HOJAE LEE

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EDUCATION

University of Michigan, Ann Arbor August 2019 – May 2024 (expected)
Ph.D. Candidate, Electrical Engineering & Computer Science GPA: 3.68
National Science Foundation Graduate Research Fellow (NSF-GRFP)
Awarded NIH F31 Predoctoral Fellowship

University of Michigan, Ann Arbor August 2017 – June 2019
M.S., Electrical Engineering & Computer Science GPA: 3.68
Courses: Deep Learning, Computer Vision, Reinforcement Learning, Statistical Signal Processing, Machine Learning, Matrix Algebra, Probability and Random Processes

University of California, Berkeley August 2011 – June 2015
B.S., Bioengineering (Concentration: Microfluidics) GPA: 3.67

RESEARCH EXPERIENCE

Graduate Student Research Assistant (Advisor: Joshua Welch) August 2018 – Present
University of Michigan, Ann Arbor, Department of EECS

- Researching 3D neuron morphology generation conditioned on single-cell gene expression data using Diffusion-based generative models and PointNets.
- Created novel StyleGAN2-based model for generating morphological images of single-cells given gene expression.
- Developed novel methods for graph downsampling and upsampling to build deep graph autoencoder for unsupervised representation learning of single-cell gene expression data.

Software Engineering Intern, Google Brain Genomics Team May 2020 – August 2020

- Developed three interpretability tools for DeepVariant, a CNN for classifying variations in the human genome.
- Experimented and validated three different attention modules added to DeepVariant at various locations to extract spatial and channel importance of feature maps.
- Developed visualization tools to insepct intermediate representations from DeepVariant using PCA, tSNE, and UMAP, with features to select points from a confusion matrix and tooltip to highlight meta-data.
- Developed tools to visualize and compare saliency maps (integrated gradients, GradCAM, and XRAI) for a given DeepVariant input image and trained model.

Research Assistant (Advisor: Stephen R. Quake) Feb 2017 – July 2017
Stanford University, Department of Biomedical Engineering

- Extracted DNA and RNA from tissues and performed library preparation for next-generation sequencing experiments.
- Performed droplet digital PCR to quantify alleles from cell free-DNA from plasma.
- Published in Clinical Chemistry for detecting single gene disorders for noninvasive prenatal diagnostics.

Research Assistant (Advisor: Utkan Demirci) Sept 2015 – Dec 2016
Stanford University, Radiology Department & Canary Center for Early Cancer Detection

- Developed microfluidic-based cell sorter to separate circulating tumor cells (CTCs) from blood using magnetic levitation.

Research Associate, Zephyrus Biosciences Inc., *Berkeley, CA* Nov 2014 – Aug 2015

- Fabricated polyacrylamide-based Lab-on-a-Chip device for high-throughput, high-speed single cell Western Blotting applications.

Undergraduate Researcher (Advisor: Luke P. Lee) August 2012 – Sept 2014
University of California, Berkeley, Department of Bioengineering

- Fabricated high-density microwell device for single cell analysis of non-small cell lung cancer.
- Used fluorescent microscopy to collect images of cMET transcript and protein and wrote MATLAB code to analyze expression level.
- Published work in journal *Lab on a Chip* in 2016.

PUBLICATIONS *(scholar.google.com/citations?user=vkcYjZMAAAAJ&hl=en)*

1. **Hojae Lee**, Welch, J. (2022). *MorphNet Predicts Cell Morphology from Single-Cell Gene Expression.* BioRxiv. https://www.biorxiv.org/content/10.1101/2022.10.21.513201v1
2. **Hojae Lee**, Yu, H., Welch, J. (2019). *A beginner's guide to single-cell transcriptomics.* The Biochemist, 41(5), 3438. https://doi.org/10.1042/BIO04105034
3. 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), 336345. https://doi.org/10.1373/clinchem.2017.278101
4. 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), 36823688. https://doi.org/10.1039/c6lc00762g

