

STATEMENT OF PURPOSE

jasonkena.github.io · jason.adhinarta@bc.edu · Chestnut Hill, MA

JASON KEN ADHINARTA

HARVARD UNIVERSITY

Emmerich Research Center was located in the same building as a tutoring center in Jakarta, Indonesia. The lab members there juggled responsibilities as both scientists and teachers; one day rigging conveyor-belt-mounted webcams to monitor larval growth and another helping kids design heat-seeking autonomous cars to extinguish candles. Who wouldn't be intrigued?

In high school, as an intern for the lab, I learned how to code by designing temperature control systems for vacuum chambers, and was introduced to computer vision while attempting to calculate reaction rates from video footage of our weighing scales. These early experiences sparked a fascination with the machine learning methods used to accelerate progress in biomedical fields. Looking ahead, I believe that pursuing a **PhD in Computer Science at Harvard University** will prepare me for a research career focused on developing **deep learning techniques that are widely applicable across neuroscience**.

A few weeks into my freshman year at Boston College, I applied to work at Prof. Donglai Wei's Computer Vision Lab. Having prior experience with computer vision techniques in interdisciplinary settings, I was intrigued by the lab's specialization in **connectomics**—a field focused on **reconstructing the brain's wiring diagram from small samples of tissue imaged at nanometer resolutions**. Over the course of a few months navigating the literature, acquainting myself with the PyTorch Connectomics codebase, and figuring out how to submit SLURM jobs on the Boston College Linux Cluster, connectomics was demystified ever so slightly.

Through my first research project at the lab, I was introduced to Shixuan Gu, who is now a PhD student at the Harvard Visual Computing Group. He hypothesized that the Frenet-Serret formulas from differential geometry could be used to improve the detection of aneurysms and synaptic connections by "straightening" blood vessel and dendrite geometries before they are fed into machine learning models. After I implemented and ran experiments for dendritic spine segmentation, we hastily prepared a manuscript detailing how enforcing this equivariance allowed our **point cloud models** to maintain high performance with **significantly less data and fewer augmentations** on our datasets. Despite my eagerness to land my first deep learning publication, our submission was rejected at MICCAI 2023.

Taking feedback from the rebuttal to heart, I evaluated the performance of modern point cloud architectures, implemented 5-fold cross-validation across our benchmarks, and manually inspected our annotations for the 4,476 dendritic spines we had. I performed detailed analyses studying how our transform induced cross-domain generalization—allowing models trained on the dendrites in the mouse somatosensory cortex to demonstrate **strong zero-shot performance on structures in the mouse visual cortex and human frontal lobe**. We submitted the manuscript to IEEE Transactions on Medical Imaging last month [D]. While I hope to do work that accelerates scientific progress, this project taught me that proper science is "slow," requiring meticulous attention to detail and the humility to recognize mistakes.

During the summer of 2023, I was awarded a \$4,800 stipend by the Boston College Eagle Intern Fellowship, which gave me the opportunity to branch out into **biomedical imaging** as an intern at the EPFL CVLab in Switzerland. Under the guidance of Dr. Jiancheng Yang and Prof. Pascal Fua, I contributed to the **Heart Augmented Reality Training System**, which aimed to develop a **surgery simulator for practicing catheter insertion**. The setup involved a simple box equipped with cameras to track catheter movements, which were mapped onto a 3D heart model displayed on screen, providing a more interactive training experience.

Sitting across from two PhD students, I gained valuable insights into their work on applying neural fields to novel view synthesis and implicit surface representation problems. Incorporating what I had learned, I was tasked with integrating models pretrained on the TotalSegmentator organ segmentation dataset with Dr. Yang's prior work on **latent-conditioned shape templates**—in order to **generate anatomically correct heart models from patients' MRI scans**. This work was published at the International Conference on Medical Image Computing and Computer Assisted Intervention 2024 [G]. Besides showing me how integral the exchange of ideas is to the research process, the internship allowed me to see that machine learning tools were not merely academic, having real promise in addressing real-world challenges.

I am currently working on three projects: enhancing the PyTorch Connectomics framework using segmentation guided contrastive learning foundation models, clustering neurons in fresh-water polyps [B] using trans-

lation and rotation equivariant autoencoders [A], and adapting cell tracking solutions to extract whole-brain neural dynamics in roundworms [C].

Working alongside researchers from the Lichtman Lab and the Visual Computing Group led by **Prof. Hanspeter Pfister** has been instrumental in shaping my approach in **connectomics**. My projects developing segmentation models for dendrites [D], synaptic vesicles [A, B, F], and cerebral vasculature [D, E] have strengthened my ability to approach complex microscopy challenges through the lens of voxel, mesh, and point cloud representations. Furthermore, my experience with CT and MRI modalities [G, H] offers a unique perspective to contribute to Prof. Pfister's efforts in **biomedical image analysis**.

