RAN LIU

Email: rliu361@gatech.edu ⋄ Webpage: https://ranliu98.github.io/
LinkedIn: https://www.linkedin.com/in/ranliu98gt/

RESEARCH INTERESTS

I am interested in developing generalizable and interpretable deep learning methods for sequential systems and computer vision. I am actively working and publishing on the following topics:

- Learning without explicit human annotation through self-supervision and generative modeling;
- Aligning large-scale pre-trained deep learning methods to out-of-distribution downstream tasks;
- Building interpretable architectures that can effectively learn on multi-modal and multi-task settings.

EDUCATION

Georgia Institute of Technology
  Ph.D. in Machine Learning (*with minor in Statistics*)   Aug 2019 - Present
  Advised by Professor Eva L. Dyer
Fudan University
  Bachelor of Science in Physics   Sep 2015 - Jun 2019
University of California, Berkeley
  Exchange Student   Jan 2017 - May 2017

INDUSTRY EXPERIENCE

Research Scientist Intern at Apple Inc.   Jan 2023 - Aug 2023
Apple AIML, advised by Dr. Ali Moin (collaborator: Dr. Hadi Pouransari)

- Led a research project investigating and developing efficient and effective transformer architectures with Fourier Neural Operators for learning on multi-modal time series and biosignals.

Machine Learning Research Intern at Cajal Neuroscience   May 2022 - Aug 2022
Preclinical Biology team, advised by Dr. Jennifer Whitesell

- Developed biological prior-guided contrastive representation learning models and class activation mapping (CAM) visualization methods for neuroimage analysis in order to assist in the development of effective drugs for treating neurodegenerative diseases (e.g. Alzheimer's disease, Parkinson's disease).

Research Scientist Intern at Facebook, Inc. (now Meta Platforms, Inc.)   May 2021 - Aug 2021
Physical modeling team, advised by Dr. Andrew Grier

- Designed a physics-assisted U-Net architecture to model the environmental change process guided by partial differential equations (e.g. Navier Stokes equations) in order to model, understand, and predict the physical parameters of sequential systems.

PUBLICATIONS

Preprints

C12 Chiraag Kaushik*, **Ran Liu**[*1], Chi-Heng Lin, Amrit Khera, Matthew Y Jin, Wenrui Ma, Vidya Muthukumar, Eva L Dyer., "Balanced Data, Imbalanced Spectra: Unveiling Class Disparities with Spectral Imbalance.", submitted to the International Conference on Machine Learning (**ICML**), 2024.

C11 Zihao Chen, Chi-Heng Lin, **Ran Liu**, Jingyun Xiao, Eva L Dyer., "Your contrastive learning problem is secretly an alignment problem.", submitted to the International Conference on Machine Learning (**ICML**), 2024.

---

[1] Contributed equally, ordered alphabetically.

C10 **<u>Ran Liu</u>**, Ellen L. Zippi, Hadi Pouransari, Chris Sandino, Jingping Nie, Hanlin Goh, Erdrin Azemi, Ali Moin., "Frequency-aware masked autoencoders for multimodal pretraining on biosignals.", submitted to the (**ICLR**) Time Series for Health Workshop, 2024.

Peer Reviewed Conference Proceedings

C9 Jingyun Xiao, **<u>Ran Liu</u>**, Eva L Dyer., "GAFormer: Enhancing timeseries transformers through adaptive group-aware embeddings.", International Conference on Learning Representations (**ICLR**), 2024.

C8 **<u>Ran Liu</u>**, Sahil Khose, Jingyun Xiao, Lakshmi Sathidevi, Keerthan Ramnath, and Eva L Dyer., "LatentDR: Improving model generalization through sample-aware latent degradation and restoration.", Winter Conference on Applications of Computer Vision (**WACV**), 2024.

C7 Mehdi Azabou, Venkataramana Ganesh, Shantanu Thakoor, Chi-Heng Lin, Lakshmi Sathidevi, **<u>Ran Liu</u>**, Michal Valko, Petar Velickovic, Eva L Dyer., "Half-Hop: A graph upsampling approach for slowing down message passing.", the International Conference on Machine Learning (**ICML**), 2023.

C6 **<u>Ran Liu</u>**, Mehdi Azabou, Max Dabagia, Jingyun Xiao, and Eva L Dyer., "Seeing the forest and the tree: Building representations of both individual and collective dynamics with transformers.", the Conference on Neural Information Processing Systems (**NeurIPS**), 2022.