POSTERS & PRESENTATIONS

1. **Hojae Lee**, Yu, H., Li, C., Welch, J.D. *Convolutional Neural Networks for Learning Representations of Cellular State.* Michigan Institute for Data Science (MIDAS) Symposium. University of Michigan, Ann Arbor, MI, USA, 2019.
2. **Hojae Lee**, Welch, J.D. *Convolutional Neural Networks for Learning Representations of Cellular State.* Engineering Research Symposium (ERS), University of Michigan, Ann Arbor, MI, USA, 2019.
3. Tocchio, A., Durmus N. D., **Hojae Lee**, Mani V., Demirci U. *Versatile method for spheroid assembly based on magnetic levitation.* TERMIS-AM, San Diego, CA, USA, 2016.
4. Coskun, B.*, Tocchio, A.*, Durmus, N. D., **Hojae Lee**, Choi, J., Mani, V., Demirci, U. *Method for Spheroid Assembly based on Magnetic Levitation.* Annual Canary Center Summer Internship Symposium, Stanford, CA, USA, June 2016.
5. Yang, J., Durmus, N. D., **Hojae Lee**, Ercal, BD., Zhang, H., Hoerner, C., Fan, A. C., Willmann, J. K., Davis, R. W., Steinmetz, L., Demirci, U. *Magnetic Levitation Cell Sorter for CTC/CTM Isolation from Cancer Patient Blood.* Stanford Bio-X IIP Symposium, Stanford, CA, USA, February 2016.
6. Yang, J., Durmus N. D., **Hojae Lee**, Ercal, BD., Ercal, O., Zhang, h., Hoerner, C., Fan, A. C., Wilmann, J. K., Davis, R. D., Steinmetz, L., Demirci, U. *Label-fee Magnetophoretic Isolation of Circulating Tumor Cells and Cluster from Blood.* Canary Early Detection Summit, Palo Alto, CA, USA, May 2016.
7. Cervantes, B., **Hojae Lee**, Park, R., Prathuri, R., Rich, T., Russ, Z., Eiben, C., Johnson, T., Dueber, J. *Genes to Jeans: An Eco-Friendly Approach to Indigo Dyeing.* Qualcomm Undergraduate Experience in Science & Technology (QUEST) Symposium, Berkeley, CA, USA, September 2013.
8. **Hojae Lee**, Cervantes, B., Prathuri, R., Rich, T. *Genes to Jeans: A Green Solution to Blue Denim.* World International Genetically Engineered Machine Competition, Boston, MA, USA November 2013.

PROJECTS

2nd Place, DCMB DEI Data Challenge Winter 2022

- Programmatically investigated whether the Gene Expression Omnibus (GEO) datasets are biased relative to the US population using DEI criteria such as sex, ethnicity, and ancestry.
- Code in available on Github at https://github.com/hojaeklee/dcmb_dei_challenge

Disentangling Biological Signal from Experimental Noise in Cellular Images Summer 2019

Kaggle Competition (Team Wolverine)

- Developed a convolutional neural network for supervised learning to predict different genetic perturbations (i.e. siRNA) from six-channel fluorescent images by using few-shot learning and correcting for large batch variation.
- Ranked Top 9% in Kaggle's Public Leaderboard.

Perturb-GAN: Predicting Genetic Perturbation Effects on Single-Cell Gene Expression Spring 2019

EECS 598: Deep Learning (Prof. Honglak Lee)

- Developed a conditional Wasserstein generative adversarial network (CW-GAN) to generate and predict single-cell RNA-seq data of cells affected by genetic perturbations caused by CRISPR-Cas9.

3D Reconstruction using RGBD Structure from Motion Fall 2018

EECS 504: Computer Vision (Prof. Jason Corso)

- Implemented structure from motion (SfM) to create 3D images with very low reconstruction error using SIFT features extracted from RGB images and inferred Depth side-information.
- Code is available on Github at `https://github.com/hojaeklee/SfM_3D_Reconstruction`.

AWARDS AND HONORS

- **NIH Predoctoral Fellowship (F31) Awardee** 2022
  Proposal title: "Linking single-neuron morphology and gene expression using deep learning"
- **Graduate Research Fellow**, National Science Foundation 2018
- **Undergraduate Research Fellow**, Qualcomm Undergraduate Scholarship 2013
- **Gold Medalist**, International Genetically Engineered Machine (iGEM) 2013

TEACHING EXPERIENCES & OUTREACH ACTIVITIES

Participant, Preparing Future Faculty (PFF) Program May – June 2022

- Accepted into nationally recognized program designed to help prepare doctoral candidates for academic job search and subsequent faculty positions.
- Seminar teaches participants on topics such as course design, classroom instruction, inclusive teaching, and will develop statement of teaching practice and course syllabus.

GSI, BIOINF 593/EECS 598-011 (Computational Biology in Machine Learning) Fall 2021

- Designed curriculum and wrote homework solutions for new course.
- Developed course content and guest lectured on generative deep models in single-cell genomics.

Teaching Fellow, Summer STEM Institute Summer 2021

- Taught and mentored ~300 high school students around the world with little to no experience in Python, data science, machine learning, statistics, and soft research skills (e.g. how to read and write scientific papers, analyze posters and presentations).
- Graded and provided written feedback to ~50 homework per week.
- Gave feedback to students on research track through lab meetings every weekend.

Executive Member, Girls Who Code (GWC) Summer 2020 - Winter 2021

- Designed curriculum and wrote Google Colab notebooks to teach Python to high school students.
- Facilitate and lecture on concepts in Python every Tuesday evening during the academic year.

Mentor, Lunch & Lab with Grad Program Fall 2019, Fall 2020

- Mentee: Pratham Dhanjal (Sophomore Undergraduate student in Computer Science Engineering)
- Advised undergraduate student on U-M Master's program, obtaining summer internships, and life as a graduate student.

Mentor, ECE Mentorship/BuddEE Program Fall 2019, Fall 2020

- Mentoring two incoming female EECS students on course selection, preparing for qualification exams, and sharing tips and resources for new students.

Introduction to Micro- and Nano-Fluidics: BioMEMS July 2014 – Sept 2014

Teaching Assistant

- Designed laboratory curriculum covering various stages of engineering design cycle of microfluidic devices.
- Prepared lectures and demonstrated lab techniques, e.g. AutoCAD for designing microfluidic devices, photo- and soft-lithography for device fabrication, and wet lab techniques for testing.