spectrum Disorder with Ricci Curvature.**” 2020. *Scientific Reports*.

- 2019 [6] A. K. Simhal, Y. Zuo, M. M. Perez, D. V. Madison, G. Sapiro, and K. D. Micheva. **"Multifaceted changes in synaptic composition and astrocytic involvement in a mouse model of fragile x syndrome."** 2019. *Scientific Reports*.
- 2018 [5] A. K. Simhal, B. Gong, J. S. Trimmer, R. J. Weinberg, S. J. Smith, G. Sapiro, and K. D. Micheva. **"A computational synaptic antibody characterization tool for array tomography."** 12, 2018. *Frontiers in Neuroanatomy*.
- 2018 [4] M. N. Asiedu, A. K. Simhal, U. Chaudhary, J. L. Mueller, C. T. Lam, J. W. Schmitt, G. Venegas, G. Sapiro, and N. Ramanujam. **"Development of algorithms for automated detection of cervical pre-cancers with a low-cost, point-of-care, pocket colposcope."** 2018. *IEEE Transactions on Biomedical Engineering*.
- 2018 [3] M. N. Asiedu, A. K. Simhal, C. T. Lam, J. Mueller, U. Chaudhary, J. W. Schmitt, G. Sapiro, and N. Ramanujam. **"Image processing and machine learning techniques to automate diagnosis of lugol's iodine cervigrams for a low-cost point-of-care digital colposcope."** 2018. *Optics and Biophotonics in Low-Resource Settings IV*. Volume 10485. International Society for Optics and Photonics.
- 2017 [2] A. K. Simhal, C. Aguerrebere, F. Collman, J. T. Vogelstein, K. D. Micheva, R. J. Weinberg, S. J. Smith, and G. Sapiro. **"Probabilistic fluorescence-based synapse detection."** 2017. *PLoS Computational Biology*.
- 2014 [1] A.K. Simhal, V.-G. Kanumuru, A. Holmes, and E. Berger. **"Exploring the use of student taught classes to introduce new technical topics to engineering undergraduates."** 2014. *Frontiers in Education Conference*, IEEE, pages 1–8.

Selected Poster Presentations

- 2020 Organization for Human Brain Mapping Annual Meeting (June 2020) - Poster. **"Mock MRI training impact on MRI scanning in children with neurodevelopmental disorders."** A. K. Simhal, J. O. A. Filho, P. Segura, J. Cloud, F. X. Castellanos, S. Colcombe, M. P. Milham, A. D. Martino.
- 2019 American Academy of Child & Adolescent Psychiatry Annual Meeting (Oct 2019) - Poster. **"Graph curvature as a method for discerning robustness in brain networks in autism spectrum disorder."** K. L. H. Carpenter, A. K. Simhal, S. Nadeem, J. Sun, J. Kurtzberg, A. Song, A. Tannenbaum, G. Sapiro, G. Dawson
- 2018 Society for Neuroscience (SFN) 2018 Annual Meeting (Nov 2018) - Poster. **"An array tomography exploration tool: Exploring synapses from FMR1 knockout mice."** Anish K. Simhal, Kristina D. Micheva, Yi Zuo, Richard J. Weinberg, Stephen J. Smith, Guillermo Sapiro
- 2017 SfN 2017 Annual Meeting (Nov 2017) - Poster. **"Automated Antibody Characterization for Array Tomography."** Anish K. Simhal, Belvin Gong, James Trimmer, Richard J. Weinberg, Stephen J. Smith, Guillermo Sapiro, Kristina D. Micheva
- 2017 SfN 2017 Annual Meeting (Nov 2017) - Poster. **"Comparing Mouse and Human Synapses with Automated Probabilistic Synapse Analysis."** Kristina D. Micheva, Anish K. Simhal, Jonathan T. Ting, Andrew L. Ko, William W. Seeley, Edward F. Chang, Alissa Nana Li, Ed Lein, Forrest Collman, Daniel V. Madison, Richard J. Weinberg, Stephen J. Smith, Guillermo Sapiro
- 2016 SfN 2016 Annual Meeting (Nov 2016) - Poster. **"Probabilistic Synapse Detection in Array Tomography."** Anish K. Simhal, Cecilia Aguerrebere, Forrest Collman, Joshua T. Vogelstein, Kristina D. Micheva, Richard J. Weinberg, Stephen J. Smith, Guillermo Sapiro
- 2015 NeuroIPS 2015 (Dec 2015) - Poster. **"Computational statistics for whole brain CLARITY analysis using the Open Connectome Project."** Anish K. Simhal, Will Gray Roncal, Kunal A. Lillaney, Kwame Kutten, Michael I. Miller, Joshua T. Vogelstein, Randal Burns, Li Ye, Raju Tomer, Karl Deisseroth, Guillermo Sapiro
- 2015 SfN 2015 Annual Meeting (Oct 2015) - Poster. **"Computational statistics for whole brain CLARITY analysis using the Open Connectome Project."** Anish K. Simhal, Will Gray Roncal, Kunal A. Lillaney, Kwame Kutten, Michael I. Miller, Joshua T. Vogelstein, Randal Burns, Li Ye, Raju Tomer, Karl Deisseroth, Guillermo Sapiro