C5 Jorge Quesada, Lakshmi Sathidevi, **<u>Ran Liu</u>**, Nauman Ahad, Joy M Jackson, Mehdi Azabou, Jingyun Xiao, Chris Liding, Carolina Urzay, William Gray-Roncal, Erik Christopher Johnson, Eva L Dyer., "MTNeuro: A Benchmark for Evaluating Representations of Brain Structure Across Multiple Levels of Abstraction.", the Conference on Neural Information Processing Systems (**NeurIPS** Datasets and Benchmarks Track), 2022.

C4 Joy M Jackson, **<u>Ran Liu</u>**, Eva L Dyer., "Building representations of different brain areas through hierarchical point cloud networks.", Medical Imaging with Deep Learning (**MIDL**), 2022.

C3 **<u>Ran Liu</u>**, Mehdi Azabou, Max Dabagia, Chi-Heng Lin, Mohammad Gheshlaghi Azar, Keith Hengen, Michal Valko, Eva L Dyer., "Drop, Swap, and Generate: A Self-Supervised Approach for Generating Neural Activity", the Conference on Neural Information Processing Systems (**NeurIPS**), **oral presentation (top 1%)**, 2021.

C2 Aishwarya Balwani, Joseph Miano, **<u>Ran Liu</u>**, Lindsey Kitchell, Judy A Prasad, Erik C Johnson, William Gray-Roncal, Eva L Dyer., "Multi-scale modeling of neural structure in X-ray imagery", the IEEE International Conference on Image Processing (**ICIP**), 2021.

C1 **<u>Ran Liu</u>**, Cem Subakan, Aishwarya H Balwani, Jennifer Whitesell, Julie Harris, Sanmi Koyejo, Eva L Dyer., "A generative modeling approach for interpreting population-level variability in brain structure", the International Conference on Medical Image Computing and Computer Assisted Intervention (**MICCAI**), 2020.

Workshops and Posters

W2 Mehdi Azabou, Max Dabagia, **<u>Ran Liu</u>**, Chi-Heng Lin, Keith B Hengen, Eva L Dyer., "Using self-supervision and augmentations to build insights into neural coding", **NeurIPS** 2021 Workshop: Self-Supervised Learning Theory and Practice, 2021.

W1 Mehdi Azabou, Mohammad Gheshlaghi Azar, **<u>Ran Liu</u>**, Chi-Heng Lin, Erik C Johnson, Kiran Bhaskaran-Nair, WashU-St Louis, Max Dabagia, Bernardo Avila-Pires, Lindsey Kitchell, Keith B Hengen, William Gray-Roncal, Michal Valko, Eva L Dyer., "Mine Your Own vieW: Self-supervised learning through across-sample prediction", **NeurIPS** 2021 Workshop: Self-Supervised Learning Theory and Practice, 2021.

Journal Articles

J3 Ce Huang, Benjamin T Zhou, Huiqin Zhang, Bingjia Yang, **<u>Ran Liu</u>**, Hanwen Wang, Yimin Wan, Ke Huang, Zhiming Liao, Enze Zhang, Shanshan Liu, Qingsong Deng, Yanhui Chen, Xiaodong Han, Jin Zou, Xi Lin, Zheng Han, Yihua Wang, Kam Tuen Law, Faxian Xiu., "Proximity-induced surface superconductivity in Dirac semimetal Cd_3As_2", **Nature Communications**, 2019.

J2 Cheng Zhang, Yi Zhang, Xiang Yuan, Shiheng Lu, Jinglei Zhang, Awadhesh Narayan, Yanwen Liu, Huiqin Zhang, Zhuoliang Ni, **<u>Ran Liu</u>**, Eun Sang Choi, Alexey Suslov, Stefano Sanvito, Li Pi, Hai-Zhou Lu, Andrew C Potter, Faxian Xiu., "Quantum Hall effect based on Weyl orbits in Cd_3As_2", **Nature**, 2019.

J1 Ce Huang, Awadhesh Narayan, Enze Zhang, Yanwen Liu, Xiao Yan, Jiaxiang Wang, Cheng Zhang, Weiyi Wang, Tong Zhou, Changjiang Yi, Shanshan Liu, Jiwei Ling, Huiqin Zhang, **<u>Ran Liu</u>**, Raman Sankar, Fangcheng Chou, Yihua Wang, Youguo Shi, Kam Tuen Law, Stefano Sanvito, Peng Zhou, Zheng Han, Faxian Xiu., "Inducing Strong Superconductivity in WTe_2 by Proximity Effect", **ACS nano**, 2018.