Last summer, I expanded my neuroscience research by developing benchmarks for neural activity trace extraction from calcium imaging [C], aiming to advance efforts in reverse-engineering the *C. elegans* nervous system. Going forward, I plan to explore how deep learning models can extract insights from neural activity recordings. In particular, I am eager to learn more about **Prof. Demba Ba's** work on leveraging sparse and interpretable models for **neural data analysis**, as well as **Prof. Jia Liu's** research on decoding neurons from **brain-computer interfaces**.

I am applying to the NSF Graduate Research Fellowship Program, DOD National Defense Science and Engineering Graduate Fellowship Program, DOE Computational Science Graduate Fellowship, Paul & Daisy Soros Fellowships for New Americans, and Graduate Fellowships for STEM Diversity to seek additional funding.

I believe that my interdisciplinary background, spanning diverse geometric representations, imaging modalities, and biomedical applications, has uniquely prepared me to contribute to rigorous research at Harvard.

REFERENCES (* indicates equal contribution)

- [A] **Jason K. Adhinarta***, Yutian Fan*, Michael Lin*, Richard Ren*, Micaela Roth*, Ayal Yakobe*, Shulin Zhang*, Rafael Yuste, Donglai Wei. **VesicleEM: A Comprehensive Vesicle Analysis Toolbox for Volumetric Electron Microscopy**. Manuscript in preparation; planned submission to PLOS Computational Biology.
- [B] Shulin Zhang, Netanel Ofer, Wataru Yamamoto, Richard Schalek, Yuelong Wu, Christoph Dupre, **Jason K. Adhinarta***, Yutian Fan, Michael Lin, Micaela Roth, Ben Cox, Celina Juliano, Donglai Wei, Jeff Lichtman, Rafael Yuste. **Connectomic analysis of the *Hydra vulgaris* endoderm: cell types and vesicles**. Manuscript in preparation; planned submission to Current Biology.
- [C] **Jason K. Adhinarta***, Jizheng Dong*, Tianxiao He*, Junxiang Huang*, Daniel Sprague*, Jia Wan, Hyun Jee Lee, Zikai Yu, Hang Lu, Eviatar Yemini, Saul Kato, Erdem Varol, Donglai Wei. **WormND: A Benchmark for Extracting Whole-Brain Neural Dynamics of *C. elegans* at the Neuron Resolution**. Manuscript under revision.
- [D] Shixuan Gu, **Jason K. Adhinarta***, Mikhail Bessmeltsev, Jiancheng Yang, Jessica Zhang, Wenjie Yin, Daniel Berger, Jeff W. Lichtman, Hanspeter Pfister, Donglai Wei. **Frenet-Serret Frame-based Decomposition for Part Segmentation of 3D Curvilinear Structures**. Under review at IEEE Transactions on Medical Imaging. [arXiv:2404.14435](https://arxiv.org/abs/2404.14435)
- [E] Jia Wan, Wanhua Li, **Jason K. Adhinarta***, Atmadeep Banerjee, Evelina Sjostedt, Jingpeng Wu, Jeff Lichtman, Hanspeter Pfister, Donglai Wei. **TriSAM: Tri-Plane SAM for zero-shot cortical blood vessel segmentation in VEM images**. Under review at IEEE Journal of Biomedical and Health Informatics. [arXiv:2401.13961v4](https://arxiv.org/abs/2401.13961v4)
- [F] Xiaomeng Han, Xiaotang Lu, Peter H. Li, Shuohong Wang, Richard Schalek, Yaron Meirovitch, Zudi Lin, **Jason K. Adhinarta***, Daniel Berger, Yuelong Wu, Tao Fang, Elif S. Meral, Shadnan Asraf, Hidde Ploegh, Hanspeter Pfister, Donglai Wei, Viren Jain, James S. Trimmer, Jeff W. Lichtman. **Multiplexed Volumetric CLEM enabled by antibody derivatives provides new insights into the cytology of the mouse cerebellar cortex**. Nature Communications 2024. [doi:10.1038/s41467-024-50411-z](https://doi.org/10.1038/s41467-024-50411-z) PMID:39103318
- [G] Jiancheng Yang, Ekaterina Sedykh, **Jason K. Adhinarta***, Hieu Le, Pascal Fua. **Generating Anatomically Accurate Heart Structures via Neural Implicit Fields**. Medical Image Computing and Computer-Assisted Intervention 2024. [doi:10.1007/978-3-031-72378-0_25](https://doi.org/10.1007/978-3-031-72378-0_25)
- [H] Liang Jin, Shixuan Gu, Donglai Wei, **Jason K. Adhinarta***, Kaiming Kuang, Yongjie J. Zhang, Hanspeter Pfister, Bingbing Ni, Jiancheng Yang, Ming Li. **RibSeg v2: A Large-scale Benchmark for Rib Labeling and Anatomical Centerline Extraction**. IEEE Transactions on Medical Imaging 2023. [doi:10.1109/TMI.2023.3313627](https://doi.org/10.1109/TMI.2023.3313627) PMID:37695967