Selected Talks

- 2018 Simhal, Anish K et al. "A Computational Synaptic Antibody Characterization Tool for Array Tomography." School of Electrical Engineering, **Tel Aviv University**. 15 October 2018. Tel Aviv, Israel.
- 2018 Simhal, Anish K et al. "A Computational Synaptic Antibody Characterization and Screening Framework for Array Tomography." Data Dialogue, IID, **Duke University**. 22 March 2018. Durham, North Carolina.
- 2017 Simhal, Anish K et al. "Automated Antibody Characterization and Screening for Array Tomography via Probabilistic Synapse Detection." Seminario Interdisciplinario Procesamiento y Análisis de Imágenes Biomédicas, **Universidad de la República**. 9 November 2017. Montevideo, Uruguay.
- 2017 Simhal, Anish K et al. "Probabilistic fluorescence-based synapse detection." Facultad de Ingeniería, **Universidad de la República**. 6 November 2017. Montevideo, Uruguay.

Leadership Experience

- 2018 – **Bull City Classrooms — Founder, Board of Directors**
Present – Created a nonprofit group address the needs of Durham Public Elementary School teachers.
– Engaged 400+ volunteers at 15+ events at local elementary schools.
– Raised \$2,000+ from community partners to support these efforts.
– www.bullcityclassrooms.org
- 2016 – 2018 **Little League Coach, Durham Boys and Girls Club – Head Coach**
– Coached twelve children, ages 9-12, for the Durham Bulls Youth Athletic League organization.
– During the season, spent 10 hours a week with the children.
– Organized practices, recruited assistant coaches, communicated with parents in English and Spanish.

Awards

- 2019 **Durham Public School Spark Advocate of the Year Award**
– Awarded by the Durham Public Schools Board of Education to an individual not affiliated with DPS for exceptional service.
- 2019 **Durham Public School Spark Advocate Award**
– Won in recognition of creating a nonprofit to engage the Durham community with Durham Public School teachers and staff.
- 2013 **Microsoft Imagine Cup Entrepreneurship Competition — 1st Place – Innovation**
– Created a physical therapy application to provide patients performing exercises and stretches real-time feedback via the Kinect Sensor in C#.
– Researched product development strategies, business models, and performed market analysis.
- 2013 **Harrison Undergraduate Research Award**
– Won competitive Harrison Award for 'outstanding undergraduate research,' which provided substantial research funding. Presented by the Center for Undergraduate Excellence at U.Va.

Industry Experience

- June/July **Allen Institute for Brain Sciences, Synapse Biology — Summer Visitor**
2016 – Worked with the synapse biology team, led by Dr. Stephen J. Smith, to develop new tools for detection synapses in array tomography data.