SELECTED RESEARCH EXPERIENCE

Research Assistant at Georgia Institute of Technology   Jan 2020 - Present
Neural Data Science Lab, advised by Dr. Eva L Dyer

- Developed a multi-stage transformer to disentangle and interpret the individual dynamics and collective dynamics of multi-channel time-series (EIT, accepted by NeurIPS 2022).
- Developed a self-supervised learning framework based on latent space augmentation to perform latent space disentanglement (SwapVAE, accepted by NeurIPS 2021 as oral presentation).
- Developed a self-supervised representation learning method based on nearest-neighbor search inside the latent space for both vision and neural datasets (MYOW, accepted by NeurIPS 2021 workshops).
- Proposed a multitask U-Net to perform both the fine-scale segmentation of brain's microstructure and the classification of brain areas (Double UNet, accepted by ICIP 2021).
- Developed a bidirectional approach to interpret low-dimensional latent representation of deep generative models from both receptive and projective field of nets (accepted by MICCAI 2020).

Research Assistant at Fudan University   Jul 2018 - Jun 2019
Zhang's Lab of Complex Systems, advised by Dr. Zhongzhi Zhang

- Analytically derived the Laplacian spectrums and calculated characteristic invariants for several special scale-free complex networks with identical degree sequence.
- Obtained the relationship between power-law degree distribution and consensus behavior on scale-free networks through studying the differences between fractal and non-fractal complex networks.

Research Assistant at Fudan University   Feb 2017 - Jun 2018
Nanomaterials and Device Lab, advised by Dr. Faxian Xiu

- Discovered a new type of quantum Hall effect in wedge-like Cd_3As_2 thin films (see Publications).
- Explored proximity-induced Fermi-arc superconductivity in Nb/Cd_3As_2 heterostructures and supercurrent in $Nb/Cd_3As_2/Nb$ Josephson junctions (see Publications).
- Fabricated $NbSe_2/WTe_2$ hybrid structures and investigated the proximity-induced superconductivity in topological Weyl materials (see Publications).

AWARDS AND RECOGNITIONS

Apple Research Program Sponsorship (received as co-PI)	2024
NSF CloudBank Sponsorship (received as co-PI)	2024
CSIP Outstanding Research Award	2023
EECS Rising Stars	2023
ICML Diversity and Inclusion Fellowship	2020
Cox Fellowship	2019
China National Scholarship — highest undergraduate scholarship nationally	2018
Chun-Tsung Scholar — honored by Chinese Undergraduate Research Endowment (CURE) awarded to less than 400 undergraduates nationally since its foundation	2018
Outstanding Leadership Awards — honored to 10 student activity organizers per year	2018
First Prize of Outstanding Students Scholarship from Fudan — awarded to top 5%	2016

PROFESSIONAL EXPERIENCES

Talks and Presentations

- "Interpretable and generalizable representation learning methods for neural data", speaker and panelist at Georgia Tech/Emory NeuroAI Summer Course, 2023.
- "Seeing the forest and the tree: Building representations of both individual and collective dynamics with transformers", presentation at the Conference on Neural Information Processing Systems (NeurIPS), 2022.
- "Towards interpretable representation learning methods for neural data", invited by the Computational Neuroscience Center (CNC) at the University of Washington, 2022.
- "Drop, swap, and generate: A self-supervised approach for generating neural activity", oral presentation at the Conference on Neural Information Processing Systems (NeurIPS), 2021.
- "A generative modeling approach for interpreting population-level variability in brain structure", oral presentation at the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), 2020.

Reviewing

Reviewer for ICLR 2024, NeurIPS 2023, ICML 2023, ICLR 2023, NeurIPS 2022, NeurIPS 2021, ICML 2021, ICLR 2021, NeurIPS 2020, ACL 2019

Teaching

- **Teaching Assistant**. "Introduction to Signal Processing", Georgia Institute of Technology, 2019.

Mentoring

- Amrit Khera, M.S. at Georgia Tech
- Wenrui Ma, M.S. at Georgia Tech
- Keerthan Ramnath, M.S. at Georgia Tech
- Sahil Khose, M.S. at Georgia Tech
- Jingyun Xiao, M.S. at Georgia Tech (now Ph.D. at Georgia Tech)
- Joy M Jackson, B.S. at University of Miami (now Ph.D. at Georgia Tech)