HOJAE LEE

hojae.k.lee@gmail.com · hojaeklee.github.io · Google Scholar · GitHub

Education

University of Michigan, Ann Arbor Aug. 2024
Ph.D., Electrical Engineering & Computer Science
Fellowships: NSF Graduate Research Fellowship; NIH F31 Ruth L. Kirschstein Predoctoral Fellowship

University of Michigan, Ann Arbor Jun. 2019
M.S., Electrical Engineering & Computer Science

University of California, Berkeley Jun. 2015
B.S., Bioengineering

Research Interests

NeuroAI, representation learning, generative modeling, and sensorimotor intelligence

Research Experience

Researcher Sep. 2024 – Present
Thousand Brains Project — research on neocortical principles for AI, founded by Jeff Hawkins

- Investigate principles of neocortical computation underlying sensorimotor learning, reference frames, and structured representations, and how they can inform new AI systems.
- Conceived and developed a method for representing surface features on curved 3D objects by transporting local reference frames, converting sensor motion and the orientation of texture edges into 2D pose and displacement.
- Led comparative experiments against Vision Transformers for the **Thousand-Brains Systems** paper, evaluating rapid learning, continual learning, and computational efficiency on the 77-object YCB benchmark. Demonstrated continual learning without catastrophic forgetting and quantified **˜34,000× fewer training FLOPs** than a ViT trained from scratch using **tbp.floppy**, a FLOP-analysis framework I developed.
- Developing new benchmarks to test compositional object learning and generalization from structured sensorimotor representations.

Ph.D. Researcher Aug. 2018 – Aug. 2024
University of Michigan, Ann Arbor — Advisor: Joshua Welch

- Conceived and led development of **3D-MorphNet**, a diffusion transformer conditioned on gene expression to predict 3D neuronal geometry, compartment types, and radii.
- Outperformed NeuroTS and MorphVAE on **20 of 22 neuron morphometrics** and achieved **27–29% lower Chamfer distance** on held-out neurons; further demonstrated generation of cortical-depth-dependent morphologies and completion of partial neuron reconstructions.
- Developed **2D-MorphNet** to predict neuronal morphology from transcriptomics, achieving FID 15.8 versus 315.7 for a convolutional baseline on held-out Patch-seq data and demonstrating generalization across multiple brain regions.

Software Engineering Intern (Google Brain Genomics) May 2020 – Aug. 2020

- Investigated learned representations in DeepVariant, developing feature-visualization tools and comparing integrated gradients, Grad-CAM, and XRAI for genomic variant predictions.
- Independently evaluated attention mechanisms in DeepVariant, achieving variant-calling accuracy approaching the team's state-of-the-art pipeline without additional domain-specific model modifications.

Research Assistant Sep. 2015 – Jul. 2017

Stanford University — Labs of Stephen Quake and Utkan Demirci

- Optimized droplet digital PCR assays for noninvasive prenatal diagnosis of single-gene disorders; second author on a *Clinical Chemistry* publication.
- Modeled, fabricated, and validated a magnetic-levitation cell sorter for label-free isolation of circulating tumor cells and clusters from blood.

Undergraduate Researcher Aug. 2012 – Sep. 2014

University of California, Berkeley — Advisor: Luke P. Lee

- Developed microwell arrays and MATLAB analysis tools for paired single-cell transcript and protein measurements; demonstrated heterogeneous lung-cancer responses to drug treatment, contributing to a *Lab on a Chip* publication.

Selected Publications

- Leadholm, N., Clay, V., Knudstrup, S., **Hojae Lee**, Hawkins, J. (2026). **Thousand-Brains Systems: Sensorimotor Intelligence for Rapid, Robust Learning and Inference**. *Neural Computation*, 38(6), 845–896.
- **Hojae Lee** (2024). **Predicting Neuron Morphology from Single-Cell Gene Expression**. Ph.D. dissertation, University of Michigan.
- **Hojae Lee**, Welch, J. (2022). **MorphNet Predicts Cell Morphology from Single-Cell Gene Expression**. *bioRxiv*.
- **Hojae Lee**, Yu, H., Welch, J. (2019). **A beginner's guide to single-cell transcriptomics**. *The Biochemist*, 41(5), 34–38.
- Camunas-Soler, J., **Hojae Lee**, Hudgins, L., Hintz, S. R., Blumenfeld, Y. J., El-Sayed, Y. Y., Quake, S. R. (2018). **Noninvasive prenatal diagnosis of single-gene disorders by use of droplet digital PCR**. *Clinical Chemistry*, 64(2), 336–345.
- Park, S. M., Lee, J. Y., Hong, S., Lee, S. H., Dimov, I. K., **Hojae Lee**, Suh, S., Pan, Q., Li, K., Wu, A. M., Mumenthaler, S. M., Mallick, P., Lee, L. P. (2016). **Dual transcript and protein quantification in a massive single-cell array**. *Lab on a Chip*, 16(19), 3682–3688.

Technical Skills

- **Programming:** Python, Julia, MATLAB; NumPy, SciPy; Git, Linux
- **Machine Learning:** PyTorch; diffusion models, GANs, transformers, representation learning, computer vision
- **Research Tools:** Lightning, Hydra, Weights & Biases, Slurm
- **Technical Areas:** 3D geometry, point clouds, single-cell genomics

Teaching

- Graduate Student Instructor / Guest Lecturer, *Machine Learning for Computational Biology* (2021–2023): developed and taught material on GANs, diffusion models, and single-cell genomics.
- Graduate Student Instructor, *Tool Development for Bioinformatics* (2024): mentored students building Python packages and scientific software.
- Project Committee Chair, PACCAR Student Club (2023): developed five Jupyter-based tutorials on single-cell transcriptomics and imaging.