- Summer 2013 **Azure Summit Technology — Electrical Engineering Intern**
 – Developed a signal processing GUI in MATLAB to augment spectrogram analysis, digital down conversion, and other signal processing tools.
 – Designed various filters to equalize hardware system channel responses. – Learned agile software development.
- Summer 2012 **Decisive Analytics Corporation — Image Processing Intern**
 – Transformed video footage from unmanned aerial vehicles to create panoramic imagery to augment existing map data.
 – Designed and executed object detection algorithms to track vehicles throughout a video using OpenCV libraries; wrote documentation.
 – Implemented and evaluated an image processing research paper in C++.
- Summer 2011 **EOIR Technologies, Inc. — Software Engineering Intern**
 – Developed video analysis software based on the Python and OpenCV libraries to analyze and augment the results of an object tracking algorithm.
 – Collaborated with engineers to develop and manage evolving requirements and specifications; learned the Software Development Life Cycle.

Teaching Experience

- Spring 2016, 2017 **Image Processing (Duke ECE 590) — Teaching Assistant**
 – Supported students taking the course in-person at Duke and online via Coursera.
- Spring 2014 **Digital Signal Processing (UVa ECE 4750/6750)— Teaching Assistant**
 – Explained a variety of topics in DSP to both undergraduate and graduate students.
 – Created and graded weekly homework assignments and exams.
 – Held regular office hours attended by an average of 20+ students.
- Fall 2012, 2013 **Circuit Analysis (UVa ECE 2630) — Teaching Assistant**
 – Taught various circuit analysis techniques to second year EE/CPE students.
 – Demonstrated an array of lab skills, including using oscilloscopes.
- Fall 2011 **Engineering Explorations — 1st Year Seminar (UVa ENGR 1595) — Instructor**
 – Introduced and facilitated an “Explorations in Engineering” Seminar to provide 1st year students with an overview of all engineering disciplines – Coordinated with the Dean’s Office to create and manage the curriculum.
- 2008 – 2015 **Smithsonian National Air & Space Museum — Education Volunteer**
 – Dynamically adapted to a wide spectrum of age groups to educate and engage visitors from topics ranging from how an airplane flies to how astronauts live and work in space.

Undergraduate Research Experience

- 2014 **Heliotropism in Sunflowers @ VIVA Research Group — Dr. Scott Acton, ECE**
 – Researched and designed an algorithm to track the motion of sunflowers over extended periods of time. It is a fascinating problem due to the constantly evolving shape of the plant and the variety present within the species.
 – Collaborated and implemented the algorithm via MATLAB and delivered GUI to Dr. Blackman, U.Va Biology Dept.
- 2012 – 2014 **Semi-Enclosed Area Occupancy Detection — Dr. Archie Holmes, ECE**
 – Designed an integrated wireless sensor platform to detect occupancy in semi-enclosed area, to help students find an empty study areas via a mobile application.
 – Constructed a full scale prototype by integrating a microprocessor, passive & thermal infrared sensors, and digital radios in a 3D printed custom enclosure.

2012 – 2013 **INTERIA Wireless Health Research — Dr. John Lach, ECE**

- Designed calibration procedure for an Ankle Foot Orthopedic device with multiple sensors and created software tool chain to support it.
- Researched various activity classifications algorithms and created step counter.
- Created program (BodySim) to scan in 3D models of the human body via the Microsoft Kinect in C++ to model human kinematics.

Selected News Articles

- 2019 9th Street Journal. “Bull City Classrooms ushers volunteers to Durham elementary schools.” January 25th, 2019.
- 2014 UVA Today. “U.Va. Undergrads Track Foot Traffic to Make Study Areas More Accessible.” March 18th, 2014.
- 2013 UVA Today. “From Programming Languages to Auto Mechanics, Engineering Students Give Teaching a Try.” December 15th, 2013.
- 2013 UVA Today. “U.Va. Engineering Students Earn Microsoft’s Imagine Cup for Innovation.” June 28th, 2013.